

TYING A COMPUTER TO A TAPE RECORDER

Norm Saunders (Mass.) wrote the following some time ago to help a member wanting to use tape:

"Perhaps I can help on the tying of a computer to a tape recorder. You have stated that you want to go between a computer and tape. You need to consider all the peripherals as well, before you start to tie the two together. As for card readers, I have had no use for them for the last 20 years since magnetic recorders became easily available.

"To give you an idea of what is involved, I'll tell you of my sequence of developments. This copy, incidentally, is printed from a 60-cent seven-inch reel of tape on a 15-year-old tape recorder by a Teletype SK33 or some such machine with speed of 3-3/4 inch/second on the tape. About five years ago I bought the Teletype new. The first priority seemed to be to make retrievable records. Hence I first built a modulator-demodulator (modem) to get to the tape recorder from the keyboard and from tape to printer. To get some editing facility, this was designed and built so that the keyboard could break into the print stream at any gap in the text and insert additional characters.

"The next need was found to be a motion-controlled recorder, so I built one. This lets me compress the rough and uneven entry of characters from the keyboard, or as played back from the real-time tape-recording, into substantially full-printer-speed capability. In my case this is especially necessary, since with only occasional use of the Teletype, some of the

bearings tend to freeze when the machine heats up after long operation, and if this happens when a copy is being printed from an analog recording and I'm not around, I've got a 25-dollar repair bill.

"The next step was the buffers to go from real-time Teletype format to a simple 8 bits at computer speeds, and back again. I chose to build a special-purpose buffer for each direction, since this, among other things, made Teletype control of the computer easier, and allowed continuous recording (with subsequent printout when desired) of any portion of the computer operation. You will realize that this is a godsend in debugging and/or recovery, at low cost, of an operation that went sour somewhere before it was completed. At present under development is 8-channel input and output, to allow sort and merge using the almost unlimited storage of tapes. Eight of the basic input/output units would use half as much TTL as my whole computer (less the CRT store and display part) does. Whereas my design for 8 channels at a time uses only a few packages more. The next step will be to go to tape recording at a one-kilobit-per-second rate, and after that to five kilobits per second or possibly more.

"A typical recording sequence starts with turning on the power. It is necessary to load the thread the tape. The next actions are: start moving, get up to speed, locate working location, read or write, decelerate, stop, reverse (speed and distance, etc., are considerations here too; often you must reverse to re-read, because an error check failed or you missed the desired location), iterate, and shut down when finished.

"There are many types of decisions required:

A. How much of the above sequence is going to be manual and how much computer-controlled?

B. Is the data to be recorded and read incrementally, with stop and start around each block (which may be as small as a single character or even a single bit) or are read and write to be switched in while running?

C. How is the data going to be entered? One or multiple tracks? By blocks? Of what size? (1, 8, 64, 512-bit block sizes have proven useful to me.) With character parity? With bit-place parity per block? These last two are sometimes called row and column parities. Or is Teletype or some other special format to be used? (When I go to 1 Kbit/sec, I'll probably go from TT to a self-clocking format.) In any case, representation for the printer or display should be in ASCII if at all possible.

D. What means of synchronization is to be used? For bits? For blocks? If synchronous idle, 1001 0110, or null is used for block synchronization, there may be trouble if this gets out into a public carrier's lines at some future extension of your system.

E. What means of error detection is to be used?

F. What means of error correction is to be used? The TT format is of some help with both of these, but if synchronization is lost in a solidly-packed TT recording, the printout is real garbage. Parity is mentioned above. Multiplicity of recordings is another approach; that is, many copies of data in proportion to its importance.

G. What mode of recording is to be used? Amplitude, amplitude modulation, frequency modulation, phase modulation, pulse width modulation, etc. Duplication, parity, self-clocking, permanent clock, come in here too.

H. What quality of recorder is

available? The 4LO Japanese recorder is in some ways my favorite (make that ten-dollar -- I'm not going to run this through the editing process but am going to keep the original and send you direct printouts from the tape so that you can see why I need the editing process). But it has many headaches, such as the lack of a capstan, and under-powered motor. The 100-dollar unit borrowed from the household is my mainstay. This is not really so cheap when your wife then goes out and buys a couple of her own. The three-motored solenoid-actuated deck was going to be my basic unit, but after getting optico-mechanical-electrical servos tied to it so as to get the one-millisecond starts and stops from high speed that I sought, I found that in overall operation these speeds, rather tremendous accelerations, were simply not needed and probably inadvisable since they stressed the tape to about a quarter of that which would begin to stretch it. When a data-processing system needs interface with only one man, the problems are quite different and some very simple and elegant solutions can be used. The wow, flutter and frequency response of the recorder to be used may dictate several of the choices mentioned. Speeds of 1-7/8, 3-3/4, 7-1/2, 15 inches per second and others are usable, but again, a choice is needed. A complete data-processing system for one man or one household could well use at least three speeds, but each speed would be used only on those units dedicated to it."

FREE COMPUTER

Mark James (Calif.) ran letters in two publications, asking for the donation of a computer, and this is what happened:

"Please excuse me for not writing

sooner; however, I had had very little luck in response to my letters in Computerworld and Datamation. Finally my long shot paid off. A company responded to my letter in Datamation by saying that they had some undisclosed computer equipment that they would be willing to give to me. What transpired was beyond my greatest expectations. The machine that was given to me is a 32K, third-generation, microprogrammable computer system with eight 556/800-bpi tape drives, a Selectric I/O unit, and a 100-cpm reader.

"The main memory consists of 32,768 locations in core, with a full cycle time of 2 microseconds, and access time of 800 nsec. The system is highly microprogrammable, with 1K X 36 bytes (used in 18-bit bytes) of microprogrammable core that cycles in one microsecond. After hauling the computer from Newport Beach, Calif. to Belmont, Calif. where I live, and moving the 1300 CPU, the tapes and control console to the lower level of our split-level home, with the help of several rather husky friends of mine, I was ready to start modifying the 208-volt, 3-phase power supply in the CPU. Very fortunately, once again I lucked out in that the power-supply design used a bank of three separate transformers to supply the main V_{CC} and V_{EE} voltages. Merely by rewiring the AC inputs of the transformers and adding an additional amount of filtering to the output of the power supply, I've been able to get V_{CC} and V_{EE}. Fortunately, all of the most critical voltages such as sense-amp supply and inhibit-driver supply came from single-phase supplies, and thus no additional filtering was necessary.

"The main frame uses approximately 6000 Fairchild CTL microcircuits, and is appropriately named an IC 6000. The system was manufactured

by Standard Computer Corp. The unique capability of this system is that it can emulate other computer systems by the use of a microprogramming language called Miniflow. I presently have IBM 7094 emulation software on cards which I can read into the micro-memory. However, I also have a rather persistent parity error in the memory, which has defied my best efforts to locate. I suspect a sense-amplifier problem; however, I haven't been able to locate it because I haven't been able to get my hands on a wideband oscilloscope. Hopefully, though, as soon as I can borrow this, I'll be able to scope out the problem. One drawback in having a system with this architecture is that the microprocessor handles all I/O channel functions, and thus I can't load diagnostics or even display a register on the control panel until the microprocessor is functioning. However, this machine is going to have virtually unlimited potential in graphics processing. I have also had some rather drastic environmental problems, considering the fact that the entire system dissipates 48,000 BTU of heat per hour, and consumes approximately 14 kilowatts of electrical energy. However, I've been able to operate the CPU, one tape-control unit and two tape drives from the electric-dryer outlet in the house."

THE TRADING POST & HELP WANTED

NCR CRAM Memory

Buster Killion (2773 N. Winrock, Altadena, Calif. 91001) writes:

"I've got an NCR CRAM (Card Random Access Memory), which is basically a drum memory with a vacuum drum with 338 different surfaces in the shape of magnetic cards. Each card is held on a rack and can be individually selected, dropped, held

to the drum and read/written like a drum memory. I've got the complete mechanical transport. I don't have read/write logic or timing logic but I do have full documentation from NCR, including all diagrams, parts lists, maintenance manuals. I'm asking \$300; pick it up at my house or trade for a dual-trace triggered-sweep scope (hopefully around 10 MHz)."

Buster would also like a Selectric I/O typewriter, will pay up to \$500. He has an RC-70, and would like to hear from ACS members who have data terminals such that programs and data could be traded via a Data-Phone type setup.

Core Electronics: Software Needed

Sal Zuccaro (2116 Athens Ave., Simi, Calif. 93065) writes, in part:

"For the local member who may have a 4K core stack, I have a number of sets of Ampex R.F.6 memory electronics boards (2). The sets are complete for 18 or 36 bits, expandable to 20 or 40 bits. Stack and diodes are all that's needed. Cycle time is 900 nsec, but may be used at slower timing. I think the sets are worth \$50 each, and any local who uses one can test his unit here on my equipment.

"Redcor Computer busted and I, the greatest scrounger of all time, just happened to be on hand and out of work. I have a complete data-processing center in operation and making money. I am presently on a tape operating system, and only time is needed for me to upgrade to DOS. From Ampex, I purchased ten mass memories of 5 million cores each. I plan to use these on DOS, using core instead of disc. I have all of the Redcor software. Locally there are about a dozen senior-level types who have Redcor systems in operation. We all share software and hardware

info. The result is that we have an unbelievable amount of software in use. We are looking for source listings of BASIC, COBOL, and NASAP. If anyone knows where we can get cards or mag-tape copies, please yell.

"The ins and outs of system software is quite an education for a hardware type like me. Fortunately we have a couple of professional programmer types in our group. They help over the bumps."

Core and Keyboard

Steve Wiebking (910 Pleasure Park, San Antonio, Texas 78227) writes:

"I have nine of the 4096-word x 40-bit core-memory units that Gary Forbes was selling about two years ago. One has a single burned-out inhibit line; the rest are probably usable on all bits, although I have not tried any of them. The stack is mounted on a plug-in unit with space for 19 PC cards. The whole unit is about 12x12x4 inches and has four 50-pin connectors on the back. I have enough PC cards for about 3 units. Cards will go to first buyers at \$80/stack, which is what I paid for them. I also have one of the Univac keypunch keyboards that I would like to sell for \$20; the case has a slight crack."

Trouble with 8223 ROMs?

Steve Wiebking also wrote: "I may be able to help Bob Harrington, who was having trouble programming the 8223 ROMs (Nov. 1972 issue). I was having what I think is probably the same trouble programming some of these at work, until I noticed that the program won't take unless there is a bypass capacitor across the 12.5v supply (put it close to the ROM) -- I was using about 20uF."

Empty Tape Reels?

Tom Crosley (14-3 King Arthur Ct., Northlake, Ill. 60164) asks if anyone knows where he can get about 6 7-inch-diameter empty tape reels, for $\frac{1}{2}$ -inch tape, standard large hub, for use on his transports.

Modem Circuit?

Jim Hart, Jr. (101 N. 8 St., Murray, Ky. 42071) asks: "Does anybody have a cheap and dirty acoustic modem circuit?"

(Jim has quit working for NASA as a physicist and is now going to medical school.)

Info on a Fabri-tek Core Memory?

Gene Witherup (RD 4, Bloomsburg, Pa. 17815) asks: "Would any reader have information about Fabri-tek core, model 3509 (Rev. C)? This is a 16K-byte core with pulse transformers and diode circuitry intact, and so far I haven't seen any circuits using pulse transformers in the address lines."

Working on Computer Music?

Ned Lagin (Box 269, Fairfax, Cal. 94930) writes: "Would like to hear from others working on computer music projects. We will need software help or collaboration perhaps." Ned plans to buy a Nova 2/10 or PDP-11/40, "depends on funds."

COMMUNITY-GROUP COMPUTER

Resource One (1380 Howard St., San Francisco, Calif. 94103) is a non-profit community group to which has been donated an XDS-940 time-sharing computer system. Projects in planning include using the computer for health care (accounting, billing and statistical reports for community clinics; developing information systems usable by clinics to improve and evaluate their services to health-care consumers),

community-group services (helping with mailing lists, accounting and other time-consuming clerical work; developing a network of shared resources, information and cooperation among many different groups), etc. A Resource One member writes: "We desire only sufficient commercial applications to support our total operation." They would no doubt welcome assistance from any local ACS members in keeping the 940 in shape and in other computer and electronic projects. (According to their flyer, One is a "community of 200 artists, craftsmen, technicians and ex-professionals, living, working and sharing their skills in a converted 5-story warehouse in the south-of-Market area.")

IN PRINT

Computer Terminal

An article by Don Lancaster, "TV Typewriter," in the Sept. 1973 Radio-Electronics (p 43-45, 50-52) describes a construction project for a computer terminal using a TV set for CRT display. Complete construction details are available in a 16-page booklet (which includes the original article) for \$2.00 from: TV Typewriter, Radio-Electronics, 45 East 17 St., New York, N.Y. 10003.

Parts are available from Southwest Technical Products: 5 PC boards for \$32.75, keyboard for \$18.75. A set of semiconductors will cost about \$50.

Radio-Electronics may be running an article in a couple of months on a simple computer to go with the TV terminal, which generates and stores 512 characters, arranged as 16 lines of 32 raster-scan dot-matrix characters each. Any keyboard will work with this terminal, providing it can generate 7 bits

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

For membership in the ACS, and a subscription of at least eight issues of Volume III of the Newsletter, send \$5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two months or so.

of TTL-compatible ASCII code, and had a keypressed output that is normally high and drops to ground when a key is pressed.

Conservative Design

Elmer Beachley (Penn.), commenting on the "Computer Technician's Handbook" by Brice Ward (June 1971 newsletter), says "I have found that many commercial schematics are more conservatively designed than is necessary for the amateur, who usually must sacrifice reliability for cost. In this respect, industry designs can be misleading."

Computer in a Cornfield

Page one of Computerworld for Oct. 3, 1973, has an article titled "In Hoosier Cornfield Rises... a Computer?!" and it starts: LIBERTY, Ind. — In the middle of a cornfield, outside this sleepy town of 2,000, sits an old concrete barn. Rented by two men for \$50/mo, the barn houses a \$2 million computer system they built for \$20,000 from surplus and scrounged hardware components and software so cheap "it might as well have been free."

The two men are Bill Eaton and Gary Forbes, both ACS members.

Eaton, while with the Air Force in Phoenix, Arizona, worked in an electronics surplus store that bought and sold computer parts dumped by the GE Salvage Operation. Forbes, an old friend, sent him \$800 to buy three tape drives, a controller, a typewriter and some circuit boards. Later Eaton bought a GE 645 Series line printer, the I/O control, and other components for \$800. Later came 32K (36-bit-word) of memory for \$800.

Out of the Air Force in 1970, Eaton bought a 645 CPU for \$350. A fully operational 12,000 line/min printer was \$750. A full set of cables for the 645 was 12 cents a pound, or \$200 in all.

Eaton and Forbes bought a Datanet CRT terminal for \$500 and 32K more words of memory for \$300. Forbes took a job in Phoenix to be close to the "store" and Eaton quit his job to spend full time on assembling a system. Using Eaton's wife's salary and Forbes' salary, they bought all the missing power supplies, 64K words more of core, and a 50M-byte GE DSU 204 disk subsystem. The complete programming for the 645 was found being sold for scrap paper and scrap tape.

Eaton and Forbes are looking for "a buyer, a backer, a proposal, anything in the form of money." They claim the system is totally compatible with another 645 or 635. The last quote from Eaton: "We don't care who buys it; we know if bought from GE the system would cost more than \$2 million. After six years it would be nice to get some money and stop living in a cornfield in Indiana."

Your Computer?

If you haven't written to the ACS about your computer, send details.

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WANG PATENTS

The July 1969 Newsletter carried an item about the basic patent on the ingenious logarithmic circuit used in the Wang calculators.

Cdr. Lyle Pellock, back from duty in Vietnam, has been researching Wang patents. He is now stationed in Washington, so "getting to the Patent Office is no problem." His first letter:

"Patent 3,402,285 of Sept. 17, 1968, "Calculating Apparatus," gives the basic theory of the Wang log generation system, replete with examples. Patent 3,428,950 of Feb. 18, 1969, "Programmable Calculating Apparatus," gives details on the Wang card reader. Patent 3,509,329 of April 28, 1970, "Calculator," is very detailed and includes many logic diagrams and logic flow diagrams. There are 47 sheets of drawings and 17 pages of text. While I have not checked it out completely, it would appear that there is more than enough detail to allow building a similar system. All in all, a very good buy for 50¢. [To get a copy of a patent, send the number and 50¢ to the Commissioner of Patents, Washington, D.C. 20231.] Patent 3,511,974 of May 12, 1970, "Automatically Controlled Calculating Apparatus," is a further expansion of 3,402,285 and discusses card programming. Patent 3,524,970 of Aug. 18, 1970, "Automatically Controlled Calculating Apparatus," is a continuation of 3,428,950. It gives details of interfacing more than one card reader. Patent 3,573,746, "Calculating System," also continues 3,428,950 and subjects as branching and looping. Patent 3,594,734 of July 20, 1971, "Programmable Calculator," gives logic-diagram de-

tails on a tape-reader-controlled calculator. Also, patent 3,474,437 of Oct. 21, 1969, "Scanned Display Device," and patent 3,449,555, "Parallel Binary to Binary Coded Decimal and Binary Coded Decimal to Binary Converter Utilizing Cascaded Logic Blocks," are informative. Patent 3,474,437 includes a schematic of the system along with component values."

Later: "The Patent Office has an excellent cross-referencing system (just like a library). All you need is one of the following: patent, inventor, application serial number (prior to patent issuance), or assignee. I am not sure if Wang is coming out with any new patents; however, the P.O. is tight-lipped on pending applications."

Letter 3: "Made another trip to the Patent Office and found the latest assigned to Wang. In my experience (limited though it is), it is kinda rare to get so detailed a patent (3,727,201, April 10, 1973, "Information Storage System"); i.e., complete with core part numbers, current levels, access time, et al. Another recent Wang patent discusses an automated braided ROM wiring machine which I'm sure matches 3,727,201. The wire size suggested in the automated loom was 28-32 AWG.

"Also enclosed is the foreward page from a March 1973 NAVELEX (Naval Electronic Systems Command) publication. Volume I (of the Digital Computer Systems Handbook) would not be too useful to ACSers. Vol. II uses the Fabri-Tek Bi-Tran Six Educational Computer [described in the Aug. 1966 Newsletter] as the functional description vehicle, and covers the 6-bit, 30-instruction machine in great detail (func-

tional logic). I feel Vol. II would make a worthwhile addition to a technical library. I have noted the Gov't Printing Office stock number (0859-0010) and the price (\$3.25).

"My latest job involves daily contact with all facets of ship-board naval electronic equipments, including, for example, NTDS, AN/UYK-7, AN/UYK-13, AN/UYK-15, etc. I am evaluating available information on Navy-used computers to see which way I want to go. The one problem with these computers is that, except for what is called the mini-UYK (AN/UYK-15), the machines are big. I am still looking at the Wang method, and may settle for a relatively simple programmable pseudo-calculator."

Letter 4: "I made another trip to the Patent Office and can bring you up to date on Wang. 3,760,171, "Programmable Calculators Having Display Means and Multiple Memories." This Sept. '73 patent addresses the Model 700 calculator and discusses the internal programming. Additionally mentions 3,727,201 (see previous letter) as covering the ROM of the calculator composed of 2048 43-bit words. 3,754,631, "Positioning Typewriter." This Aug. '73 patent discloses the Wang modifications to a Selectric to allow its use, primarily as an output device for graph plotting, etc. 3,470,542, "Modular Systems Design." Busing techniques, probably used in their old Model 4000 series. However, the details would have further applications. 3,567,911, "Sensor for Punched Cards," Details on the Wang card reader, whose basic concept is that of a non-moving card with multiple contacts for reading.

Non-Wang Patents

I have also found some interesting non-Wang patents. 3,781,820, "Portable Electronic Calculator." This

Dec. '73 patent assigned to H-P uses a recirculating shift register concept for store/recall. Very detailed, down to the logic-element level, but only for addition, store, recall, enter, and sign change. A good start for a simple desk calculator. 3,676,656, "Electronic Digital Slide Rule." This is a very interesting device, assigned to G. E. [see the Feb. 1970 Newsletter, p 6], uses a pulse-rate generator and decimal rate multiplier to generate multiplication, division, squaring, square root, addition, subtraction, exponential, logarithm, sine and cosine. The idea is a replacement for your slipstick, with inputs and answers to 4 significant figures. The patent is very detailed, down to the logic-device level, complete with recommended devices such as 7490, 9307, and B-4021 Nixie tubes. Might just build one and throw away my K&E. 3,766,370, "Elementary Floating Point CORDIC Function Processor and Shifter." This Oct. '73 patent, assigned to H-P, has got to be the best 50% bargain around: 233 pages of diagrams, complete with logic-device identification (including pin assignment), parts values, etc. This embodiment of the CORDIC technique (see the article by Volder in the Sept. 1959 IRE Trans. on Electronic Computers, pp 330-334) is designed to interface with the H-P Model 2115/2116 minicomputer and thereby generate up to triple precision on 20 functions. 3,778,775, "Microprogrammed Terminal." This Dec. '73 patent, assigned to Computek, discusses a microprogrammed, alphanumeric, single-bus computer display terminal.

"Enough on patents. I have just about completed the implementation into TTL of Wang's 3,509,329 but am hung up on a ROM problem. Need three 256 X 4-bit-word ROMs from 8223's by cascading to reduce parts count. A real problem that has so far consumed untold hours

(and all to save a few bucks — I guess it's the challenge that this pastime is all about). The other option is to use 353 2-input ANDs and some ORs. Well, I'm still working on the problem. These ROMs are used to calculate \ln , $\frac{1}{x} \ln$ (for square root) and $2 \ln$ (for x^2), in accordance with the basic WANG method. I have also replaced the core memory described with 7489 RAMs, which is one heck of a lot cheaper (there I go again trying to save bucks) and simpler. I have been through a couple of iterations of the design (more than one to correct mistakes) but don't believe I have minimized parts count yet. For example, I decided to standardize on NAND logic, i.e., the 7400, but an OR application would be a lot easier (and cheaper?) with a 7402 and I do have a lot of OR/NOR needs."

THE NEWEST PDP-8

The latest DEC minicomputer in the PDP-8 line is the PDP-8/A, \$895 each, or \$537 in quantities of 1000. The 8/A has ROM, RAM and p/ROM memory options, a 1.5-usec cycle time, and is hardware and software compatible with the earlier 8/E, 8/M and 8/F models.

COMPUTER KIT

A modular computer kit has been offered since late last year by SCELBI Computer Consulting (125 Edgefield Ave., Milford, Conn. 06460).

The PC cards can be bought separately, or in combinations. The SCELBI-8H starter set of five cards — CPU, DBB (data bus buffer) and output, input, front-panel card, and RAM card (256 8-bit words) — is \$440. One step up is the 8H standard card set, with 1024 words of RAM memory; \$565. The standard computer consists of

the standard card set plus card chassis (with console switches, card sockets, I/O and power connectors), separate power supply; \$795 in kit form, \$950 assembled. The 8H deluxe computer has 4086 words of RAM memory, and a higher-rated power supply; \$1400 in kit, \$1600 assembled. The memory can be expanded to 16K words, for about \$2760 more.

Peripherals include oscilloscope alphanumeric interface (requires a scope with a bandwidth of 5 MHz or more), \$200 kit; audio cassette tape unit interface, \$100 kit; and an ASCII keyboard (reconditioned, less case), with interface, \$100. The bit-serial interface for a 33 Teletype is \$50 without relay for tape reader, \$75 with relay.

The SCELBI-8H is a "fully programmable machine having a basic instruction set of 48 instructions, with variations of these ... allowing approximately 170 different instructions."

The machine has one full accumulator and six additional temporary registers. The CPU program counter is on a seven-level pushdown stack allowing subroutine nesting to seven levels. All eight output and six input ports are fully TTL compatible. The SCELBI-8H is 10 inches wide, 9.5 high, 12 deep.

Instructions require 3 to 11 "states" and a typical instruction requires about 5 states (20 microseconds) to execute.

SCELBI has a "wide range of programs and software support for the 8H and SCELBI-developed peripheral interfaces." Programs now available include program loaders, memory dumps, and CRT display programs. Editor and assembler programs and a "sophisticated calculator package" are being developed. The programs cost about \$5 to \$20; a listing of the calculator program

(with 2K of core) is \$50; the object coding is \$20. A program is available for assembling 8H programs on a PDP-8.

SCELEBI stands for Scientific, Electronic and Biological.

MORE ON THE PDP-8/A; THE MPS

The \$875 unit price for the DEC 8/A includes 1000 words of MSI memory. There are optional increments of 2K and 4K in RAM; 1K, 2K and 4K in ROM; and 1K and 2K in p/ROM. Prices for these have not yet been established. Maximum memory for the 8/A is 32K words.

Computers have become cheaper than a few K of memory. The 8/E, for instance, is now \$4490 with its initial 4K; an additional 4K costs \$2500. It will be interesting to see what prices DEC puts on 8/A memory.

Also new at DEC is the MPS micro-processor series, an 8-bit MOS/LSI processor for the low end of the controls market. Based on the Intel 8008 chip, the MPS has 48 data-oriented instructions, RAM memory with increments of 1K words, up to 4K words, PROM with maximum storage up to 4K words. Price is less than \$750 each, with 1K RAM. Applications include intelligent terminals, process control, and dedicated controllers on industrial machinery.

THE TRADING POST & HELP WANTED

Core Memory, Sense Amps

Ron Carlson (7333 West 90 St., Los Angeles, Calif. 90045) has a 4K X 14-bit core stack with driver transformers and resistors, mounted in a 19-inch card cage ready for timing, sense and driver cards; \$75 or trade. Also, 28 SN7529N dual sense amps by TI, cost \$1.59

each, will sell at \$1.00 each.

Ron also has "a note on my Intel 8008 computer. Proceeding slowly but sure hope to be running soon. Currently debugging the solid-state console; uses only touch switches and LEDs. If anyone is interested, will give them my circuit for it. Works quite nicely."

TV Typewriter as TTY Substitute?

Dick Snyder (621 Old Colony Terrace, Tiverton, R.I. 02878) asks "Do you know of anyone who has modified one of the Radio-Electronics TV typewriters to use with a computer as a Teletype substitute?"

Memory Chips

William Mitchell (39 Rockfield Cres., Ottawa, Ont. K2E 5L6, Canada) writes: "After a year of negotiation, I am finally able to offer "production drop-out" memory chips to ACS members. Both 2102 RAM and 1702 PROM units are available. The 2102 is a 1024-word by 1-bit MOS static RAM; single +5V supply, directly TTL compatible, fully decoded, 16-lead DIP. Typical access time is 500 nsec, but this may be one of the reasons for rejection.

"The 1702 is a 256-word by 8-bit programmable ROM, requiring +5 and -9V. Typical cycle time is 1.0 usec; TTL compatible.

"The price for the units is \$11.00 per pair for the 2102's and \$11.00 each for the 1702's, postpaid, and including Federal Sales Tax.

"Because the 1702's are rather difficult to program without the proper equipment, I am prepared to perform this operation for an additional \$2.50 per unit provided that the required bit pattern is supplied on punched cards, coded in hexadecimal, 2 columns per word and 32 words per card, it will require only 8 cards. Use columns 73-

80 for a serial number so they will be in the right order, and double-check your coding as I can only provide what is asked for. An acceptable alternate layout for the card is to separate each pair of digits by a space for better checking, and using col. 1 to 72 as required.

"If I get a chance I will try to run some tests on the units before shipping, but the samples provided to date have been operable as represented. I'm busy designing my own computer around them, as you might imagine."

Later: "I have confirmed that the units meet all spec. tests except for cycle time: the 2102's operate between 1 and 3 usec, while the 1702's are between 1 and 2 usec."

Selling, Buying

Michael Guerre (204 Faxon St., Spring Valley, Calif. 92077) has these for sale: "one Clary 703 programmer without keyboard; this is an 8-level paper-tape punch operating at 20 cps; removable diode matrix board; \$30. One Geotech 24888/14R magnetic tape head, 14-track, 1-inch, used, about 2/3 life left, \$5. One FL Flexowriter, missing part of tape reader, needs some work done; \$55. Buyer pays postage, or picks up.

"I am looking for: keyboard (non-mechanical); printer, alphanumeric, any type; incremental cassette tape drive; technical manuals (schematics, operation, etc.) for any of these computers: IME 86 SR, Unicom CP-8, Applied Systems 1100 and Home-Ec VII, Autonetics RECOMP (CP-266), H-P 2114 and 9100 A or B."

Who Has a Kenbak-1?

Tom Crosley (14-3 King Arthur Ct., Northlake, Ill. 60164) writes: "My computer is basically a Kenbak-1 [see the Nov. 1971 Newsletter], to

which I have been making additions. Right now I am working on the memory addition; then will come the CRT, second TTY, and mag tape. Even with only the original 256 words of memory, I have enjoyed writing programs for the Kenbak-1, such as a line-by-line text editor for the TTY; games (e.g., Nim); and a Turing machine simulator. After adding the 2K of memory, allowing much larger programs, I still don't feel the slow cycle time will be a drawback; since most of my applications will be TTY-oriented, most of my programs will still be I/O-bound.

"I would be interested in corresponding with anyone else who has a Kenbak-1 and has made or is thinking of making additions to it."

NRI Computer Kit Manual

Robert W. Kelley (5806 Mt Terminal Dr., Waco, Texas 76710) writes that the NRI 832 computer reference manual 10KX once available from National Radio Institute (see the Sept. 1972 issue) is no longer available; he would like to buy or buy a copy. Note: NRI has dropped plans to sell a wired 832 separate from the course.

Wants IEEE and ACM Publications

Al Marshall (412 Oakwood, Angola, Ind. 46703) would like to obtain: IEEE Systems, Man, and Cybernetics Vol 1, #3; IEEE Trans on Computers Vol 20, #4 & #8; ACM Comm Vol 15, #1 thru #6; ACM J, Vol 16 #4, Vol 17 #3 & #4. Al adds: "For others who may be missing issues, I found some extras and I have some I'm not going to keep. Drop me a line if you have a hole in your collection."

IBM 705 for Sale

Willis H. Hard writes: "Although I have never seen your publication, I have been informed by some of my

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

For membership in the ACS, and a subscription of at least eight issues of Vol. III of the Newsletter, send \$5 (or a check) to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

associates that, despite its rather small circulation, it does reach many dedicated amateurs.

"I have just decommissioned my IBM 705 computer and put it in storage pending its sale. Since it is a first-generation computer, it is unlikely to be sold to a commercial user because of its cost of operation and maintenance. Therefore, I would like to offer it to a more receptive group of potential buyers through your journal.

"The system consists of a 705 CPU with a 40K-byte core (7 bits per byte), a console (including typewriter), 745 power supply, and a card reader. It also contains a 754 tape-control unit and eight 727 tape decks (I just sold 2 of the original 10 to an amateur who is going to convert them to solid state). The system is for sale as an entity or by the piece, and my address is: P.O. Box 1132, Canoga Park, Calif. 91304."

IN PRINT

Modem Circuits

In response to Jim Hart's request for "cheap and dirty acoustic modem circuits" in the previous issue, several members sent him info.

Mark Messinger (New York) sent copies of several articles: "Low-speed modems are easy to design" (Electronic Design, Sept. 2, 1971, pp 50-52); "Design pruning trims costs of data model" (Electronics, July 20, 1970, pp 99-101); "Build your own acoustic coupler" (Electronic Design, Mar. 1, 1969, pp 68-73).

Jim Knock writes from Illinois, in part: "Another possibly useful piece of information is the product description available from Exar Integrated Systems, 750 Palomar Ave., Sunnyvale, Calif. 94086, on the XR-210 FSK modulator/demodulator. I believe there are companies selling modem kits for something in the range of \$50. Ads can be found in occasional issues of EDN, Electronic Design, Computer Design, and Electronics. There are a lot of different considerations: frequencies, switchable speeds, number of bits per character, character representations of special characters, etc. One should also be aware of the fact that the typical ham RTTY setup is distinctly different from what is generally used in the field surrounding digital computer communications.

INTEL 8080 CHIP

Intel's new NMOS 8080 microprocessor is an improvement on the PMOS 8008, with a 2-usec instruction cycle and 74 basic instructions (26 more than the 8008). The 8080 can address up to 65K bytes of memory without an external address register. It can perform double-precision arithmetic, in BCD and binary, and costs \$360 for 1 to 24. For a TTL I/O interface, the 8080 requires six ICs; the 8008 needed 20. The 8080 comes in a 40-pin package and operates from +12 and +5-volt supplies. There are assemblers, editors, and simulators.

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MARK-8 MINICOMPUTER KIT

The July 1974 Radio-Electronics has a short article (pp 29-33) on a minicomputer kit. As with the TV Typewriter (see the Dec. 1973 Newsletter, page 5), a 52-page booklet containing the full details is available, for \$5.50 (plus 7% tax for New York State residents) from Radio-Electronics, Micro-Computer, P.O. Box 1307, Radio City Station, New York, N.Y. 10019.

The Mark-8 is built around the Intel 8008 microprocessor and uses 7400-series TTL ICs, plus the 1101 (or 1101A or 1101A1) type 256-bit RAM as memory. Register readout is by four groups of eight LEDs.

A set of six PC boards costs \$47.50 for the CPU, address latch, input multiplexer, 1K memory, LED register display, and output ports. The 8008 from Intel is \$120, but can be had for \$50 or so elsewhere. No cabinet is available. The 1101 is available in quantity for about \$1.80 each. Since the 1101 RAMs are volatile memories, "information stored in them will be altered or lost if the power is shut off. If you want to save a program, leave the power on."

The six boards use a total of 74 ICs in the minimum 256-word version; for every additional 1K of memory, add 32 of the 1101 RAMs.

The Mark-8 can be used with the TV typewriter or with the ASCII Keyboard, the latter described on page 5 of this Newsletter.

According to the Mark-8's designer, ACS member Jonathan Titus (see the May 1973 Newsletter, page 6), a

minimum Mark-8, with 256 8-bit words, is about \$300. The Mark-8 circuits provide a basic capacity for up to 4 memory boards, for a maximum of 4K words; however, by adding external addressing decoders, up to 16K words can be addressed directly.

The Mark-8 is programmed in Intel assembly language, which has 48 instructions for the 8008. There is an Intel user's group; membership is obtained either by contributing software or by paying \$100 a year.

Add-ons are planned for later, and include a modem, cassette-storage interface, and a calculator interface.

COMPUTER BUILDERS ABROAD

The ACS Newsletter has been the inspiration for two foreign ones. Mike Lord ran a letter in a British electronics hobby magazine asking if anyone was interested in joining a computer club. I sent him copies of this newsletter. In March 1973 the Amateur Computer Club Newsletter appeared, with a first issue looking very much like its American cousin. However, by Vol 1 Iss 3, it had established its own identity, and included a cartoon, flowchart, some "analogue computer" circuits, a page on the game of Life, part of a tutorial on cores, etc. The ACC Newsletter (7 Dordells, Basingstoke, Essex, England) appears every 2 to 3 months; Vol 1 is 50p.

Michel Dreyfus, an ACS member, is president of the AFACO, founded this spring in France (42, rue de la Barre, 95880 Enghien-les-Bains).

AFACO is the Association Française des Amateurs Constructeurs d'Ordinateurs. The newsletter is entirely in French; the first issue describes plans to establish contacts between those who want to and those who have built a computer, publish basic articles for beginners, publish technical articles on subjects such as memory, peripherals, and computing circuits, publish the characteristics of new ICs, try to get ICs from manufacturers at low cost or free, etc. There is a brief note on memory, stating that this is the most difficult part of a computer to get working; a few words about a Universal Computer being built with a read-only storage, to use PL/1; circuit for a 5-volt power supply; 3 pages describing the "Machine Originale Numerique et Logique," a paper microcomputer. No subscription price is given for the AFACO newsletter, which the founders intend to issue every two months. The AFACO is rather optimistic, declaring that "Building a computer is relatively simple; simpler, perhaps, than building an electronic organ."

SYSTEM ONE COMPUTER KIT

The System One computer kit, mentioned in the Feb. 1973 Newsletter (page 4) is no longer available. The company marketing it, EPD (Environmental Products, Glenwood Springs, Colo. 81601), has gone out of business. Rights to publish the User Technical Notes (see the Sept. 1972 Newsletter, page 6) were bought by Technical Publications Corp., Box 954, same town; plans are to publish them more often.

TPC plans to bring out a System Two computer kit, with solid-state memory, half the number of ICs, and at about the same price.

Jim Gaudreault of Maryland writes that he bought the plans for a Sys-

tem One, and says: "The System One is a nice simple machine for an amateur to try in ICs. A word of caution: the Boolean logic equations for the Programmed Logic Array that are given in the documentation have several errors. A machine wired according to the plans would never work. Even after the errors had been corrected, the resulting machine would lack several of the features (including four instructions and any type of programmed I/O) advertised for the System One. The designers obviously ran out of room in their PLA to implement all that they had hoped for. All of this is on top of great inefficiencies in the implementation of the PLA logic. Also, the diagram of the memory timing board was omitted."

ADDING TO THE KENBAK-1

Tom Crosley writes from Illinois: "To the basic Kenbak-1, so far have added interrupt system plus real-time clock (1 second interrupt); am just completing a full duplex TTY controller (at first I used serial I/O for the TTY); am adding a paging register to select one of (initially) 16 128-word pages (only in effect for addresses 204-376; the lower addresses — and all registers in memory — will be available independent of the page register). Am making use of the "don't care" bits of the NOP instruction to add 15 I/O instructions which will be single word (data set up in registers)." Tom will be using a TV Typewriter as a CRT terminal, and two mag-tape transports.

THE TRADING POST & HELP WANTED

GRAM, Transports, Core, Etc.

Buster Killion (2773 N. Winrock, Altadena, Calif. 91001) writes: "(1) Since I've acquired other

equipment, I no longer need my CRAM [see the Dec. 1973 Newsletter, page 3] and I am asking only \$100 so I can get the storage space back. (2) Scientific Data Systems (Xerox) dual cartridge drive (two cartridge drives in one 19-inch rack mtg) minus plug-in cards but with some documentation, \$100. (3) NCR thermal printer, 80 characters per line, 8½-inch wide paper (TTL state of the art), \$250. (4) Marconi "IBM card" reader, about 400 cpm, \$75. (5) Ampex TM-4 transport deck, ½-inch 7-track, sans head and vacuum assembly, \$50.

Also I have brand-new Ampex 850-nsec core stacks, 18-bit x 4K words, \$35 each. And I purchased the IBM 727's from the other amateur that Willis Hard mentioned in the last Newsletter and would like some help, if anybody has any diagrams for head R/W electronics I can build for these machines. Also I have some Century Data floppy-disc drives model 127 sans head & electronics for \$75 each."

Core Search & Patents

Stephen E. Flocke (1407 Croyden Rd., Lyndhurst, Ohio 44124) writes:

"I'm in the process of building a 16-bit microprogrammed machine with a small core memory. My only major problem is finding some ferrite cores for a transformer-type read-only memory. The type I'm looking for have about a ¼-by-¼-inch cross-section core and about a one-square-inch opening. They were used in some rope memories made at MIT in the 1960's.

"I have been looking thru patents for computers; the Cleveland Public Library has a very complete file. One thick one, 3,400,371, has the IBM 360/30 complete with microprogram and internal logic diagrams. The Interdata Model 2, complete with microprogram listing is 3,675,

214. For historical buffs, the ENIAC is patent 3,120,606, and the Univac 1 had patent 3,784,983 issued Jan. 8, 1974 — 22 years after it was filed."

8008 for \$50

Steve Wiebking writes from Texas that there was an ad in 1973 offering the 8008 for \$50, by Bill Godbout Electronics, Box 2673, Oakland Airport, Calif. 94614.

Equipment Source

Gary Coleman writes from Ohio: "I have finished wiring up my CPU for my little machine. Big deal, 15 chips. I have found that ham conventions are great sources of cheap equipment. I bought an IBM I/O type-writer at one for \$50 in perfect condition."

Disc Controller Designs?

Owen Phairis (1908 12th St. Apt 1, Santa Monica, Calif. 90405) says: "I am working on a 16-bit machine and I have a Memorex 630A disc drive for it as well as two IBM 727 mag-tape units. Estimate one year before completion. Would be very interested in designs for a disc controller."

ACS Data Net?

Jim Hart (101 N. 8 St, Murray, Ky. 42071) writes: "I have often been frustrated by the need to ask the ACS membership about small things such as the availability of parts or information about a particular circuit, while realizing at the same time that these matters are of too little consequence to be carried in the Newsletter. In light of this, I would like to hear from ACS members who would be interested in designing a rather loosely organized data net to function as a readily accessible "bulletin board" for ACS members. The equipment could be

fairly simple: a 100-wpm modem and a mag-tape transport on a dedicated telephone number. Ideally, such a facility would be accessible to someone with a bare minimum of equipment, and would be intelligent to take care of itself most of the time.

"The cost of construction and maintenance of such an installation, given a little ingenuity in the design, could be made quite small and could be borne in several ways, including a subscription fee or, better, a small fee for posting "for sale" notices.

"It should be emphasized that such a facility would in no way diminish the importance of the Newsletter. Instead, it should augment it by serving as a medium for communicating items of limited interest and notices of short-lived interest which the time-frame of the Newsletter publication makes it impractical to carry.

"For the present, at least, I don't have the time or the resources to act as prime mover in such a project, but I would enthusiastically give what help and support I could to any person or group that cared to undertake, or at least to study, a project of this sort. I feel it would be of benefit to all of us."

Interdata 7/16

Dave Vednor (14914 D Newport Ave., Tustin, Calif. 92680) writes: "I have purchased five Interdata 7/16 CPU's at work. If any members are interested, I have sets of schematics for the CPU, memory, and many of the interfaces, and most of the software (BOSS, DOS, RTOS, assemblers, Basic, Fortran IV, etc.). If any members are contemplating the purchase of a 7/16 or have done so, they should contact me regarding hardware multiply/divide and memory parity options, as I

can supply these for less. A copy of the Want 720 service manual can also be obtained from me."

Disk Heads?

Don Tarbell (144 Miraleste Dr., Miraleste, Calif 90732) writes: "I just got my disk operating system going good, and it really helps out in program development. I also have a simple version of BASIC going, and a modem has been added to the system. I was wondering if anyone knows where I could get a set of 2311 or 2314-type disk heads. I would like to experiment with that kind of drive, as it would allow me more storage capacity.

"In response to Dick Snyder's question, I have a direct memory channel operating on my computer for the disk drive. I will soon be adapting it to an IBM 727 tape drive, which a friend of mine has converted to solid-state. The channel operates thus: index register 3 is first loaded (by the program) with the block starting address; X5 is then loaded with the block length; an instruction (block transfer) is then given to write; the disk interface counts the number of 1's, module 256, and attaches this 8-bit byte on the end of the block; for a read, the same registers are loaded, and the read-block command is given; after the data is transferred into core, the last byte (check) is automatically put into the upper half of the 16-bit accumulator; the 1's counter, which also counts during a read, is then read into the lower half of the AC, and the two halves compared for the check. A separate CHECK-BLOCK instruction is used for checking the block integrity after a write without altering core. It works the same as the READ-BLOCK, except core is not tampered with. The main drawback to this system is that concurrent I/O is not possible, as with a

cycle-steal type of DMA. This is because the program counter is "frozen" at the instruction location until the transfer is complete. However, this is no problem in my system, because my disk data transfer speed is close to the cycle time of my computer. As far as the error-detection scheme goes, I realize it is not fool-proof, but has worked quite satisfactorily for me. If anyone is interested in more detail, or has ideas, please feel free to write to me."

IN PRINT

TTL Cookbook

This is the title of the latest book by a new ACS member, Don Lancaster. Very little material is repeated from Don's previous book, the "RTL Cookbook."

After a chapter on the basics is an 84-page chapter on circuits, with a page each on 77 TTL ICs, mostly 7400 and 74100 types. The next five chapters are on: logic; gate and timer circuits; clocked logic; divide-by-N counters; and shift registers, noise generators and rate multipliers. The last chapter, "Getting It All Together," describes such TTL applications as a frequency counter, digital voltmeter, digital tachometer, TV Typewriter, etc., many of which are available in kit form from SWTP, which also has kits for TTL and RTL breadboard labs.

There are various circuits of interest to ACS members, such as Baudot-to-ASCII, keyboard encoder, keyboard debouncer, readout drivers, ASCII-to-TTY-code, etc.

The "TTL Cookbook" is \$8.95 from Sams, but Don writes that "Southwest has agreed to offer the text at discount for ACS members. The

price is \$7.95 from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas 78216."

Misnamed Book

The "Handbook of Computer Maintenance & Troubleshooting" (Reston, 336 pages, \$18.00) should really be titled "Some Information on Maintaining & Troubleshooting Digital Circuits in Military Systems." The first 100 pages are general, and could go into almost any book on electronic maintenance. The machines involved in later chapters are not computers, but mainly the digital circuits in radar and other military systems. There are computer-oriented chapters, but on printers, programming, and military test equipment. The 39-page chapter on troubleshooting is of some value, going into Boolean algebra, logic analysis, patterns and waveforms, signal-tracing, and oscilloscopes.

Microcomputer Chips

"Current Microcomputer Architecture" by Holt and Lemas of Compata, in Computer Design (Feb. 1974, pp 65-73) discusses the recently introduced microcomputers. There is a chart of the operational characteristics of seven of them (AMI 7300 and CK114, Fairchild PPS-24, Intel 8080, National IMP-16, Rockwell PPS, Signetics PIP), the block diagrams of the 7300, CK114, and 8080, a discussion of the circuitry of all seven, and a 35-item bibliography.

HARDWARE

ASCII Keyboard and Encoder

An article with this title, by Don Lancaster, appeared in the April 1974 Popular Electronics (pp 27-31). A complete kit of parts is \$39.50 from Southwest Technical Products, and includes two MC789AP hex

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Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

inverter ICs, 20 1N914 diodes, 49 keyswitches and keytops, etc. The user must supply the +5 volts. The keyboard is assembled on a single double-sided PC board. Details are included for using a Monsanto MDA-111 or MAN-2 as a single-character readout. The text notes that "the keyboard can be used as a computer timesharing terminal, either in commercial service or for home or school. The keyboard, with a simple parallel-to-series converter, forms half an ASR-33 Teletype at a very reasonable cost."

IC Digital Logic Memory Probe

An article with this name (Popular Electronics, Mar. 1974, pp 33-35) describes a penlite-size probe for checking 5-volt logic devices. The indicators are three LEDs; the ICs are a 9601 used as a triggerable multivibrator, and a 7404. Pulse-stretching keeps the center LED on for 200 ms, for pulses as short as 50 nsec, giving enough time to observe them. The top LED lights for logic 1, the bottom LED for logic 0. A switch allows the center LED to remain on permanently after a pulse. A kit of all parts is \$17.50.

Teletype Model 40

A year ago, Teletype introduced a new terminal, the Model 40, \$2500

to \$3500 with keyboard and CRT display, \$1000 more for a high-speed printer. The printer rate is five lines per second, with both upper and lower case. With its logic and memory circuits, the 40 permits editing text on the screen; when a word, line or letter is erased, the space is closed up automatically. And the 40 will store up to three 24-line pages of text without external storage, as well as formatted data.

Add \$2K of logic and memory, and the 40 becomes a stand-alone mini-computer, although Teletype won't be going that route, leaving it to others.

Across the Counter

A variety of equipment is sold by Data Instrumentation Associates (208 S. Pulaski St., Baltimore, Md. 21223). They have test equipment (scopes, counters, generators), power supplies, ICs, and digital equipment (LGP-30, \$250). "A number of items are so costly to pack that we offer them only on a pick-up basis, including magnetic-tape units. Open to the public Saturdays, 9:30 to 5:00."

1964 Digital Computer Kit

Back in the sixties there was a company called the Tesla Research Foundation, with offices in Salt Lake City, Utah, and Phoenix, Ariz. The manager was John Sehlmeier. Tesla offered a variety of analog and digital computer kits, plans for digital gadgets, and home-study courses. The DI-TR5 digital computer cost \$365 in kit form, \$440 assembled. The DI-TR5 used germanium-transistor NAND logic and diode ORs, had 15 instructions, and two registers. Input/output was with switches and lamps. Does anybody know what ever happened to Tesla and/or Sehlmeier, last heard from in 1964?

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COMPUTER KITSAltair 8800 Computer Kit

The Jan. and Feb. 1975 issues of Popular Electronics will have a descriptive article on the Altair 8800 computer kit from MITS, based on the Intel 8080 chip, an 8-bit-word/16-bit-address machine with 78 instructions.

The Jan. issue will cover the \$397 computer kit, which includes the 8080, 50 ICs, PC boards, a case (19 x 19 x 8), switches, 36 LEDs, and 1K of memory. The case is 3/4 empty, but there are 17 connectors on an I/O bus, for adding memory (65K words max) or I/O boards. The cost without case, switches or power supply is \$298; assembled and tested, \$498. MITS will send free the etching and drilling guides, component-placing diagrams, and misc. info., for a self-addressed 8 1/2 x 11 envelope with 40¢ postage on it.

The Feb. PE issue will be about programming the 8800. Later in the year will be the PE "smart terminal," with built-in CRT, 32-characters, 16 lines, 4 pages, modem, and keyboard, for about \$300 in kit form. There are plans to publish articles about a hard-copy device, a floppy-disk memory, and the Cyclops CCD solid-state TV camera that can be connected to the 8800.

The complete cost of an Altair 8800 with 65K memory and the CRT terminal is said to be under \$1500. MITS is at 6328 Linn N.E., Albuquerque, New Mexico 87108.

More on the Mark-8 Computer Kit

The Dec. 1974 Radio-Electronics has letters about the Mark-8 com-

puter kit (June 1974 Newsletter), with answers by the designer, including corrections and explanations, and also a letter about how to obtain certain parts. There is also an article on "computer modifications," on how to increase the input capability up to 8 input ports and how to use an additional 16 output commands to generate pulses for control.

SCELBE Computer Kit Prices

The prices of the SCELBE-8H modular computer kits (Mar. 1974 Newsletter) have been reduced, due to "some improvements in our manufacturing efficiency."

The standard computer kit is now \$695; assembled, \$750. The deluxe kit is now \$1249; assembled \$1295. The cost of expanding the memory to 16K words, which was about \$2760 more, is now \$2465 more.

The CRT interface and audio-cassette interface were available in kits; now, assembled and tested, they are each \$25 more. The cassette-interface system is said to be "remarkably reliable" with cassette recorders costing \$50 to \$75, which do not have to be modified.

The SCELBE-8H User's Manual (\$5.00) assumes no knowledge of computers, starts with 26 pages on basics, followed by chapters on the instruction set, operating information, and on connecting peripherals.

SCELBE now also sells "unpopulated" sets of cards, without the ICs: the five cards alone for \$135; same with the master clock circuit installed, \$149; and so on up to the set with clock, 8008 IC, eight 1101 RAMs installed, plus chassis kit, for \$429.

As for software, 24 programs are now available, either in object code or as "source mnemonic listings," for editors, memory dumps, paper-tape loaders, mag tape read, mag tape write, etc.

There is now a SCELBI "Computer Digest and User's Bulletin," published quarterly, \$7 a year for 8H owners, \$12 for others.

TERMINAL KITS

MITs Comter 256 Kit

"First Computer Terminal You Build From A Kit" (Radio-Electronics, Nov. 1974) is a description of the MITs Comter 256 kit, which is \$495 complete, or \$395 without cabinet or power supply, or \$695 assembled. The terminal has a built-in acoustic coupler, auto-transmit, cursor control, tape-recorder I/O jack, 32-character Burroughs display, standard ASCII-encoded keyboard, and an internal memory of 256 characters per page, with up to four pages of memory.

SWTP CT-1024 Kit

The SWTP CT-1024 terminal system displays up to 16 lines of 32 characters each, with a two-page memory capacity, and can be used with any TV set for display. Input may be any source of parallel ASCII code. The kit without cabinet or power supply is \$175, power supply is \$15.50, keyboard kit is \$39.95, etc. SWTP is Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216.

HOME/SCHOOL COMPUTER

"A Practical, Low-Cost Home/School Microprocessor System," by Joe Weisbecker of RCA Labs, in the Aug. 1974 IEEE Computer (pp 20-31) describes a low-cost (under \$500)

system called FRED (Flexible Recreational and Educational Device), based on the RCA COSMAC microprocessor.

FRED is designed to be used in schools for educational games, simulation exercises, etc., and in the home for games, calculator, controllable TV puppet, low-fidelity music synthesis, shooting gallery, puzzles, etc. Some of these functions have already been developed. Over 30 programs are running on prototypes.

Program loading is via an audio cassette player, which also gives the computer its voice, music, and sound effects. After loading, FRED is operated with a 16-button keyboard. FRED is attached to the antenna terminals of any TV set, for output display, using a dot pattern to form letters, numbers, or simple pictures. The basic FRED consists of the COSMAC microprocessor, 1024 bytes of RAM, keyboard, cassette player, and a TV set.

The article mentions "adding a \$25 punched card reader and \$10 manual punch" and "adding a module for recording the contents of memory on cassettes turns the FRED system into a user-programmable computer for serious hobbyists. Other possible attachments include light guns, extra memory (RAM), pre-stored programs or tables (ROM), and output relays for control uses."

Reached by phone, the author said that further details are not available, as they are proprietary. He hopes that RCA may some day make chips for FRED available, although there are no such plans now.

DEC HOME COMPUTER

According to rumor, Digital Equipment Corp. is planning to market, in a year or two, a "Home Computer"

with 16K of memory, CRT, full keyboard, two floppy disks, and hard copy, for under \$5,000. It will probably be based on either the PDP-8 or PDP-11; right now, both the 8 and 11 groups at DEC are lobbying for their designs to be used in the new machine, so there are two prototypes. It is said the system will cost DEC about \$2200 to manufacture.

ONE WAY TO BUILD YOUR OWN

According to Computerworld, an 18-year-old programmer at DEC stole parts of a minicomputer and put the system together at the place of business of his father, who thought the parts were salvaged. Police estimate the equipment could be worth up to \$75,000.

DEC PDP-8/A

Prices for the PDP-8/A, described in the previous Newsletter, have been established. The 8/A with 1K of semiconductor RAM is \$1745; with 2K, \$2100; with 4K, \$2600. For more than 4K of mainframe memory, the memory extension board must be used; that board, which also includes power fail/auto-restart, time-share control and a 128-instruction bootstrap loader, is \$500. Memory can be expanded up to 32K, using various combinations of 2.3-μsec RAM in 1K (\$480), 2K (\$835), 4K (\$1335); 1.5-μsec ROM in 1K (\$480), 2K (760), 4K (\$1300); and 3.4-μsec PROM in 1K (\$995). The boards are available separately; for instance, the CPU and 1K of RAM are \$895, for the two boards. The I/O option board is \$500, and the programmer's console another \$400. So an 8/A with 4K of RAM is \$3500; 8K RAM, \$5335.

IN PRINT

The Origins of Digital Computers

This is the title of a book of selected historical papers (most of them printed from the originals) edited by Brian Randell, who provides much connecting text (pub. Springer-Verlag of Berlin, and in New York at 175 Fifth Ave., 464 pages, 120 figures, \$23.90). The 32 papers include a dozen that are unfamiliar to most of us on this side of the Atlantic, such as two by Torres y Quevedo, on automatics and on an electromechanical calculating machine, and two by Couffignal on calculating machines. Two by Zuse are a little better known here. There is an 1889 paper by Hollerith on a tabulating system, a 1946 one by Aiken and Hoppper on The Automatic Sequence Controlled Calculator, several on relay computers, a 1946 paper by the Goldstines on ENIAC, a von Neumann EDVAC report, and the last two are on EDSAC. There is an excellent, annotated 42-page bibliography.

Rather expensive, but most of these papers would be difficult to locate today, so this is a fine Christmas present for the computer-history aficionado (or aficionada).

Microprocessor Roundup Article

"Focus on Microprocessors" is a 17½-page article in Electronic Design (Sept. 1, 1974, pp 52-69) that includes a table listing 19 microprocessors, 11 of which are available off the shelf or as samples, 6 have been announced, one rumored (Intel 4014), and one custom-made (Burroughs Mini-D).

Of particular interest is the announced Intersil ISD-8, "designed to be a CMOS/LSI equivalent of DEC's popular PDP-8 minicomputer" and which "benefits from the sizable software support that exists for the PDP-8.... However, the unit's repertoire of eight basic

memory-reference instructions tends to limit the range of applications.... Intersil plans to develop a full set of circuitry and memory, all using CMOS, to operate with the processor. Conceivably, the end result could be a pocket-sized, portable PDP-8."

Microcomputer Software

"Microcomputer software makes its debut" (IEEE Spectrum, Oct. 1974, pp 78-84; reprint \$1.50) is a fine tutorial on microsoftware, with a chart of what 10 companies (from Control Logic to Toshiba) have currently available, in self-assemblers, editors, loaders, debuggers, simulators, and other programs. Intel has many of these, but many are available only to development system users. National Semiconductor has many; some come with the prototyping system.

Intel has set up a microcomputer user's program library, with membership costing \$100, but free to those who submit a program. National is planning a similar library.

Interfacing a TTY with an IC μ P

"Interfacing a teletypewriter with an IC microprocessor" (Electronics, July 25, 1974, p 96) says that "the lengthy software service routine generally required" for an interface to such as the Intel 8008 "can be eliminated.... A shift register and some control logic are all that it takes, bringing total component cost to only about \$6.50."

16-bit μ P on a Single Chip

"Single monolithic chip holds 16-bit microprocessor" (Electronic Design, Dec. 6, 1974, p 105-6) is a new-product item about the National Semiconductor processing and control element (PACE) that "offers all the basic features of the company's multichip model. Though not

as fast nor as flexible as the older version, PACE provides the convenience and cost savings of single-DIP packaging. And it can be used for either 8 or 16-bit data processing." Tentative prices are under \$400 in single quantities, below \$100 in very high volume. "Excluding memory, only six ICs are needed when PACE is used, compared with 20 to 25 for the IMP-16. When special circuits become available, PACE and just 10 other ICs will constitute a microcomputer with 1K words (each 16 bits) of ROM and 256 words (also 16 bits each) of read/write memory."

Microcomputer Digest

This new monthly started in July 1974, has 12 to 16 or more pages, is \$60 a year, published at 2368-C Walsh Ave., Santa Clara, Calif. 95050. The third issue has a page on Japan's first microcomputer (Toshiba TLCS-12), technology items about SOS, TI's I²L μ C, etc; microcomputer-based products; memories and peripherals; literature, meetings and people.

Creative Computing

This is a new, non-profit magazine of educational and recreational computing, published 6 times a year, \$15 a year to institutions, \$8 for individuals, \$6 for students, from P.O. Box 789-M, Morristown, New Jersey 07960.

THE TRADING POST & HELP WANTED

Amateur Computer-BUILDER Workshop

Jeffrey Viola (846 Spring Valley Rd., Maywood, N.J. 07607) writes: "I am very interested in an idea to start an amateur computer-builder workshop in my area. The ACS Newsletter fulfills its purpose, but for people like me with relatively little experience in

computer building, we need something more. I think a workshop-type thing would be invaluable. Anyone who is interested, please contact me. I would like to, for transportation considerations, limit the New York City - north-eastern New Jersey area to any effort as such."

Terminal Help Wanted

Derrell V. Foster (Dept. of Computer Science, Duke U., Durham, NC 27706) writes: "I am currently trying to design an interactive-type computer terminal which satisfies these criteria: (1) it works and is sufficiently flexible (baud rates, keyboard characters, etc.), (2) it minimizes my time for construction, and (3) it minimizes my cost for construction. If you have any ideas for this type of project (say used terminals, kits, PC boards), please let me know."

To Sell & Want List

Write to Michael Guerre (204 Faxon St., Spring Valley, Calif. 92077) for a full list of his offerings (including a display terminal, Nixie tubes, B-Tran 6 manuals, Nova operating manual, two books) and wants (information on the HOME-EC VII minicomputer, the Intersil "PDP-8" microprocessor; a 32-character Burroughs Self-Scan panel, 8-digit LEDs etc).

4-Bit ALU

Gary Coleman (3227 N. Vernon St., Arlington, Va. 22207) writes: "To support my habit I'm selling 74S-181's, the Schottky version of the 4-bit ALU, for the amazing price of \$2.50. I also have a boxful of Signetic Utilogic TTL ICs which make good bus receivers; DEC uses scads of them in the PDP-11; the price on these is negotiable."

Card Racks?

Tom Mintner (P.O. Box 2598, Iowa City, Iowa. 52240) asks: "Does anyone have, or know where to get, card racks and/or smaller backplane assemblies with cards?"

"I have built several modular devices for sound processing which have digital control. These are such items as envelope generators, sequencers (really an analog memory device), gating and panning controls, etc. These are hybrids with the facility for digital specification of their operating parameters. These will then be coupled to a large (by electronic music standards) SC memory system."

Tape-Transport Controller Boards

Gary Coleman also has some CES tape-transport controller boards, "in case some members have the CES tape transports sold by Meshna, and by MNH-Applied Electronics."

Demo Computer?

Colin S.L. Keay (U of Newcastle, New South Wales 2308, Australia): "I am responsible for an undergraduate course in Electronics and Instrumentation in which I am endeavouring to give the students some insight into the working structure of small computers. I would like to build one or two small demonstration computers (wherein the cost of the processor circuitry would run to no more than \$200 or \$300 at the most), and I believe that members of your Society have developed systems which would fall within this cost range. ... The PDP-11 (of which we have 4 on campus) is a honey of a machine, and if I could find a small-scale demonstration computer kit with some of its features, I would be very pleased."

RAM and ROM Chips

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

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send \$5 to:

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

The ACS Newsletter will appear every two or three months.

William Mitchell (39 Rockfield Cres., Ottawa, Ont. K2E 5L6, Canada) writes: "Just a note to confirm that I still have 2102 RAM and 1702 ROM memory chips, as mentioned in the March 1974 Newsletter. The 1702's, however, are now production rejects due to single bits being unprogrammable. Each is marked with the location of the "stuck" bit, so I will select a suitable one if you send along a copy of the pattern you are going to use. Otherwise they meet all specs, including speed. The price is still \$11 per pair of 2102's or per 1702 (payable in Canadian dollars, please)."

Identify ICs?

Jeffrey Viola (address p 4) has a prototype CPU with 436 ICs, some of which he can't identify. Anybody recognize these?: ceramic chips labeled M134, marked Op Code and Addr; S8889, S8883, RM944, SN5580, SN74948.

Help Offered

John Youngquist (899 Niagara Blvd., Fort Erie, Ontario, Canada) is one of the newest members, and writes: "I have considerable hardware and design and would be glad to help anyone needing it with designs or with Intel 8008 or PDP-8 related

projects."

More Terminal Help Wanted

G. Depré (V. Beauduinstr. 91, B3300 Tienen, Belgium) writes: "I am developing a Video-Terminal (CRT Display), connected to a local Computer, but also including a CPU and ALU for using it as an independent calculator with possibility of vector-display. I would welcome any information at all on this kind of terminal, even at a charge."

Commercially Available

MNH—Applied Electronics (P.O. Box 1208, Landover, Md. 20785) has a 1900-baud modem for \$45, power supply (+5, +12, -12) at \$45, 7400 series TTL rejects at \$15 for 1000, computer key switches, LEDs, etc.

A MEMBER'S COMPUTER

Bob Robbins of Ohio has completed 90% of his 8-bit, 8K-word machine, using DDL Utilogic, TTL, and MOS/LSI. Memory is Datacraft core. It "uses same instruction set as Intel 8008; 5 tape drives, one of which is IBM 9-track compatible; all registers and memory locations are accessible from maintenance panel." Input/output is with TTY, modem, tape drives, plus keyboard, CRT display, and tape reader. "The basic processor is complete with the exception of interrupts, and all I/O devices are interfaced and working with the exception of two of the non-compatible tape drives."

HAVE A SCHELBE OR MARK-8 OR ALTAIR?

If anybody has a SCHELBE-8H or a Mark-8 Radio-Electronics computer, or will be getting an Altair 8800, please write the ACS about your opinions of the machine, pro & con. Copyright 1974 by Stephen B. Gray

MORE ABOUT COMPUTER KITS

Altair 8800

Popular Electronic's Altair 8800 computer kit from MITS, described in the previous Newsletter, gets a whole page in the Dec. 1974 Computer Decisions, where it is said to be "comparable to (and in many respects better than) the Nova II mini from Data General, from a hardware viewpoint." Although the basic cycle time of 2 microseconds is slower than the 1 μ sec of the Nova II, Ed Roberts of MITS notes that "it is still possible for the PE 8800 to outperform the Nova.... It a particular problem requires decimal arithmetic and a lot of I/O capability, then the MITS mini has the advantage because the 8080 contains a decimal converter that makes it easy to perform arithmetic on BCD numbers.... If the problem is a cpu-related problem that requires speed, the Nova may be significantly faster."

The 8800 can directly address up to 65K words of memory. The memory is expandable in blocks of 256, 1K or 4K 8-bit words, at about \$200 for each 4K of words.

MITS is working on a disc operating system for the floppy-disk memory; the controller will cost about as much to build as the computer; the drive will be \$600 to \$700.

According to Roberts, "a stand-alone unit that will consist of a processor, terminal and several disc drivers will be available for about \$3,000. That would be comparable to a system that now lists for 15 to 20 thousand dollars."

That's a processor with 16K memory. (The previous Newsletter's assumption of \$1500 for a 65K machine

with CRT was from an overly optimistic PE editor.)

From the Top

Ed Roberts says (by phone) that MITS generates all the software for the Altair 8800, because programs from Intel are expensive: the 8080 assembler is \$1500 to an individual; to MITS, it would be \$5000 for the licensing fee, plus \$25 per unit.

About 700 of the Altair 8800 units were shipped in February. The industrial percentage of the mix is going up. The production 8800 is different from the PE model, uses 100-pin plugs, not ribbon cable.

The disk controller will be about \$450. Software will be featured in the next Altair catalog. There is a resident assembler, which requires 8K memory and some sort of I/O device. The assembler is free with a system that will support it. BASIC (extended version) is coming along, could be used with 8K, although very little memory would be left for programming. FORTRAN is also in preparation, available sometime after May.

Nathaniel Wadsworth of SCELBI says there will be a SCELBI book on machine language this Spring. A third of the SCELBI computer kits are sold to schools, a third to businesses, a third to hobbyists.

Comments on Computer Kits

These comments have been received:

"The Altair 8800 was hastily thrown together. Very little thought has been given to interfacing it with the outside world. The availability of peripherals is a lot of hot air.

Some Altair owners are finding it extremely difficult to interface to. It uses 256x4 memories, great stuff, but impossible to add on to the original system; you have to buy another memory board. For amateur use, they should use memory that amateurs can go out and buy; they use ROMs that are not easily available."

"It's ridiculous to make a higher-level language for such a machine. Why duplicate the effort already made, as on the PDP-8 and others?"

"The 8800 is a better machine than the SCALBI, a much more powerful chip (8080 versus 8008); however, the Altair has a poor interconnection design, seems to be soldered-on ribbon cable."

"I don't think much of the 8008, it's slow and not very good. As for the Mark-8, it has problems, such as the difficulty of adding more than 1K of memory, the I/O problem, and it's also a mechanical nightmare."

"There's a rumor—repeat, a rumor—that the price dip of the Altair 8800 is due to the chip not having the full temperature range; in other words, it's a temperature fallout."

Microcomputer Newsletter

The Micro-8 Newsletter is published by the Micro-8 Computer User Group (Cabrillo Computer Center, 4350 Constellation Road, Lompoc, Calif. 93436). It was originally the Mark-8 user group, but widened its scope to include all microcomputer systems. A subscription is \$6 for six issues.

The Micro-8 Newsletter mentions The Digital Group (Box 6528, Denver, Colo. 80206), which has been working on modifications to the Mark-8 micro. Dr. Robert Suding

has developed pluggable boards, octal readout, large power supply, keyboard data entry, and an FSK cassette interface.

The Micro-8 Newsletter writes of the Altair 8800: "More and more people keep wondering about the Altair 8800 and how they can make the kit prices so low. A lot of people have gambled on it. (Several thousand back orders, according to one report.) I suspect that it's a loss leader, to try to lock people into buying their add-ons. At least one rumor is floating around about them using factory-fallout 8080's.... With the kind of backlog they are supposed to have, you may have to wait many months for delivery and then you will still be stuck with the problems of memory and peripherals... If the future articles on peripherals in Popular Electronics are glorified advertisements as the last two have been, then what?.... Even the information pack didn't contain any real construction information."

JOHN FREDERICK'S MICRO

John Frederick (306 West 100, #81, New York, N.Y. 10025) writes: "After much backing and filling, I've gotten on the microprocessor bandwagon for my computer project. I'm using an Intel 8008 from Bill Godbout and 2102 memory. The design is a mixture of the SIM8-01 one-board system sold by Intel, the Radio-Electronics Mark-8 and the PDP-11 Unibus. The 8008 has memory address bits for 16K bytes but I/O addressing for only 8 input and 24 output devices. Adapting the Unibus idea, the I/O devices are connected to the memory bus and referenced by addresses whose high-order 4 bits are all ones. Bits 0 and 1 address four 8-bit device-control, status and data registers associated with each device, and the middle 8 bits

allow 256 devices to be addressed. Doing it this way adds to the parts count, but should make life easier later.

"My first objective is a flexible controller for all my peripherals, which include (at this point) a Tally 420 tape punch, a Tally 424 tape reader, acoustic coupler and the first Radio-Electronics TV typewriter. If I can use this to emulate the PDP-8, the PDP-11 and an ASR33-compatible CRT terminal, I can utilize software which already exists.

"I have some advice for ACS members who are concentrating on sophisticated architectures and homemade instruction sets. It is that writing good software is very difficult and time-consuming. You'll get more computing done with a slow, simple machine for which free software exists.

"There's a boom right now in the use of microprocessors as dedicated peripheral-device controllers. Those of you who have surplus I/O devices but no controllers or convenient interface to the rest of your system might look at this approach. I'd be happy to correspond with anyone who wants to try it. I'm trying to set up a flexible prototyping lab for this sort of thing."

THE TRADING POST

Buster Killion (2773 Winrock Ave., Altadena, Calif. 91001) has a core FIFO buffer designed to buffer tape drives, \$50; two IBM 727 drives with all manuals, \$150 each, \$250 both; Century Data floppy-disk drives, \$250 each; 4K word x 18-bit Ampex core stacks, \$35 each; card cages with connectors, \$15 each; plus documentation on several computers, and wire, cable and Amphe-nol connectors. Write for details.

Tape Decks

John Marshall (Box 242, Renton, Wash. 98055) has several extra Wangco tape decks, model 7's, both 7 and 9-channel, brand new. Write for detailed specs or make offer.

Digitizer

Mark Messinger (85 East End Ave., New York, N.Y. 10028) has a Summagraphics digitizer with an 11"x11" tablet and binary display; cost \$2150, is a few months old, Mark would like \$1300. He can also supply the wiring list and diagrams for a PDP-11 interface using a DEC M1710 module.

Core Stack

Steve Marum (Westwood Manor Apt. 136-J, Howe, Texas 75059) says he now has enough MOS RAMs for his main memory, will sell his core stack, 16K by 24 bits, Fabri-Tek, \$300 or best offer; he'll "even throw in 34 TI 7528 core sense amps extra."

"If you know of anyone using a TI 980 who might want to trade programs, let me know. At a surplus sale I got an old one, which appears to be the granddaddy of TI's present 980 and looks to be program compatible."

COMMERCIAL HARDWARE

M & R Enterprises (Box 1011, Sunnyvale, Calif. 94088) has an 8008 with application manual, \$60; 8008 with all the resistors, caps and 15 7400's for the Mark-8, \$75; plus 1101A RAMs starting at \$5 each, 2102 RAMs starting at \$10, and the 1702A PROM starting at \$40 each. Send for a price list.

Al Sardo (2032 S.W. Expressway, San Jose, Calif. 95126) sells the 1101A RAM for \$2, 2102 at \$7, 1702A

for \$13, 8008 for \$40, 8008-1 for \$60, 2516 64x6x8 character generator for \$3; \$5 to program the 1702A with listing included.

WALK IN AND COMPUTE

The public library in White Plains, New York, has what may be the first walk-in-and-compute installation in the country. Since the beginning of 1975, a Wang 2200 hard-wired BASIC computer has been available at 25¢ for five minutes. Input is magnetic-tape cassette. There is a library of tapes for games, math, statistics, etc. Anyone who wants to write his own programs and save them has to buy a data cassette.

Because there is no off-line preparation of programs, as with an ASR33, a lot of machine time (at a nickel a minute) can be used up in preparing input.

IN PRINT

Designing Microprocessors With Standard-Logic Devices

This is the title of a two-part article by Robert Jaeger of Signetics (Electronics, Jan. 23, 1975, pp 90-95; Feb. 6, pp 102-107). The author notes that although MOS microprocessors are growing in popularity because of the few ICs required, there are drawbacks such as being slower and less flexible than random-logic TTL systems. "But there is a third design route available to meet certain system requirements: the small, applications-oriented processor built with standard high-speed logic devices, either ECL 10K or Schottky. ... Although they require more ICs than MOS microprocessors, they can replace random-logic TTL designs that need five to 10 times as many devices."

Part 1 outlines the requirements for the three basic processor elements—the register/arithmetic/logic unit, the control memory, and the input/output circuitry. Part 2 discusses how proper selection of the microinstruction format can minimize control-memory size, and also covers memory branching and outlines some designs for standard-logic processors.

For Teaching or Learning Digital

E&L Instruments (61 First St., Derby, Conn. 06418) has a new LR Innovator series for teaching (or learning) digital electronics. The series includes preassembled modular hardware, called Outboards, which plug directly into the SK-10 solderless breadboarding socket, allowing for quick set-up and interconnection.

The Outboards are used as input and output to standard ICs (mainly 7400 series), and consist of logic switches, LED display, pulse input, clock, and power. The basic system is \$247.70. The two manuals, called Bugbooks I and II, are \$16.95; in their 750-plus pages they cover experiments with gates, truth tables, counters, decoders, multiplexers, sequencers, displays, Tri-State logic, flip-flops, one-shots, memories (RAM and ROM), registers, and arithmetic elements.

The preface gives credit for significant participation in the design and implementation of the Outboards to Jonathan Titus, designer of the Mark-8 microcomputer kit and an ACS member.

The Origins of Digital Computers

This book of historical papers, described in the previous Newsletter and printed by Springer-Verlag at \$23.90 in hardcover, is now available in a second printing for only \$14.80, also in hardcover.

A FOURTH MICROCOMPUTER KIT

Several microcomputer kits are being offered by companies that specialize in selling ICs at low prices. One of the better known is the MIL MOD 8, made in Canada by Space Circuits and sold here by Mini Micro Mart, 1618 James St., Syracuse, N.Y. 13203.

The MIL (Microsystems International, Ltd.) MOD 8 costs \$85 for the seven basic boards, "uses a minimum of components, provides for a good deal of expansion, is designed around a TTY as the I/O device, has no front panel and you probably can get by without one. And if you want to go to an 8080, you put in a new CPU board, eliminate the buffer board, and it is an 8080 system."

Mini Micro Mart has this to say about other micros: "SCELBI is the most expensive route and probably the best—surely the way to go if you don't WANT to build your own, or even if you want to build your own and have a minimum of technical or software background. Good boards, good design, and most important, FULL support, even to the systems level.... The Altair 8800: the first of the 8080's attracting the amateur market, the best packaged, and the slickest promotion, and a rich man's toy as far as I am concerned. If you take their basic kit, add 3 memory add-ons, 3 I/O, and a TTY interface, the extras come to \$549, more than the kit itself, and you still have only a 1K microprocessor. Buy MITS boards, come to us for the parts, and save about 50%. My blood pressure was starting to rise, because I started thinking about the stories in Popular Electronics. I quote "but it can be economically expanded to 65,000 words." That economical expansion will cost you a mere \$4224 if you order the economical version of their memory (which I

don't think they are delivering). Assembled MITS memory is about the same price as DEC's memory boards. ... If you've gotten the impression that I'm partial to the MIL MOD 8, you have reached the right conclusion: 8008 system that modifies to an 8080, software, audio cassette interface, TTY interface, a floppy disk interface SOON."

Mini Micro Mart sells IC kits for the Mark 8, Altair 8800 and SCELBI, as well as memory ICs, keyboards and other hardware, and the MIL MOD 8080 for \$294.50 (1Kx8 memory), without power supply or front panel. The MIL MOD 8, with 6 PC boards, all the TTL, 8008, and 1Kx8 memory (no ROM board or mother board) is \$219.95 plus \$2.50 for postage, etc.

Another MMM quote: "The Mark 8 — surely not the best but it started it all — the mass interest started with this — the boards would have been nicer with plated-through holes — but is still the least expensive way to start for a novice; \$5 gets you the manual, the boards are available, and there is support to get you out of trouble (thanks to Hal Singer."

MACHINE LANGUAGE PROGRAMMING BOOK

SCELBI Computer Consulting, Inc. (1322 Rear, Boston Post Road, Milford, Conn. 06460) has just announced their new manual, "Machine Language Programming for the 8008 (and similar microcomputers," containing a detailed presentation of the 8008 instruction set, and coverage of flow-charting, mapping, editing and assembling, search and sort routines, mathematical operations, multiple-precision arithmetic, floating-point-package, I/O programming, and many other areas.

The price is \$14.95 until April 30, 1975, after which it will be \$19.95.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send \$5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

LATEST ON MICROSYSTEMS INT.

Microsystems International is part of Northern Electric (the Western Electric of Canada), which decided to stop making ICs, so MIL is in shut-down mode and will close May 30. However, Mini Micro Mart says MMM will still offer the MOD 8, will design its own board for the MOD 8080, and hopes to have software for the latter before long.

One of MIL's customers designed a discrete version of the 8080 with 7400-series TTL, for only \$90. Although it uses more power and takes more space than the 8080, it is a great deal faster. And proprietary.

It should be noted that MMM kits are sets of PC boards and ICs, without full construction plans, for engineers and advanced hobbyists.

JOHN YOUNGQUIST'S TAPE CONTROLLER

John Youngquist (899 Niagara Blvd., Fort Erie, Ontario, Canada) writes: "I have completed my low-cost tape-drive controller and interface. Designed around a two-track digital tape drive and 4K PDP-8/L, it emulates TD8E DECTape with a one-page (128-word) handler program. The DEC TD8E handler is twice as long. The standard PDP-8 DECTape format is fixed-length 129-word blocks, each numbered and individually addressable, much like disk format. Thus

my interface and software allow bi-directional searches for any block without counting file gaps. Address error detection and verification is done before a block is read or written, to prevent accidental loss of data. A parity bit for each 6-bit byte is written and verified for all data words. Blocks with parity errors are re-read up to three times before the appropriate error exit takes place.

"The interface is based on a phase-locked UART chip (i.e., General Inst. AY5-1013). Data is written serially with start-stop bits on one track and reference clock on the other. When read, the clock is phase-lock multiplied and applied to the UART. The data rate is 10K baud and tape speed is 15 ips, but could change to suit a particular tape drive. The tape drive used is a two-track and uses 8 $\frac{1}{2}$ -inch reels of $\frac{1}{2}$ -inch IBM tape. It was made by Computer Entry Systems for a special application.... The complete interface and controller contains only 20 ICs, a MOS LSI UART, some CMOS and TTL, at a cost of \$20. It can of course be applied to a variety of tape drives and CPUs. I can provide schematics, software, and application assistance to anyone interested. Please enclose \$1 with inquiries, to cover duplication costs, and request PDP-8 program listings if you need them.

"To support the tape drive, I have written a series of tape commands in FOCAL 69. I can read/write blocks of integer, 3 or 4-word floating-point variables, and chain to new programs, starting execution at any line number. This allows FOCAL to run in "batch mode" unattended for hours. I can provide the software.

"I have an Intel 8008 CPU (new, not surplus) for sale or trade. I wish to acquire some floppy-disk drives, preferably in complete working order." Copyright 1975 by Stephen B. Gray

COMPUTER KITS, PART 3

Altair 8K BASIC Special

Until Sept. 15, 1975, MITS is offering the Altair 8800 computer kit, two 4K-word memory boards (kit), your choice of interface board, and the Altair 8K BASIC language, for \$995. That's a saving of \$139 to \$175, depending on the interface you choose.

Altair 8K BASIC uses 6250 words, leaving 1750 words for programming and storage. There is also a 4K BASIC, and an Extended BASIC (12K). The 4K BASIC has 15 statements, 6 math functions, and 4 commands; the 8K BASIC has 4 more statements, 8 more functions, 1 more command, and advanced string functions. The Extended BASIC adds PRINT USING, disk I/O, and double-precision math. BASIC is available on either paper tape or cassette tape.

Altair Systems

The April Computer Decisions carries a full-page MITS ad that looks more like an ad by a mini-maker than by a kit company.

According to the ad, "... we're selling our BASIC Language System for \$2,461 (fully assembled Altair Computer with 8K of memory, a serial interface, computer terminal and BASIC language software). We're selling our EXTENDED BASIC Language System for \$2,806 (Altair with 12K of memory, serial interface, computer terminal, and EXTENDED BASIC software). Our DOS EXTENDED BASIC Language System goes for \$6,649 (Altair with 16K of memory, serial interface, computer terminal, disk controller and 2 disk drives, DOS and EXTENDED BASIC software).... we're selling our Advanced Account-

ing/Engineering System for \$10,489 (Altair with 32K of memory, serial interface, teletype [or terminal], line printer, disk controller and disk drives, DOS and EXTENDED BASIC software)."

Sound like they intend to compete with DEC. In fact, part of the ad reads, "It's almost embarrassing. We've only been on the computer scene a short while, yet we're selling more computers and peripherals than many of our long-time, established competitors."

MITS is said to have sold over 2500 Altair kits, and has opened two regional sales offices, in Orange, Calif. and Miami, Florida, "with the ultimate goal of maintaining operating service centers and display areas at these locations."

Altair Experience #1

Doug Penrod writes from California: "I ordered a MITS Altair 8800. It has been coming in bits and pieces, especially after I wrote Mr. Roberts (pres.); he called me on the phone, to get the order straightened out. Their paper-work crew is overloaded and gets things all mixed up.

"Yesterday UPS brought 2 boxes from MITS. One contained a 4K dynamic RAM board kit and a 4-slot expansion to the bus board. And a note saying that 8 chip sockets had been backordered. The other box contained two 4K dynamic RAM kits, complete. Now I have 3 manuals for the 4K RAM. Now all I lack are the 8 chip sockets and the software: the assembler and utilities package, and the 12K BASIC package.

"As you no doubt know by now, they have 3 versions of BASIC--for 4K,

8K, and 12K. No source code is available for any software, only object code, and that only in paper or audio mag tape form so far. So modifying their software won't be easy.

"I have some criticisms of the Altair. I notice that the new ads mention the use of fans, and all of the four machines at a local MITS "seminar" had fans. However, they aren't much more helpful than the blower on the motor of a Teletype, which has no air inlet or outlet. The MITS has inlets all along the top of the sides of the cabinet, and the motor blows out an outlet in the rear of the cabinet. Better. But there is no air-flow pattern in the board layout or cabinet design.

"In particular, the front-panel PC board has a heat sink for the 8v to 5v regulating transistor mounted on the front side of the PC board, where the sink is trapped in a narrow space between the PC board and the aluminum sub-panel which mounts the switches. The sub-panel, in turn, is behind, and in contact with, the thin aluminum dress panel. At any rate, there is no way for air to circulate around that heat sink, which is mounted on the top of the board, thus precluding even normal convection in the space between panels. So I changed mine, and mounted the heat sink (augmented, in my case, by a copper addition to increase the area by a factor of 2) on the rear of the PC board, where it can get some air.

"I also expect to design and build some baffles to systematically channel air-flow through the PC boards in a manner determined to keep the chips cool and keep the heat-sink air away from the chips. Actually, I feel that appropriate thermal design would have obviated the need for a fan, even in a full-

house machine. I think that the bulk of the gross regulating could be done outboard, with just enough on-board to keep the glitches away.

"I wish the MITS had an optional 18 or 19-slot bus board available in 1 piece. Now you have to use 100 jumper wires to connect each pair of 4-slot boards together, max 16 slots. Need 16 to handle the max 64K memory, plus a CPU and at least one I/O board. In my Altair, every chip has a socket; I think they ought to come stock that way.

"At the MITS "seminar" in Van Nuys, the MITS guys were saying that another Popular Electronics cover story will be coming out, presumably with a successor or alternate to the Intel 8080 machine. They said they were working with Motorola 8-bit chip, and didn't deny the National Semiconductor IMP-16. It is obvious that the cheap computer world is changing radically and rapidly this year and next. It hardly pays to design and build your own computer anymore, if results is what you're after. Especially if you consider the time and effort involved in the software. It ain't every solder mechanic who can write a compiler.

"Pretty soon it ought to be possible to buy slightly-used Altairs cheaply. Unless the buyers want to up-grade to BASIC. Incidentally, I found that their machine won't accept program input from paper tape. Too slow. Apparently doing line-by-line diagnostics. Also, there's the matter of a Line Feed on the paper tape and another one from the computer; they don't have a TAPE mode of entry. I tried some experiments to see if this can be bypassed. But for computer-generated listings, the only cure is to get at the software. I suspect that a tape which had no Line Feeds (only Carriage Returns), and nulls or rub-outs for

time between lines, might work."

Altair Experience #2

Dick Schwanke writes from Illinois: "I am now well along in the construction of my Altair 8800, thanks to rainy weather. The construction section of the manual seems to be entirely adequate for anyone who will read the instructions carefully and can identify the parts. The theory of operation section covers the operation of the parts they added, but the explanations are not easy to follow unless one is quite familiar with this type of design. The debugging section is nearly useless, and the almost complete absence of explanation of the CPU chip itself means that trouble can be anticipated in locating the reasons for not working. There is also a very obvious lack of application data, including failure to indicate how I/O is accomplished.

"The answer to the I/O question is, of course, that a tap must be put on the data, address, and control busses; and an interface controller must be constructed. I have not done sufficient research to know if there are family members (8080) designed for the specific job, but I am sure that I will sooner or later find the applications data that I need.

"The Motorola 6800 applications manual contains designs for both static and dynamic memory modules as well as huge quantities of information on I/O with or without interrupts and priority schemes. I have not yet figured out how to get a front panel on the 6800.

"Back to Altair. I am not particularly happy with the method of hooking the panel to the CPU and bus. It looks very subject to noise and crosstalk. The CPU and memory boards look as though they were

noisier than had been anticipated and have had many capacitors added to soak up the noise.

"I do expect to get my 8800 working although I have no idea as to the problems I may run into. If I have too much difficulty figuring out the I/O problem, I can always purchase the manuals from Altair and see how they did it.

"P.S. There is a shortage of wire and solder in my kit. The panel is going to be very difficult to repair in case of difficulty because all of the switches are bolted down.

"There are some new 4K static RAMs which cost \$22.75 each for 10-99."

Altair Experience #3

The writer of this letter asked that his name not be used: "I have just received my Altair 8800. I was extremely skeptical from the advertising but decided to gamble anyway.

"The printed-circuit work is of very good quality, with plated-through holes, and takes solder well. The case is excellent and expensive, and can be disassembled as required to work on the circuitry. The bus is constructed of two rails with PCB wiring and 100-pin connectors and card guides which ought to make an adequate mechanical and electrical assembly. It is sold in increments of 4 positions but came with only 2 connectors. While it is not clear, it appears that MITS hopes to make out by selling memory and peripheral adapters to people who will be unable to expand the bus by any other means. I believe most builders would be put to it to construct such a nice package for less than twice the price I paid for the basic machine.

"It is well known among computer types that lots of memory and an

assortment of input/output devices are needed to do any useful computing in a reasonable length of time. Short word lengths and limited instruction sets do not prevent good results but make the memory requirements more difficult and expensive and cost a lot of time. Orbits for cyclotrons were calculated on a machine with 256 words of memory at one time (when there was nothing better).

"Unfortunately, static memory is not the way to go in these microprocessors. The cheap 1101's take up a lot of board space and will undoubtedly produce bus problems before the memory reaches a satisfactory size. The recent-design static chips are too expensive. It is hoped that the new 4K dynamic RAMs will produce a digestible solution.

"Motorola has introduced an evaluation package which includes seven compatible chips, a CPU, a ROM with a monitor program built in, 256 bytes of RAM, two parallel interfaces, and one serial interface. The system devotes one parallel interface to a Teletype machine to be used as the console, leaving the other parallel interface and the serial interface to the user. The monitor program uses some of the RAM (possibly as much as half). The bus loading rules are such that these seven chips can be connected together without any bus drivers, so getting the whole thing working can probably be done with less than \$50 worth of parts plus an 8-level Teletype or similar console. A panel is not needed.

"Any attempt to expand the machine will require spending considerable money and effort on the bus driving and receiving arrangement, and the memory problems are the same as above.

"The Motorola instruction set is

much better than the 8080 set as far as economical use of memory is concerned. The 8080 is much better than the Motorola in the input/output interrupt structure area, as it can point to 8 separate locations in memory, compared to one for Motorola.

"It is a temptation to use the empty space in the Altair cabinet to install a Motorola 6800 and try to interface it to the 8800's panel and memory."

"I likely will not ever try to make a large useful machine out of my Altair, but will use it as an educational tool to study the programming problems of this type of machine, the results of which I can use in my job."

Altair to go Motorola?

According to a rumor in the July Computer Decisions, "the next version of the Altair... will be built around the Motorola 6800 chip.... Intel's 8080 was judged less powerful than the Motorola micro...."

Seems that the two best bets for a company going into the computer-kit business right now are the Motorola 6800 (for which there isn't much software) and the Intersil IM6100 microprocessor (\$394 in 1-24 quantities) which, as the ad says, "recognizes the instruction set of a popular minicomputer, the PDP-8/E. No need to generate complex special software. No need to learn new languages. It's already there in software everyone knows and understands. ...the most extensive software library of any microprocessor."

Two More Kits

In addition to the MITS Altair, Scelbi-8H, Radio Electronics Mark-8, MIL MOD 8 and MOD 8080, there are also the Sphere I and the Martin Research MIKE 2. (Actually,

there are now some 13 kits on the market; more in the next issue.)

Sphere (96 East 500 South, Bountiful, Utah 84010) offers a 4K "Hobbyist" computer kit, based on the Motorola 6800 microprocessor, with 512-character TV terminal, keyboard and power supply, for \$650 (\$870 assembled). Memory is expandable to 64K, at about \$240 for a 4K board, \$400 for 8K, \$750 for 16K memory-board kit.

An assembler, editor, debugging aid, and drivers for the CRT are built into a read-only memory. Available software includes Extended BASIC (with string and matrix manipulation, machine-language subroutine calls, trig functions, and disk-file I/O, plus FDOS—flexible disk operating system).

The "Intelligent" kit adds serial communications and audio-cassette capability at \$750 (until Sept. 1975; \$999 afterwards). The "BASIC" system kit adds 16K more of memory, for \$1345 (\$1765 after Sept.); the "Classic" system kit includes 65-lpm printer, two IBM-compatible floppy disks, and DOS, at \$5250 (\$6100 after Sept. 1975).

Sphere also has a paper-tape reader/perforator, and will have a network operating system, RPG II, and an integrated data-base system. Plus "unique developments in process control for the home and industry and an ultra low-cost mass storage system" by early 1976.

According to Mike Wise, president, "Sphere was started by computer professionals, and their computer was started as a system."

Martin Research (1825 S. Halstead St., Chicago, Ill. 60608) has the MIKE 2-1 CPU board, with 8008, crystal-controlled oscillator, and all the timing for the system, at \$55 kit, \$75 assembled. The MIKE-

2-20 console board has a six-digit display and 20-key calculator-type keyboard; "unlike systems with banks of toggle switches and lights, this micro is easy to program, since codes are easily visualized." The kit, \$69; \$84 wired. The MIKE 2-3 PROM/RAM board has room for up to 1K of RAM and 2K of PROM; handles up to eight 2112's and up to eight 1702A's.

The basic system, the MIKE 203, uses 256 words of RAM and 256 words of PROM; \$230 kit without 8008, \$270 kit with 8008, \$276 kit with 8008-1 and fast XTAL. A memory board with 2K RAM (450 nsec) is \$108 kit; 3K, \$137; 4K, \$165 kit.

Options under development include a CRT display interface, cassette recorder interface, Teletype interface, PROM programmer.

THE TRADING POST

ECL Source?

D.B. Lamkins (Magnolia Ave, Manchester, MA 01944) "would like to buy unused, tested ECL 10,000 ICs in small quantities. If anyone has a source at below distributor's list prices, please send type numbers, prices, and quantities."

Peripherals for Sale

Dan Miller (1191 Risa Place, Santa Ana, CA 92705) has several line printers, mag-tape drives, disk drives, card readers, tape punches and drums. Send for his price list.

DEC Modules for Sale

Steven Roy (Electronic Assembly Associates, P.O. Box 3711, Amity Station, CT 06525) has various DEC modules, including M8300 (major registers), M8310 (maj. reg. control), M837 (extended memory control). etc. Write for price list.

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send \$5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

Steven also has some fixed-head, 4-platter disk drives, with 30-in. platters, 256 R/W heads per side; \$200 per unit, you cart.

New Address for MNH

MNH-Applied Electronics has moved, to PO Box 367, Jamul, CA 92035. Their latest catalog includes an FSK modem card for \$30, small power supplies from \$5 to \$8, digital cassette-tape cartridges at \$2, etc.

Chips, ICs, Transistors

At 128 N. 81 St, Mesa, Ariz. 85207, Electronic Discount Sales offers the Intel 8080 at \$155, and a wide variety of transistors, RAMs, digital and linear ICs, switches, etc.

IN PRINT

Another Newsletter

One of the newest hobby publications is the "Homebrew Computer Club Newsletter," Fred Moore, editor, 568 Santa Cruz Ave., Menlo Park, Calif. 94025.

Computer Column

Starting with the June 1975 issue, Popular Electronics magazine is running a column called "Computer Bits" by Jerry Ogdin. The column was intended to be a quarterly feature, but readers are said to

be demanding that it run every time.

Computer Hobby Magazine

Scheduled to appear on the newsstands in September is BYTE!, an 8½-by-11, 150-page monthly magazine for the computer experimenter, at \$1.50 an issue, or \$12 for 12 issues (\$10 introductory) from Green Publishing, Inc., Peterborough, New Hampshire 03458

BUYING MINIS IN QUANTITY

A member has suggested that the ACS look into the possibility of buying a mini in quantity for ACS members, to take advantage of the quantity pricing. Well, the prices would still be rather high:

The Fabri-Tek MP12 (which is almost software-compatible with the PDP-8) with 4K core has been advertised at \$990 in quantities of 100. That machine is without power supply or I/O interface, and costs \$1340 for one. An MP12 with I/O interface and power supply is \$2395 each for 1-4, \$2258 for 5-9, \$2181 for 10-24, and \$1922 each for 100.

The PDP-8/A from DEC, with 8K of core memory (and including programmer's console and I/O option board) is \$3695 for one, with discounts of up to 30% for quantities of 100, bringing an 8/A down to about \$2600. The same 8/A with 8K of RAM memory is \$3895 for one.

FASTER INTEL 8080 CHIPS

The Intel 8080A chip operates at a 1.5-usec cycle time, compared with 2.0 usec for the 8080. Intel also plans to market a 13-chip processor set for \$250, including 8080A CPU, two 256x4 RAMs, two bus drivers, a 1Kx8 erasable ROM, decoder, priority interrupt control unit, etc.
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KIT ROSTER

Over a dozen microcomputer kits are now on the market, so maybe it's time to make a list.

1. One of the first (non-micro) kits was the 832 (March 1971 Newsletter), still offered by National Radio Institute as part of their computer electronics course. Built with 7400-type TTL, it has a memory made up of slide switches, for simplified teaching of bit storage. Input/output is by switches, lamps.
2. The Soelbi-8B is about the same as the 8H (March 1974 NL), but uses 2102 RAMs, "which allow the 8B to be directly expanded up to 16,384 words of memory at a cost comparable to that of 4,096 words of memory in an 8H." The 8B kit, with 8008 MPU and 1K memory, \$499; empty 4K RAM card, \$49; eight (1024 words) type 2102 RAMs, \$59.
3. Radio-Electronics' Mark-8 (June 1974 NL) is also build around the Intel 8008 microprocessor unit.
4. The MITS Altair 8800 (March 1975 NL), based on the 8080 MPU, can directly address up to 65K of memory, has a variety of peripherals, and can be programmed in assembly language and in BASIC.
5. The Sphere (July 1975 NL), using the 6800 MPU, is now offered at \$860 for CRT display, ROM monitor, real-time clock, typewriter keyboard, 4K memory. Extended BASIC is available (more memory needed). The CPU board, with 4K RAM, "512 times 8 PROM," serial TTY interface and hardwired ROM monitor (console emulator) is \$350.
6. The Mike 2 from Martin Research (July 1975 NL) is based on the 8008; kit is \$295, with monitor PROM and 256 bytes of RAM. Expandable to 16K bytes. For \$12, a kit of ICs for a 16-channel display on a triggered-sweep scope, for debugging and educational purposes.
7. The Mike 3 kit is \$395 (\$445 after Dec. 15), with 8080, monitor PROM, 512 bytes of RAM.
8. The E&L Micro-Designer System (E&L Instruments, 61 First St., Derby, Conn. 06418) is an 8080 system, composed of three plug-in cards, control panel (with LED displays and control switches), interface board, power supply, and software. Can use up to 65K of memory ("can mix R-W or PROM"). The basic unit is \$1,695, for a microcomputer also known as the Mark 80.
9. The MOD 8 (March 1975 NL) from MiniMicroMart is based on the 8008, sold as unpopulated boards or as a kit with 1K memory.
10. The MOD 80 from MMM uses the 8080 MPU. The C-MOD6800, a 6800 MPU on a board, is compatible with the MOD 8 and MOD 80 bus structure, input, output, etc., is for the owner of an 8 or 80 who wants to plug in a 6800 and try it out.
- MMM's R-M terminal is a surplus hotel reservation terminal, with 9 electronic boards in it. Any of the MMM micros fit in it; a Teletype 32 or 33 printer also fits inside, for another \$330 or so; the RM terminal is \$109.95.
11. MMM's RM6800 MPU "is for the person who is starting from scratch and who doesn't want to try to try the other MPUs," according to Maury Goldberg of MiniMicroMart. It will also fit in the R-M terminal, which has modem and TV-display options.

12. RGS Electronics (3650 Charles St., Suite K, Santa Clara, Calif. 95050), has the 008A kit, with an 8008 MPU, 1024x8 memory, all ICs and parts except cabinet, \$375; ASCII keyboard input kit, \$135; audio cassette adapter kit; \$100.

13. The Godbout kit, called "George" (because "it seemed nice and friendly") based on the National Semiconductor 16-bit PACE MPU, has been delayed a little, now has a delivery date of 1-1-76. The projected price is to be just under \$600, with 1K words of memory, provisions for 7K more, editor and assembler, provisions for 4K ROM and for serial cassette interface, for 3 audio cassettes, and with keyboard rather than toggle-switch input. With 8K of RAM, the price is "still under \$800." There will be no peripherals; the cassette interface will be supplied with a cassette containing editor and assembler.

Contrary to rumor, there is no relationship between the Godbout kit and the kit to be offered shortly by Radio Shack, also based on the PACE microcomputer.

For a "complete data packet" on the kit, send \$2.50 (refundable) to Bill Godbout Electronics, Box 2355, Oakland Airport, Calif. 94614.

14. Details on the MITS Altair 680 kit, based on the 6800 MPU from Motorola and American Micro-Systems, were withheld until the publication of the November Popular Electronics article.

The 680 is less than a third the size of the Altair 8800, only 11 x 11 x 4 3/4. This "makes internal expandability significantly less," which means, although the article doesn't say so, that the chassis will hold only three more boards, such as two 12K RAM boards (still in design) and an interface board. Most of the 680 is on one PC board,

which has a built-in Teletype interface, and which plugs directly into the front-panel board. The 680 is TTL-compatible, and uses only one 5-volt power supply. The 680 is slower than the 8800, with a 4-usec minimum cycle time, compared with 2 usec.

The software for the 680 includes a monitor on PROM, assembler, debug, and editor. The 680 has three interrupt levels; the 8800 has 8. Both can be expanded to 65K bytes.

A \$293 kit (\$345 after 12-31-75) includes 1K bytes of RAM. Options are: I/O socket kit, \$29; fan kit, \$16, PROM kit (256 x 8-bit), \$42; there are provisions on the main PC board for another 1K bytes, of ROM or PROM, mainly for dedicated versions of the 680; there is a blank front panel for turnkey use.

The 680's main PC board will be sold separately for \$180 (\$195 after 12-31-75) for OEM use or "for the experimenter who wishes to purchase an absolute minimum."

As the latest MITS "Computer Notes" puts it, "MITS has decided to await customer response to determine the course of further 680 development in both the areas of software and hardware." If enough users ask for a BASIC compiler, it will be provided. No price has yet been set for the 12K RAM board. Also being considered is a board containing half RAMs and half ROMs. Anything requiring more than three additional boards will also require an expander chassis, which is in design. The 680 seems to be aimed primarily at OEM controller applications.

15. SWTP (Southwest Technical Products Corp., Box 32040, San Antonio, Texas 78284) has announced "The computer system you have been waiting for," its 6800, which contains a ROM with "the program necessary to automatically place not only a load-

er, but also a mini-operating system into the computer's memory."

The 6800 is controlled by any ASCII-coded terminal. The basic 6800 includes the ROM, a 128-word static scratchpad RAM, 2K memory, serial control interface, power supply and case, plus test programs and the Motorola Programmers Manual, at \$450.

16. The Micro 440 by Comp-Sultants Inc. (P.O. Box 1016, Huntsville, Ala. 35897) is based on the Intel 4040 chip, and is available with 256 bytes of RAM, power supply, case, I/O port and Teletype interface, for \$275 kit, \$375 wired.

The 440 features 60 instructions and 24 on-chip registers. For \$175 you can get the full CPU board, front-panel controls and displays, and the 256 bytes of RAM. The case has room for 8K of RAM or PROM, in 2K increments.

17. The SRI-1000 by Systems Research Inc. (P.O. Box 151280, Salt Lake City, Utah 84115) uses the PACE MPU, and includes full keyboard control, 4K RAM, \$599 assembled and tested. Options include more RAM; interfaces for cassette, video, TTY, RS-232, TTL; floppy disk, line printer, and tape reader.

18. Imsai (IMS Associates, Inc., 1922 Republic Ave, San Leandro, Calif. 94577) has the Imsai 8080, "compatible with the Altair 8800." The basic computer includes CPU, 1K RAM, front panel, control panel with 8 extra LEDs to indicate the output port, all lights and switches, power supply, expander board and case, \$439 kit, \$621 assembled.

Imsai also sells boards that are interchangeable with Altair's, including CPU, 4K RAM, 1K RAM on 4K board, 2K EPROM on RK board, etc. And a multiprocessor/shared memory facility that "allows up to 3 Im-

sai 8080's or Altair 8800's to share the same memory"; \$295 kit, \$335 assembled.

Are there any others?

OEM EVALUATION KITS

Many microprocessors are now available as part of a PC board marketed for engineering evaluation, in kit or wired form, usually with a minimum of memory, and without power supply, chassis or case.

1. The JOLT (Pehaco Corp., Micro-computer Associates, Inc., 111 Main St., Los Altos, Calif. 94022) has a \$249 CPU card kit built around a MOS Technology 6502, which can address directly 65K of memory. ROM program memory on the CPU card consists of 1K bytes of monitor/debugger with an automatic power-on bootstrap program. A 4K RAM card kit is \$265; I/O card (peripheral interface adaptor) kit, \$96; power supply (will support CPU, I/O and a 4K card), \$145 kit. An accessory bag, with enough parts to connect one JOLT card to another, is \$40. That would make a 4K kit cost about \$850. The 6502 has 58 instructions and 11 addressing modes, and sells for \$25.

2. The Mostek F8 Evaluation Kit, at \$297, includes the 3850 MPU, a ROM, static memory interface, 1K x 8 of static RAM, crystal, 2 CMOS buffers, and a 6.75" x 5.5" PC board. A Teletype or CRT can be connected directly to the board. The ROM software permits "program loading, storing, modification, debugging (with "traps") and even hexadecimal arithmetic--all from the Teletype."

3. Cramer Electronics (85 Wells Ave, Newton, Mass. 02159) offers three evaluation kits, built around the Intel 8080A, Texas Instruments 8080, Motorola 6800. These are \$495 each, and include eight 1024x1 sta-

tic RAMs, a 1024x8 erasable ROM preprogrammed with system monitor, controls (toggle, pushbutton, and DIP switches) and displays (LEDs and 7-segment) for programming with or without a terminal. Includes both current loop and RS-232 interfaces for any terminal, and an audio cassette with test programs (audio cassettes can also be used for extra program storage). "The erasable ROM contains a system monitor that makes your microcomputer useful as soon as you turn it on.. ..A cassette full of other useful programs is included to help you debug and demonstrate your microcomputer."

Power supply is not provided. Memory is expandable to 12 additional 1K RAMs. Coming up: kits based on the AMD 9080, Mostek F8, and RCA COSMAC. And in early 1976, bipolar Cramer kits using the Intel 3001, AMD 2901, TI SBP 0400, and Motorola 10800.

The \$495 does not include a PC board. The Augat boards shown in the brochures are about \$275 each.

4. Pro-Log Corp. (2411 Garden Road, Monterey, Calif. 93940) offers a variety of assembled cards, for logic processing (using the 4004 or 4040) and for microprocessors (8008, 8800, 6800, F8), all using "1702A MOS PROMs or equivalent."

WHERE IS KENBAK TODAY?

The Kenbak-1 (June 1974, Feb. 1973, and Mar. 1972 Newsletters) \$850 training computer is no longer being marketed by its designer, John Blankenbaker. It is now in the hands of C.T.I. Education Products, Inc. (695 Coleman Blvd., Mt. Pleasant, S.C. 29464), and is the Model 5050 Digital Computer Systems Trainer, at \$1,035. CTI also markets logic labs and a variety of electronic training devices.

8080 AND 6800 PRICE CUTS

In October, Intel cut the prices of the 8080 family; the new 100-lot price for the 8080A MPU is \$40; 25-99, \$60 (was \$110); under-25, \$75 (was \$150).

Advanced Micro Devices offers its 9080A version of the 8080 MPU at \$29.95, in lots of 100.

Motorola's M6800 MPU is \$69 for 1-99 (was \$175 for 1-9). The MCM6810 1K RAM is now \$5 for 1-99 (was \$15 for 1-9). The Design Kit, with PC board, is now \$149; it was \$300 before, without a PC board.

PACE HIGH-LEVEL LANGUAGE

National Semiconductor, makers of the 16-bit PACE MPU, will soon have a Disk Operating System (DOS) and SM/PL, a resident high-level language; "this makes PACE the only fully supported one-chip microprocessor in the industry," according to the advertisement.

IN PRINT

Designing Your Own Microcomputer

This is the title of an article in the Sept. 27 Electronic Design, on how to use bipolar bit-slice microprocessors to build, for example, a 16-bit processor with 24 ICs, built around four 6701 4-bit MPUs (by Monolithic Memories?), and featuring 16 general-purpose registers, ability to address 65K words of memory, and instruction execution times from 0.9 to 1.2 usec.

"Increase microcomputer efficiency" by the same author, David Wyland (ED, Nov. 8), shows how to add interrupt and DMA (direct memory address) capabilities with only seven extra ICs, six new instructions, and nine extra control-ROM bits.

The schematic shown is basically the same as in the previous article, with the required additions.

Micro Depts.

Starting with its Nov. 22 issue, Electronic Design will have a "Microprocessor Design" section in every issue.

And Digital Design started a "Micro Notes" department, in its Sept. 1975 issue.

ALTAIR-TYPE PC BOARDS

Jim Garrett (322 Rollingridge Ln., Garland, Texas 75041) writes: "In contacting MITS about the availability of their Altair 8800 PC boards I have found that they are no longer going to supply them to the hobbyist. If there is enough interest, I will make an equivalent improved set of boards for us at cost. The purpose of this letter is to gauge interest.

"Everyone interested in Altair-8800-like boards, drop me a postcard (or letter) stating their needs. These are improved boards (DISCLAIMER: I do not offer Altair products or kits; I sell parts and accessories which can be used in the Altair 8800).

"The display board will contain the necessary mods to provide an octal display (for about \$15 more in components you can read octal instead of binary), AC switch improvements will be instituted, grounding on all boards will be improved, mods to the CPU boards will include reducing switch noise and a more conventional connecting to the display board. The memory boards will have provisions for a DIP switch for address selection (no more jumpers), etc.

"Tentative prices are: CPU, \$18.50;

4K memory (static or dynamic), \$18; power supply, \$13.50; display and control, \$33; SET I (1 each CPU, PS and D/C), \$58.50; SET II (4 each, static or dynamic), \$65; SET III (SETS I & II), \$115. This includes postage, insurance and full documentation of all mods.

"I am willing to produce any other boards if there is enough demand. Along the same lines I may be able to supply the DIP switches, connectors (both 100-pin and IC) and miniature switches, if there is enough interest, at OEM prices."

BUILDING FROM SCRATCH

Despite all the activity in micro-kits, many ACS members are still building their machines from their own design, or copying a commercial machine. Billy H. Pettit (1277 Indian Rd., Mississauga, Ontario, L5H 1K7 Canada), writes: "I'm building a 12-bit, 8K machine completely compatible with the CDC 160-A/8090. Using TTL, naturally, with a solid-state RAM memory. Been playing around with 1103's, but finally gave up. They just aren't worth the extra interfaces. Will probably go to 74S206's. [CDC = Control Data]

"Have always felt the 160-A had about the best instruction set and versatility of any 12-bit machine. In my opinion it is superior to the PDP-8 set, and easier to use. Plus, for me, the big advantage of software. For 10 years, I've used the 160-A and now have hundreds of programs. Especially useful is a very, very sophisticated FORTRAN for a 12-bit machine. There is a second FORTRAN, more primitive and similar to DEC's 8K version. Also a pseudo-COBOL and half a dozen floating-point simulator packages.

"All of which means that when it is built (my version), I can use it for something. All of the software

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send \$5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

is in the public domain, and the user's group is still active.

"If any reader ever buys a scrapped CDC component and wants some info, have him write. I can probably get a schematic of anything likely to be on the surplus market."

SURPLUS IN SWEDEN

Eskil Hedetun writes from Sweden: "As you probably know, computers are manufactured in Europe by just a few, and very big, companies; i. e., Siemens-Philips, IBM-Europe and perhaps the Swedish SAAB (same company that makes the car). This means that surplus is very scarce, and if the "goodies" ever come out of the factories, they go to various schools and universities. Surplus to amateurs is "zero." As regards components and "rejects," it is mostly sold in England, and due to the EFTA-EEC free-trade it is rather easy to get a shipment from England. For more complicated ICs like RAMs, we have to go to the US to get them. Most US dealers are very speedy and efficient. The inflated dollar has made it favourable to buy components and even computer kits from the States. In this region (southern Sweden) I know at least two persons who have bought the Altair."

TOOLS

An excellent catalog of "more than 2500 tools for electronic assembly and precision mechanics" comes from Jensen Tools and Alloys, 4117 North 44 St., Phoenix, Ariz. 85018. Some of the prices may seem high, but that's because these are all first-quality tools, including over 60 pliers, 10 pages on soldering equipment, and many fine tool kits.

THE TRADING POST

Gary Coleman (14058 Superior Rd., Apt. 8, Cleveland, Ohio 44116) has acoustic couplers, modems, keyboards, CES tape drives, etc. For a price list, send a SASE.

NEW COMPUTER CLUBS

Doug Penrod (1334 La Cima Rd., Santa Barbara, Calif. 93101) has started a new computer club.

John Vullo (230 Main St., Rte. 28, North Reading, Mass. 01864) is president of the Boston-area Alcove Computer Club.

IBM'S MINI

The IBM 5100 "portable computer" looks more like a CRT terminal than a mini, with a 1024-character display screen, typewriter keyboard, and an integrated cartridge tape drive. Memory ranges from 16K to 64K characters, and prices from \$9K to \$20K, depending on memory size and on choice of printer, auxiliary tape-storage unit, and other options. The 5100 comes with either APL or BASIC, or both. Three program libraries, each consisting of two mag-tape cartridges and a user guide, are \$500 each, for business analysis, math problem-solving, and statistical problem-solving.

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KIT ROSTER (continued)

Many more microcomputer items have been advertised or announced since the listing in the previous issue. Here are over a dozen:

19. From Sphere, the Micro-Sphere 200 is sold as a wired unit only, with 4K RAM, ROM cassette loader, 128x128 black-and-white dot-matrix graphics system, and a games package; \$860. The MPU is a 6800.

20. The Systems Research SRI-500 is also a wired-only unit, with F8 MPU, available as modules: board with 1K RAM, TTY interface, debug in ROM ("Fairbug"), \$325; power supply, \$55; keyboard, \$100; etc.

21. Wave Mate's Jupiter II comes in both kit and assembled forms; with 6800 MPU, 8K dynamic RAM, RS-232 interface, software (editor, debug, assembler, BASIC), wirewrap tool, \$1299 kit. (1015 West 190 St., Gardena, Calif. 90248).

22. The EBKA 6502 Familiarizer has a hex keyboard and two-digit display on the same PC board as the circuitry, so it doesn't require a terminal for a beginner to learn the basics. For the MOS Technology 6502 MPU, 1K-byte RAM, 256-byte PROM (monitor): \$229 kit, \$285 wired. (EBKA Industries, 6920 Melrose Lane, Oklahoma City, OK 73127)

23. The OSI 300 from Ohio Scientific Instruments (P.O. Box 374, Hudson, Ohio 44236) is a wired trainer using the MOS 6502 MPU with 128-word RAM, 7 address switches, 8 data switches, displays that indicate data, address, and program execution, lab manual with 20 experiments; \$99.

OSI has an interesting alternative:

Send in \$110, get a 315 computer trainer (identical to the 300), return it within 60 days, and you receive three PC boards (super-board, I/O board, video board) and software for TV typewriter and audio cassette monitor, for a system based on either the 6502 or 6800 MPU. To quote from the OSI Feb/Mar flyer: "The 6502 is currently the fastest N-channel microprocessor available.... It is also very inexpensive in small quantities and features an internal clock. These features are very important to the hobbyist on a budget, especially if he doesn't have a good scope. The 6800 is somewhat more expensive and requires an external clock. It is rated for a 1- μ s cycle time and therefore can operate at only one half of the speed of the 6502. It does feature two accumulators and a more extensive instruction set than the 6502. Therefore, the potential user should carefully consider it when real-time applications are not anticipated."

24. Techtra Corp. (130 Webster St., Oakland, Calif. 94607) will offer the TMC 112, "a replacement for the PDP-8," with operator's control panel, up to 32K of core or semiconductor memory, "a complete range of peripherals," etc. Based on the Intersil 6100 MPU, the TMC 112 is still in prototype, they tell me.

25. The Micro-68, from Electronic Product Associates (1157 Vega St., San Diego, Calif. 92110) is a wired unit with 6800 MPU, integral hex keyboard and 6-digit display, 512-word "John-Bug" PROM, 128 words of RAM; \$430.

26. The KIM-1 from MOS Technology is a similar unit, with 6502 MPU, 23-button keyboard and 6-digit display mounted on the PC board, 1K

RAM, monitor in 2K ROM; \$245.

27. The Dyna-Micro kit will supersede the Radio-Electronics Mark-8. A microcomputer learning system, it comes with a series of books on learning the 8080 and the system, and is scheduled for introduction in the May-June R-E.

The Dyna-Micro will be marketed by its manufacturer, E&L, as the Mini-Micro Designer, MMD-1, featuring the 8080A MPU, with everything on a PC board, including 16-key keyboard and 24 LEDs, plus a built-in interfacing breadboarding socket. Keyboard entry is controlled by a ROM, and the 256 words of RAM are expandable to 512. The complete set of parts and boards is \$350; assembled and tested, \$500.

28. Hamilton/Avnet offers the Pacer, with the 16-bit PACE MPU, 1K ROM monitor, 1K RAM, two 4-digit displays, 32-key pad, power supply and case, \$695; assembled, \$160 more. For assembly-language programming, a TTY interface/program assembler is \$175.

29. The PCM-12, from PCM (Box 215, San Ramon, Calif. 94583), uses the 12-bit Intersil IM6100 MPU, has a full set of switches and lamps, and is software-compatible with the PDP-8/E. Price: \$400 to \$600, depending on options. DEC's 4K BASIC is included, and is the only software available from PCM right now.

30. According to the Micro-8 Computer User Group Newsletter, the Astral 2000 kit (M&R Electronics, Box 1011, Sunnyvale, Calif. 94080) is based on the 6800, features 8K of memory, serial TTY I/O, and comes with BASIC. It has a 12-amp power supply, DMA, real-time clock, binary and hex front-panel display, and front-panel switches that can be used as I/O while running. Availability was scheduled for Dec. 1975, at under \$1000.

31. HAL Communications (807 East Green St., Box 365, Urbana, Ill. 61801), best known for their RTTY CRT terminals, has taken the 8080A board out of their DS-3000 and DS-4000 KSR/RO terminals, and offers it as the HAL MCEM-8080 microcomputer system, a "complete operating system on a single PC board, exclusive of power supply and Teletype or CRT terminal." Included are LED indicators, switches for system control, a break-point register, 1K bytes of PROM with system monitor, 1K bytes of RAM, for \$375. Options include keyboard/video display, power supply, ROM programmer.

32. From Texas Instruments (Box 5012, M/S 54, Dallas, Texas 75222), the Microprogrammer is the first in a series of Microprocessor Learning Modules. The 3-pound hand-held TI Microprogrammer (LCM-1001) comes in a plastic case, only 6½ x 5½ x 1 3/4 inches, has 20 toggle switches for entering instructions, data and addresses, etc., and 29 LEDs. Available wired only, with rechargeable batteries and charger and 148-page manual, at \$149.95, it has a 40-pin IC connector for expansion; future units will include a controller (with PROM), memory, input/output.

33. The UT 8100 microprocessor from Infinite Inc. (P.O. Box 906, 151 Center St., Cape Canaveral, Fla. 32920), using the RCA COSMAC MPU, will be available in June as a "completely self-contained microcomputer," with built-in keyboard programming, 256-byte RAM expandable to 4K-byte RAM or ROM on-board, external memory expandable (via 16-bit address) to 65K bytes of RAM or ROM, 4-digit hex readout, 16 keyboard switches. Available wired or kit, prices to be announced.

NOTE: The Techtra TMC 112 may not be the only unit still in prototype. There is no way of knowing from an ad if the advertiser has units all ready to ship, or has only a proto-

type and is waiting for enough response to start up production.

MICROKIT UPDATE

As new as it is, the microcomputer scene has already witnessed some major changes:

Scelbi Drops Hardware

Scelbi Computer Consulting is no longer manufacturing either the 8H or the 8B, but is concentrating on software, and at the moment is working on BASIC for the 8008 and 8080 MPUs. Other MPUs are being considered for future software.

Incidentally, the Scelbi "Machine Language Programming for the 8008 (and similar microcomputers)" is highly recommended by many microkit manufacturers, and is now in a second edition, typeset on both sides of the page (the first was all in Teletype capitals, on one side of the paper), still \$19.95 (1322 Rear, Boston Post Road, Milford, Conn. 06460).

MITS Upgrades Both Micros

The 8800B "is an entirely new Altair, the control and display panels are an entirely new design and contain PROM memory.... The clock width is crystal controlled as well as the frequency.... The interface card and front panel are connected by pluggable ribbon cable. The system bus has 18 slots.... the new switches have longer, flat handles." Four new front-panel functions are available for accumulator control: display, deposit, output, input. A slow function single-steps the processor at 32 instructions per second. Front-panel functions can be redefined by reprogramming the front-panel PROM. "Existing Altair owners will be able to purchase a kit from MITS to upgrade their existing Altair to a B at signifi-

cantly less cost than purchasing a new machine."

The new design of the 680 includes an automatic PROM loader, and a BASIC interpreter is being developed. (The original 680 had some bugs, and only two or three were sold before they were all recalled.)

SRI-1000 Delayed

The Systems Research SRI-1000 (Nov. 1975 Newsletter) was designed around the PACE MPU, but there were component delivery problems, so the wired-only SRI-500 is now being offered, with the Fairchild F8 MPU.

MICROCOMPUTER TYPES

The microcomputer scene seems to have settled down to seven basic types:

1. Box with full set of switches and lamps: Altair 8800, Altair 680, Imsai 8080, PCM-12, etc.
2. Box with very few switches or lamps: SwTP 6800, Jupiter II, etc.
3. Box with keyboard, but no switches or lamps: Micro-Sphere 200.
4. Box with keyboard and CRT: the Sphere.
5. PC board without keyboard or display: Wintek, engineering evaluation boards (JOLT, Cramerkits, Pro-Log), etc.
6. PC board with keyboard and display: MRE Mike-2 and Mike-3, EBKA 6502 Familiarizer, EPA Micro-68, MOS Technology KIM-1.
7. Surplus: Viatron.

VIATRON COMPUTERS

Verada 214 (38 French St., Box 438,

Lowell, Mass. 01852) got 20 of the Viatron 2111 Microprocessors, hopes to get more. The 2111 "is a complete computer with keyboard input, two cassette tape drives built-in, a video display, an operating system on ROM.... Guaranteed working when they left our plant": \$699, FOB Lowell.

Meshna (E. Lynn, Mass. 01904) is offering the "System 21," which appears to be the same unit offered by Verada 214, "sold as is; due to 4 years of storage, may require some adjusting/cleaning"; \$425, FOB E. Lynn.

Note that these units are no longer being manufactured, and that most of the mechanical parts (and perhaps some of the electronic parts) are thus not available if needed for repairs. A letter to Interface cries out: "HELP! I have a Viatron model 2101 that doesn't work. Would appreciate contact with anyone who could provide technical information or programming assistance...." Caveat emptor.

FIVE MPUS

Gregory Peterson says, in the Dec. 1975 Denver ACS Newsletter, in part:

"The PACE chip from National... is in a class by itself, a 16-bit machine whereas the other chips mentioned are all 8-bit units. Therefore, it handles more data at a time, but uses a relatively slow semiconductor technology and loses some of what it gained in data volume in relation to speed of execution. It has 48 instructions but only three addressing modes. It is also quite expensive in comparison to the other chips mentioned, cost-int more than twice the others...."

"If you are of the opinion that any computer worthy of the name is at least 16 bits in word length, con-

sider the LSI-11 or the monolithic implementation of the PDP-8 offered as the IM1600 by Intersil. The initial investment in these machines may be greater, but the availability of software is unparalleled.

"There is a large following of people devoted to the smaller 8-bit machines. The 8008 was the first microprocessor available with which to construct a home computer. It is also probably the most prolific of the microprocessor chips. There is a fair amount of home-generated software available to a person who constructs with one of these chips. Unfortunately, the internal architecture can now be considered archaic.

"The 8008 requires a fair amount of supporting TTL logic to make it work, and thus could never be considered for a minimal design effort. The 8080 is very popular too. ... As with any chip, software support is at least as important a consideration as the actual chip itself. In this regard, the 8080 is one of the better chips available. There is a large number of homebrew programs for these chips, and there is a very powerful BASIC interpreter package available from MITS. A FORTRAN package is available from another source. It does require 16K of memory to run, tho. The 8080 is a serious and powerful chip with a large community of users. Yet, even this chip is only a scaled-up and improved 8008. Recent trends in microprocessor design have rendered even this chip obsolete, though it will continue for some time on the sheer momentum of its usage.

"The 8080 is not as integrated a machine as the 6800 and requires that more chips be added around it to enable it to function. The 6800 also differs radically in input and output approach from the 8080. Whereas the 8080 is parti-

tioned along the classical lines of computer architecture, with input and output functions being clearly defined in relation to the flow of other data within the system, the 6800 places all input and output on the data bus as addressable memory locations. Some of the benefits gained from this are the availability of all memory reference instructions to manipulate the input and output ports. The decoding and accessing of input and output locations is easier in this system, and it requires fewer chips to support the microprocessor chip.

"There is also available a read-only memory chip for the MC6800 containing a very nice little monitor system for control of a 6800. This chip is what makes possible the stark front panel of the MITS and SWTPC 6800-based microcomputers. All the lights and switches that are synonymous with data processing are replaced by a small operating system in a ROM chip. This controls operation of the microcomputer and allows one to display memory locations and register values, and alter them at will as one develops his programs. This chip also costs a lot less than all those lights and switches, and simplifies the design of a computing system. Therefore, a computer constructed along these lines is less expensive, but at no sacrifice in computational power. It does pre-empt the ownership of an input and output medium which speaks serial ASCII code, though. A modern Teletype or a TVT with suitable interface board works well, but tends to drive up the initial investment in equipment for a functional system....

"I chose the MOS Technology 6502 chip for my design for several important reasons.... It is possibly the least expensive of the available microprocessor chips (don't forget all that support TTL for the

8008). It ranks as the most powerful chip available now to the home constructor, having 55 basic instructions selectively operating over 13 distinct addressing modes. This addressing flexibility gives the chip unparalleled ease in manipulating data in memory. The chip follows the 6800 in assigning all input and output to locations in memory. It is also the only chip discussed here that incorporates an on-chip clock oscillator. This convenience should not be overlooked. The complexity added by the high-level clock drivers the other chips require, and the increased wiring complexity, can be appreciated only after one uses the 6502.

"The 6502 is strictly a plus-5-volt machine, requiring no multiple supply voltages for chip operation. It interfaces directly to TTL. It is also very fast.... The 6502 is the only chip considered here with two distinct true index registers. This little convenience makes for unmatched ease in constructing programming loops. It also allows data to be easily shuttled about in memory with minimal programming effort. The internal architecture also incorporates an 8-bit accumulator, a fairly standard stack capability, and a good selection of testable status bits to monitor internal operations and allow the chip to alter its processing on the results of its computations. The multiplicity of on-chip registers that 8008 and 8080 users are accustomed to are absent. Computation in this machine is intended to take place between the accumulator and memory, and in a sense the addressing flexibility gives one a whole memory full of registers to use in their computations. One cannot overstress the programming ease the multiple memory addressing modes convey. Rather than having to cleverly juggle the data in on chip registers to trick the chip into accessing the portion of memory you are interested

The Amateur Computer Society is open to all who are interested in building and operating a digital computer.

For membership in the ACS, and a subscription to Vol. III of the Newsletter, send \$5 to:

Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.

Darien, Conn. 06820

The ACS Newsletter will appear every two or three months.

in, there somehow always seems to be an addressing mode to do just what you want...."

TRADING POST -- For Sale

John L. Marshall (Box 242, Boston, Mass. 98055) writes: "Well, I finally broke down and bought a box from IMSAI. I sure hope that it is as good as advertised. I also bought memory and CRT interface from Processor Technology.

"I have a few items for sale. Interested persons may inquire and make offers: Wangco 7 tape drive, MFE cassette drives, 4Kx12 memory systems, line printers, paper tape reader, paper tape punch, TMS 2105 NC, 3002, 3003, 3113, 7491, 1414L, 710, 741."

HARDWARE -- ICs, MPUs, etc.

Cybertronics (Box 18065, Louisville, Ky. 40218) has a 28-page catalog of ICs, MPUs, and wirewrap and packaging items, including the 7400 series, CMOS DIPs, op amps, voltage regulators, 7-segment displays and LEDs, 8008 (\$19.95), 8080 (\$50), PACE (\$125), PROMs, RAMs (2102, \$2.50), EROM kits, IC sockets, power supply kits, capacitors, etc.

THE TARBELL CASSETTE INTERFACE

Don Tarbell (144 Miraleste Drive

Vol. III, No. 14 -- Feb. 1976

#106, Miraleste, Calif. 90732) says: "I have been using an inexpensive audio cassette recorder in my home-designed computer system since 1972. I have over 600 files on cassettes, mostly about 4 Kbytes each. My estimate is that the error rate is less than 1 error in 1,000,000 bits. I say this because I can usually record 30 4-Kbyte files on one side of a C-60 cassette without any errors."

The letter goes on to say that the speed is up to 540 bytes per second (2200 bytes per inch); 187 bytes per second for ANSI standard 800 bits/inch; 30 bytes per second for "Byte/Lancaster" standard. Cost: \$100 for kit, \$150 built and checked out. Write for further details on the Tarbell Cassette Interface.

ONE MORE MICRO

34. Just learned of the RCA COSMAC Microtutor that uses the 1801 MPU (which has 16 16-bit registers), \$349 wired. The Microtutor may later use the new 1802 MPU, and may later be available as a kit, cheaper. The small box, about 5 x 7 x 2 inches, has 256 words of RAM memory, 8 input toggle switches, and a two-digit LED output display.

A TALL ORDER

Most questions asked of the ACS are reasonable, but this one from upstate New York a couple of years ago, asked one that I just couldn't answer: "I would also appreciate some information on the structure, current and past activities, general state of development, and overall orientation of the organization. A run-down on the various levels of accomplishment of the major computer building projects and the "state-of-the art" within the group would also be appreciated."

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