ACS NEWSLETTER

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COMPUTER
SURVEY
RESULTS

ACS COMPUTER SURVEY RESULTS

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

Memory

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

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

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

Input

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

Output

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

Clock

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

Serial or Parallel

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

Transistor Types

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

Integrated-Circuit Types

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

Card Types

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

Number of Instructions

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

Data-Word and Instruction Lengths

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

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

Add Speed

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

Number of Registers

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

Special Features

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

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

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

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

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

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

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

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

Cost

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

For "Estimated cost when complete,"

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

Wiring

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

How Long Working On It?

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

Size

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

Education

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

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

Other Information

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

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

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

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

Interested in Computers Since...

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

COMPLETED COMPUTERS

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

ECHO-4

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

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

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

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

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

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

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

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

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

Interconnections are wire-wrapped.

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

EL-65

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

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

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

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

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

MAGAZINE ARTICLES

Low-Cost Counters

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

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

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

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

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

Basic Digital IC Circuits

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

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

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

Wireless World Digital Computer

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

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

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

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

The Newsletter will appear about every eight weeks.

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

Using Miniature Relays?

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

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

BREADBOARDING INTEGRATED CIRCUITS

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

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

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

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

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

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

NEXT ISSUE

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