A High School Computer System

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We needed hard copy and a high level language . . . .

Homebuilt minicomputers such as the Altair 8800 offer an economical but efficient alternative to more expensive options.

In late May of 1975, John F Kennedy High School in Somers NY suddenly had to face a computational crisis. For the previous two years, the school had been given computing time gratis by the local Board of Cooperative Educational Services; our only expenses were the purchase of an acoustic coupler, and the telephone connection costs. But that May we were abruptly informed that the service would no longer be available.

The problem was that there were three courses that made use of the computer already scheduled for the following school year: an interdisciplinary course, a full year calculus course, and a course in BASIC language programming. Since it was too late to design new courses and drop these, the school began to search for an inexpensive computing system. Besides low cost, we needed a system with a powerful, high level conversational language (either BASIC or APL) with the ability to store programs in some form such as paper tape or audio cassette. The terminal had to provide hardcopy and come with a paper tape reader, if necessary.

Examining the Alternatives

The first possibility was purchasing computing time on a time sharing basis from a major corporation. This would have cost the school over $3000 per year, and was therefore rejected as being too expensive.

The second alternative was to purchase a self contained computing system, such as the IBM 5100 or the Wang 2200. Although they would have filled most of our requirements, their high initial costs ($9000 and $5400 respectively) made them again too expensive for our small private high school's tight budget.

The third and most probable choice was to buy a minicomputer with BASIC software and rent a teletypewriter to interface with it. Since a system of this type met our requirements at an absolute minimum cost, it was decided that this was the way to go. Now there was another important decision to make: What minicomputer system should the school purchase?

That summer, MITS Inc was running a sale on its Altair 8800 computer. What it offered was the Altair 8800 computer, two 4 K dynamic memory boards, an interface board, and, most importantly, their 8 K version of BASIC on paper tape, all for only $995. This meant that the system would pay for itself in less than a year, as compared with the next most expensive alternative. Table 1 shows the breakdown of costs we estimated during the summer of 1975.

The Teletype Model 33 ASR was selected for use as the terminal for several reasons: It provides hardcopy output, it has a paper tape punch and reader, it does not need a telephone connection; and we knew from previous experience that it is rugged and reliable, with maintenance, as needed, readily available under the leasing agreement.

Assembling the Altair

A check for $995 was subsequently mailed off to MITS in New Mexico, and we waited for the kit to come . . . and waited . . . and waited. After almost two months of patience, the kit arrived at the school in late October. Since my father and I were charged with actually building the thing, I had to bring the kit (data bus and all) home with me on the school bus (which was an experience in itself)!

The assembly manual for the Altair was somewhat disappointing in its handling of

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errata information. When MITS makes a change in one of the kits, it throws a pile of modification and errata sheets into the front of the manual. While the information is complete, this makes it hard to keep up with the changes that have been made. A better solution might have been to issue replacement "change pages" to be substituted for uncorrected originals. Another minor disappointment was the fact that not all the bugs had been caught by MITS. One such uncorrected mistake was the fact that the "+" and "–" signs on the power supply's bridge rectifier did not line up with the corresponding signs printed on the board itself. My father and I ended up having to trace the proper connections on the schematic to see what the correct alignment was. I believe that anyone who was unfamiliar with working from a schematic would have some trouble understanding how to orient that rectifier.

Other small problems included nuts, bolts, and screws that always seemed to be the wrong size for the job, and a shortage of terminal lugs.

Working nights and weekends, my father and I completed construction within two weeks. Powering up the kit for the first time, we discovered that the only defective part was one LED on the front display panel. The only thing left to assemble was the serial IO board. This time the assembly instructions were clear enough, but the theory of operation manual was somewhat sketchy.

One thing that MITS failed to mention was how to program the Altair to talk to a Teletype! You would think that they would mention that the interface must be set for 8 data bits, no parity bit, two stop bits, and device addresses 000 and 001, right? Wrong! This information was not mentioned in the documentation. Apparently MITS cannot tell you how to interface the Altair with any specific terminal because they have no way of knowing what kind of device you would be using in the first place. It is fortunate that we had read Don Lancaster's article on serial interfaces in the September 1975 BYTE. My

Table 1: Comparison of Two Year Computing Costs.

SYSTEM	TOTAL COST
IBM 5100	$9000
Wang 2200	$5400
Commercial timesharing	$6740
Phone line cost – $150 per month	
Computing costs – $100 per month	
Terminal with dialup – $87 per month	
Altair Package	$2195
MITS Altair plus software – $995	
Teletype Model 33 ASR – $60 per month	

recommendation on this point would be a set of examples showing several typical cases.

Up and Running

Finally, after a long delay in obtaining the Teletype (not purchased from MITS, but leased from RCA in New Jersey), the system was fully operational. We have been using it continuously ever since.

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MITS is to be congratulated for their excellent software. Their version of BASIC is superior to most others that we have encountered, and it uses only 6 K of memory, allowing us to write programs of considerable length (about 100 lines).

The Altair is kept powered up continuously from Monday morning to Friday afternoon to save wear and tear on the paper tape with the BASIC software; also, it would be too inconvenient to key in the bootstrap program and wait the 12 or so minutes it takes to load BASIC every day.

The security of the system is important because the Altair and the Teletype are both kept out in the same classroom. Because the computer is not very large and thus easy to steal, special precautions had to be taken. The Altair is attached to the cabinet by three screws through the bottom of its case; it is positioned close to the rear of the cabinet so the top of its case cannot be removed with a regular screwdriver. Also, a Plexiglas shield was placed over the bottom

The first addition planned for this system is conversion to a magnetic tape interface. Further in the future, we see the memory expanding to 12 K bytes, purchasing the Altair Floppy Disk System, and trading up to MITS Extended BASIC.

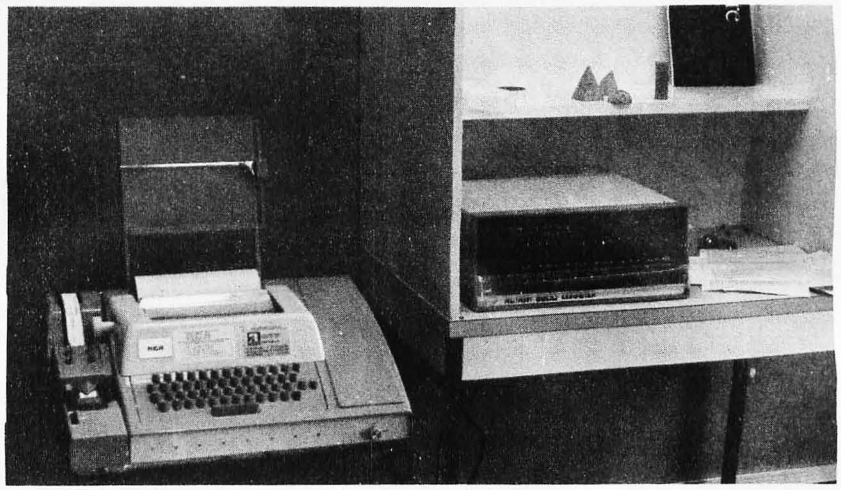

Photo 1: The John F Kennedy High School computing system. There's a Plexiglas shield over the bottom row of switches on the Altair. **—Photos by C T Nadovich**

of the Altair's front panel to keep anyone from inadvertently throwing the "OFF" or "RESET" switches and wiping out the BASIC.

A typical session at the terminal goes something like this: The student connects the computer and the Teletype by turning the selector switch to COM (communicate). There is, at present, no sign on or user password to control access to the computer. Making the student use the computer out in the open discourages those who are not authorized to use it from doing so. (Besides, 99% of the people who aren't supposed to use it wouldn't know what to do even if they got it powered up!) After making the connection, the student clears the memory to remove any data that may have been left by a previous user. He then either keys in his program or loads a program through the tape reader, and goes to work. He may also use a program from a library of special routines we have in several subject areas: mathematics, chemistry, and physics problem solving, lab simulations, text editing, and puzzles and games. When his session is finished, he can save the current program on paper tape, or simply clear the memory and turn off the Teletype.

Photo 2: Two students using the computer.

Future Plans

What does the future hold for this system? The first addition planned for it is the conversion to a magnetic tape interface. The MITS cost for this interface plus an additional expander board and a cooling fan comes to less than $170. The conversion will accomplish three important things: It will shorten the time needed to load BASIC from 12 to four minutes, provide for program storage in the more convenient form of tape cassettes, and it will allow us to trade down from the Model 33 ASR to the 33 KSR. The advantage of trading down is that the KSR leases for $15 per month less than the ASR since it does not have a paper tape punch or reader. The savings will pay the cost of the cassette interface in about a year.

Further in the future, we see the memory expanding to 12 K bytes, purchasing the Altair Floppy Disk System, and trading up to MITS Extended BASIC language, which has double precision arithmetic, controlled format output, and disk files. A TV typewriter or other similar video terminal is also envisioned.

Although this article has focused on use of a kit computer as an economical system for a small high school with a tight budget, the savings outlined are applicable for schools anywhere. In the face of rising commercial computing costs, a homebuilt minicomputer such as the Altair offers an economical yet efficient alternative to commercial computing systems for schools. ■