# Processor Technology History

By Stan Veit

The defects of the original Altair 8800 computer helped create the supporting industry. Even after the purchaser laboriously soldered together all its parts and managed to get it working, the original Altair 8800 computer was little more than a box full of promises. It consisted of a front panel full of little switches and lights, and a metal cabinet containing a power supply. The entire computer portion was one CPU circuit board with the microprocessor chip and a memory of only 256 bytes (expandable to 1,024 bytes).

To Gary Ingram and Bob Marsh, a couple of friends from Berkeley, California, the Altair's faults were seen as their opportunity. Marsh, a member of the Homebrew Computer Club, listened to complaints at each of the club meetings and determined that one of the major problems with the Altair was the small amount of memory provided with the computer kit. The Altair's design did provide for plugging in additional memory boards, and both 1K and 2K Static Memory Boards and a 4K Dynamic Memory Board were offered by MITS. However, the 4K memory board was considered unreliable.

Marsh and Ingram decided to form a company, Processor Technology Incorporated, to produce improvements for the Altair.

The two partners were completely different. Marsh, a small good-looking man with dark hair and a thick mustache, had an outgoing personality and a good sense of humor. Gary Ingram was a long haired, reclusive ascetic. He seldom had anything to say to outsiders. Both were deeply involved with electronics. Though Marsh had dropped out of engineering school, he worked on the fringes of the industry. Ingram was employed as an engineer. The partners developed a wish-list of improved boards for the Altair.

Describing their ideas as already-completed products, they composed a magazine ad and a hand-out flier, hoping to generate funds for their enterprise. This was a common practice in those days. People read ads and would send money to buy "vaporware," products that were announced and sounded good, but would only be available "real soon now." In the case of Processor Technology, their ads reaped a harvest of checks, and the partners were able to rent Lee Felsenstien's garage in Berkeley , where they went to work to make the ads come true.

The first product Bob Marsh worked on was a 4K (4,096 bytes) static memory board. He knew 4K was needed to run the smallest version of Altair Basic, yet the most glaring defect in the Altair was the lack of reliable 4K RAM memory.

There are two kinds of memory chips used in constructing computer memories. The Read Only Memory (ROM) chip, once programmed, retains its information even though you turn off the power. However, since its memory can not easily be re-programmed, the ROM chip is only used for information that does not change.

Random Access Memory (RAM), the second type of memory chip, can easily be re-programmed, and so it is the working memory of the computer. There are two types of RAM memory chips. The most common, Dynamic Memory (DRAM) needs periodically to be given a pulse of electricity (refresh) to keep its memory alive. The alternate choice is Static Memory (SRAM), which consumes more power, but will retain its information without refresh as long as it is connected to a power source. Both DRAM and SRAM will lose information once the power is turned off.

MITS had intended to make memory expansion its first priority, but the expensive 4K dynamic memory board it created did not work well. The Altair board obtained its essential refresh pulse from the 8080 microprocessor chip by a process called "cycle stealing." The problem with this technique is that sometimes the computer chip is off doing something at a time when the memory needs to be refreshed. If this happens, the memory "forgets," and data is completely lost! To make "cycle stealing" work at all, precise timing is required.

Timing problems in the Altair 4K board were what made it defective. Bob Marsh designed the very reliable Processor Technology 4KRA Memory using static memory (SRAM) chips. It had 4,096 (4K) bytes of memory, but if you didn't need that huge amount you could buy it with only 2K, and later add the rest. The 4KRA was priced at $218 in kit form, or $280 assembled, while the defective MITS board cost $264 in kit form and $380 assembled. When 8080 computer users read the ads for the 4KRA, they flooded Processor Technology with paid-in-advance orders.

The instant success of Processor Technology's 4KRA was the catalyst that launched the company into business. Bob Marsh and Gary Ingram moved from their garage workshop into a much larger industrial facility in Emeryville , California , and were joined by Steve Dompier and Gordon French of the Homebrew Computer Club. They hired Lee Felsenstein, their former landlord, as a design consultant. The company started producing a steady stream of new products that worked with the Altair and other computers of the same basic design.

## Processor Tech's Altair Mother Board

After the company's great success with the 4KRA memory, Marsh turned his attention to another acute but much simpler problem with the Altair. It badly needed a better motherboard, and MITS was not going to provide one. When you bought the computer kit, MITS only supplied a four-slot motherboard and one connector for each plug-in board ordered. If you originally bought the kit with only the Central Processing Unit (CPU) card, you only had one installed connector. When you wanted to put in a memory board, you had to disassemble the computer to solder in the 100 pins for the next connector. Most owners only went through that once. They got smart and soldered in all the remaining connectors at one time. If you wanted to expand your computer with additional **plug-in boards, you had to solder in additional four-slot motherboards and connectors.**

You really had to be a dedicated hobbyist to go though that kind of torture. Processor Technology designed an 18-slot motherboard and sold it for only $35. You could add Altair's full compliment of 18 connectors (at a cost of $15 each) all at one time. Word of this improvement quickly spread among Altair owners, and they bought all the boards Processor Technology could make.

## The 2K ROM Board

Processor Technology offered another product they thought was needed for the Altair or Imsai, a 2K ROM board. Loaded with programmed Electrically Programmed read-only Memory (EPROM) chips, this board allowed the user to start his computer without flipping countless front panel switches. The board was not much of a success. It came without the EPROMS, which were difficult to buy and once bought were beyond the programming ability of most computer hobbyists. In addition, the computer hobbyists liked to flip the front panel switches. It was part of the mystique of the computer they were unwilling to share with the casual user.

## Almost Free Software

Processor Technology proposed to supply its customers with "almost free software." For only $15, it made Software Package #1 available, containing an assembler, a text editor, and the system executive programs. The utility programs in this package made it possible for the hobbyists to develop applications using the additional memory now available. Processor Tech also promised a low cost version of BASIC, a promise that caused them a lot of trouble and was not kept for about a year.

## Computer Mart  Becomes a Dealer

Back in New York , I became the Storekeeper (the title I gave myself) of The Computer Mart of New York. Noticing a small ad for Processor Technology in Popular Electronics, I asked Les Solomon, Technical Director of the magazine, about the company. Les knew all the members of Processor Technology and recommended I do business with them. He confided to me that, in addition to the products advertised, new devices were being developed that he said would "blow you away."

When I expressed interest in becoming a Processor Technology dealer, Les called Bob Marsh from my store and arranged for my dealership. As with IMSAI, my main supplier, the financial arrangements were simple. My order was paid for with cash-in-advance, so the company could use my money to buy the parts to fill the order. I got most of the advanced cash from customers. They were so anxious to get the boards, they were willing to pay at least 2/3 of the price up front just to be placed on my delivery list. Of course, if the wait was too long, I had to refund the money. But often, no matter how long the wait, customers chose to leave their deposits rather than take a chance on being dropped from the list.

The best part of becoming a Processor Technology dealer was that it greatly expanded my customer base. Ed Roberts, head of MITS, would not let his dealers sell any products that competed with Altair. My philosophy was directly opposite. My store was the very first to sell more than one brand of computer, and my policy was to carry all kinds of computers and accessories. Since I could not sell Altairs, the people who owned them never had occasion to come into my store. However, with the Processor Technology line Altair owners flocked in to shop for the products they read about in the magazines. They bought Processor Tech boards from me as well as chips, connectors, software, books, and magazines.

Two sorely-needed new Processor Tech products revealed to me by Les Solomon were an input/output board and a Video Display Module. Until this time the difficult job of getting information into, or out of, the microcomputers required separate parallel and serial interface boards.

At that time, the main input/output device used with big computers, minicomputers, and microcomputers was the Teletyper. This wonderful but noisy machine was both a keyboard-input terminal and an output printer. In addition, many Teletyper models included a paper tape punch which could be used as the computer's memory storage.

Connected to a Teletyper, your computer could "dump" the program or data in its memory by punching a pattern of holes into a paper tape. These paper punches could also duplicate their tapes. As many copies as required could be made, and the paper tape could then be rolled or folded up and stored in a drawer. In the early days, punched paper tapes became the principal method of distributing software, mainly because there was no standard for cassette tape.

For the microcomputer user, the main problem with the Teletyper was its cost. The Teletype Corporation sold only to large companies and then only on a yearly contract. New machines cost about $1,800 (three times as much as the microcomputers) and were very hard to get. On the re-sale (gray) market, "used" machines (really, new ones) were sold for as much as $2,500 and re-built ones for about $1,200. Computer hobbyists tried to find old, obsolete models to repair and put back into service, but they were scarce.

Even if you had a Teletyper, you still needed a serial interface board to connect it to the computer. The 3P+S Interface board from Processor Technology had three parallel ports (3P) for connection of various devices such as keyboards, printers, and plotting boards. The 3P+S board also had a serial port (+S) for connection of any kind of Teletyper, no matter how old it was. This was possible because the 3P+S had hundreds of options, which you could select by installing various jumper wire combinations. No matter what printers, terminals or other I/O devices you added in the future, you would never outgrow the 3P+S.

In an effort to provide machines for Altair users, MITS made a deal with Teletype Corporation. For $1,500, MITS sold a brand new Teletyper machine that would only work with their Altair I/O board. Within a few months, the hardware hackers found a way to interface the Altair/ Teletyper machine with a 3P+S board. The information quickly became available to all users through the magazines and computer clubs, rapid conduits for all new breakthrough information. Selling for only $125 in kit form, the 3P+S became Processor Technology's best seller.

## The VDM-1 Video Display Module

In 1975, using a video terminal instead of a printing terminal for computers was a relatively new idea. The video terminals were sometimes called "glass teletypes." They were expensive. The price of a video terminal was many times the cost of a personal computer, so they were only used for large computers

In September of 1973, two years before the Altair appeared, Radio Electronics Magazine had published an article, "The TV Typewriter" by Don Lancaster, describing how to build a crude video device. This device used a TV screen to display the characters which had been typed on a keyboard. Lancaster expanded the article into The TV Typewriter Cookbook, a book written to help hobbyists build their own video terminals. The South West Technical Products CT-1024 Terminal kit, described in the previous chapter, was very difficult to connect to an Altair or IMSAI.

Before working for Processor Technology, Lee Felsenstein had been attempting to build a video-operated "Tom Swift Terminal." Therefore, Marsh and Ingram chose Lee as the person to build the plug-in video terminal board needed by the Altair.

The Processor Technology VDM-1, as it was called, was advertised for sale in the first issue of Byte in September of 1975. Delivery was promised 3 weeks after receipt of order. Processor Technology, like all the early computer manufacturers, underestimated the development time required for a proposed product. The VDM-1 was not actually available until the fall of 1976, and even then delivery might take up to 60 days after order.

When the VDM-1 finally was delivered, it did everything promised. You could connect a keyboard to the computer through the 3P+S Board, plug-in your VDM-1, connect it to a video monitor, and your computer became its own video terminal. The VDM-1 also ran one of the first action video games. Developed by Steve Dompier, Target shot arrows at targets moving across the screen.

The video board was almost too good to be true, with only a few minor faults. A real video display terminal usually had 80 characters displayed across the screen and could show 24 lines of text. The VDM could display only 64 characters on each line, and there were only 16 lines of text. A real video display terminal was made, with special cathode ray tubes (CRT's) and video circuits designed for that specific purpose. Such CRTs were not available for use with the VDM-1. You had to use either video monitors designed for closed circuit television, or converted TV sets. In TV, the picture is "painted" on the face of the tube by a stream of electrons. It "paints" (scans) one line at a time. At the end of the line, the electron stream is blanked out and is returned to the next line. Then it scans across the tube again. This TV scan rate, which permitted only time enough to display 64 characters by 16 lines, was used as the basis for the VDM-1 design. Since typing margins are usually set at least 5 to 10 characters from the edge of the paper, 64 characters proved to be satisfactory for word processing. The VDM-1 was such a wonderful board that users forgot its shortcomings. It became another best seller for Processor Technology.

## The Time of The SOL

The VDM-1 completed the full line of expansion boards for the Altair/Imsai computers. Processor Technology now proposed to write an article describing how to build a video terminal for the Altair. Popular Electronics Magazine agreed to publish the article and show the completed terminal on the cover, provided it was ready for photography within 30 days. Bob Marsh hoped a cover story would assure immediate success for the new product, so he challenged Lee Felsenstein to undertake the task. Using the same circuits Processor Tech perfected for their earlier boards, Lee set to work to meet the deadline. His final design went further than the requirements for a video terminal. He developed a complete new computer. This was a different kind of a computer, one designed not for hobbyists and hackers but for business people who needed useful applications. This was to be a machine not relegated to a workroom or the basement, but a computer that could proudly claim a place in a living room or a private office. The new machine would look somewhat like a modern blue typewriter with handsome walnut side panels and an excellent keyboard.

A friend of Bob Marsh could supply the walnut side panels for the case, if the computer was designed low enough to fit them. The height problem was solved by mounting the expansion boards horizontally rather than vertically. With only room in the case for five boards, most of the computer functions, including the CPU, video, I/O ports, and cassette interface, were mounted on a single large PC board positioned on the bottom of the computer.

Felsenstein's design included a completely new idea, the "personality module." This was a ROM containing various types of system software which changed the capability of the computer. It could have a standard operating system, an intelligent text editing system, or a special operating system designed for a specific job. To effect a change in personality, all you had to do was plug-in the appropriate module.

The stripped-down terminal version Lee designed for the magazine article had a personality module, but only had limited RAM memory. It was still more intelligent than most "glass teletypes," so it was called The SOL Intelligent Terminal.

The full version was to come in two styles. The less expensive one had a simple keyboard and only one slot for expansion. It was called The SOL-10, and very few were ever built. The second model was a complete computer with an excellent keyboard and a card cage with five slots. It was called The SOL-20, and provided enough memory for general computer applications.

When the prototype was complete, the Processor Technology crew headed for New York City to demonstrate it to Les Solomon. The machine had been named The SOL, in his honor.

When Bob Marsh revealed the name to me, I called Les and joked, "They're naming the new machine after you\_The LES Intelligent Terminal!"

Solomon was flattered by the honor in spite of the fact that when Bob Marsh and Lee Felsenstein arrived with the computer, it did not work. It took two days of intensive troubleshooting in Les's basement workshop to bring the SOL to life.

The article in Popular Electronics offered a kit version at a very low price and free schematics to all who asked. Processor Technology, deluged with orders, took almost a year to fill them. The SOL-20, the full working computer, was introduced at the Personal Computing '76 show in Atlantic City . PC '76 was the first big computer show ever held, and SOL-20 was the hit of the show.

My store was selected to be one of the first dealerships to get the SOL. We were a large, well-established New York City store, and many influential business and financial people were our customers. With an eye to attracting additional financing for future growth, Processor Technology wanted the SOL-20 to make a good impression. The Altair and Imsai computers had mainly been sold as kits. The SOL was the first personal computer to only be sold as a factory-built computer. There was one problem, however. The computers I received were "dead on arrival."

I immediately called the factory for repair instructions.

"Can you wait a few days?" Bob Marsh asked me.

"Sure," I answered. "What's going to happen? Magic?"

Three days later, Lee Felsenstein walked into the Computer Mart and asked, "Where are those dead computers?"

A fully operative SOL was important enough to put the designer on a plane for the first service call. From that time on, all computers were carefully tested before shipment. We never again received a SOL that did not work right out of the box. In fact, the SOL became known as the most reliable machine on the market. By 1977, SOL was the dominant personal computer in the industry and was the principal product in my store.

In the spring of 1977, Processor Technology called a "mandatory" dealer's meeting at its headquarters in Emeryville, and I traveled to San Francisco to attend. It turned out to be an important meeting for me as well as for Processor Technology. Here, I met other dealers from all over the United States and made contacts that proved to be of great advantage for future business. John French, owner of the Computer Mart of Los Angeles, was a telephone acquaintance, but after this meeting we became close friends and business associates.

While at the meeting, I received several urgent calls from Steve Jobs asking me to meet him in his garage "factory." He was so insistent that I took time out to meet him and Steve Wozniak. What happened there is the subject of another chapter, but two years from that meeting Apple Computer had replaced Processor Technology as leaders of the industry.

At the Processor Technology meeting, Bob Marsh described the company's plans to introduce the Diablo disk system. This disk system, which was to sell for $1,200, was exactly what the dealers needed. The SOL computer was selling to business people more than home users, and cassettes were not appropriate for storing business programs and data. Gary Ingram made one of his rare appearances, and demonstrated the disk system and the PTDOS operating system. The dealers were also promised larger memory boards and a new color video board.

Business was so good that Processor Technology announced it would no longer require cash in advance. Qualified dealers could now place orders and pay COD. Thirty-day credit terms were promised in the near future. Dealers had to submit an order every three months, and for larger orders there would be an increasing scale of discounts. We all left Emeryville with a feeling of confidence that both Processor Technology and our dealerships were well on the road to legitimacy, leaving behind the "hobbyists" stigma and emerging as a real computer business.

When I returned to New York with the news of the disk system, several of my customers started developing business software for the SOL. These included a lawyer's time accounting system, a church collection accounting system, and an income tax preparation program.

But the picture wasn't quite as rosy as it seemed for Processor Technology. The Diablo Company, whose main business was daisy wheel printers, was purchased by Xerox Corporation, and the development of Diablo's floppy disk drives was stopped. Most of Processor Technology's work on the floppy disk drive system was lost. They were back to square one using cassette tape storage.

Marsh and Ingram's answer to this problem was to adopt a new disk drive just coming on the market, the Persci 270. A new and untried device, it drove two 8-inch floppy disks with one motor. The basic idea was to obtain twice the disk storage at less than the price of two drives. The new Processor Technology floppy disk system, called Helios, consisted of a cabinet containing the Persci 270 (with two drives in one assembly), the power supply and cables. The PTDOS disk operating system was included. The cost, $1,895, was later raised to $2,300.

For a while Processor Technology continued to grow, and the dealers prospered. Then Radio Shack came out with its TRS-80 Model I at half the price of the SOL. They eventually developed a disk drive and the TRSDOS operating system. The Apple II appeared and quickly became very popular. The Apple II sold for much less than the SOL, could do graphics in color, and had an ever growing library of software. Its drawbacks were a 40-column screen and the lack of upper/lower case characters. In spite of these drawbacks, when Steve Wozniak developed an inexpensive and reliable floppy disk drive for the Apple II, it soon outsold the SOL.

At Processor Technology, the partners were mesmerized by the success of their company. They became aloof, less available to the dealers, and appeared not to be interested in their problems. Lee Felsenstein urged them to improve their products, but, except for larger memory boards, no new products were under development, and no attempt was made to upgrade the SOL to keep it ahead of its rivals. The promised color video board was never delivered and neither was the promised improved BASIC. Though Chuck Grant and Mark Greenberg, owners of North Star Computers, had been under contract to Processor Technology to develop a version of BASIC for the SOL, North Star, claiming that their agreement was non-exclusive, sold it to other computer manufacturers. Processor Technology was under the impression that the BASIC was exclusively theirs, sued, and lost the case after a long litigation that hurt both companies.

In spite of the growing problems, Processor Technology moved south to a much larger plant in Pleasanton , California . There, in big offices with windows overlooking the countryside, the partners became even more distant from the heart of the industry and their dealers. They talked more to outside financiers about investors and the possibility of going public, and less to the people who sold and used the SOL.

Meanwhile, North Star developed a new, low-cost, mini-floppy disk drive system that would work with the SOL. Coming with its own operating system, the disk cost less than half the price of the Helios.

Back in New York , Larry Alcoff, a young man interested in personal computers, had undertaken to make the CP/M operating system (now an industry standard) run on the new inexpensive North Star disk drives.

When he started, Larry did not realize he had undertaken a tremendous task. He was a wealthy young man who hung out first at my computer store, and then at Bob Radcliffe's Hoboken Computer Works. Radcliffe, a former Bell Labs engineer, urged Larry to try this difficult job as a way of learning about programming and computer hardware at the same time. As Larry progressed with Bob's help, it became apparent that the job would succeed.

To sell the product, Larry first sold "program patches" to CP/M owners that allowed them to run their CP/M software on the North Star 5 1/2" drives. Then, at the suggestion of Tony Gold, who ran the CP/M Users Group, Tony and Larry formed a business called Lifeboat Associates because they were "all in the same boat." The partners licensed CP/M from Digital Research Incorporated and produced a new North Star 5 1/2" Drive version of CP/M. If Processor Technology had adopted the North Star floppy disk system, it might have avoided additional trouble. However, because of the past legal problems, the partners refused to even consider it. They kept trying to sell the Helios disk system to their dealers. Problems with Helios started to surface almost at once. Although much faster than most of the other 8-inch disk drives being sold, the Persci 270 was very sensitive, difficult to keep in alignment, and if moved, might lose alignment and stop working. Unfortunately, these problems only surfaced after Processor Technology spent thousands on development and manufacture, and had shipped the Helios to several dealers. It was too late to switch to another drive.

In addition, many people, including the dealers, urged Marsh and Ingram to abandon PTDOS, their proprietary operating system, and adopt CP/M. The partners refused to listen, certain that their system would be much better.

When their pleas and recommendations went unheeded, the dealers became less and less interested in the Helios. They could sell the North Star disk drives and ignore the undependable, expensive Helios­. For the next year most of the dealers sold SOL computers with North Star disk drives and CP/M from Lifeboat. This made business applications possible. If you included a daisy wheel printer and either WordStar or Michael Shrayer's Electric Pencil, the SOL became an efficient word processing system that only cost $3,500. In those days, an equivalent dedicated word processing system cost $10,000. Soon other disk drive systems made by George Morrow, Micromation and Micropolis came on the market and could also be used with the SOL and CP/M.

Thus, SOL dealers who ignored Processor Tech's Helios disk and its oddball software prospered, but dealers who sold the Helios found themselves in trouble because of constant failures. In my case, one of the few Helios I sold resulted in a lawsuit by my customer against Processor Technology, one of many such cases throughout the country. Until suit was brought, Helios customers could not even get the principals at Processor Tech to discuss the problem. Marsh and Ingram would listen to no one.

As if the problems with the Helios drives were not bad enough, Processor Technology finally came out with a new line of dynamic 32K and 64K memory boards. These boards used new dynamic memory chips rather than the static memory used in the original Processor Technology memory boards. The required refresh cycles for the dynamic memory chips were generated on the board itself. This procedure supposedly made them "safe" from the problems associated with the original "cycle stealing" dynamic memory boards. But all at once, all over the country, these new memory boards began to fail. At first, Processor Tech replaced the defective boards, but the problem soon became overwhelming. When dealers sent in defective memory boards for replacement, none were returned.

Relationships with the dealers became more strained. It became harder and harder to communicate problems to the partners, yet people on the lower level were not given the power to make decisions.

To keep my dealership, Processor Technology required that I send in an order every three months, but, since I (and other dealers) were selling more and more Apple II's and less SOLs, our inventory of SOL boards and computers grew until it reached almost $100,000. I became very concerned and tried to talk to the company about my problem. I knew I couldn't afford to buy any more, and I wanted to run a sale to convert this excess inventory into much-needed cash. When the ordering period came, I declined to order anything, and Processor Tech pulled my dealership. In answer to this, I prepared an ad for Byte and several other magazines saying "SO LONG SOL" and announcing a clearance sale at 50% off. When Processor Technology heard about it, the partners called and begged me to take back my dealership.

Gary Ingram himself said, "It all was a terrible mistake. Please don't drop the line."

They would help me reduce my inventory by selling it to other dealers. Because of our close relationship in the past, I agreed and canceled the ads. But my problems were only typical of the trouble at Processor Technology. The accumulated mistakes and the unresolved problems, compounded by the inaccessibility of the owners, proved to be overwhelming. On May 14th, 1979 , Processor Technology closed its doors forever. They did not declare bankruptcy, they just closed. I was stuck with almost $100,000 worth of inventory that I had to liquidate.

Lee Felsenstein went on to design the Osborne 1 Computer, Bob Marsh went into business building mini floppy disk drives for the Osborne Computers, and Gary Ingram completely disappeared from the industry. But the thousands of SOL computers did not disappear; they survived and were used for years by their owners until they could not be maintained any longer.