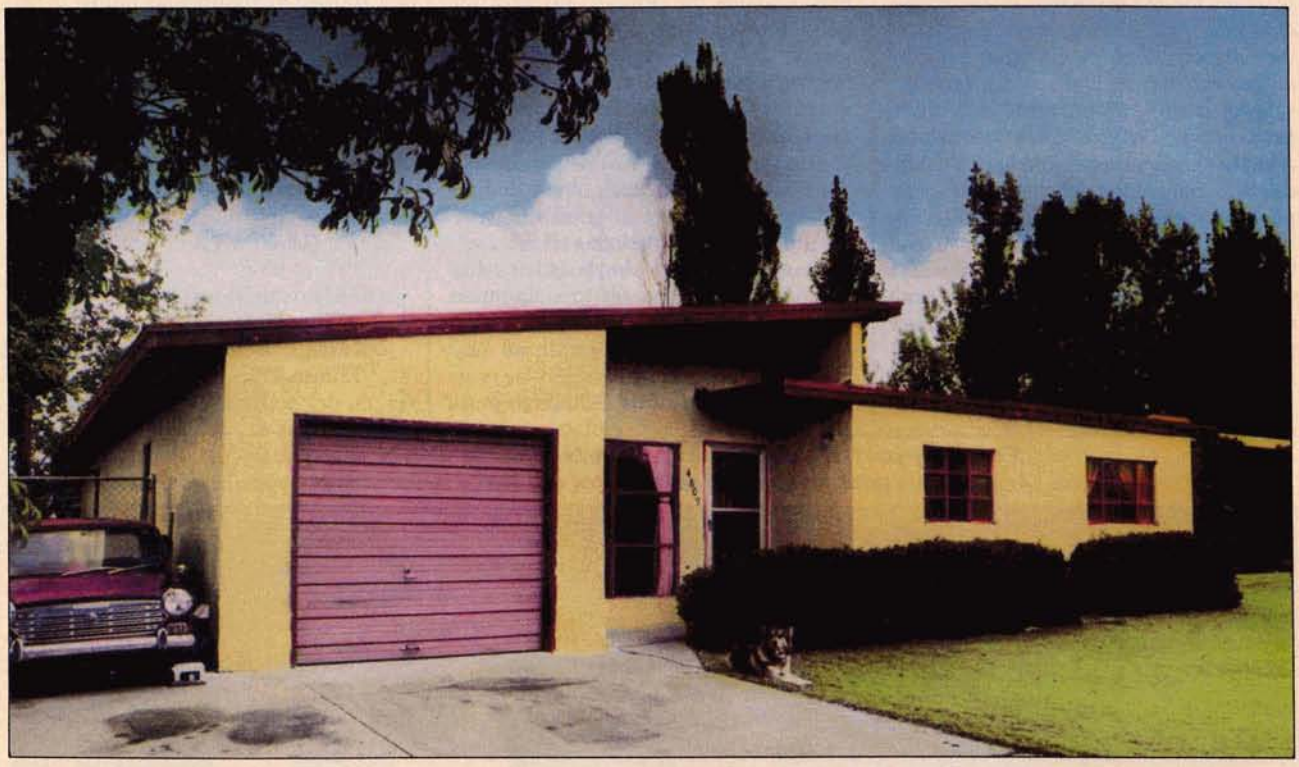
THE TENTH ANNIVERSARY OF THE ALTAIR 8800

Popular accounts of the invention of the personal computer are fraught with error, ego, and eccentricity. To tell the story behind *the story,* COMPUTERS & ELECTRONICS *asked Forrest Mims to review the history of the microcomputer. Mims is one of the founders of MITS (Micro Instrumentation and Telemetry Systems), the company that produced the Altair, the first successful personal computer. In the articles in this issue, Mims chronicles the development of the micro and talks with H. Edward Roberts, the "father" of the Altair.*



RICHARD PIPES

SETTING THE RECORD STRAIGHT

BY FORREST M. MIMS III

Few major inventions have uncontested ancestries. Consider, for example, the controversies over who invented the telephone, the incandescent lamp and, more recently, the digital computer. Now, the invention of the personal computer is being written about in magazine articles and books, and some of these accounts contain glaring errors and omissions. That should trouble those of us who use personal computers, for we are the first generation to have at our fingertips the means to extend intellectual and creative abilities once available only to a few.

Two facts about the history of personal computing are indisputable. One is that the introduction of the Altair 8800 through the pages of *Popular Electronics* exactly ten years ago sparked the personal computer revolution. The other is that both individuals and small companies were building small computers long before the Altair arrived in 1975.

As a high school student in 1959, I, among others, began building simple analog machines that performed basic arithmetic. By 1961 these early machines culminated in an analog computer that translated 20 words of Russian into English. The key circuit of this machine, which I still have, was a memory consisting of 20 miniature trimmer resistors that were automatically scanned by a mechanical sequencer made from a modified electric music box mechanism.

Ed Roberts also began building both analog and digital computing devices in 1959. Even before Ed Roberts, Stan Cagle, Bob Zaller and I formed MITS in 1969, Ed and I used to discuss the homebrew analog computers we had built a decade earlier. In the summer of 1970, we discussed designing and selling, through an article in *Popular Electronics*, a kit analog computer that would use operational amplifiers. Had not Ed become interested in designing the 816 digital calculator featured on the cover of the November 1971 issue of *Popular*

Electronics, MITS might have developed an analog machine.

Sol Libes, who writes the "Bits & Bytes" column for this magazine, is particularly knowledgeable about the pre-Altair era of personal computing. He has written about the formation of the Amateur Computer Society by Steven Gray in 1966 and several discrete logic and microprocessor-based machines built prior to the Altair.

Among the most important commercially available pre-Altair machines was the Scelbi-8H, a product of Scelbi Computer Consulting Company. This machine used the 8008 microprocessor, Intel's first 8-bit microprocessor.

Jonathan Titus' Mark-8, which was featured on the cover of the July 1974 issue of *Radio-Electronics* and which also used the 8008, soon became more widely known than the Scelbi. Titus' article listed a source for circuit boards for the machine, but hobbyists who wanted to build a Mark-8 had to locate the components on their own. Nevertheless, according to Libes, more than 500 Mark-8's were eventually assembled by experimenters.

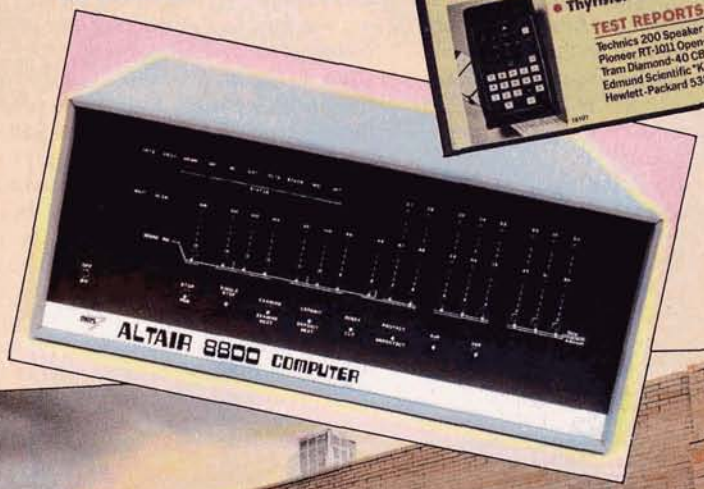
To say Scelbi, Titus or Roberts invented the personal computer would be manifestly unfair to Marcian Hoff, Stan Mazor, Federico Faggin and the other engineers at Intel who conceived and designed the first microprocessors in the early 1970s. The architecture of the first microprocessors was itself based upon concepts developed decades earlier. The personal computer was then a logical culmination of more than a quarter of a century of digital developments, and everyone involved rightfully deserves credit for the roles they played. If you want to find out more about the early days of digital computing, the classic work is *The Origins of Digital Computers* (Springer-Verlag, 1982), a collection of early papers in the field compiled and edited by Brian Randell.

The Henry Ford of Personal Computing

Though Henry Ford didn't invent the automobile, his role in the early automobile industry was unsurpassed. Similarly, while the invention of the personal computer cannot be attributed to a single individual, credit for fathering today's multi-billion-dollar personal computer industry rightfully belongs to one man, H. Edward Roberts.

Ed's Altair 8800 was a major advance over its predecessors because it used Intel's new 8080 microprocessor, a more powerful version of the 8008 that required fewer support chips. Computer

On opposite page: the garage in New Mexico where it all started. From top to bottom: Altair 8800 was introduced to the world in the January 1975 issue of Popular Electronics (predecessor of COMPUTERS & ELECTRONICS). Altair 8800 in the flesh. One of the original sites occupied by MITS. Ed Roberts.



RICHARD PIPES

FORREST M. MIMS III

PHOTO TINTING BY LINDA M. EKLUND

hobbyists knew about the 8080 before the Altair. They could obtain from Intel "From CPU to Software," a 47-page booklet that described in great detail the 8080, its instruction set and its support chips. The booklet even included two system block diagrams. But because the 8080 sold for $360 in single quantities, few people could afford it. Ed Roberts bought the chips in large quantities and was able to get a substantial discount, allowing him to sell his Altair in kit form for only $40 more than the cost of a single 8080. This helped account for the incredible response to the two Altair articles that appeared ten years ago in *Popular Electronics*.

Of course Ed Roberts and MITS did far more than design the Altair; they set the stage for the personal computer industry as we know it today. In addition to hardware peripherals and software, MITS pioneered personal computer conferences, clubs, stores, users' groups, software exchanges and company newsletters. By the time Ed sold MITS to Pertec in May 1977, MITS was often called the IBM of personal computers.

Today, comparatively few people have heard of MITS and the Altair 8800, much less of Ed Roberts. And to make matters worse, some of the new generation of computer journalists have written books and articles containing errors about the origins of personal computing. A recurrent theme in many articles and books about computers is that personal computing was born in California, either among members of the Homebrew Computer Club, in Steven Wozniak's garage or in Silicon Valley itself. Even while preparing this article, I happened across still another perpetuation of the persistent California myth in an otherwise interesting piece by Steven Levy in the November issue of *Popular Computing*. Levy described how Wozniak and others brought circuit boards to Homebrew meetings and concluded that: "Those ridiculous boards attached to boxes with blinking lights turned out to be the spark of the modern personal computer industry."

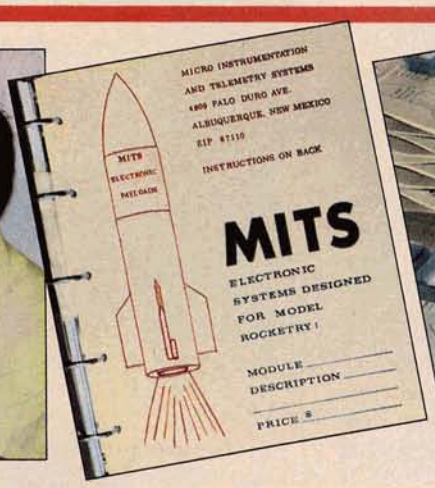
Many members of the Homebrew Computer Club can point with justifiable pride to their accomplishments. Stephen Wozniak, for example, co-founded Apple Computer, one of the most spectacular success stories in American business. But the fact of the matter is that the modern personal computer industry was sparked by the Altair 8800. Indeed, the Homebrew Computer Club, which first met in March 1975, was itself sparked by the arrival of the Altair. Wozniak himself recalls in *Digital Deli* (Workman Publishing, 1984) that when the Homebrew Computer Club was formed, "There was just one personal computer then, the Altair 8800. . . "

Rewriting History

By far the most important book yet published on the early days of personal computing is *Fire in the Valley* (Osborne-McGraw-Hill, 1984) by Paul Freiberger and Michael Swaine. This fact-filled book contains a wonderful

(Continued on page 81)

MINNIE MIMS



FORREST M. MIMS III

MIMS AND MITS

WHEN he helped form MITS, Inc., in 1969, Forrest Mims had no idea the company would eventually start the personal computer revolution. After he left MITS 18 months later to become a professional writer, Mims continued working part-time for MITS and wrote the operating manuals for the firm's first digital calculator and the Altair 8800.

From 1969 to 1976, Mims accumulated dozens of early MITS papers, photos, catalogs, ads, fliers, data sheets, and operating manuals. He also saved the carbon copy of the original draft of the Altair operating manual and 12 issues of *Computer Notes,* the post-Altair tabloid published by MITS.

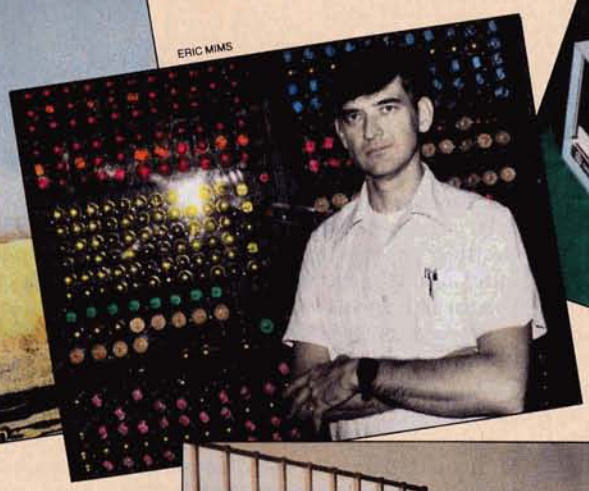
As for hardware, Mims has dozens of the model rocket telemetry modules that were MITS's first products and the 816 calculator he built while writing the machine's assembly manual. He also has an Altair, which still runs and is in excellent condition, given him by Ed Roberts in return for writing the machine's operating manual. Mims's Altair lacks a serial number because it was one of several preproduction test machines.

Last summer Mims's collection of MITS memorabilia came to the attention of Dr. Uta C. Merzbach, curator of the Division of Mathematics at the Smithsonian Institution's National Museum of American History. While Dr. Merzbach was visiting Mims's home in Texas to review the material in person, Mims suggested a conference on the history of the development of the personal computer to be held at the Smithsonian. He believes such a conference could help put an end to many of the widely believed myths now being published as facts in computer books and magazines.

Dr. Merzbach agreed to consider Mims's conference idea. She also asked him if he would donate to the Smithsonian his collection of MITS material and a language-translating analog computer he built when a high school student in 1961. Mims has agreed to donate the material as soon as he can find time to prepare an inventory and make copies of some of the papers. ◇

Left: Dr. Uta C. Merzback, of the Smithsonian Institution, with Forrest Mims. Center and right: Some of the materials that will be donated.


FORREST M. MIMS III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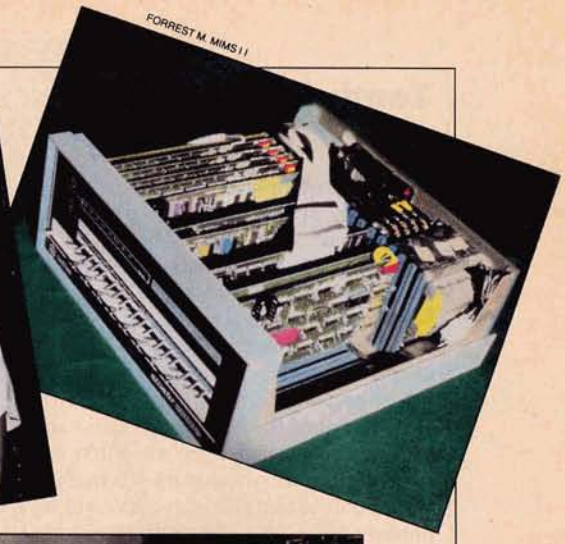
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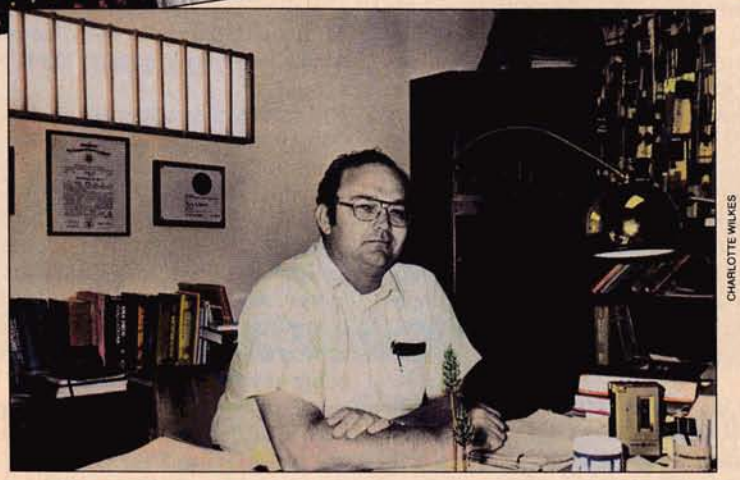
CHARLOTTE WILKES

A CONVERSATION BETWEEN ED ROBERTS AND FORREST MIMS III

If one person deserves to be known as the "Father of Personal Computing," it's H. Edward Roberts. After graduating from Oklahoma State University with an electrical engineering degree in 1968, Ed Roberts was commissioned a second lieutenant in the United States Air Force. He was then assigned to the Air Force Weapons Laboratory in Albuquerque, NM. There he met Forrest M. Mims, III, who was a research and development officer interested in lasers, model rockets and analog computers. Mims had been assigned to the Weapons Lab after service in Vietnam as an intelligence officer.

Both Roberts and Mims worked on a variety of sophisticated projects at the Weapons Lab's Laser Division. They soon developed a friendship that culminated in the formation of a company to build instruments for model rockets. The original partners included two other electrical engineers: Bob Zaller, who stayed with the company for only several months, and Stan Cagle. They named their company Micro Instrumentation and Telemetry Systems, or MITS.

In November 1970, *Popular Electronics,* as this magazine was then called, published articles describing how to build the Opticom, an infrared voice communicator developed and sold in kit form by MITS. Sales were poor, so Roberts shifted his interest to developing a kit calculator. Concerned that the calculator market would attract too much competition, Mims and Cagle sold their stock to Roberts.

Cagle eventually moved to Arkansas to become an electronics instructor in a community college in Fort Smith. Mims became a full-time free-lance writer. He has written 47 books and more than 500 articles for 30 magazines. Since October, 1975, his columns have appeared in each issue of this magazine.

Roberts stayed with MITS until 1977, and developed the first digital calculator kit, the first kit programming unit for a calculator, digital clock kits, and, of course, the Altair 8800, the first successful, commercially available hobby computer. Others had previously used TTL logic and early microprocessors like Intel's 8008 to make working microcomputers, and some of these machines were sold as complete or partial kits. But when the Altair 8800 was featured on the cover of the January 1975 issue of *Popular Electronics*, the personal computer revolution took off.

Roberts hoped to sell at least a few hundred Altairs to rescue his company from possible bankruptcy brought on by crushing competition in the calculator market. He was as surprised as anyone by the reaction to the Altair article and the fact that MITS eventually sold thousands of the machines.

In just two years, MITS pioneered the first personal computer users' group, the first company newspaper, a software exchange, the first company-sponsored personal computer conference, Altair BASIC, and scores of hardware and software products. In May 1977, Roberts sold MITS to Pertec Computer Corporation and the following summer moved his family to a 900-acre farm in Georgia. Today, at 43, Roberts is attending Mercer School of Medicine, thereby fulfilling a lifelong ambition of becoming a medical doctor. He also heads Georgia Medical Electronics, a company that develops novel computer-supported medical devices.

Over the years, Roberts and Mims have maintained their friendship. Even after Mims left MITS, he wrote the first assembly and operating manuals for the company's first calculators. After the Altair was developed, Roberts gave

Clockwise: Ed Roberts and friend at launch site. Forrest Mims. Second generation Altair 8800B. Ed Roberts today.

Mims an assembled computer in exchange for writing the machine's operating manual.

Concerned by erroneous accounts about the early days at MITS that have been published in various books and magazine, Mims has included several chapters about the historic company in *Siliconnections,* a book he has written that describes the many electronic adventures he's experienced since first experimenting with transistors as a twelve-year-old in 1956. (*Siliconnections* will be published by McGraw-Hill later this year.)

The following is a question-and-answer session between Forrest Mims and H. Edward Roberts, co-founders of MITS.

Mims: Ed, how does it feel to be known as the father of the personal computer?
Roberts: I don't think I'm known as the father of the personal computer. I don't think there are more than a dozen people in the whole world who really know that—maybe a few dozen, actually.

M: Like people with Altairs in their closets. Ten years ago did you have any idea the industry would be the size it is now?
R: I don't think anyone did. But I've been very disappointed in the speed of the technology. When we sold MITS to Pertec, you could have bought an Altair that would have done essentially anything that can be done today. It's a little disappointing that the technology hasn't moved any further than that.

M: Do you have any regrets about selling MITS?
R: No, not really.

M: How would you advise a budding entrepreneur with a good idea but no money?
R: That's a good question. The whole trick to being an entrepreneur is to be unconventional. I think the only way you make money is by getting involved in something you enjoy doing. If it turns out to be lucrative, great; and, if it doesn't, that's OK. If you get knocked down, you've got to get right back up and keep going. I think that bulldog tenacity is probably the single most important thing.

M. From my experience at MITS, the most creative times at an entrepreneurship occur when it's still a garage operation. I'm still a garage operation and I'm going to be a garage operation forever. Everytime I start a new circuit or program it's the most exciting thing I'm doing.
R: What I'm doing right now is probably the most interesting thing I've done in electronics in the last ten years. I'm the only engineer here. I'm doing all the electrical engineering and all the software; and we're extremely well funded. I've got all brand new CAD and logic development systems from Hewlett-Packard and the best scopes that Tektronix makes. It's really a fantastic laboratory.

M: Sounds like you're satisfied running a company much smaller than MITS was.
R: To put some perspective on that, after the Altair became a real product, Bill Yates (who helped develop the Altair) became really badly motivated, particularly after Pertec took over. It had been building before that; he used to tell me all the time, "Ed, MITS isn't fun anymore." And he was right. I couldn't really argue with him. It wasn't any fun for me anymore. It got to where we weren't doing anything very creative, and I was spending my whole life solving soap operas. Somebody would find out someone else was making 3 cents an hour more than he was and there would be a big panic on the production line, with everybody threatening to string up the production supervisor. I was wasting all my time with crazy stuff like that.

M: Well, like I've told you, once I had to go through a receptionist to see Ed Roberts, MITS wasn't fun anymore. After the Altair explosion people were falling all over each other to get in to see you.

Changing the subject slightly, the new generation of computer journalists is beginning to take a big interest in the history of personal computing. Some of their books have contained glaring errors about MITS.
R: In my experience with the press—and I use that term very loosely—you're better off ignoring those guys. They're going to win no matter what you do.

M: What did you think about *Fire in the Valley,* by Paul Freiberger and Michael Swain (Osborne-McGraw-Hill, 1984).
R: Well, obviously the bottom line of that book was to try to move the origins of personal computing from Albuquerque to Silicon Valley. I don't think it was as much an attack on MITS as it was an attempt to rewrite history.

One of the things that really strikes me about all this—and it means nothing to anybody now—is the hours and days I agonized over things like using BASIC. That seems like a totally logical answer right now, but BASIC was a relatively unknown language in 1974. It had only been invented in 1968. Boy, for a year I took a lot of heat that it should have been FORTRAN or APL. Nobody remembers any of that.

I could just go on and on and on with decisions I made that right now have major impacts on the direction that personal computing took. And all those decisions, that in retrospect I think were pretty good—it's as if I had nothing to do with them. The only decision I found in that whole book was that we were the first company to use 4K dynamic memories. That's a little exasperating.

M: Some well-known people are now claiming they helped you develop the Altair. I hope my new book will help set the record straight.
R: I don't know if it's recoverable now. I'm frustrated. On occasion, I go someplace like Radio Shack and, just to get the salesman to leave me alone, I say I'm the one that really started personal computing. He looks at me like I'm crazy and says, "Oh no you're not! It was some guy at Apple or somewhere else." I've gotten to where I don't tell anyone anymore.

M: Years ago I quit telling people I was a MITS founder because they always asked, "What's MITS?" Speaking of that, what one thing would you have done differently if you could do it all over again?
R: Lots of things, with 20-20 hindsight. Probably the single biggest mistake was to build Microsoft at MITS instead of building our own internal software capability. I thought we were building a software capability, but it turned out we were building Microsoft. So I would control the software more personally.

M: Everytime I sit down at my IBM computer, I'm using Altair BASIC.
R: Right.

M: And nobody knows that.
R: Right. Microsoft BASIC was developed and popularized because of the Altair. The reason it exists and the reason it's the standard is because of the Altair and not because of anything else.

M: How would you assess the status of software today?
R: What hurts the industry right now is that the software is developed independently of the hardware to a large extent. And until software is integrated into the

(Continued on page 82)

collection of stories and anecdotes about the people, programs and products of MITS, IMSAI, Processor Technology, Apple and many other early companies. Even though its title reinforces the Silicon Valley myth, *Fire in the Valley* is must reading, especially for those who entered the world of personal computing before 1978.

Unfortunately, however, *Fire in the Valley* includes several major errors about the history of MITS. Among the most curious are the claims that a *Popular Electronics* technical editor, Leslie Solomon, flew to New Mexico and along with " . . . Roberts spent many nights in Albuquerque hashing out the exact components of [the Altair]" and that David Bunnell and Ed Roberts " . . . worked long hours in the workshop on their computer." The latter claim was recently supported in a subscription appeal for a computer magazine that included a note from David Bunnell that began, "When I helped develop the first personal computer in the 70's, I didn't realize that the industry would exceed $6 billion by 1983."

Ed, who has read *Fire in the Valley*, is baffled by these assertions. He has always expressed gratitude that *Popular Electronics* was willing to publish the Altair articles. But as for receiving technical help from the magazine, Ed recently told me, "No such thing ever happened." David Bunnell was a technical writer at MITS, not an engineer. According to Ed, "He did some fantastically creative ads and the World Altair Computer Conference was his idea. But Dave never had any involvement with product design at MITS."

So who really designed the Altair? I visited MITS when the first Altair was being designed and built, and I wrote the original operator's manual for the machine. To the best of my knowledge, Ed Roberts alone deserves full credit for the decisions to build the computer and to incorporate the expansion bus. Ed also designed the circuitry, specified the bus lines, selected the 8080 and specified the various front panel switches and status indicators. As reported in *Fire in the Valley*, Bill Yates spent many hours planning most of the circuit boards and the bus terminations. A couple of times when I visited MITS late at night, Bill was hard at work laying out the double-sided Altair boards with colorful strips of red and blue tape. In addition, Ed reports that Jim Bybe made numerous suggestions that were incorporated into the final Altair design.

Fire in the Valley also claims "No one at MITS had *ever* built a computer." Actually, as I mentioned earlier, Ed had begun building simple analog and relay computers in 1959. When Ed and I first became friends at the Laser Division of the Air Force Weapons Laboratory in 1968, he often talked about building a full scale digital computer. As I observed above, at MITS in 1970, we seriously discussed building a kit analog computer. From 1971 to 1974 Ed designed and manufactured many different kinds of digital calculators and programming units that used large-scale integrated sequential logic circuits and memory chips almost identical in operation to those used in digital computers. Moreover, Ed had worked extensively with minicomputers, both at the Weapons Lab and at MITS. In short, Ed had extensive knowledge of computers when he designed the Altair.

Although *Fire in the Valley* falls short in its account of MITS, the book is filled with fascinating anecdotes about the early days of personal computing. Moreover, its authors have presented the best summary yet published of the role played by Ed Roberts' company. "It would be hard to overestimate," they wrote, "the importance of MITS and the Altair. The company did more than create an industry. It introduced the first affordable computer, of course, but it also pioneered computer shows, computer retailing, computer company magazines, users' groups, software exchanges and many hardware and software products. Without intending to, MITS made software piracy a widespread phenomenon. Started when microcomputing seemed wildly impractical, MITS pioneered a billion-dollar industry."

Silicon Valley Fever (Basic Books, 1984) by Everett M. Rogers and Judith K. Larsen is another widely publicized book that perpetuates the California myth. Though old timers will find this book dull, too long and overly simplistic, I can recommend its nonfiction content for novices interested in the high-tech culture.

As for fiction, *Silicon Valley Fever* parrots in a matter-of-fact fashion "mythinformation," such as that Apple "launched the microcomputer industry"; "Silicon Valley is the birthplace of pocket calculators [and] home computers. . . . "; the first personal computers

Circle No. 65 on Free Information Card

"were all kits"; Apple was first to offer a disk drive; and so on. MITS, which is misnamed in the text and isn't even listed in the index, is allotted a 1" footnote in small print on page 277 at the end of the book. In short, the typical reader will come away from *Silicon Valley Fever* convinced that were it not for California geniuses the personal computer would still be a twinkle in the eye of some science fiction writer.

After reading *Silicon Valley Fever*, I sent its authors a three page letter listing some of the errors in their book. I'm happy to report Everett Rogers responded that they would include corrections in the book's second printing. He also wrote " . . . we agree with you completely that [MITS] was *the* pioneer in microcomputers."

We owe future generations a complete and accurate record

Getting the Facts Together

While the men who pioneered personal computing are still with us, it is essential that they begin recording for history their recollections about the roles they played. I've asked Ed Roberts and Bill Yates to write down everything they can remember about the Altair project, and those who worked at other early companies might want to do the same.

In our lifetime there may never be another invention which will have the intellectual impact of the personal computer. Therefore, we owe future generations a complete and accurate record of the development of the personal computer. Finally, those who rightfully deserve credit as pioneers should be properly recognized, even if their contribution had its origins in a garage in New Mexico instead of California. ◇

Mims and Edwards

(Continued from page 62)

hardware, we're not going to see any major breakthroughs.

M: Tell me about the lap computer you developed at MITS in the summer of 1977 after Pertec bought you out.
R: It would fit in a briefcase. There were two versions, one that plugged in and one that was battery-powered. Neither used CMOS because CMOS was just becoming available, so they had fairly high power consumption. I think the battery-powered machine would run, maybe, 3 or 4 hours. The basic system had 16K of user RAM, a 32-character LED display, and a standard-size keyboard. Our materials cost was in the ballpark of $150, which would have meant the asssembled system would have probably been $450 or $500.

M: What happened to this machine? Did Pertec kill it?
R: They didn't actually kill it. I gave them the drawings and we had the industrial design finished; but, after I left, they just let it die. It got caught up in the NIH (not invented here) thing within Pertec, where the engineering department was doing regular product development and felt threatened by it. I think that's kind of what killed it. There were some comments made later by some of the key people at Pertec that there was no market for such a product.

M: Was any hardware built?
R: Oh, yeah. It was built and checked, tested, and run.

M: You mean an actual prototype was built?
R: Sure. When I say prototype, it was not a full-up manufacturing prototype. It was a working prototype.

It got caught up in the "Not Invented Here" thing within Pertec

M: Did the lap computer use the 8080?
R: Z80. At that time I was really interested in the Z80 because it was a hot chip that had just come out.

M: Radio Shack picked it for the TRS-80 Model I.
R: Yeah. It was fast—roughly two or three times faster than the 8080—and had a little more sophisticated instruction set.

M: Since the 8080 microprocessor was available in 1974, it was inevitable that someone would have eventually developed a successful personal computer with or without MITS. How much of a lead did the Altair give the industry?
R: We didn't see any serious competition in terms of new mainframes for about two years. People like Processor Technology began providing add-on cards for our system within 6 or 8 months after the Altair was introduced, and IMSAI may have started shipping copies of the original Altair 18 months later. But as far as anybody doing anything fairly original, I think it would have been probably close to 2 years later. ◇

Optical Computing

(Continued from page 67)

and the theories hard to grasp; yet progress and optimism are apparent in conversations with key people in the small community of researchers.

No one believes that optical computers will replace general-purpose electronic computers. Analog optical processors seem destined for specialized niches, where they can do certain jobs better than anything else.

Digital optical computing is in its infancy. If the systolic-array approach works out, optical matrix-handling modules might someday plug into supercomputers, permitting simulations far more detailed than possible today. Optical techniques might help supercomputer designers bypass the interconnection problems that restrict design of very large scale integrated circuits.

Might optical processing, with its potential for parallel processing and its inherently analog nature, match the tricky and still undefined requirements of artificial intelligence? It will be a long time before the answer is known, but the question clearly seems worth asking. ◇