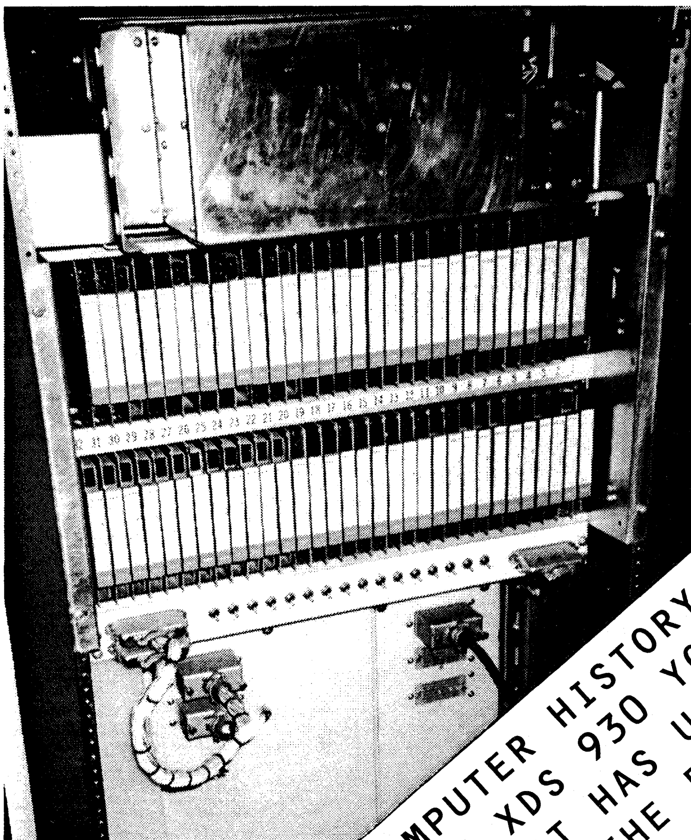
The Analytical Engine

JOURNAL OF THE COMPUTER HISTORY ASSOCIATION OF CALIFORNIA



CPU Rack

GREETINGS TO THE COMPUTER HISTORY ASSOCIATION OF CALIFORNIA.
THIS IS OUR VENERABLE XDS 930 YOU ARE GETTING. WE HOPE IT
SERVES YOU AS WELL AS IT HAS US. TREAT IT WELL AND WE
ARE SURE IT WILL RETURN THE FAVOR -- MAYBE.
SPACE ENVIRONMENT CENTER
BOULDER, COLORADO

Take it easy....

Volume 3.2 *The 930 Comes to California* February 1996

February 1996 Volume 3.2

The Analytical Engine

JOURNAL OF THE COMPUTER HISTORY ASSOCIATION OF CALIFORNIA

TIME! TIME! TIME!

"Barney Oliver, a brilliant engineer and friend of the CHAC, died in Los Altos Hills on Thanksgiving Day."

That's how much of this editorial had been written when we received the news, from JAN Lee at Virginia Tech, that Konrad Zuse had died in Hünfeld, Germany on December eighteenth. As Paul Ceruzzi points out, Zuse's death means that the "first tier" of the great concept-makers in computing — Vannevar Bush, Stibitz, Atanasoff, Turing, Aiken, Eckert, Mauchly, von Neumann, and Zuse himself — is no longer represented in mortal company.

This turn of history will no doubt provoke highly particular feelings in each person who reads this. It makes *us*, personally and particularly, feel like running out to the sidewalk of El Camino and yelling "They're dying! Help! Somebody do something!" Because at times it drives us to distraction — like a chant barely in earshot: *will be lost....slips away....has been lost.* Like a drum roll muffled but unending.

Now more than ever, raise your voices, say with us: *We have to save the stories!*

With your help, with the power and will of us all, the CHAC strives to save *some of every part* of computing in California — computing, that landscape of dazzle, stair-carpet of hyperbole, heedless sower of jargon and acronym, that cultural and economic and social jolt of ingrained flashing speed. It becomes us. It overtook our land, and other lands, reached out, and with a million sparks threaded a continent of consent — the net, the Web — a world, where none was! in the ether.

We cannot save it all, for it became us. But we *must* save *some* of it all. And most of all we have to save the stories. Silicon persists as long as the sand that gave it up; steel only grudgingly returns to earth; even paper can be saved by vigilance and care; but stories untold can die like a bolt from the blue, on Thanksgiving Day or any other.

If you read the ENGINE, please *write* for the ENGINE — and remember that we want *your* story most of all. Or, if you don't feel up to writing, certainly you can recommend someone that the CHAC might interview. Do your part for the history of computing and help us save a story today!

TECHNICAL KNOCKOUT....

The cover of the November ENGINE proudly proclaimed "Fall Double Issue." A few weeks later we turned around and realized that, if we included all the proposed material, February's ENGINE would be a "Winter Double Issue" — something we all would have enjoyed, but a luxury that the CHAC can't afford this year.

Computer history is *roaring* the world around. New museum projects abound, from California to Germany. Interest in legacy hardware and software has increased tremendously over the last year — at least if the questions we're asked, day in and day out, are any indication. And there's so much computer history news that we're hard pressed to keep up with it....which is a way of saying that we can't, but we won't admit it.

With a few more subscribers — another hundred or so — we could publish an ENGINE with fifty-six or sixty pages every quarter. (Sixty-four would be especially cool.) We could stop pushing material forward from one issue to the next. And the best part is that, if more people subscribe to the ENGINE, everybody gets bigger and better issues. That includes you.

....doesn't it? You do subscribe, don't you? Good. That's what we thought.

GET THE PICTURES!

Beginning with the November issue, the ENGINE — in a way — was a casualty of its own success. The documents in support of Chris Edler's fine HP 3000 history were the ENGINE's first internal illustrations. But they also meant that, for the first time, the plaintext version of the ENGINE wasn't the entire magazine; a state of affairs that obviously couldn't continue. We'd already considered distributing the electronic edition in more elaborate formats, such as ASCII PostScript or Microsoft RTF, but every such choice or workaround seemed restrictive.

The perennial innovator in graphics, Adobe Systems, now seems to have provided an ideal solution with Acrobat cross-platform page mapping software. Files can be printed to the Acrobat engine, which creates bitmaps of the pages, naturally including any graphics. On the subscriber's end of the wire, these bitmap files can be read with — and printed by — the Acrobat Reader program, which is widely available and free to individual users.

Thanks to the Acrobat Distiller and Reader, the print and electronic editions of the ENGINE will be in step once again. As soon as we can convert the files to Acrobat format, we'll make 3.1, 3.2, and later issues available by e-mail to subscribers and through our Web site to visitors. The latest version of the Reader will be available through a link from the CHAC's Web site. We're grateful to Adobe Systems for its part in making pictures, as well as words, an indispensable part of the Net's worldwide language.

PURE GOLD....

The golden years have begun. As you'll see in **Quick Takes,** 1996 will comprise the fiftieth anniversaries of the founding of Engineering Research Associates (ERA,) the dedication of ENIAC, and the establishment of the Association for Computing Machinery (ACM) and the IEEE Computer Society.

Clearly the ENGINE, from this day forward, must commemorate — or at least take note of — significant anniversaries in the history of computing. There will be so many, especially after the turn of the century, that we'll need help keeping track of even the major dates. This is a job for our staunch friends the spotters.

If there's an imminent anniversary worthy of notice, please, don't hesitate to remind us! Send e-mail to engine@chac.org with the exact date, the particulars of the event, and — if you happen to have one — a source for background. Thanks!

ADS, ANYONE?

We've been wondering lately if the ENGINE could be improved by accepting advertising. Certainly there are potential advertisers who would appreciate the chance to reach the ENGINE's highly qualified audience. We, in turn, might as well concede that a classified section could easily be supported by the number of enthusiasts who ask us about buying and selling historic micros....and occasional non-micros. Finally, the revenue from ads could postpone price increases. (Looked at the cost of paper lately?)

Our current intention is to include a small section of classified advertising in the May issue, and proceed judiciously from there. The ENGINE would appreciate hearing from anyone who feels strongly about advertising in its pages — and, of course, from anyone who'd like to take out an ad. But we recognize this as a significant change in policy and we'd be reassured by the consent of our readership.

NOT A COMMERCIAL,

just some sage advice. We've noticed that ENGINE subscribers very often order back issues, and in full sets at that. Naturally, an order for the complete ENGINE is one of the most flattering testimonials we can receive.

All good things come to an end, though, and our back issues are no exception. At this moment there are probably twenty or thirty full sets left in storage. We don't intend to reprint them, at least not in their current form.

If you'd like a set — nine issues, 1.1 to 3.1 — send a check for US$51 to the Palo Alto address. This amount includes first class (domestic) return postage. But do it today!

FOUR MORE YEARS....

The turn of the century is imminent, and with it, the dreaded 1999 Anomaly in full force. The CHAC, as it happens, is interested primarily in significant hardware that will be scrapped because it misinterprets the dates of the new millennium. But plenty of DP professionals are still working with live, running computers — significant in quite another way — that have this nasty little kink hidden deep in their opcodes.

In 1993, when we published the first CHAC FAQ and the earliest issues of the ENGINE, we called attention to this fact and felt like a voice crying in the wilderness. Well, no more! The Year 2000 has become such a hot topic, in this context, that some people are referring to it — with more urgency than precision — as "Y2K" for short. Programmers who need deep wizardry to keep their mainframes running can now find a lot of useful knowledge, most of it on the Net.

Peter de Jager, with the sponsorship of the Tenagra Corporation, has created a Web site — The Year 2000 Information Center — "to provide a forum for making information available about the year 2000 problem and for the discussion of possible solutions." There's an associated Internet mailing list, too. Browse the Information Center at http://www.year2000.com/ and be grateful for what you may find, because this clock is really ticking!

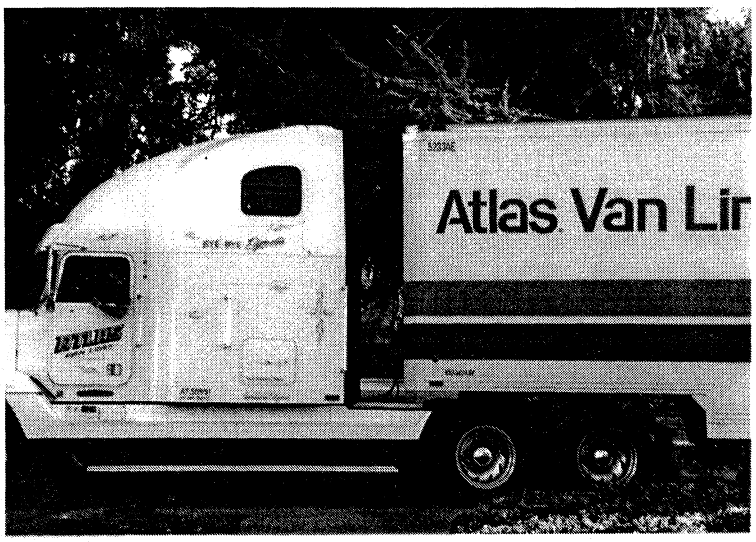
THE 930 COMES HOME

At 8:30 in the morning of October eleventh a moving van, pulling onto a blacktopped lot in the South Bay, finished its fourteen-hundred-mile trip from Table Mountain Observatory in Colorado. Inside Mike Byrd's formidable truck (and not really filling much of it) were a dozen racks, a console, peripherals, tapes, docs and cabling — in other words, the SDS 930 permanently loaned to the CHAC by the Space Environment Center in Boulder, Colorado. After a year and more of planning, outreach, publicity, and (at last) frantic fundraising, the X-PROJECT came to a successful conclusion with a unique and important small mainframe safely in storage.

This 930 was the fifteenth of (probably) 168 constructed. It was delivered from Scientific Data Systems in Santa Monica to the National Bureau of Standards in Boulder, in December 1964, and installed in a low cinderblock building called I-10C, on Table Mountain, a windswept mesa in the shadow of the Rockies. It became the main data acquisition computer of the early-warning program called HANDS, for High Altitude Nuclear Detection System. This was not trivial work, and in its day, the 930 was about the only commercially available computer capable of it.

SEC and the 930 settled into what would be a startling thirty-year relationship. The computer was too good to let go, and the Center's technicians and programmers labored to make it better. SDS factory diagnostics required that running tasks be shut down; SEC wrote diagnostics that could run while data acquisition continued. SDS support was costly and involved the delays of travel; SEC brought hardware support on-site by learning to perform it themselves, for everything but the two vast Bryant drum memories.

Thanks to SDS' rugged design and construction, and SEC's razor-sharp maintenance, this computer is pristine today; it may even be bootable. It is, absolutely, imposing and beautiful. What follows is not the whole story of the 930, which would take a book, but a few details and pictures that will let *you* — advisers, donors, and members of the CHAC — know what you accomplished. — *KC*



Fourteen hundred miles....

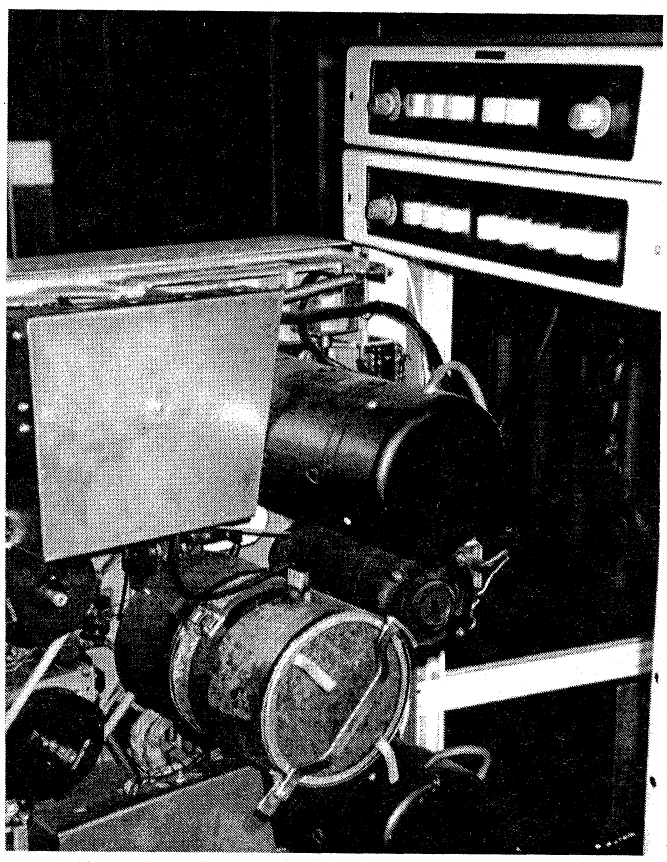
All photos by Janette Kiehn

out of Boulder, van driver Mike Byrd pulled his five-axle truck — with deceptive ease — into the parking lot where we waited. The October morning was bright with yellow leaves and banners of sunlight that made Northern California, perpetual chameleon of the seasons, look like New England at its best. About a dozen CHAC stalwarts, distinguished affiliates, and guests were pacing impatiently, talking in huddles, or stopping by a tailgate for doughnuts and desperately needed coffee. As Mike put the truck where he wanted it, and the crew dragged out the long aluminum ramp, I thought about the history and purpose of what we were getting....

PURPOSE

From the time its ARPA contract was written in 1963, this computer had a single aim in life: *data acquisition.* The Space Environment Center's dishes pointed every which way, and strip chart flowed ceaselessly from recorders, as the 930 took in data from satellite telemetry, magnetometers, radiometers, radiotelescopes, and about every kind of radio antenna from VLF to HF. All of this was intended not only to monitor, but to forecast, conditions in the upper atmosphere and in space, however they might influence the Government's state of readiness.

The system's reliability was paramount, since downtime would create gaps in recordings that were meant to be continuous. A near-perfect uptime record was achieved with the help of redundancy, clever programming, and as much on-site maintenance as possible. Native ruggedness helped too — not only of the SDS hardware itself, as illustrated by these tape drive motors, but of the numerous special-purpose peripherals built by the Center's engineers. Today's answer to these demands might involve a duplicate computer, but the SDS' full system cost of nearly $1 million made that unthinkable in the mid-sixties!



Tape drive motors.

HARDWARE

The 930's hardware was and *is* solid enough to drive nails. Mil-spec TTL on thick boards is all soldered, without a trace of wirewrap. Finned heat sinks are everywhere. Precious metals are abundant — the silver mostly in conductors, the gold mostly in connectors. Each module has an individual power supply with a voltage meter. As a former SDS engineer remarked when he learned that this 930 had had a thirty-year useful life, "We built better than we knew" — and one look inside the racks will prove that they knew they built damn well.

This lack of fragility, however, didn't slow the 930 down. A cycle time of 1.75 µsec, with most instructions requiring one to ten cycles, made this about the fastest small scientific mainframe available in its day. To keep up with the hardware, all of SEC's programming was done in raw machine language. System memory, in well-warmed mag core, is *16K* of 24-bit words — the same size as an Apple II plus. Installation of a second 16K rack was contemplated but never done.

The Magpak.

Naturally, with 16 Kwords available to handle torrents of data, nothing could linger in core a split second longer than necessary. As much as possible was swapped out to the two capacious "RADs" — fifty-megabyte Bryant stainless drums, tunable only with a masterful hand and an oscilloscope, but marvels of engineering at a mere $50,000 each.

Further away from the core stood seven seven-track tape drives, IBM-compatible at 556 bpi. Eventually these were supplemented by the interesting Magpak (at right,) a dual-cassette drive. Unfortunately less reliable than the reel-to-reel drives, the Magpak was still handy for archiving programs and data.

If the 930 as installed had a single greatest strength, of course it was I/O. Sixty-four analog inputs, thirty-two hardware interrupts and thirty-two sense inputs meant that this computer was rarely at a loss, however much it was asked to juggle. Although up to eight hardware I/O channels could have been installed, SEC made do with a single channel and relied on a gorgeous array of multiplexers to decode and drive thirty to forty channels of strip chart.

Console Teletype and a VDT.

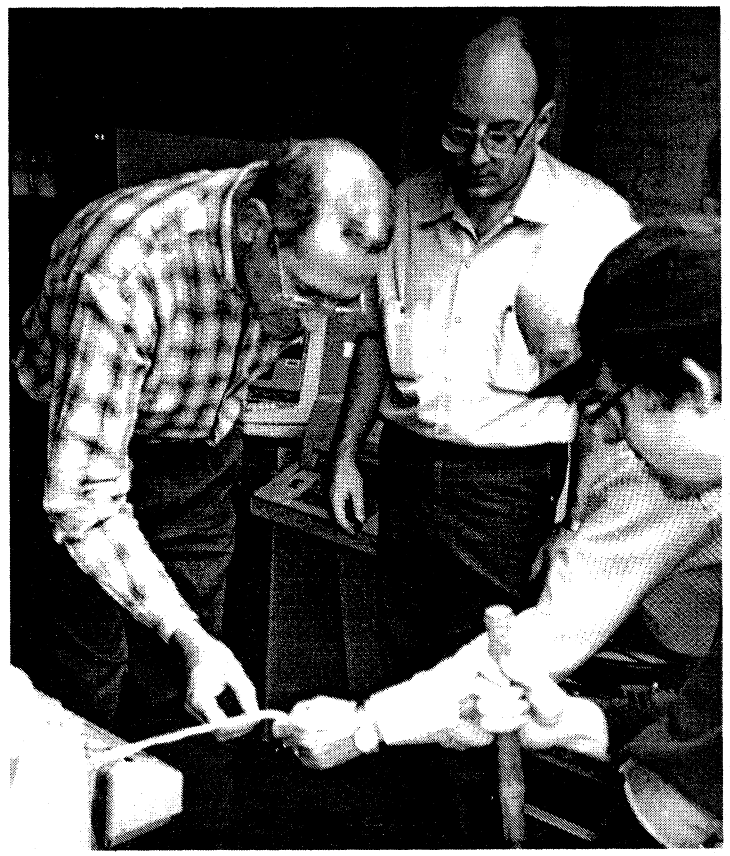
Console I/O was handled originally by a KSR35 Teletype; later some Model 33's were added along with a pair of "homebrewed" VDT's, one of which is a Bendix (at right). The Teletypes, like the seven-track drives, grumbled at constant duty and required scrupulous maintenance.

All in all, the 930 is a curator's prize for any number of reasons — its exceptional standard of design and construction, its complex configuration, its pristine condition, and its sheer physical beauty. Someday, we hope soon, this exemplary device will be set up again for the whole world to see.

WRAPPING IT UP

Getting the 930 into its locker was hard work made easier by racks on casters, but the whole process is still listed under "Don't try this at home." As soon as the moving crew had shifted everything from the van to the locker — with the kind of determination prevalent in action thrillers — it was the turn of the CHAC faithful to swarm over the pieces, pull off yards of ductape, remove some non-historical labels, and check the inventory. Generally, the only part that showed deterioration was the foam insulation in the cabinet doors, which we removed rather than let it crumble all over the hardware. We also spent a while just gawking! Some of us were tempted to slit open boxes of docs and parts, but they were so nicely taped that (sigh) we just put them on top of the racks for the moment.

As I write this, the 930 is in stable condition, with a steel roof over its head. The container is ventilated and we're hoping for relatively dry weather in February and March, after which the South Bay's rainy season is generally over. Some parts still need a good cleaning, some or all of the docs will be taken to archival storage, and the racks should ideally be wrapped in plastic. We hope to report that this work is finished in the next issue of the ENGINE.



Reading the console message (see cover). L to R: Len Shustek, Edwin El-Kareh, Bob Crosby, Kip Crosby.

TIGER TEAM PARTY

While we're on that subject! The preparation of the 930 for storage should be finished between now and May, if at all possible. An enthusiastic tiger team could probably finish the necessary cleaning, lubrication and packing in one whole Saturday or Sunday. Experience in electronic assembly and maintenance will be preferred but not required. We haven't picked a date yet, but if you'd like to volunteer, send e-mail to engine@chac.org or leave a note on our Web page at http://www.chac.org/chac/index.html. TIA!

HEROES' LIST

The 930 was saved by generosity and hard work. Some of our heroes have been supporters of the CHAC for months or years, some stepped forward to introduce themselves when this rescue became an all-or-nothing proposition. The greatest reward of this project is the safety of the 930; second only to that comes the pleasure of saluting the rescuers. Many thanks to these principled men and women who gave the cash, the logistical help, the advice and the physical work that did the job.

Anonymous

Allan Alcorn, Silicon Gaming

Gwen Bell, Computer Museum

James Birdsall

Mike and Paula Byrd and crew, Atlas Van Lines

Robert Cousins, AIM Technology

Bob and Enid Crosby

Ted Drake

George Durfey, Perham Foundation

Edwin V. El-Kareh, AB Networks, Inc.

Ralph Gorin

Alan Hawk

Dewayne Hendricks, Warp Speed Imagineering

Jerry Jensen

Janette Kiehn

Ed Klein

Jerry A. Klein, The Chatham Group

Don Koijane, Perham Foundation

Ted Laliotis

Mark Laubach

Everybody at Space Environment Center, National Oceanic and Atmospheric Administration

Mark Lentczner, Glyphic Technology

Frank McConnell, Attachmate

Steven McGeady, Intel Corporation, Intel Architecture Labs

Nancy Mulvany

John Novitsky, MicroModule Systems

Max Palevsky

Martin Reynolds

Arthur Rock

Bill Sarill

T. J. Seaney, Golden Van Lines

Len Shustek

Roger Sinasohn, Roger Louis Sinasohn & Associates

W. Bennett Smith

Marie Sullivan, IBM

Tim K. Swan, ZuniTech

Larry Tesler

Chuck Thacker

Bill von Hagen

Pierluigi Zappacosta, Logitech Corporation

COMPUTERS FOR THEIR OWN SAKE:
From the Dompier Music to the 1980 Computer Faire

An Interview with Lee Felsenstein (Part 2)

KC: I recall that there was considerable appreciation for [the Dompier Music] at the time — that the brilliance of it was immediately recognized.

LF: Yes. I proposed that he be awarded the Stripped Phillips Screw Award, for finding a use for something previously thought useless. That was a turning point, in effect, and later, when he wrote the software for Processor Technology, he put Dompier Music into the game program — Target — that he wrote for the Altair with the VDM [Video Display Module]. But I'm getting ahead of myself.

HOMEBREW GETS A NAME

The third, and significant, meeting of the Club, which didn't have a name yet, was at Peninsula School. The fourth meeting — I believe — was in the orange room at SLAC[1], and that was when we tried to figure out what this organization was called, and we settled on Homebrew Computer Club. At either the fourth or the fifth meeting, Gordon French announced that he could no longer run the meetings because he was going to Baltimore to work on a long-term contract with the Social Security Administration. Either at that same meeting or the next one — probably the next one since I don't recall that Gordon was there — Marty Spergel in the audience suggested me [to succeed Gordon] and I didn't say no, and everyone else seemed happy with that, so I got up there and began to run the meeting. I started out by going around the room, having people introduce themselves and describe what they were doing, and that was the origin of the convivial process that I developed. But at a later meeting, which must have been in SLAC auditorium, I tried to do that and it took so long — I think it took almost the whole meeting to go around the room.

[1] Stanford Linear Accelerator Center.

So I figured, let me just call on people who want to talk, but restrict them to the kind of things they would say for introductions. And then when people talk, I'll ask them to stand up so that they can be identified. If there had been some way to make them wear a number, I would have done that, but I didn't know how to do that. This was a kind of secondary information transfer and I got it from Community Memory, which was all about secondary information. Primary information was to be imparted in face-to-face discussion, or on the phone, or by various non-broadcast means. Sitting down in a meeting, and not saying anything unless called upon, was the price you paid for some very sparse information that pointed you to the person you wanted to talk to; but that only began the communication, it didn't complete it. So I wanted to go through several cycles —mapping, then random access, then mapping, then random access — and the more cycles we could go through, I figured, the better we could converge. But they never came back from the first random access session. Enough people had introduced themselves, and I said "Okay, now talk among yourselves," and it was like a cocktail party with no booze — everybody knew who they wanted to talk to, and why, and that was the rest of the meeting. It wasn't possible to get them back together. So I decided that would be the mode of organization, and it was very productive indeed.

A PROCESS IN PROCESS

My job in all that was actually to do comic routines and, when necessary, disarm certain types of people. There was always some guy who would get up, sweating, and feel like this was his big chance to say everything at once — as if he were giving a sales pitch and wouldn't have another chance. I also had to prevent back-and-forth, yes it is/no it isn't, discussions, because you could see the lights go out all over the audience when that happened. If anyone started dominating the conversation with a single topic, half the audience would go to sleep. So I was strictly the facilitator, and I warned people, "Don't come up afterwards and ask me who said this or that, because," and then I would slip into my comic persona, "I'm just thinking about my image up here and I don't know who said what. So you look for people and keep track of them yourself." I had to say that every time, along with "Don't ask me, don't talk to me, you're talking to everybody — and keep it short, you have ninety seconds that I will enforce capriciously." Of course there were exceptions; Jim Warren would start delivering this gossip column, what he called his Core Dump, and we never enforced a ninety-second limit on him. I consider that process that one of my best designs, because we learned that in that environment, the expertise was distributed but it was there and could be relied on. Sometimes we had speakers, and we'd put on the speaker first, then we would do the mapping, and then we'd have random access. But if the speaker didn't show up, I would say "Okay, we had a speaker scheduled and he was going to talk on this topic. Who here knows something about this topic?" One or two hands would go up, I would call on somebody, and they would recite a fact. I'd say "Okay, what does that bring up for anyone else?" And someone else would qualify that fact and give another fact. Through this process we could construct a lecture on almost any topic out of that audience. In effect it was rather like object-oriented programming, in that we had a collection of objects that included everything we needed, it was just a matter of figuring out how to organize them; and in this case they organized themselves. During this time, various elements got organized into twenty-three companies that we could identify, one of which was Processor Technology.

"SATISFACTORY AND DIRECT INVOLVEMENT"

KC: What time, exactly, are we talking about?

LF: The most fertile time for the Homebrew Computer Club was from 1975 to 1977 or possibly 1978. During that time there was no venture capital coming into this industry. The whole idea of making money at [microcomputer design and production] was an alluring but very dubious proposition. It was being done by people who loved to do it and who wanted this to be their main chance. I think most of the people attending were working in the electronics or computer industry, at various levels which gave them either no access to computers, or just enough access to be frustrating. They were looking for a more satisfactory and direct involvement. Meanwhile, the largest contingent I could identify outside the industry were physicians.

KC: Physicians?

LF: Yes, medical doctors who had this as a hobby. Some of them probably should have been engineers. There may have been people from other industries who didn't identify themselves, but the doctors always referred to themselves as doctors. Here we all were, doctors included, putting computers together, trying to get them to work, without much of a fixed goal as to what we wanted to do with them once they worked. That's another important point. The creativity that resulted from working without goals was a very broad creativity. Working with fixed goals could produce creativity in depth, but it would be tightly focused — very narrow. This was broad. So many people were attending Club meetings, and yet so few of the people who got involved with personal computers could really have justified them on any rational grounds. At that time, the primary entrance into personal computing was a white lie that you were going to spend $397 on an Altair kit from MITS, put it together, do some programming and then keep the recipes or checkbook or control the house environment with it. In practice that was certainly not true. Your typical real experience would involve spending several thousand dollars, as well as a lot of time to master a huge amount of information. Some of the things that you ended up learning probably wouldn't be useful in any other part of your life, but they were very interesting to learn.

KC: So these people were, on the one hand, not quite ready to concede that they were building computers for the sake of it, but on the other hand, not at all clear on what they intended to do with the computer once they had it.

LF: Right. It was a mass learning experience with definite justifications which were not easy to make, certainly not on economic grounds. The impulse was to have a certain amount of say in one's life, certainly over the technological systems that affected us all, and they knew it was important to make computers and the surrounding technology accessible to as wide a range of people as possible. This was an article of faith that People's Computer Company had been promoting, but it had also been discussed for years in science-fiction literature, and science fiction had risen to become a kind of ideology related to computer activism. Many different currents of thought were combining there.

NOT FOR MONEY BORN

I think the fundamental point, around which people came together, was a rejection of a society in which technology becomes so advanced that it's no longer accessible to ordinary, non-qualified, non-specialists. And information technology was seen to pose a particular danger in this regard. Not only are we, in effect, creatures of information, but also, information is the most plastic technology. The computer by its nature as a machine takes innumerable different forms, depending upon the program, and the program in turn can change those forms, to make it a different kind of machine. Some of the implications here had barely been explored, because the uses of the technology had been restricted to a hard industrial context. What I mean by a "hard industrial" context is one in which return on investment is necessary and everyone works for the success of the organization. The Club members were discovering and defining ways in which information technology could be developed outside of such a context. Most Homebrew members were working for personal success. Success — or return — was defined not in monetary terms, but in terms of capability. By showing that you could do something that no one else had done, you got respect. You were also expected to teach other people about it. We didn't appreciate star mentality, not that too many big stars came by, but anybody who had learned something and acted like they weren't going to tell anybody else would certainly not get much respect. So the success of the Homebrew Club was not something that had to be created; it was present in the people who came. The success of the club was the sum of the individual successes. The only way I had of organizing it was to recognize it and to give it a base to grow in.

KC: So we're talking about two examples of spiral development. In the first place, you were working with the plasticity of information and the exchange of information among a popular base. First you tried to do it with a big computer, with Community Memory, and then not all that long later you were trying to do it with the micros. The second example, distrust of stardom — of people who had information and kept it to themselves — was a reiteration of the Hacker Ethic, which had started ten or fifteen years earlier on mainframes.

LF: Had it? Mainframe hackers themselves aspired to be stars, as far as I could tell. Within their own culture they were generous with information, but they could be very scornful of someone who was not on their level. I suppose they weren't scornful of everybody who came near them, because then they wouldn't have gotten any new people coming in, but you had to go to them in order to be accepted into their society. We were doing something different, saying "Well, we're not where [the mainframe hackers] are. We're not where the big machines are. We're here, and we've got some little bitty things that don't work particularly well, and whatever we accomplish, we want to do without walls."

BREAKING OUT OF THE MONASTERY

The Club met in a room that could accommodate 275 people, but by 1978 there were over 3,000 people on the mailing list. Membership was a rotating proposition. The Homebrew Computer Club was not circumscribed by any place — you could say that it was based in Silicon Valley, but even that doesn't have a limit. This represented a significant difference in culture from the first generation hackers, who explicitly saw and described themselves as wizards. A friend of mine — my next door neighbor and someone I knew well — ran into some of them camping in the mountains or something and they were talking like that. She came back to me and was really upset by these people describing themselves as wizards and making themselves separate, so I have that independent confirmation. Another example was my interaction with the Systems Concepts folks.[1] I tried to get work there and I was treated to the "clever puzzle test." I design products, I don't do clever puzzles, and I basically decided "To hell with it. I'm not even going to attempt the clever puzzle." Stu Nelson had already been talking about not needing bypass capacitors on TTL logic if you ran the power and ground lines as absolute transmission lines — which was too dangerous for me; I had seen the

[1] Who had done maintenance and consulting for the SDS 940 at Community Memory. See ANALYTICAL ENGINE 3.1, pp. 8-9.

videodisk engineers at Ampex Special Products with a disaster on their hands because they didn't know enough to install bypass capacitors in their logic. When I finally got to look at the product, I was amazed it had ever worked. No way was I going to walk that knife edge even if this guy was spinning theoretical fineness about it.

So in comparison — this is sort of a cultural critique — the Homebrew membership were in effect second generation hackers, who said "If you know anything about [the computer,] come on in and we'll teach each other and try to take that knowledge further." Our response to the official priesthood was not at all to create a priesthood of our own. We were more interested in creating, to extend the metaphor, a lay church in which there was no hierarchy, and no qualification, and in which you did what you could do and you helped other people do better. I think the religious metaphor is probably the most apt — although here I want to be careful choosing my words, I'm trying to get my references from the Reformation and I don't think there was any one Martin Luther — because, rather than forming a mirror image of the established church of technology, we were out to popularize it and to break up the game of monasteries and elite groups. The Homebrew membership understood that kind of leveling activity and was explicitly involved in it. The parallel remains instructive today because, functionally speaking, the religion of this society is technology. There could be a lot of argument about that, but technologists are allowed to do anything they want to do. They don't have to take responsibility for it. Such people are in a powerful position because, while they continue to hold the power, the concomitant responsibility is deflected or not present. And those who object to this find out that society's response is "Well, you can't stand in the way of progress, can you?"

TECHNOLOGY HITS THE STREETS

Now I was one of the very few in Berkeley at the time who took a technological perspective on society. As a radical and as a technologist I saw that I could pursue any particular political goals and walk away from any consequences. During Stop the Draft Week, in the fall of '67, I was one of those involved in organizing the demonstrations — which you could legitimately call riots — at the Oakland Induction Center. I basically opted out of political discussions and vote-takings and endless procedure, and said, "Now I'm just a technician here, I'm going to make things happen and you guys can talk about it." Because I took this position, when the prosecutions came down, the defense lawyer said that they shouldn't have indicted these young men, they should have indicted Lee Felsenstein, because everybody had said "Lee Felsenstein did this and did that." I never was indicted and I don't know how close I ever came to it. The prosecutor being a politician went after the politicians — the case was called *Bardacke et al.*, because a well-known campus radical named Frank Bardacke had joined the steering committee at the last minute and was singled out by the prosecutor basically as his antithetical image.

I learned from this that technologists occupied a special place; I could only roughly define that place as a priesthood. The concept of the priesthood of technology was not new, but it certainly bore out. What we were trying to do was to disestablish a church, in fact, and we were trying to do it with the tools and technology that were available to us. We were not doing it by critiquing the technology. That's where I came up with a phrase — which actually was borrowed for [Steven Levy's] book *Hackers* about the 'propaganda of the deed,' — that was a phrase that had been used by anarchists in the nineteenth century mostly in regards to bombings. In any case, it was very hard to argue with what we were doing because, while it was never explicitly stated, we were in the business of defining the future, and that expressed itself in practical terms as performance. People's Computer Company overlapped with us somewhat and would write up these pages on things like "Fantasies of Future Forms." But we took as our province the process of development — we were developing the process of development, specifically as to what was possible with information technology — and we succeeded tremendously, because we learned right away that cooperation yielded the best results. We had no incentive *not* to cooperate.

SECRECY AND OPENNESS

This model, and this period, ended in 1977 when Apple got its funding and their cooperation ended. Prior to that time Steve Wozniak and Steve Jobs could be found at every Homebrew meeting. Jobs was the much more silent and would lurk around and listen and learn, while Woz showed off his stuff to everybody and immersed himself in technical discussions. From what Woz has said, they took away as much as they gave. But then, just prior to the introduction of the Apple II in [April] 1977, they stopped coming because they were forbidden to. As soon as there was a company, under the rules, you couldn't have the principals giving away all the company secrets. That was the point of demarcation. Lots of people kept coming, including people who were forming new companies, but Apple was the first serious example of a company whose rules began to change when money came in.

KC: And there began to be information that was formally proprietary.

LF: Right, right. So the economy changed and started to base itself on restriction of information, in contrast to exchange, sharing, in fact multiplication of information. It was a textbook example of something that still has to be figured out — the nature of the economy of information. Information is certainly not a commodity. We proved that because, by making it freely available among ourselves and to anyone else who would listen, we minimized the commodity value of information. Yet the value of the information increased as a result, because the space of possibilities expanded, and the multiplying information prepared us to enter and fill that space. That space accommodated those 23 startup companies, and however many other relationships were set up through this.

KC: Exactly — and this is something that 20 years or so later is coming around again. The explosive growth of the World Wide Web has arisen largely because the language is a public domain language, and everybody's flying their consoles around pirating each other's source — which is free — and building on each other's shoulders. The propagation of the source is built into the network architecture.

LF: Right. That's a nearly exact replication of what we developed in the Homebrew Club, and I would say not just in the Club, but in the personal computer industry in general. The Homebrew Club happened to be in the right place to take advantage of a tremendous amount of talent, and we also happened to be doing things the right way. You could contrast this with the Southern California Computer Society which took a bureaucratic structural approach and self-destructed — there's nothing left of that.

"A COMPLETELY NEW ENVIRONMENT"

I think the Homebrew Club can take some considerable credit for the culture of information sharing that developed and is very much still present on the Internet and in the development of the Web among other things. I remember that in about 1985, I was doing some consulting for a company that was building Amiga boards and that had this VP of engineering who was a real working-class guy, pulling himself up by his bootstraps. He knew next to nothing about engineering, but he was very sincere, and bright enough; but hardware engineering was a completely new environment for him, absolutely completely different. Now, I in turn had a hacker working for me — I'd found him on line, and had him improving this memory board and doing the software for it. The VP of engineering happened on this kid and me talking about how he gave away software; and the VP asked the hacker, "Well, why do you do that?" It was such a collision of cultures that, as I recall, there wasn't even a verbal reply — the hacker just looked at him like he was crazy, as if to say "If you have to ask that I'm not much interested in talking with you about it." This VP was very much trying to get into a property mentality, real estate for example, and he was confronted with this kid, who was doing things that he needed to have done and was also talking about how he gave things away within a culture that operated on that principle. Yet this same culture somehow worked well enough that I could find the hacker, he had free time, he was skilled, and so forth. It was a face-off between mature industrial culture and an information-based economy that was very much under development — still is. I'm getting philosophical, maybe we should return to a historical perspective.

A COMPUTER BY DEGREES

KC: I don't mind, I'm always on the prowl for social implications. Historically, we were trembling on the brink of the SOL, which started out —

LF: As the VDM-1 —

KC: — and somewhere along the line turned into more than a terminal.

LF: We'll go through that. I'd brought us right up to the point of Bob Marsh calling me into his office and saying, "I have a proposition for you. We will pay you to design the Tom Swift terminal. We want to have an S-100 board that will produce alpha-numeric video output according to that spec you wrote." I contracted with them to do that on a royalty basis. They were already buying 2102 random access memory chips in quantity, so that's what we would use — which was fine with me — and it was up to me to design the rest. The VDM-1 therefore embodied the idea of having display memory and program memory in contiguous space. In essence, I built a window in a portion of the computer's main memory, and through that window you would see an ASCII representation of what was in there. The board itself was basically a set of counters tied together with sync generator circuitry. It's always been my principle that the number of crystals in any design is equal to the number of designers, and so this was a one-crystal board, as is everything else I've done. The display was 64 characters by 16 lines, that's 1K, and Proc Tech specified the 6571 character generator from Motorola, which I recall had a 9x14 character cell. I had to make sure that the number of scan lines would fit into the 263 scan lines that TV would allow for non-interlaced sync; the goal was to generate output that met the RS-170 standard and would drive a video monitor — and through a modulator, also drive a TV, but the modulator would have to be external because I wasn't going to get into the FCC problems with that.

KC: Of course Apple came to the same conclusion later.

LF: Right, and that made Marty Spergel rich, because he imported modulators [the "Sup'r Mod"] and managed to sidestep the thrusts and parries of the FCC, to the point where he could get out of the game a few years later having sold thousands and thousands of modulators. I did a wire-wrap prototype, in the summer of '75, which is now at the Computer Museum in Boston; it's running in tandem with a board that I had designed later, which provided standalone terminal operation, and it's in a base of a modified key-to-tape unit acting as a terminal, and it works. The keys to the design turned out to be primarily timing, and then understanding the sync wave form, what I had to do to make it synchronize properly, and taking the alpha-numeric output from the character generator, and finally the blanking signal that says turn the whole screen off. Now, I combined those initially in an analog way; I had open collector inverters driving a resistor chain, so that at whatever level you pulled down on, anywhere below that was black and anything above was a level of gray, so the blank command came in at the top of the chain. From a digital perspective, you would think that would work just fine — you pull down, you get below the threshold, and everything's a zero after that.

When I ran the thing I said "Blank everything," and there, on the screen, was perfectly readable text in black on black. I could not believe my eyes, and I looked and looked with a scope, and it was doing what it was supposed to be doing. When it pulled down, there were still little wrinkles provoked by the gates below the chain when they tried to pull down. The eye is logarithmic in its characteristics, and it can see tiny details very well, especially when it has some foreknowledge of what it's about to see. That completely changed my perspective, and I put in digital gates to do the blanking and did the analog conversion afterwards.

I spent a lot of time scratching my head on that design because it was my first effort into video, and video had to be understood as a two-dimensional process. But the finished board did have several features which I felt were necessary to permit what I had described as the Tom Swift Terminal's operation. For example, if you put a certain control character at the end of the line, I had hardware that would detect that and blank to the edge of the display. Likewise, if you had a character [at the end of the line], another control character would set a different flip-flop which would blank to the bottom of the screen. All this was part of the display spec for the original Tom Swift terminal, so I implemented that — put those flip-flops and that detector circuitry in there, on the grounds that before too long, we would want the option to plug in other things and make this into a standalone terminal. I did publish the schematic of that adapter board in the Homebrew Newsletter, but I have no information that anybody ever built one, and the only one that I know to have existed is the prototype in the Computer Museum.

MEMORY-MAPPING TAKES THE LEAD

Now, the VDM as produced involved a fundamental change in architecture. As I mentioned, it constituted a window placed over a portion of the existing computer's main memory. As the best way to describe the change: One publication was doing a review, and they wanted to know what the baud rate was of this terminal. Now the baud rate of a terminal is the rate of transmission of language that describes the latent image, as it travels from the computer to the image-generating device. Another way of asking the question is, "How fast can the computer put characters into [the terminal's] memory?" Well, in the VDM's case the characters were already there, but they'd asked, so Steve Dompier did the calculations and arrived at a number somewhere up around 370,000 baud — I don't know based on exactly what, but you know, what's the smallest loop.

KC: Wait a minute — not strictly 370,000 bytes per second, but 370,000 level transitions?

LF: No, no, no. Well, the equivalent of 370,000 bits per second — divide that by 10, I suppose you get bytes per second. We probably did figure out how long it took to do the main loop in the software that Processor Technology was using as a monitor to feed the screen. The point is that it became a meaninglessly large number. Originally, when a microcomputer was connected to a terminal, the running program was the custodian of the image — it knew what the image was supposed to be. The program had to describe that image to the terminal, which was a separate device that cost approximately as much as the computer did. They both had banks of memory, and there was significant overhead in time and cost involved in simply copying the image from one bank to the other. By combining the memories, I created a device that was half the combined cost — or very little more — yet provided for a radical performance improvement because it no longer needed this language of description and transmission.

KC: You no longer needed the serial string. And it was a lot cheaper to put 4K on one board, and say "Okay, some of this is video memory and some of it is main memory," than to have two devices each with 2K on a dedicated board.

LF: In effect, yes. With a separate power supply, chassis and so forth. I mean, it costs a certain amount just to ship an empty box, so anything beyond that has to start there.

DOMPIER'S TARGET

Now for the VDM-1, Steve Dompier very rapidly did a Target game. Initially it was fairly crude, but he elaborated it very nicely, with a series of little spaceships walking across the screen — at different rates and different directions — dropping little parachute-like symbols that looked like mushrooms with feet. He was using some of the control characters for graphics and effects, and you got to shoot at them from below, and there was Dompier music running throughout all this as well as sound effects.

KC: Sounds like the game that eventually became Defender.

LF: Possibly. Certainly it was the first action game for a microcomputer. The previous ones had been descriptive games, the stuff that Bob Albrecht was doing; those were games that could be played on a Teletype, and there was even a Star Trek game that consisted of printed reports from different crew members, and an occasional printed 3x3 square showing where the enemy ship was relative to yours. Dompier wrote a Star Trek game, Trek '80, for the VDM which had a large screen presenting all kinds of things simultaneously, and reports from the crew in a caption below that, and also all these gauges showing you how much resources you had left. Trek '80 and Target were both very parallel in their presentation, whereas the printed games were necessarily serial. Meanwhile some of the video game boxes had appeared at that point, but they were like Pong — they had logic but no memory.

By now someone must be researching the evolution of computer games and video games, to see where all this comes in. But the structure of the VDM made unprecedented effects possible, and it became quite popular although it wasn't cheap. Eventually it had its imitators; there was

Cromemco's Dazzler, which was developed at the same time, but also a video board put out by Polymorphic Systems, and there might have been one more from Ithaca Audio.

Unfortunately the VDM was flawed in its execution because the guy who did the printed circuit layout had never done any before, and he really blew the layout. He never did a pencil layout and he was actually taping the board as he went, and the production VDM had an 8-line cable going across the board that was an absolute admission of failure. When I saw it I wished I'd volunteered to do the layout because I could have done a much better job. There was also a bug in production that started with my assumption that all 4029 counters had a load set-up time of 85 nanoseconds. It turned out that 85 nanoseconds was the specification for a special 4029 counter made by Fairchild using a process called SOS — Silicon on Sapphire — which produced very fast CMOS circuits; but Fairchild had recently stopped making those high-speed counters, and the figure I should have used for the commodity-grade part was 1300 nanoseconds.

KC: Other chips were twenty times slower?

LF: Almost that, about fifteen, but certainly it was a qualitative difference. So the first hundred units went out and we began getting calls that the VDM was a disaster; but Processor Technology wanted to use up their stock of circuit boards, not throw away the old boards and do a new layout —they couldn't afford that — so I had to work out a little fix which had to be put on every board, retroactively and proactively. Proc Tech was clearly a kind of hand-to-mouth operation.

RISE OF THE SOL

Now sometime in, I think, October of '75 Bob Marsh called me into his office again and said, "We have the opportunity to get on the cover of *Popular Electronics* magazine if we can do an intelligent terminal. Now do you think you can do it? Are you capable of doing it." I wasn't going to say no, I wanted to keep talking. Now my goal was to sell the VDM-1 with the standalone conversion, and I figured that this business about characters being detected and turning into blanking was probably intelligent enough. But Bob had another idea; he had been talking with Les Solomon, the technical editor of *Popular Electronics*, and — as I only found out later from other reports, I didn't know it at the time — Les wanted an intelligent terminal and had apparently been talking with ISC [Intelligent Systems Corporation] who were making a color terminal in Georgia somewhere. That fell through, so Les had asked Bob what could he do. Bob turned around and said to me "I want to take an 8080, the VDM-1, a parallel port, a serial port — " in other words, the I/O board that was being designed and that went into production later as the 3P+S — "and put them all in one board and attach a keyboard to it, and call that an intelligent terminal. And we can put an S-100 connector on it to plug in additional memory later on, and it's really a computer, but we don't tell him that." Bob was scared that if they told Les that it was a computer, Les would see it as competition for the Altair, and Bob was convinced that Les was so wedded to MITS, which contributed a lot of advertising revenue to Popular Electronics, that he would block the Proc Tech effort to protect the Altair. So Bob decided "We'll keep it quiet, we won't tell them it's a computer." He also had decided that this so-called non-computer could have walnut side panels, which finally created a use for those walnut boards.[1] So that set the height of the computer as being no more than 8 inches, and we wanted to be able to mount it in a 19-inch relay rack without the sides. We muddled around to figure out what the dimensions would be, and had some arguments, but I had to give up because I wasn't going to get anywhere, and I began designing it. It was the first time I'd ever designed a computer.

KC: Not unreasonably.

LF: Yes. Not that many people have designed a whole computer even now. So we didn't have a processor card, and I began to learn how the 8080 worked and what it would require.

KC: And it had its problems too.

LF: Well, it required a high voltage clock, a 12-volt clock with a special driver chip that Intel made.

KC: Actually it needed three voltages, +12 and +5 and -5.

LF: That's right. We could get all that from our own power supply, we could define that. But it

[1] See ANALYTICAL ENGINE 3.1, p. 12.

was very important that the clocks had to be non-overlapping — these are MOS clocks and you don't overlap them, and the ordinary, contemporary design for clock dividers would provide overlapping clocks. So I had to be very careful in the design of the clock circuitry, and then Bob wanted to have three different clock speeds settable with jumpers, because we could get faster and faster 8080 chips at higher prices, and stay ahead of the performance curve that way. Then he came back and said "I've decided we should change the crystal frequency from the VDM crystal — " which was 13.78 megahertz, that's just a number that fell out of the calculations — "to 14.31818 megahertz." That was four times the color subcarrier frequency, and it was the crystal frequency being used by the Video Dazzler from Cromemco for two very important reasons. First, if you used a different frequency the differential noise would come through and cause crawling distortion on the screen. More importantly, it would interfere with the color. On the other hand, if we were deriving our color from the same clock as the crystal of the computer, then the noise would be locked to the subcarrier frequency and we'd lose a whole level of noise that I'd otherwise have to deal with or suppress. It was a good technological decision but frustrating, because I had done the calculations of design for the 13.78 frequency and now I had to do them over for the 14.31818. So I did, and I used a flip-tail ring counter with a variable modulus to say the jumpers would change modulo of the ring counter and the non-overlapping nature was determined by the fact that it's a set of ones circulating around the shift register being inverted to a zero each time, and so gradually they walk out all zeroes and walk in all ones. You could take taps off that and know that everything is very carefully controlled. It's not the same thing as a ripple counter, in which one stage changes, and then some propagation time later the next stage changes. That's the definition of an overlap and that had to be avoided.

KC: But by putting taps at various points on the ring counter you knew exactly what you were going to get any particular clock pulse.

LF: We did use an HOO gate, or SOO, I guess it was H. Had to be high speed. LS wouldn't work fast enough for this and I combined some of those outputs to get the two phases of the clock. But it was very well controlled and predictable, and you could set up your propagation path such that one path was longer than the other, and you knew that. There would always be just a little tiny time between this signal turning off and that signal turning on. That was probably the most difficult part of it, and it was a very intense development process. I did the schematic and then we had to do the development of the prototype, and I had to help do the layout so we split the board roughly diagonally. We had this big light table, that another carpenter friend of Bob's made, and we set this up in a loft above some little offices that he had in the meantime built in the garage. So we were in this loft for about two weeks, and I guess Bob Marsh had a talent for finding green layout people, because Bob Roeder, the new layout artist, had worked for Lawrence Labs and his specialty was making nice, clean, neat parallel traces. Well, that's pretty to look at, takes a long time to do, takes a lot of ripping up and re-laying, but it doesn't really get you where you want to go. I did a pencil layout the way I knew it should have been done, blue pencil first, of the video section — this is where I finally got to lay out a VDM, in effect — and I did my section of it very nicely. I have the board here, by the way, and I recall that only two were ever built.

Roeder would drink Coke while he was going, and I would drink orange juice, and he got sick eventually — I mean, you can't sustain this kind of overwork forever with sugar and caffeine backing you up — so I had to finish up myself and we never finally did connect the two halves properly. There are about 150 wires on the bottom of that board that we had to solder on, but we made it work. As I recall it went into December of that year, and we got finished just on one side or the other of New Year's, 1976. We were attempting this in thirty days end to end, but we couldn't do that, it wound up closer to sixty days which itself was a really fast development time.

For this particular unit, Bob had somebody do a curved, smoked Plexiglas front cover with a futuristic sort of typewriter profile, because it had a cut out and a keyboard in it; it also had a little cassette tape drive, but one that wasn't hooked up to anything. This particular schematic did not have the cassette interface, or the personality module — that came later — and it may have been missing some other things, I'm not sure. But Bob wanted to have it showing there, because he intended the unit eventually to run from cassettes, so we photographed it with a dummy cassette drive attached. We had to take it to *Popular Electronics* and show it to them, so Bob booked us on a red-eye to save money, and I took a SOL and stuffed it in a paper bag, stuffed another paper bag over it and tied it with string, and that was how we carried it on the plane.

I had been up for a solid day before that working on the final portions, and I didn't sleep on the plane, so when I got to New York I was really falling to pieces. We had breakfast at Les Solomon's place in Flushing, and I saw his fabled basement full of stuff, and then we went into the *Popular Electronics* offices and the SOL didn't work. You could see there was something there, but there was snow all over the picture. From there we went on to visit *Byte Magazine* in New Hampshire and I finally fell asleep during the demo. So we went back and I had to spend two days on the bench debugging this. It turned out that a clipping from one of the tiny little wires of the shield braid for the video cable had lodged under a socket and was shorting two lines. It was there all along, obviously, but it wasn't shorting anything until we moved the computer. So in theory a good swat on the side would have fixed it, but nobody considered a swat on the side and I don't think we would have given it one. So I had to make another trip to *Popular Electronics* with the unit and my oscilloscope and my tool kit, just in case, and show it to Les.

Les looked at the computer, and at the S-100 connector on the back of it, and he said, "What's that?" And I said, "That's an S-100 connector." And he said, "What is there to keep me from plugging in a ROM board with BASIC on it from Cromemco and running BASIC on this thing?" I knew then that the deception was over, but I just said, "Beats me," with as bland a countenance as I could muster. Les bore in on this. He understood this was a computer and he was really interested in what Processor Technology's marketing strategy would be, whether they were going to buy ads. I tried to answer as little as I could, until he finally got angry with me and I said, "I don't know." But he was extremely interested and not in a negative way; he had suddenly discovered a possible competitor to MITS, which to him wasn't diminution of business, it was increase of business.

KC: He was going to double his computer ad revenue at one stroke.

LF: Right. And he could take credit for it because he was already, apparently, putting himself on the line to sort of commission this thing. So that was successful.

PROC TECH: LEARNING THE ROPES

Around that time, in the early months of 1976, Proc Tech finally had to move out of the garage I was sharing and to a place at 6200 Hollis Street in Emeryville, and start going through all the pains of growth of a new company that's trying to be a serious company. [In the garage,] when I was doing that layout upstairs, I could hear everything that was going on because it was only a little 1,100 square foot shop, just a garage really. So I could hear somebody answering the phone downstairs, then asking someone else a question, and I would shout down the answer to the question. It was a common audio space, something I've tried to use ever since when I lay out the workshops that I put together. But Proc Tech moved into an official plant with an assembly area out back and offices upstairs and a typing pool downstairs — an open-plan office with telephone intercoms — and nobody there knew how to use this stuff. There wasn't a culture of using it to begin with, and the company had grown so fast that most of the new hires were on their first jobs. Certainly it was the first serious job of the people who ran the company.

So I didn't have to lay out the SOL itself, but I was asked to show the kid that they had gotten to do the drafting how you took several pages of circuit and combined them on one page. Gordon French was hired as an effective project manager, and he did the mechanical design of the case, in very solid metal with all kinds of gussets and lots of screws. I had to document this in the SOL manual, which I still have some copies of, and so probably do you. The early SOL manuals had my sketches, perspective sketches of the assembly and then the actual drawing that the guy with Bugawan, Robleto Bugawan, had done from that. They just added those in like a little history lesson and in fact, as Bob Marsh says, they delivered the first manual to somebody important with an assembly sketch in it dated two days before, and just kept the sketch in there.

Nobody was really organizing this stuff. I had to serve as de facto temporary engineering manager and try to straighten these things out as best I could; I did okay at it but I really wasn't up to it. I like to say that Processor Technology sank because the ship was full of a lot of small holes and they had a policy of making more holes. For example, when they were going to do their Persci disk drive, they had prototyped a disk controller. I looked at this wire-wrap board, and they said, "Now we're going to put it on a PC board," and I said "You won't fit it on one, because the rule of thumb is one chip per square inch, and this [prototype] is a lot more dense than that." Whereupon Gary Ingram, who was showing it to me, said, "But there's all this space between these chips," and he went on arguing from some kind of idealized perspective. My experience told me one board wasn't going to do it, and sure enough, somewhere along the line it turned into two. Or, again, they did a 16K random-access memory board using 4K ram chips without really knowing how. Elwood Douglas designed and designed and designed that board, and the schematic gradually grew to include more and more digital circuitry to correct the problems he was finding. Revisions to the schematic were made past Z and on into the small letters and the double letters until they went crashing into the bottom margin of the drawing. Marsh and Ingram decided to ship it anyway even if it didn't work, which was the same strategy that caused MITS so much trouble, and later on Marsh said, "Oh, you know, it only cost us the company." I had said that I wouldn't have anything to do with the board because I didn't believe in dynamic RAM on the S-100 bus, I didn't think it could be reliable.

Douglas actually did learn from that. He stopped and backed out of that problem of perpetual debugging, went back to the beginning, and worked out a state-machine design using PROMS where he could infinitely, or almost infinitely, vary his logic till he got it right. In fact his design for the 32KRA was very clean, very reliable, and he redeemed his reputation in my eyes, but it was too late for Processor Tech.

Now Processor Tech had other things going against it, including a certain arrogance. It was a terrible mistake to get into a lawsuit with North Star over the rights to BASIC that North Star had been contracted to write for them; as a result, the whole possibility of any cooperation between the two firms went nowhere. The North Star [floppy] disk drive could have been integrated into the next version of the SOL and it would have been an absolute killer. It would have been the machine that gave Apple a run for its money, except for the graphics which could have been done quite easily. I could have combined the schematic of the North Star disk controller into the motherboard of another SOL, and we could have upgraded it with a [Zilog] Z80. But the two companies were at each other's throats and remained that way; so the best SOL systems always had one or two North Star drives sort of toppling off the top of them, because two drives together were a little wider than the SOL's case.

This episode had an ironic sequel. When North Star was still [called] Kentucky Fried Computers, they came to me and asked to sublet the garage and take it over. After Proc Tech moved out I had no more use for it, so I agreed. Now Proc Tech had left two phone lines in the garage, 548-0857 — I recall — which was the Proc Tech main number, and 548-0858, which was Proc Tech's backup line and became the main number of North Star. So these two companies which were each other's mortal enemies had phone numbers that were one digit apart.

HELIOS: "TWO DISASTROUS ERRORS"

Proc Tech's next decision, to return to the remarks about the prototype controller, was to go with the Persci disk drive for their Helios external storage system.

KC: Right, and the Persci drive was a voice coil drive, and it —

LF: — closed-loop, voice coil, 8-inch disk drive with dual disks on one spindle. It was a very nice design mechanically, done by mechanical engineers, but there were two disastrous errors in the first generation of production. First, they didn't use a casting as a frame for the drive mechanism, so the assembly wasn't rigid enough. That combined with Processor Tech's decision to orient the drive vertically — that is, with the disk slots vertical — meant that if you leaned on the chassis with the bottom screw down, it would put the drive out of alignment. The other mistake was to specify tungsten filament lamps for the photocell sensors, for the feedback loop for the disk drive. Little tungsten filaments like that have a tendency to oscillate at ultrasonic frequencies. When the filament hit that frequency — which, in a perfect implementation of Murphy's Law, it did — you didn't know what was happening but you knew that your performance went to hell. This was all in the context of its being a very complex drive and very expensive to make; I'm sure that Persci didn't make much money on them.

Processor Tech tried to solve the mounting problem with this huge cast metal — maybe cast iron, I don't know — case that would hold three drives, or two drives and a power supply, and that was very heavy and bulky. Meanwhile they had a DMA controller and they didn't make use of the DMA; that is, while they were doing the DMA the processor just went into a loop, and they never took software advantage of the DMA.

KC: Sounds kind of silly.

LF: There really wasn't much point to it. George Morrow was doing disk controllers which in effect would take over the main processor, using not much more than a ROM and some data separation circuitry, resulting in no DMA transfer at all. The processor was now marching to the step of the disk's requirements, because it had nothing else to do, and it could perform programmed transfers just fine. Morrow really showed the way on that kind of disk controller.

TWILIGHT OF PROC TECH

So they were building a lot more equipment for inventory than they needed in order to sell, which was one more sign that Proc Tech was really run as an amateur operation. They didn't have anybody in there who knew what they were doing. They needed a controller who knew what he was doing. At the end, the one they did have could only advise everybody to take their checks immediately to the bank.

Before the end came, the company moved out to Livermore. Now a study has been made, or maybe several studies, showing that at a certain point in a company's growth, its headquarters gets moved much closer to the home of the president. That's what Armonk, New York was about for IBM; and that's what Livermore or Pleasanton was for Gary Ingram, because he lived out there and it became "his turn." After the company moved 40 miles away I would only travel out there occasionally, mostly for discussions about what they wanted me to design next. At one point I said, "Look, you guys, what do you want me to do?" And they said, "Well, we don't know. We just wanted to see what you'd come up with." Now, they could have told me that at the beginning and it might have helped! But I went off and got involved in a video project with Bill Etra, whom Processor Technology had brought out from New York. There's a lot of historical confusion at the level of development and, I'm sure, elsewhere.

The beginning of the end was somewhat obscured because Bank of America extended a line of credit to Processor Technology. Gary Ingram called me in, chided me about something or other that I had said or done, and boasted that their problems were behind them and we were going forward, because he had all this money and a line of credit. Well, a line of credit is not a permanent resource; and the receivables for the company fell below what the Bank of America felt was the minimum required, so they shut down the line of credit. So in June 1979 I was working on a prototype of the VDM-2 which would have had smooth scrolling, writeable character fonts, interlaced display and a couple of other features — you could split the screen and above the split it would do smooth scrolling.

I didn't have this prototype finished, although I did get it done shortly thereafter, but I had to show something. I went to New York, where they were going to be showing at the National Computer Conference in the Convention Center, and couldn't find them. Where they were supposed to be was an empty space. I said, "Oh, oh, something must have gone wrong," and it took me a little while to figure out what that might have been. In the back of my consciousness was the idea that they might be out of business, but I didn't want to believe that, because I was still getting royalties from them.

PICKING UP THE PIECES

I came back, and sure enough they had closed the doors, I believe on May fourteenth. There never was a bankruptcy action; certain judgments were made, and those certainly kept Bob Marsh tied up for a number of years afterwards, but Processor Tech basically disappeared at that point. There was some discussion with a group of investors including Adam Osborne, and I recall they had somebody come by and talk to me about what should be done with the SOL design; I said it really was out of date, it needed a Z-80, it needed to be redesigned internally in several places, it needed a better display format than 16 by 64 — which was the other advantage of the VDM-2, it was going to be 24 by 80 — and my assessment, among other things, apparently discouraged them enough that they didn't bite.

I had meanwhile set up in a new 800-square-foot shop in Berkeley and suddenly had no income for it. I had been doing the development for Bill Etra — that's a whole other story that has nothing much to do with personal computers. And from there I took on a walk-in client, a Swedish guy, who wanted to design and build something that looked like an Apple II, but ran CP/M, had a Z-80 in it, and would also handle Radio Shack graphics. I should point out that by the fall of 1977, the SOL design was imitated fairly well by the Radio Shack TRS-80 Model I, although it didn't use an S-100 bus. It used dynamic memory for storage and, I think, static memory for the display, but it was the same memory space, which was important, because they were still doing a basic memory access to get something on the screen.

John French, who designed that — if I'm remembering his name correctly — credits the SOL as his inspiration, and I'm happy enough with that. That's what happens when you do a design that has legs. So Radio Shack-style graphics were one thing this Swedish guy, Mats Ingemanson, wanted to include along with color — European color, PAL. We called the computer the Expander. I bashed my way through that. Eventually I charged too little money for it and turned it over to Bob Marsh to try to get it into production. About 200 of them were produced, but they were never paid for, so only a couple of them got out and I don't know that the European color on it ever really worked.

OSBORNE IN THE DISTANCE

By then it was 1980 and I was shortly to have the encounter with Adam Osborne at the fifth West Coast Computer Faire in March, at which he proposed that we negotiate about starting a company and really doing things right — that's how he put it. Of course I was interested, first because I wanted to see how far a microcomputer company could go if it didn't make elementary mistakes, second because I was broke otherwise.

KC: And you had a lot of detailed knowledge in your head, which might have been difficult to bring to market independently.

LF: Well, that's definitely true. For example, I had also tried in the meantime to do an updated version of the VDM-1 for Bill Godbout. He requested that I do a prototype for him, and I did, but he never marketed or manufactured it. It was really a redesign of the VDM-1 that could be produced at lower cost, it wasn't as advanced as the VDM-2. I tried in the meantime to sell the VDM-2 to other companies, and discovered that there weren't an infinite number of companies who wanted me to just hand them a design. The industry had grown up in a remarkably short time and now I was hearing things like "That's all very nice, but what's your market," and "Who's going to buy and how," and "Under what terms," which was an aspect of development that I hadn't at all caught onto. One of the attractive things about joining Adam Osborne was that he could think in those terms, and had been for a while.

AN APPLE THAT NEVER WAS?

I'm sure you'll do your own research on Adam Osborne. Let me just throw something in that might provide an interesting avenue of investigation. Adam was involved in an ongoing poker game that also involved George Morrow, Chuck Peddle and Trip Hawkins. Now the late Blair Newman had worked with Hawkins, and for a short time they were both consultants to Apple. Blair was a very creative guy; he was also manic-depressive and ultimately committed suicide, but when he was in the right frame of mind he was very, very good. Among other things he took credit for having worked out the definition and form factor of a 5.25-inch hard drive. So he claimed that he and Trip Hawkins had outlined a proposed design for the computer that Apple should build in 1978, which was Z-80 based, had a 5-inch display, 40-character lines alpha-numeric, with two floppy disks, and ran CP/M. And Steve Jobs threw it out, he said....

THE HP WAY:
How Bill Hewlett and I Built Our Company

David Packard

New York, NY:
HarperCollins, 1995
212 pages, $17.00 (cloth)
ISBN 0-88730-747-7

Reviewed by Len Shustek

"In the fall of 1930 I left my hometown of Pueblo, Colorado, to enroll at Stanford University. There I met another freshman, Bill Hewlett."

So, with the directness that characterizes the entire book, begins David Packard's presentation of the history of the Hewlett-Packard Company, and of his life. It is a story told with simple declarative sentences -- Packard as autobiographer is no Thomas Wolfe -- but it nonetheless reveals the spirit and the motivation of the men behind the company which has been a symbol of innovation and an icon of American entrepreneurism for more than fifty years.

If you're looking for the inside scoop on HP internal politics and scandals, you won't find it here. If you're looking for detailed a technical or marketing history of their products, you may have to write it yourself. Packard's short account is meant to be inspirational rather than encyclopedic, and on that level it succeeds.

With obvious pride and a retrospective confidence, he describes how he and Hewlett, with the encouragement of Fred Terman at Stanford, started doing engineering consulting projects for the likes of Charlie Litton and Russ Varian, and then began the partnership that but for the flip of a coin might have been the "Packard Hewlett Company". From the beginning his was a hands-on involvement at all levels, whether learning to drive a bulldozer from Litton, or baking front panels in his kitchen oven, or taking business law and management accounting courses at Stanford "so that for the next few years we rarely required the services of lawyers".

The attributes of good management which HP has taught to a generation of newer companies were there from the beginning. Personal communications to back up written instructions -- which became "management by walking around" (MBWA) -- was inspired by Packard's first job at General Electric. There he discovered that catastrophic production failures in mercury-vapor rectifier tubes were caused not by poor engineering, but poor communication between the engineers and the production workers. The moral was that innovation in design is necessary but not sufficient: "Each person our company is important, and...little details often make the difference."

Some of the now-standard small-company tricks also came easily to them. The first product was a resistance-stabilized audio oscillator whose use by Disney for the movie *Fantasia* is legend (and, says Packard, overstated). But as a small unknown manufacturer, "we designated this first product the Model 200A because we thought the name would make us look like we'd been around for a while", and priced it at $54.40 — which turned out to be less than the cost to manufacture — because "it reminded us of '54°40' or fight'", the 1844 political slogan. Unlike many of the important business principles that survive as legacy for today's HP, that pricing theory happily does not.

Other early attitudes, though, did, and do. Noel Eldred, head of marketing and sales for many years, was the pioneer, under the direction of H and P, of the customer-centric focus. Sales engineers were instructed to take the customer's side in any disputes with the company. Customer feedback in helping design and develop products was key. And even competitors were respected: "He also insisted that our salespeople never speak disparagingly of the competition". As a principal in a company which has competed against a very small part of HP for almost a decade, I can attest to the continuation of that style of gentlemanly but aggressive business demeanor that makes HP a model of enlightened capitalism.

Packard admits some mistakes, such as HP's late entry into the computer field which eventually became 78% of their business. "It would be nice to claim that we foresaw the profound effect of computers on our business and that we prepared ourselves to take early advantage of the computer age. Unfortunately, the record does not justify such pride." Nevertheless, as early as the 60's they recognized the strengths of companies such as DEC, which HP considered acquiring for $25 million but declined due to "some complicating factors" that are, unfortunately for the historic record, left unexplained.

Technology has not been the only focus of Packard's life; it has balance. He is a lifelong hunter, fisherman, horseback rider and, since 1952, a rancher. He was president of the Stanford Board of Trustees. For three years he was deputy secretary of defense in the Nixon administration, where he describes working with the Washington bureaucracy as "pushing on one end of a forty-foot rope and trying to get the other end to do what you want."

One characteristic of the HP organization, much praised but only reluctantly adopted by others, is decentralization of control. Even HP strayed from the path when the shift to computers in the 1970's encouraged many of the managers to emulate IBM's highly centralized organizational structure. The result was a complicated bureaucracy that postponed decisions for weeks or months, and "by 1990 we faced a crisis".

Although by that time both Packard and Hewlett were normally uninvolved in day-to-day management, the long-standing "open door policy" had kept them in touch. They returned as firefighters and interviewed employees at all levels, eventually deciding to reduce the many layers of management and bring in a "gifted young manager", Lew Platt, as CEO. If Packard privately assigns any blame to outgoing CEO John Young, he pulls his punches here, and instead only praises Young as a "skilled executive who had managed the company's explosive growth through the late 1970s and 1980s".

For years HP has been justifiably lauded for pioneering employment practices which are now standard in our industry: flexible hours, profit sharing and stock participation open to all employees, informality at all levels, and open communications "guided by common sense rather than by lines and boxes on a chart". The fundamental principle is respect for the ability of individuals. "We expect them to be open and honest in their dealings with others, and we trust they will readily accept responsibility".

That trust, though, has to be continually demonstrated in practical ways. At HP it means, for example, keeping storerooms and parts bins open at all times. When Hewlett once found an equipment cage locked during the weekend "he broke open the latch and left a note insisting that the room not be locked again." The reaction of the stockroom clerk on Monday morning was not recorded.

The HP Company, and Packard and Hewlett individually, have been role models for many of us, demonstrating how to combine engineering excellence, community involvement, charitable giving, and general good citizenship. This book, while neither a roadmap for emulation nor a definitive history, conveys some of the sense of passion and commitment which made it work.

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IN MEMORIAM: KONRAD ZUSE

Konrad Zuse, an undisputed and deeply respected pioneer of digital computing, died in Hünfeld, Germany on December 18, 1995. He was eighty-five.

Doktor Zuse was a twenty-four-year-old student at the Technische Hochschule in Berlin when — like many another early computer developer — he decided that the time and labor required for repetitive engineering calculations amounted to a squandering of human genius. When he graduated in 1935 and went to work as a stress analyst for the Henschel aircraft company, he routinely encountered mathematical problems that were difficult or impossible to solve with slide rules and contemporary desk calculators. Like John Vincent Atanasoff at Iowa State College, he was determined to build a digital computing device that would automate the solution of systems of equations.

Zuse and a colleague, Helmut Schreyer, took over one room of the Zuse family's apartment and set to work. They had no knowledge of prior art; development was guided only by intuition; and their choices were restricted by the command economy of the Third Reich, which made imported goods expensive or unobtainable. Yet the two engineers created the V1 (later Z1) digital computer, which in its completely mechanical architecture owed something to the work of Babbage, while its use of binary arithmetic and gate logic foreshadowed the vast majority of the computers that followed it. For input/output, since paper tape was imported and scarce, Zuse punched the Z1's programs into used 35mm film, which the UFA movie studios in Berlin sold cheaply. Working only with spare time and money, Zuse and Schreyer finished the Z1's memory unit, with sixteen twenty-four-bit words, in 1937 and its arithmetic unit by Christmas 1938. Surviving photos of the Z1 — which almost filled the room in which it was built — clearly show its idiosyncratic design and meticulous construction; the computer was both primitive and brilliant. An upgraded replica together with a microcomputer-based Z1 simulator is displayed at the Museum für Verkehr und Technik in Berlin.

The enhanced Z2 followed in the late 1930's. Schreyer urged the use of vacuum tubes for memory and switching, but tubes were expensive and — Zuse feared — unreliable as well. The Z2 was a small experimental machine which, like its successors, used telephone relays for bit storage; rapid upgrading of the Z2 produced the Z3, completed in December 1941, the first fully operational program-controlled computer in the world. Two relay cabinets held a total of 2,600 relays; total memory was sixty-four words of twenty-two bits each, and input/output was by film tape. The Z3 was ambitious and worked well, but the Hitler government was indifferent to it, claiming that the conquest of Europe would be complete before the computer was fully developed. Held back by its limited memory capacity and the fortunes of war, the Z3 never left the experimental stage before it was destroyed by Allied bombing in 1944.

Zuse wasted no time applying the lessons of the Z3 to its successor, the Z4, which boasted 512 thirty-two-bit words of memory and was capable of useful mathematical analysis for aircraft design. Unfortunately the Z4, begun in 1942, was little used during the war because it was laboriously moved from place to place in an effort to preserve it from air attack. The end of hostilities found it stored in the town of Hinterstein in the Bavarian Alps, intact; its adventures had not then concluded, but it was finally set up and configured for programming at the Swiss Federal Institute of Technology in Zurich in 1950. Only then did Zuse's work begin to enjoy widespread attention and appreciation. The Z4 continued to operate at various locations in Switzerland until 1960; it is now in the Deutsches Museum in Munich, together with a copy of the Z3.

Commercial production of computers was next on Zuse's agenda; in 1947 he proposed a collaboration with IBM, but found no interest, so he founded his own company, Zuse KG, two years later. The company successfully produced both electromechanical and electronic computers — notably the relay-based Z11, the tube-based Z22, and the solid-state Z23 and Z25 — but although Zuse computers were widely used particularly in optical manufacture, the company ran short of operating capital, and Zuse reluctantly sold its assets to Siemens. One especially interesting Zuse product, the Graphomat computer-controlled drawing board, is now considered a precursor of computer-aided design.

Since Zuse spent most of his working life as an engineer, his formidable mathematical talents had a heavily practical bent, and during the war he became interested in the use of predicate and relational calculus to solve broadly stated problems with many variables, such as chess problems. Out of this, in the mid-1940s, came Plankalkül, which he described as a "symbolic language" and which was in fact the world's first algorithmic language; it was not meant for programming specific hardware, but as a general calculus for the sequencing of instructions. Zuse later said that Plankalkül's "true purpose was to assist in establishing consistent laws of circuitry" and that it "was meant to cover the whole spectrum of general calculating," but that, in hindsight, it "went into too much depth with regard to difficult calculations which seemed better left to the future...." Only the future, in fact, would be able to assess the language's real contribution to symbolic logic and algorithmic programming, which earned Zuse the reputation of a pioneer in software as well as hardware.

Zuse was an unrelenting innovator and admitted that "I was [often] guilty of trying to run before I could walk;" many of his most advanced ideas came to nothing because of material or labor shortages, insufficient capital, or a customer's inability to understand the full depth of his proposals. But his appetite for theoretical exploration remained prodigious, and he added significantly to the world's knowledge of manufacturing and process control, self-reproducing systems, cellular computing, and many other topics still considered experimental today.

In his later years Zuse turned to painting for relaxation, and produced colorful abstracts which earned him some commercial success. His recent portraits of German computer pioneers were exhibited at the IFIP World Computer Congress in Hamburg in August 1994, and were well received.

Recognition of Zuse's eminence as a pioneer was slow, partly because he did much of his historically significant work before the computer industry even began, partly because he worked under a wide variety of difficult conditions. Many academic and civil honors were conferred on him, but primarily from German, Scandinavian and Italian institutions; only now, when digital computing has left its adolescence and become crucial in all spheres of human activity, is his name known to scientists and historians throughout the world. In light of his visionary capacities we can reassure ourselves by letting him have the last word: "Of one thing I am sure — computer development has still a long way to go. Young people have got plenty of work ahead of them yet!"

The Computer History Association of California extends condolence to Dr. Zuse's wife Gisela, his son Dr. Horst Zuse, and to his many colleagues and friends throughout the world.

IN MEMORIAM: BARNEY OLIVER

Dr. Bernard M. "Barney" Oliver, an engineer of varied and formidable talents, died suddenly on November 23rd at his home in Los Altos Hills, CA, USA. He was seventy-nine. At the time of his death, he was a director and engineering manager for the SETI Institute in Mountain View, CA.

The SETI — Search for Extraterrestrial Intelligence — Institute is a privately funded follow-on to Project Cyclops, a scheme to probe deep space with large arrays of steerable radiotelescopes, which began at the U. S. Government's NASA/Ames Research Center during the 1970's. Dr. Oliver was a senior manager of the NASA project and gave it his closest attention, having been convinced since his boyhood that intelligent life might exist elsewhere among the half-trillion stars of the Milky Way galaxy. When Project Cyclops was threatened by Congressional budget-cutting in 1993, Dr. Oliver led the effort to raise funds for the SETI Institute, a nonprofit organization which has continued much of the original work.

A Stanford University classmate of Bill Hewlett and David Packard, Barney Oliver joined Hewlett-Packard in 1952 and founded that company's research and development laboratory on Page Mill Road in Palo Alto, CA. He was a lead designer for the world's first programmable desktop calculator, the HP 9100, and the world's first hand-held electronic calculator, the famous HP-35. Within Hewlett-Packard he was renowned as a "design debugger" who, time after time, cured the problems of prototype devices and cleared the way for their production. He held several positions at HP and served as Director of Research for almost thirty years; on his retirement in 1981, he was appointed Technical Adviser to the President and maintained an office at the Page Mill laboratory.

Dr. Oliver was born in Santa Cruz, CA, on May 27, 1916. He grew up on a ranch in the Soquel Valley and showed precocious enthusiasm for electrical engineering, radio broadcasting, and space exploration. He received a BSEE from Stanford in 1935, a master's in 1936 and a doctorate with highest honors in 1940, both from the California Institute of Technology; he then joined the technical staff of Bell Labs for twelve years, working on tracking radar, television transmission, information theory and digital coding. He was the author of innumerable technical papers and the holder of over 60 American patents, and was elected president of the IEEE. He received the National Medal of Science in 1986, and was awarded NASA's Medal for Exceptional Engineering Achievement in 1990.

Although Dr. Oliver's sustained technical proficiency made him a legend among colleagues, he was perhaps most memorable for the breadth of his interests. He helped improve the design of train detection and control equipment for the Bay Area Rapid Transit (BART) system. His Palo Alto-based startup company, Bosys, specialized in biological controls for agriculture. He fulfilled a lifelong commitment to education by teaching electrical engineering at Stanford, and by serving for ten years on the Board of the Palo Alto Unified School District. As a hobby, he designed and built components for high-fidelity sound systems; and he and his wife, the late Priscilla Newton Oliver, shared a deep affection for music and theater. John Billingham, a co-worker on Project Cyclops, remembers his long-time friend as "a technical genius, a person of humor, one of the most brilliant people I've ever met — a Renaissance man."

In spite of Dr. Oliver's venerable age, we must say that he died too young. Talking to this writer a year ago, he sketched in a list of planned projects that would have taken at least five years to complete. But his ideas will live on, not only in his designs and publications, but in the unfailing help and encouragement he gave others. He could be temperamental — and even merciless when confronted with sloppy thinking — but his tenacious grasp of principle often provided flashes of intuition that could banish any amount of indecision or confusion.

The Computer History Association of California extends condolence to Dr. Oliver's children, Karen N. Oliver, Gretchen M. Oliver, and William E. Oliver, and to his many colleagues and friends throughout the world.

A NEW HOME FOR THE MICROSHIP!

by Steven K. Roberts
Nomadic Research Labs

[Note: Steve has been busy since we last looked at his projects in ENGINE 1.4, and the Microship is well advanced. With help from Apple Computer, the Nomadic lab has now been moved to Santa Clara, and we're taking the occasion for an update abridged from *Microship Status Report* #91 and #92. — Ed.]

[A few months ago] I opened with this rather bleak comment: "We are now halfway through the lab-relocation -- we've moved out, but don't know what we're moving INTO just yet." The homeless lab spent a few months crammed into a self-storage facility in La Jolla, a hundred yards from where both trimarans sat collecting fallen leaves, dirt, and UV rays. This was getting distinctly depressing, but where to find 2,400 square feet of ground-level, secure workspace with a 14' roll-up door?

Well, I'm delighted to report that we found just that... in Santa Clara... and I'm sitting in it right now!

More accurately, Apple Computer found it for us... and sponsored the lease as well. This deal, percolating for months, can be loosely characterized as a consulting relationship -- our Macintosh-FORTH networking, sealed packaging, wireless wearable applications, and interface expansion hacks are all available to Apple along with the PR benefits of the project....

The reality has barely sunk in. We have a front office occupied by Faun, her hydroponic garden, and the whole business side of this operation. Atop the office is a mezzanine, which must surely become a lounging area for the epic all-nighters that lie ahead. That cushy heated region is carved out of a 24x100-foot high-ceilinged, fluorescent-lit, concrete-floored industrial space -- with the big roll-up door adjacent to the office. That leaves the back forty, so to speak, as the lab... and it now contains the Microship, the Fulmar, BEHEMOTH, a hundred or so boxes I haven't yet unpacked, electronics lab, computers, a carpeted office corner for me, the inventory zone, dirty shop area, white/black/cork boards, and enough space at last to turn all these technomadic dreams into reality.

Now that the major distraction of finding workspace is at last behind us, we can get back to work. I've unpacked the network components, started the new TO-DO list, installed a security system, laid the groundwork for our new Net connections (ISDN I think...), and identified the first physical projects associated with the boat itself.... In the two weeks since [hauling everything from San Diego] we've unpacked, acquired lab furniture, built the essential life/work-support facilities, and settled in. Bay Alarm is wrapping up the installation of a monitored multi-zone security system with radio backup, the espresso machine hisses away my circadian torpor, and the World's Most Expensive Boom Box is currently issuing an acoustical retrospective that conjures images of ancient rock concerts.

Now that the lab is in place, I'm actually turning my attention back to the project itself... even filling the air with the suggestive smells of solder, sawed pine, and adhesives. We face an interesting management challenge. The ol' TO-DO list is a good start, but trying to expand that to encompass the whole ship might yield a monolithic document that would leave us mired in detail. Enter the tools of project managers... PERT charts of subprojects not only help us visualize dependencies and priorities, but make lovely office wallpaper, and give such an impression of Deep Organization that I think [they] might actually be working. (Either that, or it's a grand and satisfying illusion, still not a bad thing as long as it motivates.) We now have pretty pictures that represent the whole project at multiple levels of magnification; at some point, when our Web server is unfrozen and moved to a new site, we might export some of these PERT graphics for public amusement.

Meanwhile, as any old-time hacker knows, the smells of solder and coffee are somehow inextricably linked -- evoking layered memories of epic all-nighters, the magic crackle of childhood radio projects, the endearing quirks of early TTL, the satisfying snick of relays, the warm paternal glow of dusty hard-driven finals, the whirrrrr-clack of a Gardner-Denver wirewrap gun against a backdrop of Pink Floyd, the elegance of laced cables, and yes, even the incomprehensible integration of shoulder-to-shoulder PLCCs. All of this is far more engaging to the senses than the endless rearranging of bits on disk that constitutes programming, even though hardware, to most, has become but a lowly infrastructure for software, at best unobtrusive and forgotten.

In this spirit, latte-fueled and curious, Dave Wright and I pulled a late one and bit off a small project scaled to a single evening, yet occupying a prominent spot on the A/V Subsystem Subproject PERT chart. This involved the reverse-engineering and characterization of the business end of a submarine-sniffing sonobuoy, to wit, a hydrophone. On the Microship, this will occupy one of the audio crossbar channels, allowing easy pickup and distribution of interesting sounds from Down There.

These disposable techno-marvels are interesting, and represent your tax dollars at work. When the buoy is tossed from a P-3 Orion, it hits the water, flooding an open saltwater battery and immediately generating about 20 volts. This burns out a resistor that mechanically separates, allowing two sharp points to pierce compressed-air cartridges... thus inflating the olive-drab (not dark blue) antenna. Meanwhile, the hydrophone and its linked preamplifier begin sinking to one of two settable depths, depending on a lever that blocks the unwinding of an additional coil of wire. The bottom end of all this is a LONG coil wrapped around rubber tubing, with a pop-open plastic disk near the sensor. This decouples the unit from wave motion, reducing noise. Audio is current-modulated up the two-wire unshielded line, and transmitted continuously until a timer circuit trips, causing the buoy to sink in some fashion we were unable to determine.

Our task, simply, was to excise the hydrophone and its preamp, figure out the required voltage and polarity, and determine the best way to extract a 1V peak-peak audio signal. A few scraps of paper, mutterings, signal-tracings, scope probings, and discarded theories later, we had it -- 12V at a few mils, with a series 100-ohm resistor on the low side across which is developed an adequate signal. We suspended the unit in our hydrophone test tank (a glass of water), and listened to it on the stereo. Ah, technology.

On a roll, we quickly turned our attention to a Sitex SJ-1 LORAN-C unit that I got in partial trade for a boat-rewiring project in Florida. Once we repaired a bad antenna connection and puzzled through the programming and initialization procedures, we mounted it on a discarded Motel-6 housekeeper's cart and rolled it across the parking lot... happily tracked by LOPs and derived Lat/Lon data. Damn. Ain't technology wonderful?

Finally, it's time to begin the rigging and initial non-electronic outfitting of the ship. Suggestions and pointers to key Bay Area boat people have been arriving....We're keeping fingers figuratively crossed on all counts, and will keep you posted on relevant details.

And it's GREAT to be underway at last!

Tech Corner:
APPLE II RESOURCE LIST

[This list was compiled by **Roger Aitken** with an addition by **Nick Humez**. Everything listed is assumed to be available for the II, II+, IIc and/or IIe unless the IIGS is specifically mentioned. We gladly publish this in the interest of eternal life for one — actually, several — of the world's greatest micros. — Ed.]

Alltech Electronics Co.
2619 Temple Heights Drive
Oceanside CA 92056-3513
619-724-2404 sales
619-724-8808 FAX
Miscellaneous hardware and software

Apple Resource Center
1014 Central Avenue
Tracy CA 95376-3915
800-753-0114 sales
209-832-4300 info
209-832-3270 FAX
Parts, repairs, a good source for manuals

The **Byte Works Inc.**
8000 Wagon Mound Drive NW
Albuquerque NM 87120-2845
505-898-8183
II/IIGS programming languages

Educational Resources
1550 Executive Drive
Elgin IL 60123-9330
800-624-2926
Apple/IBM catalog software

EGO Systems
7918 Cove Ridge Road
Hixson TN 37343-1808
423-843-1775 sales
423-843-0661 FAX
IIGS desk accessory software

GS+ Magazine
7918 Cove Ridge Road
Hixson TN 37343-1808
423-843-1775 sales
423-843-0661 FAX
IIGS programming. Ceased publication in August 1995, but some back issues are available.

In Trec Software Inc.
3035 E. Topaz Circle
Phoenix AZ 85028-4423
602-992-5515 sales
602-992-0232 FAX
602-992-1345 support
602-992-9789 BBS
ProTerm communications software

Kitchen Sink Software
903 Knebworth Court
Westerville OH 43081-2753
800-235-5502
Educational and drafting software

Micol Systems Inc.
9 Lynch Road
Willowdale ON M2J 2V6, Canada
416-495-6864
Advanced BASIC software

Parkhurst Micro Products
2491 San Ramon Valley Blvd.
Suite I-317
San Ramon CA 94583-1601
510-837-9098
IIGS comm programs ANSIterm and PMPFAX

Procyon Enterprises Inc.
Box 620334
Littleton CO 80162-0334
303-781-3273
IIGS programming and operating system software

Quality Computers
20200 Nine Mile Road, Box 349
St. Clair Shores MI 48080-0349
800-777-3642 sales
810-774-2698 FAX
810-774-7200 support
Apple/IBM catalog software

Sequential Systems
1200 Diamond Circle
Lafayette CO 80026-9339
800-759-4549 sales
303-666-4549 sales
800-999-1717 support
CrossWorks cross-platform link (cable and software)

Seven Hills Software
2310 Oxford Road
Tallahassee FL 32304-3930
904-575-0566 sales
904-575-2015 FAX
904-576-9415 support
IIGS comm program Spectrum; word processing, fonts, and graphic conversion

Mr. Joe Kohn
Shareware Solutions II
166 Alpine Street
San Rafael CA 94901-1008
Developer newsletter and some shareware; SASE for details. Aitken calls this the "best single source for Apple II information."

Vitesse, Inc.
13909 Amar Road
Suite 2
La Puente CA 91746-1669
800-777-7344 sales
818-813-1270 sales
818-813-1273 FAX
IIGS disk utility and FAX software

WestCode Software, Inc.
15050 Avenue of Science
Suite 112
San Diego CA 92128-3418
800-448-4250 sales
619-487-9200 sales
619-487-9255 FAX
IIGS TrueType fonts and OCR

[Further additions to this list are welcome. — Ed.]

Quick Take: ENGINEERING RESEARCH ASSOCIATES

January 8, 1996 marks the fiftieth anniversary of the founding of Engineering Research Associates (ERA) in St. Paul, MN, USA, by Howard Engstrom, Bill Norris and John E. Parker.

Sited in a converted glider factory, ERA was to become one of America's earliest commercial computer manufacturers; but the company's first product was a stored-program computer called ATLAS I, built for the U. S. Navy. A commercial derivative of the ATLAS, called the ERA 1101, was marketed in 1948, and the first example was delivered in December 1950.

The 1101 was followed by the more capable 1102 and by ERA's most successful computer, the 1103, of which about twenty were built. By 1952 ERA had sold 80 per cent, by value, of the electronic computers then in use in the United States; the company's technical aptitude brought it to the attention of Remington Rand, which purchased ERA in that year as a stepping-stone to eminence in the field. But this relationship was largely unproductive, and by 1957, several ERA engineers had broken with the parent company. Norris and Henry Forrest, project manager of the 1102, went on to found the spectacularly influential Control Data Corporation.

Because of its short life and small production, ERA is little-known today, but the company's early start and reputation for solid engineering gave it a secure place in the history of computing.

Quick Take: ASSOCIATION for COMPUTING MACHINERY

Celebrating its 50th anniversary in 1996, the Association for Computing Machinery (ACM) will kick off a year-long celebration and retrospective with ACM Computing Week 96, to be held February 14th through 20th at the Philadelphia Marriott and Pennsylvania Convention Center in Philadelphia, PA, USA.

"Computing Week 96," says Steering Committee chair Frank Friedman, "is first and foremost a celebration of those unique people who shaped modern computing." Several events during Computing Week will be of significant interest to lovers of computer history, including a Retrospective on the evolution of computing and a dinner and reception honoring early contributors to the field, on February 14th.

There's far more to Computing Week than we can present here; point your Web browser to http://www.acm.org/conferences/computing_week/ for more details — but do it soon!

Quick Take: ENIAC 50th ANNIVERSARY!

The fabled Moore School of Engineering, the University of Pennsylvania, and the city of Philadelphia will be going all-out to commemorate the fiftieth anniversary of the formal dedication of ENIAC — the Electronic Numerical Integrator and Computor, first electronic digital computer in the United States — on February 14th. Portions of the original hardware will be reactivated (got the crate of spare tubes handy?) and the initial test routines will be re-enacted.

Visitors will be invited to compare the original ENIAC to "ENIAC-on-a-chip," a complete simulation of the original machine implemented in CMOS microcircuitry by Dr. Jan van der Spiegel and associates at the Moore School. Now *that* should be one fascinating die, considering that ENIAC used decimal arithmetic....

This ceremony will be the capstone of an entire year of celebrations, performances, exhibits and seminars related to computing, at the Moore School and other educational and cultural institutions throughout Philadelphia. You can find more details at http://homepage.seas.upenn.edu/~museum/events.html.

Quick Take: BOWER AWARDS to BROOKS and PACKARD

Dr. Frederick P. Brooks, long-time champion of cross-platform compatibility, has won the 1995 Bower Award and Prize in Science, to be given by the Franklin Institute in Philadelphia on May second, 1996.

Dr. Brooks completed his graduate work at Harvard University in 1956 and went to work on IBM's earliest supercomputers, the STRETCH (7030) and Harvest. Thereafter he worked on IBM's 8000 series, whose development was sacrificed to the company-wide ramp-up for the System/360; but when he was asked to lead the planning effort for S/360, he did so with great skill and daring, pioneering operating systems and peripherals that were compatible all across the line. His efforts created numerous industry standards, such as the 8-bit byte; helped to assure industry leadership for the S/360 and S/370 lines of computers; and were crucial to the doubling of IBM's sales volume between 1964 and 1970.

In 1964, Brooks became the founder and chair of the Department of Computer Science at the University of North Carolina, where he still teaches. Since 1965 he has led the University's development projects in virtual reality, "and," he says, "we are now at the point where we can honestly say that it almost works." These projects in 3-D imaging and modeling have a medical emphasis, and are expected to make the detection of tumors and the development of anti-cancer drugs substantially easier.

Dr. Brooks is perhaps best known for his book *The Mythical Man-Month: Essays on Software Engineering,* one of the most important and intelligent treatments of project management in data processing. First published in 1975, this book is still widely read and completely pertinent.

The Bower Award and Prize in Science confers a gold medal and a substantial cash grant. The CHAC congratulates Dr. Brooks on this recognition of over forty years' trailblazing work in computer science.

BUSINESS AWARD to PACKARD

David Packard, co-founder of Hewlett-Packard Corporation, has won the 1995 Bower Award for Business Leadership, a gold medal. The Franklin Institute cites Packard's services to the computing industry, his "unstinting public service to his community and nation," and his "generous philanthropies to higher education."

Since Hewlett-Packard was founded in Palo Alto in 1938, the company has enjoyed spectacular growth and shown an unusual ability to profit from diversification. Success has not been without occasional reverses, but H-P's proactive management philosophies have minimized the impact of mistakes and enhanced — to quote Packard's autobiography — "the agility with which Hewlett-Packard Company was able to react to new technological opportunities."

In 1994, the most recent year for which we have figures, H-P enjoyed sales of $25 billion and donated over $64 million to education, social research, and other charitable causes — setting a potent example for other leading companies throughout Silicon Valley and the nation.

Quick Take: 50th ANNIVERSARY of IEEE COMPUTER SOCIETY

This year the IEEE Computer Society celebrates the fiftieth anniversary of its oldest parent group, the Committee on Large-Scale Computing of the American Institute of Electrical Engineers (AIEE). This committee found common cause with the Professional Group on Electronic Computers, formed by the IRE (Institute of Radio Engineers) in 1951; these organizations gradually merged and, in April 1964, became the IEEE Computer Group — renamed the Computer Society, in token of its broader scope, in 1971.

The organization, which bills itself as "The World's Computer Society," is one of the most prominent technical organizations worldwide, with headquarters offices in Los Alamitos CA, Washington DC, Belgium, and Japan. It publishes almost twenty magazines and journals, including *Computer* and the *Annals of the History of Computing,* which cover every aspect of computing as a science and discipline.

LETTERS

ABC RECONSTRUCTION AT IOWA STATE UNIVERSITY

Iowa State University has embarked on an ambitious project to create an authentic replica of the first digital electronic "special purpose" computer developed by John Vincent Atanasoff and Clifford Berry in the late 1930s.

Long before anyone realized its significance, the original computer was scrapped. Most of the original plans and notes went out with the trash as well. By combing through catalogues, rummaging through old warehouses, and getting the word out to the scientific community, slow but measurable progress is being made toward the machine's reconstruction.

Anyone with information about the computer or vintage parts that may have been used in it, please contact project leader Delwyn Bluhm. They are especially in need of an IBM model 0010 manual card punch.

e-mail: bluhm@ameslab.gov
phone: (515) 294-0568
post: Delwyn Bluhm
Manager of Research and Development Engineering
Ames Lab USDOE
158J MD-Building
Iowa State University
Ames, IA 50011

APPLE II: STILL A WORKHORSE IN MAINE

I read with interest of Aitken's having compiled an Apple II resource list; let me add Sequential Systems [see list]. They sell a product called CrossWorks which allows the user to move AppleWorks files from one's old Apple II across the room to one's IBM clone (in my case, a Tandy 425-SX, with an Intel 486 inside.) The total package costs about $90 plus shipping; it consists of a 6-foot cable with 2 plugs on one end and 3 on the other (depending on which actual port you want to plug into one either end when you connect your two machines) plus some disks with the software you load on each machine (I put the IBM-end stuff in a directory in my hard drive, to call up at will) just before you do the actual file transfer.

Much of the charm of the Apple II is its elegance: This machine and its flagship software, Rupert Lissner's AppleWorks, allow one to accomplish an awful lot with very little. (Recall that 128K is the "stock" RAM for the IIc, though one can, and I have, souped up one with extra chips to a grand total of 640K). Likewise, there is an appealing simplicity about CrossWorks. Its manual is extraordinarily lucid, and even has a 1 2/3 -page summary ("Quick Start Checklist," pp. 9-10) for people who simply want to boot CrossWorks up and get on with the task at hand.

This product is the closest thing to a boot-'n'shoot, zero learning-curve program I've ever seen; reading the cribsheet pages alone I got it to work just fine the first time I tried it. Moreover, I found Sequential Systems' sales and support people friendly and very helpful. (Are your desktops too far from each other for their 6-foot cable to reach conveniently? For another $40, the manufacturer will sell you a 50-foot cable, with the same multi-plug ends).

The greater question: We all know people who own antique automobiles, but who understand that an open-top Pierce Arrow just doesn't quite cut it for serious highway driving (say, Boston to New York and back), for which they will sensibly use their new Dodge mini-vans (or old Darts, bless 'em) instead. All very well printing a resource list for Apple II for those who'd like to make theirs run (better) as a matter of historical interest (or, in this case, simply as an easy way of getting all those old AppleWorks files from ProDOS into DOS, thus making one's old IIc redundant.) But a skeptic might still ask if there actually are any serious users of the IIc still out there, and why one would continue if one could do it all in Windows on an IBM clone instead.

In my case, the answer lies in the elegance I mentioned above -- and in force of habit. As a word processor, an Apple II running AppleWorks is extremely easy to use (especially after you've been doing so for a decade); driving an old Brother daisy-wheel printer, it produces copy that has the look and feel of good old-fashioned typescript. I do a weekly music column for my state's largest Sunday paper, as well as a dozen or so reviews a month for its affiliated daily. As a freelancer, I turn all of this in as hard copy (and the more it looks as though it had been pounded out double-spaced on an old office Royal in 12-pt. Courier, the happier my editors seem to be). I rent a little hole-in-the-wall office in the basement of a building a couple of blocks from the newspaper's offices, and I turn out my news copy on an Apple IIc I keep there. I can keep doing this indefinitely: My only limitation is the printer, which will probably give out some one of these days. (I own a seemingly-indestructible ImageWriter as well, but don't consider its 9-pin output quite good enough for my publishers -- nor do they.)

I keep my other IIc -- the one whose memory I boosted to 640K -- at home in my study, which brings me to the other application: As a writer of back-of-the-book indexes, I did the first 65 on index cards (the old-fashioned way, and the way every indexer should do it at least once); for the next 50 or so, I used the data-base part of AppleWorks instead, each single-field entry corresponding to a single card.

This, of course, saved a prodigious amount of time hitherto spent alphabetizing the cards and then retyping the index from them. It is only in the last year and a half that I finally acquired the DOS-based dedicated indexing software called Cindex, which does automatically does a lot of the editing I had to do in AppleWorks once I had constructed my whole data base but before I could print it: collapsing multiple entries differing only in page number, replacing open quotes and other initial characters which threw off AppleWorks' simple sorting algorithm, converting the file into a word-processor document, and giving the printer format instructions. These were somewhat tedious things to have to do, and I am just as happy that Cindex will do them for me now (the same, in all fairness, goes for Cindex's West Coast competitor, Macrex), but there is no doubt that the three beginning-to-end passes through the index required by my earlier method served as a good sieve to filter out mistakes, so it wasn't a total waste of time in any case.

While I am not suggesting that serious professional indexers will want to use AppleWorks this way (save in the absence of something better, such as Cindex or Macrex, given an IBM clone on which to run either), it might well be a good choice for casual ones -- IIc owners who also happen to be authors and are obliged to index their own books. Again, if you don't need a heavy-duty data base most of the time, so are not going to spring for Lotus 1-2-3 or the like, you will find AppleWorks' data base much less clumsy than, e.g., the one in Microsoft Works for Windows (the integrated-software package you're likely to get thrown in with the deal if you buy any Tandy IBM clone from Radio Shack). As a result, though I no longer use it for indexing, I still rely on AppleWorks when I'm constructing the data bases intended for the twice-a-year master series schedules of classical music performances which I compile for the newspaper (the only files I give to the company on disk, because the in-house typists can't be trusted not to introduce misprints and it's silly to make them type 200 col.-in. of copy all over again from scratch anyway).

That's where CrossWorks came in: Since my newspaper's computer system is DOS-based, having created the original data base for this September's winter-schedule compilation in AppleWorks, I first sorted it by date (note: Works for Windows sorts on numerical date only!) and made several printouts (so that I, my editor, and the other classical music reviewer would each have a copy). Then I sorted it again, this time on the filed listing the presenting musical organization (the order in which the information would actually be published), and turned the file into a AppleWorks word-processor document. After tweaking the format a little, I transferred it from my IIc to my IBM clone with CrossWorks, and saved the file onto a disk which I then gave the newspaper.

We who continue to use the Apple II and AppleWorks in our everyday work needn't be looked askance at, as potential Luddites: Antique though this hardware and software may be, it still runs just fine, and as we in Maine are fond of saying, "If it ain't broke, don't fix it."

Nicholas D. Humez
Portland, ME

NEW MUSEUM IN BRASILIA

Dear Sirs,

It was really nice to read about you on the Internet. I am the current president of the MNIT - *Museu Nacional da Informatica e Telecomunicaes* (Informatics and Telecommunications National Museum) - a charitable, nonprofit society established in Brasilia, the capital city of Brazil. The purposes of our organization are quite similar to the CHAC's, including our major purpose: to plan for the construction of ESPAODATA - a major public museum of electronic computing and telecommunications in Brasilia. The world-famous Oscar Niemeyer will be the architect of our museum. We are currently seeking financial resources to develop the project.

I will send you our (MNIT's) WWW homepage address as soon as it gets ready. We will be very glad to receive any suggestions from you. Please, keep in touch. Sincerely,

Edward Cattete Pinheiro
MNIT

RESTORING DIGITAL TAPES

Being interested in most everything, I've come across an audiophile company called Last Factory which makes accessories for audio components. They have two cleaners of note, System Formula 900 which cleans reel to reel and cassette deck heads, and System Formula 010, a "Magnetic Tape Preservative" which "Prevents hydrolysis of tape binder and resultant shredding and drop-outs." Each kit costs about $20. Contact Last Factory for more data.

The Last Factory
2015 Research Drive
Livermore, CA 94550
(510)449-9448
FAX (510)449-0662

Gruemann
z40m@mts.cc.wayne.edu

QUERIES

HELP WITH MAG MEDIA NEEDED FOR STATISTICAL STUDY

In the course of setting up a statistical study of the California table-grape industry, I learned that the table grape commission had retained detailed records of grape shipments on various magnetic media, going back to the early 1970s. I have been trying to find machinery on which these things can be mounted, or even to find someone who can definitely identify them. I have three samples, which represent, I believe, additional cartridges...I list them in decreasing order of age (and, therefore, size!):

1. IBM mountable disks. These things come in a big blue (!) case. I have two of them, but think there are more in Fresno. Each is round, 15 inches in diameter; at the center of the removable beige cover is a label that reads (big letters) "IBM" and underneath in smaller letters "5440 made in usa". The people at IBM do not find the number 5440 in their database. On the other side, the thing has a beige flip-up handle.

2. "Wang 80 megabyte disk pack". This is almost square, with 2 corners rounded-off, 9.25 inches in one dimension, 9.5 inches in the other, 1.75+ inches deep. Part number 725-0183. The label indicates that this is from the late 1980s.

3. "Wang Data Cartridge 450" part 725-1227. This is a tape cartridge, 5 7/8 inches by 3 7/8 inches, early 1990's. I expect this will be the easiest thing to read!

So I guess I'm asking for help identifying these disks/packs/cartridges, and for a pointer to someone, or some company, that can read them, and put the contents in some marginally-usable form (like a cartridge that we can read here, or something). I *hope* that the data are "sort of readable", and aren't locked up in some proprietary and unknown format... We will be willing to pay, within reason, for help in reading these data. Thanks very much.

Jason Christian
jason@primal.ucdavis.edu

HP 9826: NEW ROMs?

As I remember, you have a reasonable collection of HP boxes of various ages.

At a recent hamfest, I picked up a 9826 (new enough to be marked as a 9000-226) in apparent new condition. It has four 1M memory cards, and the language (BASIC 5.1 on floppies). I once used a 9836 at work, and have nice memories of the hardware and the BASIC (though not so fond memories of the poker chip cursor positioner.)

When I got it home, I powered it up, and discovered that it speaks in tongues. (That is, there are corrupt bits in certain of the characters displayed, making the diagnostic messages somewhat difficult to decipher. One complains about a "PAD", which I presume to be a PAL. I can make somewhat less reasonable guesses about some of the other messages.

Do you happen to know what would be most likely to cause this kind of problem? (I've tried removing RAM cards, but the behavior doesn't change.) I've also unplugged all the cards, and replaced them after treating the connectors with Cramoline, including unplugging and treating the one visible PAL's pins. I suspect that an EPROM has actually gone stale in the years it sat in its box. That will probably be very hard to replace. The only thing I see that looks like an EPROM is a rather large chip (40 or 48 pin) in the bottom, below the card cage, with an amber transparent label over an erasure window. I suspect a microcontroller chip of some kind with EPROM built in. I have not (yet) disassembled the system quite enough to get to this chip to verify its part number. However, I fear that it is what I will need to re-program, once I have the proper data (if ever).

Also, since this happens to be a floppy-only system, do you know of any copy of the BASIC ROM card for the system available reasonably?

Thanks much,

DoN. Nichols
dnichols@d-and-d.com

DaVINCI CALCULATOR INFO SOUGHT

I am seeking further information about the Mechanical Calculator invented by Leonardo da Vinci.

In one of my books it says: "In 1967, 2 volumes of Leonardo da Vinci notebooks were discovered in Madrid's National Museum of Spain... In these note books there was a drawing of a calculating Machine..."

A Mr. Guateeli, who was an expert in building da Vinci replicas, built in 19?? a model of this machine based on these notebooks. I have a photograph of this model. I am looking for any articles on this subject, or any pointers which may help my research. As well, I am most interested in getting a photo of the drawing. Does any one know how I can contact the son of Mr. Guateeli? (He passed away in 1994)

If you think you can help me I would be most grateful. I am only interested in information regarding Leonardo's calculating machine.

Best Regards & thank you,

Erez Kaplan
calcmach@shani.net

DEC: PDP-11 BOOTSTRAP BOARD

I have an OEM PDP-11/03 system with a BDV11 Rev. A bootstrap/terminator board (M8012-YA).

Several MicroNotes mentioned a "BDV11 CS Rev. E" with "ECO M8012-ML005 installed".

Could anybody please explain to me briefly

- differences between Rev. A and E,
- what "CS" stands for,
- what "ECO M8012-ML005" means,

and/or tell me if

- it makes sense to switch from A to E or an even later Rev.,
- there are disadvantages/risks in switching,
- there are hacking instructions to convert A to E.

Thanks in advance,
Leonhard Schneider
ubie@rz.uni-karlsruhe.de

UCSD PASCAL SOURCE WANTED

A long time ago, I used the UCSD p-System on an Apple][to program Pascal. It was not the fastest (most people called it slow), but I liked it. Now these times have gone, and almost no one uses the UCSD system anymore; but computers are faster, and so I wonder whether I should try the UCSD system on a modern machine (e.g. a Sparcstation).

So, does anybody know where to get source code or a description of the UCSD p-interpreter? I know, the description of the p-code was in the Apple][manuals, but they were missing a point. The system contained routines, which did some part of the Pascal parsing. They were not documented.

73,
Mario Klebsch
M.Klebsch@tu-bs.de

IBM XT: SysRq KEY ??!

On my XT clone keyboard, the SysRq (or shift-SysRq or ctrl-SysRq - I don't remember exactly) will type out the string "SYSTEM<CR>". It is useful in GWBASIC, where this would get you out of the BASIC interpreter environment and back to DOS. It saves you 6 keystrokes, which I guess was a real bonus feature to someone who programmed in GWBASIC. I'm not sure if this is actually what IBM intended this key to do, or whether the clone keyboard maker just decided to do *something* with that useless SysRq key ??!

Mario DeFacendis, P. Eng.
defacend@bnr.ca

IBM: DISPLAYWRITER S/W WANTED

I need software to run on an elderly DisplayWriter. All I seem to have are the diagnostic disks (the machine works fine). Also, I heard several people boasting that they have in their collections of antique computers MS-DOS boot disks for the DisplayWriter. Doesn't matter what version of MS-DOS it is.

If someone would be kind enough to email me, I'm certain we could come to some agreement on mailing them.

C. J. Knox
knoxcj@elec.canterbury.ac.nz

DEC: LSI-11 CHIPSETS?

I read about various generations of LSI-11 chips (LSI-11, T11, F11, J11) and about instruction sets and i. s. extensions (e.g. in "chip.history"), but until now I didn't find any article giving a *brief overview* telling which chips or chipsets cover which features internally (at minimum chip count) or just optionally or alternatively, and what combinations exist.

Could anybody please correct or complete this (probably erroneous) matrix I started?

cpu:	ODT	EIS	FIS	FPA	CIS	MMU	I/D
KD11-*	int	-	-	-	-	-	-
	int	KEV11	KEV11	-	-	-	-
KDF11-*	?	?	?	int?	int?	?	-?
KDJ11-*	int?	?	?	int?	opt?	int?	*
KXT11-*	?	?	?	?	?	?	?

where

ODT (Octal Debugging Technique): ?

EIS (Extended Instruction Set: Fixed Point Arithmetic):

KEV11 option on KD11-F, KD11-J

070xxx..073xxx: MUL, DIV, ASH, ASC

FIS (Extended Instruction Set: Fixed Point Arithmetic):

KEV11 option on KD11-F, KD11-J

07500x..07503x: FADD, FSUB, FMUL, FDIV

FPA (Floating Point Accelerator):

FPJ11 option ? 17xxxx:

CIS (Commercial Instruction Set: Character and Decimal String Instructions): 076xxx:

MMU (Memory Management Unit): ?

I/D (separate Instruction/Data space): ?

If there are even more options I don't know of, please tell me.

Thanks in advance,

Leonhard Schneider
ubie@rz.uni-karlsruhe.de

XEROX: BAFFLED OWNER

I have in my possession a Xerox computer, which is amazingly devoid of information as to what the thing is. All I know is the product code, which is 84D, and that it was used "for graphics things," to quote the person I got it from, who knows little about computers.

Any idea of what that product code means in real life, what computer this is, and/or of a contact at Xerox who may be helpful. The unit is post-1989, from the dates on chips, etc., inside.

Michael Brown
mjb@pootle.demon.co.uk

DAVONG/APPLE II DISK PROBLEMS

I bought a Davong external hard drive for my Apple which came with the appropriate host card. When I place the card in slot 5 and then attempt to boot from that slot (typing IN 5), it puts the machine into 80 column mode and flashes DRIVE 1 NOT READY continuously.

If this means that the drive itself is faulty (the actual MFM HDD, not all the extra Apple related electronics) can I replace it with any other drive using the same cylinders, heads, and sectors? It is currently using a CMI 5412 (a standard 10 meg drive conforming to type 1)

Do I need special software to format the drive and make it bootable, or can I do it from routines in the host card's EPROM?

Trevor James
tcidz@cloud.apana.org.au

RADIO SHACK BOOT DISKS WANTED

Desperately seeking system disks for old computers. I have found my old Radio Shack TRS-80's (I and III) again, but without any disks. But I can remember reading about a person who collects this software about 3 or 4 years ago. Any help appreciated !

Thanks,

Stefan Siebenkaes
sieben@mfk.uni-erlangen.de

WAVEMATE BOOT DISK WANTED

I need a system boot disk (5 1/4") for OASIS-8 on a multi-user Wavemate. Someone tried to get fancy and modified the system.nucleus to the point where it won't boot anymore....

Gary Bergman
gbergman@castle.net

IBM 5360/ALTOS 1086: ANYTHING

'Lo all.... Couple o questions; Does anyone have any info on the IBM 5360 <O/S, Types of stuff it uses, the whole bit> as I just got one free...:) In pieces, so no info.... whee, gonna be fun...:) Also, the Altos 1086... Damn thing needs a new OS as Xenix somehow got nuked before I grabbed it... So, anyone know what will run on it? Any info would be GREATLY appreciated....Thnx...

spragget@hubble.sheridanc.on.ca

CONTROL DATA DISK: JUMPER SETTINGS WANTED

I have a hard drive by "Magnetic Peripherals, INC (a Control Data Company)". It is a 300 MB SCSI hard drive, model number 94171-344.

I need jumper settings. Anyone?

Peter da Silva
peter@starbase.neosoft.com

PUBLICATIONS RECEIVED

Amateur Computer Group of New Jersey NEWS.

Volume 20, Number 9, November-December 1995. Building a Simple Home Page; Election slate; UNIX FAQ; Software reviews.

Volume 21, Number 1, January 1996. Science sleuths; Election results; UNIX FAQ; Software reviews.

Australian Computer Museum Society Newsletter #8, December 1995. Committee and general news; Colossus; Power House Museum acquires Difference Engine; IBM 360/30. From Jim Walsh.

Charles Babbage Institute NEWSLETTER, Volume 17 Number 4, Summer 1995. Annual report; New facility; ICCP history; ENIAC 50th plans; Dibner Fellowships; IEEE History Conference. 6 pp. From Bruce Bruemmer. (Delayed in mail.)

The Computer Journal, Issue #76, November/ December 1995. MINIX; XT Corner; East German "Z80's"; PT68K/OS9; Jade Bus Probe; Time Clock; PC Security; more. $24/6 issues, $44/12 issues. From Bill Kibler.

Hewlett-Packard *Journal*, recognizing and publicizing technical contributions made by HP personnel. Volume 46, Number 6, December 1995. Articles on aspects of the OSF Distributed Computing Environment (DCE;) Fetal telemetry; RF/ID circuitry. 102 pp. and volume index. From the editors.

International Calculator Collector, Issue #10, Fall 1995. The quest for the $100 calculator; Refinishing "chrome" trim; The Chip and I; Second Calculator and Antique Instrument Show, May '96; photo gallery, classifieds, resources, more. US$16 per year with membership ($20 foreign). From Guy Ball.

Random Output, newsletter of East Bay FOG.

Volume 11 Number 9, September 1995. (Missing from archive.)

Volume 11 Number 10, October 1995. Passage to Viet Nam; Internet; MS-Word macro virus. 4 pp.

Volume 11 Number 11, November 1995. (Missing from archive.)

Volume 11 Number 12, December 1995. InfoNet demo; Holiday party; Acrobat; humor. 4 pp.

Volume 12 Number 1, January 1996. Tech support talk; Internet humor. 4 pp. From Pete Masterson.

The Z-Letter, newsletter of the CP/M and Z-System community. Number 39, September/October 1995. Community news; Spellbinder basics; Z80MU on a PC; resources, publications, letters and classified. 20 pp.

US$18 per year (new price); Canada/Mexico, US$22; International, US$36. From David A. J. McGlone.

ADDRESSES OF CORRESPONDING ORGANIZATIONS

Amateur Computer Group of New Jersey (ACGNJ), P. O. Box 135, Scotch Plains NJ 07076. Joe Kennedy, president.

Australian Computer Museum Society, PO Box 103, KILLARA 2071, NSW, Australia. Michael Chevallier, secretary.

Charles Babbage Institute, 103 Walter Library, 117 Pleasant Street SE, Minneapolis MN 55455. Bruce Bruemmer, archivist. Note change of contact.

Classic Computer Club, 42 Achilles Road, West Hampstead, London NW6 1AE, UK. Stephen I. Walters, director.

Commercial Computing Museum (formerly Unusual Systems,) 220 Samuel Street, Kitchener ON N2H 1R6, Canada. Kevin Stumpf, president.

Computer Conservation Society, 15 Northampton Road, Bromham, Beds. MK43 8QB, UK. Tony Sale, secretary.

The Computer Museum, 300 Congress Street, Boston MA 02210. Brent Sverdloff, curator of historical computing.

The Computer Journal, P. O. Box 3900, Citrus Heights CA 95611. Dave Baldwin, editor.

Computer Preservation Society (Inc.), Ferrymead Historic Park, 369 Bridle Path Road, Christchurch, New Zealand. Abraham Orchard, secretary.

Computer Technology Archive, Box 4376, Stanford CA 94309. Bill vanCleemput, director.

East Bay FOG, 5497 Taft Avenue, Oakland CA 94618. Tom Lewis, president.

Hewlett-Packard *Journal*, Hewlett-Packard Company, Box 51827, Palo Alto CA 94303-0724. Richard P. Dolan, editor.

International Association of Calculator Collectors, 14561 Livingston Street, Tustin CA 92680-2618. Guy Ball, Bruce L. Flamm, directors.

IEEE Computer Society, 10662 Los Vaqueros Circle, Los Alamitos CA 92640. Bob Carlson, director.

Lambda Software Publishing, 149 West Hilliard Lane, Eugene OR 97404. David A. J. McGlone, editor and publisher.

Lexikon Services, Box 1328, Elverta CA 95843. lexikon2@aol.com. Mark Greenia, director.

Perham Foundation, 101 First Street #394, Los Altos CA 94022. Don Koijane, president.

Santa Clara Valley Historical Association, 525 Alma Street, Palo Alto CA 94301. John McLaughlin, director.

THANKS TO....

The Heroes' List *and:*

Paul Edwards and Henry Lowood for unfailing support in all kinds of ways.

Jodelle French and Rachel Stewart for the custom tour of the Intel Museum; and Andy Eisner for inviting us.

Network General Corporation for their donation; and Harry Saal for suggesting it.

Jude Thilman for knowing where to buy a decent tape recorder.

NEXT ISSUE / COVER ART

We're not saying *anything* about the next issue. Why? Because it'll feature one of the most startling interviews that the ENGINE has done yet! Stay tuned, you'll love it.

Covers: The 930's CPU rack, a tape drive from same, and Mike and the guys bulldogging a rack down the ramp. Photos by Janette Kiehn, scanned at Creative Computer Workshop; thanks to Karen for letting us stay late.

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NINES-CARD

ACTUALLY....

Anonymous

It was one of *those* support calls. With a polite but weary techie on one end, and a stubborn, irate, non-user — nay, anti-user — on the other. And it had gone on for half an hour.

"I *can't believe,*" said the fuming client, "that after all this time you don't know what's wrong with my computer. It doesn't say much for the quality of your support."

The techie bit his lip and dodged the jab. "I can think of one more thing to try. Type e, d, i, t, space, backslash," et cetera, "and hit Enter."

"It says 'Invalid switch,'" said the grating voice.

"You typed a forwardslash instead of a backslash."

"How do you know that?!" The user lost any semblance of civility. "Are you reading my screen?"

A diabolical spark lit the techie's eye. "Actually, sir," pause, "this is a really good phone? And I can tell what you're typing by the sound...."

From the phone, a gasp, a thick silence and a click; from the techie a gale of laughter. He might taste the boss's carpet later, he knew, but some moments were worth their price.

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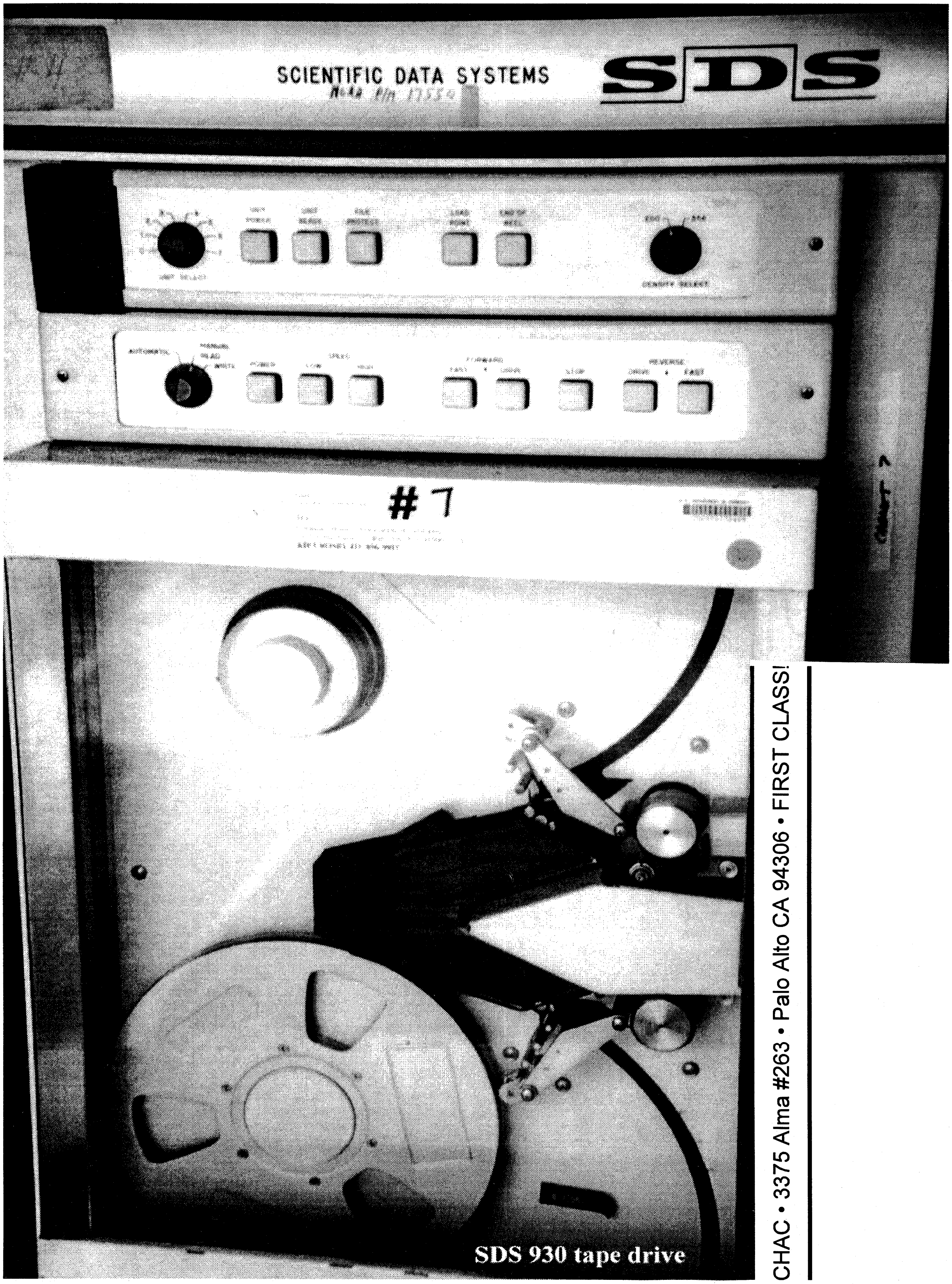

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