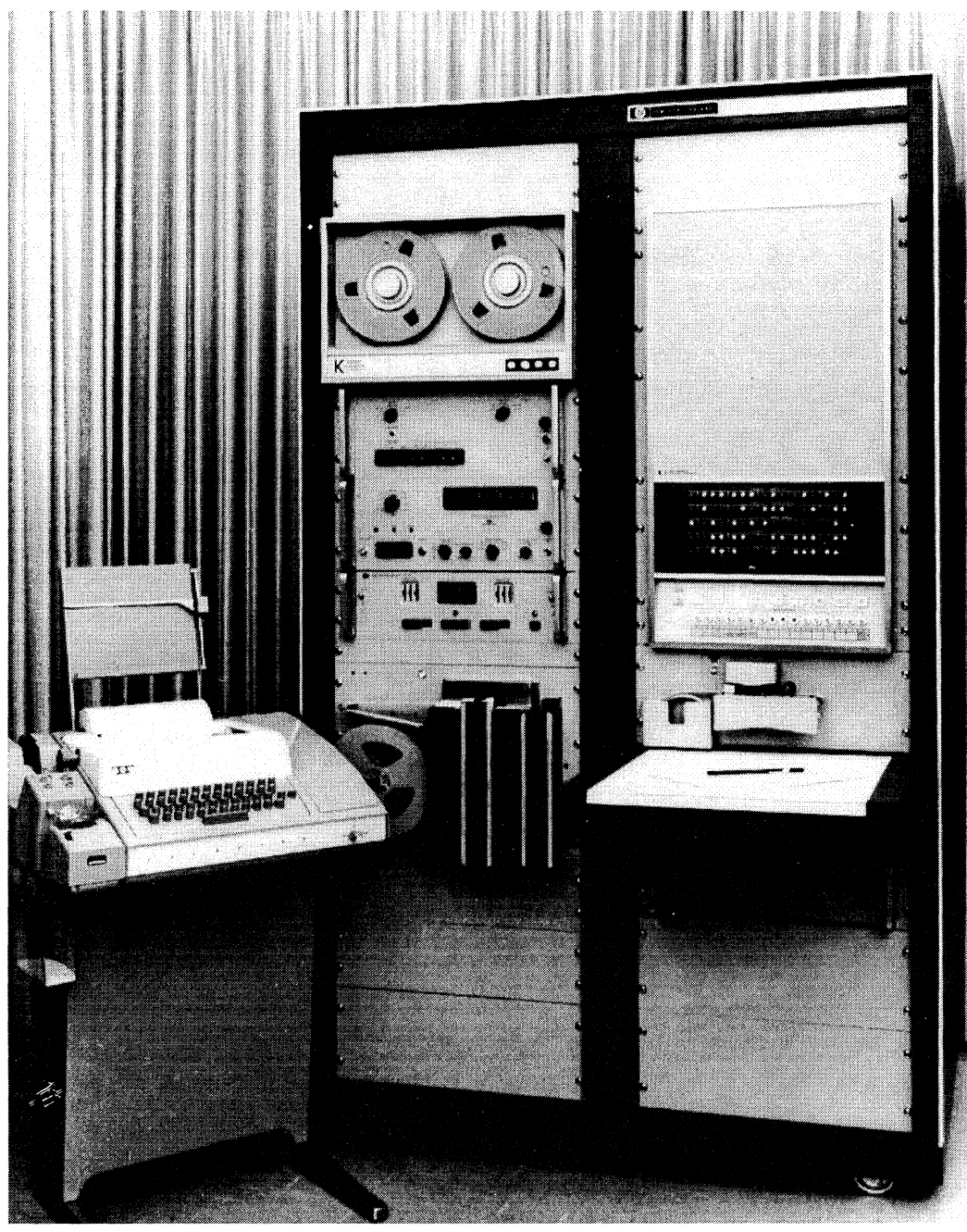


EARLY HP: 21XX/2000
RASKIN: The MAC and ME

Analytical Engine

JOURNAL OF THE COMPUTER HISTORY ASSOCIATION OF CALIFORNIA



Hewlett-Packard 2018

HP Archives

The Analytical Engine

JOURNAL OF THE COMPUTER HISTORY ASSOCIATION OF CALIFORNIA

Editorial: ALMOST HOME

The biggest thing on the CHAC's collective mind, for the last several months, has been whether we actually will rescue the SDS 930; and it now seems reasonable that we will, *if* we can raise enough money. We have the name of someone who specializes in moving vintage electronic equipment. We have enough donated storage space to pack it into. All we need now is the money to ship it.

For the last year the ENGINE has done a remarkable job of supporting itself, and paying most of our recurring bills, out of subscription revenue. But there's no way that subs can cover a large, extraordinary expense like the cost of moving a mainframe. Once again we ask for donations from concerned individuals, groups and corporations.

The SDS 930 at Table Mountain Observatory is almost certainly the last intact, bootable, fully documented SDS computer in the world. The Federal agency that owns it has worked miracles to keep it whole; but time is short, and pressure to scrap this hardware is mounting. We must rescue it all, or none, and soon, if ever.

This is the last chance. Give to save the great 930 from being tipped and crushed; give to brighten the spark of our most central purpose. Bring a mainframe home to the applause it deserves.

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Editorial: HANGING TOGETHER

Since the last ENGINE appeared, we've discovered two historical organizations whose purposes resemble our own; the Palo Alto-based Santa Clara Valley Historical Association, and the Computer Technical Archive in Sunnyvale. (See pp. 24.) These organizations and others, like the Sunnyvale Historical Society, the Perham Foundation, the Hewlett-Packard Archives, and the Intel Museum, are working hard to preserve history while it's accessible and memorable.

This is the best news we could offer. Building a museum, cataloging artifacts, creating a conceptual and philosophical architecture to organize the history of computing — these are massive tasks. (More so than we realized when we founded the CHAC, but big ideas are like big dogs; sometimes you pull them, and sometimes they pull you.) No single organization can realistically address them all. But small organizations with related purposes, springing up and persisting whatever the obstacles, are a sure sign of the *grassroots support* that will be broad and deep enough to do the work as it deserves to be done.

Contradictions and struggles are the restlessness of a great beginning. Too much history lies dormant and disorganized in filing cabinets, warehouses, garages. It's easy to be overwhelmed by the size of the task ahead. It can be hard to conceive of the power that will accomplish it. But the power of devoted, intelligent people, united by a great idea, deserves all our faith.

Sustain the history of computing. For your support of the CHAC and the ENGINE, we thank you. We encourage you, in the same moment, to contact our affiliated organizations, find out more about them, and offer your assistance. Your part in this rescue is yours to choose.

HP's EARLY COMPUTERS

Part Two:

THE EDUCATION OF A COMPUTER MAKER

An Interview with Joe Schoendorf

[Joseph Schoendorf is a venture partner at Accel Partners in San Francisco. From 1966 until the mid-eighties he served HP in many capacities, including as OEM marketing manager of the Data Systems Division and as a director of the Systems Marketing Center. His tenure at the company coincided exactly with HP's entry into the minicomputer market, and his recollections of that exciting struggle are vivid.]

KC: Today I wanted to talk about the machines built between the 2116A and the 3000, which I find very interesting, both in themselves and for what they represented. The 2116A was a special-purpose computer also called the Instrumentation Computer, and when people bought them for other things, it was somewhat to the surprise of the company. After the 2000 and 2100 came the 3000, which was a computer everybody had to have, so popular that people are writing software for it to this day. I'm looking for the story of how HP got from one to the other.

JS: I'm going to add one layer to what you've said. I joined HP in June 1966 at what was then the Dymec Division, which was the systems division. It can be difficult to talk about the exact year of introduction of an HP product because they think in terms of a fiscal year, but it happened in November 1966. We actually had a whole series of models from the 2116, probably three or four years before the 2100; we had the 2116A, B, C, then the 2115 and then the 2114, which in its own right was an extraordinarily popular machine and put us into lots of different businesses besides instrumentation. The 2116A was a pure-play instrumentation computer, and we sold it like an instrument. We used to go around and tell people very proudly that it met HP Class B environmental specifications, which means it ran from zero to 55°C and anything up to 95% humidity; and its memory was lithium-impregnated, so it wasn't sensitive to heat the way other contemporary minicomputers were. It really was a rugged thing, designed and built to run wherever your instruments would run.

KC: Lithium-impregnated core, this was?

JS: Yes. We put lithium in because memory could often be a thermometer, behaving differently at different temperatures, and lithium stabilized that; which let us advertise, because HP would only advertise what was more than true, that the computer would run in zero to 55°C, the same spec as for a voltmeter or any other HP instrument. This was unheard of at the time for minicomputers, which were then very unstable. To give you the context, the PDP-8 was out at that point but the Data General [Nova] had not yet appeared.

REAL-TIME GOES TO SEA

Our first computers were sold for instrumentation applications, as we had intended. Our very first customer was Woods Hole Oceanographic Institute, who had been using HP instruments and acquiring data to mag tape on shipboard, with the data recorded for batch processing later. The potential problem was that, coming back from a trip, they had to hope the recording worked, because if it hadn't, they had just spent 30 days out to sea for nothing — which was quite expensive for them. After they installed the 2116A they could acquire the data, perform their computations in real-time, and not only have immediate answers, but be sure they had valid data while they were still out there. Most of our 2116 orders were for instrumentation applications. Shortly after that the 2115 came out, which amounted to a half-sized 2116 with more memory — even then customers were constantly in search of more memory — and then the 2114, which I'm virtually certain predated the 2100 by a couple of years, and which set the stage for the 2100 by moving Hewlett-Packard into the OEM business for the first time.

OEM business I would call the center of the market at that time. Early minicomputer market volume was driven by OEMs who bought computers and did things with them, packaged it in other [dedicated] systems. Fishback & Moore, F&M Systems in Dallas, was a big engineering construction firm that made a specialty of repackaging computers and reselling them. I'm trying to think of some of our early customers for it.... Measurex, a major Cupertino-based process control company, used the 2115 and 14, I believe, as their prime OEM machine for paper plant management. Dave Boston was the CEO.

THE 21xx BREAKS GROUND

When the 2100A came out, it was sort of the second-generation product, if you considered the 2116, 15, 14 to be differentiated by packaging and price. With each design we were able to make the computer smaller, make it faster, and stay on the semiconductor curve. As I recall, our claim to fame with the 2100 was that we broke the \$10,000 barrier for the 16-bit minicomputer; the competition, by which I mean primarily the PDP-8, was a 12-bit machine.

KC: *Got ya.*

JS: It was a major difference. Now, the PDP-11 was contemporary with the 2100A, but I believe that because it was a newer and more complex machine, we beat them under the wire for \$10K. The other major advantage of the 2100A was that it broke the 64K memory limitation — compared to the 2116A, which was a 16K memory machine. [Laughs] Not 16 meg! Most people bought memory for HP minis in 4 and 8K segments because that fit their budget. A 4K block of memory in the late 60s was \$10,000 as I recall, and we might have lowered it to \$8,000 per 4K. If you had tried to buy a megabyte of memory at those prices, that would bankrupt you!

KC: *It certainly would. Now, when you say 4K in the case of the 2116, what was the word length?*

JS: It was 4K of 16-bit words. We had only 16-bit words. Now, the 2100 came out as our first computer with semiconductor memory, we went to RAM and there was no more core in the machine. That let us get the packaging [size] down. And we made provision for up to one megabyte of memory, or it might even have been two! I remember a wonderful meeting with the person I regard as the father of the 2100A, Bob Frankenberg, who is now the CEO of Novell; I went in to him one day and asked why they allowed for a meg of memory in the machine. His answer was absolutely mind-blowing to me at the time, and in the perspective of history, it still is. He said, "I got so tired of the sales and marketing folks beating on me for more memory," — because the old 64K limitation was pretty severe — "I wanted to put so much memory in the machine that nobody would ever ask for any more."

KC: *A meg of semiconductor memory, in the context of the early 70s, was a heck of a lot of memory.*

JS: A heck of a lot of memory and a heck of a lot more money! But, as we've learned again and again in this industry, it soon became a limitation, which is what led to the 32-bit machines.

KC: *Right. Now, the base configuration of the machine was 64K?*

JS: I believe so, but of course, the base configuration was driven by price — we were trying to make our computers attractive in a way that was relatively new to us. Ed Hayes was the OEM marketing manager, a marketing father of the 2100, and he called the 2100 the "Thoroughly Modern Mini." That was its marketing tag-line. He ran an advertisement that promoted a configuration for the 2100 and, whatever the exact configuration was, it was priced at \$9,000 or \$8,950, but there was an asterisk on it that led to a disclaimer, "quantities of 50 or more" in very small print. That was the way the game was played in OEM at that time, because OEMs didn't buy one machine; they always wanted to know what your price was for the quantity that they'd find useful, and 50 was a good starting point for a reasonable-sized OEM. Well, as I remember, either Hewlett or Packard saw the ad and got very annoyed. Ed showed me a copy of the ad as we ran it, I think in *Electronic News*, where one or the other had taken his pen and written "I never want to see this kind of advertisement again!" so hard that the point of the pen had broken the newspaper.

KC: *Oops!*

JS: He was worried that we were misleading customers by changing our pricing policy so radically. HP didn't really discount its instruments. A big discount on an HP instrument would be three per cent, and we would give that on the 31st day of every February, with great duress, if Al Oliverio said it was okay, which he usually didn't.

It was strictly ethical, strictly legal, absolutely standard practice to advertise a typical OEM price reflecting fifteen or twenty per cent discount for 50 machines; and that was our published discount. But to advertise that as an up-front price, and use it in small print as a base for the deal, was a complete break with Hewlett-Packard tradition. It was one of the great many anguishes that we went through trying to become a minicomputer company,

working from the background of having been an instrument company. You can take that story as one example of the psychic changes that had to occur because of who we were, and how great we were, and what we were trying to become — which was a fierce competitor in the mini-computer business.

KC: So, when the ad appeared, did it publish the quantity-one price?

JS: No, when it appeared, Hewlett read it as the quantity-50 price and he didn't approve the ad. The ad just got cut and I don't think we ever ran another one like it. From then on, I don't remember everything we did specifically, but we changed our approach to life.

KC: Now, the 2114 approached being a general-purpose computer?

JS: The 2114 was in every respect a general-purpose, core-based mini-computer and a really successful machine. I don't remember its dollar profit or exactly what companies bought it, but it certainly brought in new HP customers that numbered in the hundreds. The first big order from Fishback & Moore in particular, I believe, was for the 2115's or 2114's to control the new California aqueducts. To pump water from up here to down there would require 50 or 60 pumping stations along the route, with a computer in each one, and our computer was chosen. It was one of the biggest OEM wins we'd had until that time. I don't know what they're running today, but in the '60s and '70s, the California water system was built with the Hewlett-Packard 21xx; I'm sure the configuration changed multiple times, but that was a very big order for us and it underwrote very big changes in the socioeconomic fabric of the State of California.

KC: It certainly did! Now, it wasn't only an order for a respectable number of computers, but it was a high-profile project.

JS: A project that made us a much more legitimate OEM supplier, caused other OEMs to be attracted to Hewlett-Packard because we could then be perceived as competitive and aggressive. When companies are growing a business from zero, they're always marked by their big orders. And that was a big order!

KC: This is fine. When you want to assess comprehensively what the computer has done for California, rather than separating the technical history, the commercial history, and the social history, you have to emphasize the ways it all fits together. This is the kind of interview I really want because it considers the way the technical stuff came down, the effect on the business that was done, and the effect on the customer-base that it went to.Shall we move on to the 2100?

THE 2100A: DISASTER AVERTED

JS: The 2100 was, as I said, the true second-generation machine based on semi-conductor memory; and it started life with a major disaster, because we invented a power supply for it that didn't work. It was the first high-speed switching power supply.

Thirty-five percent of the cost of a mini-computer in those days was metal frame and power supply. If you were going to get the cost down, the engineering targets you were likely to think of first were the power supply and the metal frame, and if the power supply could be made smaller, the size and cost of the frame would follow it down. Well, we designed a power supply optimizing for size and it didn't work, and I don't remember exactly why, but it was temperature-sensitive as hell and it just would not meet Hewlett-Packard's quality. We were ready to announce this machine and they had to call on Barney Oliver at HP Labs in a very Apollo-project-like "let's invent a brand new power supply from scratch in a month that will work in this machine and save our butts."

KC: The other thing, to my understanding from Barney about the power supply in the 2100, was that the one that didn't work was also too big, and made for a bigger frame. Now that you talk about 35 percent of the cost of the machine, I can understand the impact. What Barney seemed proudest of, regarding that power supply, was that it was half the size of the one it replaced.

JS: The size was absolutely critical. We were in disaster mode, wondering what the hell we were going to do, and one of the designs we actually considered used the old supply but put it in a separate box from the CPU, which would have been a two-box mini, with the power supply at a distance, like you get in some audio componentry today. I think it would have been a marketing disaster, and

evidently my opinion was shared, because I know Marketing just threw up all over that; and Barney saved the day — just plain and simple. This and a lot of other episodes taught us a little bit about the OEM business, and about just selling these things without so much religion, and we began to build a pretty reasonable computer business.

DAYS OF THE GLADIATORS

KC: *Can you expand on the phrase “so much religion?”*

JS: Oh, we were religious from day one. There were always internal wars as to who got to sell these machines. The Data Systems Division, that Tom Perkins ran, got to sell the pure-play digital computers. As soon as instrumentation capability was included, that order went into what was, I think, still called the Palo Alto Division or the Dymec Division. Each division wanted to see that order on its own bottom line, so there were always games being played: if we could get the customer to buy a data systems interface, which was a 16-bit general-purpose interface, the order came into the purview of this group, the instrumentation computer group. There was a war between the pure computer group and the instrumentation computer group that was friendly rivalry, but it went on almost forever.

KC: *When you say the “pure computer group,” the Data Systems Division, you mean Cupertino?*

JS: Yes. Sometime in late 1969 or 1970, HP bought the Varian building on Wolfe Road in Cupertino, what was called Building 40 — or 41 — which I believe they just tore down a few months ago. They created a “real computer” business that was focused on pure-play digital computers meant for end-user applications development. That was in contrast to Palo Alto and Dymec, what began as roughly the “technical computer” business and evolved over the years to “technical and commercial” — technical, we sold to engineers, and commercial we sold to business people. But in ways that was an ill-founded separation, because some of the capabilities we had in the technical computer were capabilities that business people wanted. One of the great stories — pardon me going fast-forward for a minute — is of this pretty good database that the commercial computer guys invented called “Image,” which ran in our DOS operating system,

not DOS like Microsoft DOS, but the disk operating system for the machine. In contrast, the main operating system that the technical guys had was a real-time operating system. Well, if you think about it, a lot of commercial customers wanted real-time capability.

KC: *Oh, you bet they did!*

JS: They didn’t have a use for instrumentation, you understand, they just wanted real-time capability sort of as the equivalent of today’s multi-tasking preemptive capacity. Parenthetically, a lot of the stuff that the personal computer guys think is rocket science today, we were doing twenty years ago in proprietary operating systems, and making it work! But I remember Paul Ely, one of the truly great guys of the “pure computer” division and a gentleman I consider a mentor, would not allow the real-time guys to put a database to put Image under real-time. He just would not allow it to happen.

KC: *What was his thinking, so far as you understood it?*

JS: Customers didn’t need it, it would confuse the business, and if real-time customers wanted Image, they should just buy DOS because that’s the way it was! In the face of this we ran a guerrilla action — including, I think, going over to the Data Systems Division and stealing the source code — so that we could port Image to the real-time system. We were going to defy Paul’s direction, disobey on principle, and implement Image in real time. (One of the accomplishments of that project, incidentally, was to introduce me to my future wife, whom we had just hired out of Iowa State as a computer science engineer.) The guy we put on the project was someone we’d hired from Harvard named Freddy Gibbons, who later went off and founded Software Publishing. He was the product manager for Image-1000, as we called it then, because the real-time system — the system that had the 2100 as part of it — was collectively designated the Series 1000; this is in the mid-’70s. We introduced it, period, and it became a very, very successful product, because real-time and database was a natural combination that we sold to many companies who would not otherwise have become customers of Hewlett-Packard.

KC: *Okay. Now it seems like time to throw in something Barney mentioned, which was that, when*

you got as far as the 2000, 2100, there was a certain sector of HP management that began to worry; because HP was achieving a high profile in the general computer business, and without compromising traditional standards of quality and ruggedness, which had some people concerned that IBM — as Barney said — might put a tenth of their talent on it and really try to crush HP.

JS: That was exactly right. I mean, Hewlett was very appropriately conservative here. Pardon me thinking anecdotally —

KC: *Please do.*

JS: First of all, I don't remember the 2000 and the 2100 as being the same thing. The 2000 was a time-share system that, I think, came to market before the 2100 did and was first used with the 2114. Ed McCracken was the father of it, both in the visionary sense and in the commercial sense, and he built a wonderful time-sharing business. I believe he had responsibility for the educational marketplace, which was the prime market for time-sharing in those days.

KC: *Right. And the time-sharing was inseparable from the version of BASIC.*

JS: It was time-sharing/BASIC, one and the same, and Mike Green invented that, and then Mike went off to become a co-founder of Tandem. Time-sharing was another capability that got us into big businesses. Leasco became Hewlett-Packard's single largest customer by buying our time-share systems and leasing them to institutions, selling time, building service bureaus, making a market by replacing the larger time-share systems that had been run on mainframes. They built a huge business for themselves, and obviously for us too.

KC: *And unlike some people, you didn't particularly object to that. If somebody wanted to buy HP hardware and lease it out, that was fine.*

JS: Yeah, that was no problem.

OMEGA: OPPORTUNITY FORGONE

But this opportunity that we picked up unfortunately led to another one that we missed. We ran a conservative company, which is why it's as great as it is, because we've stood the test of time, but we've also declined certain risks. We saw this commercial data processing opportunity and

launched a very big project, under the leadership of Tom Perkins, called the Omega Project — to build a 32-bit computer at least three to four years before DEC built the VAX.

KC: *You built a prototype.*

JS: We built the prototype computer and were ready to launch it, and it would have worked — I mean, it ran! But it wasn't a question of the product pure and simple. We didn't have a lot of experience in pure commercial computing, in mid-range distributed computing, in commercial operating systems and COBOL, all of the stuff that was going on then; so we were even more careful than usual, because this would have required a frontal assault on IBM's market and everybody knew it. Now, HP's strongest suit besides reliability has always been support; we try to support our products better than anybody else, and if we can't support it, we don't sell it. As far as I remember, the issue finally came to a head when Perkins told Hewlett he'd need a \$5 million investment to build a support organization for this product, which started an examination of the whole cost of becoming a serious computer player — all the introduction costs and all the support costs, infrastructure, inventory, training, to do it the HP way. We began to wonder whether we could even complete the project. In the end the risk was judged excessive and the top-down decision was "kill the project."

KC: *Well, there were a number of influences on that decision. Barney makes the point that, at the time the full R&D budget for the Omega Project was being considered, Cupertino had already spent a lot of money and had less to show for it than some people found appropriate.*

JS: They had not made any money.

KC: *Right. The other thing is that — in context of the comprehensive R&D, manufacturing and support budget for a new line of computers — everybody has to have remembered that Tom Watson, for the launch of the System/360, had spent \$5 billion — he had literally bet the company on introducing a new line. There might have been some reluctance to take relatively the same position.*

JS: With a company that had not proved its ability to make a profit in the business. At that point, the computer business did not contribute profit to the Hewlett-Packard company very well

at all, whether you were talking about the technical or the commercial computer business. Yes, that was a big bet that the company chose not to take at the time, and I remember a cataclysmic meeting for which they literally called all the engineers into a room, and told them that the project was dead, and at that very minute moving men came in and moved the Omega prototypes out of the building, so nobody could ever work on them again.

KC: *Were they destroyed?*

JS: I don't know. I know they were taken to warehouses. Whether they were physically destroyed or not, that decision effectively dispersed a lot of HP's most advanced resources in computing. You just have to look at the consequences! Most of the people who worked on that project ended up as founders of Tandem; and, because of the so-called disaster of 32-bit computing, nobody wanted to touch one again in any of HP's multiple computer divisions. So when DEC came out with the VAX, which was a 32-bit computer and a great one, we didn't respond because nobody had the *cojones* to build up a project after what had happened to Omega. We would have had a tremendous lead over DEC into the 32-bit market, whether it was five years or four or three, and we wouldn't touch it, we wouldn't respond. When we finally did struggle with it, with projects like Vision and Wide Word and a whole bunch of concepts that were being played with in the early '80s — by that time, not having a 32-bit machine was killing us. Only the loyalty of Hewlett-Packard customers prevented us from going the hell out of the computer business during those years. We could have, or would have.

KC: *But you did exactly the opposite; because the 2000 and the 2100 led up to the 3000, which, so far as I'm concerned, was the machine that committed HP to the computer business irreversibly.*

JS: Well, as I mentioned, the 2100 was a general-purpose, 16-bit mini-computer that ran core and we used it with DOS and we used it with the real-time executive and we used it with time-sharing — with, in essence, three separate computer operating systems.

GENESIS OF THE 3000

Now, the HP 3000 was a project that was getting underway just as the Omega got canceled, so we

said, if we can't build a 32-bit machine, let's build the world's most modern 16-bit architecture; one that can address a full range of purposes without being three different machines. We decided on a register-based machine with re-entrance and several other advances over the 2100 architecture — and I don't remember all the differences, but the 2100 had a 16-bit memory register that gave limited addressing capability and the architecture was not comprehensively register-based....I think it included an A&B register and that was it. So, to emphasize our design goals for the 3000, we created this three-ring sign logo for real-time, time-sharing and batch. The time-sharing came from the 2000; the batch came from DOS; and real-time came from the real-time. And then we broke the cardinal rule at Hewlett-Packard; we started to advertise and sell that machine before we built it.

KC: *Ouch!*

JS: We took orders for it based on what we thought it would do, not based on what it did, and we had people lined up. Had it done what we claimed it would do, that machine would have been phenomenal, but it wasn't possible. I think we told people it would do 64 terminals of time-sharing and run multiple jobs of batch and run real-time all at the same time. That was so far beyond the state of the art that people were just coming to us and betting on it, because this was Hewlett-Packard talking, and we didn't go out and talk through our hats, so we had a lot of credibility, but this time we weren't talking through our mouths. We got in big trouble! And we finally had to go out and pull the 3000 off the market after it had been introduced, after we had taken orders for it, because we could not deliver what we had committed to deliver.

KC: *This was 1971. In what ways did the 3000, as first introduced, fail to live up to its advance billing?*

JS: Almost every way. I'm serious. With respect to software, I think it ended up not doing anything we said it would do. The number of terminals it supported was about four, instead of 64, and it couldn't run DOS if you were doing anything else. I mean, it was just really slow. We pulled the product off the market. We sent teams of senior managers out to sites where 3000's were already installed, to offer refunds and say, "We're sorry! We shouldn't have taken your money." Some customers wouldn't give us the machine

back because they liked it and they knew eventually we'd get it right, but we were so ethical that we had to sever contracts and, in effect, say "This is not a sale. We sold you the wrong thing. Here's your money back. Give us the machine and we'll see you later." This wasn't "it didn't work by a little bit," it didn't work by a lot!

KC: *So the majority of first-generation series 3000s were pulled.*

JS: Overwhelming majority.

KC: *And when was the re-introduction done?*

JS: I don't remember the exact year, but a couple of years later we relaunched with very toned-down specs that only included about half the capability we'd originally promised. In fact, we never did deliver a 3000 that fulfilled the original design goal, which was real-time, batch and time-share all running simultaneously in the same machine.

"FIVE YEARS TO GET DEBUGGED"

KC: *That didn't prevent the 3000 from becoming an immensely popular computer.*

JS: After four or five very hard years of building a business, during which we learned how to sell true commercial data processing and distributed computing. That was a great learning curve for the company and we did get it right, but the process took us at least five years, and McCracken called that exactly. He used to go around telling people that any new operating system would take five years to get debugged and to find commercial acceptance in the marketplace. I think that was prophetic, because that's about how long it took the Macintosh to get right and at least how long it took Windows to get right.

KC: *At least!*

JS: McCracken said "at least," and that was a contrast, because we were always thinking, "Well, we've introduced this thing: year one, it's going to work."

KC: *And that sort of stood the industry perception on its head because people must have begun to realize, by then, that with luck you could get a generation of hardware right in 12 to 18 months.*

JS: For us then, probably 18 to 24, coming down to 12 to 18. We had a long-cycle design men-

tality; it took us too long to build hardware and we were trying to reduce that, to get it down to 12 months, but it took us two years at that time to do anything reasonable.

KC: *Even so, there's a major disparity between that and five years for the operating system.*

JS: Yes.

KC: *I have to touch on a point here, and it may be a painful point. The first time you took people's money before you had the thing to sell to them, it turned out to be not a win, to put it mildly. What effect did that have on HP's marketing practices from then on?*

JS: Some people lost their jobs. General managers were moved and pulled out of the business. I think Bill Terry was one of the victims. We became ultra-conservative in marketing. Don't introduce it until you can prove it and ship it! We went to the other extreme, the way we had with instruments. We never introduced an instrument we couldn't demonstrate and deliver in a reasonable time-frame. When we could demonstrate a capability to a customer and prove that we could build in quantity, then we'd deliver it. Actually we became, I would say, a bit shell-shocked.

KC: *Back to core values, but in a way it was a salutary lesson.*

JS: It was a good lesson about how you do things, and it rebuilt our credibility; not without people losing their jobs — which in HP, meant getting other jobs, not getting fired — but George Newman was one of the people who was involved in that whole thing, too. We were very chastened. It hurt us badly, hurt our psyches, hurt our sense of winning. And it probably caused some people some major career points.

FLOATING-POINT DIVISION

KC: *One more question: If there was this split in the perceived computing market, between the real-time or engineering system and the time-shared commercial system, to what extent was that split carried forward into the division between the 3000 and the 9000?*

JS: HP was always organized on a division basis, and that was its greatness. It was also its weakness in the computer business, because you couldn't break up computer markets by divisions,

and there was a war on at Hewlett-Packard from day one about “which computing platform, which hardware, which software.” At one point we realized that we had over half a dozen different BASICs in the corporation, none of them compatible, each aimed at particular markets by the division that sponsored it. We were horribly inefficient in attacking the market because a division could do anything it wanted; there was maximum independence and minimum coordination. The problems got worse as platforms and their divisions proliferated — the hand-held division, the desk-top division. Our entry into the 32-bit computer finally came out of the desk-top division, because the Focus chip set was designed to power a computer that was ten times faster than the 9845, which was a single-user desk-top BASIC system, that we then tried to put UNIX on and make it a general-purpose “workstation” using a \$100 million proprietary chipset — instead of going with the then-standard 68000 from Motorola, and that’s a whole different story....

THE MAC AND ME: 15 Years of Life with the Macintosh

by Jef Raskin

INTRODUCTION

The success of the Macintosh cannot be credited to any one person. I gave it its human-oriented, graphics-based, compact-sized nature from the very first, invented some now-universal interface concepts, and made many decisions that proved fundamental to its success. I hired a crew of unknowns who have become, almost without exception, men and women known throughout the industry for their continued innovation. It was not just me, but my original Macintosh crew of four, then a dozen or so, and finally hundreds of people, who created that first Macintosh. Now thousands at Apple continue to create and expand the Macintosh line of computers and the machines that will follow in its footprint. And even so it would have been a dead-end product, after all this effort, without the work done by thousands of software developers who give tens of millions of Macintosh users the tools they need. In this logarithmically spiraling cascade of numbers we come today to something over a hundred million people who use — at their desks at home or at work, in their schools and libraries, at the beach, in airplanes, everywhere — systems that look and feel much like Macs. Amplified by all this effort and the sincerest form of flattery, the influence of the Macintosh may well have touched the lives of over one percent of the world’s population.

The phenomenon that I have just described represents the expansion of one person’s stream of ideas into a flood, but the stream had to first gather force from numerous tributaries. It was not just my own inspiration, but the flowing together of the genius of Ivan Sutherland and Douglas Englebart, the scientists at Xerox PARC, the development of the microprocessor, the success of the Apple II, the efforts of many other people whose work I studied and learned from (I will never be able to thank them all) — and a lot of luck — that led to that one nexus in space-time, in the spring of 1979, when I went to the CEO of Apple and told him that I wanted to design a new product I had been dreaming of for a while, and that I wanted to call it Macintosh.

In 1994 the 10th anniversary of the introduction of the Macintosh was celebrated with a rash of articles — some of dubious accuracy — and parties at Apple and elsewhere. But it was also the 15th anniversary of the origin of the Macintosh project. This is the story of how the Mac, a product that has changed the face and interface of computing, first came into being.

THE HUMAN-ORIENTED COMPUTER SCIENCE STUDENT

It's hard to say when the conceptual framework for the Mac began. Parts of it can be discerned as early as 1965 when I was a graduate student in computer science at Penn State. Already steeped in the technicalities of computer design and programming, I nonetheless found computers aggravatingly — and unnecessarily — difficult to use, and always looked for ways to make them less intimidating. I soon earned a reputation as being sympathetic and helpful to our least technical users, especially those in the arts and humanities. Since I was (and am) as comfortable in the humanities and the fine arts as I am with science and mathematics, I never forgot our shared pain and frustration with the nonsensical ways computers were (and are) operated. In contrast, most of my fellow students celebrated their detailed knowledge and seemed to enjoy the power and status that distinguished them from "ordinary users." They preferred to work with hard-nosed programming students with whom they could attack problems in full jargon.

In my 1967 thesis, "The Quick Draw Graphics System," I took issue with the display architecture then in vogue. At this time, input was mostly via punched cards, and output took the form of extravagant quantities of oversize paper sheets from massive and noisy "line printers." Those who wanted pictures turned to expensive plotters designed to do engineering drawings. There were only a few CRT terminals at the Penn State computer center, and these could display only letters and symbols, usually in green or white on a black background. Hamstrung by specialized electronics — in particular a circuit called a "character generator" — that permitted no other use, they could not display graphics. One display at the center could draw thin, spidery lines on its large screen. With it you could do drawings that now seem crude, annotated by child-like stick-figure lettering.

In this milieu my thesis was radical in suggesting that computer displays should be graphics- rather than character-based. I argued that, by considering characters as just a particular kind of graphics, we could produce whatever fonts we wished, and mix text and drawings with the same freedom as on the drawn or printed page. To prove my point, I wrote a program that generated the complex, two-dimensional notation of music. To accomplish this, I needed to enter graphic data into the computer system.

Commercial digitizers were then as expensive as a small house; my only choice was to design and build one. Its input was somewhat indirect, in that as I pointed here and there, it produced punched cards which had to be read into the computer later. With only limited access to a machine shop and within the tiny budget a graduate student might worm from the university, I found it hard to achieve the required precision and repeatability; but my digitizer, although mechanically and electronically Rube-Goldbergish, was an inexpensive and practical one-point-at-a-time Graphic Input Device (GID). I did not know of [Douglas] Englebart, on the West Coast, and his recent invention of the mouse; even if I had, it would have been hard to hook it up to the mainframe we were using.

A mark of how much things have changed was my casual use of the word "fonts" in the paragraph above. Today, almost every computer user thinks of character display and printing in terms of fonts; but when I was a graduate student — and even when I started the Macintosh project — most people in the computer world did not think of fonts in connection with computers. When I talked about the merits of serif and sans-serif fonts, the advantages of variable- over fixed-pitch fonts, or the beauties of Bodoni's work, I got blank stares and people might mutter. "There goes Raskin with his odd art stuff again." To talk about fonts and drawing was to emigrate from computer science to the world of graphic artists, typographers and other "arts people." Now, everybody seems to have a few dozen fonts on their computer to play with; what I wished for has happened.

Another radical claim I made in my thesis was that ease of use should have a higher priority in the design of computers than speed and efficiency. Learning how to make code run in shorter time, or

less memory, or both, was central to computer science training; human interface was not given the slightest consideration. Computer time was expensive then, and pride of place for human convenience was an alien concept. It was not unimportant at that time to use internal computer resources efficiently, and it is still essential today. But efficiency should be neither an end in itself nor the highest ambition of the computer scientist — contrary to the impression one often got in graduate school in computer science.

Old-fashioned computer centers were an ideal breeding ground for pranks. Appalled by the daily waste of paper, a few friends and I once decorated the computer center building with a day's discarded output. Early arrivers the next morning found a band of white interrupting the red brick, and had to do some tearing to get into the building. The same stunt now could be considered a work of art. On another occasion a state-level dignitary was visiting the computer center. I set up the computer so that opening the massive printer cover (done by a remote command) would dump a wastebasket full of the punched-out paper chips from a card-punch into an air vent intake, giving the startling effect of a short-lived snow storm coming up from the floor. No one doubted the identity of the perpetrator (I guess I had a reputation) so sweeping and vacuuming were my lot.

My friend and office-mate Steve Zins and I engaged in a rubber-band gun arms race: my best designs were single-shot guns of unprecedented accuracy, needed to shoot the flies generated by the adjacent cow fields. Steve created a Gatling gun that could plaster my chest with some 60 rubber bands in less than a second (though the gun took five minutes to load for that one burst.) But I digress...

TO THE WEST COAST

The first truly interactive graphical computer system that came to my attention was Ivan Sutherland's Sketchpad. Though the hardware available at Penn State would not allow me to follow his lead, Sutherland's work was a revelation and an inspiration. It used a CRT display and had a light-sensitive "pen" for graphic input. In high school I had built a rudimentary light pen for an oscilloscope, so I immediately knew how it worked. One peculiarity is that you had to put up a mark of some sort (Sutherland used the word "INK") so the pen

had some light to detect. You just could not start drawing without first pointing to the "ink," after which the computer could track the light pen. If you tilted the pen too far or moved it away from the screen, the computer "lost" the pen.

These details must be emphasized. Without them it is too easy to imagine, when you hear that Sutherland's ground-breaking system had "rubber band" lines and could do graphic input and output, that it all worked in the now-familiar Macintosh and Windows fashion. By present lights Sutherland's system was crude and limited. In its own day it was a wonder and an inspiration.

As I fretted with the details of getting my thesis approved, I began dreaming of a computer that would be graphical, easy to learn, easy to use, capable of everyday tasks such as word processing, and, above all, affordable. At the time this was not just a dream, but simply impossible. For a while, getting my degree also appeared an impossible dream; my thesis was rejected for not following the rules. One rule in particular was that you were to use only one font in a thesis; they didn't want you to turn out part of it on one typewriter and the rest on another. This had launched a local industry of typists who knew the university rules to the letter, and whom you paid to produce the final draft exactly to specifications, in the required number of copies.

My thesis had characters in several fonts, exactly to demonstrate that one could produce distinct fonts on a graphics-based system. The use of varied fonts was, I complained, part of the subject matter; to rule out their use was to attack the content, and not just the form, of the thesis. After months of verbal wrangling and a memo war, my thesis was accepted, fonts and all.

Tired of Pennsylvania winters and Penn State's cold bureaucrats, my wife and I drove west, until we ran out of land in La Jolla, just north of San Diego. We knew nobody in the area, but by luck had ended up at the University of California's Scripps Institution of Oceanography. Walking out onto the Scripps pier I saw, for the first time, a pelican abruptly fold its wings and splash into the ocean. I thought it had been shot.

EARLIER INFLUENCES

Sometime in middle or early high school I was given a copy of Claude Shannon's marvelous *Information Theory*. I can remember no other books from that time, by both title and author, except Arthur Conan Doyle's Sherlock Holmes mysteries. It was eye-opening and completely wonderful to learn that this ephemeral, seemingly unquantitative stuff called information was amenable to a physics as rigorous as that for objects and motion — and that this physics was almost purely mathematical in its development. This was extremely appealing, as mathematics was by far my first love, queen of all the subjects I could command. It may seem premature for one at the age of 14 or so to be so smitten; but it was my good fortune that Ron Genise — a most wonderful teacher, and later friend — had begun, in my sixth grade, to make the beauty and power of mathematics as alive and vivid for me as the performance of sports figures and cars were for my classmates. I believe that he first pointed out the Shannon book to me, and if my memory is astray on that point, at least I know that he led me to the intellectual point of view from which I could appreciate it.

During this time I read an article about the rate at which information (measured, as Shannon had shown, in bits per second) could be communicated from the eyes to the brain. The number seemed much too low. For example, I could sight-read pieces by Chopin and Beethoven on the piano. As an early exercise in information theory I calculated the number of bits in each symbol. This is not difficult; for example, a note head specifies one of the 88 notes on the piano, and this takes a little over seven bits. It also specifies a duration, which for most practical purposes has one of 8 values, which is exactly three bits of information. So a note conveys approximately 10 bits of information.

Ignoring other symbols and some details here (I was more precise in the paper I wrote at the time) and considering music where one is reading four chords each of six notes in a second, implies a transmission rate of 2400 bits per second (2400 baud.) This exceeded the rate at which neurophysiologists believed the senses could transmit data. This made me realize that I wasn't really reading each note, but analyzing the chords into harmonies: "that's an E-flat major chord in the first

inversion..." and so on. All my brain had to deal with was the single concept of a certain chord, and not all the details of each note. Later, reading about psychology, I found that I had re-discovered a phenomenon called "chunking" which allows us to grasp much more than would be indicated the slow data rates experiment shows our brains can handle.

This has been a paradigm typical of my entire life; supposedly different disciplines merge or interact, reinforcing each other. Studying math opens the path to a book on the physics of information which informs my classical musical studies, enhanced by my having ignored my music teacher's wishes and learned to play from jazz "charts" instead of sticking only to classical music. The speed at which I can read music seems to violate a fact I read in a science magazine (I am a compulsive reader, and will read almost anything,) the solution to which gives me an anchor of understanding when I am learning about something in psychology years later. Somehow it all fits together.

FAMILY AND FEMINISM

My parents brought my brother and me up to recognize oppression and to fight it. Popular, gregarious, and very active in civic events, they risked friendship and fortune in defending racial equality in the 1950s and 60s.

The following is part of the column I wrote about my father for the local paper:

My father, Bill, died last week. It was not at all unexpected. His health had been failing since my mother died a few years ago. Recently he had had a stroke and was also diagnosed with congestive heart failure. He could barely speak. My brother Michael had flown in from Boston and the three of us were together for what was to be the last time. Bill struggled for speech and repeated, "What can I say? What can I say?", a phrase he had always used when overcome with emotion. We told him that he didn't have to say anything, but he finally said, with evident effort, "I love you." and embarrassed us a little by taking our hands and kissing them. All I could think to do was to return the gesture and kiss his hand. At this he smiled his delightful smile, made lop-sided by his stroke, yet a smile that reminded us for a moment of the father he had been.

If you had met him you'd have found a mild-mannered man, soft-spoken, well-liked and without self-interested ambition. The love between my parents was constant and evident to all who knew them. A responsible citizen, a merchant, a member of the school board after my brother and I had gone on to college — he would not be on the board while we were students to avoid tainting our achievements with suspicions of favoritism. For many years he was the secretary of the Lions Club. He never accepted the many nominations to be president. He liked to lead by example, by quiet persuasion, and with gentle humor from the sidelines.

On moral issues he was inflexible; I have space for only one example. In the '50's, long before the present civil rights movement was in full steam, he incurred the enmity of nearly the entire town by supporting the hiring of man of African descent as an English teacher, and backing another as a member of the Lions Club. I remember a long-time customer coming in to our store and saying, with true regret in her tone, "I can no longer shop here. You understand why."

We had a solemn family meeting. Our parents told us that we had a choice to make: if we continued to back our beliefs we would be very poor for a while, there would be no toys at year's end, no going to restaurants, and so forth. We knew what he meant, our family-owned store was too often quiet, the piles of layaways for Christmas were not building up in the basement as they had in previous years. The other choice, he said, was to hold onto our beliefs privately but not push matters. He would not impose his values and the attendant risks on his children. It was up to us and we knew he would abide by our decision. Michael and I had no patience with people who judged others on their race or cultural background, and we said (as Bill proudly recounted years later) without hesitation that we didn't care about presents but that we did care about our friends. To do nothing was to give tacit approval to racism.

Some would say that we lost. We had to sell the store across from the railroad station and set up shop in a poorer neighborhood. Instead of big Buicks and Packards we drove the cheapest Renault. We no longer had a summer house by the lake. And the lovely presents we had become used to came no more. The Lions club split in two, a

large whites-only club and a tiny integrated one with my father as secretary. But we won. The high school had its first black teacher, and others followed. The white Lions club faded and Bill's survived.

There were no services; he was an atheist as righteous as any church-goer. He donated his body to science, and his love of humanity to his sons.

The messages were clear. One was: figure out what is right and then stick to your guns. Another: principle is more important than practicality. These were two of the beliefs that propelled the Macintosh as it came into being. I was not uncomfortable defying common wisdom.

This early training also made it easy for me to recognize girls and women as an oppressed class in our society. As a child I had seen my intellectually brilliant cousin, Miriam, given dolls while I would get the far more interesting Erector sets and chemistry labs we both preferred. My feminist leanings were deepened by some of the things that later happened to my friend Karen Kalinsky. For example, when we were undergraduates at S. U. N. Y. at Stony Brook, I held a job in the computer center. Karen, also a math major, became interested in computers and decided to take the programming course; the head of the computer center there had offered jobs to the people who got the three highest scores on the final and Karen was rarely outscored on any test. Looking at the posted list, we saw that she had received the top score, and we anticipated working together at the computer center. The jobs, however, went to the three top men in the class! We were mad, she raised a ruckus, and I quit in protest.

We went to Penn State next. As usual, I got a job at the computer center, and as usual, they wouldn't hire her — in spite of credentials better than mine in some ways, such as grade point average — because her "boy friend" worked there. After we were married, there was no way she could be hired. Nepotism, you know.

By the time we reached the west coast, degrees in hand, we were smarter about jobs. She took a position first, running the computer at the Institute for Geophysics and Planetary Physics at University of California at San Diego (UCSD.) Shortly thereafter, I got a job at the University Computer Center.

They didn't think to ask a man if his wife worked in a professional capacity — on the form it only asked if your husband worked at the University. I also saw some of the sexist hurdles my cousin Miriam had to face, such as being ignored by the professors in classes. (Miriam is now a professor and researcher at the University of Michigan at Ann Arbor.) These experiences are relevant to our story; for one thing, they influenced my choice of the name “Macintosh” for my favorite computer.

While working at the UCSD computer center, I became familiar with other parts of the school. The music department, filled with avant garde composers and performers, was intrigued by my background in both computers and music (I had designed and built the first electronic music studio at Penn State.) It looked like a good fit and I became a graduate student there, working toward a Ph.D. in music. UCSD, like some English universities, is divided into colleges; at the time, the first two were named Revelle and Muir Colleges, and the newest was simply called “Third College.” By a peculiar series of events (that would, for once, take us too far afield if I described it here,) I soon became the computer center director and a professor of Visual Art at Third College, positions I held from 1969 through 1974.

The main computer center at Revelle College was noisy, antiseptic, and lit by fluorescent lights that glared off white vinyl floors. It was punch-card-oriented and built around a physically huge, multi-million dollar mainframe computer. The computer center I designed for Third College, located in a war-surplus Quonset hut, was very different. It used a pair of Data General Nova minicomputers with 16 interactive terminals. The decor was beanbag chairs and Japanese paper lanterns, giving my center a friendly, funky feel. It became the natural home for people with what were then seen as “odd” computer applications, like music and art. Some of the campus's computer aficionados found that they preferred the unhurried, interactive context of the minicomputers to the fluorescent, buzzy mainframe environment on the other side of campus. In light of today's personal computers, which operate in homes, cars, and at the beach, it is hard to remember that in the early 1970's a computer center such as the one I created was counter-cultural, and perhaps unique.

THE THIRD COLLEGE COMPUTER CENTER

My computer center was funded primarily by the National Science Foundation and the University of California. I suspect that if Senators Proxmire or Helms had ever visited it they would have mistaken it for a typical waste of taxpayer's money. It looked more like a place to get stoned than to get educated, a hippy haven.

But looks are just looks, and I have always made my courses friendly in spirit while I demanded hard work from the students. The new computer center was an effective educational facility. Only ten per cent of the undergraduates who learned programming at UCSD went through my courses, but nearly half of the students who held paying jobs at the main computer center had done so. There was no doubt that the Third College computer center was doing a good job at creating future computer scientists. Better still, it was reaching students who would otherwise never have gone near a mainframe, just as the Macintosh would someday be used by people who thought they'd never touch a computer. It was not the technology that made my teaching so effective, but the interface! Students learned more and better in a pleasant environment where, to test their programs, they simply pressed a key and got results. The other side of campus was batch-oriented; you presented a deck and went to the printer to await your output. Fortunately Ken Bowles, the director of the Revelle center, had an enlightened attitude for someone in his position at the time; he did not regard a second, student-oriented computer center as a challenge to his hegemony. Years later Bowles would spearhead development of the computer language and operating system called UCSD Pascal, which would be essential to the success of Apple and the Macintosh.

In retrospect, the Third College Computer Center was all that a grant administrator could wish for: it met its educational aims, resulted in appropriate publications, and later went on to inspire commercial products that have boosted the GNP (gross national product) to the tune of billions of dollars. It is definitely possible to see precursors of the Macintosh in the Third College center's low tables with small rectangular monitors and detached keyboards. Though they had to be tied to a common system, the effect was as if each student had a per-

sonal computer. Resources had to be shared in 1973, when a 4K byte (enough to hold about 800 words of English) random access memory (RAM) memory unit cost nearly two thousand dollars. As this is written, each 4K bytes of RAM in my Macintosh computer costs less than 10 cents.

During the summers, I used one of the Novas as my personal computer. My mostly volunteer staff and student friends (notably Jon Collins, Barbara Zakarian, Bill Atkinson, and Steve Clark) helped me put the computer into the back of my truck on a wheeled dolly, and we used it wherever we went. One memorable time we took it with us into a restaurant, using it to figure the bill and the tip, to the amazement of the waitresses and patrons who crowded around. A computer outside of a lab was an absolute novelty. These experiences with a "portable" computer system gave me a foretaste of what it would be like to own a personal computer. Like the crocodile in Peter Pan, I would never forget that taste, and craved it for years.

SAIL AND SILICON VALLEY

In 1972 I visited the Stanford University Artificial Intelligence Laboratory (SAIL,) which had an established reputation as a center for advanced research in computer science. I was also introduced to another magical place that had recently opened and was a short bicycle ride away. The Xerox Palo Alto Research Center (PARC) was to become even better known than SAIL in the coming years. Thanks to a strong common interest in early music as well as computers, I soon found a close friend in the person of Doug Wyatt, a tall, thin man who is as quiet as he is technically brilliant and musically talented. Doug took a leave of absence from PARC and came down to San Diego for a while to write new software for my computer center.

A programming language I designed, "FLOW," was implemented and improved by Doug. The human interface used in this system, as well as the design of the language itself, were somewhat ahead of their time. It proved so effective that it came to the attention of the cognitive psychologist Don Norman, later to become a leader in the fields of cognitive psychology and man-machine interfaces, who is now an Apple Fellow and a writer of popular books on the subject. Norman did some of his first computer-interface-related work investigating

why students learned faster and better with the "FLOW" computer language.

The next summer I was invited to become a Visiting Scholar at SAIL. It was a great place to be. I remember fondly the memorable daily, end-of-the-day volleyball game, after which most of us would retire to the lounge and watch *Star Trek*. After which a lot of us would get supper and go back to work. There are a number of reasons why I remember watching *Star Trek*. I enjoyed the show, and once it led to a remarkable incident.

To understand what happened, you have to know that an experimental robot occasionally roamed the halls and parking lots at SAIL. The rambling robot (in case you were picturing C3PO walking across the desert with R2D2) looked like a wheeled table full of surplus electronics. It was not at all humanoid, or even robotoid. On this occasion we were sitting down to watch Captain Kirk and his enterprising crew when the robot wandered in, stopped, swiveled its TV eye at the set and sat there throughout the show. At the end, it whirred into life, rolled itself around, and left as we did. Later I learned that Hans Moravec was working at a terminal that did not have TV feed (most terminals at the AI lab did — another development way ahead of its time that I was exposed to) and had sent in the robot to beam the picture and sound back to his monitor. It occurred to me that we were probably the only people in the universe watching *Star Trek* in the company of a robot.

While at SAIL I used the early Defense Department progenitor of the now-popular Internet. ARPAnet allowed us to communicate with and use remote computers. It felt like magic to be sitting in California and running a computer at MIT. I became an early e-mail junkie, a habit that I have yet to kick after 20 years.

PARC

The populations at SAIL and PARC intermingled freely and I found myself gravitating more and more toward the beanbag chairs at PARC. A significant portion of their work was based on the same goals as my own, to make the power of computers accessible to non-specialists. I suspect that I fit in easily and well because they didn't have to start by converting me to their point of view; I was already there. I meanwhile felt at home since, for

the first time, I was among computer scientists who were on the same wavelength as I. They had accomplished independently what my thesis had called for a few years earlier: computers that were graphic-based, without impediments such as character generators. What was more exciting was that the people I spoke with were concentrating on interface design, which I also saw as the area of computer science most in need of development.

By 1974 I was fed up with the politics in the UCSD art department and left the University, making my point in artistic fashion by ascending in a huge hot air balloon, playing the soprano recorder, and announcing my resignation from 100 feet up in the air. I was also tired of the directions the computer industry was taking. It was all "more" and "bigger" and "faster," but not really better (this history is being repeated with personal computers today.) Nobody seemed interested in what I was preaching about usability. I sold my house near San Diego and moved to Brisbane, a town just south of San Francisco. I tried the life of a street musician and music teacher, started a company that made radio-controlled model airplane kits (a business that continues today,) and became the conductor of the San Francisco Chamber Opera. I also worked briefly as a packaging designer, but left when I couldn't convince the owner that we could design boxes faster and better with a computer. In the 1990's the owner's son, who better understood what I had proposed, wrote a set of computer programs to do box layout, and now has a successful business making boxes — and an even more successful one selling the software.

I also worked as an advertising and portfolio photographer (having been taught a bit about the art by my former student and forever mentor David Wing, now a professor of art at Grossmont College east of San Diego.) During this period of wandering, I started a company called Bannister & Crun to write software and manuals. The company was named after two characters (Minnie Bannister and Henry Crun) featured on the BBC's beloved Goon Show. Between the way the Goon Show's players mangled English and the spotty reception of my shortwave radio, it was sometimes hard following their humor; they were to radio what Monty Python was to become to TV.

Our first job at Bannister & Crun was to computerize the South San Francisco sewer billing system,

a job that required me to visit the sewage treatment plant from time to time and work on one of the most dreadfully designed computers I had ever seen, an early Qantel model. We also worked on other software projects and wrote manuals for companies that included National Semiconductor and Heathkit.

ENTER THE MICROCOMPUTER

In late 1974 the general purpose microprocessor chip was put on the market and I remember discussing its incredible potential with Doug Wyatt and a mutual musical friend, a talented and extraordinarily pleasant man named Brian Howard. Of broad learning, with a degree in Electrical Engineering from Stanford, he was working for the preventive medicine department at the university, doing a characteristically wide range of things including building test equipment. Brian was to become a central intelligence in the development of the Macintosh and, later, one of the designers of Apple's first laser printer — another product that changed the face of computing. He continues as a respected engineer at Apple.

When the first microcomputer kit, the MITS Altair, was announced in 1975, Brian, Doug, and I just had to have one. With soldering iron, oscilloscope, and logic probe in hand, Doug and I built the Altair and (somewhat to our surprise) got it working. This was a non-trivial endeavor, but Doug's combination of methodical care and clever insight solved many a problem. I was experienced with a soldering iron and felt comfortable with the construction because electronics had been a hobby of mine as a child. I had won a science fair prize for a computer I made while in high school. Building a computer is, perhaps, nothing to crow about now, but in 1960 individuals just didn't have computers and kids didn't use or program them. I was still a hardware jock as an undergraduate, designing and building a computer from scratch for the Biology department at the State University of New York, then at Oyster Bay (now Stony Brook.) This background proved useful when creating the Mac, since I had a realistic idea of what could and could not be done with electronic components. Having done electronic design and testing myself, I could communicate with electronic wizards, and not be snowed when they spoke of impedance or logic levels.

We got the Altair running a program that did stock market analysis, and we sold it for about \$5,000 to Jim Hurst, a stock market guru. He'd been paying \$10,000 per month in time-shared computer charges for the same work, so the micro system amortized out in two weeks — a great savings to him. The computer had cost us a few hundred dollars and had served well as an introduction to microcomputing. With part of our profits we bought a slightly more sophisticated IMSAI, and I built the first modem kit that became available. I made back a bit of the money I spent on that kit by authoring a review of it for *Dr. Dobb's Journal*. I liked reviewing kits and I was soon writing the "Consumer Notes" column for that magazine. I became a reporter on the early personal computer scene; pieces I wrote appeared in *Personal Computing*, *Interface Age*, the *Silicon Gulch Gazette*, *Kilobaud*, *Datamation*, and *Byte* magazine.

Jim Warren, who ran the wonderfully-named *Dr. Dobb's Journal of Computer Calisthenics and Orthodontia* (Running Light without Overbyte,) is a delightful, jovial, and unconventional man who sparked much in the industry. He created the West Coast Computer Faires and now works on creating political enfranchisement through technology. He often managed the Faires by cruising their huge exhibit halls on roller skates. One of the assignments he gave me in 1976 was to interview two fellow-members of the now-legendary Homebrew Computer Club centered in Palo Alto. The club, many of whose members went on to become prominent in the computer industry, was moderated by the very funny and genial Lee Felsenstein. This was also the man who designed the modem I reviewed (it's a small valley.) Doug Wyatt and I got an ovation one night when I announced that we had run our IMSAI for over a month without once taking the top off to fix something; it was a real milestone (and a tribute to clean soldering.)

THE TWO STEVES

The members I was sent to interview were building a new computer in their garage. By coincidence both were named "Steve" and their project was the Apple I. I was impressed by Steve "Woz" Wozniak's brilliant and efficient design and pre-decoded bus concept, and his exposition of the advantages of the 6800 and 6502 architecture over the competing 8008 and 8080-based machines.

(Incredibly, this competition between architectures continues to this day.) I remember Woz explaining how the pre-decoded bus made peripherals simpler, that you could send information to peripherals the same way you wrote to memory, and that memory wasn't paged — unimportant details in this essay perhaps, but indicative of the kinds of considerations that Woz paid careful attention to. And I loved the name "Apple" instead of the techie names everybody else was using; it fit my kind of iconoclastic spirit. Now we have become so accustomed to it that it is hard to remember how joltingly countercultural that name was at first. A computer company named "Apple"?

The other Steve, Steve Jobs, was a delight to talk to about less technical aspects of computers. His enthusiasm and business orientation were exciting. They were just starting on the design of the Apple II, and I tried to convince them that they should employ bit-mapped graphics and not have a character generator, but Woz thought that software couldn't handle the character generation task fast enough and Steve Jobs didn't understand why I thought it so important. I had a different vision of what a microcomputer should be like, and PARC's programmers and my own work had convinced me that software could do the job. I tried to convince Woz by working out the code to put bit-mapped characters on the screen and calculating timings by counting cycles, but the Steves were not open to the idea. The concepts I espoused were far from the mainstream of computer design and for all their mold-breaking thinking, Steve and Steve were very strongly conditioned by the minicomputers they had seen. To do them justice, Woz was absolutely correct in stating that a character generator was much faster and its software less memory intensive than my all-graphics approach. But had I been able to convey my vision better, I suspect he could have made bit-mapping work fast enough back then.

It was by the slimmest of chances that the Apple II had a high resolution graphics mode (Hi-Res) on which bit-mapped graphics could later be explored. Woz was not going to include it but Jobs asked Woz how many chips it would take to add the feature. Woz said that it would take only two, so Jobs insisted that they could afford it. Sometimes history stumbles along from accident to accident, things are done that seem like a good idea at the time, and every now and then they are.

I tried to convince Jobs and Woz to visit PARC, which was a very academic and open place (Xerox may later have felt that PARC was too open,) but did not succeed. Jobs repeatedly told me (and anybody else he could get hold of) that a large corporation like Xerox couldn't do anything interesting. Hewlett-Packard's rejection of Woz's proposal for a personal computer, when he worked there, was a prime example of such corporate blindness, and ever after remained part of their psychological motivation. If I could have told them then that Hewlett Packard would someday make millions of dollars simply by selling peripherals to Apple computer products (as has happened,) the Steves would have been ecstatic, and rightfully so.

APPLE MANUALS

I worked with Jobs and Woz and, under the aegis of Bannister & Crun, wrote a user-oriented portion of the manual for the Apple I. There was a tiny misunderstanding about the price: I was talking about \$50 per finished page and they thought I had said that it would cost \$50 for me to write the whole manual. We resolved our differences amicably and work proceeded.

At about this time Jobs made a decision crucial to the history of personal computers. Paul Terrell ran the Byte Shop in Mountain View, one of the first retail computer stores in the world. When Jobs and Woz asked his advice he insisted that the Apple II must have a non-rectilinear, consumer-oriented, plastic case and — unlike the Apple I and many of its competitors — should never be sold as a kit for which potential users had to scrounge parts at local surplus or electronics stores. I well remember the hassle of finding keyboards that worked properly with the very early microcomputers, and connectors to fit the idiosyncratic circuit boards. The Apple II, Terrell suggested, should circumvent these problems by being factory-built with an integral keyboard and power supply.

Terrell was not quite alone in recognizing these desiderata. The SOL, designed by Lee Felsenstein and manufactured by Processor Technology, had a typewriter look. A Utah company, Sphere, sold a complete little machine with a programmer's hexadecimal keyboard (base 16 numbers only) and included a video screen even before the Apple I was released. The Commodore PET and TRS-80, both designed with much attention to consumer

needs, followed soon after the Apple II. But though Apple was not alone, it had important advantages. One was Woz's remarkable BASIC interpreter with color graphics commands embedded in it. Another was that Apple was led by a raving firebrand in the person of Steve Jobs — which was just what the industry needed.

Bannister & Crun was engaged to write the manual for Apple II's BASIC. This gave me the chance to put some of what I had learned as a computer science professor into a vehicle that I believed would reach tens or hundreds of thousands of people in a few years. It had been hard to give up teaching, which I love and yet hope to get back to, but (as I wrote to my parents) I felt that I could do more good for education by working at Apple than in any other way open to me.

The BASIC manual, first published in 1978, turned out to be a trend-setter. Instead of starting off with the then-customary explanation of the internal architecture of the computer, it got right to what people had to do to get the product working. It first explained in a step-by-step manner how to hook up the computer and use the keyboard. It then quickly moved the learner into doing color graphics (in 1978!). Another first: the manual used color illustrations and photos.

Today, when computer products are graded by magazines on the quality of their documentation, it may be surprising to learn that the nascent company barely saw the need for an Apple II manual at all. Mike Scott (Scotty,) a large man whose occasionally high-handed manner and gruff speaking style could be intimidating, had come from National Semiconductor to be Apple's president. He said, half seriously, that at National they had done very well with one-page data sheets, and I could save the company a lot of money by doing likewise. I soon learned that in spite of his manner, he was open to cogent arguments. Later he was to protect and nurture my Macintosh project when it was at a delicate stage.

Writing user documentation was a perfect prelude to creating the Macintosh at Apple. Doing manuals forced me to look at each product — in excruciating detail — from the customer's point of view. It is an experience I wish all computer and interface designers could share. Any design flaw that interferes with learning or using the product becomes painfully apparent as you struggle to

explain the quirk to the user. Time after time Brian Howard and I would wrestle with these problems, our frustrations coming out as subtle, snide remarks about design errors — remarks that, in those innocent days, often appeared in our manuals. This sometimes annoyed marketing people, but it actually served the purposes of Apple's products. The comments told the truth, showed sympathy for the customer's plight, and created credibility for the rest of the manual and the company as a whole. Too many manuals are fairy tales about how a product is supposed to work, or how it worked in the previous version.

When we wrote the Apple II manuals at Bannister & Crun the product was already finished — we weren't trying to write a manual from specifications or rough prototypes. Trying to document a product still in development is an often-made mistake which guarantees a second-rate result. Since almost everybody now does this, customers have come to accept such manuals as standard. It can't work well, since you are documenting something different than what the customer will get, you are writing about a fiction, a planned product (and we all know that products always turn out exactly as planned.) To be sure, the manual can be edited to conform with changes, but that is not nearly as good as having the whole picture in mind from the beginning. Besides, you never catch all the changes, as the customers eventually find out.

We weren't the only group writing good manuals; another example was the superb HP 35 manual. The HP 35 was the first scientific pocket calculator, another fabulous product that opened up an industry. Its manual was an inspiration in terms of writing, use of color and layout, and informal conversational style. Instead of a lecture about the calculator's remarkable stack architecture or revolutionary custom electronic chips, the manual started you out punching buttons and seeing what happened. Later, when the topic had some value and experiential basis, you were given a mental model of what was going on inside. Along with my Apple I and Apple II (serial number 2) I keep my HP 35, still in working condition, in my office. The inspiring manual is displayed alongside it.

The Apple II manuals also worked because they were tested with typical users and rewritten as necessary, a concept nearly unique at the time in the computer industry, and one now regularly aban-

doned (to the detriment of users everywhere) under the excuse of time pressures. The time thus "saved" is not always a win; what the manufacturer gains by a few weeks' shorter product cycle is lost doubly — to customer dissatisfaction, and as a continual drain on the bottom line attributable to increased support costs. As CEO of Bannister & Crun I demanded that I have a real product in its packaging before I wrote a manual, and in those days I got what I asked for. Errors in the manuals were extraordinarily rare thanks to these procedures. Brian Howard turned out to be a great editor, along with his other talents; his comments and those of Doug Wyatt were my education in how to write clearly and simply. My writing has never achieved the standards they set, but inasmuch as it is better than it was, they — and the many other people who have since bravely waded through my first drafts and let me know in no uncertain terms that a lot more work was required — deserve a lot of credit.

APPLE'S MANAGEMENT

Having already approved the use of high-quality, coated paper, four-color illustrations, two-color printing throughout, and full-length manuals, management was reluctant to support the use of a wire binding so that the manual would lie flat (at least we had gone beyond flat lies.) I had often observed that most users didn't have a third hand to hold the manual open as they typed. During 1977, when I was merely a vendor to the company, two key people supported my point of view: co-founder Steve Jobs and chairman "Mike" Markkula, also known by his initials "ACM." Markkula had profited significantly from his experience at Intel, not only financially, but as a well-polished manager. Not having been in industry, I had never worked with a person of his extraordinary business skills, and I am still striving to live up to some of the examples he set. For one, he always gave the impression of having all the time in the world to hear what I had to say. He proved that he was listening, either by acting on my suggestions, or by taking the time to explain to me why they were not good ideas. One of my not-very-good ideas was to lower the price of the Apple II. I had been upset when I figured out how large Apple's margins were. Markkula patiently explained that while Apple's products were more expensive, the resultant financial strength of the company meant that

Apple would be there for its customers in the future. It would have the money to develop new products and successfully market them while its competitors, who seemed to be doing a favor to their customers in the short term, would soon be out of business. He was right.

Jobs, in the early days of Apple, was an adamant protector of my writer's prerogatives who championed the need for testing and revision when Scotty didn't see things my way. Thus protected, I did the manuals as I thought they should be done, and Apple got what the press — and even other companies — praised as the best manuals in the business.

DEPARTMENT BUILDING

In mid-1977 I was still running Bannister & Crun, but my writing for Apple and the magazines had made me pretty well known in the industry, and I had lots of job offers. Chuck Peddle, leader of the PET computer project at Commodore, wanted me for a position there. Steve Jobs, who is as persistent a person as I've ever met, kept on asking me to join Apple as head of their publications department. I repeatedly declined, and he eventually asked what it would take to get me to join Apple. To put him off I made an impossible list which included an office with a window and a musical instrument, time to play gigs (I didn't want to let my musician friends down,) flexible hours, Apple's hiring everybody at Bannister & Crun who wanted a job at Apple, and so on. He simply agreed to all my conditions, which I then wrote down; as it turned out, I should have done this with more of his promises. Bannister & Crun became Apple's publications department with me at its helm. I joined on the 3rd of January, 1978 as Apple's 31st employee. I presented no resume and signed no forms. Apple did no checking on my background. That I had led a team that had produced the nascent industry's best manuals was enough.

One day I heard that a new product, called the Apple II Pro, was being put together in the lab. From some technical details, I surmised that it could not possibly work as expected. So I snuck into the laboratory and turned on the prototype. Sure enough, it didn't do what it was supposed to. I went to Mike Markkula and told him that the machine wasn't up to snuff, and he replied that I couldn't be right, his engineers had assured him that all the problems had been solved. He was ac-

tually making plans for marketing and shipping the product and was about to start taking orders from dealers.

I took him to the lab and demonstrated my discovery. Upon talking to the people working on the project I had discovered a classic management nightmare (though it was new to me at the time): the engineers working on the project said that while the project was mostly going OK, there were still some unresolved problems. The next level reported to their bosses that a handful of problems would no doubt be rapidly fixed; they in turn told Scotty that it was nearly done, and Scotty told Markkula that it was just about ready to roll. In a more mature company I would probably have been fired immediately for my end-run around the hierarchy, but this time I was able to make a case for a "New Product Review" department. This would do for systems and software what QA (Quality Assurance) programs did for circuit boards and mechanical assembly. Suddenly, I was managing two departments.

Computers are not terribly useful without software (my definition of a computer is "a box for running software".) I argued that Apple would need to provide something new, application software, if we were to sell computers more widely. I created what may have been the first application software department at any microcomputer company. I tried to convince Apple to buy Visicalc, the first spreadsheet, when it was offered to us, but was out-gunned by Jobs and Markkula. It was Markkula's theory — at least as he expressed it years later — that to become a major application provider would have put a damper on third-party software developers, in the long run hurting Apple. What he said at the time I do not remember, but I do remember remaining unconvinced. With Markkula's approval I took a brief leave from Apple, arguing that if I could help make Visicalc a winner, Visicalc would sell a lot of Apple II's. As a result, I got to write the tutorial portion of the Visicalc manual, reporting to Dan Fylstra. Visicalc did sell a lot of our computers, established a new category of software, and — since it was a business application — greatly helped the credibility of microcomputers in general.

In 1979 I found managers for two of my departments and became manager of Applications Software. Meanwhile, I was chafing at the limitations

of the Apple II. The publications department managed to keep a secret that would have been embarrassing to the company had it been revealed at the time: the publications department was using not Apple IIs but Poly 88 computers. We were running a word processor I had designed and which had been implemented at Bannister & Crun. The Polys were a competing microcomputer that could handle both upper and lower-case letters — a necessity in manuals. Due to mediocre design (they had no Woz,) poor marketing, and less imaginative management, they were soon out of business. Back in the garage days, in 1976, I had argued that the Apple II must have lower-case letters, but Woz disagreed. I held that the single biggest use of microcomputers would be word processing, he claimed that they would be used for game playing and programming in BASIC. But he had the ultimate argument: upper-case-only character generators were lots cheaper.

Though I often felt they were on the right track, I still could find myself at odds with Apple's founders, who were a strange mix of the radical and the conservative. They wanted to create personal computers, but expected them to work much like the hard-to-use minicomputers from DEC, HP, and Data General. Dragging the two Steves into the interface future was preaching in an unknown tongue, and from my perspective, they didn't appear to be the advanced thinkers that they were made out to be in the press. They were visionary, and working like mad to drag the world into the personal computer future, it's just that I was a few years further out in the future. In spite of these differences I was the typical way-over-100%-effort and totally Apple-oriented employee. This extended into my personal life. Apple's Cupertino phone number was 996-1010. When I moved to Cupertino, I chose my home phone number, symbolically, to be just one step ahead of the rest of Apple: it was 996-1009.

BITMAPPING

Apple employees were a diadem of the brightest and best cut jewels of Silicon Valley, some well known and some newly discovered. I was amazed at the competence of the people, whether in financial management, marketing, manufacturing, engineering or whatever; and they all seemed willing to share their knowledge and points of view with me.

Competence clustered at Apple, partially thanks to the many contacts men like Markkula and Scott and our investors had in the industry, and partly as a result of Steve Jobs' incredible persistence. When Jobs was convinced he wanted someone, that person would be hounded to death, complimented, provided blandishments suited to his or her nature, and offered the world. Soon enough, Apple could deliver many of these promises. At NeXT, Jobs was to continue making similar promises, repeating the ploys he had developed in Apple's first years, to the disappointment of investors, employees, and customers alike. Too often we mistake the randomness of the universe as our own accomplishment when things go our way. Still more often we take that same randomness, when it goes against us, and regard it as punishment for our sins. In a complex world it is often impossible to tell accident from design.

When Ken Rothmuller was hired from HP to start the Lisa project (which was after I had proposed the Macintosh, but before it was officially approved as a research project) I saw a new opportunity to get my computer interface and architecture ideas accepted. I argued again that the screen architecture of this new product should be bit-mapped. But where I had failed with Woz and Jobs, I managed to convince Ken and his crew — probably to Ken's detriment as Jobs found him difficult to work with (i.e. had strong opinions and didn't kowtow) and fired him. Jobs probably found me equally difficult, but I had already proved myself and my very productive and cost-effective publications department was one of Apple's many gems; it would have been hard to justify getting rid of me.

In spite of the loss of Ken Rothmuller, the bit-mapped screen survived. This was a key win for me and (though they didn't know it at the time) for Apple, because it would force the software I was dreaming of to be implemented. No longer would computers be restricted to whatever font was in the character generator, and have to treat characters and graphics as fundamentally different kinds of things. Another major battle that I fought was to have black characters on a white background instead of the then-conventional white (or green!) lettering on a black background. The Lisa hardware designers were, like Jobs and Woz, dead set against this idea, noting that it took too much power, would require a higher refresh rate to avoid

flicker, was not the way computers usually worked, and so on. I argued that people often printed computer output on white paper, and that was black-on-white, and that if you wanted it to look the same on screen and print (the WYSIWYG, or What You See Is What You Get principle) you had to do it black-on-white. But my industrial-strength argument had to do with something the Lisa crew (like the whole micro-computer industry) was just not thinking about: grayscale, or dithered, graphic images. If you worked in white-on-black and had a part-text and part-graphics image on the screen, which got reversed on printing, then either the screen or paper image would have to be a negative, and nobody wants to be forced to look at negatives.

Again, after many memos, meetings, and informal and formal discussions, I managed to sell the idea. It was another key to the future.

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IN MEMORIAM: TOM MANDEL

Tom Mandel, a highly regarded futurist and a specialist in on-line communications, died at Stanford Hospital in Palo Alto on Wednesday, April 5. At the time of his death he was 49 and had been a long-time employee of SRI International. He also administered the electronic version of Time Magazine distributed by America Online.

While Dr. Mandel did his most formal work at SRI, he was best known to the computing community as a definitive participant in the emerging phenomenon known as cyberspace. Not content to view computer networking as a simple medium of communication, he worked tirelessly on the Sausalito-based WELL (Whole Earth 'lectronic Link) to create a global forum where diverse ideas and opinions could be explored thoroughly in real time. He was abundantly comfortable with opinions himself, and brought intelligence, a quick wit, and a quick temper to ten years of postings in any number of discussions.

Dr. Mandel was diagnosed with inoperable cancer on November 4 of last year, and immediately began a frank discussion of his prognosis, concerns and fears in a WELL forum he called My Turn. (Traffic from the forum was excerpted in the April 25th New York Times.) Expert medical attention could not slow the progress of his illness; but, true to his perceived responsibility within the on-line community, he continued to post on the WELL until three days before his death.

A native of Chicago, Dr. Mandel lived primarily in Hawaii until 1965, when he joined the U. S. Marine Corps and served a tour of duty in Vietnam. He then returned to finish college, earning a bachelor of arts degree in futuristics from the University of Hawaii in 1972.

The ANALYTICAL ENGINE extends condolence to Tom Mandel's wife, Maria Syndicus of Mountain View; his mother, Mrs. Fred Mandel of San Mateo; his sister, Susan Cathey of Fresno; and his brother, Steve Mandel of New York.

CAROTHERS JOINS CHAC ADVISORY BOARD

Steve Carothers, a science teacher and head of the Technology Committee at J. L. Stanford Middle School in Palo Alto, CA, has joined the Advisory Board of the CHAC.

Carothers has worked extensively to introduce middle-school students to computer communications, including on-line services, Internet presence, and the World Wide Web. He has also volunteered as a coach for Odyssey of the Mind, an international problem-solving competition for secondary-school students, sponsored by IBM. We value his membership on the Board, and look forward to his counsel, particularly on development of educational resources in computer history.

WEST WHIPS EAST IN BI- COASTAL COMPUTER BOWL

The seventh annual Computer Bowl™ competition, played for the first time in cyberspace on the evening of April 20, was won decisively by the West Coast team with a final score of 230 to 180. Held simultaneously at the World Trade Center (Boston, MA) and the Santa Clara (CA) Convention Center and connected by satellite uplink, the one-hour competition was hosted by industry executive Chris Morgan and by Nicholas Negroponte, director of the MIT Media Lab.

The winning West Coast team included Eric Benhamou, 3Com; Steve Blank, Rocket Science Games; Andy Hertzfeld, General Magic; Roel Pieper, LTB Networks; and Captain Cheryl Vedoe, Tenth Planet. East Coast contestants were Joe Alsop, Progress Software; Captain Katherine Clark, Landmark Systems; Paul Gillin, ComputerWorld; John Landry, Lotus Development; and Carl Ledbetter, AT&T Consumer Products. Gillin, voted East Coast MVP, and Blank, West Coast MVP, received awards sponsored by ComputerWorld Magazine and presented by publisher Gary Beach.

At half-time, The Computer Museum held a Celebrity Auction of items and services donated by individuals and pioneers in the high-tech industry. Popular items included a book of essays about Albert Einstein, signed by him; the opportunity to

be publisher of ComputerWorld for one week; and an original painting by AARON, the world's only artificially intelligent robot artist. Auction and gate proceeds contributed more than \$250,000 to The Computer Museum's educational programs.

This is believed to be the first time a game show for broadcast has been conducted without the players in the same room. Game play was supervised by Dave Nelson and Bob Frankston, using a customized digital buzzer system designed to eliminate transcontinental timing delays.

Subscribers to America Online (AOL) could log on to receive the questions as they were being asked of the contestants, then determine their individual scores after every question. Prizes were awarded to the highest-scoring AOL players. It also aired nationally as a special edition of "Computer Chronicles" on 298 PBS television stations and in 200 major cities worldwide.

A BOOST FOR SILICON VALLEY'S HISTORY

The other day, just up our street, we discovered a "new" organization that will make a major contribution to this area's historical literature. The Santa Clara Valley Historical Association, by the end of this year, will "document the origins and history of the most technologically innovative region in modern times" in a book-and-videotape set, *The Making of Silicon Valley: A One Hundred Year Renaissance*.

Narrated by Walter Cronkite, the videotape will combine still photographs, archival footage, and interviews into a vivid chronology of the Valley's development, from the founding of Stanford University to today and tomorrow. Interview subjects include Bill Hewlett, Dave Packard, Ed McCracken, Steve Jobs, Gordon Moore, Regis McKenna, Finis Conner, Mike Malone....we don't have space for the whole list, but it's amazingly comprehensive.

Projected retail price of the set is \$24.95 — not much for a potential classic of photojournalism. We'll let you know when it's available!

DEDICATED TECHNICAL ARCHIVE IN SUNNYVALE

Days after we discovered the Santa Clara Valley Historical Association, Frank McConnell forwarded an ad from *IEEE Grid* soliciting donations of technical docs for the new Computer Technical Archives in Sunnyvale. With the stated objective “[to] create a unique collection of documents related to the computer industry....not generally available in any other public collections,” the Archive boasts roughly 1,500 linear feet of materials. Its director, Bill vanCleemput, actively seeks a wide variety of collectible docs including:

- Software user docs and code
- Demo disks or tapes
- Data sheets and collateral marketing material
- Press releases
- Quarterly and annual corporate reports
- Business plans
- News clippings
- Research reports
- Master’s and Ph. D. theses (those not available from University Microfilms)

The lion’s share of the current collection is stored in lockers and the Archive seeks funding (of course) to expand the collection and make it publicly accessible.

The CHAC looks forward to close and fruitful collaboration with the Computer Technical Archives as we confront the entirely nontrivial job of saving the paper (and mag) history of California’s computers. If you have anything you’d like to offer Bill, you can snail-mail him at Box 4376, Stanford CA 94309 USA; FAX to him at +1 408-733-8008, or voice him at +1 408-733-1300.

VINTAGE ARTIFACTS AUCTIONED ON THE WEB

As we go to press, a “virtual auction house” — Onsale, Inc., in Mountain View, CA — has begun operation on the World Wide Web at www.onsale.com. Founded by former GO Corporation executive Jerry Kaplan, Onsale offers vintage computer hardware, software and docs to the highest on-line bidder. All lots are illustrated, provenances are carefully written and bidding rules seem scrupulously fair.

Our whirlwind tour of current lots disclosed a few startling prices — is a tan-case Osborne One really worth a thousand bucks? — but much worthwhile material is in the thoroughly affordable range of US\$10 to \$50. Some classic and early sourcebooks on computing, like original publications by von Neumann, Turing and Wilkes, would tempt almost anyone to go higher. There’s even a 1906 Millionaire, one of the earliest and best-known mechanical calculators, although a starting bid of \$4,000 means you might have to hock your laptop to pay for it. (We make no representation that these lots will still be available when you read this, but others will take their places.)

An organized collector’s market in computer memorabilia is a new phenomenon, and its repercussions can only be imagined. On one hand, agreed-upon standards of valuation may mean that less of this material will be casually destroyed — and more will be learned about what remains. On the other, such a market might stimulate speculative pricing that would put vintage computers out of reach for amateur collector/historians. We don’t know which way this cat will jump, but ENGINE readers can be trusted to assess the issues fairly and decide for themselves.

Philosophy aside, this hypertextual “auction catalog” is probably as engrossing as anything on the Web. Whether you bid — just a click! — or abstain, you might find yourself browsing far into the night. We did.

NEW HOPE FOR THE AMIGA?

Fresh buzz of an Amiga revival followed the announcement that Escom AG, Germany's second-largest computer company, had acquired the assets of Commodore International Ltd. for the advantageous price of US\$6.6 million. Escom president Manfred Schmitt announced that his company proposed a comprehensive line of desktop computers including Amigas, to be built in China, and Commodore PowerPC's, probably to be built in Europe.

Although Schmitt and others are optimistic about the sale, it still faces many hurdles, including the necessary approval of the U. S. Bankruptcy Court and of the Supreme Court of the Bahamas, where Commodore was incorporated. Objections have also been raised by IBM, by Dell Computer Corporation — an unsuccessful bidder for these assets — and by a Commodore trustee. Finally, Commodore's creditors have not yet agreed to the terms of sale.

Personally, we hate to see popular and potent technology hog-tied by courts. Recent third-party development in Germany and elsewhere demonstrates that the Amiga platform still has lots of room to grow. We understand that Commodore's legal situation is of paralyzing complexity, and that a fair settlement is a prerequisite; but that shouldn't "paralyze" future production of Amigas, which are still eagerly sought by professionals in film, video, music and many other fields.

SPOTTER FLASH

The CHAC has been featured in "Business Reports: Techie Collectibles," an article on computer collecting by freelance writer Gary M. Stern, appearing in the May issue of *Profiles*, the in-flight magazine of Continental Airlines. Thanks to Gary, to editor Anna Studabaker — who sent us a copy — and of course to Continental.

The useful article by Dr. Edward Then ("The Discolouration of Plastic Computer Cases," ENGINE 2.3) is summarized in *Kovels on Antiques and Collectibles* for May 1995. This is one more indication that obsolete computers are gaining the notice of antiquarians and collectors, and we're glad to encourage the adoption of proper conservation techniques.

SPOTTER ALERT

Copies of the ENGINE, the FAQ, and project information have been pouring out to print and broadcast media, especially in Silicon Valley. We do have tearsheets of most of the ink we know about. But is there ink we haven't heard of? Once more, with feeling: If you spot any mention of CHAC or the ENGINE in any periodical, *please*,

- * If your copy of the piece is clippable, clip and mail to the Palo Alto address.
- * If you can't spare the physical copy, send the text as net.mail to engine@chac.org, or photocopy and fax to the Palo Alto address.
- * If you're too busy for that, just send the publication name, date and page number and we'll do the hunting.

Thanks! (And thanks to the spotters who have given us invaluable help with keeping up so far.)

NOMINEES SOUGHT FOR CHAC ADVISORY BOARD

The Computer History Association of California invites nominations for membership on its new Advisory Board, a planning body that will help shape our policies on such important questions as accession, fundraising, exhibition, site selection, education, and publishing.

An ideal nominee will have, first, a demonstrated interest in computer history or other technical history; second, a noteworthy record of accomplishment in a field or fields related to the mission of the CHAC; and, finally, a commitment to the survival of the nonprofit sector. While we anticipate that the majority of Board members will be residents of California, we welcome nominees from any state or nation.

Please submit nominations by e-mail to engine@chac.org, by fax to +1 415 856-9914, or by snail-mail to the Palo Alto address.

MONEY, the UNIVERSE, and EVERYTHING

It had to happen; the ENGINE's gaining weight again. We've always been 100% fat-free, but putting on muscle is one of our favorite activities. More pages, more pictures, and color are only a matter of time.

Now, more pages and more copies do cost more to print. Fine! That contradiction resolves beautifully when *you* subscribe to the paper edition. And if you do it now, your sub will start just in time for these muscular, captivating, picture-laden issues.

The best ENGINES are yet to come. If you're already a subscriber, your renewal will be its own reward as we send you *more* and *better* computer history for the same old thirty-five bucks. If you've been thinking about subscribing, surely you can be equally tempted by the same logic. Join the ever-growing — but still select — roster of CHAC members today.

(And if you're one of the few — yes, there are a few — whose subs have lapsed? Hey. These hefty issues-to-be are exactly the ones you might miss; not to mention that, if you end up with holes in your collection, we can't promise to supply back

issues indefinitely. Dig into the stuff on your desk, find your renewal form, and send it with a check. Thank you!)

YOU PUBLISH! OR WE PERISH!

Each word of our title — Computer History Association of California — has a special and resonant meaning. Let us point out in particular that “California” means *all* of California, without slight or favor.

The first eight issues of the ENGINE (hey! it's true!) have inquired into the history of Intel, Hewlett-Packard, Apple, IBM, and several other renowned companies. But almost every major article we've published has been set in Northern California.

Certainly our material has earned an enviable reputation for the ENGINE and frankly, if we were lazy, we'd mine Silicon Valley for articles and interviews that would fill our journal for the next thirty years. And yet....

What about the pioneering institutions like UCLA, like Cal Poly, like the Jet Propulsion Labs? What about the Golden Land's great hardware builders — SDS and Lobo, to name just two? What about cutting-edge coders, from Northrop to Quarterdeck and beyond? The computer history of Southern California is a treasure chest waiting to be cracked.

If *you* worked in computing in Southern California, we want to hear from you. More precisely, we'd like you to wave an article in our faces. Read the GUIDELINES FOR SUBMISSION, fire up your mail software, and break the silence of the whispering palms!

Legacy Book Review: TV TYPEWRITER COOKBOOK

Don Lancaster

Howard W. Sams, Inc., 1976

256 pages, \$9.95 (paper)

ISBN 0-672-21313-3

Reviewed by Kip Crosby

And it did come to pass, brothers and sisters, that LSI begat VLSI, and VLSI begat ULSI. And the suits entreated, let the micron be cloven, or we may go no further. And the lithographers muttered, nay, nay; but the engineers proclaimed, yea, yea; and behold, the micron was split in two. And in the fullness of time, once more the suits did implore....

Well, having squinted at my share of modern CPU dice, I can assure you that those quarter-microns are *really hard to see*. Naturally, they're also crucial to the astounding functionality of contemporary chipsets. VLSI in its maturity has become one of the truly Big Wins of modern technology; a win so dazzling that not many are tempted to ponder the corollary loss. What have we lost? Read Don Lancaster's *TV Typewriter Cookbook* and you'll know the answer.

Between 1973 and 1976, electronics for the hobbyist was revolutionized (again) when integrated circuits became easily available and cheap. Don Lancaster possessed a masterful understanding of solid-state electronics, demonstrated at length by his earlier *TTL Cookbook*; and his specialty was the modular, straightforward circuit design that the electronic experimenter has always loved. He saw that by using a wide variety of IC's, conveniently through-plated blank PC boards, a handy TV set, and some diodes, resistors and keycaps, a hobbyist could affordably build a device he christened a "TV Typewriter" — really a formidable knockoff of a video display terminal, but (at mid-seventies prices) hundreds or thousands of dollars cheaper than a "real" VDT. Lancaster claimed repeatedly that his device could be reproduced for "\$30 to \$150" and, even if the lower figure was wishful thinking, the higher was probably generous.

Building the TVT was not for the faint of heart or tremulous of hand, but if you had bench space, patience, ready access to parts, and a reliable soldering iron, ten bucks more would buy you this book and the keys to the kingdom. In 256 (hmmmm....)

copiously illustrated pages, Lancaster shepherds his reader through electronics and scanning fundamentals and the basics of data encoding — ASCII, Baudot and Selectric — before plunging into an exhaustively annotated comparison of commercially available IC types. Then he discusses memory, stressing proper application of PROMs and SRAMs, and constantly showing concern for the reader's wallet with money-saving shortcuts — some of which seem horrific today, like lighting only five of the seven bars of an output LED.

But the truly scary parts, for the modern computer user, are chapters four through eight, which treat system timing, cursor management, keyboard design and encoding, and serial and video interfaces. No summary I could give will be as vividly illustrative as a sample:

In Figure 5-6, we have used inverting tristate drivers for the tv typewriter timing and for external minicomputer control. We could also use a third set of drivers for access by a frame-rate cursor. But, since the frame-rate rise and fall time is not very critical (we have the entire vertical interval to use,) we can continuously "float" the frame-rate cursor addresses onto the memory address lines with high-value resistors. If we enable neither the tv timing nor the external timing, the frame-rate cursor addresses appear on the memory bus. If we enable either of the other address sources, the low-impedance output of the drivers swamps the cursor address and takes over....

This passage, like much of the book, can be puzzled out concept by concept. But as someone who bought his first micro several years after this book was published, I've relied on my cursor for over a decade without ever thinking about swamped addresses. Similarly, if you use an external modem, you probably get very annoyed on the rare occasions your serial port locks up. And if you accidentally press a key before you let up on the one before, do you still get the output you want? Then your keyboard has n-key-rollover; and believe me, twenty years ago, n-key-rollover was *tough* to design and build. Expensive, too.

This book was of tremendous value in 1976 and remains so today, but the emphasis has migrated from the practical to the historical. The technical problems that Lancaster anatomizes have long

since been solved, their solutions embedded in submicron ASICs produced by the billion. It would be unthinkable today to find a description of video circuitry that extended to the merest flip-flop — at least in a mass-market paperback. The tremendous density and modularity of modern computer components, together with the changed character of an audience that can buy rather than build, means that today's books about "How Computers Work" speak primarily in conceptual terms. All the more important to remember that those flip-flops, etched into nearly ageless silicon, are working for a living in your Pentium or Sparcserver, hidden by a gray epoxy cap from sight and imagination.

Lancaster's book is an inimitable classic poised exactly on a cusp of history, when the micro revolution was showing its earliest force, but the hand-wiring of circuits was still common art. Few other books as potently demonstrate the mystical moment when the solder only just flows and you know you hit it right. Scout your used bookstores for the *TV Typewriter Cookbook* — it may be hard to find but easy to spot, our copy is screaming chartreuse — and read it carefully, slowing down for the bad corners. Then sit back and think "That was just the terminal. I'd still have to build the computer." You'll know at last how computers work....and why you'd probably rather buy, plug and play.

OVERVIEW OF BUREAUCRATIC PROCESSES

Various governments sent us forms that we had to fill out and mail back. None of them bounced, so we must be doing something right.

ACQUISITIONS

Dilating on this would only be depressing. Let's just say that if we can ever find any more storage space, we're going to have *lots* more computers. Assuming they still exist by then.

LETTERS

20-YEAR REUNION FOR MITS ALTAIR

We're organizing a 20-Year Reunion of MITS Altair folks who took part in creating the first affordable "micro-computer," the MITS Altair in Albuquerque, NM. Ed Roberts, MITS founder and president 20 years ago, has been contacted and plans to attend. David Bunnell, MITS tech writer and later founder of PC World Magazine, has also been contacted, as have dozens of other former MITS folks.

The governor of New Mexico is sending personal letters of invitation to these, plus Bill Gates and Paul Allen, who first formed "Micro-soft" in Albuquerque twenty years ago. We've been in contact with Paul Allen's office and been told "the timeframe is good for him...", though we don't yet have a firm commitment.

The reunion will be held on the second day of the New Mexico Computer Fair & Expo, a three-day computer show at the Albuquerque Convention Center from June 9-11, 1995, organized by ComputerScene Magazine in New Mexico.

If you know anyone who worked for MITS during the time of the Altair's creation, or for more information on the reunion or the New Mexico Computer Fair & Expo, please call ComputerScene at 1-800-658-6790.

Greg Hansen
 Publisher, ComputerScene Magazine

UNISYS HISTORY NEWSLETTER ONLINE

The Unisys History Newsletter was written and published by George Gray. George is a Systems Programmer for the State of Georgia Department of Administrative Services and is heavily involved in Unite Inc., a Unisys User Group. He began his work on the Unisys History Newsletter as a hobby and published these six newsletters; now, he writes a regular column for UniSphere magazine.

UniSphere is currently working on getting the remaining articles online via WWW, but unfortunately they are not available yet. With George's permission, I am able to bring you these six fascinating articles on-line.

The newsletter is located at the WWW URL

<http://www.cc.gatech.edu:80/services/unisys-folklore/>

Here are the six titles:

UNIVAC in Pittsburgh 1953-1963 , Vol. 1, Num. 1 (September 1992).

The UNIVAC Solid State Computer, Vol. 1, Num. 2 (December 1992).

EXEC II, Vol. 1, Num. 3 (March 1993).

The UNIVAC 1100 in the Early 70s, Vol. 1, Num. 4 (June 1993).

The UNIVAC File Computer, Vol. ?, Num. ?

The UNIVAC III Computer, Vol. ?, Num. ?

As you can see, mostly UNIVAC/Sperry history, but there is a light sprinkling of Burroughs within a few of these articles.

Enjoy!

Randy Carpenter
Georgia State University
sysrc@panther.gsu.edu

THIRTIETH ANNIVERSARY of the PDP-8

On March 22, 1965, DEC unveiled the PDP-8 computer. That was 30 years ago, and it's worth a pause to remember how far we've come since that day!

For US\$18,500, you could buy a 300 pound desktop computer, implemented in word-parallel solid state logic, with a 12 bit word and 4K words of 1.5 microsecond core memory. The price included an ASR 33 teletype, and the available paper-tape-based software included an assembler, a FORTRAN compiler, and a text editor of sorts.

For more money, if you had room for two 6 foot tall mounting racks, you could expand the system to 32K of core memory and add other peripherals such as DEctape drives (functionally equivalent to floppy disk, but slower.)

The PDP-8 computer was the minicomputer that opened up the small computer marketplace we know today! It was the first word-parallel machine costing less than \$20,000, and its upward-compatible successors broke the \$10,000 and \$7,000 price barriers. Many PDP-8 systems continue in use today, mostly in industrial automation applications, and DEC continued to manufacture machines based on this architecture until 1990, when the microprocessor based DECmate III+ word processing system was finally discontinued.

For a trip back through time, you can find more information about the PDP-8 on the Web at:

<http://www.cs.uiowa.edu/~jones/pdp8/>

Followups should be directed to alt.sys.pdp8.

Doug Jones
jones@cs.uiowa.edu

HCS: VERY MUCH ALIVE, THANK YOU

Dear fellow members, friends and enthusiasts, I am writing to tell you that the Historical Computer Society and "Historically Brewed" are still alive! We have not disappeared forever. We are about to resurface with the long lost, and eagerly sought after issue #8 of "HB." I am very sorry for the lateness of issue #8 and for leaving you all in the dark for so long. In the past, I have been late with other issues of "HB," but never this long. I have experienced many personal difficulties and challenges over the last few months and my life aside from HCS has become extremely busy with the simple task of earning a living to support my family (if only I could run HCS full-time). I would also like to announce the birth of our son, Andrew David, on March 20th.

To get to the point; I find that I am unable to further handle the entire operation of HCS — now more than ever. It is very important to me . . . but I have let it slip. There almost seemed to be no light at the end of the tunnel, but the good news is — HCS has added two new additions to its management. I would like to announce to you — Kevin Stumpf, HCS' new Associate Editor and Walter Peterson, HCS' new Technical Director. Together (with your help too!) we plan to get HCS and "HB" back on track. There is still much interest, I receive loads of letters and e-mail, and we have a readership of over 300 members. You all have been very understanding and I know that we all want HCS to succeed. I have discovered that the hardest thing to recognize when managing a project, is when to realize that you can not do everything yourself, and when to delegate responsibility and authority to others. I've learned some valuable lessons.

Here are a few other announcements:

* Issue #8 will go out April 8th, whether at its best or not. Work on issue #9 will commence immediately thereafter.

* Issue #9 will contain an exclusive interview with Ed Roberts, the creator of the MITS Altair and "Father" of the PC revolution. We let January slip by without even mentioning the 20th anniversary of the personal computer — the Jan. 1975 issue of "Popular Electronics" announcing the Altair to the world!

* Walter Peterson has plans to create a place for HCS on the Internet very soon! Stay tuned.

* As Associate Editor, Kevin Stumpf will be taking responsibility for answering overdue correspondence, e-mail and article coordination.

* Please allow us another week or so to get caught up on orders. If we still owe you a back issue, book or anything — then write and remind me.

* Help spread the word about the Historical Computer Society! Show "HB" to your local college library, computer club and computer stores.

* Please send your stories and photos of computers!! We need a regular photo page.

Computer History is inspiring and dynamic. I have never regretted what I started, nor have I ever wanted to quit. I have just been overwhelmed. Please accept my sincerest apologies. Thank you for all of your support and confidence!

Kind regards,

David A. Greelish

President and Founder

Historical Computer Society

historical@aol.com

[We sympathize — to an amazing extent — with David's response, and salute his undimmed spirit. Producing a magazine of high caliber, for a small and specialized audience, is an unending struggle; and certainly the ENGINE, too, has been late in its time. Yet, because "computer history is inspiring and dynamic," *Historically Brewed* and the ENGINE must persist, must prevail. Please support the HCS in its laudable mission. — Ed.]

[We were enthused and reassured to receive *HB* #8 just as we went to press. See PUBLICATIONS RECEIVED, p. 33.]

MSX EMULATOR AVAILABLE

The 0.9 Unix/X version of a portable MSX/MSX2/MSX2+ emulator is available at <http://www.cs.umd.edu/users/fms/MSX/Sources.html>

This version includes *disk support*, support for several different kinds of MegaROM cartridges, MSX2+ option, and many small improvements.

Marat Fayzullin
University of Maryland

[We urge any interested reader to check out Marat's Web site, www.cs.umd.edu/users/fms. It's one of the widest-ranging and most eccentric computer history Web pages around — and that's a compliment. — Eds.]

PDP RE-UNION DINNER during DECUS-95 AUSTRALIA

Here is an opportunity for all those past (and present) Digital PDP users (or anyone interested in PDP-1 through to PDP-15) to get together at a Re-Union Dinner to be held during the Symposium, on the Monday evening, 21st August, 1995. This has been chosen to avoid clashing with other Symposium events.

The celebration will be held during the Symposium week, but not formally part of the Symposium, so that non-Symposium-goers could attend. It should cost no more than \$45 per head for DECUS members and \$50 for non-members.

The committee is seeking **ADVANCE BOOKINGS** — do not send any money yet — so that we can decide on a suitable location.

We hope to make this a fun night for all with displays of light/portable memorabilia and some Guru Quizzes.

The fact that 1995 is 30 years since the release of the PDP-8, and 25 years since the release of the PDP-11, should give added impetus to the function. Note that there will be a PDP-8 30th Anniversary Display at DECUS-95.

Enquiries: Mike Chevallier (02-498 3383) and John Geremin (02-764 4855).

QUERIES

TCP/IP ON A 3COM SERVER — OH, BOY....

I'm looking for the TCP/IP software for an old 3Com/Bridge CS/210 terminal server. All I have is the XNS disk.

Please respond if you have this software, I would really like to get this up and running. 3Com will not help me. Thanks much.

James Sanford
jsanford@geeks.org

BCPL SOURCE: ANYONE HAVE IT HANDY?

I have just gotten the portable BCPL compiler working on my PC and would appreciate any pointers to archived BCPL source code. I would be particularly interested in acquiring the sources to OS6 by Strachey and Stoy; also the two monographs on OS6 published in the Oxford Programming Research Group Monographs series, 197?

Hans B. Pufal
Cross Products Ltd, Leeds, England
Hans@crosspro.demon.co.uk

HP 35 CALCULATOR: ACCESSORIES WANTED

Anybody got one floating around? Have calculator, would like to find clean manual and leather case. TIA,

Randy
Randy3@aol.com

HP APOLLO 425e: GENERAL INFO SOUGHT

What was an HP Apollo 9000 Model 425e? I seem to remember that the model 300 was a 68030 based workstations, so does 4xx indicate a 68040 machine? If so, what does the 25e bit mean? What was the rest of the machine like (ie graphics)? Any info gratefully received,

Dave Wragg
dpw93@ecs.soton.ac.uk

IBM SYS/36: BACKGROUND WANTED

Could someone point me to information about the IBM Model 36 minicomputer, and [perhaps] specifically the B23 version? All I know so far of any historical relevance is that it was released after the System/32 [ca. 1975].

References to books/e-texts or actual core dumps of your favorite bugs in the machine would be greatly appreciated.

Richard "frodo" Martin
g4frodo@cdf.toronto.edu

**LOCKHEED ELECTRONICS
INFO WANTED**

Anyone out there who worked on / designed or used a Lockheed Electronics LEC or MAC 16 minicomputer or the telefile Computer Products TCP16/5 mini which emulated it (in microcode); I would be interested in hearing from you.

Regards,

Scott Finner
srfinner@acacia.itd.uts.edu.au

uPROC STATISTICS SOUGHT ASAP

I'm doing some research on microprocessors but I've found limited, new background info on the subject.

Does anyone here know what the top 4 companies that make microprocessors in the United States are? I'm guessing it's the same companies that are considered the top manufactures of CPUs, such as AT&T, DEC, Intel, Motorola, and National Semiconductor. But I have a feeling I could be mistaken.

Also, does anyone know where I can find out how many microprocessors were manufactured in the United States last year? Please e-mail me back ASAP if you have any info to these questions. My e-mail address is: burtonb@ucsu.colorado.edu.

Thanks ahead of time for your help.

Bonnie Burton
University of Colorado

Q*NET LAN: ANYTHING AT ALL?

I'm looking for a needle in a haystack :-)... information on a PC based LAN called Q*NET from somebody called TCS. The software seems to be copyrighted 1984. I also need info on something called Ethershare (I believe from 3Com) from the same period.

We have a piece of software running on this that we'd like to interface to the rest of our network if possible primarily so users of this software don't need 2 PC's to access both their proprietary software & our network services.

Given the age of the network software this seems like the place to ask this question. Pointers to other appropriate places to ask would also be appreciated.

Thanks,

Andy Stoffel
oddjob@oz.plymouth.edu
Plymouth State College, Plymouth, NH, USA

SINCLAIR HISTORY WANTED

I'm working on a book on pocket electronic calculators and am looking for an address for Sir Clive Sinclair (Sinclair calculators, computers, and a host of other uniquely designed electronic equipment) so I can ask him some questions about his involvement at the time. If anyone can help, please email me at mrcalc001@aol.com. Even if you know a friend of a friend, anything that may help, please forward it. Thanks!

Guy Ball
Editor and Publisher
International Calculator Collector

WINDOWING ENVIRONMENTS INFO WANTED

I'm looking for a brief history or chronology of windowing environments — and not just Mr. Gates' version... I'm interested in Englebart's work, the stuff that went on a Xerox PARC, at Stanford, MIT, Sun, etc. And oh, yes, that Microsoft Windows thing as well. While it's relatively easy to find information about PC/DOS-based environments...it is more difficult to find, for example, details of UNIX-based windowing systems and environments.

The information need not go into excruciating detail — a general timeline would be a great start. Any help or pointers would be greatly appreciated.

Thanks,

Scott Fordin

SUN BOS Information Architecture
sfordin@east.sun.com

PUBLICATIONS RECEIVED

Australian Computer Museum Society Newsletter.

#3, 13 February 1995. Committee news; Membership information; Computer Museum Boston; Notice of General Meeting; Draft Collection Policy document; more. 14 pp.

#4, 11 April 1995. Committee news; Membership information; Oral history; Correspondence; Top 10 computers; more. 7 pp. From Jim Walsh.

Charles Babbage Institute NEWSLETTER, Volume 17 Number 2, Winter 1995. CBI accepts Hurd papers; CBI on the Web; Tomash Fellowship to Akera; New trustees; Update on Kevin Stumpf's Commercial Computing Museum; Recent publications. 6 pp. From Judy O'Neill.

The Computer Museum NEWS, Spring 1995. AARON the Robotic Artist; Computer Bowl 2.0; Networked Planet. 8 pp. From Gail Jennes.

Hewlett-Packard *Journal*, recognizing technical contributions made by HP personnel.

Volume 46 Number 2, April 1995. Design and development of the PA 7100LC microprocessor; integration of MPEG video, telephony, and multimedia peripherals; business server development; HP Distributed Smalltalk; more. 120 pp. From the editors.

Historically Brewed, newsletter of the Historical Computer Society. Issue #8, Spring 1995. Doug Jones' PDP-8 Story part II; For the Collector; Intro to Classic Computing (blinkerlights); Home Arcade Enthusiast; Apollo mission exhibit at American Computer Museum. 16 pp. US\$15.00 per year; Can\$20.00; International, US\$24.00. From David Greelish.

HISTORY OF COMPUTING: An Encyclopedia of Computer History by Lexikon Services. Version 3.41, April 1995. Approximately 800 pages, featuring expanded treatments of early micros, Internet, and chronologies. US\$19.95. From Mark Greenia.

International Calculator Collector, Issue #8, Spring 1995; Calculator Twins, HP Calculator Database, interview with Jack St. Clair Kilby, classifieds, resources, more. US\$12 per year with membership (\$16 foreign). From Guy Ball.

Random Output, monthly newsletter of East Bay FOG.

Volume 11 Number 3, March 1995. Computer History in California; AOL Demo; How to Buy a Modem. 4 pp.

Volume 11 Number 4, April 1995. Computer History in California; Web glossary; Joseph Jacquard; Family Tree Maker. 4 pp.

Volume 11 Number 5, May 1995. Lotus macros; Cache buffers; QBasic. 4 pp. From Pete Masterson.

The Z-Letter, newsletter of the CP/M and Z-System community.

Number 35, January/February 1995. New products; CPMUG, SIG/M and Sound Potentials libraries; Starting to Use the Z-System; programming, letters, resources and more. 24 pp.

Number 36, March/April 1995. AmigaZ80; Intro to aliases; Tax prep on CP/M; Index to issues 1-34; programming, letters, resources, more. 22 pp.

US\$18 for 12 issues (2 years); Canada/Mexico, US\$22; International, US\$36. From David A. J. McGlone.

ADDRESSES OF CORRESPONDING ORGANIZATIONS

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. Judy E. O'Neill, associate director.

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. Brian C. Wallace, curator of historical computing.

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

East Bay FOG, c/o Pat Watters, 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.

Historical Computer Society, 2962 Park Street, #3 (note change of suite number,) Jacksonville FL 32205. historical@aol.com. David A. Greelish, director and editor.

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

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

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

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

THANKS TO....

James Birdsall for his donation.

Brian Case for proposing that we attend the Asilomar Workshop; John Wharton for making sure it could happen; and Lee Felsenstein for enjoyable transportation.

Max "Clive" Maxfield for fellowship and good ideas.

Len Shustek and George Comstock for a fine working lunch.

Bill Terry for help with this issue's interview.

Dale, Doug, Patrick and Valerie — the Cosmic Wombat Band — for putting up engine@chac.org and keeping it there.

All the great new ENGINE subscribers!

NEXT ISSUE / COVER ART

Mac and Me, part two? HP 3000? An interview with a micro pioneer? Why SUN is SUN? We'll leave you guessing, but it might be the thickest issue yet!

The cover: The HP 2116A, Hewlett-Packard's first computer, here serving as the processor for an HP 2018 Computing Data Acquisition System. Note Teletype I/O. From the Hewlett-Packard Archives, supplied by Karen Lewis; once again scanned at Creative Computer Workshop.

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The ANALYTICAL ENGINE solicits manuscripts of 750 to 2500 words on the general topic of the history of computing in, or with significant reference to, the State of California. Articles should focus on one interesting or illuminating episode and should be written for a technically literate general audience. Submissions are welcome from both members and non-members of the CHAC. Article deadlines are: July 15 for the November issue, October 15 for the February issue, January 15 for the May issue, and April 15 for the August issue.

Each author may publish a maximum of one signed article per year. This restriction does not apply to letters, queries, book reviews or interviews. Thank you for cooperating to protect diversity of voices and topics. Previously published material will be republished only in clearly attributed quotations or citations; or when its publication in the ANALYTICAL ENGINE will bring it to the attention of a significantly broader audience; or when the original publication is materially obsolete or inaccessible.

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The preferred document file format is Microsoft Word for DOS or Windows, but almost any DOS or Macintosh word processor file will be acceptable. Submit manuscripts on DOS 5.25" or 3.5", or Mac HD (1.4) diskettes. Alternatively, please send your article as ASCII or ISO Internet mail. Please avoid submitting on paper unless absolutely necessary.

NINES-CARD

POOR KITTY!

submitted anonymously....

As many of us know, cats have a special affinity for computer peripherals, especially that are purring softly, even more so if they're warm.

A woman in the Los Angeles area had a cat, and also owned a LaserJet — a IIp, to be exact, with a front-opening paper tray. Said owner started a batch and left the room, only to hurry back in when she heard her pet scream in pain.

You guessed it. The fascinated cat had taken a closer look at the autonomous motion of the paper being printed; the rollers of the paper feed had grabbed the cat's tail and tried to pull it past the laser....and done a remarkable job. Kitty was still in one piece, but there was no question of simply pulling its tail out backwards.

The woman called the fire department and met with laughter, from a dispatcher who figured that now he'd heard *everything*. She called her vet, who came to the house, shaved the cat's tail — presumably after administering a tranquilizer — and extricated it. Then HP Customer Service (the source of this story) cleaned the cat hair out of the printer. The cat has since recovered, and the LaserJet still works fine, but they're not often found in the same room.

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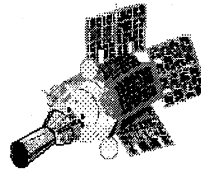
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Computer History Association of....ah, Northern California? No way.

Sure, when somebody says "Silicon Valley" we breathe a little deeper. But when California's computing began in the mid-forties, it wasn't in any chopped-down orchard. Swing toward the sun....

and remember the aerospace factories of Long Beach, El Segundo, Glendale, Santa Monica. Remember MINAC at Cal Tech, SWAC at UCLA, RAYDAC at Point Mugu. Remember the SDS's and Sigmas, and the genesis of ARPANet. And the Jet Propulsion Labs!

Heavy-duty computing? Oh, very.

We want articles. You know that. Did *you* work at the aerospace companies, the great research establishments, the universities? Your most profound experience *deserves* to be written up for the ANALYTICAL ENGINE....and you're the only person who can write it. Write it short and we'll give you a half-page of your very own; write it long and we'll grow the issue to fit. But only you can help us live up to our name....

The Computer History Association of California.