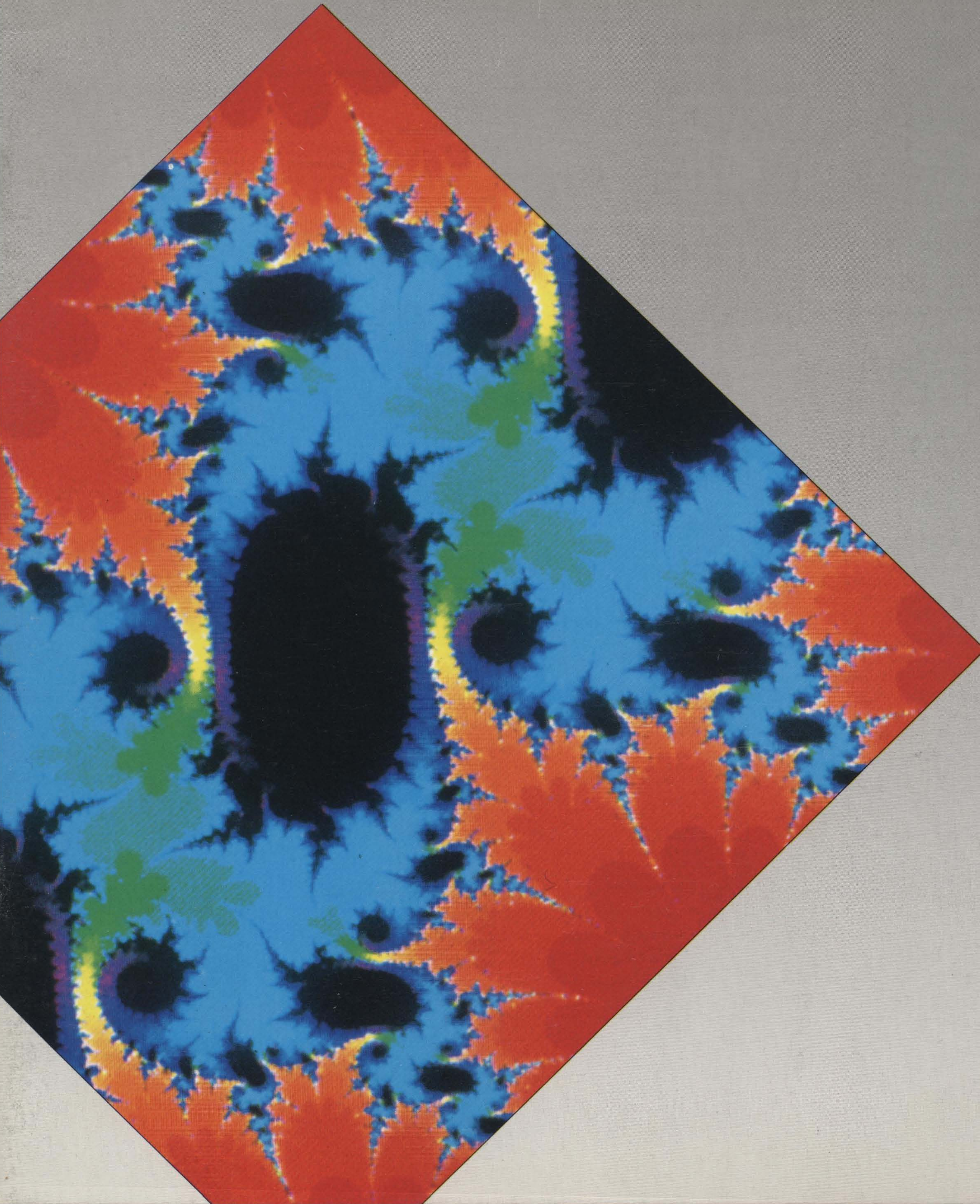
THE COMPUTER MUSEUM REPORT

VOLUME 16 SUMMER 1986



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THE PRESIDENT'S LETTER

Contents

Cover

Colors of Chaos,
Julia set of (.1 +.17i)sin(z) after 35 iterations by Robert L. Devaney, Boston University (see article on page 16).

This young Museum is still filled with first experiences. Two are especially worthy of attention: three of our first interns have achieved important career objectives and the first members survey has been completed.

The Museum's first intern from the pre-Boston days, Beth Parkhurst, passed the general examinations in history for her doctorate at Brown University and has been awarded a Smithsonian Fellowship to study women in programming. Her first paper on the subject was presented at the 1985 meeting of the American Historical Association and will be published in *Daedalus*.

Gregory Welch, who took a year off from Harvard to work on the 1401, Cray, and manufacturing exhibits, has not only graduated Magna Cum Laude but also received the Shaw Travelling Fellowship. Greg will spend next year studying science and technology museums of Europe.

Bill Wisheart, who started as an intern on the collections after graduation from Boston College, has been accepted in the master's program in Computer and Information Sciences at Dartmouth College.

Survey of Museum Members

Almost 100 members replied to the first survey of the membership and it's my pleasure to publish its results. The respondents, from 25 different states, reflect the wide geographic distribution of members, with membership in 46 states, 9 European countries and Australia, Brazil, Canada, Japan, Indonesia and Israel. Before opening in downtown Boston, the ratio of local to non-local members was 2:3. Now it has reversed.

One-third of the respondents had visited the Museum three or more times and another one-third had never visited it. In the month of March, three percent of the visitors were members.

Preservation of computers and a liking for history were by far the most common reasons for becoming a member. Only 13% cited membership benefits as the reason for joining.

Respondents felt that the most important feature of the current membership plan is The Computer Museum Report. Thus, the Report is an important area where we can better serve members. The most interesting articles were on history, followed by anecdotes about artifacts, and articles about exhibits. The sense, in reading the individual comments, is that the Report should stand on its own. One written comment noted:

> I like historical articles both about the museum collections and computing in general. I am not overly fond of reports about events or exhibits that don't make sense unless you have been there.

Many respondents would like the Museum to undertake more outreach activities and include more member participation. By outreach, people mean both travelling exhibits, events, and making films available. These projects are all within the long range plan of the Museum. The first step is making films available. For example, Sperry videotaped the Presper Eckert talk and will add the historic ENIAC film to it. The purpose is to make this available for distribution by the Museum and by Sperry. The Museum is also beginning to build up a data base for member involvement with a redesign of the membership renewal form allowing you to indicate your wish to actively participate. Collecting activities is one area where members can be particularly helpful.

It's very rewarding to watch the network of Computer Museum alumni and members grow.

Gwen Bell
President

The Computer Museum

The Computer Museum is a non-profit 501(c)3 foundation that chronicles the evolution of information processing through exhibitions, archives, publications, research, and programs.

Museum Hours: The Museum hours are 10 AM–6 PM, Tuesday, Wednesday, Saturday, and Sunday and 10 AM–9 PM, Thursday and Friday. It is closed Mondays, Christmas, New Years, and Thanksgiving.

Membership: All members receive a membership card, free subscription to The Computer Museum Report, a 10% discount on merchandise from The Computer Museum Store, free admission and invitations to Museum previews. For more information, contact Membership Coordinator at The Computer Museum, 300 Congress Street, Boston, MA 02210, (617) 426-2800.

Dr. J. Presper Eckert (foreground), co-inventor of ENIAC (Electronic Numerical Integrator And Computer). As the world's first all-electronic digital computer, ENIAC weighed more than 30 tons and occupied approximately 15,000 square feet. Performing 5,000 additions or subtractions per second, ENIAC launched the computer industry as we know it today. Dr. Eckert currently serves as Vice President and Technical Advisor for Sperry Corporation.

ENIAC The Electronic Numerical Integrator And Computer

J. Presper Eckert

If you consider the ENIAC as the starting point, the computer is forty years old. So, by the way, is the United Nations and I feel that we've done alot better than they have.

Talking about the ENIAC is like going back into the attic of my mind. And going into my real attic, I found a clipping from February 15, 1946. It says:

> "Mathematical brain enlarges man's horizons. . . A new epoch in the history of human thought began last night The scope and area in which man's brain can grasp, predict, control suddenly opened outward into the distance with revelation of secret construction during the war of a 30 ton mathematical brain that solves the unsolvable."

I read another article that said every time we turned the ENIAC on it dimmed the lights in West Philadelphia. This is pure fiction. We had it connected to a regulator in the generator room that was adequate for its power level.

Although the press notes that February 13th is when the machine was turned on, February 13 is an arbitrary date on which an announcement was made after some tests and trials. Other reporters stated that over 200 people worked on the project but the maximum group was 50 and the usual was about 30.

I met Dr. Mauchly at an advance management defense training course at the University of Pennsylvania. This course included about 30 people not in electrical engineering, of whom 16 were Phds. I was one of the lowest people on the totem pole; I was a graduate student and a teaching assistant. The meetings with Mauchly were along with a lot of very bright people. Mauchly and I had time to talk and we found that we both had a passion to build some kind of computing device. Mauchly had worked for the weather bureau and one of his motivations was to build a device that would help to predict the weather. The other thing that he had done as a professor of physics was build gas tube and neon lamp counters. I ran tests on them and found that they were not only slow but had very bad margins of safety, although they had the advantages of being cheaper than vacuum tubes overall.

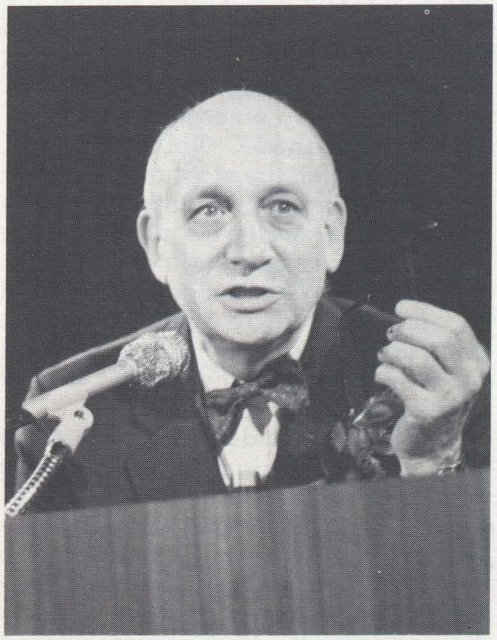
Those responsible for the ENIAC project and present at the dedication appear in the group photo. I reported directly to Dr. John Brainerd and he reported to Dean Pender, a very wise man, who had been head of electrical engineering at M.I.T. before he came to be dean at the Moore School.

Colonel Gillen, the contract officer for the Army at Aberdeen Proving Ground, named the ENIAC, The Electronic Numerical Integrator And Computer. Originally, the name stopped with Integrator because we had only planned to use it for equations relating to the flight of a shell. As time went on, various people felt that the machine should be used for other problems. Colonel Gillen realized the uses would get more complicated so he added "And Computer" to the name. He said this was political protection. If the general accounting office said we went beyond the original bounds, we could point to the name and say it was in the proposal.

Second to me in the photo is General Barnes, head of the Ordnance Department. In 1943, I reported to the Roxboro draft board consisting of a French teacher and two men in the textile business. They thought everyone should be drafted, especially everyone in textiles where the men could be replaced with women. They also thought that anyone at the University could not possibly be doing anything for the war effort. I was doing something, but they couldn't be told what it was. They thought I was a new form of draft dodger. Each time before they called me, the French teacher would forewarn me and the university staff could be prepared. The doctors knew me quite well because I actually took the preliminary exam six or seven times. When the French teacher went on vacation, the other two men decided they would get me. I was called without advance notice and almost drafted. By this time, the University realized the importance of the project, contacted the Ordnance Department and got a letter signed both by General Barnes, head of Ordnance of the US Army, and General Hersey, the head of selective service. The Roxboro draft board didn't harass me anymore.

After graduation from Penn, I worked at MIT's Radiation Laboratories building a special amplifier to test a switching device used in radar. The design of this amplifier, having a rise time of a tenth of a micro-second with a gain of over a thousand, gave me experience building high speed circuits. Then I had a project to measure a radar signal–travelling out and back–with an accuracy of 1 yard out of 100,000 in less than 9 nanoseconds. This was quite a problem because small, at the time, was 100 nanoseconds. I was instructed to do this with analog methods and decided in several weeks that they didn't know what they were talking about. I proposed a digital system using electric delay lines and another system using a mercury delay line that I invented for the purpose. Brit Chance, my boss, let me try my idea even though he didn't believe in it. I was working on that device using counters and delay lines when the idea for building the ENIAC came along.

While I was at MIT, Mauchly dictated a memo about the design of a computer that his secretary typed with several carbon copies. The original was given to Dr. Brainerd to mimeograph and distribute. Brainerd apparently lost the paper before it was copied. Herman Goldstine asked for one of the carbon copies; but no one



Presper Eckert.

could find one. Fortunately Mauchly's secretary still had her shorthand notes so she reproduced them for Goldstine who used them to get interest at Aberdeen Proving Ground. This formed the basis for Aberdeen's request for a proposal for a machine from the Moore School. Dr. Brainerd who was in charge of getting projects for the School was now pleased with the idea. The three of us wrote a proposal and delivered it to Aberdeen on April 9th, 1943 (my 24th birthday). Dr. Brainerd and Dr. Goldstine presented the proposal to Colonel Gillen and Dr. Deterick, a civilian scientist. During the presentation, Mauchly and I, sitting in the next office, wrote the technical appendices backing up the proposal. When the group emerged, we asked, "What happened?" Goldstine said, "We gave them the story and Deterick said, I've got to go to another meeting but it seems pretty good and Simon agreed to give you the money." After we caught up on our sleep, we started to work right away even though the contract did not arrive for several months. Actually, the ENIAC project started on April 10, 1943.

Herman Goldstine was a great help getting us classified documents on counters built by RCA and NCR. These counters were used by the Ballistic Reseach Laboratory to measure the speed of shells as they left the guns. I built both circuits and by modifying the RCA counter arrived at a very stable design. We then decided on standards for the rest of the circuitry. I talked to the people at RCA's tube research laboratory in Harrison, NJ, about tubes and they shared the results of experiments where they got a much longer tube life by running them at lower voltages than consumer products. They also advised us to use standard tubes because they never got all the bugs out on special runs. They said it took 100,000 tubes before they were working right. I asked, "What do you do with the first 100,000." They said, "We sell them."

My education had prepared me to lead an engineering design team. At Penn Charter, I had a phenomenal math teacher who had put ten of us in a fast track studying solid trig, college algebra, differential calculus, and enough other material so that on testing at Penn I had completed the first year or so of engineering mathematics. Although I was admitted to MIT, my parents thought it would be better if I stayed closer to home and went to Penn. My father wanted me to study at the Wharton School of Finance, but I left after a short time because I hated it. I then went to the physics department but I couldn't get in because they were full and that's how I ended up in electrical engineering.

Carl Chambers, my advisor at the Moore School, was a mathematician, engineer, a former employee of RCA, and had a father who, at one time, was president of the American

Left to Right: J. Presper Eckert, Jr., Chief Engineer; Professor J.G. Brainerd, Supervisor; Sam Feltman, Chief Engineer for Ballistics, Ordnance Department; Captain H.H. Goldstine, Liaison Officer; Dr. J.W. Mauchly, Consulting Engineer; Dean Harold Pender, Moore School of Electrical Engineering, University of Pennsylvania; General G.M. Barnes, Chief of the Ordnance Research and Development Service; Colonel Paul N. Gillon, Chief, Research Branch of the Army Ordnance Research and Development Service.

Actuarial Society. When Carl grew up his father wrote the exams and would give Carl the summer job of grading them if he could pass it. And he always could. So he was also a fine statistician. When I got a D in something like nineteenth century English novelists, I went to him. And he said, "That's ok. I did the same myself. In fact, I figured if I got too good a grade on something I didn't like, I was spending too much time on it. " Carl taught me the importance of very careful design. I did some circuit design for him and he always had me test it for all the variations possible. For the ENIAC, I implemented that idea with a vengeance. I didn't like the idea of ever making a failure by not doing it quite right; that can set progress back a step instead of forward. The Wright brothers were quite good in this way. They decided that Dr. Langley's equations that were available were probably not quite right even though his little plane had gone 4,000 feet powered by a steam engine. They decided to do something no one had done; build a wind tunnel first to test the wing designs. That's the real story behind Kitty Hawk. It's like the ENIAC: they didn't invent the engine or the idea of a wing or even the idea of an engine and a wing assembly. Another example is FM. In 1924, John Carson, who worked for Thornton Fry at Bell Labs, wrote a paper that worked out the equations for FM. He showed that in the normal ten kilocycle band width, FM would result in equally as much noise as AM. They also reasoned that building an FM detector was harder than AM and therefore they bypassed it. He was exactly right in all his mathematics, but of all the engineers who read it not one tried it. Then Major Armstrong came along and thought about it, saw that wide bands were available by then, and made FM work.

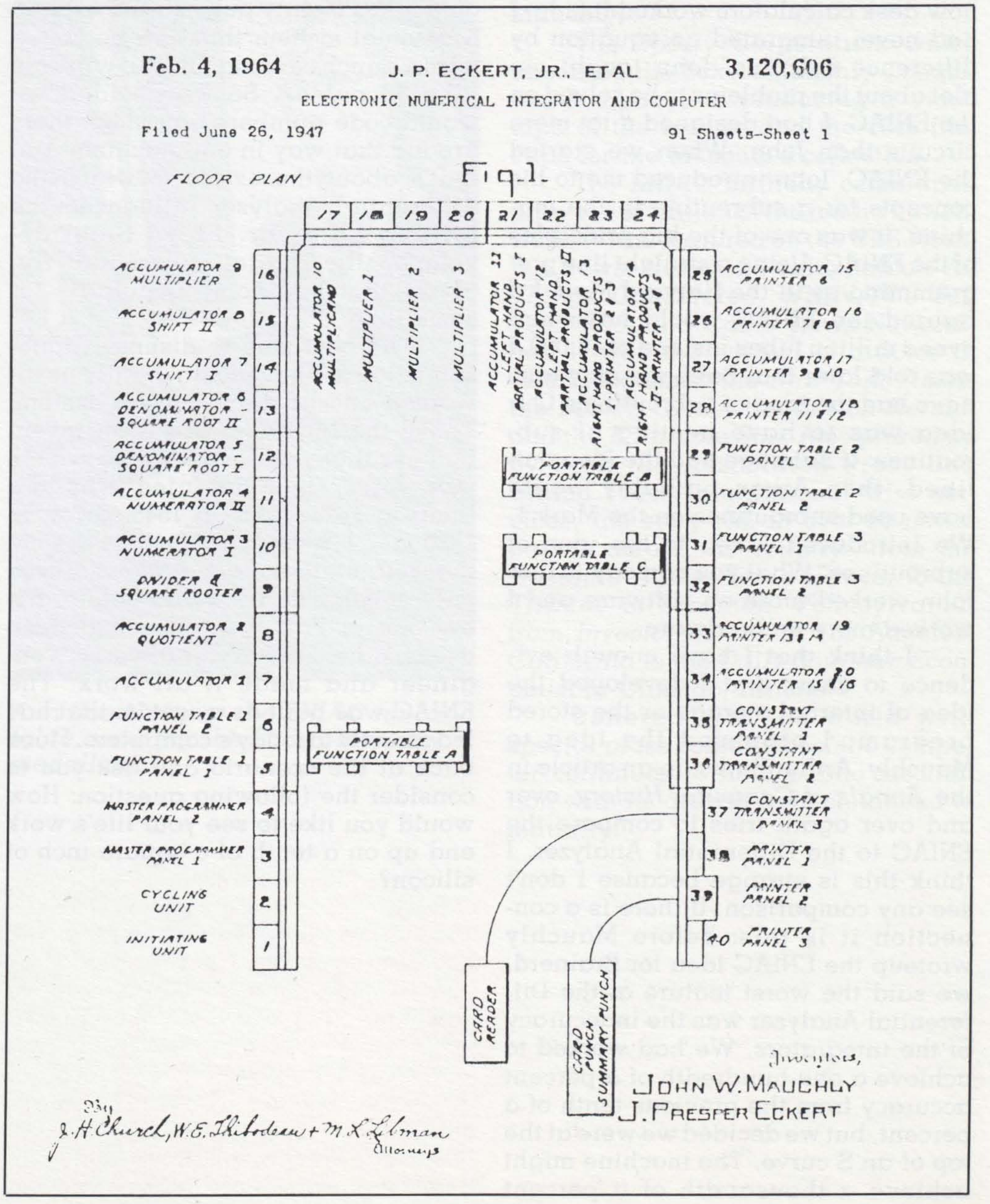
When we were building the ENIAC, the only other company I know who had experience building a machine with a large tube count was The Hammond Organ Company. They built about 1,000 Novachords, fully electronic musical instruments (synthesizers), each with 170 vacuum tubes. Eventually I bought an obsolete one for $100 from a men's drinking society. I refinished the cabinet, repaired some circuits, and replaced all 1,000 resistors. When I retired my machine five years ago, all the 144 tubes (operating at about 5 volts versus the specified 6.5) in the tone generating part were original. If the tubes gave any trouble then we lightly sandpapering the pins and they would work again; the surface of the pins deteriorate but nothing else.

At the time we were hassled by a number of scientists for relying on vacuum tubes. Enrico Fermi knew an electrical engineer named Willy Higginbottam working on a 150 vacuum tube counter at Los Alamos. Fermi assumed that the level of engineering perfection that we used was the same as Higginbottam who had a much simpler problem. We knew what we were up against and had to have long life from the tubes. Fermi, a great statistician and physicist, ran statistics on Higginbottam's counters and told Dr. John von Neumann that with the number of tubes in our machine it perhaps would only run 5 minutes without stopping. Since the ENIAC was 1,000 times faster than anything else, if it only worked 5 minutes out of every hour or so it would still be perhaps100 times faster than any other machine. So we didn't worry about it.

The big surprise to us was that programming would turn out to be so enormously difficult. That was a shock to everyone. At the beginning, every time the machine came up with a wrong answer, we blamed it on a machine failure. We soon learned to blame it on a programming error. We were incredibly careful in designing the machine. I took a slide rule and rechecked every circuit that was designed at least to a rough approximation. I found that I had to do this or the rules that we had set were not being stuck to. We realized that we had about 4,000 knobs on the machine. We started to wiggle a few test knobs and found that they could come loose. Someone suggested that we use hardened set screws with a hole in the switch shaft. We tested them and no knobs fell off. We "high potted all the wiring", that is we put it out on high voltage to check for weak spots in any insulation.

I had had experience with mice eating some forms of wire. So we got some mice, put them in a cage, starved them for a while, and then put in various kinds of wire that we were considering using. Sure enough, they loved some of the kinds of tubing we were planning to use. Then we used only wiring that passed the mouse test.

People often thought I was a nut because I was so fussy about standards, but I was only implementing the concept behind the famous statement of William Thompson, Lord Kelvin that Colonel Gillen had prominently hanging in his office. It stated, " When you measure what you are speaking about and express it in numbers, you know some things about it.



But when you cannot measure it, express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge but you have scarcely in your thoughts advanced the stage of science."

The other principle that I went on, was that one ought to be liberal about new ideas but be conservative on their execution. In later years, we had a big sign in one of our labs and it said, "Principle or execution." What it meant was, when something didn't work was it due to the principle or to its execution.

I sometimes see articles that say John Mauchly was the idea man and Pres Eckert the implementer. This is a vast over simplification. In the beginning, John had built some counters and I had worked on the differential analyzer. I had learned to use a desk calculator, but I didn't know as much about them as John. Mauchly knew how desk calculators worked inside. I had never integrated an equation by difference calculus. John taught me alot about the problems to be solved on the ENIAC. I had designed a lot more circuits than John. When we started the ENIAC, John introduced me to his concepts for a subroutine in the machine. It was one of the big principles of the ENIAC. Using a straight line programming as in the Harvard Mark I, I figured the ENIAC would have had over a million tubes instead of 18,000. I was told later that Babbage may also have had the idea of subroutines. Our idea was to have nesting of subroutines. If Babbage had the idea outlined, then Aiken probably would have used subroutines on the Mark 1. We introduced Aiken to the idea of subroutines. What you can say is that John worked more on software and I worked more on hardware.

I think that I have enough evidence to show that I developed the idea of internal storage or the stored program. I proposed the idea to Mauchly. Arthur Burks, in an article in the *Annals of Computer History*, over and over again tries to compare the ENIAC to the Differential Analyzer. I think this is strange because I don't see any comparison. If there is a connection it is this: before Mauchly wroteup the ENIAC idea for Brainerd, we said the worst feature of the Differential Analyzer was the inaccuracy of the integrators. We had worked to achieve a one-hundredth of a percent accuracy from the previous tenth of a percent, but we decided we were at the top of an S curve. The machine might achieve a thousandth of a percent accuracy, but only with hard work and that was the end of the curve. Further room for improvement would have to be electronic. We thought that we might take the shafts that came into the integrator, put little pinwheels with stripes on them, look at them with photocells and get pulses out that told how the shafts were spinning around. These would be fed into some counters, multiply these counters, accumulate them in another counter, and then use another pinwheel on the output shaft and feed it back through a servomechanism to make it track the thing. This was a mechanical integrator whose guts were sort of a digital system. We decided that was crazy, if we were going to have all these pulses then we should shoot them directly and get rid of all the gears. Then we thought this counting pulses is crazy, to count a million you need a million, but in the binary code it only takes twenty pulses. And even in a decimal system that can be based from a punch card machine, it will only take 60 pulses. So we decided we would code numbers and shoot them around that way in our machine. And that's about the extent to which the differential analyzer influenced the ENIAC. Later Dr. Floyd Steel developed the Digital Differential Analyzer that had some popularity for some time.

The best way to dismiss Atanasoff is to say the machine really never worked and he didn't have a system. That's the big thing about an invention: it's that you have a whole system that works. De la Rue tried to build a lamp in 1820, Starr in 1845, Swan in 1880, and Edison built a whole system that related to the generator that was only developed five years before. Every one of Edison's ideas had been used before. Edison was a system's engineer and made it all work. The ENIAC was built as a system that has led directly to today's computers. I look back at the scenario and ask you to consider the following question: How would you like to see your life's work end up on a tenth of a square inch of silicon?

ENIAC's Birthday

On February 13, 1986, The Computer Museum celebrated ENIAC's 40th birthday with a champagne-and-cake gala complete with 1940's orchestra to remind revelers of the era which gave birth to the machine.

ENIAC's Big Birthday Bash was conceived and sponsored by Ann Roe-Hafer, Marketing Director for Bitstream, Inc. of Cambridge. Starting in 1985, Bitstream dubbed February 13th the beginning of the Digital Year with a special calendar. The 1986 edition of the calendar was given to each attendee.

Many aspects of the event paid tribute to ENIAC's significant impact on the evolution of the computer. The invitation to the Birthday Bash was designed and produced using computer generated graphics featuring the special effects of digital fonts. ENIAC received the most fantastic birthday card ever produced by a computer for a computer, thanks to the Fantastic Animation Machine. They created a computer generated animated video birthday greeting that was displayed throughout the evening, and has now been added to the Museum's permanent collection. The 20-second long piece required about 100 hours of compute time and would normally cost about $3000 per second of finished video—a labor of love to honor ENIAC and a show of support for The Computer Museum.

Presper Eckert and Kay Mauchly.

Maurice Wilkes, Gwen Bell, Mike Parker, Presper Eckert and Kay Mauchley.

The birthday cake for 500 guests was fashioned after a Bitstream font spelling out E-N-I-A-C. A tastier type there will never be. Among the decorations was a ten by one foot digital sign in the Museum elevator carrying a continuous birthday message.

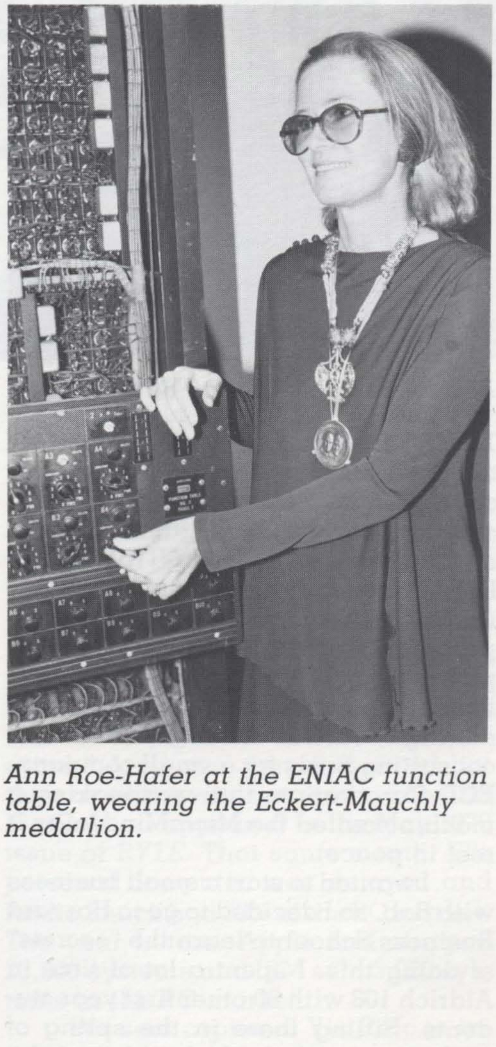
To insure many happy returns of the day, eight "ENIAC Enthusiasts", AT&T, International Typeface Corporation, NCR Corporation, Michael Parker, John Poppen, XRE Corporation, Herman Zapf, and Zenith Data Systems, each contributed $10 for every year of ENIAC's age to support the event and subsequent Museum projects.

The tribute to ENIAC was really a tribute to those who had created her. What turned this celebration into a momentous occasion was the talk by her co-inventor, Dr. J. Presper Eckert. Dr. Eckert's appearance drew a full house with close to 500 guests seated and standing in the auditorium, and watching on closed circuit T.V. in the galleries.

Bitstream president, Michael Parker was Master of Ceremonies for the evening. He first presented Bernard Gordon, President of Analogic, to introduce Dr. Eckert. Bernard Gordon, who had worked for Eckert Mauchly Computer Company, introduced Dr. Eckert as, "the greatest engineer and role model I've ever known". In his opening remarks, Dr. Eckert expressed his regret that co-inventor John W. Mauchly was not there to share his stories or be a part of the celebration. However, he noted that Kay Mauchly Antonelli, Mauchly's widow, and a programmer on the ENIAC, was in attendance.

After Dr. Eckert's talk, a film composed of the only existing original footage of the ENIAC from 1946 was viewed. It was met by the audience with both awe and amusement, and was a perfect transition from the inspiring talk by Dr. Eckert to the official toast and cake cutting.

Michael Parker, back on the podium, offered the first toast to the "41st digital year". The next toast "to the ENIAC" was given by Professor Maurice Wilkes, who studied the ENIAC before building the EDSAC. Kay Mauchly Antonelli toasted "the young ladies in the film", her fellow programmers. The closing toast by Dr. Eckert was in memory of John W. Mauchly.



Ann Roe-Hafer at the ENIAC function table, wearing the Eckert-Mauchly medallion.

The Sperry Corporation, which absorbed the Eckert Mauchly Computer Company, is producing a video tape of the lecture and the 1946 film clips for the Museum's collection.

The ENIAC birthday celebration drew the attention of the media nationwide: it was featured on the CBS Morning News, National Public Radio's *All Things Considered*, WNEV-TV's *Sci-Tech Spot* and Cable News Network, and it was the subject of articles in *TIME* Magazine, the *New York Times*, the *Boston Globe*, the *Boston Herald*, and the *Baltimore Sun*. Also picked up by both the Associated Press and United Press International wire services, the story ran in over 50 newspapers across the country—from the *Honolulu Advertiser* in Hawaii to the *Tribune* in Scranton, Pennsylvania, from *Investor's Daily* in Los Angeles, California to the *Daily Southern Economist* in Chicago, Illinois!

Ushered into the world with special press conferences, the computer continues to hold public fascination with its growth from childhood to maturity.

VisiCalc and Software Arts: Genesis To Exodus

Daniel Bricklin

Bob Frankston, who wrote the first spreadsheet has noted, "In the early part of the century, with the growth of telephones, experts said that everyone in the world would be a telephone operator by the nineteen fifties."

People laugh and say, "That's not true."

But it turns out, it is true. By 1950 everyone had a dial phone and knew how to "be an operator."

Similarly, a few years ago, *Fortune Magazine* and others were predicting that a million programmers would be needed by the nineteen eighties. Now with a million users of VisiCalc, two million users of 1-2-3, and with another million users of other spreadsheets, four million people are programming on spreadsheets alone. The prediction is true. People just don't know they are programmers.

Ben Rosen once said, "You communicate with VisiCalc in English." What he meant was that you communicate in a way that feels natural, but it isn't English. It feels natural, but it's also a programming language. FORTRAN was also quite natural for people who worked with formulas. Unfortunately FORTRAN, when used to do other kind of programming, is strange and unnatural. Different kinds of programming languages are needed for different applications. The programming language is not important, but it is important that people program. In fact, a single computer language restricts a person to one way of thinking. If people learn spreadsheets and word processing, then they are on their way to programming.

In the early seventies, it was predicted that the first personal computers would be used to control the watering of the lawn, store recipes and do other household tasks. Personal computers are still not used for these tasks, but are used, among other things, to run spreadsheets. In fact, when new personal computers are announced a spreadsheet program is part of the package.

Bob Frankston and Dan Bricklin.

GENESIS

Bob Franston and I met in late 1969 or early 1970 at MIT when we worked at TECH Square at the now defunct Multics Project. We learned about good code and products that either did not capture people's imaginations or were not marketed well. After MIT, I went to Digital where I was project leader of the WPS-8, their first commercial word processor, and I also worked on computerized typesetting. This gave me a lot of experience with screens and editing. Bob was writing BASIC on a consulting basis for a small company, ECD Corporation, that was making a machine called the MicroMind (may it rest in peace).

I wanted to start a small business with Bob, so I decided to go to Harvard Business School to learn the "secrets" of doing this. I spent a lot of time in Aldrich 108 with 80 other first year students. Sitting there in the spring of 1978, I came up with the idea of the electronic spreasheet. With all those other classmates to contend with the professor, there's lots of time for daydreaming, especially if you sit in the front row and the professor looks out above you. I invariably made simple addition mistakes in my homework. I wanted to do what the professor did on his blackboard: he would erase one number and Louis up in the back of the room would give him all the calculations that he had done all night to recalculate everything. I wanted to keep the calculations and just erase one number on my paper and have everything recalculated.

I had my little TI calculator that I would rest my hand on and imagine that it was a mouse-like object controlling a head up display similar to that of an airplane pilot. Then I could look ahead and say, "15% would be ok." Going with that metaphor I knew I wanted to move all kinds of things around. Getting more practical I thought it could be done on a micro like a Z80 with a screen and also a mouse. The first machine that I considered was the PDT from DEC, an LSI-11 based machine that didn't sell very well. Having heard about it, I learned that it would be on display at the annual shareholders' meeting. By holding one share of stock, I was able to go and see it. They were not very agressive in trying to sell it to me. In the summer of 1978, I made a decision that when I graduated in 1979 I would pursue creating the electronic spreadsheet on DEC equipment and maybe sell it door-to-door on Route 128.

Before I left for the summer of 1978, I went to various professors for advice. I went to my finance professor, but he was busy and couldn't see me. I went to my production management professor and he said, "Well, that's really a good idea. People really use blackboards and they will use two roomsfull of them to set up the numbers for manufacturing production schedules. If you could do that electronically and connect them, then it would save time." But he was too busy to help me. Nevertheless I was encouraged by what he said. Then I went to an accounting professor. He told me, "Improving the human interface to any system would be good." Finally, I got to see my professor of finance. Looking up from his FORTRAN listings, he said, "There are many financial forecasting tools already. The idea will never sell. People have everything they need. But why don't you ask one of my students, Dan Fylstra, and he'll tell you why you can't sell personal computers to real estate agents to do their calculations." That's how I met the person who eventually published VisiCalc.

Dan Fylstra, a second year business school student, was running a small home computer publishing company called Personal Software. He had just signed up a chess program called Microchess.

STARTING SOFTWARE ARTS

Frankston and I got together and decided we would work on an electronic spreadsheet in Bob's attic in Arlington, Mass.

One of the most difficult and important ideas was how to label where something was. It was clear to me that the simplest way was a grid coordinate system. Since people usually think in letters and numbers, I labelled the top with letters and put numbers down the side. My background had been on interpreters, on Multics I had implemented APL twice and VisiCalc is an interpreter. I used these skills and viewed VisiCalc as a programming language. Instead of the program being vertical, it was in two dimensions.

In the fall of 1978, we made a deal with Dan Fylstra that we would produce this electronic spreadsheet and he would publish it. We went to a Chinese restaurant out by Fresh Pond, Bob and I ordered without msg and Dan with it, and we got some very good terms. Two-thirds of the profits, 35.7% of the gross, went to us. In those days, Dan's company, Personal Software, was in an apartment in Allston.

Then sitting in a Kentucky Fried Fish place, Bob and I came up with the name of our company, Software Arts.

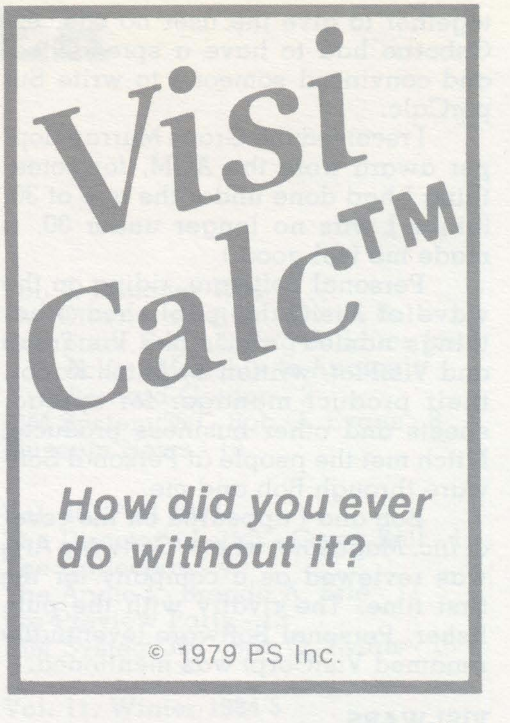
That fall, I prototyped the product in 200 lines of BASIC to simulate the electronic spreadsheet. I wanted to have a mouse, but the machine that Fylstra had that was available to use, the Apple II, didn't have one. The Apple did have game paddles to turn the dial and move things sideways. So I modified it to behave like a mouse and position things. Unfortunately the cursor moved too slowly using the paddles so I switched to the two arrow keys, one going right and one left, and used the space bar to go up and down. Then it ran much faster.

The final version of the original VisiCalc was written on the MULTICS system at MIT which we paid dearly for out of our pockets. We used timesharing at night. Bob would get up at 3 PM when I would get back from school and work until 6 or 7 in the morning. Since MIT took three months to bill, we also had a little float.

The name VisiCalc was conjured up at "Vic's Egg on One" outside of Porter Square on Mass Ave. Early one morning, Frankston and Fylstra, desparate to come up with a name, were having breakfast and each claimed to have come up with the name. I claim they just looked at the menu that said "Vic's" — and were inspired. Frankston threw together the first working version of VisiCalc in two to three weeks.

In January 1979, Fylstra went off to Apple and Atari to show them the product. Markulla at Apple said, "Hm, interesting checkbook program you market it yourself, we're not interested." Atari was very interested but their machine was not ready. The first VisiCalc ad appeared in the May 1979 issue of *BYTE*. That same month, TI's personal computer was delayed and Radio Shack had 50% of the PC market. The year before, Apple had shipped 20,000 systems and IBM sold 5,000 systems in the PC market.

We sent copies of VisiCalc to influential people, including an analyst at Morgan Stanley in New York, Ben Rosen. Ben liked his copy (the one that is now archived at the Museum) and wrote about it, saying, "Someday this may be the software tail that wags the hardware dog." And he was apparently right, because the spreadsheet par-



tially made personal computers sell so well.

In June 1979, Software Arts moved from Bob's attic to a basement in Central Square, purchased our own Prime 550 timesharing system, and announced the product. Since I had just graduated and Bob was living like a student, we had simple requirements. We borrowed from friends and family to purchase the Prime. We didn't receive pay for about a year — and we used lots of float on Master- and Visacards.

"ALL HAIL VISICALC"

The first mention of VisiCalc in the *New York Times* appeared on the first page of the second section in a humorous article entitled, "A Layman's Trip into the Mega-mega Land of Computers." In giant letters, the author said, "All hail VisiCalc." He thought it was funny. We thought we could now say, *New York Times* says, "All hail VisiCalc."

In the winter of 1979, Software Arts moved again. Later, Julian Lange, a professor at Harvard, was hired and eventually became President. VisiCalc was then moved onto a large variety of machines. After a year, the original version was no longer sold, but replaced by an upgraded version.

We won Adam Osborne's White Elephant award for changing the course of industry. Our first cover shot was on the Boston Computer Society's *Computer Update*.

Then we had our first real competition. The Osborne I was announced with hardware and software bundled together to give the user no choices. Osborne had to have a spreadsheet and convinced someone to write SuperCalc.

I received the Grace Murray Hopper award from the ACM, for something I had done under the age of 30. (Since I was no longer under 30, it made me feel good.)

Personal Software, riding on the wave of VisiCalc, published other things named "visi", like VisiTrend and VisiPlot, written by Mitch Kapor, their product manager for spreadsheets and other business products. Mitch met the people at Personal Software through Bob and me.

Bob and I appeared on the cover of *Inc. Magazine*, where, Software Arts was reviewed as a company for the first time. The rivalry with the publisher, Personal Software (eventually renamed VisiCorp) was mentioned.

VISI-WARS

Because of the rivalry with our publisher, Software Arts started to look toward scientific markets. TK!Solver was developed to do this and announced on the top of the John Hancock building in 1981. At this time, Micro-Finance Inc., a little company down the street, changed its name to Lotus Development Corp.

Software Arts was growing so much that it needed more space and moved out to 128 in Wellesley Hills where an old warehouse space was renovated. We spent lots of resources developing products for new PC's that weren't successful, such as the DEC 350 and TI's personal computers. The company spread its resources very thin. We announced an Advanced VisiCalc on the Apple III, with everything everyone wanted, except we chose the wrong machine.

Lotus 1-2-3 and TK!Solver shipped within a few weeks of each other. I was the youngest distinguished lecturer at MIT until Steve Jobs gave his talk. At this time, VisiCalc was still the most popular program on the IBM PC and the Apple III.

In the spring of 1983, we realized that TK!Solver was not bringing in enough revenue to pay for our development projects. We decided Software Arts either needed additional funding or to be acquired.

Returning from the airport after midnight in September 1983, I was greeted by the information that I was being sued by VisiCorp. You can't sell a company when you are being sued! Almost everything stopped for months while the lawyers took depositions. After four days in court, it became clear that Software Arts would win the law suit a few years later. One day the next June, I was called back from the West Coast and we laid off half the employees to save money. That was about the most down day of my life. We finally hammered out an agreement with VisiCorp where we received all the rights to VisiCalc and a check for half a million dollars. It cost both sides a substantial amount of money and management time. Don't ever do it if you can help it.

"Four million people are programming on spreadsheets alone."

Despite this, Software Arts came out with updated versions of VisiCalc and TK!Solver for the Macintosh, and Spotlight, a desktop manager program. But the company was underfinanced and we were still trying to sell it.

During this depressing time, Frankston and I turned up in *Esquire's* list of special people under 40. It was really getting very bad and we finally switched to a bankruptcy expert for a lawyer.

EXODUS

In the spring of 1985, I decided to go to Softcon and ran into MItch Kapor, Chairman of Lotus, at the airline counter. He said, "Hey, Dan, how ya doin?"

I said, "Lousy."

"Not really."

"Ya, lousy."

Then Mitch asked, "Do you want to talk?"

I went from my seat in steerage up to first class and Mitch and I talked about the Software Arts situation. Mitch said since Lotus was starting a scientific division they might be interested. A day or so later, Software Arts made a presentation to Lotus. Within 48 hours a letter of intent to purchase some of the assets was signed. Frankston moved over to Lotus and I was given an office.

Then Lotus decided they would no longer sell VisiCalc, and the press wrote nice things about it.

Now, I work at home in my office at my new company, Software Garden, named after the Garden city of Newton Massachusetts, where I live. My product is a "slide show" type of program that lets you create a simulation that tries to appear indistinguishable from a real running program. It's a real program for the creators of vaporware.

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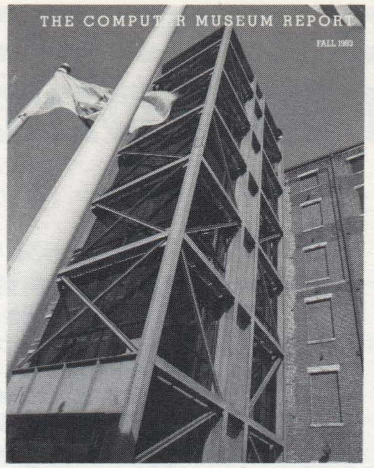

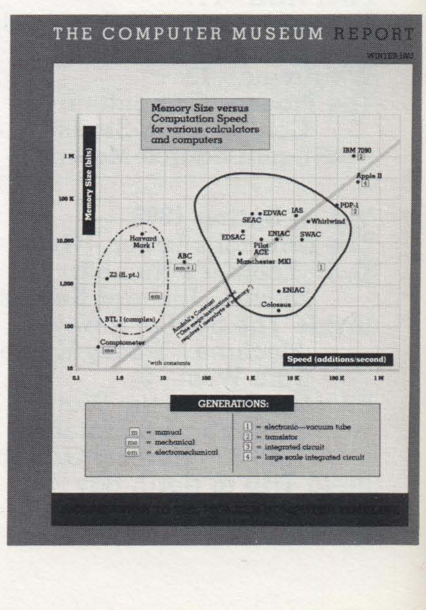

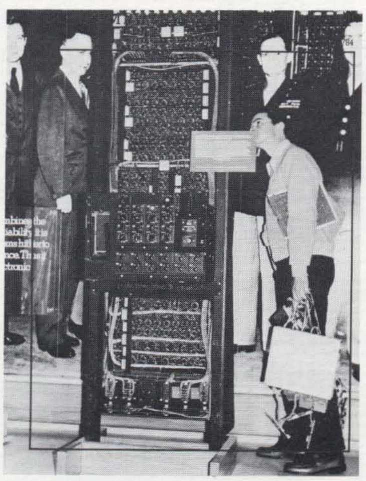

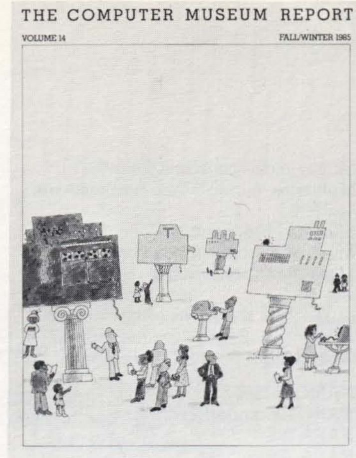

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VOLUME 14
FALL/WINTER 1985

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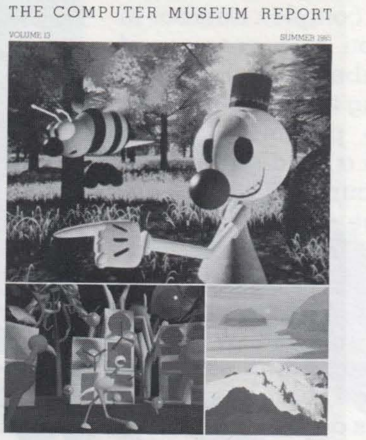
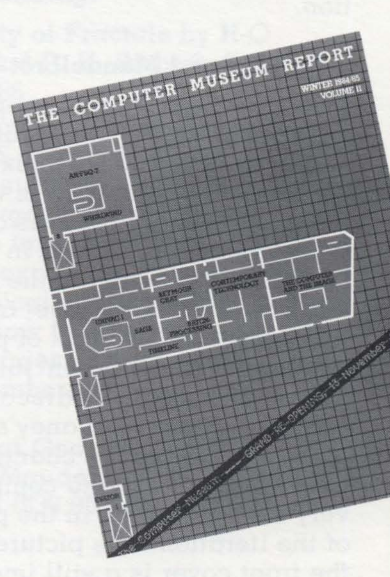

THE COMPUTER MUSEUM REPORT
VOLUME 13
SUMMER 1985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VOLUME 11

Colors of Chaos

A Special Exhibit April 11-September 8 1986

Oliver Strimpel

The pictures of Colors of Chaos are the result of using computer graphics as a tool for research in complex dynamics, a branch of mathematics and physics. The goal is to understand what happens to simple mathematical formulae when they are iterated.

The pictures are built up in the following way: each point is iterated using the mathematical formula under investigation. For example, if the formula is the trigonometrical function cosine, this corresponds to entering the number corresponding to a point in the picture into a calculator, and pressing the cosine button again and again. The point in the picture is then colored depending on what happens. In some of the pictures, the color shows how quickly the point "escapes" to infinity, leaving black those points that never escape. In others, the colors show where points end up under iteration, with the shades indicating how quickly they get there. Thus the colors represent the dynamics of the iteration.

Julia Sets and Mandelbrot Sets

Two types of picture can represent the iterative process. In the Julia set, the initial value of the complex number at the start of the iteration is varied over the plane. The parameters of the iteration are fixed. A point is in the set if it lies on the boundary of the points that become larger and larger as the iteration proceeds. Each set of parameters creates a whole different Julia set. One of the remarkable discoveries revealed in Robert Devaney's images is that the Julia set can change dramatically, even evaporate completely, for very small changes in the parameters of the iteration. The picture shown on the front cover is a still image from a film showing the dramatic change in the structure of the Julia set for the sine function as the parameter is varied. The black region shows points that have not escaped to infinity after 35 iterations, while the colored regions show escaped points. Red points tend to infinity the fastest, followed by points colored in orange, yellow, green, blue and violet.

The Mandelbrot set is an example of the second type of picture. Here, it is the value of the parameter that is varied over the plane and the initial value of the complex number is set to zero everywhere. Each formula being iterated has only one of these pictures. A point is a member of the set if it never escapes to infinity under iteration.

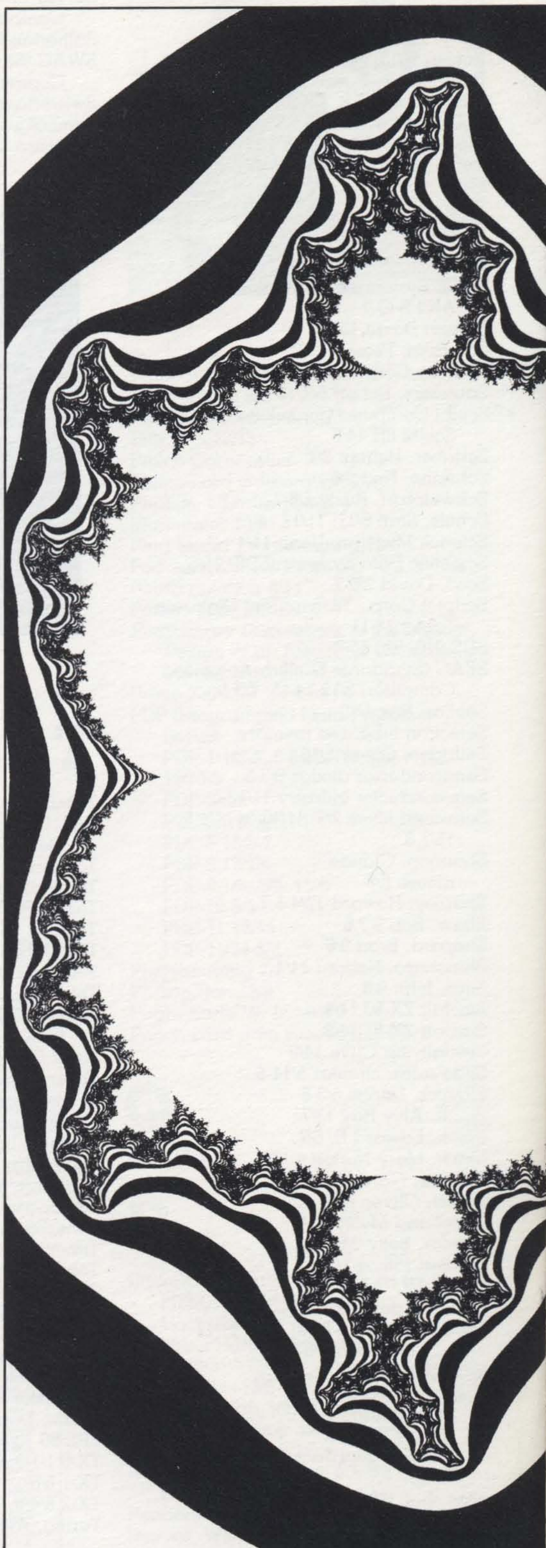
The first formula investigated by Benoit Mandelbrot in 1975 was simply the squaring of the complex number in which one iteration step consists of squaring the number and adding a constant. By varying this constant over the plane as the parameter, Mandelbrot discovered a cardioid shaped set with a hairy boundary—the Mandelbrot set. To the mathematicians' surprise, this shape appears to be universal in that it crops up, albeit somewhat modified in detail, when many other formulae are iterated. When the boundary of the Mandelbrot set is examined in fine detail, baroque swirls, spirals and tendrils appear, including some that lead to offshoots containing smaller replicas of the Mandelbrot set itself. It is this fascinating structure at the boundary of the Mandelbrot set that is vividly represented in the Colors of Chaos images that came from the Bremen group.

Julia sets and Mandelbrot sets can take a lot of computing. Firstly, each point of the picture has to be iterated separately (unless one uses a parallel machine), so the time taken to create an image is proportional to the total number of pixels computed. Secondly, the number of iteration steps required per point can be as high as several thousand. The closer to the boundary of the Mandelbrot or Julia set you go, the longer it takes a point to 'make up its mind' as to where it is really attracted. Each iteration step takes several floating point multiplies or the evaluation of a trigonometrical function. Robert Devaney has just used 72 hours of the Cray supercomputer at Digital Productions to make a new spectacular film showing Julia sets of cosine. It will be added to the video showing in the exhibit.

Images in the Colors of Chaos Exhibit

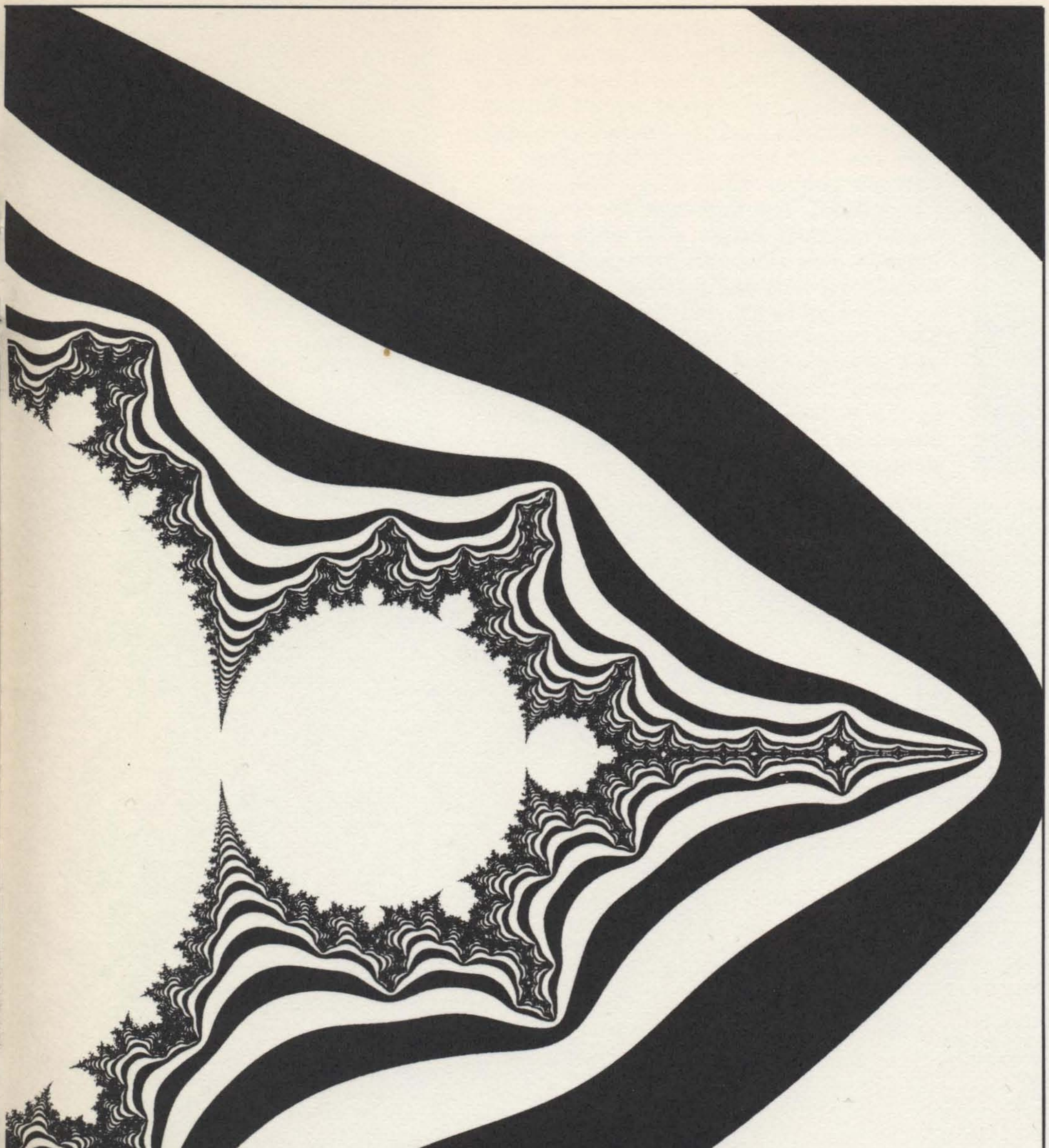
A series of twelve pictures shows Julia Sets and Mandelbrot Sets generated by the iteration of polynomial functions and ratios thereof by a team from the University of Bremen led by Heinz-Otto Peitgen and Peter Richter.

A second series shows Julia sets of sine, cosine and the exponential function by Robert L. Devaney from the Department of Mathematics at Boston University.



Why do this?

Because it's there! The beauty of the images continues to spur along ever



more detailed explorations of these newly discovered objects. But the computation of Julia sets and Mandelbrot sets can also be viewed as numerical experiments in complex dynamics. When combined with mathematical intuition, they uncover universal patterns and stimulate the progress of mathematics. They are also important in the new field of fractal geometry. Indeed the boundary of the Mandelbrot set is a fractal. Mandelbrot conjectures that it may have a fractal dimension of 2, which would mean that all offshoots would have to be connected to the main set and that the set's surface has barely been scratched. According to John H. Hubbard, Professor of mathematics, Cornell University, who was the first to make detailed computer images of the Mandelbrot, it is "the most complicated object in mathematics".

The iteration of complex functions also models the way many nonlinear natural systems evolve. Simple iterative laws can predict very complex, chaotic behaviour. Examples include the growth and decline of the population of a biological species, the motions of the planets, the changes in the weather and even the daily fluctuations of the stock market.

The Mandelbrot set, courtesy of Benoit Mandelbrot/IBM

Further Reading:

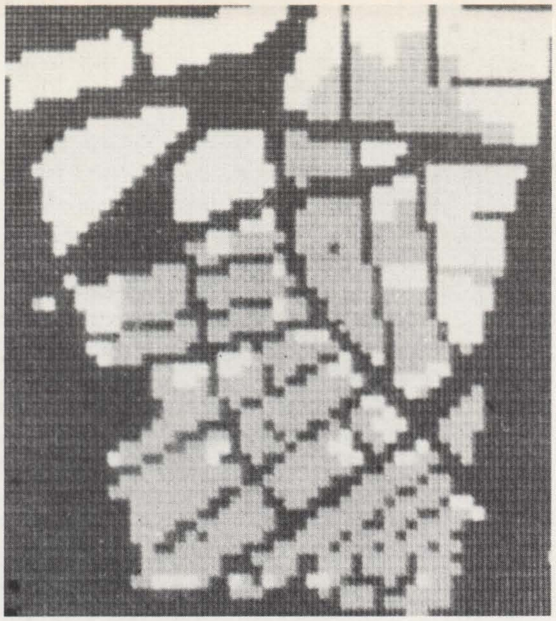
The Beauty of Fractals by H-O Peitgen and P. H. Richter, Springer-Verlag 1986
This new release contains approximately 75 color and 65 black and white illustrations, including many of the images on display in the exhibit. The text appeals to both layman and expert, and ranges from philosophical background to suggestions on how to generate your own fractal images. ($33.95 postpaid, $30.95 members)

The Fractal Geometry of Nature by Benoit B. Mandelbrot, W. H. Freeman, 1983 ($38.95 postpaid, $35.45 members)

Introduction to Chaotic Dynamical Systems by Robert L. Devaney, Benjamin Cummings, 1985 ($33.95 postpaid, $30.95 members)

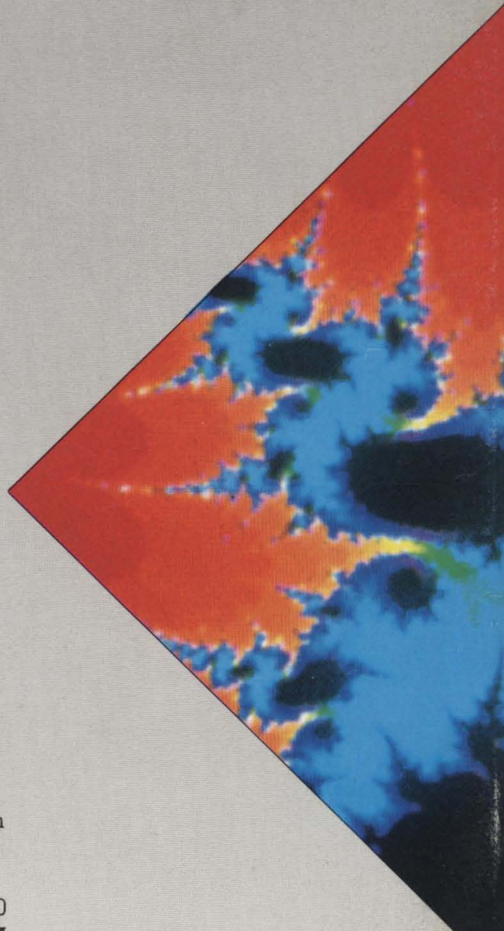
The above books are available from The Computer Museum Store. Also available are a set of 8 color postcards of the Bremen images, including several on display in the exhibit ($4.00 + 1.00 postage).

Scientific American Computer Recreations column by A. K. Dewdney, August 1985 issue



The End Bit 0000000001

The first computer-generated land use map produced in May 1959 on the TX-0 at MIT. It shows the assessed land value of a 1000 x 1000 foot area of central Boston. Boylston Street and the Boston Common form the right edge of the map. The triangle shaped block is the Sheraton Plaza Hotel. The three shades of grey represent land value, with white the highest. The data was amassed from various records and gridded into 20 x 20 foot cells by hand. After input into the TX-O, maps were displayed on the CRT and photographed with a specially mounted Polaroid camera. *Map produced by Gwen Bell for Harvard's Graduate School of Design master's project; program by Gordon Bell.*



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