Oral History of Aaron Marcus

Interviewed by:
Dag Spicer

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Spicer: Today is December 5th, 2019. We're here with Aaron Marcus, one of the world's foremost computer graphics and design/art pioneers. Aaron, welcome.

Marcus: Thank you very much. I'm happy to be here.

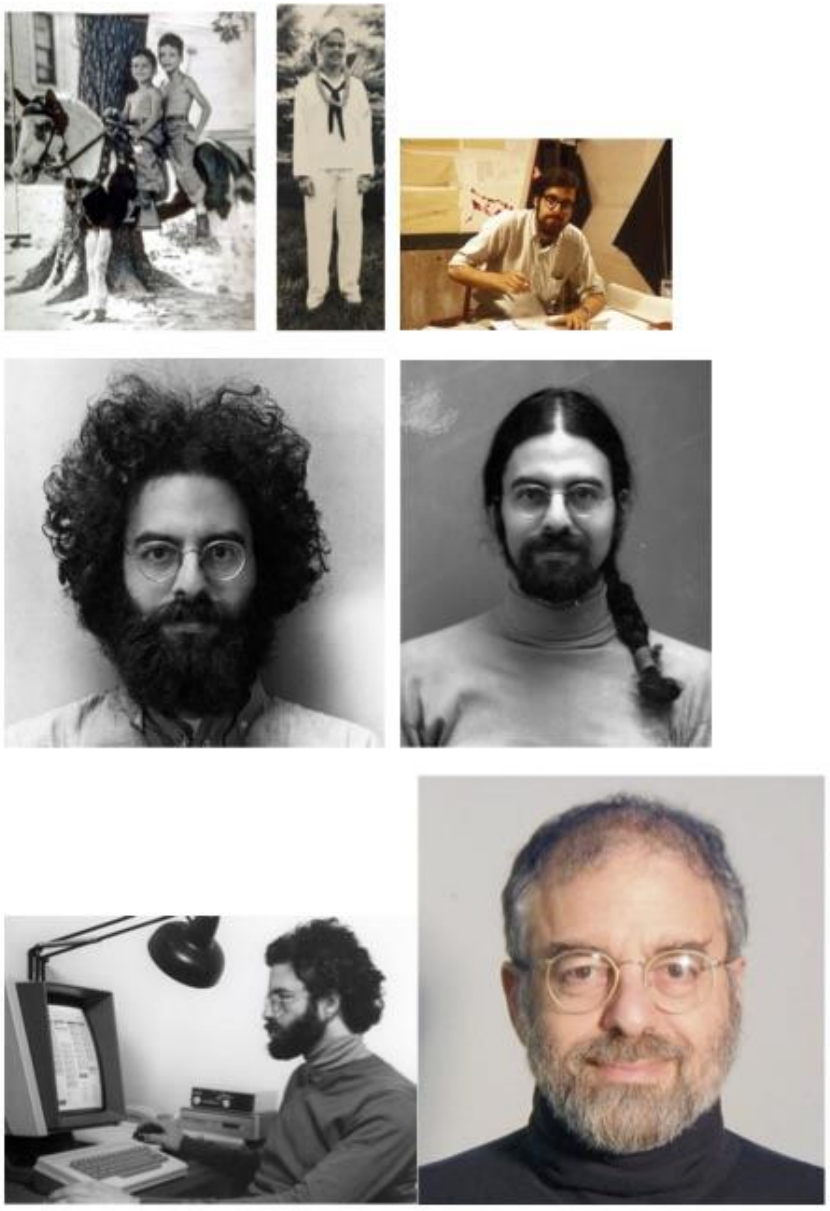


Figure 1: Images of Aaron Marcus across several decades and locations.

Spicer: We're so happy to have you here. You've made so many interesting contributions to the use of computers in enhancing people's artistic expression beginning in the 1960s. But before we get to that, I wonder if you could tell us a little bit about your early life and early sources of inspiration, hobbies, that kind of thing.

Marcus: Of course, I'd be happy to. I was born in 1943 in Omaha, Nebraska, in the middle of the United States. My parents, now passed away, encouraged me in being an artist as well as a good student in school [and] to study science and math. Even by the age of 10, I was already a “nerd-in-training.” That's a NIT, as in nitpicker or a nitwit. One of my pleasures was memorizing the value of pi to 50 decimal places. Doesn’t everyone want to do that? 3.14159265358979 and so on, I've forgotten some of the digits by now. I had already, by then I think, designed and built a “rocket ship control panel” in the basement of my house…fake, obviously, out of wooden orange crates, to which were attached dials and blinking lights and switches of various kinds, whatever I could find in junkyards or in the local trash cans. I built around that some walls to create a spaceship control room. There, my late brother, Steven, and I could fly to other planets as we wished.

Figure 2: Space Helmet designed by Aaron Marcus, modeled by his late brother Stephen, c. 1953.

Also, I was very interested in astronomy. Thanks to my uncle Maxie, we had a three-inch reflector telescope, which I still have. We could go to other planets in our minds, in our imagination, as, I suppose, many kids did, maybe especially boys at that time in the early 1950s. That was about 1953. And all through grade school and high school and into college, I was pretty good at drawing, cartooning. I had mastered the styles of Walt Disney, Al Capp's Li'l Abner, and Chester Gould's Dick Tracy. I appreciated all of the nuances of their line work and visual forms in which they depicted their characters. I learned to simulate all of those styles just by training myself, because I loved drawing so much. I also loved comic books. I used to collect about 18 brands of comics, which was always a mystery to me because at 10 cents a comic, I only got a dollar-fifty allowance, and I didn’t know how I could pay for all of them, but, between two other friends and myself, we collected almost everything that came out. In fact, in 1972,

decades later, I sold 1,500 of those comics to fund a trip to Israel. I still have about 300 of those comics, including all of the first 25 issues of *MAD* comic/magazine, which are perhaps now somewhat more valuable than when I purchased them. Among *MAD* artists, Basil Wolverton was one of my favorite cartoonists who drew grotesque creatures. I liked cartooning also, and so in high school and in college, I worked as a cartoonist and published a few of my cartoons.

Spicer: May I ask, how much of your work was influenced by the space program in your life?

Marcus: Well, I loved Chesley Bonestell's paintings and drawings of space technology and space travel. Some of these have come back into popularity as iconic images of the 1950s and '60s. And in fact, about three years ago, I donated almost all of my drawings and artwork and designs and documents to the Letterform Archive in San Francisco, which is publishing a book about my life's work in 2021. They have, I believe, a collection of all of my childhood drawings and paintings, including cartoons and many depictions of rocket ships, robots, ray guns, and scenes on other planets. I loved technology. I thought it was intriguing, appealing, only natural in the evolution of humankind, and I followed all of the articles that appeared in the major magazines at the time like *Life*, and *Collier's*, *Saturday Evening Post*, etc. And, of course, I was a devoted viewer of "Tom Corbett, Space Cadet" and "Captain Video." In fact, I even lecture today about the past 100 years of science fiction movies and television and show sample imagery from that time of "Captain Video" and "Tom Corbett," and "Flash Gordon" decades earlier. I follow the emergence of science fiction movies and television and, in particular, their approach to depicting human-computer interaction. That's the particular approach I've taken on those movies.

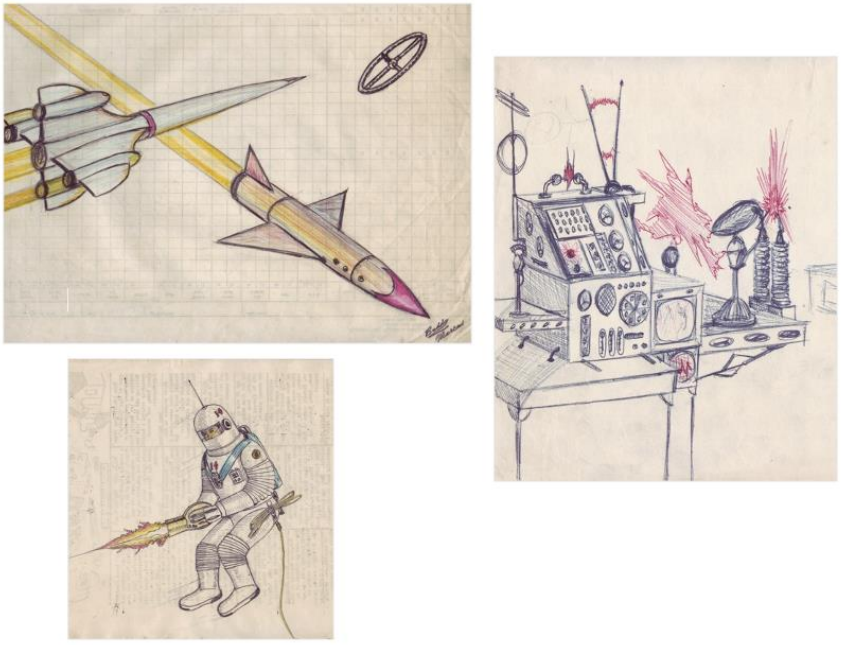


Figure 3: Drawings by Aaron Marcus of rocket ships,
man in space suit, and rocket-ship control panel, c. 1953.

Spicer: I'm so glad you brought that up because I was going to ask you what you think the public perception of computers was at the time. Were they the "giant brains" of the ENIAC era?

Marcus: In the 1950s and '60s, as you might recall, or some might recall, computers were depicted as these large boxes with blinking lights, twirling magnetic tape reels, plus a few simple screenshots of text screens. That was enough to convey that "this advanced technology is beyond your understanding. You'll have to accept it and believe it that it's superhuman, super-powerful, capable of great good and possibly great evil." That hasn't changed.

Spicer: Now, did the evil part come from science fiction and the popular press, whereas the more positive--?

Marcus: Whether computers were for good or evil came from depictions in pulp science fiction magazines and dystoptian novels. I forgot to mention that I was also an avid reader of *Galaxy*, *Astounding Science Fiction*, *If*, and perhaps half a dozen other pulp fiction magazines that came out at the time. I show, in my lecture, Hugo Gernsback's *Science-Fiction Plus*, which was a large format (8.5 by 11-inch) magazine that was unusual for its time. Some of these depictions of computer technology were positive with occasional bad events and invasions by alien lifeforms.

There were some positive views about advanced technology being able to accomplish many improvements to help people. Think, for example, of H. G. Wells' movie of 1936 *Things to Come* which tells the story of a decades-long World War 2 resulting in plague and anarchy until a rational state rebuilds civilization and moves towards space travel. This film was based on Wells' own earlier publication *The Shape of Things to Come* in 1933. On the other hand, one finds Aldus Huxley's dystopian novel *Brave New World* of 1931 and George Orwell's *1984* written in 1949, before it became a movie.

So, there have always been debates and ambivalence about whether all of this technology is for good or evil. Even two days ago, in the *Wall Street Journal* or the *New York Times*, there was yet another full page or half-page essay article discussing technology and democracy.

Spicer: Sasha Baron Cohen?

Marcus: Well, I do remember that one, but this essay was about advances in artificial intelligence and what we have to worry about: there are tremendously powerful benefits, but we have to consider who owns that data and who has access to that data, in addition to how that data could be or should be used. All of these questions are as yet unresolved issues. So, I'm only saying that this debate about whether computers were for good or evil, or fire was for good or evil several millennia ago, or now artificial intelligence is good or evil, goes on all the time. And it is a good thing because the effects are not only good. Remember the slogan in the 1950s: "better living through chemistry," DuPont's slogan, used from 1935 to 1982. Many corporations emphasized only the positive outcomes.

Spicer: "We bring good things to life," GE's slogan.

Marcus: Yes, we bring good things to life, perhaps. There was a very positive view presented about all of that technology.

Spicer: And progress, generally.

Marcus: Progress was good, inevitable, and unavoidable. However, I was more-- well, I was very enthusiastic, but I was also more suspicious or--

Spicer: Skeptical.

Marcus: Skeptical, yes. I certainly had this attitude after my first encounters with computer programming and the creation of computer graphics and computer art. Remember: I went through college and studied physics because I was good in science, but along the way, I decided that physics wasn't-- I was being led into directions that, while interesting, were not what I wanted to study. I had decided to go on to graduate school in physics, I was accepted at several very good universities. I was in physics at Princeton University, which had an outstanding physics department, but I was being moved toward masers and lasers -- “light amplification through stimulated emission of radiation.” But I didn’t want to do that. I wanted to study gravitation and the evolution of the universe and cosmology, etc.

So, I decided to take a chance and apply to art schools where I could study art and design, because I had always enjoyed photography, calligraphy, sketching, cartooning, painting, lithography, many of the forms of expression in which I had participated all through high school and college. As it happened, fortunately, only five days before I graduated from Princeton, and uncertain about what I was going to do the following year, I was accepted into Yale Art School. I was overjoyed. I had been on the waiting list. I got in! There I began a three-year program to learn about graphic design. I really didn’t know what graphic design was, because no one had ever told me or explained that earlier, except for my one mentor, Gillett Griffin, now deceased unfortunately, who helped me prepare my portfolio and helped me get into Yale. He was one of the first graduates of that Graphic Design Department about a decade earlier.

So…having recently studied quantum electromagnetic theory, and advanced mathematics, I now found myself in an art school, in classes cutting out little pieces of colored paper. I asked myself, really, whether was I actually in art and design school now or merely in a mental institution, an asylum. Perhaps I was in therapy that they're giving me. I drifted along, having to accept what I could, because, frankly, I had no idea what anyone meant by the words they were using when they talked about art and design. They would say things like, "Oh, that works." And I would ask myself, "It does? Well, I'm glad, but what is it that's working? What are you talking about? Why am I here? What am I supposed to be doing here?" Gradually, after about half a year, the language filled in with meaning, and I could understand what people were talking about as we studied typography, basic design, and visual communication. These were not activities that were unknown to me. I just didn’t know the terminology. Frankly, after I accustomed myself to my new environment, I loved it so much. I had more fun in graduate school than I'd ever had in my life. I literally did not sleep for about three years. I mean, I would, exhausted, go home and sleep for four to six hours maximum, and then go back to my desk in the Graphic Design Department or work in the photography darkroom all night, or do whatever it was that needed to be done to get my projects finished… and I loved it.

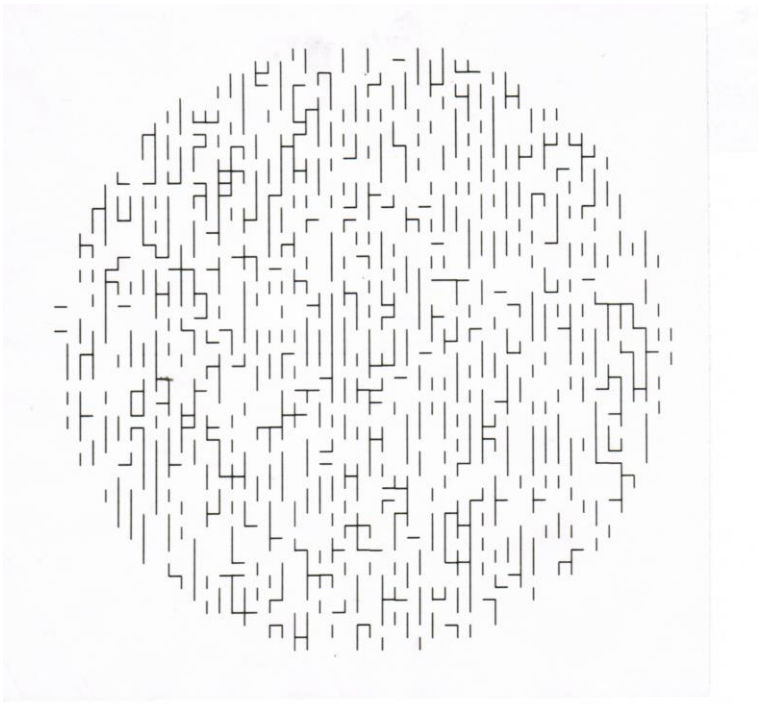
My master's thesis was on the history of number systems and the depiction of numbers. *One, Two, Three… Infinity* was the title of George Gamow's book (first published in 1947). I think his book had inspired me. I had read his columns in *Scientific American*, [to] which I have subscribed continuously since I was about 10-15. During my time at Yale, in 1966, I had already decided, for one reason or another, to take a programming course at the computer center, FORTRAN IV. I enjoyed that experience. Sometime during 1966-67, I also took a course in the basic functions of computers. I marveled at my ability to understand all of the essential, arithmetic-logical processes that were going on in a digital computer. It was very exciting, very satisfying, very compelling to be able to understand and embrace, at the time, an entire emerging technology.

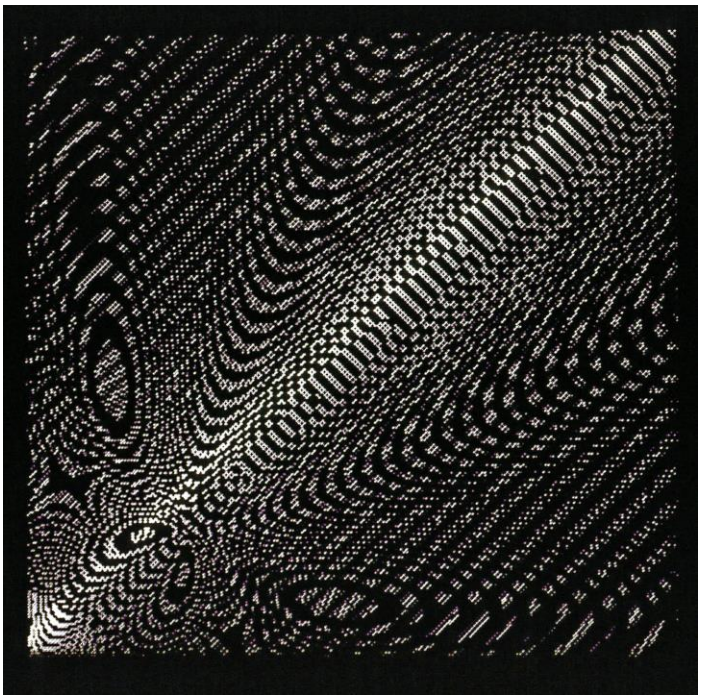
Even when I was doing initial programming in 1966-67, I noticed that I could control a line printer to make line after line of dots and other symbols, and I could actually make imagery of various kinds. And so, some of my earliest experiments were, in fact, computer graphics, but in a very primitive way. They mirrored or improved upon what I could do with a typewriter at the time, because I was also interested in typographic art, I would say, typographic imagery. And that is a stream of work of many artists, and visual poets, or concrete poets… And so, that kind of art became a thread of my work over the next few decades.

At the end of the academic year in about May-June of 1967, I had no clear idea about what I should do for a summer job. One of my classmates, Bob Nix (RIP) said, "Hey, Aaron, don't you know that there are interviewers coming from AT&T, a very big technology company?" In fact, representatives of AT&T Bell Labs, Murray Hill, NJ, were interviewing people for summer internships. He added, "And you know how to program computers." I was one of three or four people in the entire art, architecture, and design school who could. He challenged me: "Why don't you go to one of those interviews?" And I said, "Well, okay." I didn't think they would want to hire me because I had such rudimentary programming skills and rudimentary typography and graphic design skills after my second year out of three, but I went to the interview…I came into this little room in which there was a small table.

Sitting across from me at the table were two men who looked like they could have stepped out of the film "Men in Black" decades later. They didn't have sunglasses on, but they had dark suits, white shirts, narrow ties, and expressionless faces. I was a little intimidated, and I said what anyone coming in for a job interview should never say. I said, "I don't know why on Earth you would hire me, but I did study physics, now I'm studying typography and graphic design, and I've learned FORTRAN programmming. Can you do anything with that?" They listened to me. Each of them turned to the other, one smiled a little, turned back to me, and said, "Well, actually, we're looking for someone *exactly like you*." I couldn't believe it. And that was the beginning of my career in computer graphics, computer art, computer technology, computer programming, user interface design, user experience design, etc., for the next 50 years.

Spicer: Wow.





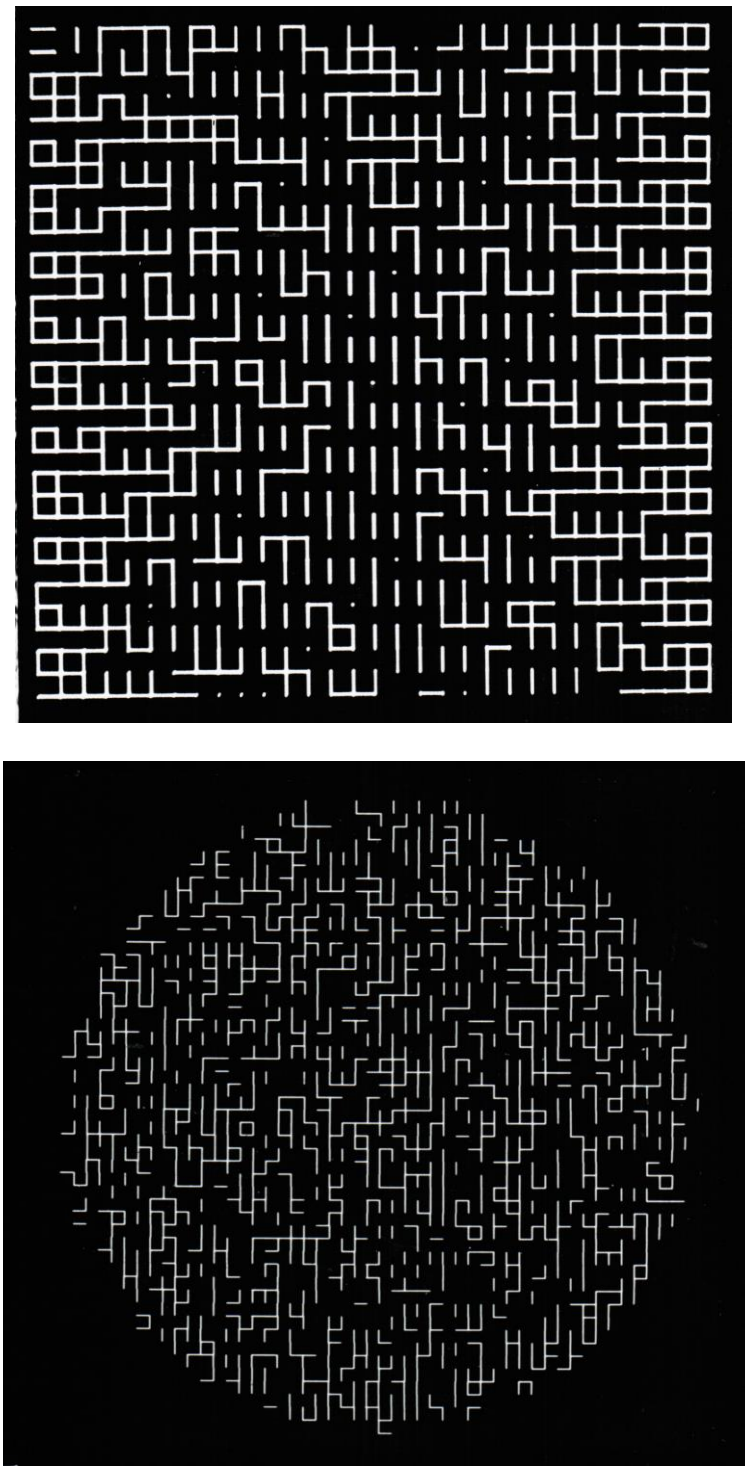


Figure 4: Early computer graphics art programmed and generated by Aaron Marcus while at AT&T Bell Labs, 1967, 1969-71.

Marcus: So, in June 1967, I suddenly became, within a month, a summer intern at AT&T Bell Labs in Murray Hill, New Jersey, the best research laboratory in the world at the time, better than anything on the West Coast, anything in Europe, or Russia. Sitting in cubicles near me were some of the leaders of emerging technology, like Ken Thompson and Dennis Ritchie, who developed the first version of Unix, and Brian Kernighan, who worked with them. I had the pleasure of working with state-of-the-art digital computers, like the mainframe GE 635, graphic recording devices like a Stromberg Carlson microfilm recorder. My managers Peter Denes (RIP) and A. Michel Noll, asked me to just "play" (explore) and get comfortable with programming in their local graphics languages. About that time, AT&T had first connected black and white raster scan television displays to digital computers. My job, eventually, not in '67, but in '69 through '71, was to program a prototype interactive page design system for the AT&T Picturephone, which Bell Labs had introduced in 1964 at the New York World's Fair.

In '67, I already started to produce line or vector imagery which was interesting to me, in part influenced by some other people at the lab who were experimenting with the depiction in dot matrix imagery based on rather simple, mathematical formulae which produced strange, interesting swirly patterns. These images seemed appealing and beautiful to me, and to others. I've always liked the expressive power of geometric imagery, as well as other kinds of imagery. I learned, at that time, that I really had to work with the computer as a partner in creating these images. If I tried to force the computer to do what *I* wanted to do, I was likely not to succeed, but if I accepted some of the computer system's limitations and quirks, and occasionally because of my mistakes in programming, strange things would occur, something startling, new, innovative, and unexpected, and I would say, "Oh, that's actually better than what I intended to do." And I accepted those as *my* work in collaboration with state-of-the-art digital computers.

Spicer: Right, by the way, I wanted to ask you quickly: didn't you use computers for your physics degree?

Marcus:. That's a good question…No, I did not. Computers were just being introduced into engineering departments, physics departments, *etc*., in the early '60s. I graduated in '65. I knew about them, but my particular undergraduate thesis was about Raman scattering from a gallium phosphide crystal using a ruby laser. So, it was leading me to a possible future technology connection to lasers. And I didn't generate that much data that I needed a computer. In fact, in my undergraduate career as a student, to earn money, I was a "computer" in the old meaning of the word.

Spicer: Oh, do tell us.

Marcus: I plotted engineering and scientific charts based on data I was given and carefully drew out the lines connecting points with pen or pencil and presented my clients the visualization of data they wanted. My tools were pen, ink, pencil, paper, and slide-rule calculator. Remember slide rules? I had a 6-inch version that I carried in my shirt pocket with my pocket protector full of pens and pencils, just like a bona-fide engineering nerd….

Spicer: And you've been doing visualization ever since.

Marcus: I was doing-- yes, data visualization by hand in 1962… let's say, to '65.

Spicer: Wow.

Marcus: But I never touched computers. I only began to program them at Yale because the Yale Computer Center wanted to reach out to various departments to get people to use their new interactive computer systems. The ones that I used at Bell Labs used slower computers. I would take a deck of 100-1000 punched Holerith cards to someone sitting behind a little window and turned in the program. The next day, if I was lucky, I would get back a paper printout of something. And there were a couple of remarkable experiences that I would call “religious,” certainly spiritual, which I had during that time at Bell Labs. One was watching a systems programmer look over the printouts of Hollerith characters, you know, they might be a two- to three-inch paper print out from a line printer

Spicer: On a punched card?

Marcus: No, standard line printer output. That's what the printout was, two or three hundred pages of IBM 1103 printouts. The software analyst would flip, flip, flip, through the pages…and suddenly stop and say, "Aha, here's your problem. You made a mistake there." And point to a spot of hexadecimal codes. I would wonder how on Earth can he read through this gray mass of printout pages, page after page? Then, I realized, this was no different than high priests from three to five thousand years ago looking at the entrails of a goat and determining the future saying, "Aha, I see that you're going to lose that next battle."

Spicer: Maybe <laughs>. The computer is real, though.

Marcus: I found it quite moving and startling.

Spicer: Yes, I guess they're finding patterns or something, right, in there, pattern matching in some way.

Marcus: They were finding patterns. They were discerning things that could not be discerned or noticed by anyone else on Earth. They were high priests of computers..

Spicer: Yeah, so this is at Bell Labs, right?

Marcus: This is at Bell Labs in '67 and/or '69 through '71.

Spicer: Right, so I want to stick with Bell Labs because, as you mentioned, it was really the leading technical laboratory in the world. This was an extremely fertile time on a number of fronts in computing with the Unix people, computer animation by Ken Knowlton, and--

Marcus: I was just about to mention some of my friends at the time.

Spicer: And Mandelbrot, was he there?

Marcus: Yes, I knew him.

Spicer: So, please mention those, the environment there.

Marcus: I shall. I was just about to get to that.

Spicer: Oh, okay. Sorry.

Marcus: The other-- the second religious, spiritual experience I had was on one occasion when I first entered the mainframe room in which the GE 635 equivalent was housed on a raised floor, with the fans humming in the background. I realized at one point in that space, that I was the only human being in that room, and I was surrounded by a digital brain far more powerful than mine and that I was witnessing the future of humankind, of all civilization. We had come to this moment. And here I was just witnessing, appreciating, thanking God that I could experience this moment. It was quite moving for me at the time.

Spicer: I know exactly what you mean. I had a similar experience. When I was 14, I went to the National Research Council in Ottawa. A friend of mine brought me there just as kind of an experience to expose me to computers. It was the largest computer system in Canada at the time. And I know the kind of transcendental experience that you have with the fan noise and the feeling of this ominous being in the room.

Marcus: Yes.

Spicer: It's quite overwhelming.

Marcus: The feeling of being in a room with some sort of being--

Spicer: Yes.

Marcus: Well, a similar occasion was, in Finland, in Helsinki, I think in the late 1990s, when I sat down inside of a Cray computer. There was an opening for a technician to make repairs and a little seat where the technician could sit. All around me were all the modules of the Cray computer. I thought: I am inside one of the most powerful computers on Earth. I don't know what to think or feel, but I am deeply moved.

Back at AT&T, in 1967 and '69 through '71, I'm not sure of the exact years-- Billy Klüver, created Experiments in Art and Technology, an organization and environment that brought many filmmakers, television and media artists, and musicians together at Bell Labs, all kinds of strange people. So, I had opportunities to bump into Stan Brakhage (RIP), the filmmaker, Nam June Paik (RIP), a national treasure of South Korea, who was experimenting with television sets, and used small TVs strapped to Charlotte Moorman's breasts while she played a cello in a media concert somewhere in New York, I believe.

Spicer: Interesting.

Marcus: Yes indeed, all kinds of interesting and unusual people who were coming to the Labs as honored artistic guests. Oh, I forgot to mention Ed Emshwiller, a science-fiction illustrator whose work I

had admired when I first started reading science fiction magazines in the 1950s. Also, among Bell Labs researchers, I was able to meet Ken Knowlton, who had just invented BEFLIX, a domain-specific language for computer animation, and was making the first animated movies…and to meet Max Matthews, who was experimenting in sound production and voice production from digital computers. Some might know that he created the computer-voiced song "Daisy, Daisy, give me your answer, true," that the HAL 9000 computer sings as it is deconstructed in the film “2001.” I had magnetic analogue tape copies of that song for at least a year or more before I noticed that Stanley Kubrick had found the song enjoyable, too, and had incorporated it into the movie. Also, I met there …Mandelbrot, what's his first name?

Spicer: Benoit.

Marcus: Yes, Benoit Mandelbrot (RIP)….. I met him several times there and had good conversations with him. As I did, also with Bela Julesz, who wrote a book about his theory of cyclopean perception. Through him, I met people who were capable of significant achievements of eidetic memory. They had photographic memories. Dr. Julesz was interested in how images are processed in the brain to become 3D. One of these people was the wife of one of his researchers there; Dr. Juleaz could show her an image of random dots one day; the next day, show her a second one, and she would say, "Well, I see a cube floating in space," because, in fact, the random dots were so arranged carefully that they produced an image of a three dimensional cube floating in space. She could integrate those images because she could remember completely the image from the day before shown only to one eye and combine it with an image shown only to the other eye. It was remarkable experience..

Spicer: Can you tell us a little bit about what made Bell Labs, which after all was owned by the phone company and was very, presumably, bottom-line driven, what made them go into these directions to become one of the most fertile computer-science centers in history. Any idea? Inviting artists and musicians and filmmakers...

Marcus: I believe that history and some of the rationale is covered in several essays and/or books. That period is covered in part in Jon Gertner’s *The Idea Factory: Bell Labs and the Great Age of American Innovation*, 2012, and in Michael Noll’s essay, “Memories: A Personal History of Bell Telephone Laboratories,” 2015. Michael Noll was my immediate mentor at Bell Labs. I learned much from him during my years working with him and reporting to him.

Spicer: Okay.

Marcus: Hmm….. I remember now that I wrote a letter with social-action or political-action implications at that time. I could read that the Picturephone™was being introduced, and my work was supposed be for the Picturephone. I thought this technology achievement was incredible, what AT&T was introducing into society. I wondered: Have they studied at all or even thought about the impact of this technology on society? I feared not. So, I wrote Dr. William O. Baker, who was then vice-president of research. My boss of my boss, Peter Denes, was somewhat annoyed that I had gone around Peter, violating protocol, and had written directly to a head of the Lab saying, "Why aren’t you studying this matter?" Oh, I know. They

had just published a copy of the *Bell Labs Record*. I had a copy (that I donated to the Letterform Archive in San Francisco), which was extoling the benefits, the blessings, of this new Picturephone technology without a single word about possible social, psychological, or cultural side effects, whether good or bad.

Spicer: May include loss of privacy <laughs>.

Marcus: Well, the executive of the Lab wrote back to me and said, "Thank you for your letter, but we don't investigate those kinds of things. That's more for sociologists and psychologists. We're engineers and scientists. And we don't do that kind of analysis," which seemed to be his way of washing his hands of any responsibility.

Spicer: But that's not really accurate, is it?

Marcus: Well, I think it was accurate at the time.

Spicer: They're hiring people like you, though, and--

Marcus: But my presence was a local aberration of typical engineering interests. Billy Klüver's efforts made it possible to meet amazing people wandering around the Lab down the corridors, but these were small in number. Most of the people were standard researchers and engineers. I mentioned I was around the corner from Brian Kernigan and--

Spicer: Ken Thompson?

Marcus: Huh?

Spicer: Ken Thompson?

Marcus: Ken Thompson were inventing Unix.

Spicer: Or Dennis Ritchie.

Marcus: Dennis Ritchie, I'm sorry, yes. Their office was just around the corner to the right. And I talked with them on occasion. Another fellow was inventing TROFF, which was a way to get better looking printouts through typesetting control. So, I had an introduction to all of those efforts. By the way, I was not using email at the time in 1967 and 1969-71. But by 1981, I had become a staff scientist at Lawrence Berkeley Laboratory, to jump ahead, and I was using email as it existed at the time. Anyway, Bell Labs, for me, was a wonderful experience, a rich and varied experience, and had a lifelong impact on my career.

Spicer: Not to get too granular, but can you share a little bit about some of the hardware and programming languages that you were using at this time?

Marcus: Well, I mentioned that I was programming in '67 for GE 635 mainframe computer and using a Stromberg Carlson microfilm recorder. By the time I came back in '69 raster scan displays had just been connected to computers. I was using a minicomputer, I believe, to display images of my programs.

Spicer: Okay.

Marcus: I can't remember--

Spicer: I saw some of your art from-- let me show it to you. And this shows actually that you used FORTRAN and APL on a PDP-10 for these. That might be after Bell. It's in the '70s.

Marcus: Yes… '71 is one of my “Cybernetic Landscapes,” I'll comment in a minute. All these others were from a future setup, which I'll comment on in a minute. But I had-- I can't remember to what kind of raster display I had access in '69 through '71. It might--I think I mentioned it in my article for *Visible Language* about my work for Bell Labs during that time. That was published in maybe '72. And I'm pretty sure I describe the equipment that I was using.

Spicer: Okay, right. We can look that up.

Marcus: You can certainly find it out through my publications, but I'm afraid I can't remember every word that I've written.

Spicer: No, of course not. Programming languages? Does it help at all?

Marcus: No, they were local graphical languages with a lot of specialized--

Spicer: Commands.

Marcus: Terms and commands that would do things like rotate objects, *etc*. So, I don't know how much of those became widespread conventions. They were probably locally invented. And frankly, the work that I did to create a prototype desktop publishing system in 1971, about 10 years ahead of commercial products—

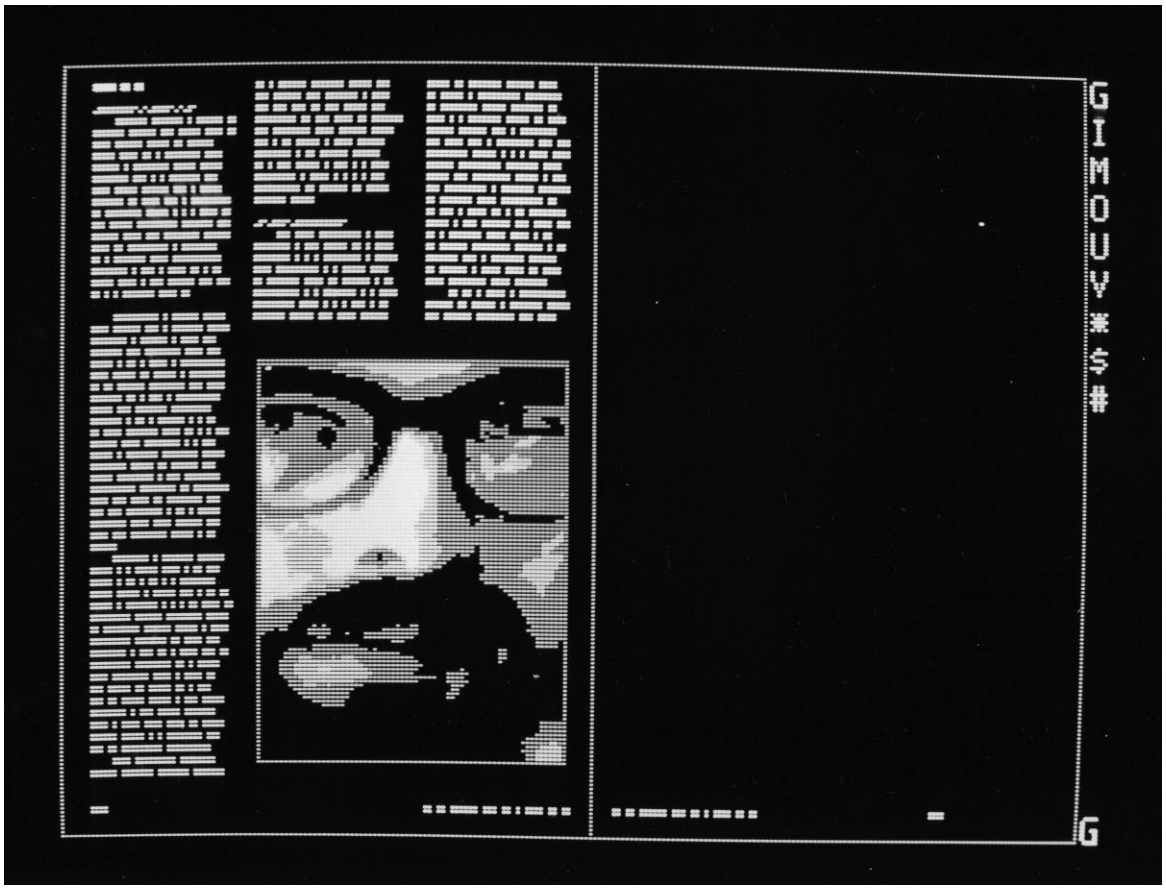


Figure 5: Prototype Interactive Page Layout System, programmed by Aaron Marcus as a research project while a consultant to AT&T Bell Labs, Murray Hill, NJ, 1969-71.

Spicer: Yes, now tell us about that and how it works with the Picturephone.

Marcus: Sorry?

Spicer: How it was supposed to work with the Picturephone.

Marcus: Well, AT&T wanted to make improvements in the process of developing ads for the Yellow Pages of North America and checking with advertisers and then publishing all the telephone books of the United States and Canada, a big deal, a big publishing effort. So, I was part of the effort to find a digital means to edit the text and imagery of a page so that it could be adjusted, communicated to someone, okayed, sent back, and then sent to a printing and publishing facility. I remember, now that I think of it, at the time that I did some research for comparable systems, there was a magnificent system at Time-Life headquarters in New York City. Because *Life* magazine's fame was built on all of these wonderful collages of 35 mm slide imagery sent in by photographers from all over the world, engineers had built a gigantic circular metal frame in which they could have perhaps 20-40 slide projectors mounted. Then with a series of prisms, each of the projectors could be projecting an image. These multiple images could be

focused on a back projected display so that the magazine designers could assemble those images, crop and size them, position them at the specific location on the page with other images, captions, and I think some depiction of dummy text, or “Greeking,” as we called it then, and lay out the pages of *Life* magazine. Their mechanism was a very expensive analog device for laying out pages using actual photos.

Spicer: Do you know who made that?

Marcus: It might be in some of the notes for resources for my article. I cannot remember at this moment.

Spicer: That sounds … it sounds amazing.

Marcus: But I’m sure *Life* magazine archives would--

Spicer: Sure.

Marcus: Provide information about it.

Spicer: Okay, 80 slide projectors.

Marcus: Well, maybe it was only 20.

Spicer: Okay, still though.

Marcus: Let's be--

Spicer: It's amazing.

Marcus: Let's be minimalist about this. Let's say 20 projectors, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10--

Spicer: In a circle?

Marcus: Ten or 20. They were all in a circle projecting their images into the center where prisms or half-silvered mirrors under analog electronic control would refocus the images onto the display.

Spicer: Wow. It's really unusual.

Marcus: Well, humankind has done many strange and wonderful technical things.

Spicer: Absolutely. So, your system replaced that, I guess.

Marcus: Well, it was an attempt to research how this would work using digital computers. I was designing a user interface with light buttons that needed to be selected. And I had a depiction of dummy typography

and imagery that could be manipulated and moved around like a desktop publishing system would do on even a microcomputer by 1984. But this was 1971. That was the best I could do.

So, with that background, I had gone back after Yale to teach at Princeton. I hadn't expected ever to return there.

Spicer: Sorry, what year is this?

Marcus: I came back-- I was graduated from Yale in '68, and I didn't know what I was going to do, once again, for the summer and my life afterwards. I was somewhat nervous that I might be drafted into the Vietnam War. And just as I was-- oh, I remember. I had applied for and had been awarded a Fulbright scholarship to study in Europe for a year at the Ulm Design School, which was the best graphic design and industrial design school in the world, I thought. Many other people thought so, also.

Spicer: Wow.

Marcus: I felt very fortunate that I was going to have a year to immerse myself in all of the discipline, faculty, and lore of Ulm. I knew about the school. I had seen some of their publications, and this was about May or June of 1968. At one point in time, I had in front of me a letter from the German government saying, "We congratulate you. You've won a Fulbright scholarship to study at Ulm, one of our best design schools." But in my other hand I had a front-page article from The *New York Times* saying, "The Ulm School has been dissolved because of student riots, and the German government or the local government has shut down the school." I didn't know whom to believe. <laughs>

Spicer: Wow.

Marcus: The *New York Times* or this letter from the German government? I decided it was too uncertain for me, and I didn't want to wind up going to Ulm, Germany, and finding a wreckage of a school.

Spicer: Chaos.

Marcus: Chaos.

Spicer: Yeah.

Marcus: An inability to do anything. What was I supposed to do then, just hang around the chaos for a year? It might've been nice in some ways, but I would have no teachers, no input, no access to the wonderful facilities, *et cetera*. Well, all for which I had hoped had completely disappeared in one week. I was increasingly nervous, "What am I going to do?" Suddenly, one of my classmates said, "Aaron, there's a phone call for you at the public telephone at the end of our room. I said, "Who would even know that I'm here to call me?"

Spicer: <laughs> Right.

Marcus: So… I picked up the phone, and it turned out to be <laughs> none other than Emilio Ambasz, who had been an incredible student friend of mine at Princeton. He and I started out at Princeton in the same year, 1961, and four years later, in 1965, I had achieved my AB in Physics. Okay. Emilio, in the meantime, had not only finished his undergraduate degree, but had gone on to complete his master's and then, I think, had achieved a PhD in the same amount of time, because he was so unbelievably smart. I should mention that I had another extremely smart friend, my roommate as an undergraduate, Robert Cover, who unfortunately died early in his life, but before his death, he taught at Yale and was an incredible legal scholar who had founded a whole branch of legal theory based on his work. So…. meanwhile Emilio was still alive and said, "Listen, Aaron, I think I want you to take over my course at Princeton, because I've got to go on to become the associate curator for design at the New York Museum of Modern Art." I said, "Oh, …uh….okay." <laughs> I didn't have any other employment or activity lined up, due to the last-minute collapse of the Ulm option, so Emilio's call was an unexpected blessing out of the blue, and he said, "But you have to come for a faculty meeting so you can meet the faculty and they can decide whether you should be hired or not."

So…probably in June, just before the end of the academic year at Yale, I gathered up my portfolio, went by train from New Haven, Connecticut, to Manhattan, to Max's Kansas City Restaurant. You may not know this place, but inside, it's pitch dark. The tables were lit by one little candle at each table. It's very romantic and atmospheric, and there I'm introduced to all of the key faculty members of the Princeton University School of Architecture and Urban Planning. They're all sitting around a long table. I'm invited to sit down next to the Dean, Bob Geddes. We talk a little bit. The faculty members introduce themselves. I tell them a little bit about myself. … Time is running out for what I think is a lunch meeting, and I said to the Dean, "Don't you want to see my work?" and he said, "Oh…. Oh, yes. Yes, of course. Show me it. Show me it," and there, by the light of one candle, I'm flipping through the pages of my portfolio, trying to describe the projects. No one else can see anything from a medium to long distance away, and he said, "Thank you very much. Okay. You can go, and we'll be back in touch."

I packed up all my portfolio and went back to New Haven by train thinking, "What is this farce that I've been through? This is so confounding and seemingly humiliating." Only later did I realize my selection was a done deal and the ritual a necessary formality. If Emilio said, "He's going to take over,"…then, I'm going to take over the course. I was already in, but no one had ever mentioned that fact to me. So that was June of '68. By September '68, I started teaching at Princeton and continued there for about nine years. During that time, I started to use the computer graphics equipment of the computer graphics lab in the Biology Department, I think. They had an advanced system for molecular display, 3D, color, and live action. It was an LDS-1.

Spicer: Ooh, yeah.

Marcus: Evans and Sutherland Line Drawing System 1, capable of drawing a 2,000 vectors simultaneously. Not much today, but that was a big deal then.

Spicer: Yeah, that was an important system for sure.

Marcus: And so I had access to that, the special graphics language that they used, and I began programming. I did maybe some experiments in architectural depiction of floor patterns, floor arrangements of furniture, but what I really decided I wanted to focus on was computer art, my own imagery, and so I became one of the first artists or designers to actually create virtual reality art. Years before most people were aware of it, and in 1971 to ’73, I created “Cybernetic Landscapes,” which were simple, abstract depictions of things in a 3-dimensional space, a fairly large space, and people could come and visit it, and if they looked in the right direction they would see wonderful sculptural structures with lines flickering in a way because they were going along a sacred path down the middle of the space.

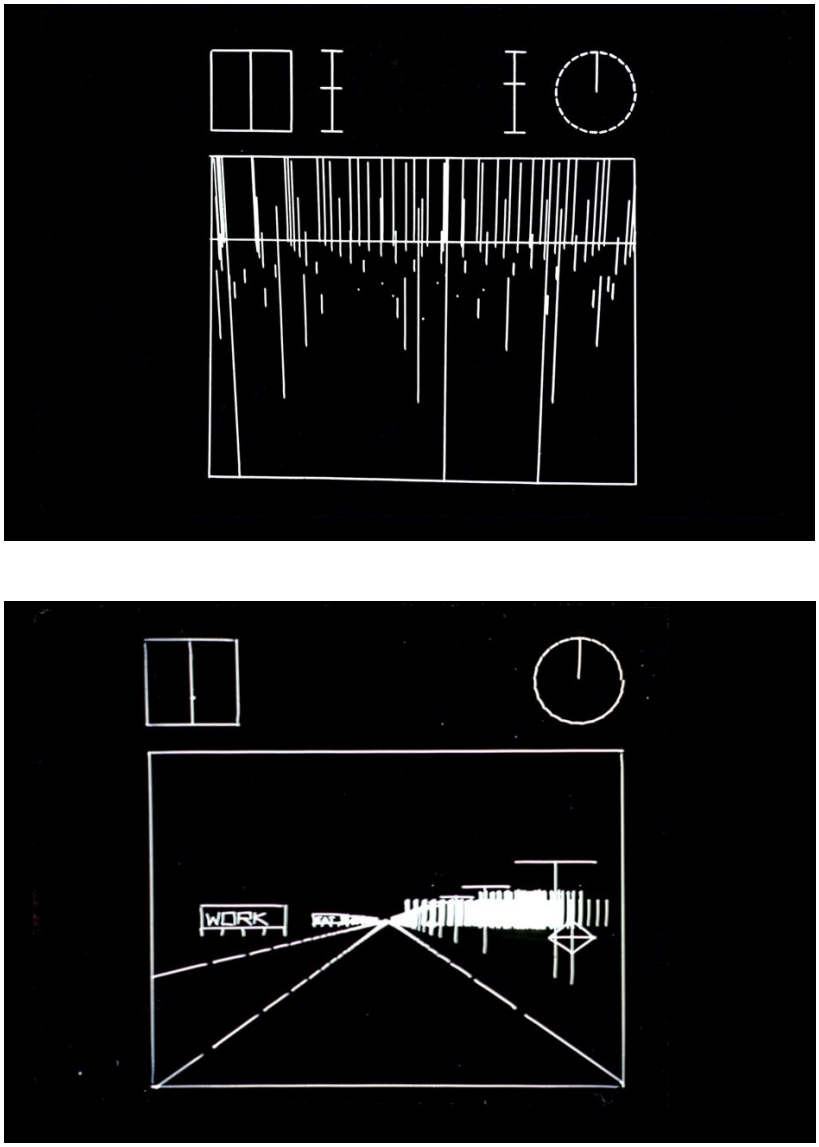
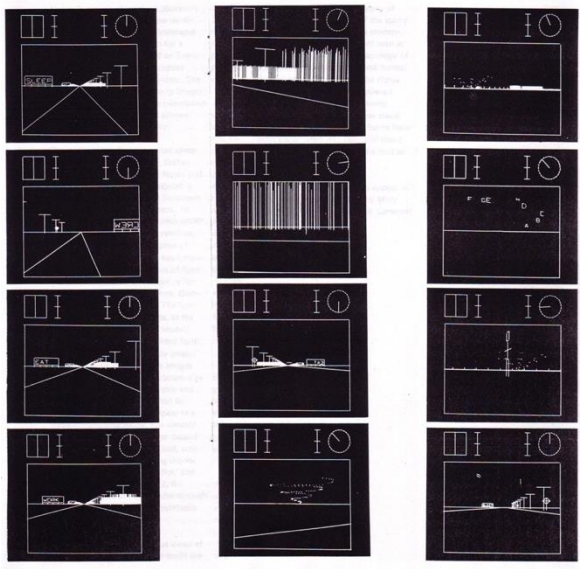
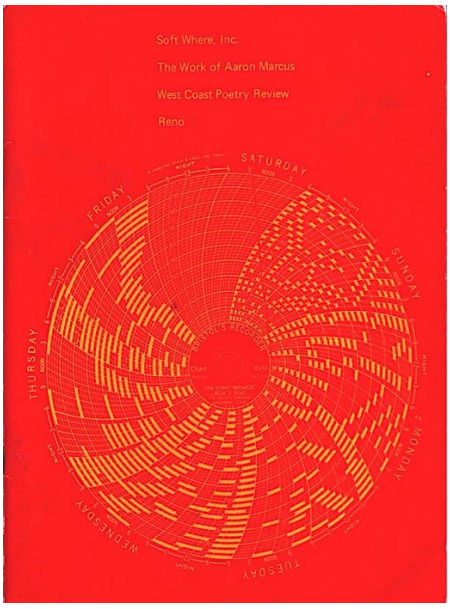
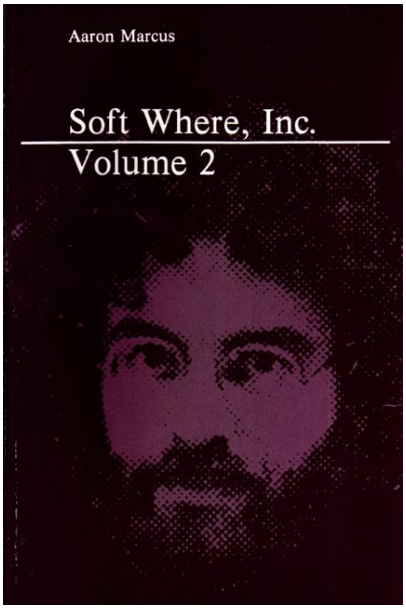


Figure 6.1: Images from “Cybernetic Landscapes,” 1971-73.



Collection of images of “Cybernetic Landscapes”, 1971-73, by Aaron Marcus, reproduced in Marcus, Aaron, *Soft Where, Inc.,* Vol. 1, pp. 12-14, 1973.





Cover images of the books *Soft Where, Inc.*, vols 1 & 2, by Aaron Marcus.

Spicer: Okay. <laughs> Thank you.

Marcus: So you could see things in perspective. You could look into the space. I didn't program color. I decided not to complicate things. It was only a black and white landscape, and images of this landscape were the physical remnants of my code. They were shown in San Francisco at the Museum of Modern Art, where they have some of the first hard copy depictions of that space, and some of the code printouts from my experimental "Cybernetic Landscapes"

Spicer: Is that on permanent display or...?

Marcus: No.

Spicer: No.

Marcus: It was a show in 2016 called, "From Typeface to Interface."

Spicer: Oh, neat.

Marcus: Put together by Joseph Becker, the Associate Curator of Design.

Spicer: Okay. Thank you.

Marcus: And...

Spicer: Did you know of Myron Krueger and any of his work at the time or...?

Marcus: Oh. Probably he did, but actually it was Myron Krueger, whom I knew, who wrote in his first book that I was the first virtual reality artist.

Spicer: Mm, wonderful.

Marcus: Not <laughs> too many other people have--

Spicer: Well, there's not many people who--

Marcus: --acknowledged that or--

Spicer: --can speak to--

Marcus: --commented about it. No.

Spicer: Not many people can speak authoritatively about it, so that's great, because he's an interesting figure too.

Marcus: Yeah. Well, in this space, I also had a little dancer, a person who moved around the space. This was a design which I developed inspired by something that Michael Noll had programmed, a little dancer, because he was interested in *labanotation*, the dance music notation, and wanted to see if you could program a creature and then have it maybe produce automatic labanotation for the movements or vice-versa.

Marcus: So in addition to that, there were little twirling, three-dimensional kinetic sculptures that would do their thing, and you might or might not see them if you didn't discover all of the mysteries and wonders of the space, and along the sacred way there were something like Burma-Shave signs.

Spicer: <laughs>

Marcus: If you know Burma-Shave.

Spicer: Yes. <laughs> I do.

Marcus: That would have just slogans. "Sleep," "Eat," "Love," "Die," *et cetera*, as a kind of philosophical comment about the sacred way of life, of a life. So it was meant to be a philosophical work of concept art, but also a work of formal art in which you could have interesting and satisfying visual experiences, depending on where you wandered or flew through the space. So, I did those in '71 to '73, but in the meantime, during that period of time I had a sabbatical and returned to Yale to teach in the Graphic Design Department and also work with the Yale Computer Center, which had connected for the first time a photo-typesetting machine to a digital computer, and so I was able to program the typesetting machine to produce various things. Could be pieces of English text floating around in a two-dimensional visual space.

Spicer: Could you create your own fonts, figures?

Marcus: That would be possible.

Spicer: Symbols? Yeah?

Marcus: In fact, I did something of that kind in a way that you might not expect. But to design a font is a significant amount of work, and I did not, in my short period of time there, want to get bogged down in designing a font, so I used available fonts, and in available fonts, there are things like bullets, little discs of dark ink, squares, ovals, circles. There are the various letter forms and special characters. So I programmed the computer to display those in special ways that created what for me were satisfying visual imagery, and those became the works of art called, "Evolving Gravity," "Radioactive Jukebox," "Shades of Hades," and "Urbane Nova," that were later turned into color prints and published in the first place as imagery for a bank in Virginia's annual report.

Spicer: <laughs>

Marcus: But they were kind enough to print hundreds of extra copies for me.

Spicer: Oh, nice.

Marcus: Which became a limited edition, signed and numbered--

Marcus: --selection, and you have a set. So does SFMOMA.

Spicer: Oh, wonderful.

Marcus: Letterform Archive, Berkeley Art Museum, and others, also; and they were, you know, I think, beautiful and interesting.

Spicer: Yes.

Marcus: I produced them in small size in ’74. It was also the case that the Pratt Institute’s special facility in Manhattan, not in Brooklyn, where Pratt Institute is, heard of my work. They asked me to write an article for their magazine, which I did. I did publish a lot of articles about the coming world of technology and the role of design and computer art issues, *et cetera*. I published something in one of their journals and then they said, “Oh, we like what you did with the typographic works. We would like to commission you to create two large serigraph prints as a member giveaway, a benefit. So they produced in their facilities very high-quality printed serigraphs of two of my works, “Evolving Gravity,” and “Noise Barrier,” In the case of “Noise Barrier,” when you look at it, you see a lot of chicken scratches and then dark black, then a red bar and then more white chicken scratches that create the rectangle of imagery. The actual print image is an error in my programming, because if I had succeeded it would have been a more boring image of, something like a Persian carpet, of chicken scratches. And how did I make the chicken scratches? Well, you asked about designing one’s own font. Fonts, when they are typeset with the Mergenthaler--

Spicer: Linotype?

Marcus: … Linotype printing equipment, which could be connected to a digital computer to drive it, relied upon a glass plate of about, I’d say, six inches by six inches, about a quarter of an inch thick, and on its surface were perfect renditions of every character that would be used in a particular font like Times Roman, and could be used at a number of different sizes, and while that was wonderful and an incredible technology achievement, I wanted to create signs and symbols, as I’d been interested in from childhood, in a new language, a language of another culture, another time and space, maybe from another planet. How could I do this? Well, I decided that I could take out the glass plate and insert my own six-inch-by-six-inch plate, which I had held over a candle to cover it with lampblack. Now--

Spicer: Oh. Was this plate frosted glass initially or...?

Marcus: Well, it was clear glass, but with a photographic emulsion on one side.

Spicer: Oh, okay.

Marcus: With a perfect rendition of all of the characters, I faked out the typesetting machine by putting in this glass plate I had made, and in the lampblack I took a safety pin or a pointed instrument and I made random scratches in the surface, trying to create strange characters from another planet. I had no idea what it would look like, but when it came out, the typesetting machine didn't know that… it might've been a setting… I can't quite remember, some text from a day of the *New York Times*. But what appeared were all these small segments of scratches, set one after the other, as though they were type, and altogether they made a carpet and pattern of strange signs or symbols, un-interpretable in normal language. But enjoyable to look at as visible language, and that became that image which was transformed into "Noise Barrier" in 1972 to '74. So I continued experiments using computers, Calcomp plotters, other computers in other facilities. I published some of the imagery. I had exhibits all over the world, in Japan and the U.S. and Europe, and I think South America, and in Israel.

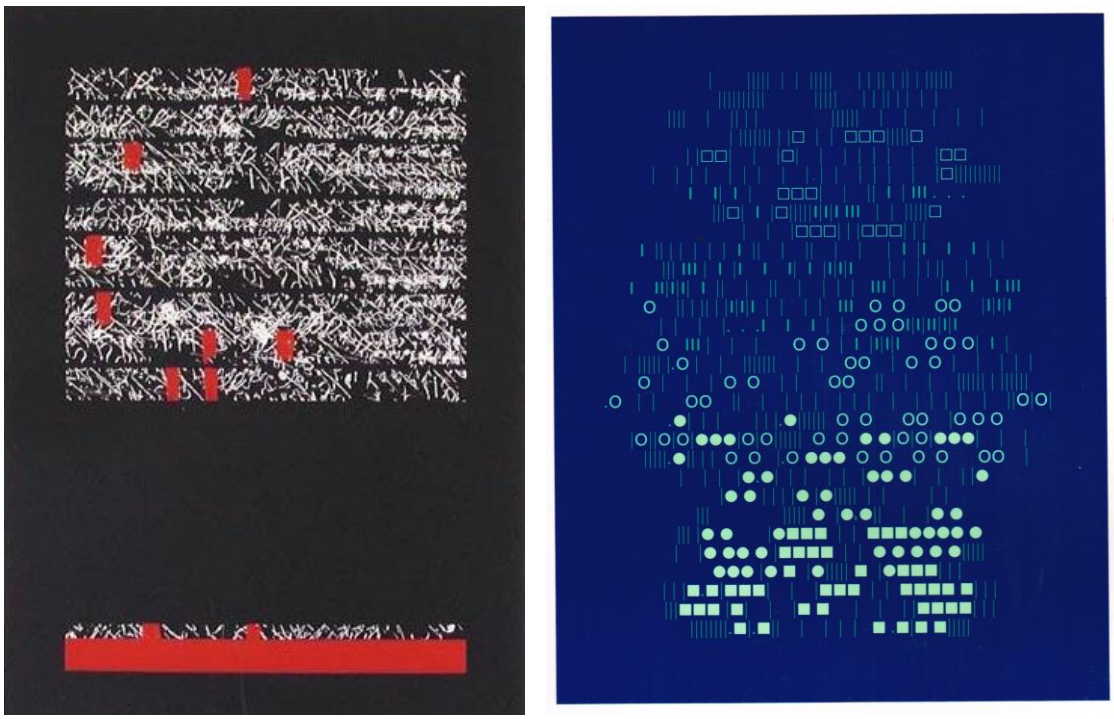


Figure 7: Yale Computer graphics art works by Aaron Marcus, 1972-74.

Spicer: Now, at this stage, by computer, you mean a mini or a mainframe, one or the other?

Marcus: They-- that's a good question. I think by that time the computer that ran the typesetter was a PDP-10.

Spicer: Mm, okay.

Marcus: A minicomputer.

Spicer: Right. Okay.

Marcus: And I would have to learn a particular programming language to make sure that everything--

Spicer: Do you remember using APL at all, because that's...?

Marcus: I studied APL. I may have used APL a little bit for one project, but I didn't go very far.

Spicer: Because it certainly has an interesting characters set. <laughs>

Marcus: Oh, yes, yes, yes. Well, that leads me to, soon, to my DARPA project, but just going through time I…I'm trying to remember some of the artworks that I created. Many of them were experiments in trying to create new signs and symbols, and I did that also in artwork back even in '71, I think, with press-on lettering called Letraset on top of scientific chart paper. Some of those works were published in *Typographische Monatsblaetter* in Switzerland, and some were most recently republished in a book about the history of Letraset type. Many graphic designers all around the world used this kind of press-on lettering. I had hundreds and hundreds of sheets of it back in the '70s and '80s.

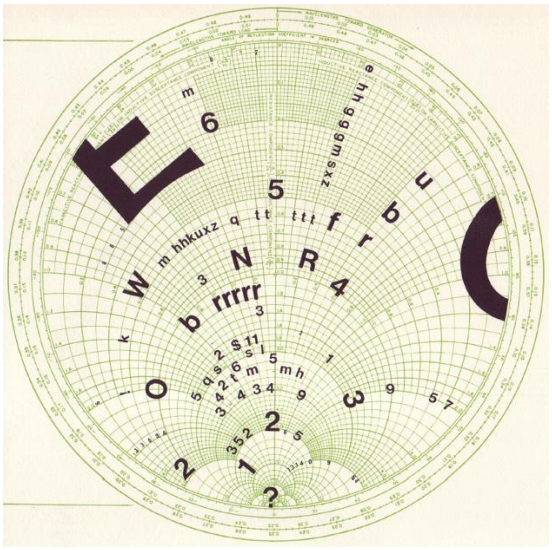


Figure 8: Symbolic Constructions, 1973.

Spicer: It's also used in prototyping, when you prototype a product. To label front panels and stuff.

Marcus: Correct. You would press it right on to the object or a new display of vehicle or airplane or a box of soapsuds, depending on what you were designing.

Spicer: That's good. Do they still make that, by the way, Letraset?

Marcus: I should know, having worked with these people creating the Letraset book. I can't quite remember. I think there may still be some production, but it surely must be very limited and for the connoisseur <laughs> or for the nostalgic collector. So we're back in 1977. My career as a faculty member at Princeton was coming to an end. I decided to move to Israel. I thought I would stay there. It didn't turn out that I could, because I couldn't work out a permanent teaching position, and I did some--

Spicer: Can you tell us – sorry -- what university was that?

Marcus: Well, sorry. Good point. I was teaching at both the Bezalel Academy of Art and Design, which was separate at that time from the Hebrew University, both of them in Jerusalem. I was teaching in the Graphic Design Department and the Industrial Design Department at Bezalel. They didn't know that I was also teaching at the Hebrew University in the Communications Institute that Elihu Katz, Professor Katz, now deceased, had created, and also in the Geography Department. I was teaching basic computer cartography there. So I had quite a load of teaching. I was teaching often in Hebrew, and-- because my Hebrew was much better then, as was my German.

Spicer: May I ask where you learned that? Was that as a child?

Marcus: A little bit through Hebrew school, but I really learned it when I first went to Israel… when I first had a semester sabbatical in Israel in '75, I think, and I went to Ulpan Etzion, which is a very good place where you learn to speak Hebrew very fast.

Spicer: Wow.

Marcus: And so I learned spoken Hebrew, street Hebrew. I still had some trouble with newspapers and literature, but I can read it, and at that time I could speak fairly fluently, and I also had lectured in '69 in German in Switzerland, because I had taken German for four years for physics. It was either German or Russian at the time, and I like languages and had some ability to learn these languages. So I was teaching at one point in Israel in February of 1978, in four different departments where classes were ending and new classes were starting, but nobody's calendar was ever coordinated with any other departments or institutions, and consequently I was teaching 40 hours per week!

Spicer: Oh, my gosh. That's about 10 times more than a normal professor -- <laughs>

Marcus: I would drive in my car from one place to the other, re-using lectures from some class into another class, back and forth.

Spicer: Oh, my God.

Marcus: Luckily it was only two weeks.

Spicer: Exhausting.

Marcus: But it was exhausting.

Spicer: Yeah.

Marcus: Had a good time, in general, but as I say, II couldn't convince anyone to give me a permanent position. I did do some further work in Israel, and I had done that in 1975 at a computer graphics lab that was I think jointly funded by both Bezalel and the Hebrew University. But, unfortunately, that place had come to an end just as I was arriving in 1977. So it was bad timing on my part.

Spicer: It's kind of like the Ulm thing.

Marcus: Yes.

<laughter>

Marcus: Yes. It was very Ulm-ish.

Spicer: Yes.

<laughter>

Marcus: So I did what I could. I had some exhibits of my work. I think it must've been at that time that I was able to convince the Israel Museum to accept some of my artwork into its collection. Later, I came back to the United States. I happened to learn of a research fellowship position in Honolulu, Hawaii. So I moved from Jerusalem to Princeton for the summer and onto Honolulu to begin a research project to design a visual communication of important concepts related to the subjects of study at the East-West Center at the University of Hawaii. They were studying population and energy and demographics and other major topics, and it was an incredible opportunity. I led a team of about seven people, including my ex-first wife Susan; and Yukio Ota, a very famous graphic designer from Tokyo, Japan; and a media specialist from Tehran, who was the first person in Iran to translate Marshall McLuhan's work into Farsi!

Spicer: Oh, isn't that interesting?

Marcus: And an audio-visual specialist from India, and a Chinese cartographer. So, we were a multicultural crew trying to tell a story without words about global energy interdependence, one of the things we're still trying to learn about these days.

Spicer: More than ever…

Marcus: And how nations needed to cooperate in order to share the Earth and to distribute Earth's resources. Well, it was a remarkable project. We were able to study all these topics for about four months

and then work on visualizing them for two months, and that was the project that convinced me to move my career in graphic design and, well, I could say user-interface design into information design and information visualization, because that's what we were trying to do. I have images that I could display at this moment to show what some of the imagery was like. It was only black and white. It was charts, maps, diagrams, pictograms, and ideograms to communicate all of this information without using words. Also, we had an international, multicultural music background to move the viewer through the presentation. This audio-visual presentation was shown in the US, India, Japan…. I don't know if it was shown <laughs> in Iran because just around that time the Shah was kicked out and relations of the United States with Iran came to an abrupt end.

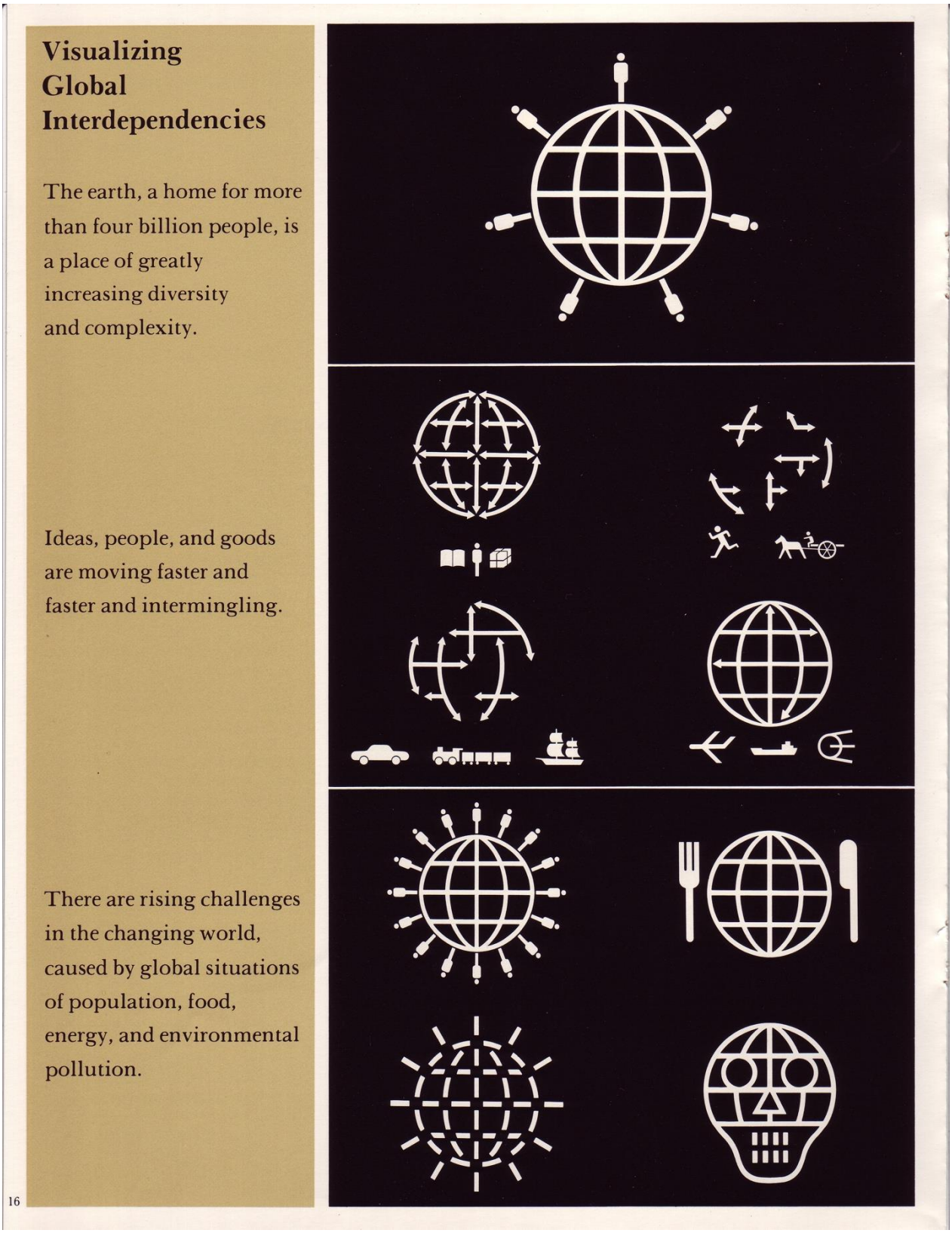


Figure 9: Images of East-West Center Project, 1979. From *Perspectives*, East-West Center.

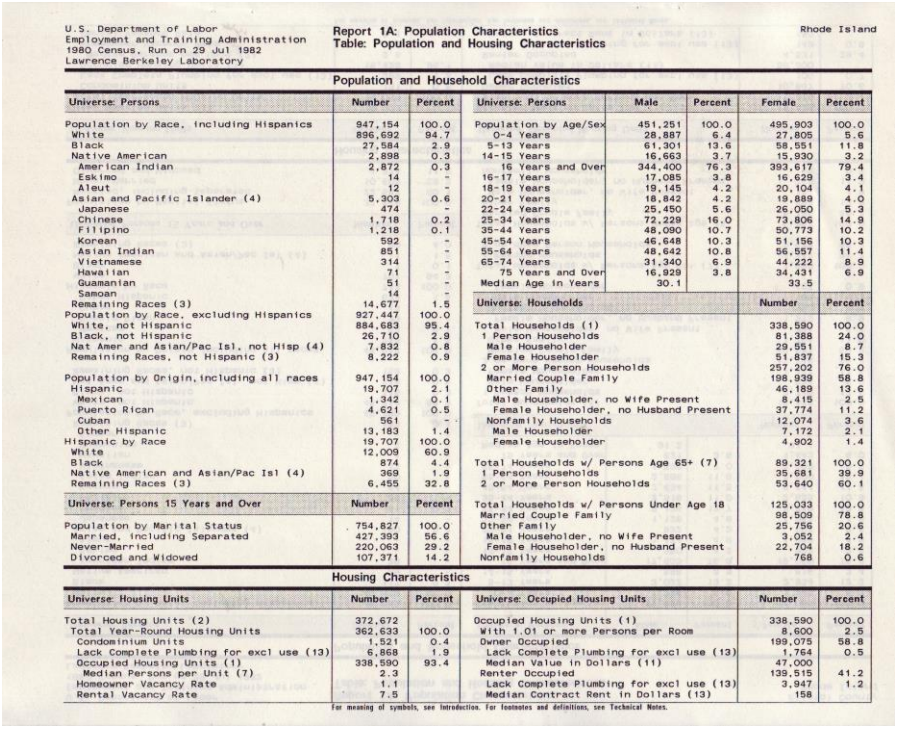
Spicer: Right. So this is ’78--

Marcus: ’79.

Spicer: ’79.

Marcus: Yeah, it was issued in about January of ’79. By that time, I had found a home at the University of California at Berkeley, where, again, I was teaching in a College of Environmental Design to architects and urban planners. That didn’t last too long, because I had hoped to create a Center for Graphic Design, information graphics, user-interface design, but I was about 30 years too early. Just when I thought, once again, “What am I going to do to keep myself employed or my family funded?” I realized that there was a government research laboratory nearby. Lawrence Berkeley Laboratory, and I had already decided that my future career had to be within a 15-to-20-minute bicycle ride or walk from my house. I was not going to move my family again through international commotion. So, I did a very strange thing. I found out how to contact the head of the Computer Science and Mathematics Department. I went to him [Carl Quong] and said, “Look. You don’t know me, but here’s my background briefly. I think I could help you. I think I could do something here that would be beneficial and would help communicate the information that you’re trying to produce to the people who need to see it, to make better use of the computer equipment that you have,” and that group was creating a multilevel, multidimensional, multi-database visualization of socio-economic, environmental, demographic information systems for the U.S. government, for the Department of Energy and the Department of Labor. They had been doing this for many years. They continued for many years, and suddenly I found myself learning about their systems and being able to help improve charts, maps, and diagrams and text information that this cross-platform information system could produce.

It was at that time that the first depictions of the U.S. Census data… we’re just now starting to collect for the 2020 Census. So, they had just acquired the 1980 Census data. This was about 1981, and so for the first time, anyone in the United States could request from the U.S. government, through a paper form faxed to the right official center, any demographic information depicted that was public property, public databases, about any geographic area of the United States. These had all been produced in a limited run by hand and analog means for decades. In fact, going back centuries. This was the first digitized production of U.S. Census data, and so my task as a designer was to design a book with perhaps a million pages that I would never see, but to set up the parameters for how text, charts, maps, and diagrams would appear on pages that would be automatically laid out by the software. That was my task, and we accomplished that.



U.S. Department of Labor
Employment and Training Administration
1980 Census, Run on 29 Jul 1982
Lawrence Berkeley Laboratory

Report 1A: Population Characteristics
Table: Population and Housing Characteristics

Rhode Island

Population and Household Characteristics

Universe: Persons	Number	Percent
Population by Race, including Hispanics	947,154	100.0
White	896,692	94.7
Black	27,584	2.9
Native American	2,898	0.3
American Indian	2,872	0.3
Eskimo	14	-
Aleut	12	-
Asian and Pacific Islander (4)	5,303	0.6
Japanese	474	-
Chinese	1,718	0.2
Filipino	1,218	0.1
Korean	592	-
Asian Indian	851	-
Vietnamese	314	-
Hawaiian	71	-
Guamanian	51	-
Samoan	14	-
Remaining Races (3)	14,677	1.5
Population by Race, excluding Hispanics	927,447	100.0
White, not Hispanic	884,683	95.4
Black, not Hispanic	26,710	2.9
Nat Amer and Asian/Pac Isl, not Hisp (4)	7,832	0.8
Remaining Races, not Hispanic (3)	8,222	0.9
Population by Origin, including all races	947,154	100.0
Hispanic	19,707	2.1
Mexican	1,342	0.1
Puerto Rican	4,621	0.5
Cuban	561	-
Other Hispanic	13,183	1.4
Hispanic by Race	19,707	100.0
White	12,009	60.9
Black	874	4.4
Native American and Asian/Pac Isl (4)	369	1.9
Remaining Races (3)	6,455	32.8

Universe: Persons 15 Years and Over	Number	Percent
Population by Marital Status	754,827	100.0
Married, including Separated	427,393	56.6
Never-Married	220,063	29.2
Divorced and Widowed	107,371	14.2

Universe: Persons	Male	Percent	Female	Percent
Population by Age/Sex	451,251	100.0	495,903	100.0
0-4 Years	28,887	6.4	27,805	5.6
5-13 Years	61,301	13.6	58,551	11.8
14-15 Years	16,663	3.7	15,930	3.2
16 Years and Over	344,400	76.3	393,617	79.4
16-17 Years	17,085	3.8	16,629	3.4
18-19 Years	19,145	4.2	20,104	4.1
20-21 Years	18,842	4.2	19,888	4.0
22-24 Years	25,450	5.6	26,050	5.3
25-34 Years	72,229	16.0	73,806	14.9
35-44 Years	48,090	10.7	50,773	10.2
45-54 Years	46,648	10.3	51,156	10.3
55-64 Years	48,642	10.8	56,557	11.4
65-74 Years	31,340	6.9	44,222	8.9
75 Years and Over	16,929	3.8	34,431	6.9
Median Age in Years	30.1		33.5	

Universe: Households	Number	Percent
Total Households (1)	338,590	100.0
1 Person Households	81,388	24.0
Male Householder	29,551	8.7
Female Householder	51,837	15.3
2 or More Person Households	257,202	76.0
Married Couple Family	198,939	58.8
Other Family	46,189	13.6
Male Householder, no Wife Present	8,415	2.5
Female Householder, no Husband Present	37,774	11.2
Nonfamily Households	12,074	3.6
Male Householder	7,172	2.1
Female Householder	4,902	1.4
Total Households w/ Persons Age 65+ (7)	89,321	100.0
1 Person Households	35,681	39.9
2 or More Person Households	53,640	60.1
Total Households w/ Persons Under Age 18	125,033	100.0
Married Couple Family	98,509	78.8
Other Family	25,756	20.6
Male Householder, no Wife Present	3,053	2.4
Female Householder, no Husband Present	22,704	18.2
Nonfamily Households	768	0.6

Housing Characteristics

Universe: Housing Units	Number	Percent
Total Housing Units (2)	372,672	
Total Year-Round Housing Units	362,633	100.0
Condominium Units	1,521	0.4
Lack Complete Plumbing for excl use (13)	6,868	1.9
Occupied Housing Units (1)	338,590	93.4
Median Persons per Unit (7)	2.3	
Homeowner Vacancy Rate	1.1	
Rental Vacancy Rate	7.5	

Universe: Occupied Housing Units	Number	Percent
Occupied Housing Units (1)	338,590	100.0
With 1.01 or more Persons per Room	8,600	2.5
Owner Occupied	199,075	58.8
Lack Complete Plumbing for excl use (13)	1,764	0.5
Median Value in Dollars (11)	47,000	
Renter Occupied	139,515	41.2
Lack Complete Plumbing for excl use (13)	3,947	1.2
Median Contract Rent in Dollars (13)	158	

For meaning of symbols, see Introduction. For footnotes and definitions, see Technical Notes.

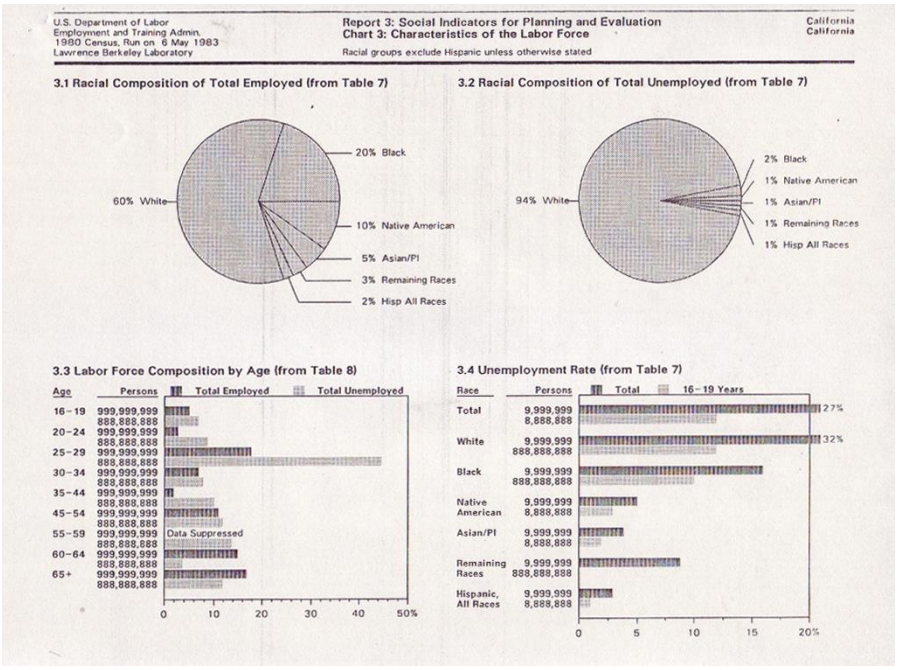


Figure 10: LBL SEEDIS Data Visualization, about 1981-82.

Spicer: So, this would let you look at a, say, a specific zip code, let's say, and in a visual form, say, I'll just guess and say a pie chart. It might've been more sophisticated.

Marcus: Could be a pie chart or a bar chart of a distribution of incomes in that area, levels of education, house values, other information, which was gathered as public property.

Spicer: Mm, perfect.

Marcus: You could say, "Well, this was the first digital invasion of privacy on such a grand scale," <laughs> and it was. But at the time it was viewed as beneficial and advantageous for the U.S. government, and for any business that wanted to produce depictions, but also any citizen who wanted to know.

Spicer: So a citizen could conceivably could also use this?

Marcus: Yes. Yes, yes. It was announced by the U.S. Printing Office and was made available to people.

Spicer: Pueblo, Colorado, I believe, was the <laughs> standard place they sent stuff from.

Marcus: I can't quite remember whether it was Pueblo, but it was Washington, D.C., where you had to send the request, I believe.

Spicer: Right. Well, that's great. Very, very nice.

Marcus: So that was exciting, and around that time, I happened to become friends with Ron Baecker, who was teaching at the University of Toronto's Computer Science Department, and who had created his own company called Human Computing Resources. He helped me to understand how to use my skills as a visual designer and a user-interface designer, which were just emerging. I wrote one of the first user interface design guidelines for the system that Lawrence Berkeley Lab computer scientists and demographers, *et cetera*, were creating in '79 or '80. There weren't too many user-interface design guidelines at that time, and I realized they needed to be written so that everybody on the team would be on the same page, so to speak.

Spicer: Do you still have those, by the way, in your archives or...?

Marcus: If I don't have them, they're probably at the Letterform Archive.

Spicer: Okay. Thank you.

Marcus: Ron made me aware of DARPA. I don't even think I knew what DARPA was before I met Ron, and together we wrote a proposal for two or three years of research with Ron and myself being co-principal investigators, to improve the depiction of the C programming language. Why that topic? Because DARPA had a large research program with funding for program visualization. Why? Because they knew

that programming was becoming the largest literature-production effort on the face of the planet, and most of it was terrible, unreadable, hard to understand, with few or no comments, and that programs to launch rockets, to run airplanes, to build airplanes, were becoming one million lines of code, and that this effort was headed for disaster if someone didn't find a way to make this [code] more understandable and more human-friendly. So that was our research project. We succeeded in getting it funded, and once I did, I left the Laboratory, set up my own user-interface, information-design, and -visualization firm, Aaron Marcus and Associates, in 1982. We were one of the first computer-based graphic-design studios to exist in the world. I think there might be some others, but I don't know any that early. We operated out of my house in Berkeley, California. We had state-of-the-art equipment. State-of-the-art equipment in those days meant we had a vertical 300-dot-per-inch display screen. That is one-to-one with a laser printer! That was a Three Rivers--

Spicer: Called the PERQ.

Marcus: PERQ computer. You know. This is great. And the PERQ Accent operating system, running a Xerox laser printer. I can't remember the nomenclature for it, but it [the laser printer] was the size of a small refrigerator.

Spicer: They called it the Dover, the prototype, but I don't know if that was what you had.

Marcus: I don't think I know it under that name. So, in order to be able to print a letterhead piece of paper that shows your name and address, you needed a computer graphics system, a computer, and graphics software, that cost about $80,000, and the Xerox printer cost about $20,000. So, you needed about a hundred thousand dollars--

Spicer: In 1980.

Marcus: In 1982.

Spicer: '82, yeah.

Marcus: To print a letterhead sheet.

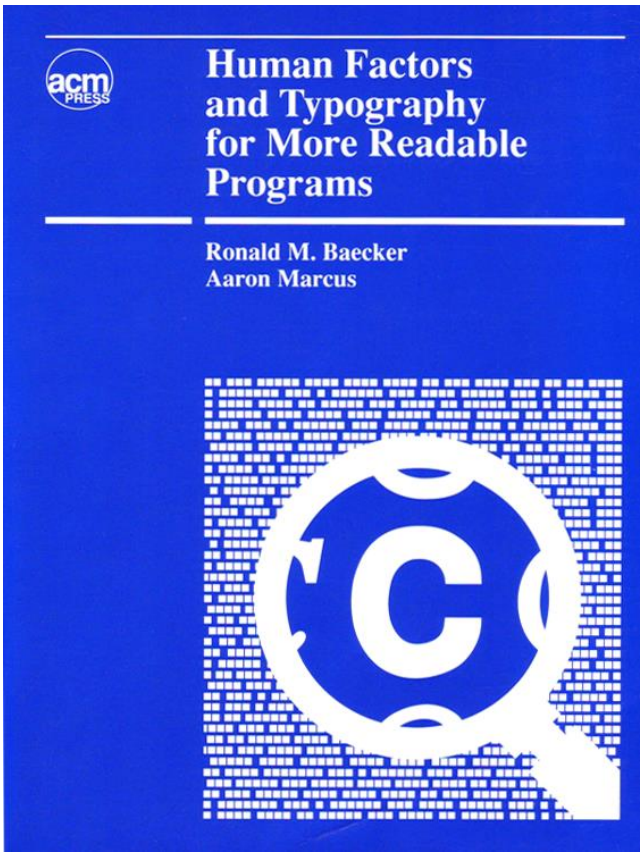
Spicer: <laughs> Wow.

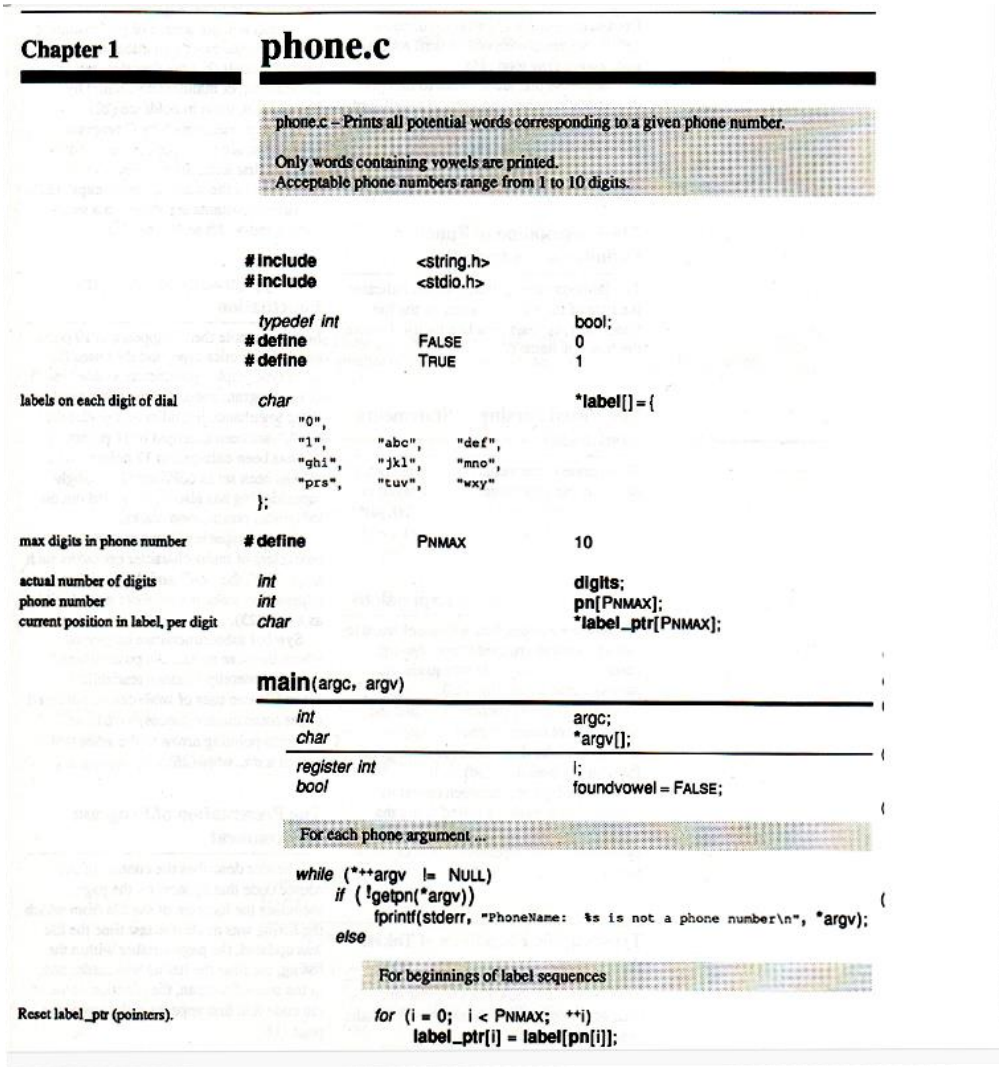
Marcus: And by the way, when we started, we had trouble finding any fonts for the Xerox printer. I wanted at least Times Roman and Helvetica. It was difficult but we eventually were able to get those fonts, and we began to produce prototype layouts of pages of C code, the likes of which had never been produced before in the history of the C programming language, nor programming in general, and I was using all of the skill that I and my associates-- one of them was Michael Arent, who I think was my first employee, and together with Bruce Browne, we started to do massive rounds of experimentation of how all of the tokens of the C programming language should appear, because you could change size, you could change regular to bold, Roman to italic, substitute some other special characters in order to group

all of the elements of an expression so that a reader could visually intuit what it meant more effectively, and we had ways to present comments in legible form on the same page with the code. It wasn't actually part of DARPA's requirements to test our solutions. It was Craig Fields, by the way, who ran our program at the time. He later became the head of the Microcomputer Technology Consortium (MCC) in Austin, Texas.

Spicer: Oh, yeah.

Marcus: I'll get to that in a moment, but he was, I think, originally an applied psychologist. I think, and he interestingly did not even want us to conduct experiments to prove that our designs were better. But I felt we should, so Ron and I arranged to have our new designs, which AM+A worked out, and Ron was able to implement into sort of an advanced pretty-printer program, but far beyond anything that any pretty-printer program had ever accomplished, and we showed that novice programmers improved their comprehension of code by 12 percent just by how the carbon dust was laid down on the page. No further training in C. No changes in the tokens of C. Just more legible, more readable presentation of code, and that is a big improvement. So, DARPA was happy with our work. We were the only program that was allowed to continue to the end. They killed all the others, I think, and Ron and I eventually published a book about our design-research called *Human Factors in Typography for More Readable Programs*, through Addison-Wesley.





Chapter 1

phone.c

```
/* phone.c - Prints all potential words corresponding to a given phone number.
 *
 * Only words containing vowels are printed.
 * Acceptable phone numbers range from 1 to 10 digits.
 */

#include      <string.h>
#include      <stdio.h>

typedef int                   bool;
#define       FALSE           0
#define       TRUE            1

/* labels on each digit of dial */
char                          *label[] = {
        "0",
        "1",      "abc",      "def",
        "ghi",    "jkl",      "mno",
        "prs",    "tuv",      "wxy"
};

/* max digits in phone number */
#define       PNMAX           10

/* actual number of digits */
int                           digits;
/* phone number */
int                           pn[PNMAX];
/* current position in label, per digit */
char                          *label_ptr[PNMAX];

main(argc, argv)
    int                       argc;
    char                      *argv[];
{
    register int              i;
    bool                      foundvowel = FALSE;

    /* For each phone argument ... */
    while (*++argv != NULL)
        if (!getpn(*argv))
            fprintf(stderr, "PhoneName:  %s is not a phone number\n", *argv);
        else {
            /* For beginnings of label sequences */
            /* Reset label_ptr (pointers). */
            for (i = 0; i < PNMAX; ++i)
                label_ptr[i] = label[pn[i]];
```

Figure 11: DARPA-supported research in improved presentation
of “The C Programming Language,”1982-85,
including book about the project published in 1990 by Addison-Wesley.

Spicer: Now, the traditional font for C is Courier; <laughs> is it not?

Marcus: Yes.

Spicer: It’s basically a typewriter font.

Marcus: That is correct, and you could choose, if you wanted, to have-- thank you for pointing that out. You could choose to have if you want certain things appearing in that font if it were necessary and appropriate, but we were actually using Helvetica and Times Roman to be able to group characters more

closely so you could see what was a constant and what was a variable, what groupings of parentheses were enclosing various tokens.

Spicer: I see, you know, I think what you did is you prefigured how an IDE works today, an integrated development environment, in the sense that, like, they will match parentheses for you and flag the related bits of code in different colors too ...

Marcus: That is correct. Only at the end did we experiment with color, because we were not actually conducting the research for a screen display.

Spicer: Right. Of course.

Marcus: We were doing it for [black-and-white] laser printer documentation of code. But much of our innovations could be transferred to any kind of screen display. So, that was a project which helped AM+A to get started as a business.

Spicer: Oh, terrific.

Marcus: And we were then busy. I was trying to learn what the possibilities were in the world of business amongst our clients, and eventually, over the next 30 years, we worked for almost every platform, almost every vertical market, for almost every kind of user group in the U.S., and also clients in South Korea, Japan, Europe and elsewhere, could provide. We helped to integrate all of Reuters' financial data display into a single screen instead of multiple screens, because people were being overwhelmed by all the data that could be displayed. We worked for CAD/CAM, computer-aided design and manufacturing engineering…CAE, computer-aided engineering. We worked for medical systems, for the National Institute of Health, for the human genome project at Lawrence Berkeley Laboratory in the depiction of genes. We worked for the U.S. Federal Reserve Bank, for three different branches of the U.S. Federal Reserve Bank, because the San Francisco branch was developing. <laughs>

It seems kind of amusing to remember this, that in 1994 to 2000, I think, during the time that we worked with the Fed, they were trying to create a more integrated computer-based system that could look at and manage the health of all 12,000 U.S. banks, or maybe it was 8,000. I forget. [The number varied between those two figures during those years.] They had no means to do that. They were using pieces of paper, faxed sheets of information, handwritten messages, things mailed, telephone calls, who knows what. It was not integrated at all! And you might think, "How could the United States have managed itself?" But that's the way hospitals were, also. And in some cases, still are.

In the case of the Fed, they had a project called AMY, A-M-Y. Maybe it stood for something, but I can't remember now. And we created a series of prototypes, demos, that we distribute and show, if necessary, I could show you a cleaned up version that's okay to depict. And we worked with their technical people to make sure that everything we showed was feasible for software tools about three years from then when we could not predict where the software tools would be. And lo and behold, three years later they built it. And then the U.S. Treasury Department saw this work and said, "Ooh! We want one of those, too! Can

you do that for us?" And so we started to have some discussions with the U.S. Treasury Department to improve the way all agencies of the U.S. Government are paid. And when we saw the spaghetti diagram of how this occurs, we were aghast. You know, the U.S. Park System employees have to be paid, and whatever other government agencies there are, all have to be kept track of and paid. So, based on what they showed us, we tried to figure out what would be a better, and hopefully suitable, way to depict the commands and the data elements that needed to be provided. And we made some computer generated sketches of what that would be like. Remember we had done no research to speak of, other than looking at the information they provided. This was not functioning software. It was not interactive. And they said, "Oh, I see, okay. Well, thank you very much, we'll get back to you." Well, good! We waited and waited and waited. And after a while I thought, "I really should check in with them. I don't know-- maybe they didn't like what we did and or maybe they've abandoned this plan." I didn't know. So I contacted the people and they said, "Oh! Thank you very much!" [And I said,] "Well, can we help you now to develop this system?" And they said, "Oops, no problem, no need. We already built it!" And I said, "You what?! You built this system based on our somewhat innocent and initial sketches?" "Oh, yeah, yeah! We took care of all of it, thanks very much! Great job! Good-bye!" <laughter>

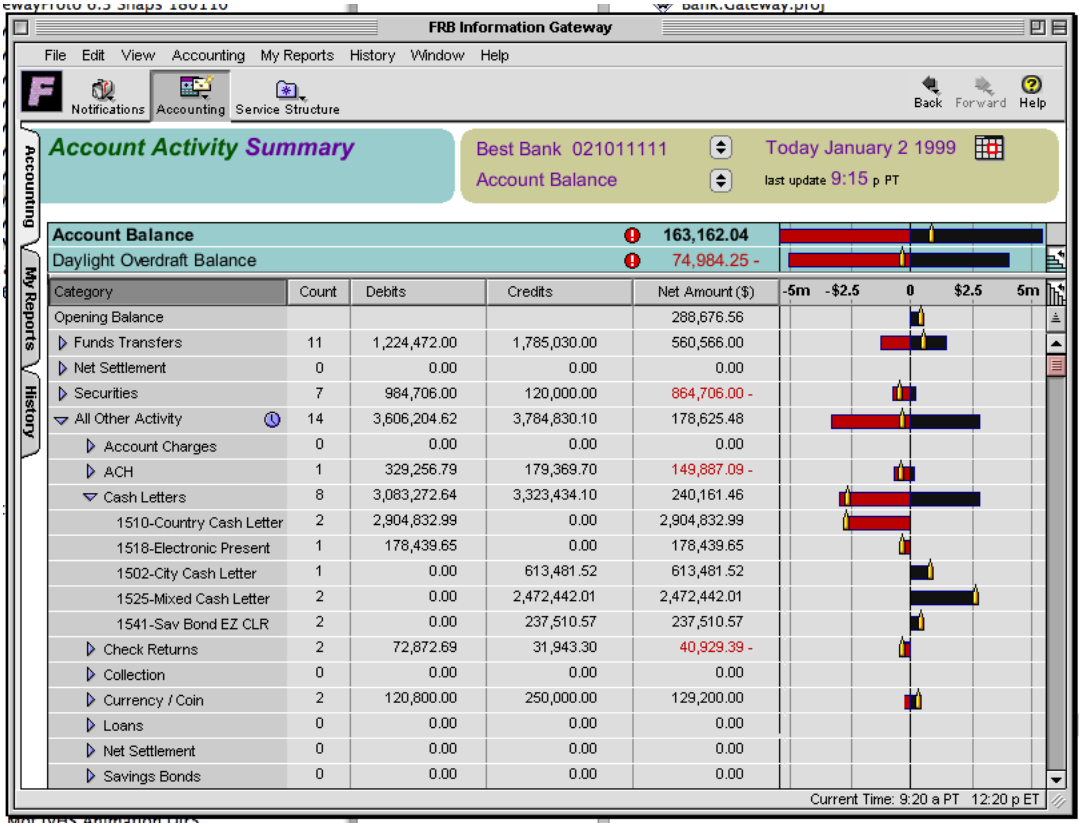


Figure 12: US Federal Reserve Bank, prototype re-designs of an advanced software program to help the Fed manage the status of all US Banks. Designs by AM+A, about 1997.

Spicer: That's great.

Marcus: So, in the annals of user-centered design, and proper design process, this was totally absurd! But that's what happened.

Spicer: So speaking of user-centered design, there's a programming style known as Visual Programming. I'm sure you know about where-- and correct me if I'm wrong-- but I think you start with the user interface, in that you build what the user will see first.

Marcus: Well, yes!

Spicer: And do you have any comment on that style of programming?

Marcus: Well, the fact is that is what we were doing for AMY. For the U.S. Federal Reserve Bank. Depicting all the major sequences of what you would need to see, and how pressing on this button would lead you to that screen. And to connect all those, you could create, as we did, interactive demos. In fact, at an early stage, very early in our history, we were using Macromedia Director to do that, at a time when no one knew about using Macromedia Director for user-interface design depiction.

Spicer: Now for Web-based things? Or is this--

Marcus: Oh, this was pre-Web.

Spicer: So how do you-- Director would run on a PC or something?

Marcus: Oh, excuse me, I should say that by January of 1985, yes, we were an all Macintosh office. We still had the Perq system and the Xerox laser printer, but that project had come to an end. The U.S. Government forgot about the equipment. We didn't know what to do with it because technically we didn't own it. And yet they had signed off and said good-bye to us. And we contacted someone in their Logistics [area] and they said, "We don't want to know about it. Do with it whatever you want." So we tried to contact UC/Berkeley, I think their Computer Science Department said, "Well, okay, we'll take it and see what we can do with it." It probably sat in their hallway until they threw it out.

And so this $100,000 piece of equipment, three years later, was worthless. And we knew about that, Apple Macintosh emerging. In fact, people from Apple's development team had contacted me asking me questions about chart, map, and diagram design. So, I sort of knew what they were planning to produce. And when it finally came out, we bought eight Macintoshes, networked, and a laser printer. And a gigantic external hard drive. We didn't know how we would ever fill it up with enough data. It was 20 megabytes. And it cost, I think, $10,000 in 1985. The eight Macintoshes-- I'm sorry, did I say eight? I think, yeah.

Spicer: Yeah, yeah.

Marcus: Were five-thousand-dollars apiece. That's $40,000, plus the network software and connections.

Spicer: Oh, yeah, that's a big expensive setup, for sure!

Marcus: It was! In fact, in Apple's first year, if you looked at their sales, we were a noticeable little blip.

Spicer: Really? <laughs>

Marcus: In their annual sales.

Spicer: Because they didn't sell many Macs in the beginning, you know?

Marcus: We bought them right at the beginning.

Spicer: Yeah.

Marcus: Because we knew that would be--

Spicer: Did you have color at this point? I don't think so.

Marcus: -- the future. No.

Spicer: No.

Marcus: Anyway, we became basically a Macintosh office, although we had PCs along the way for various purposes. And so, for a while, Apple was our client on several projects for their marketing department to depict all of their programs, marketing programs interactively. 1994 was the first time that any one of our clients came to us and said, "I think we need to hire you, because we need to design some new metaphors by which to depict this software." And I said, "Really? I've been writing about metaphors and semiotics. In fact, almost all that I've done as an artist and a graphic designer, visual designer, user-interface designer, I would cover under the umbrella term, "applied visual semiotics." Semiotics, the science of signs. And we were trying to invent new ways to put together sign communication to help people understand complex structures and processes. That's underneath what I mean by helping people to make smarter decisions faster. The way you can do that is if you present information to them in a way that makes sense to them. Assuming that you have rational people. But of course, not all people are rational.

Spicer: Another big proponent of visual design is Edward Tufte. Do you have any comments on his work?

Marcus: Well, I knew of him at Princeton where he taught when I was teaching there. I didn't have too much of an interaction with him. After I got out of Yale, I saw him produce his books. I especially thought the first and second book were very good. To my mind, he seemed to be a connoisseur of good visual

design, and that somehow IBM and others thought he knew about computer graphics and information display. Although, I don't think at the beginning he had that much experience.

But his tutorials were very well attended. His books were beautifully produced. I think, in general (he may have changed things, because I haven't had much contact with him in decades) he would say, "I know better. And this is good. That's bad. And this is very good. Follow my advice." I was taking a different approach. I had to deal in our clients with programmers every day, and I was trying to teach them in my tutorials how to discern bits and pieces of good design, bits and pieces of good typography, good layout, good color, good sequencing. And those were the subject matter of the components of my lectures and tutorials. And of our consulting with our clients. So, some of my staff took his workshops, and I know that he's been quite successful, and bankrolled his own house, re-mortgaging it, to pay for his books, because he wanted them to be published his way or the highway.

Spicer: Oh, I see. Right. I'd like to just ask a little bit about how much of what you do is dependent on human psychology, or human neurology, in the sense of the ways our brains work in the world.

Marcus: It's a good question. Certainly, much of our design work is based on basic principles of human perception. And some of those have been written about and talked about and taught since Wertheimer in 1923 published his principles of human perception. Similarity, proximity, *et cetera*, are all factors that exist in our retina and visual cortex that help us to understand visual phenomena. So, those were definitely part and parcel of the underlying principles or rules governing good decisions about what to do and how to structure information. I would say that as the years went by, certainly after 1999, I became more and more interested in cultural factors that also could influence people's understanding and decision-making. And I started to lecture and tutor about those. And to consult with our clients in how to, for example, for a library system software, to make American- or English-based software more suitable for use in Saudi Arabia by students and librarians of a school system. Companies were interested in porting products, and normalizing them… localizing them for a particular group. Usually that had meant changing the language [visible to the user] to be suitable, and there are techniques for doing that. But people had not spent so much time thinking about the imagery, about certain concepts or references that might or might not be appropriate for the target user community.

More recently, speaking of psychology, beginning-- well, it's been an interest of mine for decades, maybe going back to my first cartooning, and drawing Walt Disney images of Mickey Mouse. That [cartoon] character has gone through a lot of transformation to make it more appealing, more cute, more engaging. And that applies more and more to products and services that are designed in the early part of the 21st century. And so, I began to study with colleagues the principles of "cuteness"…what makes things cute. And what makes things cute in different cultures. And so, I published in 2017 *Cuteness Engineering: Designing Adorable Products and Services* through Springer. And invited colleagues from Japan and China-- who else? As well as myself and some others to write essays about what cuteness means in those cultures.

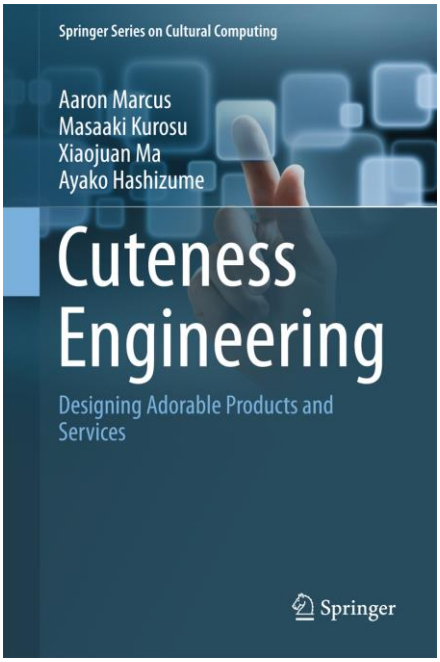


Figure 13: Cover of *Cuteness Engineering,* by Aaron Marcus *et al.,* Springer, 2017.

Spicer: I'm laughing, because I know the Japanese have a special word for that. Do you remember what it is[1]?

Marcus: Yes, I do. *Kawaii*.

Spicer: It's kind of like the Hello Kitty--

Marcus: Yes, yes, yes. No, we had-- oh, I know. We had the current manager of the design for Hello Kitty write an essay about the history of Hello Kitty.

Spicer: Oh, wow!

Marcus: Which appears in the book.

Spicer: Got to get this book. That's great.

Marcus: And [in the book, my co-authors added] a fascinating history of cuteness in Japan, and also a fascinating history of cuteness in China. They are not the same. They apply to different things; they apply to different age groups; they apply different terminology and artifacts that are designed. And there are

[1] [Editor's note] The word is Kawaii. Japanese: かわいらしさ

certain rules or principles that govern their use. But as products become more and more shipped around the world, and attempts are made to be certain that something designed in China is going to be acceptable in the U.S. and vice versa, people have to be-- professionals need to be, involved to help think out, govern, manage the design of what exactly is going to be shown or heard or smelled. All of it contributing to acceptability.

Spicer: And I guess the word "Engineering" in the title suggests that this is something that's carefully crafted and shaped and--

Marcus: I wanted to be somewhat provocative in the title.

Spicer: -- designed. Yeah. It's a wonderful title! <laughs>

Marcus: You wouldn't think you'd have to engineer cuteness. But in fact, it is done all the time.

Spicer: I get it! It's a wonderful title. <laughs> I just instantly laughed so hard when I saw that, and understood immediately what it was about. So that's wonderful.

Marcus: Let's see.

Spicer: Yeah, where are we?

Marcus: VISA, for seven years, we worked with divisions all over VISA to depict financial information better for their own professionals as well as end-users. Sometimes running into conflict with VISA's corporate marketing people who had their so-called VISA standards, but didn't know how to implement them in screens, and didn't know the limitations or how some of what they thought would be done, or should be done, was completely inappropriate.

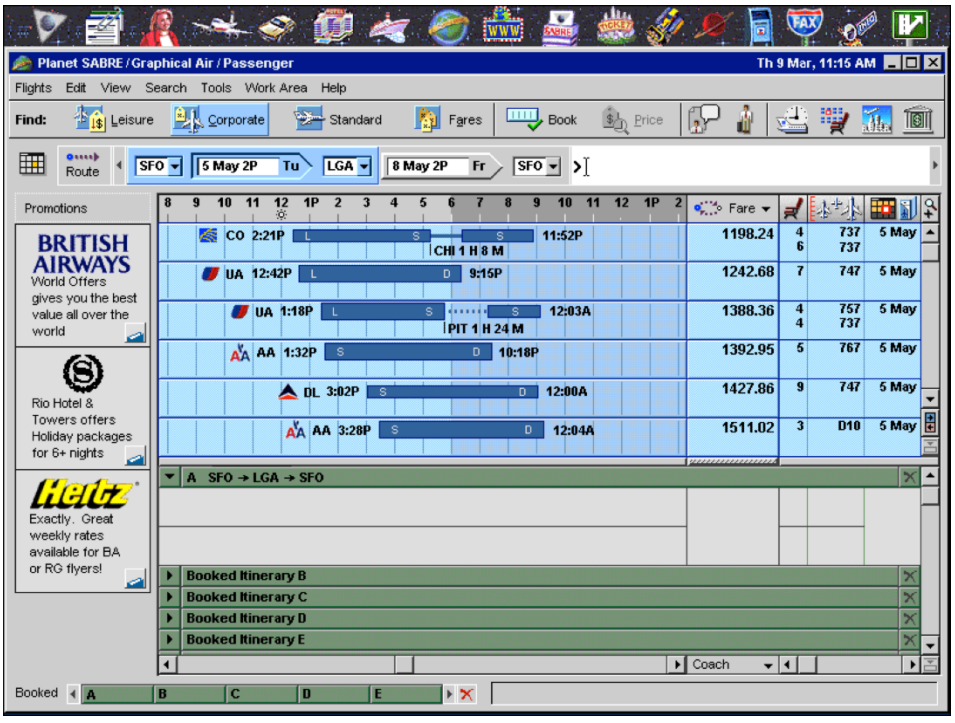
Spicer: Right.

Marcus: Oh, I was saying [earlier] that in 1994, the person who came to us to ask for metaphor design was a designer from Sabre, the arm of American Airlines that designed their reservation and ticket booking system. It was designed in about 1973, and they were coming to us in 1993, or '94. And we started a project which lasted many years for us to redesign the travel agents' access to all of Sabre data in a much more appealing way, much more visual way than ever before.

It was an enormously challenging project, satisfying project-- occasionally very frustrating-- but we were blessed with an incredible opportunity to re-design the entire approach something like 20 times and to have it tested. That isn't done normally in product development. No one takes that amount of time. We were trying to reduce errors and unanticipated actions by the user and improve satisfaction and engagement to whatever Sabre considered was an appropriate minimum. And eventually that was done. We then-- because Sabre-- the three key people from Sabre left and moved to Orbitz. We started to work with them, but then Orbitz and Sabre got into legal conflicts about, "You're stealing our trade secrets. You

can't do that," blah-blah-blah. We did not want to get caught in-between the arrows and spears of two groups of corporate lawyers, so we left both of them. We actually worked on the booking system for Virgin America, also.

Initial sign-on screen.



Graphical air booking screen.
Figure 14: Planet Sabre Screen designs, 1994-99, by AM+A.

In each of these vertical market areas, we've had a fair amount of in-depth experience across, as I say, multiple platforms of computers and display equipment. We've even worked on user-interface designs for personal super-computers.

Spicer: Can you tell me what machine that was?

Marcus: It was Stellar.

Spicer: Oh, Stellar! Yeah, okay!

Marcus: My gosh, you know all these names!

Spicer: Oh, yeah.

Marcus: That's great! Andy van Dam at Brown University's Computer Science Department was key to our being able to work on that project.

Spicer: Next up: I wanted to ask you a couple of things.

Marcus: Sure!

Spicer: One is it seems like for a lot of your career, at least with your company, you've been helping people transition to screens.

Marcus: From more textual screens to graphic screens.

Spicer: And mobile, the whole mobile revolution, probably.

Marcus: And from large screens, also mobile. In 1997 we tutored Samsung employees from almost every division of their company in advanced user interface design, including mobile. There were people in my tutorial who were designing control panels for nuclear reactors, and microwave ovens, and cameras, and telephones, and who knows what else?

Spicer: That's fascinating!

Marcus: It stopped suddenly because in 1997… We didn't finish all of our training, because during that time the South Korean *won* collapsed, and lost half its value. Suddenly, we were twice as expensive and they couldn't afford us, and they said, "Bye-bye!" which was unfortunate for us. But in the year 2000, a group returned to us to say, "Could you help us design ideas for improved versions of Samsung smartphones to be introduced into the U.S. three years from now?" We said, "Sure!" So we produced an idea book of about 50 or 100 concepts, including ones that were very much like the iPhone, about seven years before the iPhone was ever introduced: with large screens, touch sensitive, full range of display. We turned over all of our ideas to Samsung. We lost control of everything, and we were only dealing with

the user interface design group; then they fed the designs to the engineering and marketing groups and others to decide what should be done. We also worked with Nokia over a period of maybe ten years.

Figure 15: Samsung mobile user-interface designs, 2000.

Spicer: Wow!

Marcus: I tutored many Nokia people in Finland. We worked-- we even produced … Nokia had done an incredible amount of research in user interface design for their products, and they were very good. And [they] produced a book published, I think, by McGraw-Hill about the Nokia “religion” of user-interface design. And the head of all design hired us to create a set of slides that would introduce to third party software developers around the world what the Nokia “religion” was. And we designed those.

Amazingly, they even let us brand at the bottom that it was Nokia, and also AM+A, that was presenting this information, which is rare. And we had a good relation. And in 2005, we even worked with the Nokia Advanced Product Development Group in London to envision future Nokia designs. We had access to all of Nokia's strategic product development. Of course, around that time, Nokia was beginning its decline. Samsung was becoming stronger all the time. And of course, the iPhone had been introduced in 2007.

Spicer: Right. The other thing I wanted to ask you was you have been helping people understand the information displayed to them from the days of the command line, just text on the screen--

Marcus: True. True, true.

Spicer: -- to the GUI, and I'd love to hear your thoughts on the advantages and disadvantages of both, and if what do you think about the current, let's say, Mac OS and Windows [operating system] as an instantiation of a great--

Marcus: There are still things about the iPhone's iOS, the operating system of Apple's, that irk me, and so also for OS, the operating system of the Apple MacBook Pro. Other systems have certainly improved, Microsoft's and Google's. I was just looking recently at Google's display advice, and it seemed so well-designed, because they had major text elements quite large, so you could easily see them at a quick glance, and they were showing the right things to guide people. And I thought, "Whoa! Someone has finally really learned their lessons about how to give information to people who need to see it quickly under stress, distracted, *et cetera*, which is about how most phone information is portrayed."

Spicer: Yes, right.

Marcus: Let's face it. And I certainly feel the same thing: that in desktop use, sometimes graphical user interfaces are not helpful at all. They just make people have to move their hands around to do things, where line commands, textual interactions are far faster, more efficient, more beloved by the people who have to do a lot of dedicated work. Frankly, I love icons, but I'm quite happy if my fingers can do command interactions to get some things done, so that I don't have to go poking around a screen, which I consider a waste of time. And that's true of a lot of dedicated professionals. So, the graphical user interface was introduced for the rest of us, for novices and intermediate users, and that's its orientation. There are still people who love Unix. <laughs> And I thought Unix was pretty great for all of the things that you could do. Multiple buffers that most operating systems don't have. And I remember-- do you remember the Be Operating System [BeOS]?

Spicer: Yes.

Marcus: It was incredible, because users could re-arrange what clumps of information might be displayed in the equivalent of a finder screen, so that you could see characteristics of data files that would be important for you, and that could be reconfigured personally for any kind of user. And in some cases, they are somewhat bizarre for different uses. And it would be easy to do that. It's not so easy with all of the fixed conventions, say, of the Macintosh Finder, or Windows screens.

Spicer: How about NeXT? Did you ever--

Marcus: Work with NeXT?

Spicer: Did you ever work with them, or interact at all?

Marcus: I knew about them, we had all the guidelines of most of the operating systems. In fact, one of the books we produced in 1994, I can't remember the date of NeXT being introduced.

Spicer: That seems about right.

Marcus: We began a project for one of our clients to compare all the operating systems of all the GUIs. They had never been compared before.

Spicer: That's great.

Marcus: And we published that as "The Cross-GUI Handbook." I'm trying to remember who published it now. It's on my shelf. I can sort of see it. And it wasn't-- was it Addison Wesley? I can't remember, I'm embarrassed to say.

Spicer: Oh, that's okay.

Marcus: And our client provided two co-authors [Nick Smilonich and Lynne Thompson]. We studied in detail all of the widgets of all of the major GUIs. If you recall at that time there was Motif, Open Look, Apple, Windows, and NeXT. And we listed out all of the widgets, all of their characteristics, cross-compared them, as to what they were called and what they did, so that if you were porting from one system to another, you would have some idea of what was appropriate to do. And that was the first time that anyone had ever produced such a cross-comparison. Maybe there are others now, but at that time there were [none]--

Spicer: How did they compare in terms of how much were they alike?

Marcus: Well, I don't know how to say this. In many cases, they were quite similar. But in other cases, they were very different. They all had to depict radio buttons and checkboxes. Those might be depicted in the same way. But the particular use of window scroll-bars or other specific widgets that accomplished complex functions, those might differ radically from one operating system to another. That reminds me that I was present when Don Norman gave a talk at, I suppose at an early CHI [Computer-Human Interaction] conference, discussing the latest debates about whether when you [wanted to move downward within a window] on a user interface, should scroll bar scroll up or down? Because there was no standard at the time. It had to be--

Spicer: Now the iPhone lets you choose. <laughs>

Marcus: -- debated as a convention.

Spicer: They punted on the issue and just let you choose it.

Marcus: Then it became fixed, and now more recently, you can do whatever you want.

Spicer: Yeah, that's funny. Can you draw any connections between the increasing computing power that we've lived through, and how that's affected your work?

Marcus: Well, Moore's Law means that there are more and more functions and more and more data available, presumably at lower cost and with faster means of production than ever before. That has led to several things. One, almost all users are used as guinea pigs. Almost all products are released before they're actually finished. They are finished by getting some feedback from users who complained about things and then some adjustments can be made. I don't know about you, but I'm inundated with requests

to, "Just take 30 seconds to evaluate how your experience was with your last Uber driver," or, "Your last piece of software," or, "Your last taste of toothpaste."

Spicer: Yeah.

Marcus: We have all been turned into feedback slaves. We're not paid-- we're not given money for that. In the old days, some people had to be paid to be recruited and used for feedback and dedicated time was given to their interrogation and analysis of results. I'm sure that's still done, but more and more we see people have slipped into an assumption that all of the users are available all of the time for no payment at all, and no concern for interrupting their lives, "So you can improve your experience with our product and/or service."

Spicer: Right.

Marcus: So that's somewhat annoying and a dilemma for consumers as well as producers of products and services. It also means changes are coming all the time. You don't wait one year before Version 2.0, or between Version 13 to 14. And it's a never-ending series of versions that require some amount of education to get used to changes and awareness of what the changes are and what impact they might have on one's life and use of the product. I know in my own case, and I've heard from colleagues, that it's best to avoid installing all improvements at least until Version 13.2 or .3 or .4.

Spicer: Oh, yes, yes.

Marcus: Because they don't want to be unwitting guinea pigs to suffer whatever wasn't finished for 13.0.

Spicer: Yeah, okay.

Marcus: Another general problem is that we are, as I predicted 40 years ago, we are inundated with more and more information that we have to somehow accumulate, understand, make decisions about. And it is sometimes possible, but often not available, [by] any means to have that curated or prepared for us as though we were an expensive valuable executive, who used to have this done for him or her all the time. We are all now turned into unpaid executives given insufficient information summaries.

Spicer: I'm glad you brought that up, because it's something I was literally on the verge of asking you, which is the role of information overload, which people as far back as Alvin Toffler in "Future Shock," [wrote about] and I'm sure [appears] in your own writings.

Marcus: I certainly talked about it in 1981, if not earlier.

Spicer: That we would have far too much information to even neurologically process. And what can you do to help people feel less overwhelmed with information?

Marcus: Well, to the extent that I can inform and *persuade*, … which, by the way, I haven't touched much about persuasion design in all of this, B.J. Fogg's work, as well as other people's.

Spicer: Feel free to discuss that, if you'd like.

Marcus: I digress for a second to say that in 2007, I first attended the Persuasive Technologies Conference, which happened to be held at Stanford [University], and was very impressed by the efforts that people had made with PC platforms in general, not so much Macintosh, and certainly not mobile phones at the time, to improve people's behavior by using the technology to persuade people to change their habits? To smoke less, to eat more nutritiously, to take their medicines. And to do other things in their [daily] routines, which were for their own good and recommended by doctors, and the PC's software and systems would enable them to accomplish that objective. And I thought, "Wow, that's really very benign and very humane, and a good use of technology."

So about 2009, two years later, I had started a series of mobile design projects, in which I used interns to help design future concepts for mobile software that would persuade users to change their behavior, because we knew about the techniques of behavior change. And we applied them to, in the first case, energy conservation. How could you get people to be more energy conscious and to remember to turn out the lights? And to use products appropriately that would not waste natural resources? That was called the-- good heavens, what was it called? Not the Energy Machine-- the Green Machine. The Green Machine.

Spicer: Yes, right.

Marcus: In 2009. And people at SAP saw that [project], learned about it through my friends and contacts at SAP. We were invited to work with SAP to incorporate those principles into actual enterprise software that would encourage people in corporations to be more energy efficient. We went on to design mobile versions of the Green Machine, the Health Machine, the Learning Machine, even the Innovation Machine, which taught every corporate person to be more innovative using known techniques and persuading them to carry out their projects of innovation more effectively. [We also designed] The Marriage Machine and the Happiness Machine! There are theories of happiness.

Spicer: I'd like the Happiness Machine. Can I order a copy? <laughs> It's okay, I'll order it. I'll get it online.

Marcus: I don't remember where I put them. I had prepared myself with this. Well, excuse me. So there are a series of [things that create or promote] happiness, and we studied the basic techniques, many of them overlap. Many of them are incorporated into religions of the world.

Spicer: Right.

Marcus: And we tried to show how if you carried out these techniques, like journaling, keeping track of what's good that's happened, not only what's bad; by helping others (doing good deeds creates

endorphins)-- and by the way, we're speaking of long-term happiness, not short-term [happiness, the kind you get from sugar and other chemicals--

Spicer: Stimulants. Yep.

Marcus: -- that give you a real buzz for a short while and then you collapse. The long-term happiness objectives of the Happiness Machine are sustainable and can be carried out over long periods of time. So that was a series of ten projects that we produced over a period of four or five years. We published all of them, and several of them won design awards. We never produced commercial products from them, because that's too much effort. We didn't have the time… we only had three months to produce anything with a given set of interns. And so we went in… we studied the material and we created concept designs. Fake screens that would show what it would be like, and we gave that information away to anyone who wanted to try to build something.

Green Machine: Energy conservation behavior change.

Health Machine: Nutrition and exercise behavior change.

Happiness Machine: Long-term happiness behavior change.

Figure 16. Machine persuasion-design UI projects, 2009-14.

So that was, I forget, we were discussing something, and I happened to think of persuasion design and our mobile persuasion design projects, and we published them all in a book called *Mobile Persuasion Design* published by Springer. Now I think you asked me another question earlier, which I got sidetracked on. Let me see if I can retrieve it.

Spicer: That was: How can what you do with information design help us feel a little less overwhelmed?

Marcus: Oh, well, what we did, even in the mobile persuasion design projects, is try to give the right amount of information in the right form at the right time. And to do that, you need to know your [audience] pretty well, as well as the subject matter and the use context, and if so, you can create curated versions of information, which are well designed for use at a particular moment in time.

Spicer: With a good signal-to-noise ratio.

Marcus: In effect, this is an invitation to AI and learning engines, which can construct such things. I can only say that behind mobile persuasion design projects, and behind what I just described, one also has to have a good ethical basis for decision-making.

Spicer: Hmm, of course, yeah.

Marcus: Because what I've just described could be used to corrupt people more effectively than ever before! In fact, the complaints about Russian intervention in the 2016 election are forms of, "Giving people exactly the right thing, only for *my* reasons, not for their needs."

Spicer: Right, right.

Marcus: So I've just described what needs to be done, and you can see a bad version of that in the Ukrainian hackers and sources of data infiltration, which I just heard about on NPR were tested in Somalia? Or tested in Borneo? Somewhere unusual, before they were tried out a second and third time in Europe and the US. They perfected the techniques.

Spicer: And the technique is what? Brainwashing? Or propaganda?

Marcus: No, of inserting, of knowing quite well how to change people's behavior and attitudes, in effect, change their lives.

Spicer: With social media?

Marcus: Through social media, yes, for sure. And it doesn't even require that the nation be very highly developed in social media. They were using an example of the technique supplied to Northern Nigeria, where the people were very conservative, didn't have the technology, but as soon as someone who had learned about the bad information started talking about it on television or through radio or other means, started influencing other people to think the same way.

Spicer: Right.

Marcus: So you asked a very telling and powerful question, how can we help people get a better sample of the news, or of information in order to make good decisions? There are techniques to do that, and whoever is doing it has to be looked at carefully to make sure it's not gone awry.

Spicer: I think your work is more important than ever, it's just so germane today. There was a study yesterday in *The New York Times* of five- or six-thousand high school students to test their internet literacy, and it was appalling. They could not distinguish between true and false.

Marcus: Oh, oh, oh, yes. I didn't see that one, but I've seen other studies--

Spicer: It's connected--

Marcus: -- that show that people cannot-- well, it's going to get worse with deep fake photos and videos which people, in general, will not be able to distinguish from reality, and it is amazing that you can create a young Robert De Niro.

Spicer: Oh, yes, right. <laughs>

Marcus: And Joe Pesci. With facial depiction, and that the Chinese are building a database of 1.4 billion faces of people. These are awesome constructions of technology and we're right back to that question we asked earlier in the 1950s, "Is this for good or for bad?" It will always be there. And it is a blessing that we have people challenging any blind acceptance, or assumption that all technology is good.

Spicer: Perfect. Thank you, Aaron.

END OF THE INTERVIEW

