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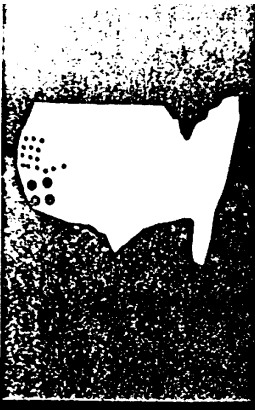
Macintosh



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7 pages

Macintosh's Other Designers

BYTE
Aug. 1984

Three original
designers
discuss the
earliest days

BY JOHN MARKOFF
AND EZRA SHAPIRO

The Apple Macintosh computer has attracted so much attention that it's curious so little has appeared on the formative days of the development project. To set the record straight, BYTE West Coast Editors John Markoff and Ezra Shapiro interviewed three of the original members of the Macintosh design team: Jef Raskin, Bud Tribble, and Brian Howard. (The fourth member was hardware designer Burrell Smith.) Two of the three left Apple before the Macintosh was introduced; Tribble switched to a new career in medicine, and Raskin started his own company, Information Appliance Inc., in Palo Alto, California. However, their recollections of the development effort provide an interesting perspective on the Macintosh as a product.

BYTE: We thought we could start by asking each of you to introduce yourselves and to tell about your role in the Macintosh project.

HOWARD: I'm Brian Howard, and I joined the Macintosh project almost in its infancy to help out with documentation and publications for it. Since it turned out that there wasn't much to write about in the early days, I started to help Burrell Smith build all the original prototypes and to document the hardware, and I more or less stayed on in the hardware vein. TRIBBLE: My name is Bud Tribble or Guy Tribble, depending on what city you know me in. I knew people at Apple for a long time, Jef [Raskin] before Apple, and Bill Atkinson down at UCSD. I heard from Jef that he was working on a new project at Apple; specifically, he was starting up a research section at Apple, and that he had some interesting ideas for making a computer that was different from what had been on the market previously. Since I was interested, I came down and talked to him. He showed me a big notebook that was the *Macintosh Document*, which had been worked on by Brian and Jef.

BYTE: What year was it?

TRIBBLE: I think it was 1980.

RASKIN: Sounds about right. We already had the *Book of Macintosh* at that time—400 pages.

TRIBBLE: And it was an extensive description of a cheap, user-friendly machine that went beyond what was the state of the art then (the Apple II) in terms of a personal computer. I

got so excited that I told the program I was in at school—a fairly prolonged M.D. program with a Ph.D. in neurophysiology—that I wanted to take a year off, or maybe more. Finally they let me take the year off with the option of going back.

When I got here Jef's group was made up of Jef, Brian, myself, and Burrell Smith. I think Joanna [Hoffman] joined just after I did.

Burrell had already mocked up a Macintosh computer. It consisted of a 6809 processor, 64K bytes of memory, and a screen linked to an Apple II, and you could download programs into it. Jef had written down his extensive ideas about what it should look like in the end and some ideas about user interface. My first order of business was to just get this thing to be able to assemble and cross-assemble on the Apple II, to get a basic BIOS or operating system up on the machine, and also to worry about other kinds of things—whether it should have a modem, include serial interfaces, and what kind of mass-storage device it should have.

I was very impressed with the amount of work already done, before even having a machine, in deciding on a philosophy for the machine. I was also impressed with the caliber of that core group, especially Burrell.

BYTE: Who put the *Book of Macintosh* together?

RASKIN: I think I wrote almost all of it. Macintosh started out as my dream of what a personal computer might be. I was already thinking about it at UC San Diego back in the early seventies when I developed the "flow language," a language that was so simple that it had no error messages at all; it was impossible for a user to make a syntactic or semantic mistake. Students loved learning programming on it. Working on that and other projects had taught me that one could do things more simply than had been done and that computers had a long way to go before they were pleasant to use.

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BYTE WEST COAST

What I wanted with Macintosh was a low price. I wanted it to be all in one piece with no connecting cables, a minimum number of parts, and a minimum number of interconnects so that it would be highly reliable. Brian and I built many cardboard models and did dozens of drawings. So if the fact that it's two pieces is one of the great success factors, it's certainly not from something that I can take any credit for. I also wanted it to have a monochromatic screen that could be bit-mapped, rather than a character generator.

As a matter of fact, when I started working at Apple, the Lisa was a character-generator machine and I was the only voice saying it should be bit-mapped, and I convinced the crew working on it. I guess I was also this disembodied voice that changed it from a three-button mouse to a one-button mouse at Apple—that was a big fight.

Macintosh was started very close to the time Lisa was. Two totally separate tracks.

BYTE: *Two separate philosophies?*

HOWARD: Actually, I think Lisa had been worked on in some form for almost a year.

RASKIN: But it was a very different machine then.

HOWARD: It was going to be a bit-slice piece of hardware. They were going to do a Pascal p-machine chip set.

TRIBBLE: Since Jef was on the initial user-interface committee for Lisa, he was putting in his ideas, and at the same time he was managing the initial Macintosh project.

RASKIN: One thing I strongly believed was that Lisa was much too large and expensive a machine for a company of Apple's style and type. Lisa was definitely headed toward the business market, and I thought that it was a severe mistake to make a machine that would, in price and capability, compete head-on with Wang, DEC, IBM, and DG.

BYTE: *As a researcher, did you have an input into those marketing questions?*

RASKIN: I never hesitated to speak my mind.

HOWARD: Also, "researcher" was partly a title that was created to explain that there wasn't a production item related to his ideas.

BYTE: *Let's take a popular myth and tell me to what degree it's wrong. The myth is that Lisa*



Photo 1: Brian Howard

and Macintosh technology come in some sort of straight line from inside the corporate sanctum of Xerox PARC [Palo Alto Research Center].

RASKIN: Yes and no. I always thought that Babbage and Turing and Van Neumann hadn't gone quite far enough in generalizing the idea of a computer. I remember clearly enunciated—sort of the Turing principle—that memory could hold anything. A symbol is a symbol and you can interpret it in different ways. But then at PARC they had cleverly gone on to generalizing the screen. Any point is the same way as any other point. Characters just happen to be one kind of picture we can generate. The keyboard is the same way.

One of my first thoughts was that Macintosh should be the most absolutely general machine that you could conceive at that price, so that you could do anything on it you could do with any machine with that amount of hardware.

I tried for over a year to get Steve Jobs to see what they were doing at PARC because I felt that they were at least seven years ahead of their time. They had the Altos going then, with bit-mapped keyboards and screens. You could do anything you wanted on them. They also had the mouse on it. Although I couldn't stand the mouse, I was the only person at Apple who had even seen one, and certainly the only person who had ever used one. Finally Steve Jobs, Bill Atkinson, and a few others went to Xerox PARC and came back enthused.

BYTE: *What's the other side? In what sense is Macintosh a departure from what was being done and thought of at PARC?*

RASKIN: Theirs was all based on Smalltalk and had a different model of what the user interface would look like. I thought they had a lot of good ideas.

The difference between Apple and PARC is that Apple was designing things to be sold in large quantities and PARC designs things to play with. While they weren't concerned with questions of production, I very much was.

BYTE: *Why did you initially settle on the 6809 microprocessor?*

RASKIN: It's a very pleasant microprocessor. It seemed like it would be available in great abundance. It's much, much cleaner, and it doesn't segment memory into 256K-byte parcels.

TRIBBLE: Bill Atkinson was heavily involved with developing QuickDraw and working on the Lisa project. While I was working on the 6809, writing software to run on a bit-mapped screen, he was developing this neat bit-blit software to do characters and graphics on the Lisa screen on the 68000.

I realized that in terms of the cost of the machine, the microprocessor is a small percentage; it didn't make sense to limit ourselves to the 6809, and if we could use the 68000, we [also] could take advantage of a large portion of the software that was out for Lisa. I was thinking of lower-level things like the QuickDraw software. This represented a major investment; I didn't want to do it over again for the 6809.

I also figured out that the project simply could not be done fast enough on a 6809. I got together with Burrell Smith and said, "Can you hook up a machine with only 64K bytes of memory," which is what the Macintosh was supposed to have then, "and run with the 68000?" That was kind of a trick because 64K bytes done on a 64K-bit chip is only 8 bits wide and the data bus on the 68000 is 16 bits wide. It required multiplexing and demultiplexing, while at the same time trying to keep chip counts to a minimum. Burrell Smith came up with a design that did all the timing and did the multiplexing and demultiplexing in a minimalist type of way.

Burrell did nonstop wire wrapping, and I wrote programs on the Apple II to emulate the timing that Burrell was

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BYTE WEST COAST

programming into the programmable-array logic chips. And at the end of four days, we had a board with the 68000, 64K bytes of memory, and a bit-mapped screen and keyboard up and running the QuickDraw software. At that point we went to Steve [Jobs] with the working model, and he said, "Okay. Let's do it this way."

RASKIN: I was against the 68000 at first because I wanted a low-priced machine and the 68000 would bump up the cost. Burrell and Bud convinced me that the 68000 was the way to go, especially because of the software. It was clear that we could never catch up on the work that Bill had done.

BYTE: *What's the history of the Mac mouse?*

RASKIN: Jobs gets a hundred percent credit for insisting that a mouse be on the Mac.

HOWARD: When we chose the 68000, we did it partly so that we could use the low-level graphics routines and so on. Then the question starting coming up whether we also wanted to make use of the user interface as defined for the Lisa or maybe some parts of it. At some point, if you take enough of it, then the mouse has to come with it because that's definitely designed into the user interface in the Lisa.

RASKIN: I wasn't too antagonistic toward using the Lisa user interface, since I had had a strong hand in that. It had many of the features that I wanted.

To give a little history, I had a conversation with Mike Markulla long before this about wanting to make a low-priced machine. A concept called "Annie" was developing then, and he said, "Can you design a machine to sell for \$500?" I came back a week later and said, "Not one that would really be functional, but I can design one to be sold for \$1000." I didn't like the names Annie or Lisa—that is a sexist kind of approach—so I proposed that Apple name projects after varieties of apples, and I called mine Macintosh.

HOWARD: Sort of a fruitist attitude.

RASKIN: Steve Jobs had named the company Apple so you get started off on a fruit image. There was a Pippin for a while and some other internal apple names.

After Steve Jobs got stronger on the project, he kept edging it toward a more expensive machine. That was the main



Photo 2: Bud Tribble

reason I didn't want the 68000, because there was no way I could have met the charter of a \$1000 machine. It's my opinion to this day that if we had built such a machine it would have been dynamite because no one was even thinking in that price range with that kind of capability.

I happen to enjoy the 68000 far better than the 6809. It's a nice processor to work with. And they're both nicer than the ancient 6502. But as we started making those changes, the price started escalating very rapidly.

TRIBBLE: It was a domino effect. After the 68000, we started talking about putting on a mass-storage device that would be more commensurate with that—a more expensive disk drive.

BYTE: *You originally had started with a 5¼-inch drive.*

TRIBBLE: Before that there was going to be a small tape drive and that drove the price up. The screen went from a 256- by 256-pixel screen up to an intermediate screen and finally to where it is now. The memory started out at 64K bytes, but all of a sudden we got QuickDraw, which was 20K bytes, and all this Lisa software and extra pieces lying around. So the ROM [read-only memory] went from 4K bytes to 64K bytes in steps. And the price of the machine went up with that. The RAM [random-access read/write memory] went from 64K bytes to 128K bytes eventually. The keyboard became detached, which also drove up the price of the machine.

All of these things were edging the design, and the price, closer to Lisa. I think Jef was reacting against the danger of pricing the machine out of people's reach. I take some of the blame for going along with a lot of these changes because I was closely allied with Bill Atkinson, who was working on Lisa, and we thought along the same lines. The other thing is that I was, and still am, a technological junkie and like fancier bits in my computer. Not that I didn't have an appreciation for Jef's idea for a computer that people could afford.

BYTE: *Is that the central tension in the design process of Macintosh?*

HOWARD: That's a tension in any design in any project. Especially with a hardware group, there is always a tendency to use chips that are a little bit more on the leading edge of what's possible, to run things just a little bit faster, and to get a little bit more resolution out of the screen. Without strong direction from above, all projects have that tendency to float upward on the scale.

It's a little misleading now [to think that we thought] Macintosh could be sold profitably at \$1000, but partly that's because it's taken about three years to get it out on the market. Three years ago, the price differential was much more astounding that it is now. Of course, the price of all those chips has dropped dramatically since we were working with them originally.

BYTE: *Is Burrell Smith as unusual a hardware designer as we have heard by reputation?*

RASKIN: I think he is very, very good. Bill Atkinson thought he had a great deal of talent. I talked to Burrell and decided he was as good a digital designer as I had ever met.

TRIBBLE: My orientation was more toward software. But I found it extremely easy to communicate with Burrell, and part of that was that the turnaround time with Burrell for trying out new hardware ideas was like the turnaround time I was used to for trying out new software. He would do it overnight. If I came up with an idea from the software standpoint and said to Burrell, "Wouldn't it be nice if we had this in the hardware?", he would come back the next day and say, "We can do that if you make this slight change in the software." In a very short time, we would get the whole thing going.

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BYTE WEST COAST

RASKIN: That is one thing that I was pushing for very hard—the interaction of hardware and software. You don't build a hardware box just to suit some hardware engineer and then try to cram software into it. You design your hardware to support the software, you design the software to put the two together, and they grow together.

HOWARD: The constant interaction was one of the most fun things about the early Macintosh project in general. No decision was made by any one person and handed down to somebody else. The original Mac room was one big room—any discussion that took place involved everybody in the room. Even after we moved, constant group meetings coalesced everywhere. People would run in, and help shape the idea.

RASKIN: I tried to keep the spirit of the group, and also my personal spirit, very playful. We were always playing music and frisbee, and shooting dart guns.

BYTE: *To what extent was Macintosh in the early days influenced by the Apple III experience?*

RASKIN: Tremendously—to get as far away from it as possible!

HOWARD: The team size was definitely reinforced by the Apple III. It was clear that a large team would tend to go off in the direction of writing mountainous amounts of code and things that were not well focused. That was part of our incentive for keeping the group small.

BYTE: *Back in the days of the Book of Macintosh, was Macintosh a closed system in the sense that the outside world wouldn't have easy access to the bus?*

RASKIN: No. I believed in having a bus brought out on an edge connector.

BYTE: *What happened?*

TRIBBLE: Rod Holt, who was involved with the analog design [and who was] doing the FCC certification on the Apple II, kept bringing up the point that if you bring out an 8-MHz, or whatever, bus to the outside world you're in trouble. I retrenched and said that what we needed were fingers to come out that could be used for testing purposes.

RASKIN: As a matter of fact, in the original Macintosh specification it was called the Bus Diagnostic Port. That was part of the original definition.

TRIBBLE: Then Rod said, "If we put in a knock-out plastic port, the FCC is going to say 'Obviously you are inviting people to knock that out, and we're not



Photo 3: Jef Raskin

going to certify you." I think he was being a little paranoid.

It came to pass that there was no way to get into the Macintosh at bus speeds. But I went through Burrell's hardware manuals and found a serial chip that could run at 1 megahertz, which was the SCC chip. So I said to Burrell, "You've got to design this thing in." I think it's adequate. What I was worried about was not having enough bandwidth to talk to a hard disk or a network.

BYTE: *Do you think you've got it?*

TRIBBLE: I think we've got it. The bandwidth on most Winchester disks is a few megahertz. The bits come streaming out of the disk at a few megahertz, and with the SCC chip we can go in at close to 1 megahertz. We lose a small factor there, but most of the wait time on the hard disk is head motion anyway.

RASKIN: If you can get at the bus itself you have so much more control. I still think it was a mistake to not put those fingers there, even behind a hidden port.

HOWARD: Just putting in fingers doesn't come for free, though. As soon as you say it's okay for the outside world to start hanging junk on your high-frequency signals, you have to somehow isolate yourself from what they do—enough so that your machine will still work with things hanging out there. You have to take all that into account.

RASKIN: I still think you should put it on, call it a diagnostic, and use it for diagnosis. You take no responsibility because it's not a user part, but if some OEM wants to use your board or your machine and take that responsibility,

that's okay. I didn't see it as something that a user would casually plug into.

TRIBBLE: I ended up leaning toward a more closed system because, as software manager, it became appealing to me to have every single one of the machines that were out there all exactly the same. If software ran on one machine, it would run on all the others. I didn't want a big proliferation of weird addresses on the bus so that if you access them with such and such hooked up it would do something funny.

BYTE: *The story of the IBM PC.*

RASKIN: The story of the Apple II.

BYTE: *One thing that surprised people. I think, when Mac was first introduced, was that it only had one disk drive.*

RASKIN: I know why there was [only] one originally. When I was there, the software was designed to work with one. But after you have the typical Lisa kind of software on it, it definitely needs more than one. Having first made the choice of putting that software in, certainly I would have put in two disk drives. It's not very convenient to use with just one.

BYTE: *Who came up with the idea of a detachable keyboard?*

RASKIN: I think Jobs.

BYTE: *What are your feelings about that?*

RASKIN: Once Macintosh grew to its present size, the separate keyboard was the only way to go.

BYTE: *Did it start out physically significantly smaller?*

TRIBBLE: Not very much smaller. The screen was a little bit smaller, but the whole box was a much lower profile.

RASKIN: But it was not like a Tandy Model 100. It did have a CRT [cathode-ray tube]. It was slightly smaller. It grew a great deal.

BYTE: *Have you seen any of the third-party software that's just beginning to emerge for Macintosh? We've seen some where we think the third-party developers have missed the point of the Mac.*

TRIBBLE: I think that's bound to happen, especially where you have so many people—a hundred companies are out there—writing software. It's a tremendous problem in communication. You have to reeducate all the people who write for CPM, UNIX, and whatnot to write for a system that is completely different from anything they're used to.

HOWARD: It certainly takes a lot of

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BYTE WEST COAST

rethinking about how you want to be doing what you're doing.

TRIBBLE: Early on, designing the operating system, I decided to incorporate most of the user-interface routines and procedures almost into the operating system. It was partitioned off as something called the user-interface toolbox—a set of tools that you could use to conform to the Macintosh user interface.

RASKIN: The original design documents also said that the user interface is pretty much the operating system.

TRIBBLE: But further than that, we have a problem because it is harder to conform to that user-interface standard than it is to just treat the thing as a TTY [teletypewriter]. How were we going to get all these third-party software vendors to go along with us? The strategy was not to legislate by saying, "You must do this;" but to legislate de facto by putting all those toolbox routines in ROM. Then anybody who doesn't use those routines is penalized because the 64K-

byte ROM is sitting there with all these nice routines, and they're chewing up RAM with their own routines for their user interface. So it's a way of legislating a consistent user interface.

BYTE: *You started with 64K bytes and it was released with 128K bytes, and there is constant talk of a half-megabyte Mac. When did a half megabyte creep into the design philosophy?*

RASKIN: Very early on Burrell pointed out that it's very easy to make a design, once you had the 68000 in place, where you could just take out 64K-bit chips and put in 256K-bit chips. I've always believed that you just simply take the largest chip that is economically feasible to use in terms of the memory, and if they're bit-wide chips and you use 8 or 16 of them, then that should be the size of your memory. The size of memory, to be economical, should be the word length times the number of bits you have in a chip.

So it's clear that if you have 64K-bit RAMs and a 16-bit bus you get a 128K-

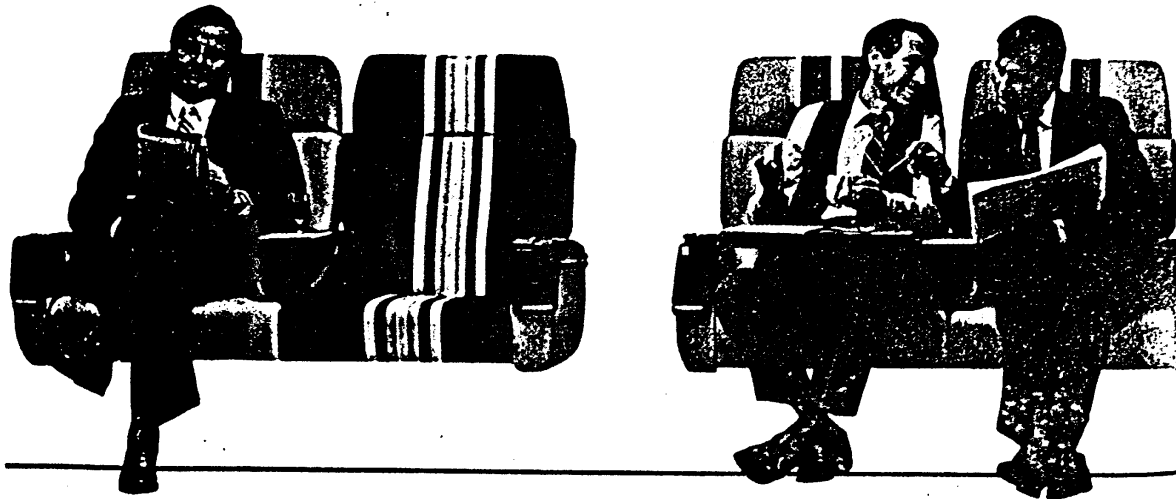
byte machine that's really fast. Burrell loves designing for it, software people had no trouble handling that, and it's very clean. When the 256K-bit chips come you just plug in all those and everything runs just about the same.

BYTE: *What brought Jobs to the Macintosh project? Why did he get interested in it?*

HOWARD: One reason was that Apple had no new projects in that sort of low price range, and I think it was becoming obvious that at some point people were probably going to quit buying the Apple II and Apple better have some other, at least that low if not lower-priced, project in the works. And part of it is that I think he was being sort of edged out of the Lisa project. Or that he could see that it was going off in a direction, perhaps even with his blessing, that he wasn't happy being a part of and therefore it was time for him to move on to something else.

By then it was becoming clear that Mac was the most exciting thing going

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BYTE WEST COAST

on at Apple. Jobs definitely loves to be in on new projects as they get going, and he's not very able to just sit back and watch that happen. [He's] a very forceful person [who] has to get in and exert his influence.

BYTE: *What happened between Raskin and Jobs as Jobs moved into the Macintosh project?*

TRIBBLE: When I went to work for Apple, I went specifically to work for Jef. And there is an incredible difference in philosophy between Jef and Steve. In my own mind I was initially more aligned with Jef's philosophy than Steve's. I have to admit that I became somewhat influenced by Steve as time went on. I also have a somewhat Machiavellian view toward the Macintosh project. By that time I was in love with it and wanted to see it happen, and here were these bad, political things happening, kind of above my head. What I saw as inevitable was that essentially the company had turned against Jef. Things were not getting done and

were blocked here and there. It was upsetting. I almost decided to go back to Seattle right when Steve was taking over. But I made a decision that if Steve takes over the Macintosh project, then we'll have resources of the company available to us, and we won't be blocked here and there. At least we'll be able to get something done. That turned out to be partly true. But the flip side of that was that Steve is good at lots of things but not at being a boss on a one-to-one level.

BYTE: (to Raskin) *When did you leave the Mac project?*

RASKIN: I was sort of forced out. Like someone squeezing on a toothpaste tube. I resigned in February of 1982. It was gratifying that Markulla and Jobs did not accept my letter of resignation. While I disagree with Jobs in lots of ways, the *Rolling Stone* article [S. Levy, "The Whiz Kids Meet Darth Vader," March 1, 1984, page 36] made it appear as though he summarily fired me, which

is not at all true. He has not been in general a person who does that. He and Markulla asked me if I would please stay another month even if I didn't come in to work; they knew I was very unhappy there. At the end of that time they would make me an offer that I couldn't refuse.

They went back to the way it had started. They were going to set me up with a research division. This was the third or fourth or maybe the ninth or tenth—I don't remember how many—times I had been offered that and every time I had done it, something came up. And they would say, "Oh, you've got to turn this into a product; you've got to come over and put out this fire or something."

They made me the same offer over again, and I think I had finally learned that there was little likelihood of it actually happening. So I left. . . .

BYTE: *Were any of you surprised at all by the*
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BYTE WEST COAST

extent of the Mac hype? The scale?

HOWARD: That's something of Apple's. I guess you would call it extreme right from the start. I guess that is what has differentiated Apple from a lot of unsuccessful computer companies that have had products that were more or less comparable to Apple's—its marketing ability, its ability to really blow things up. TRIBBLE: Apple was good at hype, for one thing. For another thing, we, the people involved in Macintosh, believed that there was something worth hyping. HOWARD: It is a computer that you can get affectionate feelings about in a way. RASKIN: I still think it has a lot of qualities that I wanted in it originally. Not exactly the same, many things have changed. But a lot of the feel has somehow managed to come through. I think the Mac is certainly the best of the personal computers of today. TRIBBLE: The people who worked on Macintosh, especially that initial core group, were all emotionally involved in the machine. That is a lot of what made it turn out well.

The idea came up again and again from the early days, though, that the major problem of the Macintosh was going to be one of educating people about the machine. It's a new concept and you have to spend effort to teach people about it.

A person should be able to watch for five minutes and then sit down and do something useful. You shouldn't have to read a big manual.

Jef may not agree, but I feel that it's the mouse that allows you to do this. Because it's difficult to see what someone's fingers are doing on the keyboard

when you're watching them manipulate a program, and it's very easy to see what they're doing with the mouse. RASKIN: I don't disagree. Except I have my strong belief that that's not a convenient thing to do for very long. It's certainly great to play with MacPaint. BYTE: *Where did the concept of the Mac division as pirates come from?*

HOWARD: It came because of an internal public relations effort to show people who were afraid that Macintosh was turning into this giant organization, like the Navy, with lots of forms, rules, regulations, guidelines, and procedures, that this was not the case—we invented the slogan of "pirates."

TRIBBLE: Well, there is the idea of Macintosh stealing from Lisa.

HOWARD: I don't think that was intentional—I think that was the way they took it. It certainly did not improve Macintosh's relations with the rest of the company—since that made the rest of the company the Navy by implication.

BYTE: *In the very first days, was it more or less unofficial? Was it all backdoor?*

TRIBBLE: It was not a product.

HOWARD: We were calling it research partly so that nobody would be upset that we were working on these ideas. TRIBBLE: If it's not a product we can do whatever we want.

BYTE: *There were some resources committed toward your "blue-sky" research?*

HOWARD: It wasn't that many resources were being committed. There were some bodies. Four or five of us were in a room that Apple was renting. But that was about it.

BYTE: *Did you feel like you were a secret society, in a sense?*

HOWARD: Kind of.

TRIBBLE: We made no attempt to keep ourselves secret, though.

HOWARD: We did feel that we were going off in a different direction from the rest of Apple.

RASKIN: And nobody, especially Steve Jobs, believed that we could do anything useful. Maybe a few clever ideas may come out of this group but certainly not a product. They were not going to get a product out of Raskin, Tribble and Howard. . . people who play music.

BYTE: *Is Mac a product that can evolve well?* HOWARD: In a sense that any computer can because you can write an infinite number of programs on it.

RASKIN: The Mac in particular is easier to write infinite numbers of programs on that most computers.

TRIBBLE: It's a generalist's computer. It's a bit-mapped screen with some memory and a processor.

HOWARD: With some limitations, you can hook almost any piece of hardware to it through high-speed serial ports. And people will go on plugging all kinds of weird things in it.

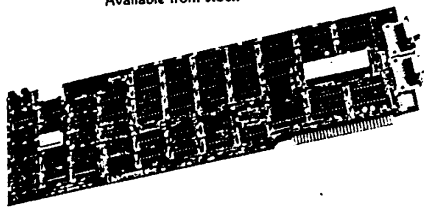
BYTE: *Could Mac be done again in 1984?* HOWARD: I think it could, but only by a similar process, a little group splintering off, working separate from the big group. I don't think it could be done on purpose, as Macintosh was not done on purpose.

RASKIN: From my point of view it was done on purpose, but from Apple's point of view it was an accident.

HOWARD: Actually Steve Jobs would support that kind of thing. That is the kind of thing that Jobs will go out on a limb for. ■

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