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Jef Raskin Information

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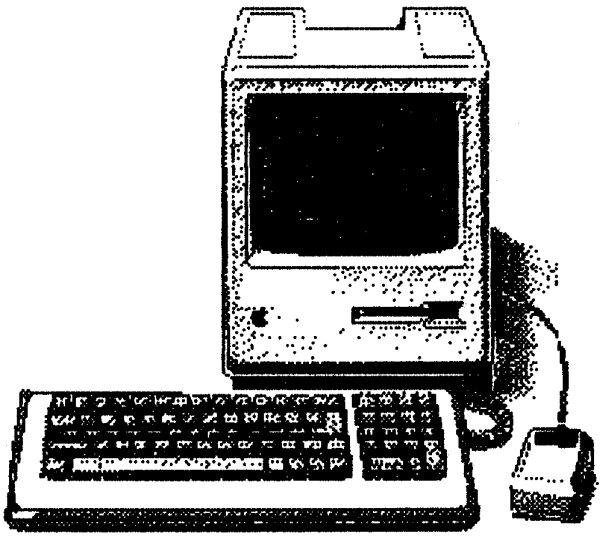
Apple Macintosh Technical Information

Jef Raskin Macintosh Project Note

Macintosh Research Project: Progress Report of July 1980



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THE MACINTOSH RESEARCH PROJECT--PROGRESS REPORT OF JULY 1980

Brian Howard, Marc LeBrun, Jef Raskin (project leader) and Burrell Smith

FEATURES

- Portable, compact, one-piece design.
- Built-in video display.
- Built-in typewriter-style keyboard.
- Built-in mass storage device.
- Built-in speaker.
- 64K bytes of memory, exactly.
- Microphone input, RS-232 port, real-time clock, and modem, standard.
- Diagnostic and expansion port with DMA ability.
- Built-in word-processing, calculating, scheduling and communications software.
- All system software designed with a unified human interface for rapid learning and clear, concise documentation.
- Low cost (under $1500, complete).
- Model changes not required for international use.

1. INTRODUCTION

Apple Computer is now so large and growing so rapidly that it is hard to know what is going on in every department. This document's purpose is to aid in communication by explaining the aims of the Macintosh project, and by encouraging comments that might improve our goals or our plans for achieving them.

This is a research project, and not product development. As has already happened a number of times, concepts studied here have proven helpful to product development by other groups. Macintosh serves as a vehicle for studying many software and hardware problems, as well as giving us a head start on a possible Apple product. The research aspect is expected to expand into experimental research into human factors, using naive and computer-experienced subjects to test proposed features.

We feel that we now have a satisfactory definition of the entire system hardware. The next phase of the project will consist of finishing the prototype to the definition given here, and completing the preliminary software design. We have a Macintosh processor, display, and keyboard running in the lab, and have completed design studies for almost all of the various parts of the project.

2. THE MACINTOSH CONCEPT

As Steve Jobs has said, we design products that we ourselves want to own. Macintosh is such a computer.

The project formally started in September 1979, although informal work was being done as early as late 1978. Macintosh (a code name chosen because the project leader's favorite Apples are Macintosh Apples) is, above all, intended to be a low cost but complete computer. It requires no wires or cables to attach to TV or disk, no boards to plug in, no complicated instructions to read. Most of the instructional materials will be presented by the computer itself.

By "low cost" we hope for an end-user price of under $1,500. By "complete" we mean that it includes a built-in display, a mass storage device, a standard port so that you can easily connect a printer (RS-232), a modem (so that it can communicate over telephone lines), and a date-and-time clock.

There is no doubt that we wanted more--more mass storage, a built-in printer, color graphics--but we feel that low price and portability are the most important attributes, and we have kept strenuously to these goals. The configuration we have tentatively adopted allows a very wide range of applications, and we believe it to represent a very good price/performance tradeoff.

2.1 UNIFORMITY BETWEEN MACHINES

We emphasize that the capabilities we settled on are all "standard", so that all Macintoshes are the same. If one Macintosh can do a task, then all Macintoshes can do it. This is intended to make the programming task much easier, and will encourage outside vendors to create software. You don't have to ask "will this package run on my Macintosh?". If it runs at all, it runs on your machine.

This decision also solves many manufacturing, inventory, quality control, after-sales service, and dealer support problems.

Macintosh is seen as being produced in very high volume. It is a consumer item. As such it is not a home computer since we do not see it controlling the home's temperature or running the vacuum cleaner. It is not intended to be a business computer since it does not have the memory or mass storage capability of an Apple III or a Lisa. It is not a low cost entry into general purpose computing as is the Apple II since it does not have the II's expansion slots--although many hobbyists will find it desireable.

We see it as a personal and educational computer, where low cost, ease of use, ruggedness, and reliability are important considerations. In addition, it is electronically very simple, having many fewer parts than even an Apple II. This simplicity and the resulting low power consumption, small size, and light weight make it possible for Macintosh to become a battery powered, truly portable computer.

2.2 INTERNATIONAL COMPATIBILITY

By virtue of the external-transformer power supply, the built-in display, and the total absence of a hardware character generator or keyboard mapping circuit, a model for use in another English-speaking country (whatever the TV or power line conventions) requires no changes. For non-English alphabets, simple key-front embossing, and a single ROM replacement (or a piece of software) is all that is required.

3. THE MACINTOSH USERS

These people know nothing of computers or programming. The main technologies with which they will be comparing Macintosh are hand-held calculators, telephones, home appliances and televisions--not with other computers.

3.1 APPLICATION AREAS

We expect that individuals will use a Macintosh computer to access information, to communicate with data bases and other individuals, to do a limited amount of calculation, to keep personal records and schedules, and to do word processing. We recognize that using a computer by means of a typewriter styled keyboard implies typing--and the correcting and re-arranging of what has been typed.

Therefore all the abilities of the computer will be seen by the user as options within a very easy-to-use word processor. For example, the calculator abilities will apply to numbers that are entered the same way any text is entered. The traditional concept of an operating system is replaced by an extension of the idea of an on-line editor.

Like the hardware, the software will be unified. It will not look like a number of separate components held together by a few menus or a catalog, just as the computer will not be a number of separate boxes attached by cables. The different main applications will be seen by the user as features in the editor.

This will significantly decrease the size of the software, the length of the manuals, and the time it takes for a user to become conversant with the system.

The uniform hardware environment, and the limited abilities of the editor will help limit the size (and, therefore, development and maintenance costs) of the software.

4. SPECIFIC HARDWARE CHOICES

The consumer-level user does not care what processor drives the computer. On the basis of cost versus performance, we have chosen the 6809E. The 68000, while a more attractive processor and an ideal choice for LISA, is both too large (in terms of its bus width and support chip requirements) and too expensive for Macintosh. The 6502, used on Apples I, II, and III, is not nearly as powerful as the 6809 (for example, it does not support self-relative

code), and would make the software much more difficult and expensive to write. It would also complicate the hardware.

Software compatibility at the machine level would be counterproductive for a product as different from the Apple II/III as is Macintosh. Software compatibilty at a higher level is, on the otherhand, important and will be provided.

4.1 MAIN MEMORY SIZE

There is never enough memory. This principle along with the 64K address space of the processor and the principle that all Macintoshes are to be the same, fixes the memory size: 64K. This must not be a user option as with our other products.

As John Viega of purchasing points out, 64K RAMs are now available (from OKI) at $25.00. This makes the cost of memory (at 8 of these chips) $200. This is expected to drop to $120 by the time a Macintosh-derived product is introduced, and the costs given below are based on this figure.

4.2 MASS STORAGE

For most personal applications mass storage serves as a filing cabinet. Things inconvenient to keep on your desk are put into the cabinet. Similarly, things inconvenient to keep in Macintosh's memory are put onto a mass storage device. In most business and many scientific applications mass storage also serves a more active role, as an extension of the computer's memory, to store intermediate results.

On many computer systems (including our products) mass storage also holds the system software and brings it in as necessary. Users get annoyed if this process takes much time. For example, you have to wait over 8 seconds to use the Editor on the UCSD Pascal system.

The customer does not share our knowledge that this represents a great improvement over what has been available on personal computers until very recently. What is expected is immediate response to any demand--which is why "instant-on" TV sets were so popular (you'd think that to anticipate watching an hour's show by 15 seconds was not too much to expect--but it is).

But response times in the seconds are the best we can achieve with floppy disks. What we need is response times in the tenths of a second range. But even a single floppy disk drive (which currently would add over $200 to the end-user price) is too expensive for Macintosh. Since archival storage is necessary for any realistic computer, we may use a digital cassette drive (not a re-packaged audio cassette recorder). This would add about $100 to the end-user price. In accord with the principles set out above, a floppy drive would not be an option on Macintosh (although communication with, say, an Apple III or a LISA for large data base storage is part of the design).

4.3 THE USE OF ROM

We want to give our customers computer power with calculator convenience. When it is turned on, it is ready to operate. If the user has to fiddle with

cassettes or diskettes, or give irrelevant system commands in order to edit a memo, do a calculation or store or recall an item from his or her schedule, the computer is not a Macintosh. The only technology that can handle this problem is ROM.

It is true that you could put the system software on a cassette, and that this would have to be read in only once whenever the machine is turned on. This would probably take about 20 seconds. But, even if that long a delay was acceptable, think about the person who used the cassette drive to store a business letter and then turned the machine off. When it is turned on, the system cassette is not in place, so an error message is given. The person has to switch cassettes (muttering: "damn! what a pain in the ass!") and try again. Unfortunately, the user just brought the machine home to work on the letter some more, but left the system cassette back at the office.

It may be psychologically acceptable to require a user to remember his or her own documents, but not to have to drag along our system software. For a consumer product not only must the machine be in one piece, but the major software must be included as well. (Remember, the user will not mentally separate Macintosh into a hardware and a software component as we do.)

ROM has some strong disadvantages, especially for a more general-purpose machine. Our testing time will be greatly increased, and updates will be out of the question. But this is also to our advantage--we, the software vendors, and the dealers will know what a Macintosh is. Our customers will, too.

We have rejected plug-in ROM cartridges since we already have an automatic cassette drive, which is functionally the same from a user's point of view (just pop in a small object). Our design provides for 32K of built-in ROM.

4.4 I/O

A single pair of A/D and D/A converters will serve for the cassette system, the modem, the graphic input device, and the audio input and output. A Bus Diagnostic Port will have all internal bus and processor signals and will be designed to allow automatic testing--a necessity at high volumes. This port will also, due to the design of the 6809E, allow a very high speed (e.g. real-time video) DMA. Electronics to support this ability is very cheap and will be included. The diagnostic port can also be used to connect the Macintosh to many other systems or devices.

Most of the interfacing, from the keyboard through the I/O ports to the display, is done in software rather than in hardware, making Macintosh a very flexible machine in spite of its apparent limitation in terms of having no peripheral slots.

4.5 THE DISPLAY

Reasons of cost force us to the CRT. Flat-panel displays are just not quite ready yet. However, we are implementing some flat panel displays in the lab in preparation for future developments. It is probable that the first practical flat displays will be monochromatic, and we hope to make use of them as early as possible--another reason for making Macintosh monochromatic. The size and shape of the display are based on the 8-bit wide bus, which makes 256 by 256

dots very efficient, and the human eye's property of blending dots when they are spaced at about 25 per cm. at normal viewing distances, which fixes the size at about 10 X 10 centimeters.

Using the Macintosh font, the system will show 25 lines of text at an average of 72 characters per line. Like LISA, it will have a proportional font.

A special advantage of a built-in display is that no modifications have to be made for use internationally.

5. COST INFORMATION

Many decisions on this project are driven by considerations of keeping the cost low. We have an absolute requirement that the resulting system be truly useful to the purchaser, and at Apple we have high standards in that regard. This keeps us from making an extremely low-cost product, but in no way prevents us from making a product with the best benefit/cost ratio available.

5.1 COST OF RAM

The prototype Macintosh uses 64K dynamic RAMs. The cost has been discussed above, and will be about $120.

5.2 COST OF I/O

We have investigated a number of display options. All current flat-panel displays are costly, and the driving circuits more costly still. The CRT still has no competition. Our cost for a CRT and driving circuits is about $40.

Since the keyboard is simple and straightforward electrically, we expect the cost to be about $10. This is especially low because the keyboard will probably go on the main PC board, and thus not require a PC board of its own. Other I/O, including connectors, is expected to cost about $10.

5.3 COST OF CASE AND MAIN ELECTRONICS

To keep plastics costs down, and to minimize assembly time, Macintosh is in one physical piece. Thus, only one assembly line is required, automation possibilities are enhanced, and troubleshooting is simplified.

Estimates for the case (the design of which has not been determined) run to about $25, according to Dick Conway. The PC board, since it is small, might cost as little as $15, and can be populated (except for RAM, CPU and ROM) for about $25. The small size of Macintosh should make RFI shielding relatively easy.

5.4 POWER SUPPLIES

Probably the least expensive power supply, using a wall-mounted transformer to keep size, weight and heat build-up to a minimum, will cost about $14. The wall-mounted transformer will supply 12V, and a small converter will drop this

to the 5V needed internally. Thus Macintosh could also run from an optional battery pack or a car battery.

A wall mounted supply has the additional advantage of making VDE, UL, and CSA approval much simpler. Furthermore, the computer itself does not have to be changed for operation on various international line voltages and frequencies.

5.5 MASS STORAGE DEVICE

We have been considering the mass storage device as an "information packet", and we might consider marketing it with such a name so that it is not confused with conventional technology--since the mass storage device is essentially a digital tape cassette drive. Our present plan is to only allow reading or writing one item (which could be as large as 200K bytes) on an information packet. The cassette would be automatically rewound so that whenever taken from the machine it was in ready-to-play position. There would be no user controls on the drive.

A digital cassette system will have a cost of about $35, is the least expensive alternative--and is acceptable so long as it is not used for system software swapping. Large data base work will be done via remote links, or on an Apple II or a LISA. Macintosh cannot be (and should not be) all things.

5.6 GRAPHIC INPUT

At present, the most cost-effective device is a joystick. Since the existing analog circuits can also be used for joystick input, the cost of such input amounts to the cost of the sticks themselves--about $10.

6. RETAIL PRICE

Our costs are:

RAM	120
ROM	12
DISPLAY	40
KEYBOARD	10
PC BOARD	15
IC's	25
CPU	8
MASS STORAGE	35
POWER SUPPLY	14
CASE	25
MISC.	10
TOTAL	314

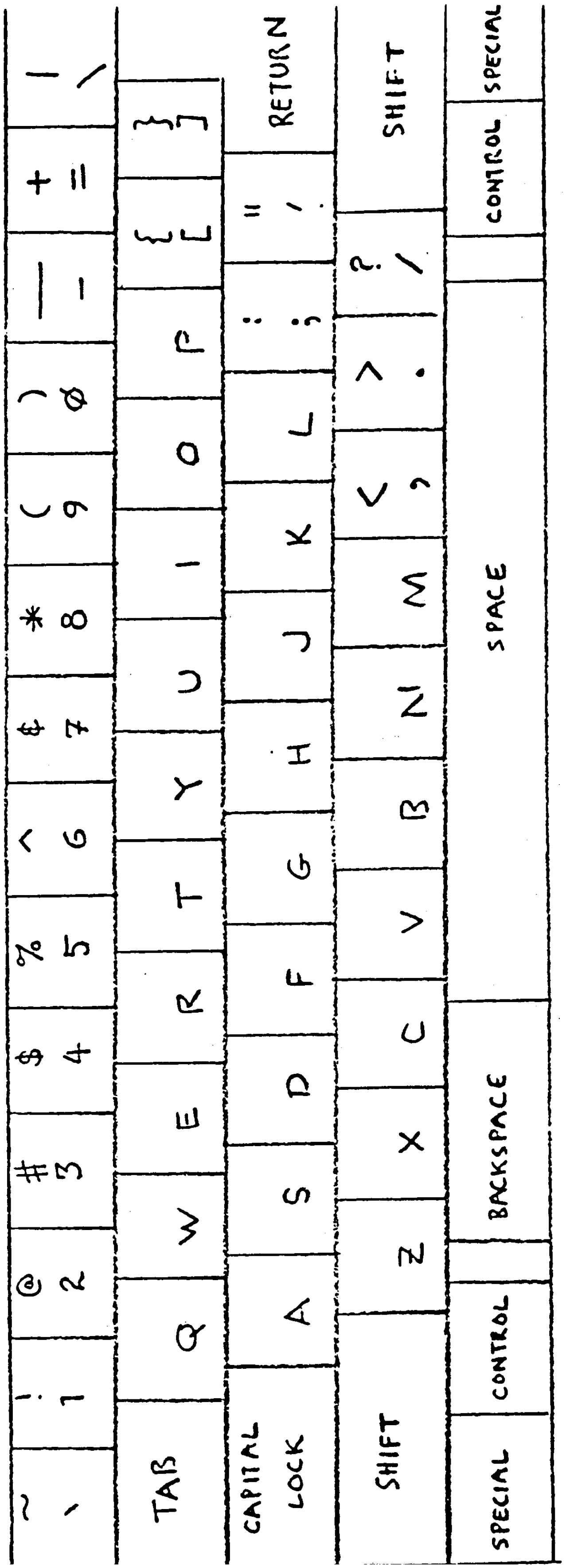
(These are current costs, with the exception of RAM.)

Our usual price/parts-cost ratio is about 4:1, which makes Macintosh a $1300 item. Considering that it has 64K of RAM, a display and mass storage device

built-in, this is an excellent price, and we believe it to be eminently marketable.

With excellent engineering and production automation, we may be able to reduce our costs a bit, but since all projects tend to run over cost estimates, we expect the price estimate above to be realistic (in 1980 dollars).

MACINTOSH keyboard layout
(preliminary)



ITEM	QTY	PART NUMBER

TOLERANCES
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.

DRAWN BY Jef Raskin | DATE 7-11-80
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apple

Macintosh Report, July 1980

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