

BUILD YOUR OWN MACINTOSH® AND SAVE A BUNDLE

Bob Brant



- ▶ Step-by-step instructions—no experience necessary
- ▶ Upgrade to SE, II, IIx or IIcx performance
- ▶ Parts lists—estimated costs—ordering information

Cat Mac Assembly Checklist

Model _____ Built by _____ Built for _____ Date _____

Parts to order/build

Part/model no.	Ordered from	Cost	Promise date	Rec'd date
Logic board _____	_____	_____	_____	_____
Memory accelerator board _____	_____	_____	_____	_____
SIMM chips _____	_____	_____	_____	_____
Hard disk _____	_____	_____	_____	_____
Floppy disk _____	_____	_____	_____	_____
Video display _____	_____	_____	_____	_____
Video cable _____	_____	_____	_____	_____
Video adapter _____	_____	_____	_____	_____
Keyboard _____	_____	_____	_____	_____
Mouse _____	_____	_____	_____	_____
Chassis _____	_____	_____	_____	_____
Power supply _____	_____	_____	_____	_____
Power cable _____	_____	_____	_____	_____
SCSI cable _____	_____	_____	_____	_____
Floppy cable _____	_____	_____	_____	_____
Rear cover panel _____	_____	_____	_____	_____
Floppy bezel panel _____	_____	_____	_____	_____
RPI shroud (optional) _____	_____	_____	_____	_____
Mounting hardware _____	_____	_____	_____	_____
Speaker (32 ohms or more) _____	_____	_____	_____	_____
Floppy disks (3 ¹ / ₂ ") _____	_____	_____	_____	_____
Software (Apple System) _____	_____	_____	_____	_____
Software (hard disk format) _____	_____	_____	_____	_____

Assembly

Step	Step	Step
<input type="checkbox"/> <i>Make</i> logic board template	<input type="checkbox"/> <i>Mount</i> power supply	<input type="checkbox"/> <i>Make</i> power cable, connections
<input type="checkbox"/> <i>Make</i> rear cover template	<input type="checkbox"/> <i>Mount</i> logic board	<input type="checkbox"/> <i>Connect</i> other internal cables
<input type="checkbox"/> <i>Make</i> floppy bezel template	<input type="checkbox"/> <i>Mount</i> accelerator/video cards	<input type="checkbox"/> <i>Connect</i> other external cables
<input type="checkbox"/> <i>Drill</i> chassis case	<input type="checkbox"/> <i>Mount</i> hard disk	<input type="checkbox"/> <i>Power on:</i> Phase 1 tests
<input type="checkbox"/> <i>Drill</i> rear cover plate	<input type="checkbox"/> <i>Mount</i> floppy disk	<input type="checkbox"/> <i>Connect</i> hard disk
<input type="checkbox"/> <i>Drill</i> anything else	<input type="checkbox"/> <i>Mount</i> speaker and cable	<input type="checkbox"/> <i>Power on:</i> Phase 2 tests

**Build Your Own
Macintosh[®]
and
Save a Bundle**

Bob Brant



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Apple	Apple Computer, Inc.	MacWrite	
Apple Desktop Bus		LTE	Compaq Computer Corp.
AppleTalk		Cutting Edge	Cutting Edge, Inc.
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Finder		IBM AT	
HyperCard		IBM PC	
ImageWriter		IBM XT	
LaserWriter		PC DOS	
Lisa		Microsoft	Microsoft Corp.
Mac		MS-DOS	
Macintosh		Motorola	Motorola, Inc.
MacWorld		MAX 15	Princeton Graphic Systems
MultiFinder		Radio Shack	Tandy Corp.
Unix	AT&T Information Systems	Nubus	Texas Instruments
Claris	Claris Corp.		
MacPaint			

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¹This book presumes you are already familiar, at least in passing, with Apple Computer, Inc. and the Apple Macintosh Computer. If you want additional information contact any Authorized Apple Dealer or Apple Computer, Inc., 20525 Mariani Ave., Cupertino, CA 95014, 408-996-1010. Apple, the Apple logo, and Macintosh are registered trademarks of Apple Computer, Inc.

²Xerox filed suit against Apple in December 1989 on the grounds that Apple copied and failed to acknowledge innovations developed for the STAR. In March, 1990, much of Xerox’s suit was dismissed by the court. Apple’s legal debt to Xerox, if any, is still to be determined.

third-party vendors, both software and hardware, for continuously pushing Apple and the “outside of the envelope” as Chuck Yeager would say.

Special acknowledgment and thanks are due to Darwin Gross, author, musician, wayshower to many, and the most humble, creative genius anyone could ever have the good fortune to meet, for the continuing inspiration; to my wife Bonnie Brant for challenging the ideas, proofreading, and ensuring my written expression fell somewhat within the confines of the English language; and to my mother Mary Brant for first sparking my interest in books, writing, and life.

Preface

It always intrigued me, in my contacts with various developers and system houses during the past several years, that many of them “just happened” to have a custom-built Macintosh lying around, usually a Mac in a PC case. I would ask them, “What kind of a computer is that?” The answer was usually the same. Well, we wanted to do *x*, and we just couldn’t do it in a regular Mac chassis.

It reinforced my own experience as a full-time computer consultant. Clients would ask, Could you mount that Macintosh in a rack? Could you fix it so I just have one larger monitor on my desk? Could you mount it in this size space? On and on. I knew from my own experience that you could repackage a Macintosh to make it do exactly what you wanted to do and, wonder of wonders, if you could put it in a standard PC case, it cost you a lot less than buying a new Macintosh.

Despite the wealth of information available to all on the Apple Macintosh computer, it also always intrigued me that nobody ever spoke about what was inside the box, except in hushed tones, until articles in *Computer Shopper*¹ broke the ice.

I believed that it would be more helpful if all this information could be gathered together in one place. This is what you now hold in your hand. A book that

¹Max Stax, “Building the Hackintosh: the Computer for the Rest of Us,” *Computer Shopper*, August 1988, p. 11.

gathers this information together in one spot for the first time so you can focus on the big picture. This book is a look at all the options and tradeoffs, so you can decide what the best solution is to meet your needs.

Build Your Own Macintosh and Save a Bundle certainly contains nothing new or extraordinary. But some nifty technical things have been done. Because the ideas are not mine and I do believe in giving credit where it is due, you will be informed where to look further. Being neither a hardware nor a software genius myself, the chapters have been deliberately kept simple.

My goal was to give you the tools that make it easier than ever for you to upgrade your own Macintosh or build a customized Apple Macintosh of your own from catalog parts—a Cat Mac²—at the best possible price. We live in a rapidly changing world, so this book was intended as a starting frame of reference rather than a final statement. I wanted to create a book which gives you the tools and a foundation you can build upon and use over and over again in the future. I believe *Build Your Own Macintosh and Save a Bundle* delivers on that goal.

Writing forces you to question all the things that you thought you knew. I wrote a mail order ad before I finished the first version of this book. It began, “Build your own Macintosh, learn secrets of experts. . . .” Now, after having written the book, I am not sure there are any secrets or any experts. If you look hard enough, chances are you will find someone has already done it before—maybe even better. And nothing is more sobering than to hold yourself out as an expert and then talk to someone who really knows what they are talking about. Ahhh, the sweet humility one learns from living life and writing books.

Time has validated the basic premise of this book. Building your Cat Mac will always be less expensive than buying a new system. Many Cat Mac computer parts are already less expensive today than they were less than a year ago when the first version was written. This trend, because of existing marketing and distribution channel trends, will continue in the future.

We are all individuals, and each person’s concept of the Macintosh will always be different from the next person’s. I continue to hold the vision that the highest purpose of the better computer for “The Rest of Us” will always be served by each person custom tailoring a Cat Mac to meet his or her own unique needs; there will always be new, different and better ways to do this. Starting with the platform that Apple has provided, whether staying outside the box or going within, you cannot help but benefit from what these chapters provide.

It has been said that nothing is stronger than an idea whose time has come. If that is true, then you are about to embark on a voyage of expanding information and knowledge from which there is no turning back. The corporate management at Apple and third-party Macintosh vendors should be well pleased because this cannot help but sell more Apple Macintosh computers—both new and used.

²This book is about building your own Macintosh from catalog parts. Catalog Macintosh has been shortened to Cat Mac throughout the book.

Knowledge is power, and all I have done here is to move the pivot point a little closer to you, the user.

Who I am

I am a full-time Macintosh consultant who provides both software and hardware solutions for a wide range of business clients. In 1983, as Operations Manager for a publishing firm in Northern California, I became “hooked” by having one of the first \$10,000 Apple Lisa systems on my desk. My initial Macintosh introduction followed a short time later. Several years in various sales and management capacities with Businessland, Nynex, Microage, and a regional reseller in the Northwest honed my experience. Prior to that, a combined 10 years with DEC and Data General in the minicomputer industry with a BSEE from the University of Denver and credits toward MSEE and MBA degrees gave me my frame of reference.

Introduction

You have probably heard this saying many times: *Give a man a loaf of bread and he can feed his family for a day. Give him the grain and show him how to plant and harvest and he can feed his family for a lifetime.* This book will build on the same principle. Because the technology is changing so rapidly, this book will focus on the techniques that will help you over the long term as well as today. Think of it as if you were building a house. I am going to give you the tools and plans and show you the process. The exact house you build is up to you. Guaranteed that prices will be lower and, if you can wait before buying your upgrade or Cat Mac parts, you will be well served by the decline in prices.

Why use this book

In reading *Build Your Own Macintosh and Save a Bundle*, you will learn why building a Cat Mac might be a good idea for you and the reasons why it will always cost less than buying a new Macintosh.

Although the title says “build” you are actually going to “assemble” your own Macintosh from catalog parts. These two words are used interchangeably in the text but understand the distinction. You won’t have to “build” anything from scratch or have to do a lot of soldering, etc. Yet, it is always your choice; you can if you want to. Instead, this book will focus on the easy way—you learn how to

“assemble” your Cat Mac from parts that already exist with little or no soldering. The difficult work has already been done.

By purchasing the identical, if not superior, parts from catalog and mail order sources and assembling them yourself, you guarantee that the Cat Mac you build will always cost less than the equivalent standard Apple Macintosh model.

This book is not a technical manual with detailed schematics and broad-level engineering details. The instructions, photographs, and illustrations are intended to assist you in assembling your Cat Mac and getting it running in the shortest possible time so that you can enjoy the fruits of your labors, a fully operational Cat Mac. Other more detailed schematics exist for hardware-oriented users who would rather spend more time in building.

This book can help if you are a Mac owner and want to upgrade your original vintage five-year-old Mac 128 or any other Mac. It can also help if you want to add more memory, a hard disk, bigger display, or accelerator card. All these are discussed and more. It gives tips on putting together the lowest priced, low-end Mac to just do some word processing or getting the newly announced, highest performance Mac IIx’s capabilities at the best price.

This book gives the exact details of how to build a Cat Mac using the Mac SE or SE 30 logic boards. Other Mac logic boards are also discussed in general terms and some useful building details are provided. This book will not help you if you want to build an MS-DOS compatible, 8088, 80286, or 80386 based computer¹ (although some of the concepts are similar).

How to do it

Chapter 1 tells you why you can put a board in a box and save a bundle, points out the benefits a Cat Mac might hold for a DOS PC user, discusses the pro and cons of building a Cat Mac, and suggests you remember that the force is with you; the market trends that guarantee that building a Cat Mac will always be less expensive than buying a new one.

Chapter 2 helps you decide which Cat Mac you should or should not build and helps you select the best system to meet your needs from the many available options using price as a criterion with the bottom line result averaging around a 50 percent savings off list.

Chapter 3 reviews Atari, portables, clones, and some nonstandard Cat Mac approaches you might consider.

Chapter 4 looks at the many logic board and memory options and suggests what choices you should make from a performance point of view. It also explains why the SE and SE 30 logic boards are the best value for the Cat Mac builder today.

¹Aubrey Pilgrim, *Build Your Own 80386 IBM Compatible and Save a Bundle*, (TAB BOOKS, 1988) and earlier books in the series do an excellent job in this area.

Chapter 5 shows how accelerator boards can help you, especially if available at a price lower than buying the next more powerful logic board. Chapter 5 also reviews some new combination accelerator/video boards available now that might be a good choice for you.

Chapter 6 examines the world of hard disks and rapidly dropping disk prices, with suggestions on which and how to buy, and shows you how to install and format your Cat Mac hard disk.

Chapter 7 looks at floppy disks from 400K to 1.4Mb and suggests the best one to buy for your Cat Mac project.

Chapter 8 discusses monitors and video boards and how to choose the best solution for your Cat Mac.

Chapter 9 looks at the rapidly growing world of keyboard and mouse alternatives with suggestions for choosing your Cat Mac keyboard and mouse.

Chapter 10 discusses the benefits of PC cases, different case options and the benefits of the low-profile Cat Mac case. Then it looks at wiring and all that there is to cables needed by the Cat Mac SE and how to build them.

Chapter 11 goes through a step-by-step approach showing you, with photographs and illustrations, how to build your own Cat Mac SE (or SE 30).

Chapter 12 explores topics that might be of interest to you after you build your Cat Mac, such as peripheral hardware, software, and “now that you are up and running tips.”

In this version of the book, I have deliberately placed parts sources in the chapters that discuss them, organized by manufacturer and distributor name, to make it easier for you to acquire your own parts.

Who can do it

There has traditionally been a certain aura of mystery in adding third-party products to your Apple Macintosh. Apple has contributed to this greatly by always making strong statements about “. . . voiding your warranty . . .” if you open your Macintosh or permit other than certified Apple dealer service departments to work on it. Apple’s warranty, until extended to one year in March 1990, was one of the shortest in the industry at only 90 days. So if you wanted to void it, you had to be quick.

Certainly Apple cannot afford to have you wandering around the insides of your Macintosh with a 250 watt soldering iron; it is not a toaster. But understand that this has less to do with Apple’s benevolent interests in you than in serving its own interests in keeping profits up. So, the first message is don’t be afraid to open up your Macintosh and look inside it. Actually, you will find little need to attack the components of the Macintosh with a soldering iron. The most you would use your soldering iron for is to build a few cables or some minor board work. In the worst case scenario, you might want to tackle upgrading your early vintage 128 Macintosh to a 512 model. This task really is better done by a number of qualified

third-party technicians around the country.

Anyone who has ever assembled a component stereo system or attached a video recorder to a TV set can probably handle any Cat Mac assembly or Macintosh upgrading. Even more probable is that anyone who has ever finished a Heathkit electronics project can. But that is no guarantee. There is no certainty. There are risks involved, particularly if your first electronics project ever is building your Macintosh from the ground up and installing a custom accelerator board, large screen video display, extra memory chips, and a hard disk. But it would be safe to say that the average competent Macintosh owner, exercising caution and prudence, and checking to make sure each step is understood before taking it, will probably have no trouble with anything mentioned in these chapters. Ahhh, these are tradeoffs that make life worthwhile, yes?

Okay, ready? Remember to read Chapter 11 carefully. That's where you actually look over my shoulder as a Cat Mac SE is being assembled. Use your common sense, work carefully, and take the time to reread a step if you are not sure. All you are going to do is assemble your Cat Mac just like you would assemble your component stereo system—step by step. Isn't this fun? Just a few housekeeping items first.

A few disclaimers

You wouldn't think of opening the back of your TV set and touching the high voltage lead-in wire on the picture tube. Inside your Macintosh lurks the same type of tube with the same high voltage. Don't even think of touching it. Ideally, you should unplug your Macintosh and wait for 30 minutes before working on it. If you are in a hurry, at least discharge the Macintosh's high voltage power supply's capacitor before working inside. Open your Mac. Remove your logic board. Clip a wire on the chassis of your Mac whose other end goes to *ground*, the third wire in your electrical appliance plug. Take two long bladed insulated handle screwdrivers, and touch one to the chassis. Slip the other blade under the suction cup of the Mac's internal CRT until it touches the metal contact of the wire. Now touch the two blades together and watch the nice spark. Better this than electricity flowing unexpectedly through your fingers. Sometimes capacitors can retain their charge for days. If you enjoy living dangerously, you can ignore the foregoing and plunge ahead—just stay away from the high voltage area (this is not recommended, however).

One other little tidbit. If you are wandering around your house in the middle of winter drawing three-inch static discharge arcs off your doorknobs after shuffling around on the carpet, it is not a good idea to work around the delicate 5 volt logic board circuitry of your Macintosh unless you are using a grounding strap and/or have thoroughly discharged yourself by touching a ground first.

A big disclaimer next. It is important that you understand that when you build, assemble, or upgrade your own Mac, there are no guarantees. Unlike buying something off the shelf from your friendly local Apple dealer, *If you fry it, you*

own it is the prevailing order of the day. Actually, it is highly unlikely that you will ruin everything you just invested in; only a part of it, if anything at all. The point is you have to fix the part or parts on your nickel.

Another disclaimer. Apple has undertaken to set up a series of legal road blocks aimed at third-party clone manufacturers. For example, they have recently ordered dealers not to sell ROMs or logic boards except for repairs. If you have just been awarded the contract to sell 500 Macintosh clones to Boeing or General Dynamics, you should be a little nervous. On the other hand, if you are upgrading your personal Macintosh, moving your ROMs to another board, you have little to worry about. Apple, for “goose that laid the golden egg reasons,” has no desire to interfere with the used Macintosh equipment market and impact the market mechanism that makes upgrading to a new Apple Macintosh so easy.

A special piece of advice next. If someone approaches you with some cheap Apple 128K ROMs, just say no and walk away. Apple takes a dim view of anyone copying their ROMs, regardless of the quantity. Frankly, I don't blame them. You just don't need to do this. Enough are available at a fair price in the marketplace, and you break no laws and create no problems for yourself or others.

Better price performance is what the Cat Mac delivers versus the standard Apple Macintosh offerings and is why it fills a market need. When you finish reading *Build Your Own Macintosh and Save a Bundle*, you will know how to build your own Cat Mac, how much it's going to cost, where to get the parts from and how to put them together. This knowledge, whether you decide to tackle the Cat Mac or just upgrade your present Macintosh, can save you bucks. Those with more experience might just want to jump directly into a chapter that interests you, or you might read it from cover to cover with a bag of munchies at your side.

The test of time and recent history

There have been many industry changes in the last year since I wrote the first version of this book. But the major premise of the book has stood the test of time. Apple announced price reductions and Cat Macs also became less expensive to build. In the computer industry, one year is a lifetime. The changes fall into three categories.

First, industry supply and demand trends produced much lower hard disk pricing and much, much lower memory prices. Hard disk prices dropped 25% and memory prices over 75% from levels of a year earlier.

New products and price reductions were announced by Apple and third-party vendors. Apple announced the Mac Portable, IICx, IICi, and IIfx computer models, extended their warranty period to one year on all products, lowered price on memory and selected Macintosh models, and preannounced the availability of their System 7.0 software in late-1990. Third-party vendors introduced quite a number of new mice and, in general, better and less expensive versions of everything.

Finally, with feedback from readers of the first book, I learned a lot, too. Some of the letters received went all the way back to question as to “Why a Macintosh in the first place?” To level the playing field for those coming from the DOS PC and noncomputer world (in which the word Macintosh probably specifies a type of apple or stereo equipment), this book devotes part of Chapter 1 just to unravel that topic and put all readers on an even keel. Other reader questions and explanations of problems they were encountering in building their Cat Macs dictated that some sections be expanded, others be shortened, and entirely new material be added for some.

You have undoubtedly heard about the turmoil at Apple Computer, Inc., which the media put under a microscope in early 1990 because of falling earnings resulting in lower stock prices, upper management resignations, and layoffs. Compounding the situation was Apple’s embroiled legal position of simultaneously being involved as plaintiff and defendant in numerous lawsuits.² The increased competitive pressure applied by the marketplace as other vendors on other computer platforms increasingly attempt to emulate Apple’s easy to use Macintosh interface has not helped either. This is sad because all these events and conditions tend to distract Apple management away from their highly successful mission of building a better computer for “The Rest of Us,” which for the most part they have already done. I know that history will record the above events as only a blip on the growth path of a highly successful \$5 billion company on its way to bigger things.

Specifically, Apple has taken heat in the press for failure to have a cost effective low-end product to shore up sagging Mac Plus and Mac SE sales, to produce a color Mac that can compete in price performance with the midrange MS-DOS clone offerings, and for stubbornly clinging to its outmoded 90 day warranty policies.³ (In late March 1990, Apple announced their new one year warranty policy.)

This book addresses each and every one of these areas. Before Apple gets around to doing anything about them, which I firmly believe they will, you as a Cat Mac builder have better solutions to each problem that can be exactly tailored to your own needs. Apple’s Mac Plus and Mac SE prices might be set artificially high, but this book shows you how to build your own for a lot less. A color system competitive with a mid-range MS-DOS clone? No problem. The book shows you how to start with a discontinued Mac II and get great price performance. And when you build your own, virtually all vendors offer one year or greater warranties.

²Apple sued HP and Microsoft over creating interfaces which emulate the look and feel of Apple’s. Xerox claims Apple did the same to them. The Apple label is not too happy with Apple either. The list goes on.

³These were a few points out of many made in the *MacWEEK* editorial, February 20, 1990, p. 24.

1

CHAPTER

Why build your own Macintosh

Put a board in a box and save a bundle.

The original book was written on a Macintosh SE built from catalog parts—a Cat Mac SE. Much like the Apollo Astronauts who went to the Moon on equipment built by the lowest bidder, my Cat Mac got me where I wanted to go, was very reliable, and saved me money. Not only that, but because I built it myself, I felt a pride of ownership, particularly when I took it out to shows and on demonstrations. Your Cat Mac can do the same for you.

This book is being written on the 5Mb Cat Mac SE 30 shown in Fig. 1-1. I merely pulled the SE logic board out of my earlier Cat Mac and dropped in the SE 30 board; the connectors, board size and mounting holes are identical. I use a Princeton Max 15 multisync monitor connected to a Power R video adapter, so the internal cabling could not be any simpler. A Cutting Edge 800K floppy and a Seagate 80Mb ST296N hard disk, a Cutting Edge ADB extended keyboard, and an A+ ADB optical mouse round out the system. Later on I changed the case. Am I happy with it? You bet I am. This system (with all components from third-party vendors except the Macintosh logic board) really flies, the big screen is easy on my eyes and, best of all, the price is right at almost 50% off the Apple list price for the same performance.



1-1 My Cat Mac SE 30.

This is what I mean by “put a board in a box and save a bundle.” I obtained the “heart” of a Macintosh, its Apple Macintosh logic board, at the best price from the used equipment market. I surrounded it with better price performance products from third-party vendors obtained via the cost saving mail order distribution channel. Then I put it together myself. Result: I saved a bundle, yet I have a Macintosh as good if not better in every way than a standard Apple Macintosh model.

Other than the “thrill of victory and the agony of defeat” as they say on “ABC’s Wide World of Sports,” why bother to build your own Macintosh? What’s in it for you? This chapter examines the benefit to you of building a Cat Mac versus a DOS PC, examines the advantages and disadvantages in building your own Cat Mac versus buying a Macintosh, shows the prevailing marketing and distribution channel trends that will always make building your own Cat Mac less expensive than buying an equivalent new Macintosh, and shows how a Cat Mac builder is ahead of the game no matter what future changes come along.

Why build a Macintosh vs. a DOS PC

A recent article by Stewart Alsop¹ observed that the Macintosh, after recent announcements of A/UX 2.0 from Apple (Apple's Unix software) and the latest version of Soft PC from Insignia Solutions (emulator software), is the only computer that can simultaneously run Macintosh, DOS, Windows, and Unix software. This capability is also available on a Cat Mac. "But there are so many more DOS PC machines," you might say. By the end of 1990, there will be more than 5 million Macs in the world. By that same time, there will be more than 40 million DOS PCs installed. So let me first answer the question: "Why build a Macintosh versus a DOS PC?"

From my own DOS and Macintosh computer consulting business experience, I have learned that there are definite applications that each type of system is best suited to perform. I can pass either type system solution on to a client; sometimes both working together is the answer.

I have also learned that DOS PC users typically have four main objections about a Macintosh: It's a toy, not DOS compatible, too slow, and too expensive. There are as many, if not more, DOS PC users who are adamant and gung ho that their DOS PCs are the best as there are Macintosh users who feel the same way about their Macs. These hard-core users are not even interested in trying a Macintosh under any circumstances. I've learned through experience not to even attempt to tell this class of DOS PC user anything about the Macintosh. However, the majority of PC DOS users that I encounter in my business are a bit more open minded.

I also know it is impossible to convey in words—written or spoken—the difference a "Macintosh environment" makes in working with a personal computer. So I simply tell them that nothing I can say can possibly change your opinion of a Macintosh until you actually use one and then compare it application by application with the DOS PC you are now using.

I tell them to be fair though and don't ask to see a Mac 128. Ask to see a Mac SE or SE 30 or Mac II, etc. Go up to a friend who also happens to own a Mac and ask them for a demo of their Mac. Tell them the ground rules are they are to "shut up" during the demo—no Mac proselytizing. All they can do is answer any question you might have, briefly. Help them out a bit though by telling them what you might be interested in doing with a Mac (word processing, spreadsheet, graphics, database, etc.) so they demo in your interest area. If you have no Mac friends, have a salesperson at a computer store reproduce the process.

No matter who did the demo, you should at least have gone away with the following impressions:

¹Stewart Alsop, "Apple's A/UX, Version 2.0 Will Give the Mac a Leg Up on DOS, Unix," *Infoworld*, 2/2/90, p. 106.

- The Mac is different—especially that, what do they call that funny little thing you hold in your hand—a mouse? After I got the hang of it, it saved me a lot of time.
- The Mac is graphic—well I remember all I had to do to delete a file was to put its *icon* in the *Trash*. Hey, look at me, I’m talking Macintosh.
- The Mac might be easy to use. Those icons and pull-down menus that I just clicked on with the mouse, they couldn’t be that hard to learn.

Guess what? Your instincts served you well. You are correct in your perceptions. Some say that Apple employed the Trojan horse strategy to bring Macintoshes into corporate America. The simple fact is the Macintosh has sold itself.

Initially, the Macintosh was positioned squarely against IBM PCs and their clones. Now it is “the second standard.” How quickly we forget. Why, despite its overwhelming disadvantage in numbers, price, and marketing has the Mac succeeded? What is it about Apple’s Macintosh interface that has IBM and others running, not walking, to copy it?

In company after company around the world, when PC users tried a Mac and then tried out the identical application on their DOS PC, and later were asked to choose between a Mac and a DOS PC machine when price was removed from the equation, they overwhelmingly chose the Mac. Study after study conducted in these corporations proved what you already know from a brief exposure to it. The Mac is easier to learn and easier to use.²

So let me go back to the four initial objections. It’s a toy, not DOS compatible, too slow, and too expensive. The first three objections are today untrue. The fourth one is solved uniquely by the Cat Mac.

A toy You don’t compromise software power on the Macintosh. Some of the most powerful software programs made for any computer run on the Macintosh and, in fact, were ported back to the PC. Aldus PageMaker and Microsoft Excel are two examples that come to mind. If a software application is not available for the Macintosh, it usually is because it has not been developed yet, not because it cannot be. The Mac is not a toy.

Not DOS compatible Apple’s newest Macintosh FDHD Superdrive reads and writes DOS PC 3½” floppies. Third-party vendors make products to read DOS PC 5¼” floppies in a Macintosh. DOS word processing, spreadsheet, and database programs are all accessible via Apple File Exchange software and third-party software such as MacLink Plus from DataViz. You run DOS software on a Mac using a software emulator and, if you need better performance, you can even put a hardware board into your Macintosh to make it emulate a DOS PC. Of course, without an emulator, you cannot run DOS programs on a Mac; but that

²One Minute Manager, “Apple and Peat Marwick & Main prove Mac Productivity,” *MacWEEK*, 9/12/89, p. 40, and *Marketwatch*, “What justifies a Mac purchase?,” *MacWEEK*, 2/13/90, p. 76.

was never the issue. The data is the issue. And there is no DOS PC text data, that I am aware of, that you cannot pull over into a Macintosh and operate on. Graphical data is a little trickier to play with between DOS and Mac platforms, but there are ways around this also. I would say the Mac is DOS compatible.

Too slow Apple's latest high end offering, the Macintosh IIfx, significantly outperformed IBM's top-of-the-line 80486 PS/2 Model 70 and Compaq's 33 MHz 80386 in recent independent testing company equivalent cross platform Aldus Pagemaker and Microsoft Excel benchmarks. Basically, you can add accelerator cards to any Macintosh to obtain this performance. And DOS machines are now also adopting the SCSI interface because it performs so well on the Mac. Nope, the Mac is not too slow.

That leaves price The DOS PC environment is an open one. Multiple vendors competing on a somewhat-level playing field to make the best product drives the prices down. Not so with Apple. Apple's proprietary Mac environment has kept high prices to amortize engineering and development costs and keep their stockholders happy. Apple Macintoshes are more expensive than DOS PC machines.

Enter the Cat Mac. If you build it in a PC case, as most do, it even looks like a DOS PC. But it does everything the Macintosh does. It is a Macintosh. Because you build it yourself, you save money—typically 50% of the Apple list price for the same performance.

Advantages of building a Cat Mac

In the business arena, the driving marketing credo is find a need and fill it. That is why people form companies and why little companies grow into big ones. They are filling a need. That is also the driving reason for building your own Macintosh, your Cat Mac. No matter how many different Macintosh models are manufactured, no one can ever be custom tailored for you. You have to do that part yourself. You are the only one who can exactly fill your own needs.

In the business arena, another driving credo is to get the most value for your money. When you upgrade your existing Macintosh or build one from catalog parts, you save money because you are providing the labor.

Let's look at the advantages and disadvantages of your built-up Cat Mac versus the standard Apple product in several important areas.

Price Your Cat Mac has better price performance, i.e., lower cost for the same performance or higher performance at the same price. As Chapter 2 will show, you can save 50% or more off the retail Macintosh price by building your own. Even if you don't build an entire Macintosh, you can save money by creatively using third-party vendor equipment when upgrading your Macintosh. On the other hand, Apple retail discounts are already 30% and sometimes more off

list price in some areas, so you need to examine and work the pricing tradeoffs on what makes the most sense in your particular case.

Flexibility When you build your own Macintosh, you have total flexibility. You can choose from more options. Monitors? You don't need two on your desk to get to use a bigger one. There are more cost effective hard disk solutions than those from Apple. More accelerator and video options are available due to less space and power restrictions. You don't need to take the keyboard, mouse, and floppy drive you receive from Apple. You can choose from many third-party alternatives. You have the advantages of a bigger power supply and fan and also of a bigger case with more flexible mounting of additional memory and options. On the other hand, when you purchase a new or used Apple Macintosh today, you have a wide selection. There are only so many models and options to choose from, and there will never be as many as there are people to choose them.

Resale The Macintosh is a commodity item. As a used computer, it has a definite resale value.³ You can go out tomorrow, sell it, and have the money in your hand. On the other hand, the Cat Mac has a questionable resale value. When you go to sell your Cat Mac creation, the shoe is on the other foot. You might have difficulty in selling it because it is an unknown. The Cat Mac is a very desirable item to anyone who knows of its benefits, so the secret to selling it is to find a buyer who needs the features of the one you have to sell. Then the future buyer's choice will also be easy.

Time Your Cat Mac, being a unique creation, takes time to build. Even the simplest Cat Mac implementation will require time to order and receive the parts from the catalog or mail order sources before putting them together. Then you are looking at several hours to several days to put it together. On the other hand, you can go out and buy an Apple Macintosh today.

Repair Since your Cat Mac creation will probably be put into an oversized chassis rather than a small crowded box, with a higher capacity power supply and an industrial strength fan which dissipates much of the heat normally generated, the likelihood of your Cat Mac breaking down is a lot, lot lower. But only you and a handful of others can repair it. The downside on this is less frightening than you think. By the time you finish building your Cat Mac, you will know a lot about it and will not be too intimidated by the thought of getting in and fixing it. And you can perform the repairs at wholesale rather than retail. On the other hand, Apple has a worldwide network of repair locations to fix your Macintosh. But, you have very little control over the time it takes them to repair your Macintosh, and you might not be smiling over the repair bill when you receive it.

Table 1-1 summarizes the choices using the Cat Mac and standard Apple Mac SE configurations that will be discussed in more detail in Chapter 2.

³Deborah Branscum, "Stalking the Used Mac," *Macworld*, August 1989, p. 57.

Table 1-1 Why build your own Macintosh tradeoffs.

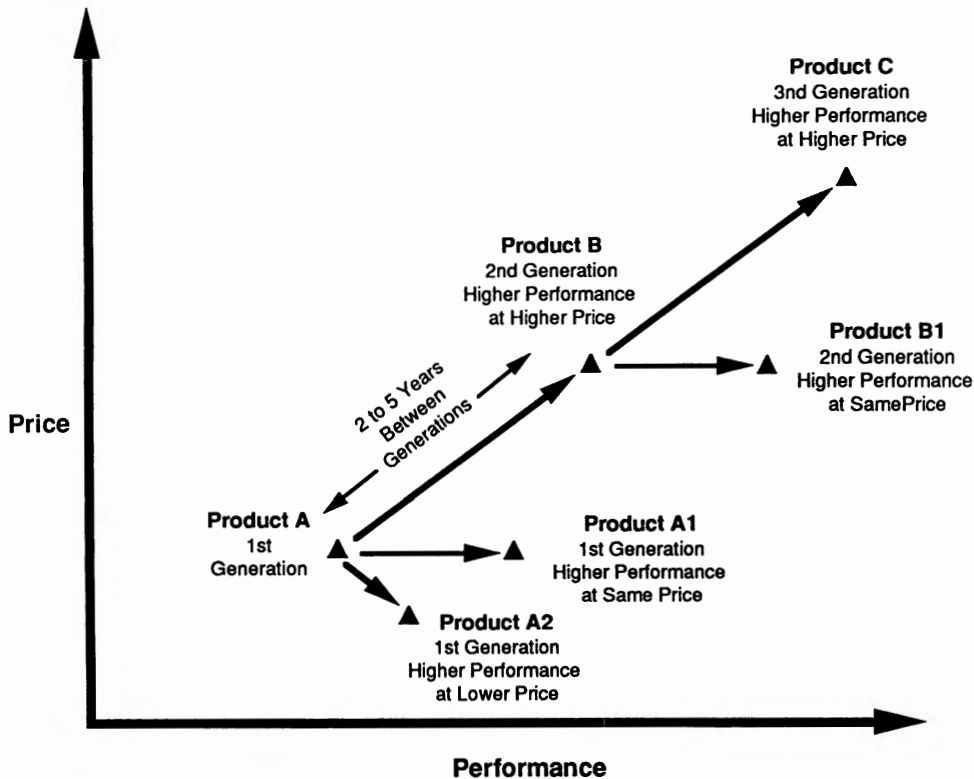
Comparison item	Apple Mac SE	Cat Mac SE
logic board	standard SE	identical
memory	1Mb SIMM	identical
hard disk	standard 3 1/2" 20Mb	Seagate 5 1/4" 20Mb
floppy disk	Sony 800K	Fujitsu 800K
keyboard	Apple ADB Extended	Cutting Edge ADB Extended
mouse	Apple standard ADB	A+ optical ADB
video monitor	9" monochrome	Princeton Max-15 multi
power supply	76 watts max output	150 watts nominal
case	standard SE	larger PC case
expansion	1 slot in case	1 slot, but room for more
price	Apple list price	typically 50% less
flexibility	Apple	more options
resale	commodity item	harder to resell
time to build	buy it now	weeks
repair	Apple dealer	do it yourself

On balance, Table 1-1 should convey that the Cat Mac delivers some definite benefits. The tradeoffs are many. In the final analysis you must determine whether it's worth it to build or to buy. Why do people climb mountains?

Remember, the force is with you

Four prevailing marketing and distribution channel trends guarantee building your own Cat Mac will always be less expensive than buying an equivalent new Macintosh.

This little history lesson will explain. Digital Equipment Corporation (DEC), Data General, and other primary minicomputer vendors personified a trend in the minicomputer field in the 1970s and early 1980s. Figure 1-2 shows a typical price performance trend for a vendor's product line. Starting in time with any product (I called it product *A*), new technology and continuing development allowed the vendor to evolve new products *A1* and *B*. Product *A1* delivered higher performance at the same price and was usually the same generation of hardware milked or tweaked for extra performance. Product *B* typically defined a new generation and delivered still higher performance at a higher price. Then product *B1* was introduced and the process repeated. The *A1*, *B1* type products defended the vendor's low-end product price. In a very price competitive market, it would also be necessary to introduce a product *A2*, which would provide the same or slightly higher performance at a lower price. Typically, same generation product introductions took place roughly each year and there were two to five years between new generation announcements.



1-2 Minicomputer price performance trends.

This was the minicomputer industry's famous price performance curve. IBM had a similar situation with their minicomputers, and it was also true of their mainframes in that period and earlier. Third-party vendors could always offer their peripheral products such as memory, disk drives, tape drives, and printers at lower prices than a DEC or IBM. These vendors that wanted to attach anything to a piece of DEC or IBM gear nearly always did so at their own risk. A DEC or IBM could (and often did) suddenly change the rules by simply introducing a new model, bundling in more memory at a special price, or altering the microcode to handshake with the disk drive. All these held nasty financial consequences for the third-party vendors.

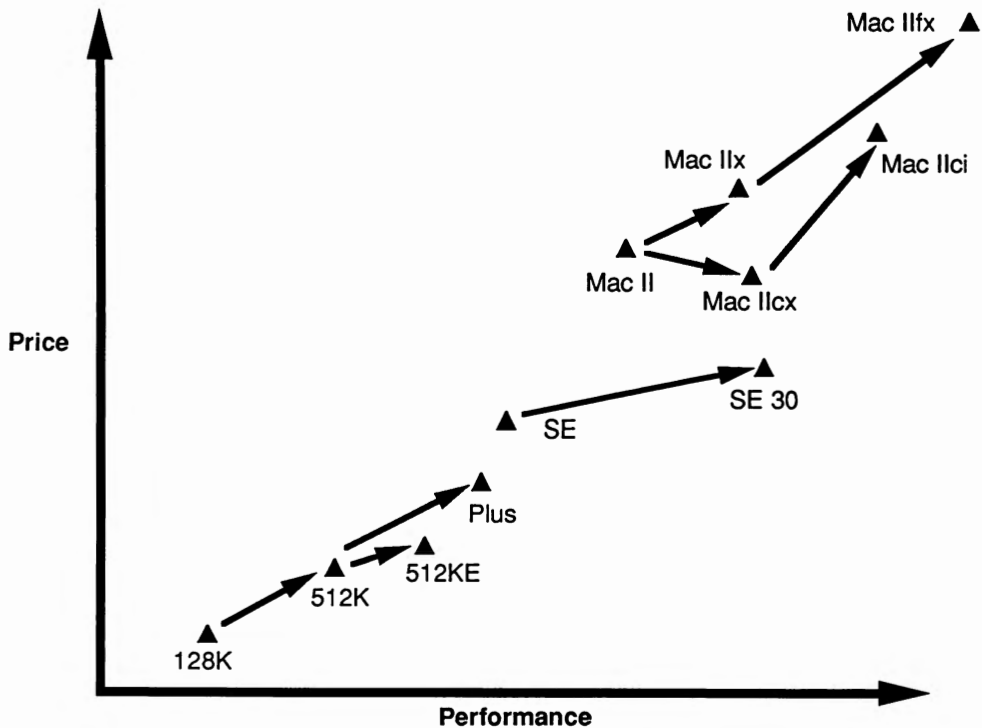
Yet no matter what IBM or DEC did, it was always possible to get a better priced or better performing add-on or add-in peripheral from some third-party vendor who was able to move faster in implementing the new technology and deliver it to the marketplace quicker. Although IBM and DEC always caught up with (sometimes with a vengeance), and occasionally even led the third-party vendors in technology, an entire thriving cottage industry grew up around the ability of nimble, smaller companies beating the bigger guys to market.

Trend one: Apple Macintosh price performance

The strategy has not changed much in today's microcomputer field, only the size of the computers has. You will notice a striking resemblance between Fig. 1-2 and Fig. 1-3. Four Macintosh families and their growth through successive generations are visible: 128 through Plus, SE through SE 30, Mac II through Mac IIcx and Mac IIcx through Mac IIci. Apple is doing today exactly what earlier computer makers did, only with new chips and new technology.

What does all this mean to the Cat Mac builder? Figure 1-3 shows that Apple will, in order to grow their market, have to continue offering new products to fit this framework. Every time Apple introduces another product, the Cat Mac builder wins. Why? Because that product obsoletes an existing product and causes it to move to the used equipment market where it is now available not only as a complete system, but also as component parts. Its key component, the logic board, is now available at a price defined by market supply and demand as opposed to only being available at an Apple upgrade option price, if at all.

Today, an obvious void for Apple is at the low end. I say they will move to fill it, yet that product and its future generations will only form another constellation pattern in Fig. 1-3. When they do, regardless of how its low-end system or box is priced, it will sooner or later be available to the used equipment market where its

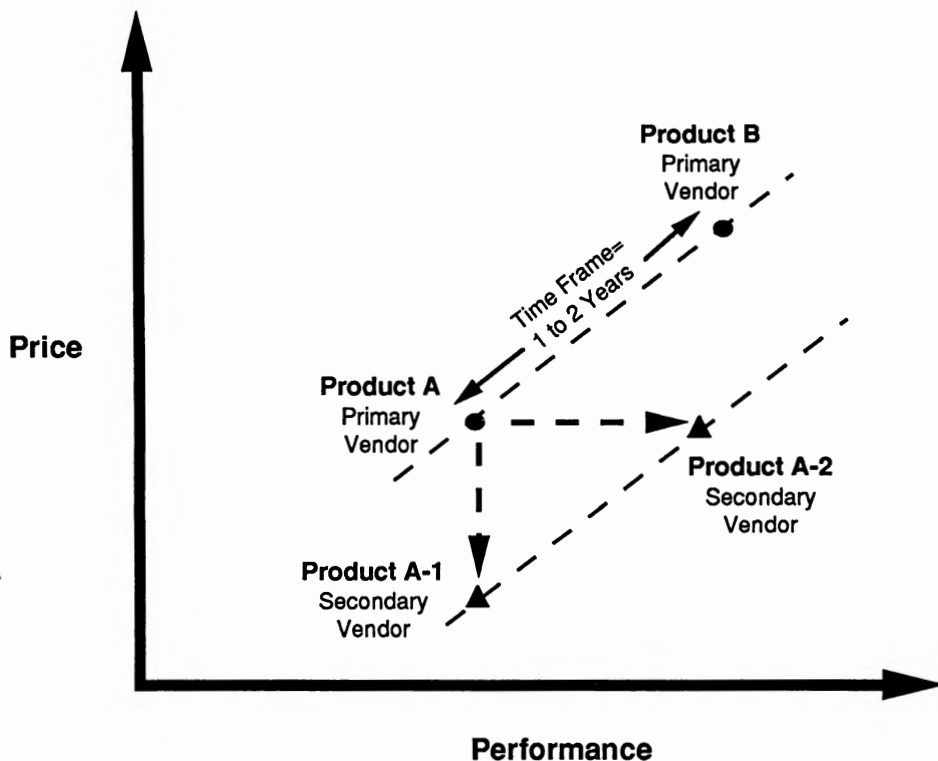


1-3 Apple Macintosh price performance trends.

logic board will be available to Cat Mac builders at a fraction of the system price. Thus, the Cat Mac builder wins again. Apple's price performance pattern will not change in the future. Only new products and new generations will be added.

Trend two: Third-party vendor performance

As in the minicomputer days, today the third-party vendors offer their add-on or add-in products with better price performance than Apple. Although many of these vendors have for years been manufacturing similar types of products for the DOS PC world, they are still typified by smaller, more nimble organizations quicker to market with their products. This is shown in Fig. 1-4. The third-party or "secondary" vendor either offers an "A-1" product at a price significantly lower than Apple's price (i.e., memory, disks, monitors, keyboards, mice) or an "A-2" product with a performance significantly greater than Apple's performance (i.e., accelerator and video cards, disks, monitors, mice). These vendors fill a market need by also offering entirely new products that Apple does not offer and, in effect, prototyping this market for Apple until the product demand builds up and it is large enough for Apple to apply its manufacturing economies of scale to and make a profit (i.e., hard disks and monitors).



1-4 Third-party vendor price performance trends.

Also, as in minicomputer days, third-party vendors still operate at their own risk. It is to Apple's advantage to let third party vendors assume the technical and marketing risks during the prototyping stage as just discussed; Apple is careful to nurture cordial relations with its third-party developers. However, as many a third-party vendor is painfully aware, Apple can change the rules of the Macintosh game at any time and has done so many times already.

Third-party accelerator board manufacturers have a particularly "fun" time as Apple alternately solders and sockets its CPU chips to the board and changes its input/output interface access as its architecture evolves. In the traditional Macintosh, the third-party vendors originally had no bus to attach their products to. They had to attach directly to the CPU chip. Apple had a closed box. Now, the pendulum has swung back the other way with the SE models having a 96-pin direct slot, the Mac II models having multiple 96-pin Nubus slots, the SE 30 having a 120-pin direct slot, the Mac IIfx and IIfx models having a cache controller slot, and the Mac IIfx having a 120-pin processor direct slot which is a superset of the SE 30s. Apple's new strategy now forces third-party vendors to deploy resources and time to consider all these when they design their products.

What does all this mean to the Cat Mac builder? It is guaranteed that no matter what Apple does, it will still always be possible to get a better priced or better performing add-on or add-in peripheral from some faster moving third-party vendor. It is also guaranteed that the third-party Apple Macintosh related cottage industry will continue to thrive as clever, nimble, smaller companies take advantage of the holes in Apple's product line and get into market faster with their own products.

Trend three: Used equipment vendor performance

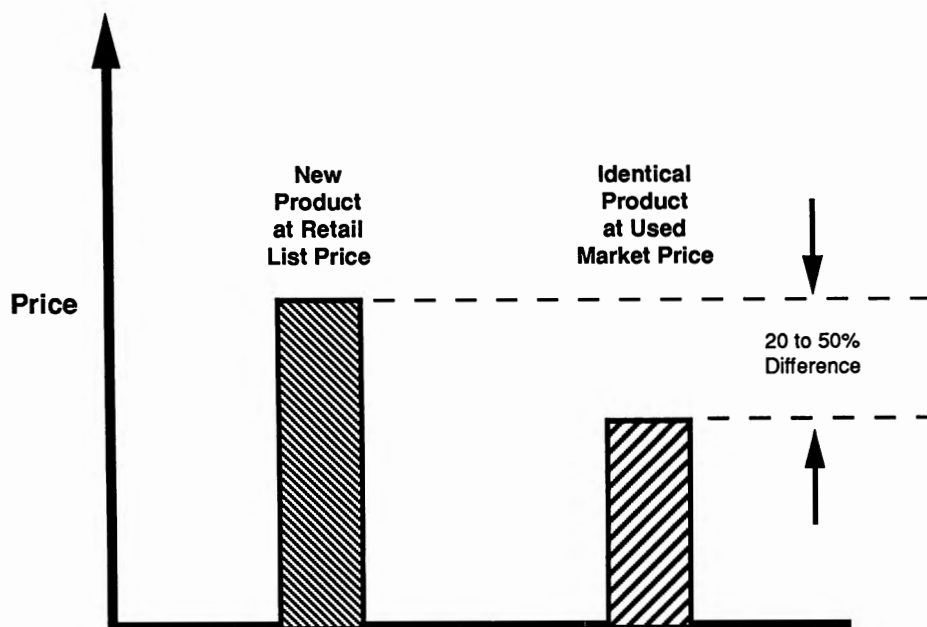
As older systems are replaced by new, they go on to the used equipment market. This market has been in existence for decades for the mainframe and minicomputer manufacturers, for at least five years for the DOS PC makers, and for the last several years as the Macintosh market has reached maturity and critical mass. Actually, used equipment appears in the marketplace for many reasons: corporate and individual users sell their old Macs to buy new ones, dealers liquidate their older inventories, and other dealers go out of business.

Another large source of supply exists. It has existed since the dawn of computer history and neither IBM, DEC, nor Apple likes to talk about it. It is called the *gray market*. Simply stated, in order to meet primary vendor quotas and keep their discount levels, volume users had to offload or sell, without adding any value, a certain amount of their product that could not be used or resold within that month or quarter. Although every primary vendor periodically engages in gray market "witch hunts," woe be it to the reseller who is tagged with the label of a *gray marketeer*. The simple fact of the matter is this practice is necessary and will continue as long as primary vendor discount structures are based on volume incentives.

Still another source of Macintosh supply exists from Apple's developer, education consortium, and regular education market accounts. All these receive Apple products at discounts substantially higher than the dealer channel, and for numerous reasons which neither Apple nor any others care to discuss, some portion of this product finds its way into the used equipment market.

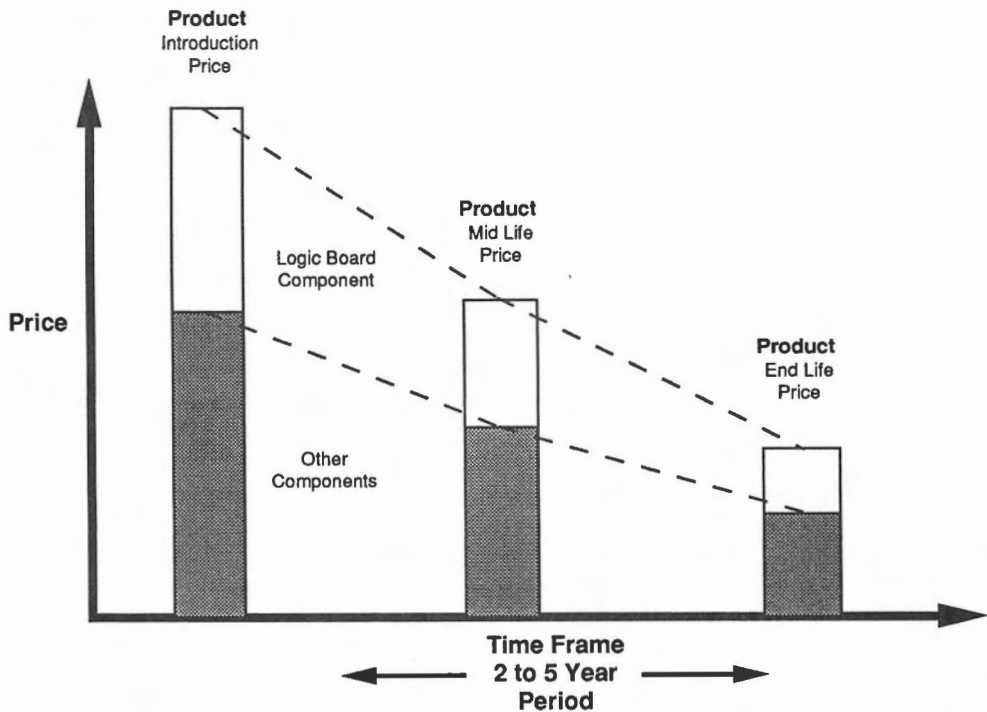
Just as with automobiles, the thriving used Macintosh market supports and assists the new equipment market.⁴ By definition, used systems will always be less costly than new with the difference in price created by the market forces of supply and demand. Figure 1-5 illustrates that an identical product is offered at 20% to 50% discount from its new list price in the used equipment market. The difference in price being attributed to age, condition, accessories, etc.

Systems on the used equipment market decline in price with time as Fig. 1-6 illustrates. In Fig. 1-6, logic board and other components of the system price are shown along with the logic board's tendency to become a less significant part of the system price with time, although market supply and demand forces sometimes check and even reverse this trend. For example, the latest new Macintosh SE 30 price (with extended keyboard) is \$4098. The SE 30 upgrade logic board had a new list price from Apple of \$1699 plus the value of an SE board (about 60% of the total). A Mac 128 originally offered for \$2495 in 1984, today sells for \$200 in the used equipment market; its logic board sells for \$50 (25% of the total).



1-5 Used equipment market pricing.

⁴Deborah Branscum, "Stalking the Used Mac," *Macworld*, August 1989, p. 57.



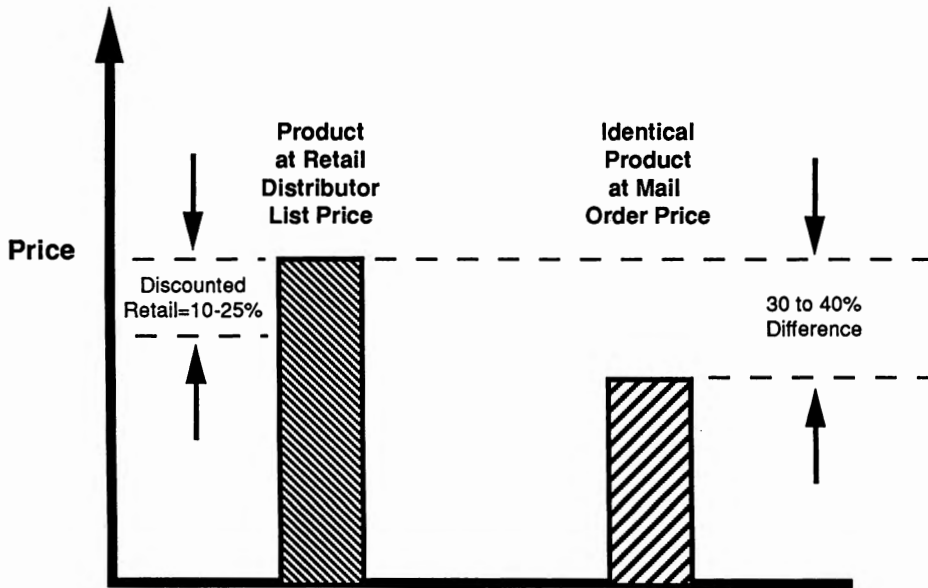
1-6 Decline in used equipment price with time.

What does all this mean to the Cat Mac builder? Unlike automobiles, logic boards don't wear out yet they decline in price with time. An absolutely wonderful situation for the Cat Mac builder. A "used" Macintosh logic board is perfect for use as the heart of your new Cat Mac system, whose other parts are probably all brand new.

Trend four: Mail order vendor performance

Mail order evolved as a viable channel of distribution of microcomputer parts as more sophisticated users required less support but wanted better pricing. Minus the need for the support overhead of the dealerships or chains, yet with the capital to obtain the same purchasing economies of scale, these mail order resellers could pass products on to the end user at nearly the discount levels as the industrial distributors did to their wholesale clients.

Figure 1-7 illustrates the mail order advantage. Identical products to those sold via the retail channels are offered at a 30% to 40% discount from list price. The retail channel also offers discounts, typically the 10% to 25% range, but cannot compete with mail order because of the higher "people" costs (outbound and retail sales and support personnel) plus the "bricks and mortar" costs (storefront and finished office facility). The mail order channel needs neither expensive people (they can multiplex their telemarketing sales and support personnel) nor facilities (they can operate out of little more than a warehouse). All they need to do is



1-7 Mail order market pricing.

present a “clean” image to the buyer over the phone and via their catalog and provide good service and prompt delivery.

And they do. I once ordered a floppy disk from MacWarehouse in New Jersey at 4 P.M. my time (I live in Oregon). They delivered it at 9 A.M. in the morning the next day. That’s good service and prompt delivery!

What does this mean to the Cat Mac builder? No matter what products are developed, it is guaranteed that the mail order distribution channel will continue to deliver to users at the best price.

One of the few guarantees in life

As a Cat Mac builder, you benefit from one of the few guarantees in life. Because of these four trends I just discussed, building your Cat Mac will always be less expensive than buying a discounted new system. To summarize them again:

- Primary vendors such as IBM, DEC, and Apple must always provide increased price performance in their new models, thus obsoleting the old and riving them to the used equipment market.
- Third-party vendors must always provide cheaper and/or faster add-on or add-in products than the primary vendors.
- Used equipment must always cost less than the same equipment purchased new and used equipment prices decline with time. Logic boards also decline in price with time yet they don’t wear out.
- Mail order vendors must always be the least expensive distribution channel from which products can be purchased.

And unless some other market forces change the rules, you can expect these trends will continue indefinitely into the future.

The future

Whatever Macintosh you are now using or plan to use, it is virtually certain that a slicker, faster, cheaper, or lighter one will be developed in the future. Just as new models roll off the Detroit auto assembly lines each year, the marketplace in its quest for better price/performance and Apple's stockholders in their quest for profits, demand continued Macintosh improvement and innovation. The third-party vendors, whose product cycles are even shorter than Apple's, are even more intensely driven by change to excel.

You, the astute Cat Mac Builder and Macintosh user, are the real beneficiary of this change because you can work it to your advantage. Just as you wouldn't necessarily buy a new auto each year, unless the price of a new car represents only a week's allowance or is merely pocket change to you, it isn't necessary to always buy the latest Macintosh model either. You can add enhancements to the Cat Mac or Macintosh model you have, get the maximum value out of it, and save your big outlays for those times when there have been major changes (improvements!) made to the Macintosh product line. Keeping in mind, of course, the XIVth corollary of Murphy's Law which loosely translated states, "Never buy serial number 0001 of anything—wait for others to test the new, improved model to verify that it is improved and continues to work after it is new."

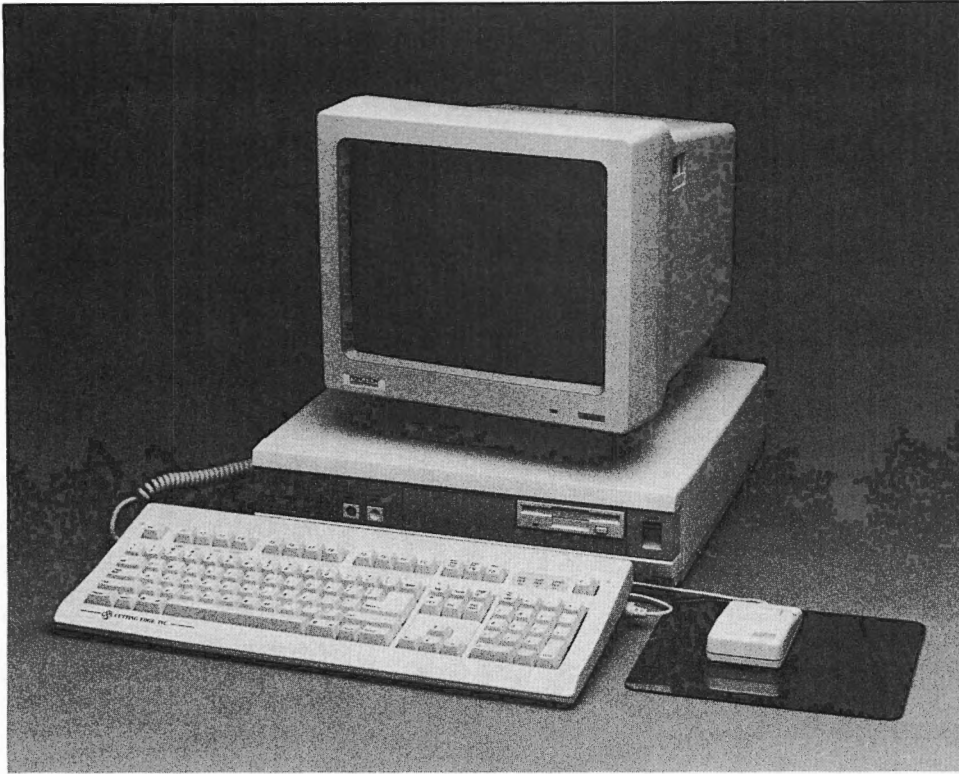
2

CHAPTER

How much you can save

When you take a trip, you usually decide on your destination first. Same with building your own Cat Mac. Normally, you are starting from someplace. You have no Mac, you have a 128 Mac, a Mac SE, etc. You have a destination, a goal, an objective. You want to build a Cat Mac from the ground up but keep it under \$2000. You want to get the best price/performance and money is no object. (Please call me. My daytime number is . . .) You want to add a video monitor or hard disk to your existing Mac. Regardless of what you want to do, it helps to first list your options. Then you can narrow down your list to home in on your objective.

Of course, just about everyone's final objective is different. That's the beauty of building your own Cat Mac. You control the outcome, you're in control of your own destiny. If you want a larger disk, put one in. A bigger monitor, add it on. If you don't want to spend as much, scrounge for better prices on parts or go the used or bartered parts route. In any event, the choices are practically limitless and totally up to you. Figure 2-1 shows an example of completed Cat Mac project. Besides, once you have your own expertise, you can add enhancements neither Apple nor anyone else has thought of and be able to market it for a few bucks, thus reducing the cost of your machine even further!



2-1 A Cat Mac SE in my preferred chassis, a low-profile PC case.

The availability of newer products might mean you change what you build and how you build it. However, the approach outlined here has stood the test of time and will be useful to you regardless of what you do or how you do it.

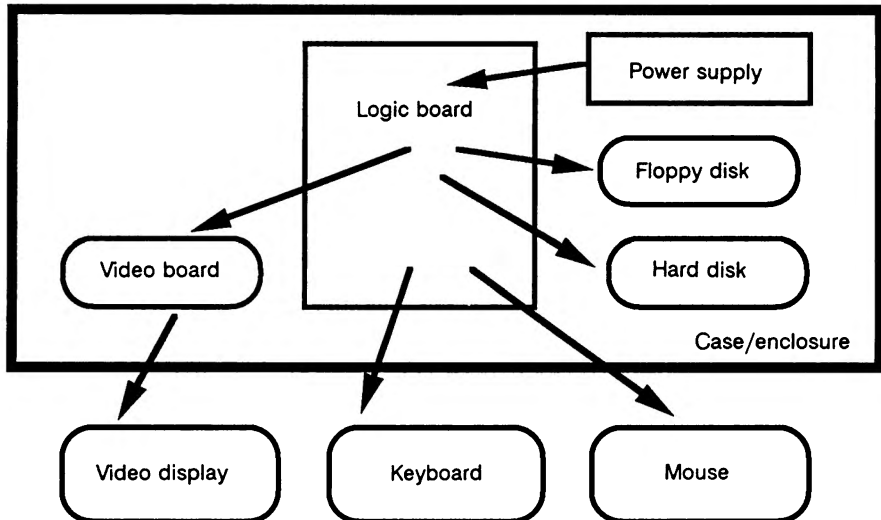
In other words, you will always be able to begin with a standard Apple Macintosh logic board¹ available in the used marketplace from a number of sources at a worthwhile price, put it into the chassis of your choosing, wire it up to have your power supply provide the voltages needed by the board you are using, and add the other components that make up your Cat Mac to finish your project as you choose. It will always be possible to do this at a price that is lower than buying a new Macintosh.

How much can you save by building your own Macintosh? You determine that by deciding what kind of Macintosh you want to build. That, in turn, is determined by the costs of the parts (or building blocks or modules) you put into your Cat Mac. This chapter will focus on costs; Chapter 4 focuses on the performance aspects.

¹Existing Macintosh 128 through Mac IIx logic boards are covered in this book. You will have to research future, not-yet-released, logic boards yourself.

The Macintosh block by block

To assist you, the Cat Mac builder, in evaluating the cost alternatives of any decision you make, let's take a look at the modules that make up every Macintosh model including your Cat Mac. Later chapters cover each one of these in detail. The block diagram in Fig. 2-2 shows the relationship between the modules described next.



2-2 The Cat Mac module or building blocks.

Logic board and memory The heart of your Cat Mac and usually most expensive part ranges in cost from \$50 for a Mac 128 to \$2000 for a Mac IIfx logic board. Mac IIfx logic boards to upgrade your Mac II are aggressively priced by Apple at \$2999 plus your Mac II logic board in trade. Logic boards and memory are discussed in Chapter 4. All other decisions are subordinate to and dependent upon your choice here. Accelerator cards would also logically be grouped with this module, but to keep the comparisons focused and simple, they have been left out of this chapter's cost tradeoffs, and they are discussed in Chapter 5.

Hard disk drive The second most important and expensive part after the logic board ranges in cost from \$250 for a Seagate 20Mb 5¹/₄" hard disk on up to thousands of dollars for higher capacity/speed drives. Your Cat Mac's performance is mainly determined by your hard disk and logic board choices. Hard disks are discussed in Chapter 6.

Floppy disk drive The floppy disk drive is the main input/output and archival storage device for your Cat Mac. The 800K bytes model, available from numerous mail order sources at \$150, is the best one to use today for the reasons discussed in Chapter 7.

Video display and video board These form the visual interface to your Cat Mac. Every Cat Mac builder enjoys the advantage of selecting up front exactly the type of monitor needed. The Princeton MAX 15 14" multisync monitor at \$250 gives good flexibility and performance for the price. The Power R video module at \$100 plugs directly into your Mac 128 through Mac SE 30 logic board and enables you to drive any multisync monitor. Monitors and video options are discussed in Chapter 8.

Keyboard and mouse The keyboard and the mouse compose the main user interface for your Cat Mac. There are many quality third-party manufacturers today, but the Ehman ADB extended keyboard at \$100 and Mouse Systems A + ADB optical mouse at \$80 are good performers. Keyboard and mouse options are discussed in Chapter 9.

Power supply This is another Cat Mac advantage as many PC power supplies provide more than enough power. A 150 watt supply is more than adequate for your Cat Mac and is available at \$60.

Case/enclosure The housing is a Cat Mac advantage as many PC cases provide almost total flexibility in housing. A PC/XT case is available at \$40. Figure another \$20 for miscellaneous cables, connectors, and other parts you might need to finish building your Cat Mac. Chapter 10 covers chassis, wiring, and power supplies.

Logic board cost overview

Logic board costs are definitely a moving target varying almost daily with supply and demand, new product introductions, Apple policies, and who you talk to. Those summarized in Table 2-1 and used throughout the book were taken from reliable used equipment sources' published data. Your personal negotiation skills and scrounging abilities might enable you to do much better.

Two of Apple's newest Macintosh logic boards are not included in Table 2-1; these are hot 25 MHz Mac IIcx and the top of the line 40 MHz screamer, the Mac IIfx. They are too new to be readily available in the used equipment channels yet. For rough comparison purposes, Apple priced the upgrade kits for the Mac IIci and the Mac IIfx at \$2399 and \$2999. You complete the transaction by trading in your Mac IIcx or Mac II logic boards, respectively.

Here are a few summarizing points about Table 2-1 and other Apple Macintosh logic boards not in the table, followed by my overall logic board recommendations:

- All the logic boards have 1Mb of memory, SCSI ports and at least 128K ROMs. In other words, all low-end logic boards are at least the equivalent of a Mac Plus.

- Because of the need to add 128K ROMs, the Mac Plus board is actually more expensive than the Mac SE board, even though it has less capability and performance.
- Building up a Mac Plus board from a 128 or 512 board is actually less expensive at this time.
- The SE 30 boards costs less than a Mac II board at this time, but doesn't give you the flexibility of the Mac II's color options or six expansion slots.
- If you only need three expansion slots, the Mac IICx logic board, while more expensive than the Mac II, is a better choice, because it already has a 68030 chip.
- The Apple IICi offer of \$2399 plus your existing IICx board in trade is not as good as their IIFx offer of \$2999 plus your existing Mac II board in trade. Which would you rather have? The IIFx? Me too.
- The Mac IIFx upgrade offers the Cat Mac builder a very attractive "special situation" that I explore later in this chapter.

My advice to the Cat Mac builder is to go with an SE board at the low end; if not, upgrade a 128 or 512 board. Go with an SE 30 at the high end. Buy a IICx versus the SE 30 logic board if you need speed plus slots plus color now and don't want to spend almost twice as much for the Cat Mac version of Apple's top of the line IIFx model. If you just need speed, stick with the SE 30 logic board to save money.

Best news of all the Cat Mac builder is Apple's aggressive IIFx upgrade price of \$2999. If you own a Mac II now, this means you can get top of the line performance at a very attractive price. If you don't own a Mac II, it means you can buy one in the used equipment marketplace, get color and lots of slots now, and upgrade it now or later with the IIFx kit and FDHD kit and save a bundle over Apple's list pricing.

Table 2-1 Costs for 1Mb Macintosh logic boards.

Component	128K	512K	Plus	SE	SE 30	II	IICx
logic board ¹	50	200	450	500	1100	1400	1900
256K SIMMs	100	50 ²	100	100	100	100	100
128K ROMs	125	125	125	—256K ROMs included—			
SIMM-SCSI upgrade	250	250	—	—	—	—	—
total	525	625	675	600	1200	1500	2000

¹Summary of logic board prices quoted from Maya Computer, Micro Exchange, Pre-Owned Electronics, and Shreve Systems in March 1990. SIMM-SCSI upgrade board price is from Newbridge or Computer Care. Conservative pricing was used so you should be able to do as well or better.

²The upgrade boards use the memory on the 512K logic board to only 2 extra 256K SIMMs are required.

Cat Mac cost overview

How much can your Cat Mac SE save you? In 1988, Eric Winn wrote an interesting article in *Macworld*² that dissected an Apple Macintosh SE in terms of its component module manufacturing costs. His figures are dated today because Apple's automated manufacturing capability (its people, machines, and processes) is perhaps the best in the entire computer industry at squeezing out costs. I built Table 2-2 using Winn's 1988 SE Manufacturing cost figures, compared them against a standard list price 1990 Apple Macintosh SE,³ using Winn's cost ratios as a multiplier to arrive at its component costs, and then against a 1990 Cat Mac SE's actual costs.

Table 2-2 The Apple Macintosh SE cost vs. the Cat Mac SE cost.

Module	Mac	Mac	Cat Mac
	Manufacturing cost	list price	cost
SE logic board	200	1036	600
20Mb hard disk	250	1295	250
800K floppy disk	50	259	150
keyboard ¹	15	229	100
mouse	8	42	80
video display (multisync)	15	78	250
video board (power supply)	32	166	60
case/enclosure	7	36	40
miscellaneous	11	57	120
total	588	3198	1650

¹Apple Extended Keyboard list price of \$229 was added to Mac SE 20 list price of \$2969 to get the \$3198 price. The \$2969 figure was used to prorate the list price per the manufacturing cost. The Cat Mac used an equivalent third-party extended keyboard.

Now you might remark that a TV set certainly contains circuitry more complex than that of the Macintosh yet it sells for one-tenth the price (\$300 versus \$3000). But TVs are manufactured by the millions whereas Apple only makes Macs by the hundreds of thousands. Also, Apple is amortizing a substantial marketing and engineering cost over each Mac sold. The article's comment, "When you're the only game in town, the price of admission isn't negotiable," is probably accurate.

What does all this mean to you the Cat Mac builder? Using state-of-the-art, automated, robotic, assembly machines using the highest quality reliable components Apple has manufactured, your Cat Mac logic board, the part that enables you to save money. If you don't appreciate it in your Cat Mac chassis, you can

²Eric Winn, "How Much Does a Mac Cost?," *Macworld*, June 1988, p. 114.

³Apple Price List, March 19, 1989, Apple Computer, Inc, Cupertino, CA.

mount it on your wall. An Apple logic board, any of them, but especially the most recent models, are truly a work of art in addition to being an engineering and manufacturing marvel.

Unlike used automobiles, used Macintosh logic boards don't wear out. As a Cat Mac builder, you are in the incredible position of being able to purchase a logic board whose price has declined with time but whose capability to perform for you has not changed at all. The \$1650 retail price of your Cat Mac SE 20 based on an Apple SE logic board shown in Table 2-2 is not done with mirrors. It is a 48% saving off the list price of an Apple Mac SE 20 available to anybody off the street today via mail order or catalog sources. This is what first attracted me to the idea of building my own Cat Mac. For a comparison to begin with, look at the Apple Macintosh new machine pricing in Table 2-3.

Table 2-3 The March 1990 Price List for the Apple Macintosh models.

CPU type ¹	68000	68020	68030
Macintosh Plus	1799 ²	—	—
Mac SE CPU/2-800K	2798	—	—
Mac SE 20	3198	—	—
Mac SE 40/2Mb	3598	—	—
Mac SE 30	—	—	4098
Mac SE 30/HD 40	—	—	4598
Mac SE 30/HD 80/4Mb	—	—	5798
Mac II ³	—	5696 ⁴	—
Mac II/HD 40	—	6996	—
Mac II/HD 40/4Mb	—	8196	—
Mac Iix	—	—	6096
Mac Iix/HD 40	—	—	6796
Mac Iix/HD 80/4Mb	—	—	8496
Mac Iicx	—	—	5496
Mac Iicx/HD 40	—	—	6196
Mac Iicx/HD 80/4Mb	—	—	7896
Mac Iici	—	—	6898
Mac Iici/HD 40	—	—	7598
Mac Iici/HD 80/4 Mb	—	—	9298
Mac Iifx	—	—	9796
Mac Iifx/HD 80/4Mb	—	—	10696
Mac Iifx/HD 160/4Mb	—	—	11796

¹Apple Price List.

²The Extended Keyboard at \$229 was added to all prices after the Macintosh Plus to make the price comparisons equivalent to the Cat Mac configuration. The standard keyboard is available at \$129.

³The Mac II does not actually appear on the Apple March 1990 price list. It was allowed to die a quiet death and is included here for comparative purposes only.

⁴In addition to Extended Keyboard, an Apple Hi-Res 12" Mono Monitor at \$399 and 1-bit video card at \$199 were added to all the Mac II, Iix, Iicx, Iifx models to make the price comparisons uniform. No additional video card is needed for the Mac Iici.

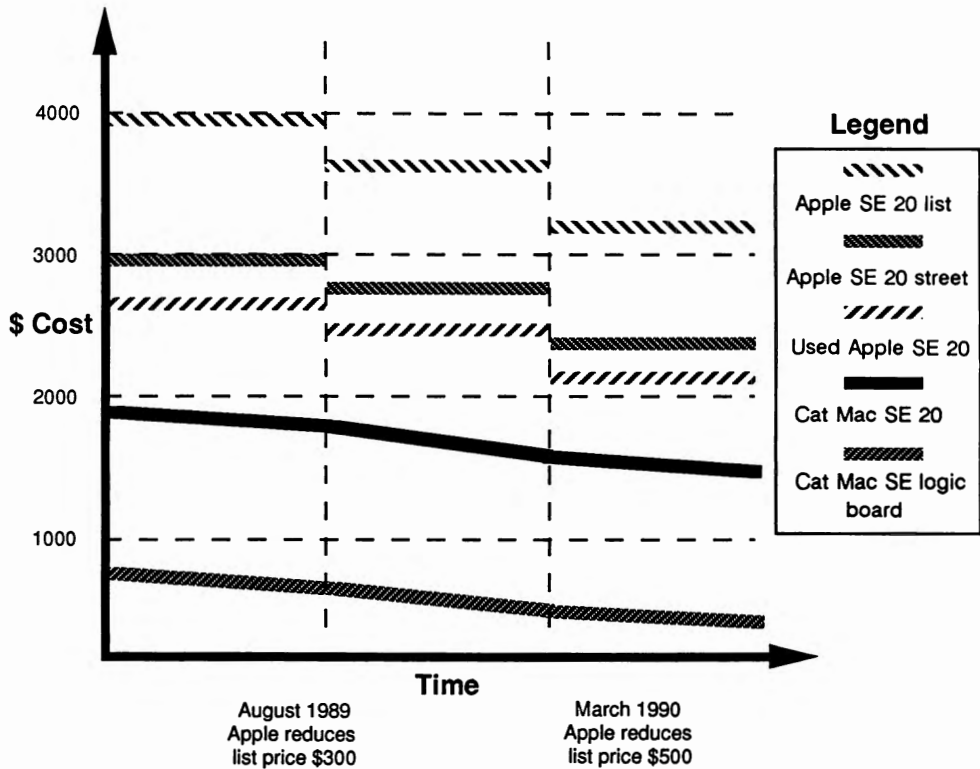
Table 2-3 compares the Macintosh models on the March 1990 Apple Suggested Retail Price List except for the Portable, which will be dealt with in Chapter 3. After looking at Apple list prices, you are probably curious as to how much a Cat Mac can save you over the Apple prices and which are the best Cat Mac Model choices. The balance of this chapter is devoted to just that subject. The Apple list prices of Table 2-3 are just numbers on a piece of paper—numbers which will seem low to some readers, high to others. Let me depart briefly into the subject of “real world” prices to clear up the confusion.

Apple Macintosh real world pricing

In some parts of the world, the Apple U.S. dollar list prices quoted in Table 2-3 would be low. Export *uplifted* prices seem to average about 35% above list. On the other hand, in some parts of the United States (New York City and Los Angeles for example) typical *street* price discounted prices seem to average 30% below list. In addition, Apple is continuously playing with its dealer costs via various incentive programs and outright adjustments. Beyond that, there is the used Macintosh local and mail order market to consider. An *overhang* of used models in any particular geographic area or in the national mail order channel tends to depress the street value of new models even further. This typically occurs several months after a new model is introduced and Apple Developers and Value Added Resellers (who purchase at 40–50% off list), Apple Education and Consortium Accounts (who purchase at 40–50% off list), dealers (40% plus), and Apple itself (60% plus) liquidates its older inventory to free up capital and make room for the new models.

What does this mean to you the Cat Mac builder? Look at Fig. 2-3. It shows a snapshot of the different prices in action during a several month period from August 1989 through March 1990 for one popular model, the Macintosh SE20 with the extended keyboard. Five separate price lines to follow are in Fig. 2-3. Let's look at each one.

Apple SE 20 list price This started out at \$3998. Apple dropped their list price by \$300 in August 1989. When Apple did this, the street price and used price, which are tied directly to it, also immediately dropped. In other words, when you woke up the next day and read in the morning paper of the price reduction, your own personal Macintosh SE 20 model had also dropped in price (and of course numerous dealer inventories with that model in it, but dealers receive “price protection”). In March 1990 Apple dropped the list price again, this time by \$500 to \$3198. Again it had immediate impact on the street and used prices. To keep Fig. 2-3 uncluttered, I omitted the reduction of December 31, 1989, where Apple dropped their dealer costs without changing their list price.



2-3 Variation of Apple Macintosh and Cat Mac SE 20 costs during a recent 6-month period.

Apple SE 20 street price This averages roughly 20 to 30% off list so it started out at about \$3000 and at the end was about \$2400. This price is tied to the Apple list price but is usually a “whatever the traffic will bear” phenomena driven by supply and demand in a given geographic area. The simple fact of life is buyers in a city with many dealers and alternate sources pay less than buyers in cities with fewer dealers.

Used Apple SE 20 price This is typically about \$300 lower than the street price so it started out at about \$2700 and at the end was about \$2100. This price is also tied to the Apple list price and also a “whatever the traffic will bear” phenomena, but it is driven by supply and demand in the new and used equipment distribution channel, a much broader geographic market. In any given “spot” market, the price can vary widely. Do you need to sell your Mac SE 20 today for a downpayment on your new car? You might take a lot less for it, etc. Or the converse: Mr. Smith, I can get you those ten used SE 20s today but you’re going to have to pay a little extra for them, etc.

Cat Mac SE 20 price This price is driven by the cost of the SE logic board, typically the most expensive module, to which all of the other third-party vendor module costs are then added. It started out at about \$1900 and at the end was \$1650. It is tied only indirectly to the Apple list price and tends always to go downward as more cost effective third-party modules are introduced and the logic board declines in price with time.

Cat Mac logic board This price is only a composite of what it could be obtained for on the used equipment marketplace. At any given time, its "spot" price can vary widely and is more dependent on its availability on a given reseller's shelves than any Apple list price or price reduction. To the delight of the Cat Mac builder, its price slowly but relentlessly decreases with time. It started out at \$800 and at the end was \$600.

That was the real world of prices. Notice how the passage of time validated the main premise of this book. Apple dropped their SE prices twice but logic board prices also dropped and the ratios stayed the same. You still save 50% by building your own Cat Mac.

Now a look at how each of the Cat Mac Models compares with its Apple Macintosh counterpart and how much you can save.

Cat Mac SE vs. Apple SE

Using mail order list prices available to anyone, let's build up a Cat Mac SE 20 equivalent to the Apple Macintosh SE 20Mb model, and compare it feature for feature with the Apple model as shown in Table 2-4.

With the Cat Mac SE 20, you save \$1550 (\$3200 - \$1650) over the cost of Apple's SE 20 offering or 48%. You've saved almost half off the price of a standard Apple Mac SE 20. In addition, you have a larger 14" high-resolution multi-sync monitor, an identical extended ADB keyboard, an ADB optical mouse, a

Table 2-4 The Apple Macintosh SE 20 cost compared to a Cat Mac SE 20 cost.

Item	Apple Mac SE	Cost	Cat Mac SE	Cost
logic board	standard SE	—	identical	600
memory	1Mb SIMM	—	identical	—
hard disk	standard 3 1/2" 20Mb	—	Seagate 5 1/4" 20Mb	250
floppy disk	Sony 800K	—	Fujitsu 800K	150
keyboard	Apple ADB extended	—	Ehman ADB extended	100
mouse	Apple standard ADB	—	A + Optical ADB	80
video display	9" monochrome	—	Princeton Max-15 (multi)	250
video board	with power supply	—	Power R cable	100
power supply	76 watts maximum output	—	150 watts nominal	60
case and misc.	standard SE	—	larger PC case	60
expansion	1 slot in case	—	1 slot, but room for more	—
total price	—	\$3198	—	\$1650

heftier 150 watt power supply and fan, the same capacity hard disk, and more chassis expansion room. On the downside, you only have an 800K floppy versus the Apple FDHD drive but Chapter 7 shows why that might not be that important to you.

Cat Mac SE 30 vs. Apple SE 30

Let's do the same thing with the SE 30. Using mail order list prices available to anyone, let's build up a Cat Mac SE 30 equivalent to the Apple Macintosh SE 30/HD 40 model, and compare it feature for feature as shown in Table 2-5.

Table 2-5 The Apple Macintosh SE 30/HD 40 cost compared to a Cat Mac SE 30 cost.

Item	Apple Mac SE 30	Cost	Cat Mac SE 30	Cost
logic board	standard SE 30	—	identical	1200
memory	1Mb SIMM	—	identical	—
hard disk	Quantum 3 ¹ / ₂ " 40Mb	—	identical	400
floppy disk	Sony FDHD	—	Fujitsu 800K	150
keyboard	Apple ADB extended	—	Ehman ADB extended	100
mouse	Apple standard ADB	—	A + Optical ADB	80
video display	9" monochrome	—	Princeton Max-15 (multi)	250
video board	with power supply	—	Power R cable	100
power supply	76 watts maximum output	—	150 watts nominal	60
case and misc.	standard SE	—	larger PC case	60
expansion	1 slot in case	—	1 slot, but room for more	—
total price	—	\$4598	—	\$2400

With the Cat Mac SE 30, you save \$2200 (\$4600 – \$2400) over the cost of Apple's SE 30 offering or 48%. You've saved almost half off the price of a standard Apple Mac SE 30. In addition, you have a larger 14" high-resolution multi-sync monitor, an equivalent extended ADB keyboard, an ADB optical mouse, a heftier 150 watt power supply and fan, the identical hard disk, more chassis expansion room, and a longer warranty period. Again, on the downside, you only have an 800K floppy versus the Apple FDHD drive but Chapter 7 shows why that might not be that important to you. It still sounds like a worthwhile tradeoff. Doesn't it?

Cat Mac II vs. Apple Mac II

Now let's look at the Mac II. At the time of this writing, the Pre-Owned Electronics people⁴ have an extremely attractive deal working on the Mac II. Because of the special situation existing right now of Apple artificially obsoleting the Mac II in favor of its newer 68030 models, you have the identical Apple configuration,

⁴From Pre-Owned Electronics, March 1989. The \$2100 package includes Mac II Logic Board, 1 Mb RAM, 800K Floppy, Power Supply and Mac II Case.

case, keyboard, monitor and all, but built up from parts and save \$3920 (\$7000 – \$3080) or 56%. Table 2-6 shows the details. You could say that Mac IIs are a real bargain at this time.

Table 2-6 The Apple Macintosh II/HD 40 cost compared to a Cat Mac II/HD 40 cost.

Item	Apple Mac II	Cost	Cat Mac II	Cost
logic board	standard Mac II	—	identical	2100
memory	1Mb SIMM	—	identical	—
hard disk	Quantum 3 1/2" 40Mb	—	identical	400
floppy disk	Sony 800K	—	Sony 800K	included
keyboard	Apple ADB extended	—	Ehman ADB extended	100
mouse	Apple standard ADB	—	A + Optical ADB	80
video display	Apple Hi-Res monochrome	—	Princeton Max-15 (multi)	250
video board	Apple 1 bit	—	identical	150
power supply and case	standard Mac II	—	identical	included
total price	—	\$6996	—	\$3080

Cat Mac IIfx vs. Apple Mac IIfx

A very "special situation" is created by one of the line items in Apple's announcement for their top of the line wonder machine, the 40 MHz, 68030-based Mac IIfx. Apple has aggressively priced their Mac IIfx "upgrade" kit at \$2999. As a Mac II to Mac IIfx kit costs \$2199 and the Mac IIfx kit does far more, it is really an exceptional offer. Apple is definitely seeking to unlock the puzzle of how to tap the wallets of the estimated 400,000 Mac II and Mac IIfx owners with this upgrade.

Table 2-7 The Apple Macintosh IIfx/HD 40 cost compared to a Cat Mac IIfx/HD 40 cost.

Item	Apple Mac IIfx	Cost	Cat Mac IIfx	Cost
logic board	standard Mac IIfx	8969	identical	5100
memory	1Mb SIMM	—	identical	—
hard disk	Quantum 3 1/2" 40Mb	400	identical	400
floppy disk	Sony FDHD	—	Mac II FDHD upgrade kit	600
keyboard	Apple ADB extended	229	Ehman ADB extended	100
mouse	Apple standard ADB	—	A + Optical ADB	80
video display	Apple Hi-Res monochrome	339	Princeton Max-15 (multi)	250
video board	Apple 1 bit	199	identical	150
power supply and case	standard Mac II	—	identical	included
total price	—	\$10196	—	\$6680

See the result in Table 2-7. Start with the attractive Pre-Owned Electronics deal on the Mac II just mentioned. Trade your local Apple dealer the Mac II board out of it in exchange for the Mac IIfx upgrade kit and add the FDHD upgrade kit. Result: you have a Cat Mac IIfx with the identical Apple configuration—case power supply and all—built up from the new Apple IIfx upgrade kit and save \$3516 (\$10,196 – \$6080) or 34%. As a Cat Mac builder you save over \$3500 on Apple's latest top of the line machine—not too shabby.

Cat Mac IICx vs. Apple IICx

Now lets move to the high-end IICx. Again using mail order list prices available to anyone, let's build up a Cat Mac IICx equivalent to the Apple Macintosh IICx/HD 40 model, and compare it feature for feature as shown in Table 2-8.

With the Cat Mac IICx, you save \$2920 (\$6200 – \$3280) over the cost of Apple's SE 30 offering or 47%. You've saved almost half off the price of a standard Apple Mac IICx. In addition, you have the same Apple high-resolution 12" monochrome monitor and video card, an equivalent extended ADB keyboard, an ADB optical mouse, a heftier 150 watt power supply and fan, the identical hard disk, more chassis expansion room, and a longer warranty period. On the downside, you have no automatic power on from your ADB keyboard and again only have an 800K floppy versus the Apple FDHD drive. Chapter 4 and 7, respectively, discuss why these might not be that important to you.

Cat Mac IICi vs. Apple IICi

As of this writing, Mac IICi logic boards are scarce as hen's teeth and very expensive, so you really can't build one today. But wait 6 to 12 months or so. The same industry phenomena responsible for bringing you a Mac 128 at \$2495, whose

Table 2-8 The Apple Macintosh IICx/HD 40 cost compared to a Cat Mac IICx/HD 40 cost.

Item	Apple Mac IICx/HD 40	Cost	Cat Mac IICx	Cost
logic board	standard Mac IICx	—	identical	2000
memory	1Mb SIMM	—	identical	—
hard disk	Quantum 3 1/2" 40Mb	—	identical	400
floppy disk	Sony FDHD	—	Fujitsu 800K	150
keyboard	Apple ADB extended	—	Ehman ADB extended	100
mouse	Apple standard ADB	—	A + Optical ADB	80
video display	Apple Hi-Res monochrome	—	Princeton Max-15 (multi)	250
video board	Apple 1 bit video card	—	identical	150
power supply	standard Mac IICx	—	150 watts nominal	60
case and misc.	standard Mac IICx	—	larger PC case	90
expansion	3 slots in case	—	identical	—
total price	—	\$6196	—	\$3280

logic board you can now buy for \$50, will also put a Mac IIci logic board in your hands at a reasonable price. Meanwhile you can certainly replicate the IIci's performance with other existing logic boards and accelerator options. So if you have to, you can get IIci performance today.

Recommended Cat Mac systems you can assemble

As Tables 2-4 through 2-8 show, your Cat Mac project can save you 34 to 56% over an equivalent Apple Mac system. This is with Cat Macs built up from standard Apple logic boards or entire systems in the case of the Mac II. Thus far the Cat Mac has been compared to the respective Apple models. Now let's move ahead and compare the different Cat Mac options among themselves and give you a recommendation.

Recalling back to Table 2-1, the Cat Mac SE should leap out at you as an outstanding value. Versus a Mac Plus or anything lower, if you start with an SE logic board, it is more powerful to begin with, will take you less time to build, offers more expansion options down the road, and it runs all the popular Mac software. Yet it costs less than the Plus logic board (or 512)! Chapter 4 will show you some additional benefits of starting with the SE logic board versus the Plus version.

Actually, you shouldn't build anything less than a unit starting with an SE logic board in it, a 40Mb hard disk, a high-resolution multisync monitor, and a video driver cable/adaptor card. (In other words, the systems shown in Table 2-9.) Why? Because not only does building them make dollars and sense to do, but it's guaranteed you will enjoy the results more. Let's look at them again.

After adding on all the peripherals, Table 2-9 verifies my recommendations following Table 2-1: Go with an SE board at the low end; if not, upgrade a 128 or

Table 2-9 Recommended Cat Mac systems cost comparison.

Module	Cat Mac SE	Cat Mac II	Cat Mac SE 30	Cat Mac IIcx
logic board/1Mb RAM	600	2100	1200	2000
Quantum 40Mb hard disk	400	400	400	400
800K floppy disk	150	included	150	150
Ehman ADB extended keyboard	100	100	100	100
A+ ADB Mouse	80	80	80	80
Princeton Max-15 multisync	250	250	250	250
Power R cable	100	—	100	—
Apple 1-bit video card	—	150	—	150
chassis, power supply, misc.	120	included	120	150
Cat Mac Totals	1800	3080	2400	3280

512 board. Go with an SE 30 at the high end. Buy a IICx versus the SE 30 logic board if you need speed plus slots plus color now and don't want to spend almost twice as much for the Cat Mac version of Apple's top of the line IIfx model. If you just need speed, stick with the SE 30 logic board to save money.

Not recommended Cat Mac systems you can build

At the other end of the spectrum, you can build an entry level Cat Mac for a little more than \$400 using the Mac 128 logic board, the 400K older style floppy drive, and the 64K ROM set and used parts for the other items wherever permitted. You can also use an inexpensive TTL monitor and build your own video card. Table 2-10 shows the costs associated with doing this as well as those for building the other traditional Macintosh family members from catalog parts. The Mac 128 shown in Table 2-10 is with used parts, except monitor and case; all the other Cat Macs are shown with new parts. Table 2-10 is not recommended for you to do, it is only intended to show the possibilities available for a hobbyist or for a low utilization (perhaps a word processing only) Mac user. From a cost standpoint, it is also difficult to justify anyone building a Mac 128 for \$430 when you can buy a used one for \$200, a Mac 512KE for \$975 when you could buy a used one for \$700; or a Mac Plus for \$1275 when you could almost buy a new one for that price. Now the Mac SE—that's another story. It still looks real good!

Not obvious from Table 2-10 is that, although you can save money by going the build-it yourself custom video card and low-end Samsung monitor route, you are talking about a nontrivial investment of your time and energy to do so versus going with the 14" monochrome multisync monitor and buying a driver cable already built for it. In Chapter 8, you will see that the results are not all that good

Table 2-10 Cost comparison of the not recommended Cat Mac systems.

Module	128 (used)	512KE	Mac Plus	Mac SE
logic board	50	200	450	500
256K SIMMs	—	50	100	100
400K floppy	50	—	—	—
800K floppy	—	150	150	150
128K ROM chips	—	125	125	—
keyboard	50	130	130	100
mouse	50	70	70	80
Samsung 12" monitor	75	75	75	75
custom video board	25	25	25	25
chassis, power supply, misc.	130	150	150	120
Cat Mac totals	430	975	1275	1150

either. The same can be said for starting with any of the logic boards less than the SE; the complexity of the project and the time you spend just isn't worth what you get for it versus starting with the SE logic board platform.

Once you build your Cat Mac, it only gets better. Each step you take opens you up to more future possibilities. You also gain the knowledge and experience to do more innovative things, and think of all the fun you will have, plus learning. Plus your wife or husband, friends, or business associates will think you're a genius when you say, "Why, yes, I built it myself."

Sources

The sources for the parts to build your Cat Mac are presented at the end of each chapter. The logic boards prices used in this chapter were provided by the dealers listed. (A more comprehensive listing can be found at the end of Chapter 4.)

Mail order, used Apple Macintosh equipment dealers

MAYA COMPUTER
P.O. Box 680
Waitsfield, VT 05673
800-541-2318

SHREVE SYSTEMS
2421 Malcolm St.
Shreveport, LA 71108
800-227-3971

PRE-OWNED ELECTRONICS
30 Clematis Ave.
Waltham, MA 02154
800-274-5343

3

CHAPTER

Atari, Mac clones, Mac portables

This book would not be complete without at least discussing in passing some of the other alternatives available to the Cat Mac builder because they can also save you time and money even though they might build on a nontraditional, non-Apple Mac logic board platform. Other alternatives are also available today to Apple's Macintosh Portable. And, recalling the message of this book's introduction, these third-party vendors are moving at least as fast as Apple, if not faster, so future announcements from them might be very exciting.

Just as there are few free lunches, there are pros and cons to these Mac alternatives. Quite honestly, the Atari solution, which will be discussed first, impressed me. Several of my friends were equally impressed with Atari's new Stacey portable seen running Mac software at a recent show. But the downside is that you, the Cat Mac builder, must expand your own knowledge base to take full advantage of some of the price performance benefits. Also, their emulator uses 128K ROM chips that are slick in a low-end unit, but they don't measure up across the board to a real SE much less the SE 30 or Mac IIxx family models. The "pure" Mac clones are even more attractive but have a legal downside as you will learn later in this chapter.

The Atari connection

A small classified ad in the local newspaper caught my eye one day because it advertised SE clones with better performance and a lower price than the real thing. Being naturally curious and this being right in my main interest area, I just had to go to their place for a first-hand look. I wound up at a local Atari¹ dealer.

An interview with the dealer was fascinating—especially their positioning of the Atari machine versus the Apple Mac SE. The product being touted as a Mac SE killer was the Atari MEGA 2 with a hard disk and monochrome high-resolution monitor. The interview was followed by receiving a price sheet and additional material summarized in Table 3-1. The price sheet's first item was the following MEGA 2 package: 2Mb RAM, 30Mb hard disk, 800/720K floppy disk, 13" monochrome monitor, enhanced keyboard, and mouse for \$2295 versus the Atari dealer's quoted Mac SE 40/2 price of \$3598 (my visit took place before recent Apple price decreases). The dealer touted the desktop publishing system based on the Atari MEGA 2 or 4 system, along with their SLM804 laser printer and gave a rather convincing argument about its speed and performance advantages over Apple's equivalent. At the \$4495 system price for the combo, even I had to agree it was a good deal. The interview ran as follows:

Q. What exactly is a MacClone?

A. Our MacClones all use the Motorola 68000 processor, same as the Mac SE, but run about 35% faster. This is accomplished with a graphics accelerator chip, direct memory management, and full 8 MHz utilization of the 68000.

Q. Is the monitor any bigger?

A. Yes, 40% bigger. Not only is it bigger, but it is sharper and easier on the eyes. At 90 dots per inch, the resolution is better, and since it is running at 90 Hz, there is no flicker.

Q. How compatible is it?

A. We use real Macintosh ROMs made by Apple. This makes the system compatibility very high. We're not sure how compatible it is because we can't find anything that won't run on it. A few programs we've used are PageMaker 3.01, Microsoft Word 4.0, Excel 1.5, Works 2.0, Illustrator 88, Aldus Freehand, WriteNow 2.0, SuperPaint 2.0, HyperCard 1.2, Cricket Draw, Cricket Graph, Canvas, 4th Dimension, FileMaker Plus, and Ready Set Go.

Q. Can I use Apple printers?

A. Yes, without any problems, but we suggest Panasonic or NEC because of their better price performance ratio over Apple's. Our systems

¹If you want additional information contact any authorized Atari dealer or the Atari Corporation. Atari, the Atari logo, MEGA 2, MEGA 4, SLM804 are registered trademarks of Atari Corporation.

have a standard parallel port built in so you can use any printer without spending more money on a serial interface.

Q. Does it run MS-DOS (IBM) software too?

A. Yes, at either XT or AT speed. AT speed is only a \$299 option.

Q. Will it run in color?

A. Sorry, we have the same limitations as the real Mac as far as color, but there is a color card built into the motherboard so that when you are in IBM mode you can have CGA color graphics.

Q. Bottom line, how much is it?

A. This, of course, depends on how the system is configured, but it usually works out to about half the price of a Mac SE.

In addition, I was shown a working unit and immediately sat down at the keyboard for a test run. The screen looked just like my SE Cat Mac Apple high-resolution monochrome monitor screen although the Atari SM 124 monochrome monitor is manufactured by Goldstar. For a dyed-in-the-wool Mac user of many years standing, such as myself, to admit that the other guys at Atari might have a good idea is the highest form of heresay. Yet, watching their MEGA 2 machine blow away a standard Mac SE on some straightforward Microsoft Word, Microsoft Excel and Aldus PageMaker timings, I became a believer. The first answer in Table 3-1 provides the reason: Atari uses a graphics accelerator chip, direct memory management, and full 8 MHz utilization of the 68000 chip. Similarly, their desktop publishing system is faster to print a page because they use the MEGA

Table 3-1 The Atari Mega vs. the Apple Macintosh SE
(from Atari Mega literature).

Comparison Item	Mega	Mac Se
processor	68000	68000
clock speed	8.0 MHz	7.83 MHz
graphics accelerator chip	yes	no
main memory (standard)	2Mb or 4Mb	1Mb
monochrome monitor size	12"	9"
maximum resolution	640 × 400	512 × 342
RGB monitor size	12"	N/A
maximum resolution	640 × 200	N/A
color palette	512	N/A
maximum colors on screen	16	N/A
Centronics parallel port	yes	no
RS-232 serial port	yes	yes
mouse port	yes	yes
joystick port	yes	no
hard disk port	yes	yes
built-in MIDI port	yes	no
keyboard included	yes	no

system memory and run the data through a much faster Direct Memory Access (DMA) channel rather than a serial port as Apple does.

Gadgets by Small

The most interesting part of the visit was the story about how Atari got to be in the Mac emulation business in the first place, confirmed by an earlier article in *MacWeek*,² which also mentioned a comparable device for the Commodore Amiga 500 and 1000 under development by a Toronto-based company called ReadySoft. It seems that basically a single chap out there pioneered the whole thing. (This in itself was refreshing to hear—that a single individual still can make a difference.)

The individual is Dave Small, now of Gadgets by Small, Inc., which makes the Spectre series of Mac emulators. He started out by designing for another company the Magic Sac which used the Mac 64K ROMs. Now, his company makes the Spectre 128 and Spectre GCR Mac emulators at \$179 and \$299, respectively, which use Mac 128K ROMs. These devices are just small circuit boards, or *carts* in Atari parlance, which the standard Mac 128K ROMs plug into. The boards in turn plug into the Atari MEGA.

According to the dealer, the Spectre GCR requires 128K Mac ROMs and an Atari computer and is fully compatible. It reads and writes Macintosh format diskettes (you “plug and play” with Mac disks; no need to copy Mac disks to Spectre disks) with your Atari disk drive and runs the latest Mac software like HyperCard. The GCR also has an overall speed 20% faster than a Mac Plus, allows a 30% larger screen, and is hard disk compatible.

The envelope please

So what is the bottom line? Let’s do a pro and con look at the Atari connection. The upside is that on one computer with a fast clock speed you can run Mac, DOS, and Atari (of course!) software. The MEGA with Atari’s laser printer also appears to be a good price performance choice for a desktop publishing platform.

The downside is, first and foremost, it is an Atari computer. You have to learn a second computer just to use your Mac, and this does not follow the KISS (Keep it super simple) principle in my book. Even after you buy your machine and have the dealer configure and partition your disk, when you get it home you still need to have enough Atari skills so that you can initially instruct it in the Atari language to boot up and emulate a Mac. Initially, it is not automatic; someone has to do it for you. Even if the dealer also writes a nice batch setup routine, sooner or later you are going to have to also learn about the Atari aspects of your Atari Mac clone. There are some Atari operating system idiosyncrasies, 16Mb maximum disk partition size limitations, for example, that are also strange to a Mac user.

To be totally honest, the Atari people have done their homework well. There are indeed a few “gotchas” in the Table 3-1 for Apple. Atari is merely positioning

²Emily Brower, “Emulators let Amigas, Ataris run Mac software,” *MacWEEK*, 10/4/88, p. 1.

itself as an alternative platform on which to run Mac software. I did have the curious thought that no similar underground movement exists within the Macintosh community. Nor is there an Atari emulator available for my Cat Mac.

To be equally fair, what Table 3-1 does not point out is, if Atari was really comparing “Apples to Apples” their souped-up Mac Plus with 128K ROMs should be compared to a real Mac Plus also with 128K ROMs and not against a Mac SE which has 256K ROMs. The dollar difference would then not be quite so favorable for Atari. The monitor and port comparisons are, of course, nonissues for the Cat Mac builder. I did get a chuckle out of the last item, the keyboard comparison. Someone at Atari believes that when you buy your Apple Mac SE, the least Apple can do is throw in the keyboard. Right? Yup.

Let’s just say that from a Mac purist’s point of view, if you didn’t have an Atari need, not knowing about these other options would probably not be a loss to you. But if you were into or were going to need to get into Atari and DOS in the future, this technology is certainly worth a look at.

On the other hand, Atari has already shown its Stacey portable, a 15-pound package that has a 640 × 400 backlit supertwist LCD display and comes with a floppy drive and 1Mb of RAM for \$1495. It only awaits FCC approval. To this, you add the Spectre GCR and you are on your way. Maybe you could learn some Atari code after all.

Apple Portable Macintosh

Apple’s Portable Macintosh received better coverage than any other product in the Western technical press. Unfortunately, it’s been a disappointment to everyone including Apple (translation: poor sales). December 1989 *Computer Shopper* carried the headline, “Apple Mac Portable: Overdue, Overweight, Overpriced?” In its November 1989 article,³ *Macworld* prophetically stated “. . . there will be little growth until Apple addresses one or more of the chief drawbacks: weight, size, price, and performance.” *MacWEEK* of January 16, 1990, carried the cover headline “Portable Sales Lackluster.” You get the idea. Although sporting some nifty technical ideas such as an active-matrix LCD display, static RAM, clever power management hardware/software and a configurable keyboard, it also weighs in at slightly under 16 pounds, only has a 68000 CPU, and sets you back \$6499 for a model with 1Mb RAM, a FDHD floppy, and a 40Mb hard disk.

I was unimpressed during my one hour hands-on session with the Mac Portable at a local computer dealer. This turned to depression later that day when shown a Compaq LTE portable. I could see the screen much better (backlit supertwist electroluminescent display), it fit inside my briefcase, and had a 1.44Mb floppy and 20Mb hard disk—all at less than half the weight (6.7 lbs) and

³Bruce F. Webster, “The Macintosh Portable,” *Macworld*, November 1989, p. 144.

price (\$2999). No contest, Compaq won hands down. It made me sad because Apple could have just as easily done the same thing. Do I want an Apple Mac Portable? You bet I do. But I'll have to wait until one or two years down the road when they unload the remaining stock at fire sale pricing. Meanwhile, as a Cat Mac builder, I'll look for a case and screen that only requires a Mac logic board to drive them. That Atari Stacey is looking real good to me.

Mac portables

In addition to Atari, at least three other companies active at this time in producing Mac portables are Colby Systems, Dynamac Computer Products, and Outbound Systems, Inc. (formerly Wallaby Systems).

Colby, who added a 68030 WalkMac model to its line of portables, repackages a Mac logic board into their portable case with a supertwist, backlit LCD display. Their WalkMac SE goes for \$3999 and the WalkMac SE 30 at \$6699 for a system with 1Mb RAM and an 800K floppy. I was excited by their unit until one day when I was invited to look inside it. The rat's nest of wires included a SCSI cable being routed between an accelerator and logic board with numerous twists and bends along the way. Ouch! I'd rather build my own, thank you.

Dynamac, a Mac Portable manufacturer that has been around a few years, also recently added a 68030 model to their line of portables. Dynamac repackages the Mac logic board and keyboard into their black magnesium portable package with a very fast, very readable, amber plasma display, and also offers a host of other options allowing the user to connect to other monitors, expansion chassis, etc. Their Dynamac Plus pricing starts at \$4995, with the newly announced Dynamac SE 30 at \$7995 for a system with 2.5Mb RAM, an 800K floppy, and a 40Mb hard disk. I was very pleased with the Dynamac unit I evaluated. If the price was lower, . . .

Outbound Systems has a 10 pound portable. Unlike Colby and Dynamac who repackage their systems around original Mac logic boards, the Outbound Laptop System uses their own board. It was initially touted as an add-on product to the Mac Plus and SE and using its ROMs.⁴ At press time they announced their own ROM kit, approved by Apple legal.⁵ The unit can be operated in a stand-alone battery powered mode or connected to the host system (from which the ROMs are derived) via a docking adapter. Build around a 15 MHz 68000 chip, the unit features a 640 × 400 backlit LCD display (same as the Compaq SLT 286), a floppy that reads both 800K Apple and 720K DOS diskettes, a detachable infrared keyboard that can be used several feet from the display, an Isopoint pointing device

⁴Raines Cohn, "Outbound: Have ROM will travel," *MacWEEK*, 1/16/90, p. 1.

⁵Raines Cohn, "Outbound ROM set will make laptop's host into server," *MacWEEK*, 4/3/90, p. 6.

(the mouse plug is provided, the mouse is \$95 extra), two AppleTalk compatible ports, an external LCD port for connecting to projection devices such as the Kodak Datashow, and a three-hour rechargeable battery. Their base model with 1Mb RAM and the 800K/720K floppy costs \$2995. A model with a 40Mb hard disk in place of the floppy goes for \$4295. Either hard disk or floppy but not both . . . Oops! On the other hand, Outbound is working very closely with Apple and its dealer channel and might have the best compromise of the current Mac compatible laptop offerings.

Mac clones

At least two companies active at this time in producing Mac clones are Powder Blue Computers and Akkord Technologies. Each company uses the Mac 128K ROMs, but each takes a little different tack.

Powder Blue's BlueMAQ II and IIX clones use the Mac Plus logic board for I/O port control and add a second logic board that allows them to achieve up to five times the performance of a Mac IIX. The company offers four models ranging in price from \$4799 to \$7999. The base model BlueMAQ II includes a 16 MHz 68020, 1Mb RAM, 800K floppy, and a 85Mb hard disk. All models come with built-in monochrome video and a monitor. I have not heard too much from them lately.

Akkord's Jonathan uses a 68000 housed in a case about the size and shape of an external hard drive. It is sold only through European OEMs at a price 30% below European prices for a Mac Plus and includes a 14" Phillips black-and-white monitor, built-in AppleTalk connector, and external and internal SCSI ports. The company says it plans to enter the U.S. market initially with a \$3000 kit with which purchasers can construct a 12 pound Mac portable by adding a logic board and the 128K ROMs. This system will be in stores as soon as it receives FCC certification. A future version of the system will use Mac compatible ROMs that Akkord plans to develop itself.

Unfortunately, Apple staged a sting of their operations and found illegally copied ROMs in their products.⁶ I would say they face an uphill battle.

Now a word from your sponsor

Frankly, I don't see Apple ever allowing any clone manufacturer a toehold. Apple's proprietary strategy is an all-or-nothing game. On the other hand, they have nothing to lose and everything to gain from a strategy of peaceful coexistence with the portable/laptop makers. Who knows, Apple might even learn something.

⁶Carolyn Said, "Apple complaint prompts police raid on clone builders," *MacWEEK*, 4/3/90, p. 67.

The used Apple equipment market is another game entirely. It directly serves Apple's advantage. Without it, they cannot have a strong market for the new machines, so it will always be strictly hands off. This is a definite advantage to the Cat Mac builder. If you are patient, you will find a case and screen combination that you can drop an Apple logic board into and make your own laptop—and the price will be in the same ballpark as the savings on other Cat Macs, maybe even using Apple's portable logic board. You read it here first.

Sources

Atari equipment mentioned is available through Atari dealers. Apple portables are available through Apple dealers. Other portables and equipment mentioned and clones are available directly from the manufacturer. Outbound at latest report, announced agreements with a number of resellers to carry its products in the dealer channel.

AKKORD TECHNOLOGY
Cheng-Teh Rd. No. 1160, 2nd Floor
Taipei, Taiwan
886-2-882-1538

GADGETS BY SMALL, INC.
40 W. Littleton Blvd. #210-211
Littleton, CO 80120
303-791-6098

ATARI CORPORATION
1196 Borregas Ave.
Sunnyvale, CA 94086
408-745-2000

OUTBOUND SYSTEMS, INC.
4840 Pearl E. Circle
Boulder, CO 80301
303-796-9200

COLBY SYSTEMS
2991 Alexis Dr.
Palo Alto, CA 94304
415-941-9090

POWDER BLUE COMPUTERS
3670 Highland Dr., #234
Salt Lake City, UT 84106
801-273-3993

DYNAMAC COMPUTER PRODUCTS
14001 E. Iliff Ave.
Aurora, CO 80014
303-695-7780

READYSOFT
P.O. Box 1222
Lewiston, NY 14092
416-731-4175 in Toronto

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CHAPTER

Logic board, memory, upgrades

Which logic board should you use? How much memory do you need? What do you do with the Macintosh you already own? Chapter 2 focused on costs; this chapter will focus on performance and answer each of these questions.

In the real world, you want the most for your money. This is what the Cat Mac delivers. Today you can have a Cat Mac SE or SE 30 with a fast hard disk, multisync monitor, 800K floppy disk, ADB extended keyboard, and optical mouse for almost 50% less than the Apple list price for the same performance. At this time, the SE 30 logic board delivers the best price performance for the Cat Mac builder. Its availability and attractive price, combined with its snappy 68030 CPU performance, make it the platform of choice for Cat Mac builders who do not need immediate color or extra expansion slots.

Do you need color and slots? A discontinued Mac II complete with case and power supply can also be had for a very attractive price via the reseller channels, and many add-on options are available to step up its performance. Also, once you own a Mac II, you can just turn around and add a top of the line Mac IIfx upgrade kit to it and save a bundle off the Apple list price—I am talking thousands of dollars here. If you don't want a IIfx but need color and slots and more speed than a

Mac II, the IICx board and (another hot performer) is just starting to become available from third-party vendors at around \$2000. Build a Cat Mac IICx for only a little more than a Cat Mac SE 30.

More memory is always better. With memory prices having dropped rapidly from the debacle of late 1988, there is no excuse for you not to have at least 2Mb or more. This enables you to at least be able to run Apple's Multifinder software in a low-end Mac and Apple's new System 7.0 software when it becomes available in a Mac II (with PMMU chip also added) or SE 30. Adding 4Mb or more is really necessary for any graphics or desktop publishing work. The best OCR scanner software requires 4Mb minimum for text. For graphics, 4Mb-and-up TIFF files are not uncommon for full-page scans.

Upgrades to your existing Macintosh is a broad subject in itself. Add-on boards make it possible to take even the earliest 128K Mac up to a 4Mb 68030 screamer. The general rule of thumb is keep your existing Mac and upgrade it. Unless you bought it very recently, you have already substantially amortized or written off the cost of your Mac, so you are now comparing the cost to upgrade versus the cost to buy a new Mac, and the upgrade usually wins. On the other hand, if you do not have a Macintosh, make the investment in the logic board that gives you the performance you want. A higher performance logic board from Apple, assuming it is available at all, will usually cost less than the sum of a lower performance logic board plus an upgrade product.

The soul of a new machine, your logic board

For all intents and purposes, the heart of your Cat Mac and usually its most expensive part is the logic board. Once you have selected your logic board, you have your Macintosh. The rest of the items are just peripherals to support it. All you need to do is connect power to it, add the disk drives, video display, keyboard, and mouse, put it in a pretty enclosure, and presto, you are in business.

Some excellent Macintosh technical documentation by Apple, as well as a repair guide and a new repair and upgrade guide,¹ cover earlier logic board details. More recent logic board details, such as SE 30, IIX, IICx, IICi, IIFx, are covered in the Macintosh trade press.

This section will give you some background, show performance tradeoffs, and focus on what you get with each logic board.

The 68000 chip family background

The logic board is the heart of your Cat Mac and the Motorola 68xxx chip is the heart of your Apple Macintosh logic board. This microcomputer chip is the

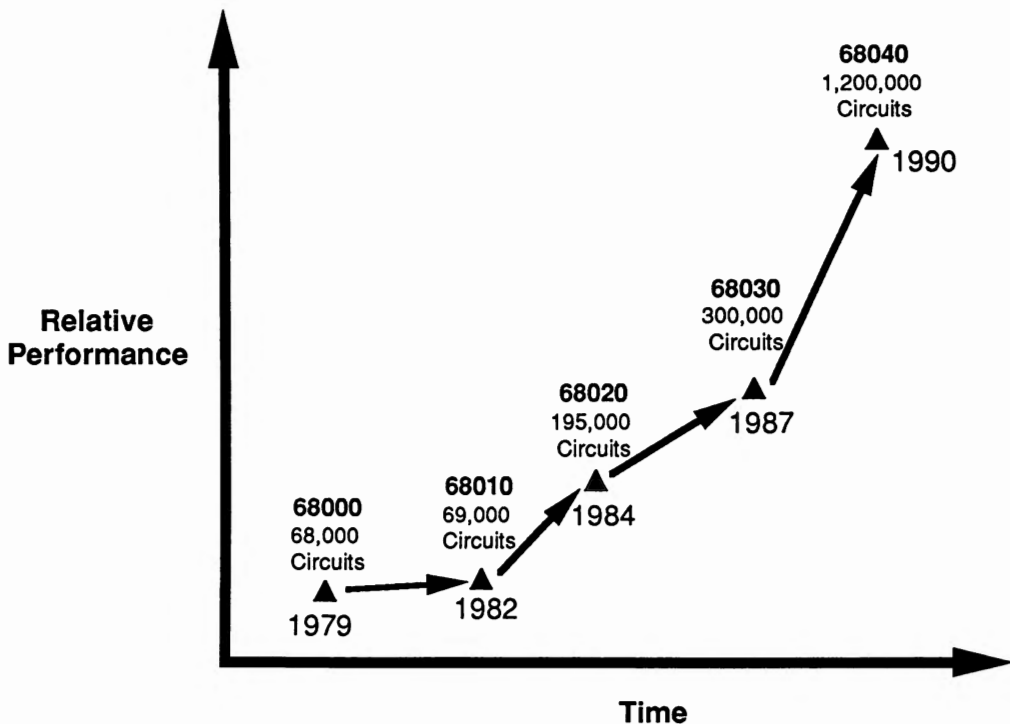
¹Apple Computer, *Macintosh Family Hardware Reference*, Addison-Wesley Publishing, 1988; Gene B. Williams, *Macintosh Repair and Maintenance*, Chilton Book Company, 1986; Larry Pina, *Macintosh Repair and Upgrade Secrets*, Howard W. Sams & Co, 1990.

engine that makes your Cat Mac go. Although encased in a larger protective housing, the chip itself is no larger than your thumbnail, yet it offers more capability than the room full of electronics required by the IBM mainframes of the 1960s or the rack full of electronics required by the Digital minicomputers of the 1970s.

Thanks to the lessons well learned from Digital and other minicomputer makers of the 1970s, Motorola has chosen a path that ensures Apple's (and many other CPU manufacturers also) software investment will not be obsoleted. Each newer chip is fully instruction set compatible with the one before it, yet it contains significant performance improvements. Thanks to this strategy, you can replace an older chip with a newer one in your CPU line and everything runs—only faster. Of course, you have technical hardware details to work out (how do you talk to the chip, etc), but your software code still works.

This is good news for the Cat Mac builder. You can remove your SE logic board from your Cat Mac chassis and pop in your SE 30 logic board and everything works. It would also work for 128 to 512, 128 or 512 to Plus, II to IIx, IIcx to IICI, and II to IIfx. On the downside, any logic board you have today will be surpassed in the future as Motorola introduces newer CPU chips in the family.

Figure 4-1 shows the trends in the Motorola 68xxx chip family on which the Macintosh is based and hints at the magnitude of your problem. It took five years



4-1 Motorola 68000 chip family growth history.

to go from 68,000 to 195,000 circuits on a chip in the early 1980s, it only took two years to go from the 68030 chip with its 300,000 circuits to the newly announced 68040 chip with its 1,200,000 circuits. No one knows exactly where CPU chips are going (i.e., the upper end performance limit), but it is very apparent they are going there at an increasingly faster rate. Fortunately, it takes awhile for the software to catch up with the hardware.

Some say that the 68030 chip, which is used in all Apple's newest Mac models, is already over the hill. Motorola officially unveiled its 25 MHz 68040 in January 1990, work has already started on the 68050, and Apple should have a 68040-based Macintosh out by 1991. Motorola says its 25 MHz 68040 offers three times the performance of a 25 MHz 68030; its integral on chip floating point unit (no separate 68882 style chip needed) allows it to perform floating point operations faster. The message to you the Cat Mac builder is to be aware of this trend and know that because of it, the industry is soon going to be presented some increasingly attractive alternatives to the 10-year-old 68000 chip technology now used in the Mac SE logic board. It has started already.

Logic board tradeoffs benchmark data

Chapter 2 looked at the cost tradeoffs of selecting various logic boards and concluded an SE, SE 30, or Mac IIfx family logic board was best for your Cat Mac project. Now you will see that the performance and technical data also support this conclusion.

Table 4-1 adapted from information provided in *InfoWorld*² shows the relative performance of the various Mac logic boards running a benchmark timing in vari-

Table 4-1 The Mac family performance
(with the Mac Plus normalized to 100%).

Logic board	Excel	PageMaker	FoxBase	Total
128/512 Plus	N/A	N/A	N/A	N/A
SE	118	102	108	109
SE 30	572	395	377	416
Mac II	442	223	291	292
Mac IIfx	521	248	348	341
Mac IIfx	572	346	366	395

²Doug and Denise Green, "Choosing the Right Mac From Apple's Lineup," *InfoWorld*, Target Edition #23, 8/7/89, p. S6. An interesting supplement well worth reading—much useful information.

ous software programs, arbitrarily defining the Mac Plus performance as 100% for comparison purposes. Looking at the total column, what Table 4-1 says is that in terms of total elapsed time to execute the same common benchmarks, the SE was only 9% faster than the Plus, while the Mac II was nearly three times as fast and the SE 30, the benchmark winner, was over four times faster. The 128/512 boards, although not rated, would give similar performance to the Plus if equipped with identical memory and ROM chips.

Table 4-2 takes the data from Table 4-1 and combines it with cost data from Table 2-1 in Chapter 2 to arrive at a performance per unit of cost (PUC) figure. In Table 4-2, the 128 and 512 boards are shown upgraded to 1Mb with 128K ROM, i.e., a Mac Plus equivalent. Table 4-2 says that the Mac SE 30 logic board is the best choice; it has the highest PUC figure. The SE 30 logic board gives you four times the performance of the SE logic board at only twice the cost. It also shows that the IICx logic board is the next best choice with the next highest PUC.

Table 4-2 Performance per unit cost for Macintosh logic boards.

Logic board	128	512	Plus	SE	SE 30	II	IICx	IICx
performance	1.0	1.0	1.0	1.09	4.16	2.92	3.41	3.95
cost (Table 2-1)	\$525	\$625	\$675	\$600	\$1200	\$1500	—	\$2000
cost (plus=1.0)	.78	.93	1.0	.89	1.77	2.22	—	2.96
PUC	1.28	1.08	1.0	1.23	2.34	1.31	—	1.50

Extrapolating this data to the upper end Mac family logic boards, the IICi with its 25 MHz 68030 CPU chip and 25 MHz 6882 floating point chip running at 1.5 times the speed of the Mac IICx chips is roughly 50% faster. The IIFx, with its 40 MHz 68030 chip and other hardware architecture boosters is roughly 100% faster.

Just for the fun of it, let me calculate the IICi and IIFx PUC for you. My seat-of-the-pants estimate based on recent market pricing action says sometime down the road you should be able to pick up a IICi board at roughly \$2500 and IIFx board for \$3000.

Now, some performance calculations: $3.95 \times 1.5 = 5.93$ for the IICi and $3.95 \times 2.0 = 7.9$ for the IIFx. Dividing these figures by their normalized costs of 3.70 and 4.44 respectively, you get a PUC of 1.60 for the IICi and a PUC of 1.78 for the IIFx. This little exercise says that the Mac SE 30 logic board is still the best price performance choice today, a point strengthened by the fact that you cannot get either of the high-end boards at the estimated price yet.

Now let's take a look at the individual logic boards in the Macintosh family.

The 128 and 512 logic board

As I write this, Steve Jobs, standing over a row of Mac 128s, smiles back at me from the cover of the May/June 1984 *Macworld*, the premier issue. Much has happened since then, but the elegance and simplicity of the vision he and the “team” created has not been dimmed by the passage of time. Yet the 128K and 512K Macs clearly have been passed over in time. They have no benefits to them, and their downside is considerable.

Today, the minimally acceptable configuration for doing useful work probably is the Mac Plus. Yes, the older 64K ROMs and 400K floppy drives will enable you to run MacWrite and MacPaint programs in older Macintosh File Format (MFS) format on your 128K Mac and enjoy yourself immensely. But if you want to take advantage of the newer Hierarchical File Format (HFS) System and Finder, high-speed SCSI hard disks, 800K floppy drives, and the wealth of Mac software available today for which these are a prerequisite, it takes a Mac Plus or more to do it.

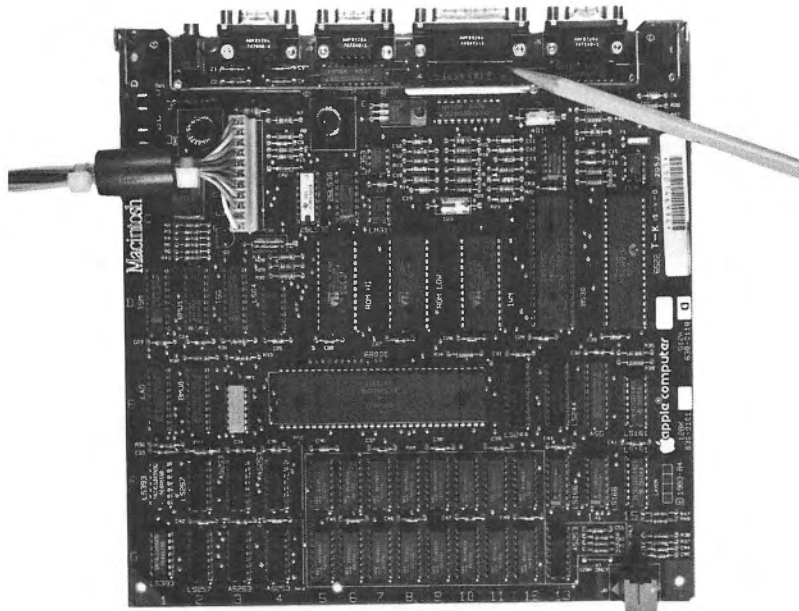
If you own either one, there is no logical rationale for keeping it, especially in nonupgraded form, versus opting for one of today’s Mac offerings. Their slower, smaller drives, limited memory, older 64K ROMs and lack of SCSI hard disk interface lock you out of all but the most rudimentary current software and limit you to earlier versions of powerful software programs such as Word, Excel, or PageMaker.

However, once upgraded, it performs easily as the equal of the Plus board, or it can be taken all the way up to a 68030 with 4Mb of memory by the addition of an accelerator card. The Plus upgrade (i.e., 1Mb of memory and a SCSI port) would be my minimum recommendation for your use of a 128/512 logic board today. Above that it only depends on what you want to spend.

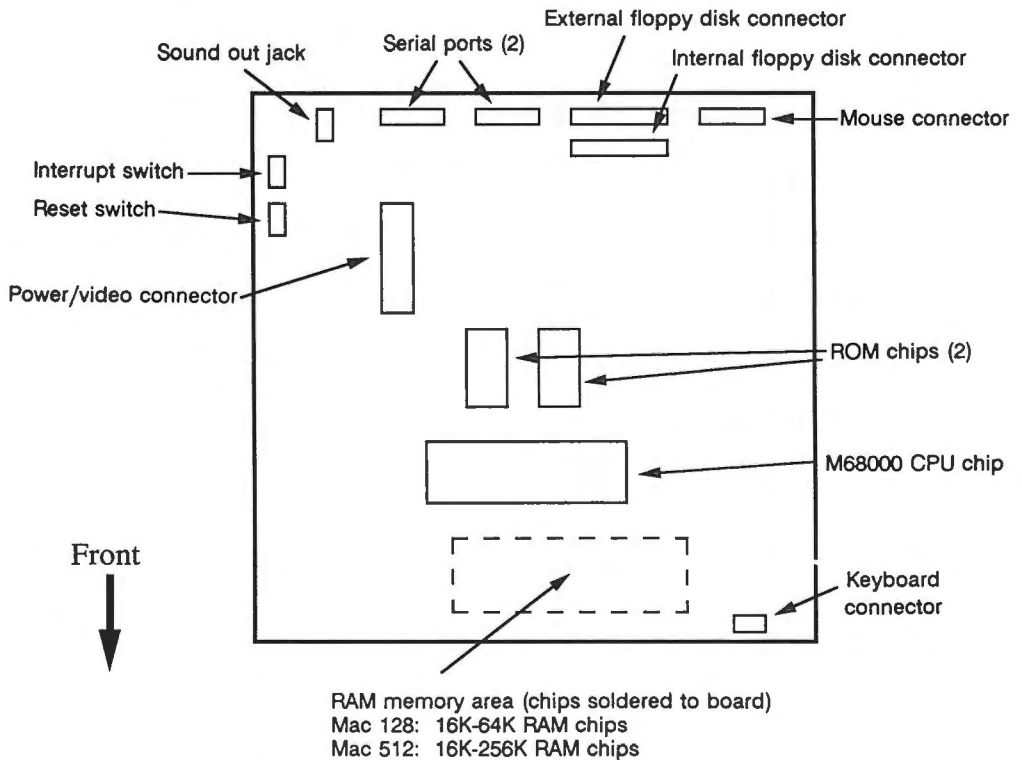
Figure 4-2 shows a photograph of a Mac 512 logic board, and Fig. 4-3 helps you identify some of its key components. In Fig. 4-2, the power cable is shown attached to the board. The pencil points to one of the downsides—the floppy connector is the only internal signal connector on the board, anything else to be attached must be connected via the 68000 chip. For another downside, notice the soldered in memory on the front of the board which is much harder to replace than a defective SIMM chip.

The Mac Plus logic board

The Mac Plus logic board opens additional possibilities for the Cat Mac builder. The two main benefits are its SCSI port and SIMMs sockets. The addition of the NCR 5380 SCSI chip brought out to an external connector lets you attach external SCSI hard disks mounted in their own cases. The addition of snap in SIMMs memory chips rather than soldered on memory chips enables you to easily expand your memory to 4Mb using the 1Mb SIMMs chips.



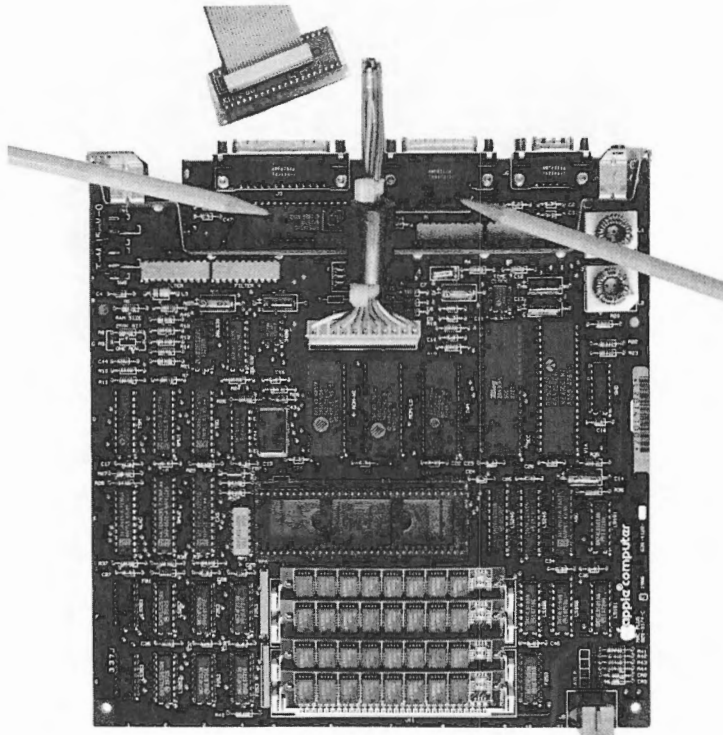
4-2 Mac 512 logic board.



4-3 Mac 512 logic board key components.

Interesting articles about the capabilities/features of the Mac Plus and expanding it appeared in the March 1986 *MacUser*, April 1986 *Macworld* and May 1986 *MacUser*.³

Figure 4-4 shows a photograph of a Mac Plus logic board, and Fig. 4-5 helps you identify some of its key components. In Fig. 4-4, the power cable is again shown attached to the board. Notice the cable has been moved from its location on the 512 board. Just beyond the back of the board, you can see a 40-pin Killy clip,

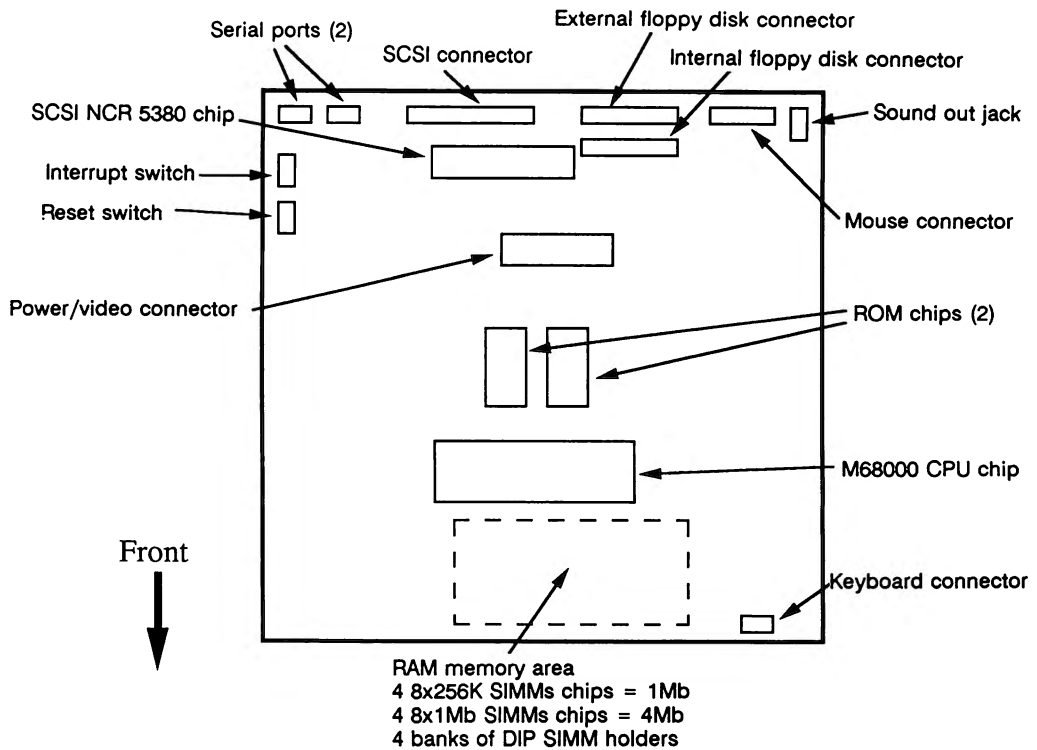


4-4 Mac Plus logic board.

the kind you would attach to the NCR 5380 SCSI chip (indicated by the pencil) to have internal case access to the SCSI bus. The other pencil points to the internal floppy connector. In this case, the 68000 chip has a Killy connector clip on it, waiting for a third-party device to be attached. The four rows of SIMM memory chips in their sockets are clearly visible at the front.

The Plus board is a solid low-end performer and makes an ideal Cat Mac project foundation when equipped with a 2Mb or 4Mb of memory. It too can be taken all the way up to a 68030 with 4Mb of memory by the addition of an accelerator card.

³Michael D. Wesley, "Macintosh Plus! Packed With Power," *MacUser*, March 1986, p. 38; David Ushijima, "A Change for the Plus," *Macworld*, April 1986, p. 86; Steven Bobker, "The Macintosh Maze," *MacUser*, May 1986, p. 42.



4-5 Mac Plus logic board key components.

The Mac SE logic board

With the Mac SE logic board, you have a whole new ballgame. It opens up five additional benefits for the Cat Mac builder.

- **Internal SCSI connector**—In addition to the 25-pin external SCSI connector port is a SCSI 50-pin connector on the board, so the Cat Mac builder just needs a ribbon cable with connectors on it to add an internal SCSI hard disk.
- **SE 96-pin direct connector**—Allows connection to expander adapter cards, which opens your SE to a variety of accelerator card and large-screen video options without the need for clipping onto the 68000 chip.
- **ADB (Apple Desktop Bus) connectors**—No significant work has to be done in terms of attaching keyboard or mouse peripherals; it is all there via two ADB connectors with easy access.
- **Lithium battery, 7-year**—Already attached and mounted on the Mac SE logic board so no significant work has to be done with a battery attachment.
- **ROM chips 256K**—Gives you a Cat Mac that is roughly 15% to 20% faster than the Mac Plus with its 128K ROM chips, and at no increase in price.

So the Mac SE logic board emerges as the clear winner. You get all sorts of capabilities and options for less than the price of the Plus or 512 logic board. Numerous articles cover the Macintosh SE and its capabilities and features. In addition to the Apple reference mentioned earlier, *Macworld* had April and May 1987⁴ articles.

Figure 4-6 shows a photograph of a Mac SE logic board, and Fig. 4-7 helps you identify some of its key components. In Fig. 4-6, the power cable is again shown attached to the board using an SE style 14-pin Molex type connector. The pencils point to the internal SCSI connector and two internal floppy connectors. The four SIMM sockets are still at the front of the board but in two parallel rows. Two 1Mb SIMM memory chips in their sockets are clearly visible at the front. The 1/2/4Mb memory jumper is just behind the SIMM socket at the left front.

Without question, the logic board I would start with as a Cat Mac builder is the SE. It is readily available, its price has come down below even that of the Plus or 512 board, yet it offers significant advantages. You don't have to run around looking for expensive 128K ROM chips, you have numerous video monitor and accelerator card options, and it is easily expandable to 4Mb of memory with additional 1Mb SIMMs. The SE board is presently the best foundation for your Cat Mac project, and that is why I used it for the project described in Chapter 11.

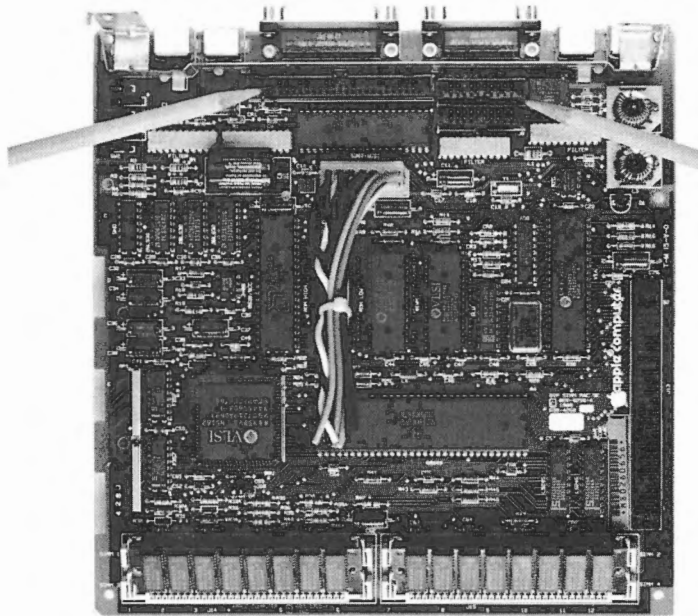
Apple's newest SE logic boards have a battery holder rather than the battery soldered to the board and carry new ROM and SWIM (Super Wozniak Integrated Machine) chips which support Apple's FDHD Superdrive 1.4Mb floppy disk. This board, which has recently found its way into the reseller channels because Apple is now shipping only FDHD-based Mac SE models, makes even a better building block for your Cat Mac project, but you will have to trade off its extra cost versus its benefit to you. If you don't need the FDHD capability, no point in paying extra for it.

The Mac SE 30 logic board

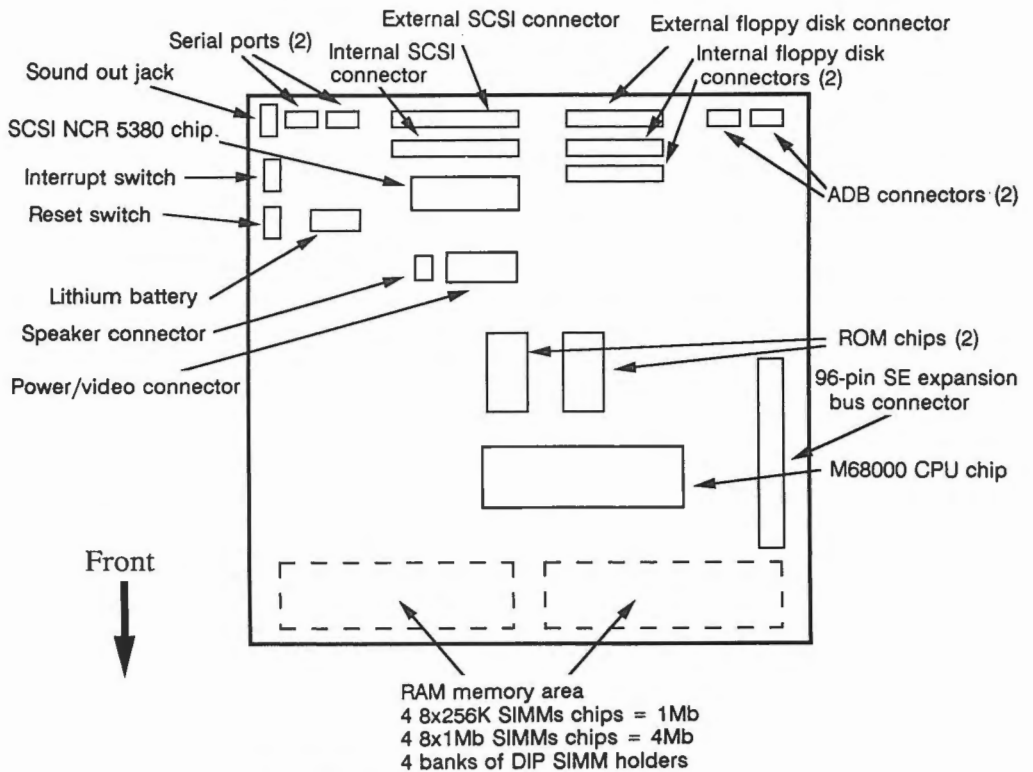
The SE 30 logic board, exactly identical to the SE logic board in size, mounting holes, and power connector pinouts, is even better than the SE board for a Cat Mac project—if your budget allows it. Apple made it slightly easier for the Cat Mac builder by announcing its SE 30 logic board as an upgrade kit at a list price of \$1699 on their Price List. Most Apple dealers will insist on your exchanging your Macintosh SE logic board before obtaining the SE 30. However, if you are persistent, you can obtain one without an exchange. If not, you should be able to get one from a used equipment dealer at about \$1200 without the exchange.

As to the benefits of starting with the SE 30 logic board, there are many. Its CPU is a 68030 chip running at 16 MHz. Its the fastest, latest, and greatest in

⁴Lon Poole, "More Than a Plus," *Macworld*, April 1987, p. 141; Jerry Borrell, "SE Close-Up," *Macworld* May 1987, p. 112.



4-6 Mac SE logic board.



4-7 Mac SE logic board key components.

technology from Apple and will probably be around for a while. No accelerators are needed unless you want a hotter performing 68030 chip, screaming along at 25 MHz, 33 MHz, or 50 MHz. It supports the new FDHD Apple floppy; its 256K ROM SIMMs support color plus grayscale graphics and video; and it has eight RAM memory SIMM sockets like on the Mac II family boards, supporting up to 32Mb or RAM total when the 4Mb SIMMs become available.

The biggest downside to using the SE 30 logic board as your Cat Mac project's foundation is the SE 30's new 120-pin direct slot which, unlike the SE's 96-pin connector, is designed to accommodate vertically mounted option cards. Unless you have elected to use the NeXT cube, with its roughly one cubic foot form factor as your mounting enclosure, the standard mounting connector on the new third-party SE 30 option cards are not going to fit in your Cat Mac PC chassis unless you can find a way to mount them on their side, find a 120-pin adapter, or some other idea.

However, as more Cat Mac builders encounter this situation, a simple solution will be found other than the only current obvious solution of mounting it in a mini-tower PC case. Apple recently announced a 120-pin processor direct slot for their newest Mac IIfx model which, although different from the SE 30's, does mount inside a lower profile Mac II style case. Mobius has announced an adapter to adapt their 96-pin SE video card to the 120-pin SE 30 slot. It uses a 90 degree Euro DIN connector. You basically need the same adapter, but with a straight through Euro DIN connector. I am sure that time will provide a solution. How difficult can it be?

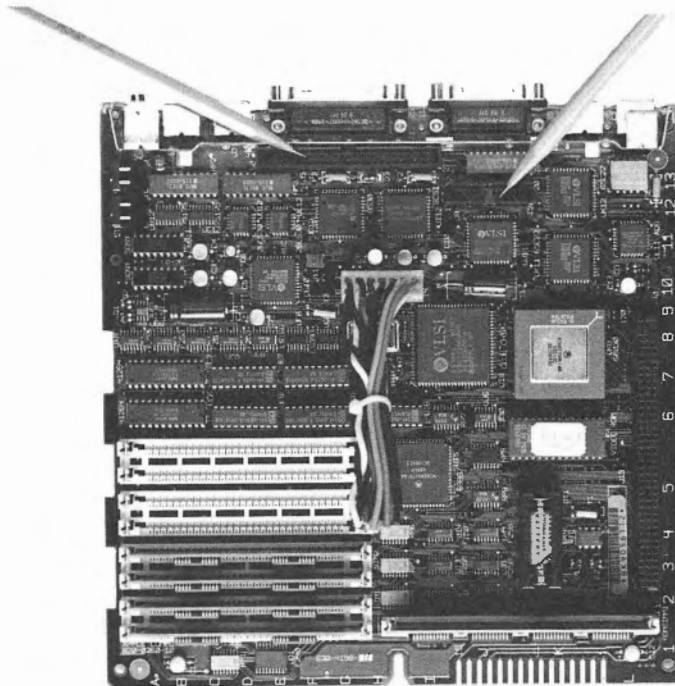
Apple advises that the Macintosh SE can be upgraded to a Macintosh SE 30 without upgrading to the FDHD. The converse of this is that the SE 30 will work perfectly well with the 800K floppy drive.

Numerous articles have covered the Macintosh SE 30. *MacUser* had a March 1989 and *Macworld* article.⁵

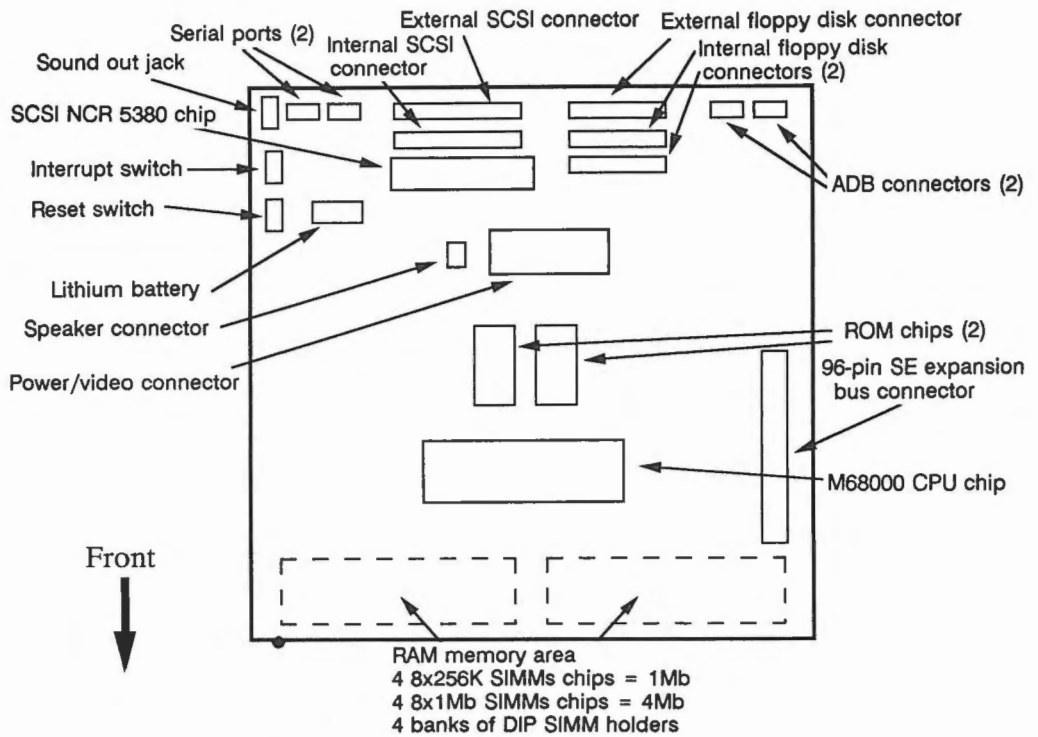
Figure 4-8 shows a photograph of a Mac SE logic board, and Fig. 4-9 helps you identify some of its key components. In Fig. 4-8, the power cable is again shown attached to the board, still the SE style 14-pin Molex type connector. The eight SIMM sockets are all in a row at the front left of the board. Four 256K SIMM memory chips in their sockets are clearly visible at the front. Notice the 68030 chip is socketed and upgradable. The SE 30 ROMs are also socketed and appear on the right front of the board opposite the front row of SIMMs.

As a happy user, I find that the SE 30 logic board is my engine of choice. In Chapter 11, an SE Cat Mac is built only because the SE board is more available, more affordable, and probably appeals to a broader class of Cat Mac builders (i.e., not everyone wants the power and speed of an SE 30).

⁵Henry Bortman, "Much Ado About Something," *MacUser*, March 1989, p. 174. Bruce F. Webster, "The Mac SE Turns 030," *Macworld*, March 1989, p. 112.



4-8 Mac SE 30 logic board.



4-9 Mac SE 30 logic board key components.

The Mac II family logic boards Mac II, IIx, IIfx

Introduced in early 1987, the Mac II was the first open architecture Macintosh. It was an instant success because it had six self-configuring Nubus expansion slots (unlike the PC, you didn't have to tell it what card was in which slot and set jumper switches, etc). It also offered a 68020 processor chip versus the 68000 chip used by the Plus and SE, its contemporaries of the time, and was the first Macintosh to support color monitors.

Its 68020 processor ran at twice the clock speed of the 68000 (16 MHz versus 8 MHz) and moved twice as much data per cycle (32 bits versus 16 bits of data). So it resulted in a Mac II computer with roughly four times the throughput of a 68000-based Mac SE. All subsequent improvements in the Macintosh processor logic chip use variations of this basic theme—move more data and move it faster. Newer logic boards use other wrinkles too, such as fewer wait states (CPU does not have to wait for faster memory), cache memory (described later in this chapter; CPU thinks it is looking at faster memory), direct memory access SCSI chip (CPU gets data from hard disk faster), and peripheral controllers (CPU gets data from serial, floppy, and ADB ports faster).

With the advent of the Mac IIx (16 MHz 68030 processor chip in a Mac II chassis), SE 30 (16 MHz 68030 processor chip in a modified Mac SE chassis), IIcx (16 MHz 68030 processor chip in a similar style, but smaller footprint, with three Nubus expansion slot Mac II slot chassis), and IICI (25 MHz 68030 processor chip in a Mac IIcx chassis), the Mac II was rapidly artificially obsoleted and finally (yet very quietly) discontinued by Apple in their drive towards the 68030 processor chip standardization (versus the 68020 processor chip in the Mac II).

The Mac II, far from being a dinosaur, is an outstanding price-performance proposition. Its situation can best be described as a “special buying opportunity” for you the Cat Mac builder. In a nutshell, it offers speed, expansion, and color benefits versus an SE. With the birth of the Mac IIfx, the latest, greatest, top-of-the-line model, the Mac II becomes even more valuable because it shares the same chassis and power supply.

What can a Cat Mac builder do with a Mac II? If you already own one, you can use Apple's new aggressively priced IIfx upgrade to expand its capabilities all the way to a top of the line model. If you don't already own one, you can now buy one at a very attractive price and either use it as is, upgrade it, or use it as an intermediate step to obtain Apple's top of the line IIfx model at an attractive discount.

The Mac II has a larger footprint area (12" by 15") than any other Macintosh logic board. To save yourself time, rather than running around trying to find a chassis to fit it, I recommend you mount it only in its own case with its own power supply. Special package prices deals from Pre-Owned electronics and other ven-

dors (as of March 1990) make this a rather painless choice. In addition, using the Mac II in its own case with its own power supply lets you take advantage of the Apple innovation (all Mac IIxx series share this feature) of being able to turn it on from your ADB keyboard and turn it off using the “Shut Down” command from the desktop menu.

To accomplish the same function as Apple’s Mac II for Mac IIcx power supplies, which each cost about \$350,⁶ you have to modify a standard PC power supply with some switching circuitry. To do this is not too complicated,⁷ but it goes beyond the scope of this book, which is minimal soldering and tinkering at the electronic component level on the part of the Cat Mac builder. Your other choice is simple; if you don’t need this feature, you don’t need a special power supply or extra circuitry.

Do you cache my drift?

A *cache* is a small pocket or purse, like a change purse. You look in it first to get your change. Mainframe and minicomputer manufacturers have for years used the technique of putting a small amount of high-speed memory in front of regular processor memory to speed up their computers. Here’s how it works: When your computer writes data in main memory, it leaves a copy in cache memory, too. When your computer goes to read data, it looks first in cache memory. If it finds the data there, it doesn’t bother with looking in main memory. If your cache and your program loops are of the right size, your computer hardly ever looks in the main memory. The result is that everything runs a lot faster.

Motorola, Apple, and a host of third-party vendors have integrated these concepts into their products. Motorola’s 68020 has a 256K byte instruction cache, the 68030 has 256 byte instruction and data caches, and the 68040 has 4096 byte instruction and data caches. Apple has added RAM cache connector slots onto its newest logic boards, the IICI and IIFX. Third-party accelerator card vendors have designed a variety of products covering a wide-price range using the cache concept.

David Ramsey, a former Apple programmer, explained how the Mac II could be inexpensively upgraded to compete with the 68030-based Macs in one of his many interesting *MacWEEK* articles.⁸ He explains that 68030, with its on-chip Paged Memory Management Unit (PMMU), represents a packaging not a technical advantage over the Mac II’s 68020 processor chip and separate 68851 PMMU chip; any operating system from Apple that will run on a 68030 will also run on a 68020 Mac II with the 68851 PMMU chip installed. The 15% improvement in

⁶Pre-Owned Electronics, March 1990.

⁷Apple, *Mac Hardware Reference*, p. 23–5.

⁸David Ramsey, “Upgrading a Mac II may be a better investment than buying a IIcx,” *MacWEEK*, 8/15/89/, p. 42.

speed of the 68030-based 16 MHz Mac Iix over the 68020-based 16 MHz Mac II is because the Mac II uses one wait state while the Mac Iix uses two. The Mac II design uses one wait state for the motorboard RAM and another for the external PMMU chip so using memory faster than the 120 nanoseconds or even adding the external PMMU chip will not make your Mac II run any faster.

So, how do you economically make your Mac II run faster? Add Orchid's \$219 MacSprint cache card, which plugs into your 68020 processor socket and caches motherboard RAM into 32K of very fast RAM. You reduce the Mac II's memory access times to under one wait state, making the Mac II faster than a Mac Iix.

How do you add PMMU to your Mac II? Add Apple's \$499 PMMU upgrade chip, which plugs into your 68020 logic board, or a third-party PMMU upgrade at \$149. Now you can run the same software as the SE 30 and Mac Iifx family logic boards.

You can add an FDHD superdrive to your Mac II by using Apple's \$599 Mac II FDHD upgrade kit. The Mac II can be upgraded to use the FDHD drive without upgrading to a Macintosh Iix logic board (Apple Mac Iix upgrade for the Mac II costs \$2199) or can be upgraded to a Macintosh Iix without upgrading to the FDHD drive. For further information about the Macintosh II and its capabilities, see *Macworld* April 1987 and *MacUser* April 1987 articles.⁹

For you, the Cat Mac builder, the Mac II represents an outstanding value at this time, particularly if slots or color are important to you. Okay, so you don't build all that much—you get it in its own case—but you get a great platform to build upon.

The Mac Iix, which comes packaged in the identical chassis as the Mac II and offers its identical six slot Nubus capability, extends the capabilities of the Mac II to the 68030 CPU chip and the 1.4Mb FDHD superdrive floppy when it was quietly announced in late 1988. Mainframe and minicomputer makers would call it a *midlife kicker* product—one introduced with minor innovations to extend the life of the original product. Although the Mac Iix did exactly that, the advent of the Iicx, Iici and Iifx machines, make the Mac Iix somewhat of a dinosaur because newer machines offer the same CPU chip with much higher price performance at both lower and higher price points. To find out more about the Mac Iix, read the *MacUser* November 1988 and *Macworld* December 1988 articles.¹⁰

To quickly close the discussion about the Mac Iix, I would not recommend any Cat Mac builder buy one at this time. Keep it if you own one, accept one as a gift, but do not buy one.

The Mac Iifx, Apple's latest and greatest Macintosh, is the reason why you

⁹David Ushijima, "Macintosh II: Opening to the Future," *Macworld*, April 1987, p. 126; Michael D. Wesley, "For the Best of Us," *MacUser*, April 1987, p. 74.

¹⁰Gil Davis, "Meet the Mac Iix," *MacUser*, November 1988, p. 34; David Ushijima, "68030 at Last," *Macworld*, December 1988, p. 83.

don't need a Mac IIfx. It comes in the same chassis as the Mac II and the Mac IIfx, offers the same six Nubus slots but then you get a blazing fast 40 MHz 68030 CPU and 68882 coprocessor, a 32K static RAM cache, a superset of the processor direct slot on the SE 30, a SCSI DMA memory chip, custom I/O processors, and it supports Apple's new 24-bit video cards. On the downside, Apple is pushing their 64-pin RAM memory package for the machine at \$999 per megabyte. However, third-party vendors should quickly jump into this market at more attractive prices.

An Apple-hired independent testing organization, National Software Testing Laboratories of Philadelphia, stated that the new Mac IIfx significantly outperformed both IBM's top of the line Model 70 80486 machine and Compaq's 33 MHz 80386 machine when performing similar cross-platform programs by a 2:1 and nearly 3:1 margins respectively.¹¹ I guess one could say it is fast.

Best news of all for the Cat Mac builder is Apple's aggressive IIfx upgrade price of \$2999. If you own a Mac II now, this means you can get top of the line performance at a very attractive price. If you don't own a Mac II, it means you can buy one in the used equipment marketplace, upgrade it with the IIfx kit and save a bundle over Apple's list price.

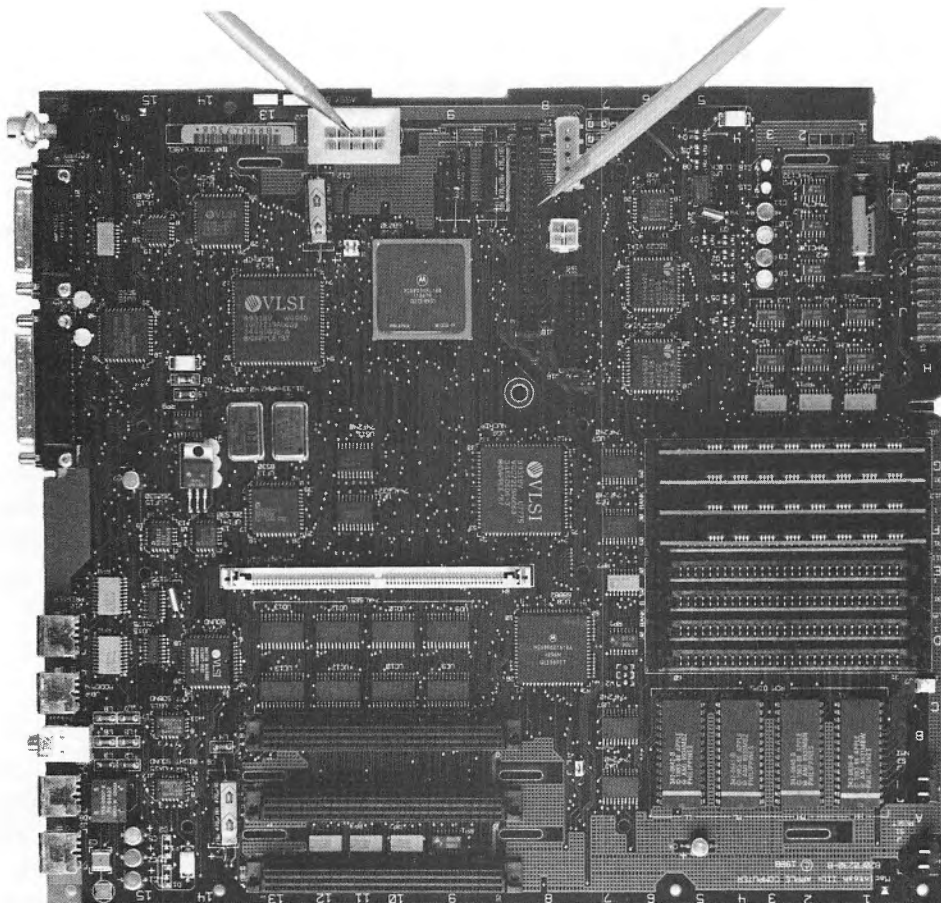
The Mac II family logic boards Mac IIfx, IIfci

Apple's IIfx immediately became its most popular model shortly after being introduced in early 1989. It wasn't hard to see why. Although having only three Nubus slots and being limited to one floppy disk and one hard disk in 3 1/2" form factor only, it delivered all the other capabilities of the Mac IIfx at a lower price. Its case had an innovative one-screw snap-apart construction, could sit on either its bottom or its side to minimize desk space and weighed only 14 pounds without its monitor (actually lighter than Apple's portable).

Other than its logic board being a thing of beauty (in PC board circles, they call it an object d'art) as shown in Fig. 4-10, what does it do for you the Cat Mac builder? Plenty. Unlike the oversize 12" by 15" boards of the II, IIfx, IIfci, you can put the 12" by 11" Mac IIfx board in an AT-size PC case instead of using Apple's case and power supply. Yes, you give up the ADB power-on feature, but how important is it to you? The Mac IIfx logic board is just now becoming available through used equipment dealers at around \$2000. It gives you plenty of performance, plus expansion, plus color capability—all at a price not too much higher than the Cat Mac SE's price as shown in Chapter 2. By buying it as a board and putting it in its own case, you save a bundle over Apple's list price. To find out more about the Mac IIfx, read the *Macworld* April 1989, *MacUser* May 1989, and *MacUser* June 1989 articles.¹²

¹¹John Battelle, "IIfx puts Apple at head of performance pack," *MacWEEK*, 3/20/90, p. 1.

¹²Russell Ito, "Introducing the Mac IIfx," *MacUser*, May 1989, p. 30; John J. Anderson, "Apple Mac IIfx: The Modular Macintosh," *MacUser*, June 1989, p. 120.



4-10 Mac IIcx logic board.

My advice to the Cat Mac builder is to buy it over the SE 30 logic board if you need speed plus slots plus color at this time and don't want to spend almost twice as much for the Cat Mac version of Apple's top of the line IIfx model. If you just need speed, stick with the SE 30 logic board to save money.

With the Mac IIfi, Apple added another dimension. Not only do you have a 25 MHz 68030 chip to start with, but an added 120-pin cache controller slot allows you to add third-party cache cards to crank up the speed even more. In addition, Apple added on board video circuitry that allows you to deliver 8-bit color to a monitor without using a Nubus card slot to do it, boosted the ROM up to 512K with sophisticated new 32-bit quickdraw features, and uses the IIfi's 80-ns RAM memory as a video screen buffer. Apple lowered the manufacturing cost by using the identical IIcx case and 90 watt power supply and by using more custom VLSI chips to reduce the parts count from the IIcx. Unfortunately, later IIcx and IIfi boards have soldered on 68030 chips for this same reason, making it somewhat difficult for third-party providers to add accelerator board options. To find

out more about the Mac IICI, read the *Macworld* November 1989 and *MacUser* November 1989 articles.¹³

My advice to the Cat Mac builder is don't buy it now unless you have his and her BMWs in your driveway and need a new toy to tinker with—seriously. It's a great box from Apple, but you cannot get the logic board from any reseller at any price yet. The Apple IICI offer of \$2399 plus your existing IICI board in trade is not as good as their IIFX offer of \$2999 plus your existing Mac II board in trade. Which would you rather have? The IIFX. Me too. But I'll keep my eye on the price and availability of the IICI. It will make a great platform for a future Cat Mac project when the price is right.

Upgrades

Upgrades to your existing Macintosh is an extremely broad topic which is very important to you as a Cat Mac builder because, unlike Mac users who rely on specialists to handle their Mac upgrade needs, you are more than likely going to be doing them yourself. *Macworld* published a world-class article on the subject in February 1990.¹⁴ It's definitely worth a read if you can still find it in your stack of old magazines.

What do you do with the Macintosh you already own? Depends on what Mac you have and where you want to go. Knowing how much money you have to spend is nice, too. If you want to make a small upgrade or a series of incremental upgrades, you will find it better to keep the Mac you have. If you are looking at a big jump in capability, like adding color to your 128 Mac, it is better to start fresh.

The avalanche of new products regularly coming from Apple and third-party software and hardware manufacturers requires that you adopt some sort of procedure tailored to your own set of circumstances ensuring your Macintosh setup is reasonably up to date. This does not mean you adopt every new machine and piece of system software that comes out—far from it. But every three months, every six months, or at least once a year, you need to put your Macintosh setup under a microscope to see if new hardware or software or even a new computer would be a better solution for you.

To simplify things, let me divide the Apple Macintoshes into four classes (not including the Mac Portable): let me arbitrarily call the Mac 128/512/Plus Mac class number one; the Mac SE and SE 30 Macs class number two, the Mac II, IIX and IIFX class number three, and the Mac IICX and IICI class number four. Upgrades mostly deal with the first two classes, i.e., the 68000-based Macs and the 68020-based Mac II. Once you have your 68030 logic board, only plug-in third-party accelerator boards or an Apple (Mac II family) board swap can speed it up.

¹³Dan Littman and Tom Moran, "Apple Introduces a High Performance IICX," *Macworld*, November 1989, p. 114; Russell Ito, "Macintosh IICI: New Speed Champ," *MacUser*, November 1989, p. 46.

¹⁴Brita Meng, "Is Your Mac Obsolete?," *Macworld*, February 1990, p. 124.

Hardware upgrades come in two flavors: Apple and third party. Apple upgrades are easy. You take out the old disk or board and put in a new one and return the old product to Apple. The downside? You give up a future Cat Mac logic board and/or floppy disk and probably pay more. The plus side? You get a standard product with a defined resale value. With newer upgrades, you get a product you cannot get anywhere else at any price. Table 4-3 summarizes the Apple upgrades. Of course the real world doesn't always follow the rules of Table 4-3. If a dealer has a warehouse sale or is overstocked on SE 30 logic board upgrade kits and wants to move them, he might offer you a special discount on the upgrade kit and just forget about the return required.

Third-party upgrades come in two flavors: fixed function and expandable. *Fixed function* upgrades are just that: you upgrade your memory to 1Mb period—no further upgrading is possible. The plus side is they are usually less expensive. Expandable upgrades like daughterboards with SIMM memory sockets and accelerator cards with chip and memory sockets let you grow from your initial step.

As a general rule of thumb for Cat Mac builders, if you are upgrading within a class boundary as described above, a third-party offering will usually be less expensive than Apple's. If you are crossing between class boundaries, a higher performance logic board from Apple, assuming it is available at all, will usually cost less than the sum of a lower performance logic board plus an upgrade product. For example, almost all third-party offerings to make your 512 logic board into a Plus are less expensive than Apple's upgrade kit. On the other hand, if you want to upgrade your Plus to an SE 30, you are really better off to start with Apple's SE 30 upgrade kit. This option would not apply to non-Cat Mac builders because there is no upgrade from a Plus to an SE 30; the distinctions apply only when using Apple's Mac chassis and case.

Upgrade paths

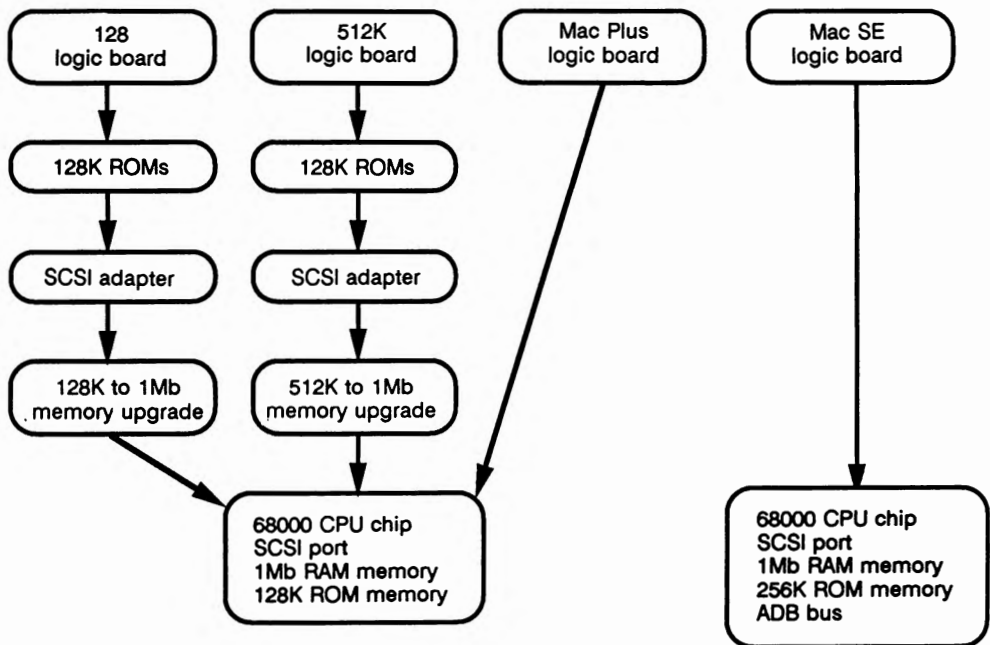
As a general rule of thumb, in today's environment you want to have at least 2Mb of memory across all classes of machines to at least be able to run Multifinder.

Table 4-3 Apple Macintosh upgrade kits.

Apple upgrade	Class	Return required	List price
Mac Plus disk drive kit	1	400K floppy	299
Mac Plus logic board kit	1	128,512 board	599
Mac SE 30 logic board upgrade	2	SE board	1699
Mac SE FDHD upgrade kit	2	800K floppy	599
Mac Iix logic board upgrade	3	Mac II board	2199
Mac II FDHD upgrade kit	3	800K floppy	599
68851 PMMU chip	3	N/A	499
Mac Iifx logic board upgrade	3	Mac II board	2999
Mac Iici logic board upgrade	4	Mac Iicx board	2399

Class one Mac owners should all have SCSI ports and 128K ROMs (i.e., be upgraded to the level of a Mac Plus). Class two and three Mac owners need to focus on upgrade strategies that take them to a 68030 or an upgraded Mac II that allow them to run Apple's new System 7.0 software. Class four Mac owners can kick back and sip a tall iced tea.

Figure 4-11 shows the discrete steps in upgrade paths involved for class one Mac owners in getting their Mac 128 and Mac 512 systems expanded to the Mac Plus standard. Figure 4-12 shows the simpler process for class two and three Mac owners in going to the 68030 standard.

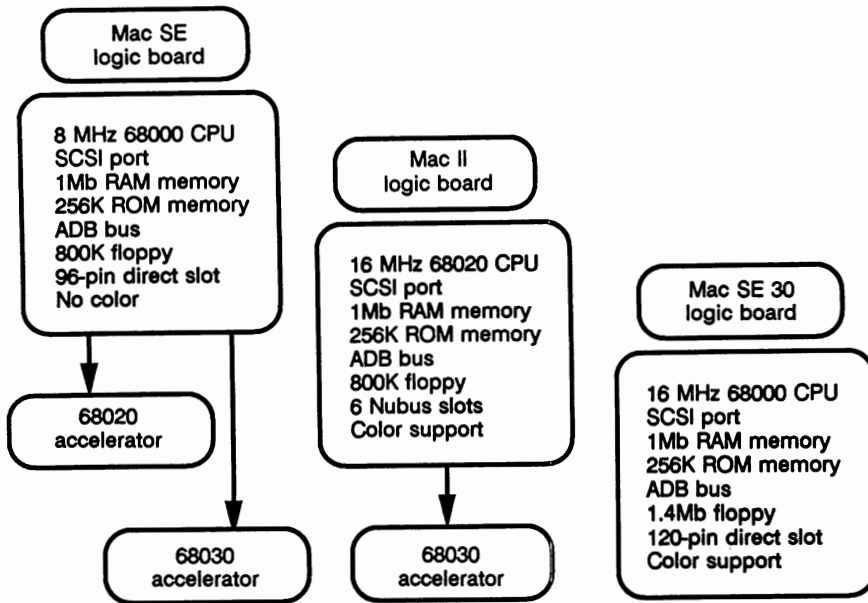


4-11 Mac 128, 512, Plus upgrade paths.

Fixed upgrades for 128 and 512 logic boards

If you are on a budget, the 128 Mac is the least expensive to start with. You can bring it up to 1Mb Mac Plus equivalent status including the cost of new 128K ROMs, for approximately \$525 (see Table 2-1) to which you would at that point add your other peripherals.

Memory chips in the 128 and 512 logic boards are soldered in, so do-it-yourself upgrades are difficult at best. However, numerous sources still provide memory upgrade options for these boards including mail-in and user-installed varieties. In general, fixed expansion options do not easily permit you to expand memory beyond 2Mb.



4-12 Mac SE, Mac II, SE 30 upgrade paths.

The Dove MacSnap series are probably the most popular user-installed memory upgrade boards. Dove Computer Corp markets 524S (1Mb) and 548S (2Mb) memory upgrade boards that come with the SCSI port adapter. They are typically available for \$235 and \$475 respectively.

To do a fixed one-time upgrade of your 128 Mac to 1Mb, another attractive deal is available from Mac Products USA. You send in your Mac 128 logic board and get it back with 1Mb of memory on it plus a bill for \$295 plus shipping. The same company also offers a SCSI adapter that clips onto the 128 or 512 logic board for \$69. To upgrade the Macintosh 512 to 1Mb, Mac Products also offers a mail-in logic board upgrade for \$149. Their SCSI adapter at \$69 is again added to complete the upgrade.

With fixed 128 and 512 upgrades, what you have the first time you upgrade is what you get; fixed memory upgrades are not expandable. If expansion is important to you, make sure your upgrade is expandable.

Expansion of memory in your Cat Mac in this way compares extremely favorably with the conventional Apple upgrades of 128 to Mac Plus at \$799 and 512 to Mac Plus at \$599. In the case of your Cat Mac project, less expensive is actually better because you couldn't care less about the new plastic housing that comes with the Apple upgrades. As far as the input/output connection being standard, your Cat Mac logic board is going to be inside a case of your choice, and you can use whatever kinds of adapters you want to adapt to whatever kinds of connectors you choose.

Expandable upgrades for 128 and 512 logic boards

The best way to expand a 128 or 512 logic board is to use the motherboard-daughterboard technique. Computer Care and Newbridge Microsystems provide similar solutions for \$250 and \$300 respectively. You get a board with 6 SIMM sockets (Computer Care) or 8 SIMM sockets (Newbridge) along with new 68000 chip and SCSI chip and cable, and Killy clip. The Newbridge allows you to intermix 256K and 1Mb RAM SIMMs. The computer case was either all 256K or all 1Mb. You attach the clip to your existing logic board 68000 chip, plug in their daughterboard, add memory chips, set the jumper settings, and you are in business. You have instant Mac Plus capability for a fraction of the Apple upgrade cost.

Adding an accelerator card to the 128 or 512 logic board also allows either of them to be bumped to 4Mb of RAM memory and you can even add a blazing 68030 chip under the hood as an extra performance boost.

How is your memory?

First, a few definitions and a little history. Computers “think” in *binary language* using a 1 or a 0 meaning that the circuit is either “on” or “off.” In computer terms, each individual 1 or 0 is called a *bit*. In mathematical terms, the number 2 raised to a power is a binary number. If I had three bits in a row, 111 which represented binary numbers with values of 2^0 , 2^1 , 2^2 , their base ten values (the numbers we think in) would be 1, 2, 4, and it would represent the number 7. By changing the 1s and 0s pattern, the sum of their digits could represent any number from 0 to 7, or eight different values. In its simplest form, this is the way computer values are changed to those we understand.

The smallest computer word or character consists of 8 bits and is called a *byte*. With 8 binary bit positions, you can arrange them to define 256 different characters or symbols. That is how your computer keyboard works. In shorthand notation, *K* means roughly 1000 (1024 is accurate) and *Mb* or *Meg* means 1,000,000. Earlier computers and chips “thought” in word lengths of 8, 12, 16, and 24 bits. They defined and moved data in chunks of that size. Two raised to that number defined the limit of memory they could directly address. Most of today’s computers and chips use 32 bits and are able to directly address 4 gigabytes (or four billion or 4,294,967,296 to be exact) address locations.

Memory is also called *RAM* (random access memory); *DRAM* (dynamic RAM; you have to constantly refresh it), *SRAM* (static RAM; does not need constant refreshing, has lower power consumption). Today’s semiconductor computer memory, like the processor chips is very fast but volatile, when you turn the power off, you erase memory. Mid-1970s minicomputer memory used magnetic cores and was slower but nonvolatile. It was also less dense. In those days, 32K of memory was a lot: top-of-the-line minicomputers had 256K. Computers used 4K

memory chips then 16K, then 64K, then 256K, then 1Mb. Soon they will use 4Mb chips, and 16Mb chips are in the labs now. The increase in capacity and decline in price of computer memory chips, coupled with the availability of powerful computers on a chip is what has really fueled the personal computer explosion.

A word about ROM (read-only memory): You give any computer its unique personality by telling it how it will execute certain instructions. You do this by storing its programming instructions in ROM. The Motorola 68000 processor chip at the heart of the Macintosh is also used in the Atari, Amiga, and numerous other computers. The major difference between them (physical architecture aside) is the instructions stored in their ROM chips. Each computer family uniquely instructs the generic 68000 chip how to perform its instructions. Put the Apple Mac ROM chips into an Amiga, and you have a Macintosh as discussed in Chapter 3. When Apple first introduced the 128 Mac, the instructions optimized and crammed into its 64K ROM is what really made it a Macintosh. It represented countless thousands of software and hardware man-hours, was the engineering marvel of its day (1982–1983), and still is very impressive by today's standards. How did they do that? Now you have at least a small idea of why Apple covets its ROM code so zealously.

On the earliest Mac 128 logic boards, Apple soldered 64K RAM chips directly to the board. In the 512 logic boards, Apple soldered in 256K RAM chips. To repair or upgrade them was very difficult. Then the *SIMM* (Single Inline Memory Module) was introduced. A SIMM consisted of eight individual RAM chips (PC style SIMMs use nine chips; the extra one is for parity, a quick way of checking your memory's health) attached to a small printed circuit card. Matching SIMM sockets were placed on the logic board and the entire repair and upgrade process was made simple.

SIMMs come in two flavors: *DIP* (Dual Inline Package) and *SOJ* (Surface Mount). DIP SIMMs are soldered on through holes, require a larger width SIMM circuit card, sit higher in their logic board socket, and cannot be used in height critical Plus or SE boards. But they cost less. SOJ SIMMs are soldered onto the surface of the circuit card, can be used in any SIMM socket, and cost more. Cat Mac builders can ignore all these words because you don't have to worry about such things; there are no height restrictions inside your Cat Mac case to create SIMM problems. *MacUser* had an excellent February 1989 article which delved into this and other memory concerns.¹⁵

The suffix numbers on the SIMM chips are important. The *-15* means you have a 150 nanosecond chip, *-12* means you have a 120 nanosecond chip, *-10* means you have a 100 nanosecond chip, *-80* means you have an 80 nanosecond chip, *-70* means you have a 70 nanosecond chip, etc. There is no advantage in using chips faster than your logic board needs; its clock speed and wait states are

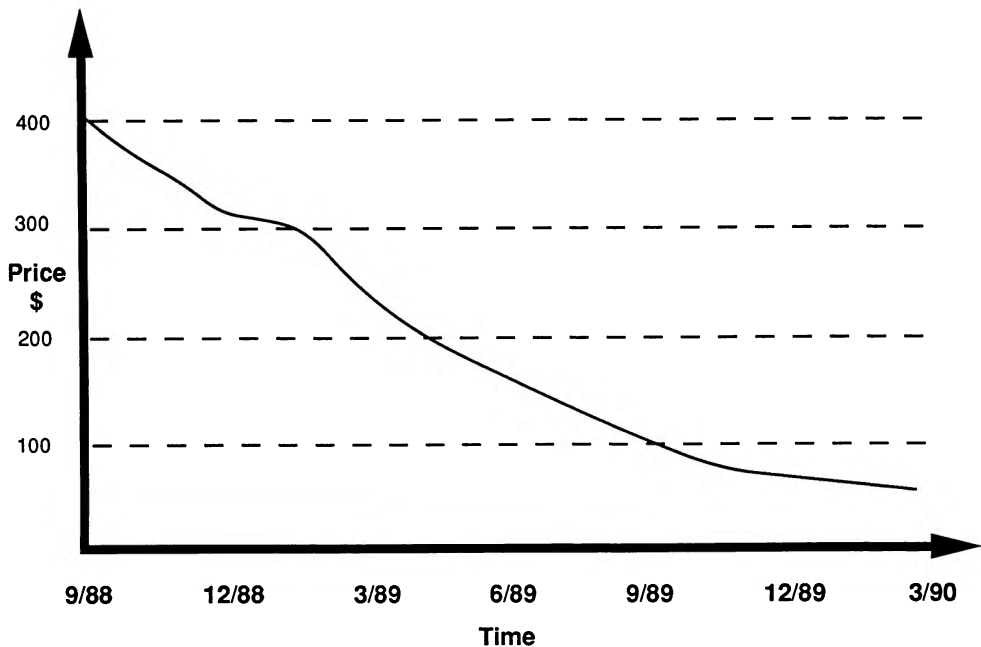
¹⁵Russell Ito, "The Persistence of Memory," *MacUser*, February 1989, p. 140.

fixed and cannot take advantage of faster chips. So don't spend money on faster SIMMs than you need. Anything faster than 150 ns on your Mac Plus or SE and faster than 12/ns on your Mac II or SE 30 is wasted. On the other hand, the SE 30, Mac Iix and Mac Iicx will take 100 ns and your accelerator board might need 100 ns or better SIMMs to perform well. The Iici, which used RAM in its video circuitry, requires at least 80 ns chips. Definitely do not use chips slower than your processor needs or you set the stage for Murphy's Law to strike you down; you will get strange error messages and spend days trying to track down the cause.

SIMM memory prices is an interesting subject. Look at Fig. 4-13 showing the price of 1Mb SIMMs between September 1988 and March 1990. I took this data straight out of the advertising pages of *MacWEEK*. The price dropped from over \$400 to less than \$65 in 18 months. Apple, who unfortunately stocked up on DRAM memory chips during the 1988 memory shortage, priced its 1Mb (4-256K SIMMs) upgrade at \$499, and its 4Mb (four 1Mb SIMMs) upgrade at \$1999 throughout this entire time. In late March 1990, they reduced these upgrade prices to \$299 and \$999 respectively. The Cat Mac builder and other astute buyers who frequent the mail order advertising channels can really save a bundle.

SIMMs rules for the Mac Plus and SE

On the Mac Plus and SE logic boards, socketed SIMMs make the memory upgrade process to 4Mb much easier. Both the Mac Plus and SE logic board have four SIMM sockets. As you look on down on the Mac Plus board, with the front



4-13 Decline in Macintosh 1Mb SIMM prices between September 1988 and March 1990.

edge toward you, the SIMM pockets are numbered 1 through 4 starting with the SIMM socket closest to the CPU chip. The Mac SE board with the same orientation has two rows of SIMM sockets, with 1 (left) and 2 (right) in the row closest to the CPU, with 3 and 4 below them respectively. Four allowable memory configurations use the 256K and 1Mb memory chips, and these are summarized in Table 4-4.

Table 4-4 Possible configurations for Mac Plus and SE memory SIMMs.

Configuration	1Mb	2Mb	2.5Mb	4Mb
SIMM #1	256K	1Mb	1Mb	1Mb
SIMM #2	256K	1Mb	1Mb	1Mb
SIMM #3	256K	—	256K	1Mb
SIMM #4	256K	—	256K	1Mb

Apple has laid down some simple rules,¹⁶ which, if followed, make life much simpler. Here are the SIMMs guidelines for either a Plus or an SE:

- Each SIMM must use 150 ns or faster RAM chips.
- All RAM chips in a row must be the same speed and size.
- Each SIMM must be filled with eight RAM chips. The nine RAM SIMMs used in IBM PC chips will not work.
- All rows must either be empty or contain two SIMMs.
- The SIMMs with the larger RAM chips must always be installed in row 1.

There is also a need to be aware of what to do with the SIMMs resistors on the Plus and SE logic boards. Table 4-5 summarizes it.

Table 4-5 SIMMs resistor status for Mac Plus and SE logic boards.

Configuration	2 SIMMs	4 SIMMs	All 256K	All 1Mb
Plus; resistor R9 “one row”	installed	removed	—	—
Plus; resistor R8 “256K bit”	—	—	installed	removed
SE; resistor R36 “one row”	installed	removed	—	—
SE; resistor R35 “256K bit”	—	—	installed	removed

On the SE 30, Mac II, Mac IIx, Mac IIcx logic boards, socketed SIMMs allow you to expand memory to 8Mb. All these logic boards have 8 SIMM sockets. As you look down on the logic boards, with the front edge toward you, the

¹⁶Apple, *Mac Hardware Reference*, p. 3–5.

SIMM sockets are numbered 1 through 8 starting with the SIMM socket closest to the front on the SE 30 and Mac IICx, and to the left on the Mac II and Mac IIX CPU. The five allowable memory configurations using the 256K and 1Mb memory chips are summarized in Table 4-6.

Table 4-6 SIMMs memory configurations for Mac SE 30, Mac II, Mac IIX, and Mac IICx.

Configuration	1Mb	2Mb	4Mb	5Mb	8Mb
SIMM #1	256K	256K	1Mb	1Mb	1Mb
SIMM #2	256K	256K	1Mb	1Mb	1Mb
SIMM #3	256K	256K	1Mb	1Mb	1Mb
SIMM #4	256K	256K	1Mb	1Mb	1Mb
SIMM #5	—	256K	—	256K	1Mb
SIMM #6	—	256K	—	256K	1Mb
SIMM #7	—	256K	—	256K	1Mb
SIMM #8	—	256K	—	256K	1Mb

Apple's rules changed slightly for these logic boards, but there are no resistor changes to worry about. Here are the SIMMs guidelines for an SE 30 (or a Mac II, Mac IIX, Mac IICx):

- Each SIMM must use 120 ns or faster RAM chips.
- All RAM chips in a row must be the same speed and size.
- Each SIMM must be filled with eight RAM chips. The nine RAM SIMMs used in IBM PC chips will not work.
- All rows must either be empty or contain four SIMMs.
- The SIMMs with the larger RAM chips must always be installed in row 1.

A few concluding thoughts on memory. RAM memory chips and SIMMs are a commodity. To get the best price on the SIMMs you need today, buy them direct or wholesale from reputable suppliers who guarantee their product. History has proven new memory replaces the old. Use up your 256K SIMMs on other projects or sell them. They can no longer compete on price or utility. The 1Mb SIMMs are now the most cost effective and will continue to be for the immediate future. But 4Mb chips, now in production, will compete with and replace 1Mb chips in approximately two years as manufacturing economies of scale drive their yields up and costs down.

Sources

Logic boards are available new and as upgrade replacements through Apple dealers. Used boards are available through the Apple used equipment dealers and, occasionally, through other distribution channels.

Manufacturers, Apple

Apple dealers will stock logic boards under the following part numbers:

661-96152 Mac 128
661-96236 Mac 512
661-0525 Mac Plus
661-0526 Mac SE 800K
661-0536 Mac SE FDHD
661-0527 Mac SE 30
661-0528 Mac II
661-0529 Mac IIx
661-0537 Mac IIcx
661-0532 Mac IIci

Manufacturers, Memory Upgrades

COMPUTER CARE INC.
420 N. 5th St., Suite 1180
Minneapolis, MN 55401
800-950-2273

NEWBRIDGE MICROSYSTEMS
603 March Rd.
Kanata, ON K2K 2M5 Canada
800-267-7231

DOVE COMPUTER CORP.
1200 North 23rd St.
Wilmington, NC 28405
919-763-7913

Mail order, used Apple Macintosh equipment dealers

ACCESS II
Salem, NH
800-662-5606

CRA SYSTEMS INC.
700 S. University Parks Dr., #600
Waco, TX 76706
800-950-8212

BOSTON COMPUTER EXCHANGE
Boston, MA
617-512-4414

EXSEL INC.
2200 Brightn-Henrietta Twnln. Rd.
Rochester, NY 14623
800-624-2001

COMPUTER BROKERAGE SERVICES
New York, NY
212-947-7848

INTERSTATE COMPUTER BANK
Mountain View, CA
415-968-8733

COMPUTER DISCOUNT WAREHOUSE
New Jersey
201-224-4273

MACHEAVEN
Chantilly, VA
703-263-2567

MAC SALE INTERNATIONAL
New Jersey
800-729-7031

MAYA COMPUTER
P.O. Box 680
Waitsfield, VT 05673
800-541-2318

MICRO EXCHANGE
682 Passaic Ave.
Nutley, NJ 07110
201-284-1200

PERIPHERAL OUTLET
314 South Broadway
Ada, OK 74280
405-332-6581

PRE-OWNED ELECTRONICS
30 Clematis Ave.
Waltham, MA 02154
800-274-5343

Mail order, memory and upgrade suppliers

BARGAINS N' DEALS
800-446-2433

CHECKMATE TECHNOLOGY
800-325-7347

CHIP MERCHANT
9285 Chesapeake Dr., #L
San Diego, CA 92123
619-268-4774

DATA MEMORY SYSTEMS
15 Union St.
Lawrence, MA 01840
508-683-2325

DELTA RESEARCH LABS
11090 E. Artesia Blvd., #C
Cerritos, CA 90701
800-999-1593

SHREVE SYSTEMS
2421 Malcolm St.
Shreveport, LA 71108
800-227-3971

SUN REMARKETING
P.O. Box 4059
Logan, VT 84321
801-821-3221

TEXAS DIRECT
Austin, TX
800-880-0458

VISION INVESTMENT RECOVERY
11 6th Rd.
Woburn, MA 01801
800-242-5224

DIGI GRAPHICS
764 E. Village Way
Kaysville, UT 84037
801-544-2009

GRAND TECHNOLOGY
4019 Clipper Ct.
Fremont, CA 94538
415-659-0943

HARDWARE HOUSE
3440 Market St.
Philadelphia, PA 19104
800-RAM-4MAC

HWH MICROSYSTEMS
Hammond, LA
800-673-0586

MACPRODUCTS USA
8303 Mopac Expwy, #218
Austin, TX 78759
800-622-3475

PSI
2005 Hamilton Ave., #200
San Jose, CA 95125
800-622-1722

MEMORY MASTERS
2023 O'Toole Ave.
San Jose, CA 95131
800-726-2897

SHERCOM COMPUTERS
22755 Savi Ranch Pkwy. G
Linda, CA 92686
800-366-4433

MEMORY MODULE TECHNOLOGY
10291 E. Grand River, #E
Brighton, MI 48116
313-229-9303

SOUTH COAST ELECTRONICS
700 S. Flower St., #2200
Los Angeles, CA 90017
800-289-8801

MICRO ELECTRONIC TECHNOLOGIES
35 South St.
Hopkinton, MA 01748
800-766-SIMM

TECHNOLOGY WORKS
4030 Baker Lane W.
Austin, TX 78759
800-622-2210

Mail order, Macintosh suppliers: repairs, parts, consulting

CMO
477 East Third St.
Williamsport, PA 17701
800-233-8950

SIMMONS CONSULTING
5526 Pemberton St.
Philadelphia, PA 19143
215-471-9242

MIPRO III DISK REPAIR
204 Franklin
Redwood City, CA 415-364-5374

SOFT SOLUTIONS
907 River Rd., #98
Eugene, OR 97404
503-461-1136

PERIPHERAL OUTLET
314 S. Broadway
Ada, OK 74820
405-332-6581

TURBO TECHNOLOGIES
112 Denton Ave.
New Hyde Park, NY 11040
800-542-7466

5

CHAPTER

Accelerator boards

Accelerator boards are the Cat Mac builder's customizing tool. They come in all sizes, speeds, option configurations, and prices. They can be used to take your 128K Mac to a 4Mb 68030 screamer, your Mac II to a 68030 running at 50 MHz, or merely to double the speed on your 68000 SE chip from 8 to 16 MHz and give you a performance boost on the software programs you now run.

The Macintosh market has undergone a healthy growth, and with it the market for accelerator boards and the number of board suppliers. When Apple makes a move, such as announcing its SE 30 logic board¹ and, most recently, the aggressively priced Mac IIfx logic board² upgrade kit, the other suppliers move rapidly to adjust their prices and reposition their products. An astonishing, if not bewildering, array of accelerators are available and not all are created equal. The newer boards are less expensive, easier to install, and provide a higher compatibility with existing software than did their predecessor accelerator boards of just two years ago. The performance levels have drifted higher as increasingly hotter chips become available, and this trend will continue.

¹Dale Coleman, "The Market for SE acceleration undergoes dramatic changes," *MacWEEK*, 4/4/89, p. 24

²John Battelle, "IIfx puts Apple at head of performance pack," *MacWEEK*, 3/20/90, p. 1.

The subject of accelerator cards is a broad one. My objective in this chapter is not to discuss the pros and cons of every one of them, only to introduce those relevant to you as a Cat Mac builder. To get you started, I will discuss what they are, what they do for you, and several types you might consider for your Cat Mac project.

Your goal is simple. How to avoid spending \$600 for your SE logic board and \$900 for your 68030 accelerator board if you can obtain the Mac SE 30 logic board to begin with for only \$1200. On the other hand, if you already own a Mac SE and a 68030 accelerator board lets you improve its performance and costs less than going to an SE 30 Mac logic board, you should probably take a look at it.

For additional information, *MacUser* in February 1989, and *Macworld* in March 1989, and February 1990³ featured excellent comprehensive articles on accelerator boards and are well worth a read. Other excellent articles on accelerator boards, although they are now dated, appeared in *MacUser* in March 1988 and *MACazine* November 1988.⁴ You also might want to look at some of the articles that have appeared covering the broad subject of to upgrade or not.⁵

Okay, accelerate me

Accelerator cards and combination accelerator-memory-video upgrade boards actually work better for the Cat Mac builder than for the traditional Mac user. This is because they don't have to be squeezed into a small box, powered by a smaller power supply, and kept cool by a smaller fan. The Cat Mac builder has the entire inside of a PC chassis in which to work, along with the luxury of much larger power supplies and cooling fans. The additional space means no height limitations restricting the type of SIMM memory you use; you can use the less expensive DIP SIMMs.

In your car, you can take out the four- or six-cylinder engine and replace it with a more powerful eight-cylinder one; the car body and everything else stays the same. The same principle applies in adding an accelerator board to your Mac. You take a new board with a more powerful CPU chip and associated circuitry and either clip it on to your existing logic board CPU chip or remove the old CPU chip entirely and plug the new board in its place. Everything else stays the same. Well, not exactly. You also need some additional software, and you might even

³Gil Davis, "Maximum G-Force," *MacUser*, February 1989, p. 169; Bruce F. Webster, "Processors: Is Faster Better?" *Macworld*, March 1989, p. 118; Brita Meng, "Is Your Mac Obsolete?," *Macworld*, February, 1990, p. 124, and Bruce F. Webster, "Pushing the Mac II Performance Envelope," *Macworld*, February, 1990, p. 135. Both do an excellent job of summarizing recent accelerator board technology.

⁴Chip Carmen, Jim White, Steven Bobker, "Pedal to the Metal," *MacUser*, March 1988, p. 108; Savant Labs, "Speed Thrills," *MACazine*, November 1988, p. 41.

⁵Cheryl J. Goldberg, "The Sale of a New Machine," *Macintosh Business Review*, January 1989, p. 41.

want to reformat your hard disk for better performance. Most of your programs—all of the major ones (word processors, spreadsheets, etc.)—will run exactly as before only faster.

To begin with, you need to know something about the terms you are likely to encounter in discussing accelerator boards, including CPU chips, their floating point unit (FPU) and paged memory management unit (PMMU) features, their clock rate or speed, throughput, cache, memory options, and the additional control software and expansion options that each accelerator board provides. Some definitions follow.

CPU chip Today, accelerators come in three flavors of chips: 68000, 68020, 68030, and it is only a matter of time before the 68040s come along. The 68000 chip has 68,000 transistors or switches on it, with 32-bit internal architecture and 16-bit data input paths. The 68020 chip has 195,000 switches on it, full 32-bit architecture and an on-board 256-byte instruction cache. The 68030 has 300,000 switches on it, with an on-board PMMU and additional 256-bytes of data cache. The 68040 has 1,200,000 switches on it, and an on-board FPU, PMMU plus expanded instruction and data cache of 4096 bytes each. For additional speed, the 68040 chip adds parallel, independent instruction and data buses that are accessed simultaneously.

Clock speed 68020 and 68030 chips in Mac II and Mac SE 30 logic boards (respectively) run at 16 MHz versus the 8 MHz clock speed of the 68000 chip used in the SE logic board. Two times the operating frequency means that twice as many operations are performed each second. Today, accelerator boards are available to run at up to 50 MHz.

Throughput 68020 and 68030 chips use 32-bit versus the 16-bit data paths in the 68000 chip. Two times the path width means that twice as much data is transferred each operation. Twice as much data moving at twice the previous speed means the 68020 and 68030 chips have four times the throughput of the 68000 chip (in theory).

Cache As explained in Chapter 4, imagine this as a change purse in a woman's handbag or the change pocket in a man's blue jeans. Rather than looking in the big handbag or all of the jean's pockets, the coins are easier to find in the change purse or change pocket. Same way with cache memory. Put a small amount of faster memory in front of main memory, and the CPU only has to look at it for the next instruction or piece of data. The on-chip instruction cache in the 68020, with the additional data cache in the 68030, improve performance, especially of looping, iterative programs. Radius accelerator boards, for example, use the technique of very fast static RAM cache to achieve outstanding performance even with the slow RAM chips used for main memory.

FPU and PMMU Don't worry, these are less intimidating than their titles. FPU is an optional 68881 or 68882 (newer chip about twice as fast as the 68881) chip used in conjunction with the CPU chip to accelerate math intensive applications such as spreadsheets, graphics, and CAD programs. The PMMU, already on the 68030 chip and on the optional 68851 chip used in conjunction with the 68020, does nothing for your software now unless you are running A/UX (Apple's Unix Software) or Connectix's Virtual (*virtual* software allows you to use your hard disk as part of memory; by definition it is not "real" memory so it is "virtual" memory), but Apple's System 7.0 (Apple's first system software to have virtual capabilities) will use its features.

Memory options Not all accelerator boards are created equal in this department. Some use their own RAM exclusively, some use your logic board's RAM, while some use both. Some specify that you must use faster RAM chips than the 150 ns (nanosecond) SIMMS that probably came with your Plus SE logic board. You want to ask some very specific questions in this area because extra needed RAM chips could bump your accelerator board price considerably higher.

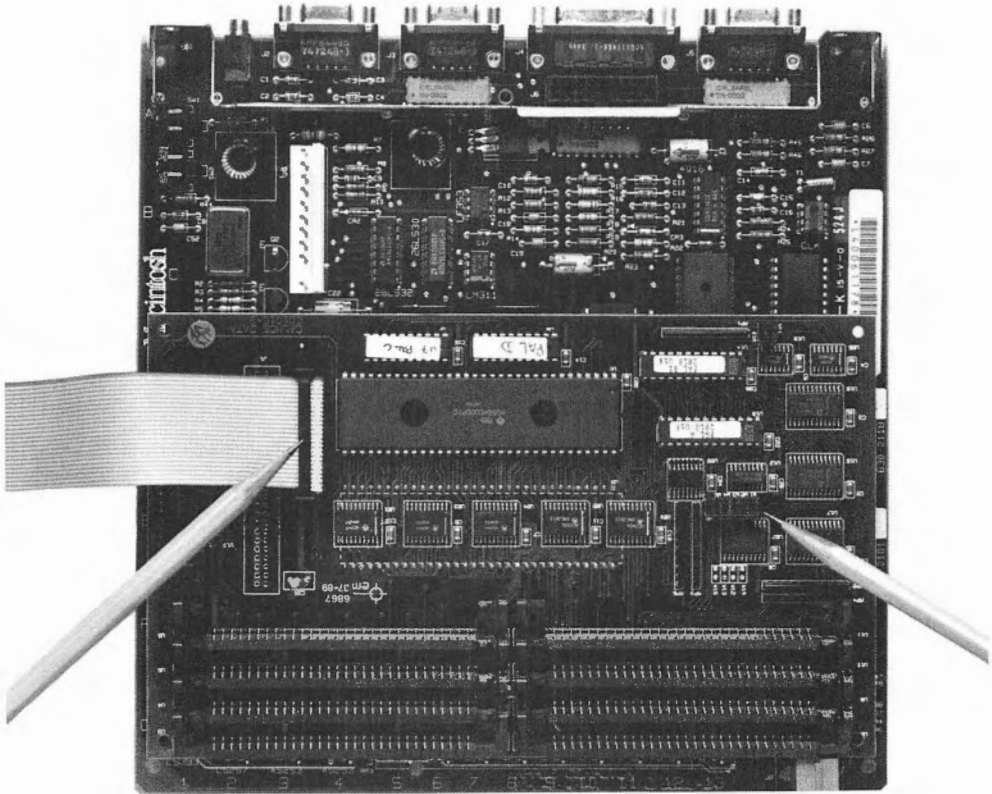
Control software Packaged with the board, control software must allow you to disable the accelerator board or 68020 cache. This is important if you are running programs that only work in the 68000 native mode and want to keep using them. All other control software features, such as copy ROM into high-speed RAM at startup, configure 68881 options, set speeds, and size memory fall in the nice-to-have category.

Expansion options Can you drive a video monitor or piggyback other option cards off your accelerator card? When Radius entered the market in 1987 with their complete expansion solution designed by Burrell Smith (the Mac's original hardware designer), it piggybacked video onto the accelerator card and set the standard for virtually all accelerator cards that followed. All accelerator manufacturers support their own video that monitors (e.g., Radius). Some support others (e.g., Gemini supports E-Machines). Some give you an SE 96-pin direct slot extender and you do what you want (e.g., SuperMac).

Boards I have known

Although I briefly discussed them under the heading of "expandable third-party memory upgrades" in Chapter 4, the daughterboard add-ons from Computer Care and Newbridge Microsystems resemble accelerator boards in their appearance and attachment. I have used them both. They are easy to install, transparent in operation (you don't even know they are there), reliable, and best of all, easy on the pocketbook. I can get all the capabilities of a Mac Plus on my 128 logic board just by adding memory SIMMs.

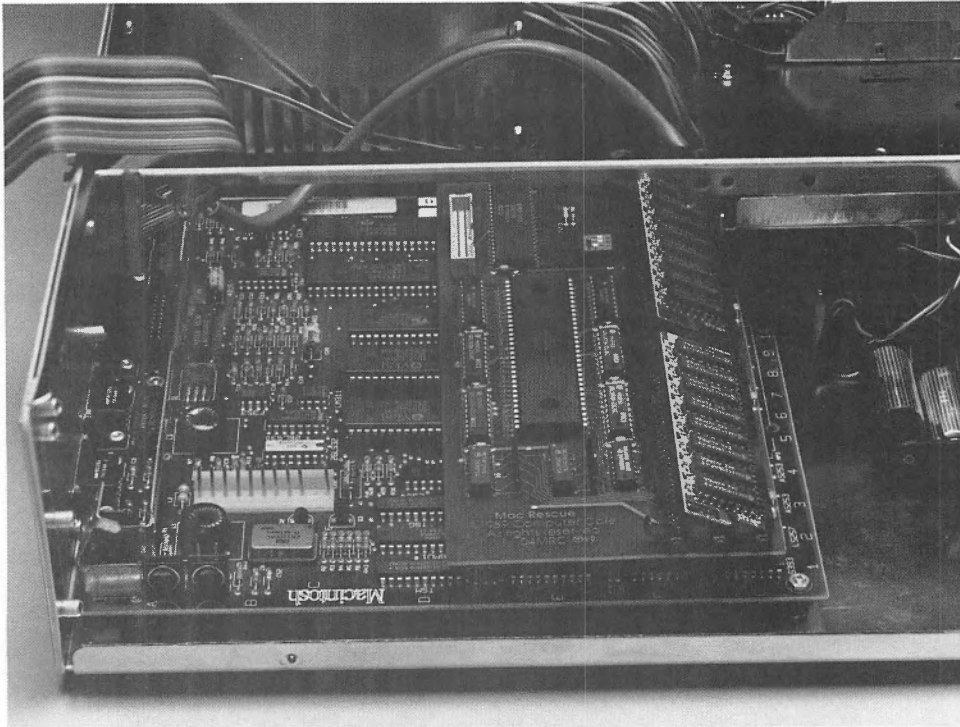
The Newbridge Microsystems board, without any SIMMs on it, is shown



5-1 Newbridge Microsystems board installed on a 512 logic board. Pencils point to SCSI cable and memory jumpers.

attached to a 512 logic board in Fig. 5-1. The pencils point to where the SCSI cable attaches to the board and to where the memory jumpers are located. The main advantage of the Newbridge board, with its eight SIMM sockets, is you can mix and match 256K and 1Mb SIMMs in 512K increments all the way up to the 4Mb Mac Plus limit. This is a handy feature and helps you find a place for all those 256K SIMMs you might have laying around from other upgrades. You can use the memory already on the 512 logic board to help you, but not the 128 logic board's memory.

The Computer Care board, with two 256K DIP SIMMs on it, is shown in Fig. 5-2, attached to another 512 logic board (the board is mounted in the ATS preassembled chassis mentioned in Chapter 10). As you can see, it is almost identical to the Newbridge board in appearance, but it has only six SIMMs sockets and uses a DIP switch rather than jumpers for memory settings. The DIP switch is located behind the far SIMM in Fig. 5-2, the 5380 SCSI chip is to its left, with the SCSI cable socket to the left of the chip. You can only use either all 256K or all 1Mb SIMMs at one time with your only options being 1, 2, 2.5 or 4 megabytes.

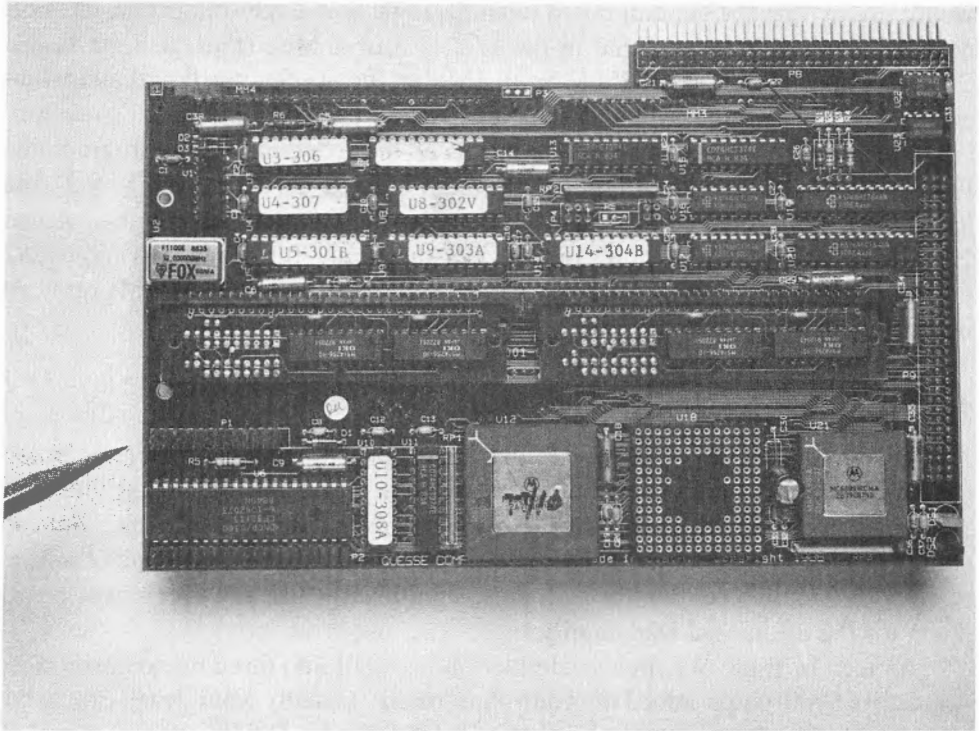


5-2 Computer Care board installed on a 512 logic board.

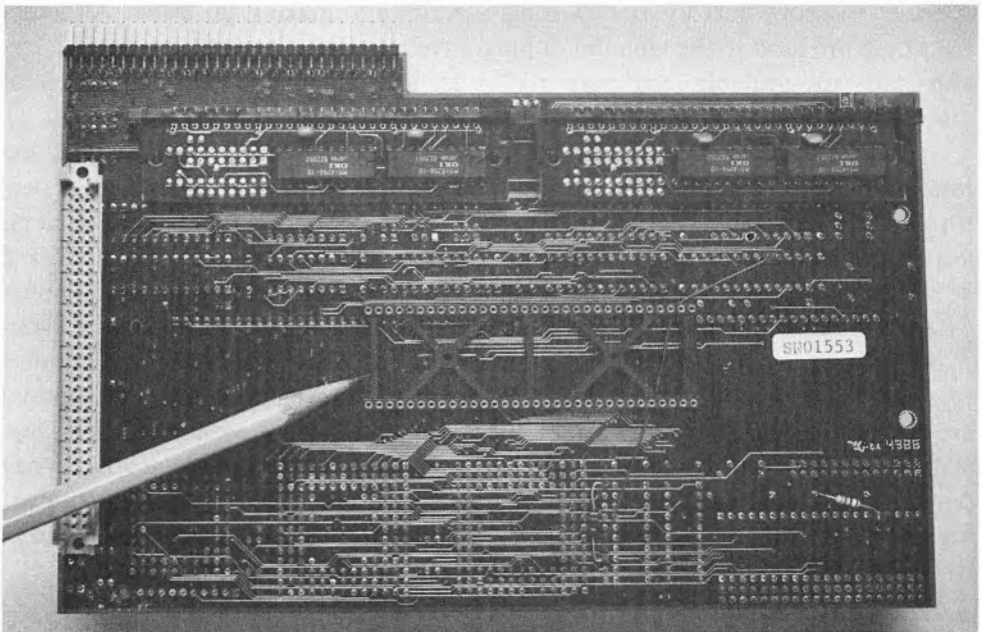
As with Newbridge, the 512 logic board memory is usable; the 128s is not. But the DIP switch makes memory settings a breeze, and it cost slightly less than the Newbridge board.

Both boards come with a Killy clip adapter that snaps over your earlier vintage plastic 68000 chip case—a two-minute operation (unless you are doing it for the first time). If you have a ceramic 68000 chip case, you are in trouble. You can only solder an adapter slip's leads to each matching pin of your existing logic board's 68000 ceramic chip to reliably attach the daughterboard—a step I believe is best done by a specialist. After the Killy clip is in place, you plug in the daughterboard, add memory chips, set the jumper settings, and you are in business. You have instant Mac Plus capability for a fraction of the Apple upgrade cost.

The Gemini accelerator board from Total Systems shown in Fig. 5-3 is no different from the Newbridge and the Computer Care boards in its installation and cabling. Performance is another story. Earlier in the book, I mentioned adding an accelerator card to bump your 128 or 512 logic board to 4Mb of RAM memory with a blazing 68030 chip under the hood; this is one of the boards that does it. Flexibility—you have it. Attach it to either a 128, 512, Plus, or SE logic board. In Fig. 5-4, the pencil points to the adapter clip on the underside of the board for attaching to either 128, 512, or Plus boards. Under the pencil is the connector you



5-3 Total Systems Gemini accelerator board with 16 MHz 68020 and 68881 installed.



5-4 Total Systems Gemini accelerator board bottom view pencil points to adapter which plugs into Lilly clip.

would use to plug the Gemini board in an SE logic board's 96-pin expansion slot. Memory expansion is available in the 1, 2, 2.5 or 4 Meg steps; use the fastest SIMMs you have, either all 256K or all 1Mb on the accelerator board and whatever you have on your existing logic board. Again, the 128 logic board's memory is not used. The Gemini accelerator controls all these options via preprogrammed PAL chips (the ones with white tape on them marked Ux-30xx in Fig. 5-3) and jumper settings on the board. Figure 5-3 shows the Gemini board with socketed 16 MHz 68020 and 68881 chips but you can substitute 20 MHz 68030 and 68882 chips for better performance. This version, with 80 ns or better SIMMs on it set up at zero wait states really flies.

I don't want to board you

As I mentioned earlier, there really is a bewildering array of accelerator board choices. Table 5-1 shows some but not all of them. If you are able to take video off your logic board power connector using the Power R video driver cable, you can connect your Cat Mac to the Princeton Max 15 Multisync monitor, which I prefer, or any other multisync monitor and, most significantly, use any accelerator board made for the traditional Mac family.

As seen in Table 5-1, the accelerator choices fall into three broad categories: speedier 68000 chips added to your Plus or SE (usually your least expensive choice); 68020 chips at various speeds; and finally the 68030 options. Another category is cache cards; these add performance at an economy price by placing speedier memory next to your existing CPU chip to make it go faster. Although list prices are used in the table for comparative purposes, virtually all the accelerator cards are available from both mail order and manufacturer direct sources at discounts of 20% to 40% off list.

Which board should you choose and why? That depends on your budget and how much performance you want. Buy the one that gives you the best price performance. From Table 5-1, for traditional Mac family 68000 logic board owners, a mail order purchase of a speedier 68000 chip will set you back about \$250 to \$350; an entry-level 68020 about \$500 to \$750; and an entry-level 68030 about \$1000 to \$1250. Cache cards buy you more speed at a slightly lower cost of about \$250 to \$750 depending on your choice. If you already own a Mac II, Apple's Mac IIx upgrade is the best game in town today; third-party accelerator vendors are scrambling to lower their prices.⁶ If you already own a Mac IIcx, then Daystar, Siclone, or Total Systems should have something for you, but you will have to pay for it. If you already own a Mac IIci, add a Daystar cache card and just relax, kick back and sip a tall iced tea—see if your Mac IIci can calculate the value of pi to 10²⁰ decimal places before the ice melts in your glass.

⁶John Battelle, "Accelerator prices decelerate," *MacWEEK*, 3/27/90, p. 1

Table 5-1 Cat Mac accelerator card options grouped by the accelerator's CPU type.

Manufacturer/accelerator	Logic board	CPU speed	List price
<i>Accelerators Using 68000 CPUs</i>			
AOX Double Time 16	SE	16	395
Irwin Exceleator XL	SE	16	495
Newer MacSelerator	SE	16	345
Siclone Turbo SE	512, Plus, SE	16	398
Super Mac Speed Card	SE	16	399
<i>Accelerators Using 68020 CPUs</i>			
Computer System Assoc FasTrack	Plus, SE	8	599
Dove Marathon 020	SE	16	699
GCC Hypercharger 020	SE	16	549
Irwin Exceleator XL 20	SE	20	995
Irwin Exceleator XL 25	SE	25	1695
MacProducts USA Railgun 020 Plus	128, 512, Plus, SE	16	549
Microtech 68020 Accelerator	Plus, SE	12	599
Novy Mac 20 MX/16	512, Plus, SE	16	895
Novy Mac 20 MX/25	512, Plus, SE	25	1595
Orchid Mac Sprint II	Mac II	16	299
Radius Accelerator 16	Plus	16	795
Radius Accelerator 25	SE	25	1395
Spectra Micro Development Proboard	128, 512, Plus, SE	16	995
Total Systems Gemini 020	128, 512, Plus, SE	16	995
<i>Accelerators Using 68030 CPUs</i>			
Daystar Power East Cache IICI	Mac IICI	N/A	995
Daystar Power Card 16/030	Mac II, IIx, IICx	16	1495
Daystar Power Card 33/030	Mac II, IIx, IICx	33	1995
Daystar Power Card 40/030	Mac II, IIx, IICx	40	2495
Daystar Power Card 50/030	Mac II, IIx, IICx	50	2995
Dove Marathon 030	Plus, SE, Mac II	16	699
Dove Marathon 030	SE, SE 30, Mac II, IIx	32	1599
MacProducts USA Railgun 030 Plus	128, 512, Plus, SE	25	995
Microtech 33/68882 Accelerator	Mac II	33	1799
Newbridge Ultramax NM 030 MX	512, Plus, SE	25	1595
Siclone SI3033	Mac II	33	3995
Siclone SI3050	Mac II, IIx, IICx	50	5495
Total Systems Gemini 030	SE	16	1395
Total Systems Voyager 33	Mac II	33	4195

As Cat Mac builder, your choices are somewhat simplified. A Mac SE logic board costs about \$600, an SE 30 about \$1200. If you already own a 128 or 512 or Plus logic board, upgrade it using the accelerator board criteria mentioned here. If not, start with either an SE or SE 30. For the Mac IIxx family, the same criteria as above also applies to you.

Don't overaccelerate: Video and other considerations

Some manufacturers offer combination that put both accelerator and video functions on the same board, thereby lowering the cost from the piggybacking standard and improving reliability. Table 5-2 shows a few. For economic reasons, this trend is probably where all accelerator boards are eventually headed.⁷ Rather than going the Power R drive cable route, these boards enable you to get accelerated and provide 640 × 480 resolution to your 12" or 14" hi-resolution multisync monitor and some larger screen monitors as well. Again, list prices in the table are used for comparative purposes, but the combination cards are also available at discounts. I am sure that all these prices will be impacted by the new, low-priced, full-page monitor and accelerated video card announcement from Mobius (late March 1990) discussed in Chapter 8.

Table 5-2 Cat Mac combination card options.

Manufacturer/accelerator	Logic board	CPU speed	List price
<i>68020 family</i>			
Nemonix VXL-SE 68020	512, Plus, SE	16	1295
Super ADD PROboard 68020	512, Plus, SE	16	1495
<i>68030 family</i>			
Newbridge 68030	512, Plus, SE	25	1595

As a Cat Mac builder, the key is keeping your future expansion options as open ended as possible for the direction you want to go. If you are thinking of adding a bigger monitor later on, it pays to think now of what kind of monitor that is going to be, and make sure that the present accelerator board you choose now supports it. Better still, buy them both now if you can afford to. In any event, it is really a much better idea to buy the accelerator first or buy it with the larger screen monitor. Otherwise, if you are used to viewing the standard Macintosh screen and you just add a bigger screen to your existing Macintosh, the larger monitor, by virtue of needing a longer time to "paint" a larger screen, will give you an apparent reduction in performance.

Of course it is always possible to expand your Macintosh or Cat Mac. An available product called MacExpand from Second Wave can add extra slots to your Mac Plus, SE or Mac II, which accomplishes this in the most direct manner—although you pay for it.

⁷Clay Andres, "The Single Slot Machine," *MacWEEK*, 8/22/89, p. 26.

It is important to understand that even though the Apple SE 30 and Mac IIfx logic board upgrades are available at attractive prices, the existing accelerator boards in Table 5-1 have and will continue to play an important role. Why? Because they offer the following flexibility:

- *Lower entry point pricing, stretch out your purchases.* You can start with an SE logic board or less, add a 68020 accelerator card, later upgrade it a 68030, later upgrade it to a hotter 68030. This installment plan approach means you pay more money overall but each step costs you less.
- *More performance options.* An accelerator card can be found to add to any Apple logic board to make it faster than Apple's offerings; that is why the third-party accelerator board manufacturers are in business. You can add accelerator options to a logic board you already own to bump its performance past Apple's Mac IIfx or IIfx.
- *Video expansion options.* The SE logic board is compatible with numerous video options of interest to the Cat Mac builder; the SE 30, at this point, is not. Adding an accelerator board to the SE gives you the best of both worlds.

Accelerators to get you started

It is difficult to make a recommendation for someone else's Cat Mac accelerator board, sight unseen, so it won't be attempted here. Heck, choosing your own is part of the fun. But there are a few that might make sense on a pure cost basis and these are shown in Table 5-3. To make the pricing comparisons equivalent, the accelerator upgrades using their typical street prices were added to the \$1800 basic Cat Mac SE configuration price from Table 2-8. If a video card was used in place of the \$100 Power R video cable, the basic price was lowered to \$1700.

Table 5-3 Comparison of accelerated Cat Mac system options.

Configuration	Base System	68000	68020	68030	Total
Super Mac Speed Card	1800	250	—	—	2050
Speed Card + Mobius Card	1700	600	—	—	2300
Dove Marathon 020	1800	—	450	—	2250
Marathon + Mobius Card	1700	—	800	—	2500
Nemonix VXL-SE 68020 w/video	1700	—	900	—	2600
Newbridge Micro 68030 w/video	1700	—	—	1200	2900

Table 5-3 holds no surprises. Compared to the \$2400 cost of the SE 30 system shown in Table 2-8, starting with a Cat Mac SE 30 logic board to begin with is less expensive and better building than building up to it. On the other hand, if you already own the \$1800 Cat Mac SE system of Table 2-8, you can come real close to the SE 30 system performance by adding options to the SE.

Sources

Apple upgrades are available through Apple dealers. New and used Apple upgrades are also available through the Apple used equipment dealers. All other accelerator boards are available directly from the manufacturer and through the mail order distributors.

Manufacturers, accelerator board suppliers

DAYSTAR DIGITAL
5556 Atlanta Hwy.
Flowerey Branch, GA 30542
800-962-2077

NEWBRIDGE MICROSYSTEMS
20 Edgewater St.
Kanata, Ontario, Canada
800-267-7231

DOVE COMPUTER CORP.
1200 N. 23rd St.
Wilmington, NC 28405
800-622-7627

NEWER TECHNOLOGY
1117 S. Rock Rd., #4
Wichita, KS 67207
800-678-3726

GCC TECHNOLOGIES
580 Winter St.
Waltham, MA 02154
800-422-7777

NOVY SYSTEMS
2341 S. Ridgewood Ave.
Edgewater, FL 32141
904-427-2358

IRWIN MAGNETICS
2101 Commonwealth Blvd.
Ann Arbor, MI 48105
313-930-9000

ORCHID TECHNOLOGY
45365 Northport Loop W.
Fremont, CA 94538
415-683-0373

LEVCO
6181 Cornerstone Ct. E., #101
San Diego, CA 92121
619-457-2011

RADIUS
404 E. Plumeria Dr.
San Jose, CA 95131
408-434-1010

MICROTECH INTERNATIONAL
29 Business Park Dr.
Branford, CT 06405
800-325-1895

SECOND WAVE INC.
9430 Research Blvd.
Echelon II, Suite 260
Huston, TX 78759
512-343-9661

NEMONIX
106 South St.
Hopkinton, MA 01748
508-435-9087

SICLONE SALES AND ENGINEERING
1515 Centre Point Dr.
Milpitas, CA 95035
408-263-8207

SUPERADD COMPUTER PRODUCTS
2 St. Claire Ave. W., #1700
Toronto, Canada
416-925-2739

TOTAL SYSTEMS
99 W. 10th Ave., #333
Eugene, OR 97401
503-345-7395

SUPERMAC TECHNOLOGY
295 No. Bernardo Ave.
Mountain View, CA 94043
415-964-8884

6

CHAPTER

Hard disks

Remember the old-time music jukebox in the corner restaurant? It had its 78 or 45 rpm record platters in a stack or bin. When you made your selection, the record with your music on it would be moved into place, and the pickup arm with the needle in it would be moved over the starting groove on the record. Hard disks work in remarkably similar fashion. The platter is a polished metal disk rather than a vinyl plastic one; perfectly flat, with a thin magnetic oxide layer deposited on it to a high tolerance of purity and uniformity rather than grooves; the read/write head is a tiny electromagnet at the end of an arm that has been optimized for minimum mass rather than a pickup arm with a phonograph needle in it. The read/write head goes directly to the part on the disk it wants, just like today's CD players go right to the music track you selected.

Hard disks have changed drastically since their first introduction in the 1950s; this technology trend continues today. Next to memory and CPU chips, they are probably the number one reason responsible for the increase in the number of personal computers installed today. Their increased storage capacity, smaller size, reduced access time, and much lower cost has brought their benefits within reach of every personal computer user.

The first hard disk I ever saw, on an old IBM Ramac 650 machine, had a stack of platters mounted in the open air occupying a space larger than today's home washing machine tub! I believe it stored less than 5Mb. Later models had

14" and 8" diameter disks, before arriving at the current 5¹/₄" and 3¹/₂" standards. Today, 600Mb 5¹/₄" hard disks are a fact of life along with 200Mb 3¹/₂" disks. Recently, Areal Technology announced a 2¹/₂" form factor 50Mb hard disk, Quantum and Seagate announced a 1" high 3¹/₂" hard disk, and IBM announced a laboratory breakthrough it believes will lead to gigabyte capacity hard disks. There is no end in sight.

Every hard disk has one or more rigid, magnetic oxide coated platters in it, sealed in a filtered enclosure that keeps dust off them. Each disk platter has two sides or surfaces accessed by one or more read and write heads. These heads are positioned by either slower, less expensive, "stepper" motors (the heads are moved in fixed increments or steps across the disk) or faster, more expensive voice coil and servo track mechanisms (the heads move across the disk in precise increments using servo feedback technology). The electronic data going to and from the heads is formatted and controlled by circuitry adhering to well defined interface specifications such as the modified SCSI Standard used by the Macintosh.

My objective in this chapter is to give you the framework to make your own hard disk choices and answer Cat Mac builder hard disks questions for you such as: Which hard disk should you use? How much storage capacity do you need? To get started, I will discuss some definitions and background, move into what hard disks do for you, types that I have used, and those you might consider for your Cat Mac project. To learn more, two good books are *Macintosh Hard Disk Management* and *The Hard Disk Companion*; and two articles "Getting Started with Troubleshooting"¹ and "Macintosh SCSI Drive Secrets Revealed" can help you. Excellent articles also appeared in *Macworld*, *MacUser*, and *Computer Shopper*.²

Why buy a hard disk

Apple changed to a revamped pricing strategy with their new model hard disk introductions in 1989 because estimates were that they had captured only 180,000 or 20% out of the 880,000 drives sold in 1988. The other 700,000 went to the more than 40 other companies in the highly competitive Macintosh disk drive market.³ Apple's hard disk pricing still leaves considerable room for other vendors to provide solutions as Table 6-1 illustrates.

¹Jim Heid, "Getting Started With Troubleshooting," *MacWorld*, August 1989, p. 233. Has an excellent sidebar: "A SCSI Primer;" Ted Drude, "Macintosh SCSI Drive Secrets Revealed," *Computer Shopper*, September 1988, p. 28.

²Cheryl England Spencer, "Turning 40," *MacWorld*, September 1989, p. 172; Winn L. Rosch, "101 Hard Drives," *MacUser*, February 1990, p. 153; Tom Badgett and Corey Sandler, "Buyer's Guide: Hard Disk Drives," *Computer Shopper*, March 1990, p. 101.

³Philip Devin, "Hard Driving in the Mac Market," *Macintosh Business Review*, p. 37.

Far more Mac users buy hard disks for their Macs than do PC users for their machines because of the graphics intensive nature of the Mac. Anyone buying a Macintosh today and wanting to do any kind of serious work on it should add a hard disk for three reasons: speed, cost, and convenience. Even the smallest of the hard drives sold today, 20Mb, gives you 10 times faster access time versus a floppy disk. Prices have come down to where you can buy a mail order 20Mb hard disk for less than the list price of an Apple 3¹/₂" external floppy disk drive.⁴ Also, your applications are always at your fingertips waiting for you to point and double click your mouse to get into them.

When you build your own Cat Mac, you can save even more. Even if you don't build your own Macintosh, you can save by using the tips in this chapter. If you buy a Mac Plus or 512KE, you typically have to add an external drive. This means you have another housing case plus another power supply (more money). One of the byproducts of building your own Macintosh in a PC case is that the power supply and housing case you need for the hard drive are already there. The 135/150/200 watt, etc., power supply you get with the PC case will also power your hard disk, and the disk itself mounts inside the PC case—no need for a separate one. The bottom line is that your cost is reduced.

When you build your own, you have no limits. You can be bold, brave, adventuresome. Put a full height, 300Mb hard disk into your built-up Mac along with your SE logic board! This is where your Cat Mac project can reap you the biggest rewards. The inside of your Cat Mac chassis probably gives you space that the original Mac designers at Apple could only dream about. In this space, you can safely and easily mount 3¹/₂", half-height 5¹/₄", and 5¹/₄" full height drives, maybe even several of each if you have opted for the tower configuration chassis.

Hard driving

To begin with, you need to know something about the terms you are likely to encounter and those I have already used in discussing hard disks. These terms include capacity, access time, formatting, sector, interleave, track, SCSI interface, size/height, and MTBF. Some definitions follow.

Capacity This refers to the amount of binary data in 8-bit bytes that can be stored on the hard disk's multiple surfaces. Be aware that not all hard disk capacities are stated equal. It is difficult to state accurately until after the disk is installed in the computer and formatted because different computer types, controllers, formatting software, and disk drives themselves produce different results. Two hard disks used on my Cat Mac SE and formatted with the identical software illustrates the point. A Maxtor LXT100S SCSI drive with a manufacturer's rating of 100Mb formatted to 88Mb. A Seagate ST296N SCSI drive with a manufacturer's rating of

⁴Ehman Engineering offered an external 20Mb drive for \$349 in March 1990, Apple's external floppy listed for \$429.

96Mb formatted to 84Mb. Each would format yet differently on a PC DOS machine.

Average access time *Average access time* refers to the amount of time it takes, on average, to position the read-write heads over the track that holds the data. Again be aware; not all hard disk average access times are stated equal. Technically, it is defined as seek time (time to find the track) plus settling time (time to stabilize over the track) plus latency time (time to bring the sector data on the track under the head). Some manufacturers ignore both the average consideration and the latency factor to publish better times.

Formatting When you first obtain a hard disk, although it has been preformatted and tested at the factory, it is a clean slate to you as far as your purpose is concerned. Much like you would take a blank wall on the inside of a post office building and build sorting bins into it, the formatting step puts these specific track and sector “pockets” into your hard disk; it builds exact locations where you can later find data. To quickly move data on and off the disk, it identifies certain tracks as directory tracks. These contain information tags, flags, or pointers that point to or identify the location of data on the disk. When you delete data on a PC-DOS machine or throw an icon into the trash on a Mac, all you are doing is deleting its entry from the directory. The data is still there until you write over it.

Tracks *Tracks* are the pattern of concentric circles or rings on the hard disk’s surfaces established by the formatting software onto which the data is written.

Sectors *Sectors* are also called *blocks*. A sector is a specific location on a given track onto which data is written. A Mac disk might be formatted with 512 bytes of data in a sector or block. The interface reads or writes one sector at a time regardless of the amount of data actually being read from or written into the sector.

Interleave Depending on the speed of the computer attached to the hard disk, the computer might not be fast enough to read all the data from one sector transferred by the disk interface or to write it in one rotation of the disk. To avoid this problem, disks initially being formatted to work with slower Macintoshes have their sectors *interleaved*. A slow Mac Plus requires a 3:1 interleave. That means the next logical sector from which the controller reads or writes data actually skips two sectors over from the last “physical” sector located on the disk. A faster Mac SE requires a 2:1 interleave. The next logical sector read or written actually skips one sector over from the last physical sector located on the disk. Mac II’s, Mac SE 30s, and up use a 1:1 interleave. The next logical sector read or written by the controller is identical with the physical sector located on the disk.

Fragmentation On a new disk, files are written to continuous and connected (called *contiguous* in computer parlance) sectors and tracks. As you use

the disk, erasing files, writing new ones, etc., all the contiguous space eventually gets used up and new files are then written all over the disk. This is called *fragmentation* and greatly reduces disk performance.

SCSI interface *SCSI interface* refers to the Small Computer System Interface, a high-speed 5-megabits-per-second bus that allows you to daisy chain and allows up to seven devices including disk drives, backup drives, tape drives, CD-ROM devices, scanners, printers, etc., each generating its own input and output traffic on the bus. SCSI hard disks contain an *embedded controller*, meaning an intelligent controller board is part of the disk drive package. You need to connect a ribbon cable from it to logic boards for the Macintosh SE and up.

Size and height *Size* refers to the diameter of the disk inside the enclosure; typically 5¹/₄" and 3¹/₂" today. *Height* is a carry over from early IBM DOS-PC days. Full height refers to a disk that takes up the entire height of the original PC front bezel opening designed to fit 5¹/₄"-wide disk cases. Half-height means half that dimension; you stack two drives in that space.

MTBF The letters stand for *mean time between failures*. An MTBF rating of 50,000 hours does not mean each hard disk will last that long before needing repair. It means that in a population of 50,000 hard disks, one will fail every hour, 24 hours per day. This means that about 18% of the drives will have to be repaired before year's end. Over a three-year period, over one half (54%) of the original 50,000 hard disks will require some amount of service. So the third rule of thumb is buy the hard disk with the higher MTBF.

A quick update on hard disk pricing

If you are not acquainted with hard disks, it will be helpful to name the players for you so a few brief definitions are in order. First, there are the original manufacturers of the hard disk drives. This would include Seagate, Miniscribe, Quantum, Rodime, Connor, Maxtor, Fujitsu, and Sony to name a few. Then there are the repackagers of other manufacturer's disk drives. This includes Apple, LaCie (Cirrus), Crate, DataFrame (Supermac), Ehman. Then there are the mounting kit providers such as LaCie, Tulin and UniMac who package an external disk enclosure/power supply or internal mounting bracket along with SCSI/power cables and formatting software.

Also, the mail order resellers, such as Hard Drives International, MacLand, Mac Warehouse, and PC Connection, sell both the original manufacturer's and repackager's drives along with the mounting kits. The industrial distributors such as Hamilton Avnet, Marshall, (Merisel) /MicroAmerica, and Softsel typically deal in larger quantities and offer bigger discounts if you are eligible for wholesale pricing.

So as not to offend anyone, it is worth stating that there are hundreds of hard disk manufacturers, distributors, and resellers not mentioned here, some with even superior products and services, that this short paragraph did not permit including. For further disk drive information, look at the Macintosh Product Registry.⁵

As for the technology, the older 5¹/₄" hard disks are the best buy per megabyte but the newer 3¹/₂" drives are catching up rapidly and typically offer higher performance versus the 5¹/₄" drives at any given capacity. Disk drive pricing has dropped drastically since the early days of the Macintosh. The Seagate and Miniscribe hard disks are currently most cost effective, but pricing is quite volatile and change frequently, always trending downward. The current pricing from Apple and others⁶ summarized in Table 6-1 can be considered a snapshot in time.

Table 6-1 SCSI hard disk price comparison (March 1990 prices).

Manufacturer/Model	Capacity (Mb)	Internal	External
<i>Apple:</i>			
HD 20SC	20	799	699
HD 40SC	40	1199	1299
HD 80SC	80	1699	1799
<i>Ehman (Cutting Edge):</i>			
Seagate 20	20	299	349
Seagate 45	45	399	479
Seagate 80	80	529	599
<i>Hard Drives International:</i>			
Seagate 20	20	269	319
Seagate 45	45	329	399
Quantum 40	40	379	459
Seagate 80	80	479	499
Quantum 80	80	599	649
<i>Mac Land:</i>			
Seagate 20	20	299	359
Seagate 45	45	399	449
Quantum 40	40	399	519
Seagate 80	80	499	589
Quantum 80	80	649	769
<i>Mac Zone:</i>			
Quantum 40	40	410	588
Quantum 80	80	648	826
Quantum 105	105	748	926

⁵Macintosh Product Registry, "Redgate Communications Corp., 1990.

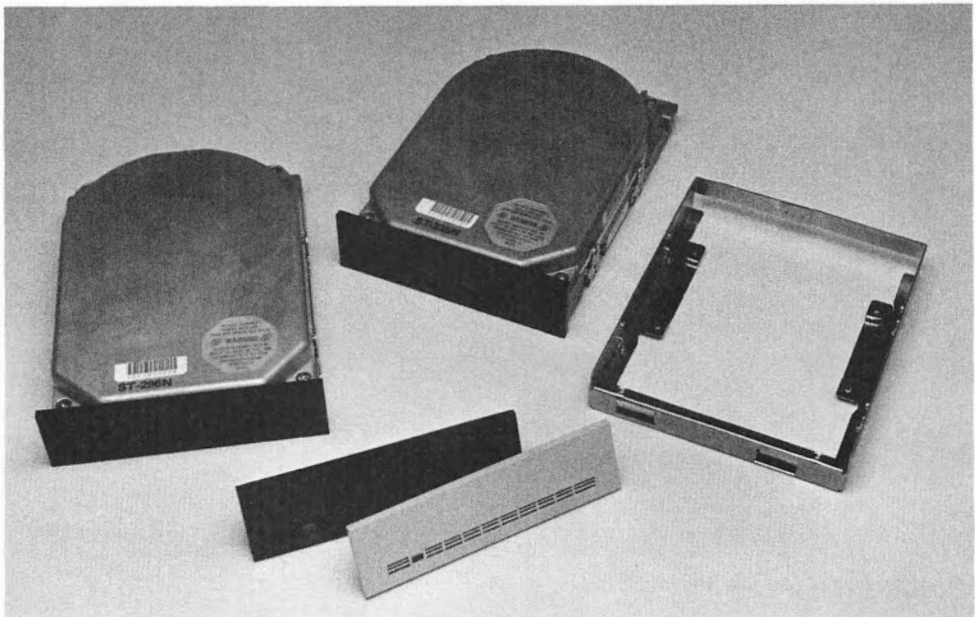
⁶Apple March 1990 Price List. Other prices from April 1990 *MacWorld* or *MacUser*.

Please consider this information subject to change early and often, and refer to your actual hard disk supplier for current updates. Apple, who had not changed its disk prices in over a year recently (March 1990) lowered the price of its external 20Mb unit to \$699, creating the situation (I believe temporary) that its internal 20Mb bare hard disk costs \$100 more than its external drive with case, cable, and software. All third-party vendors listed in *Macworld* or *MacUser* and now even Apple offer a one-year warranty on their hard disks. Quantum offers two years.

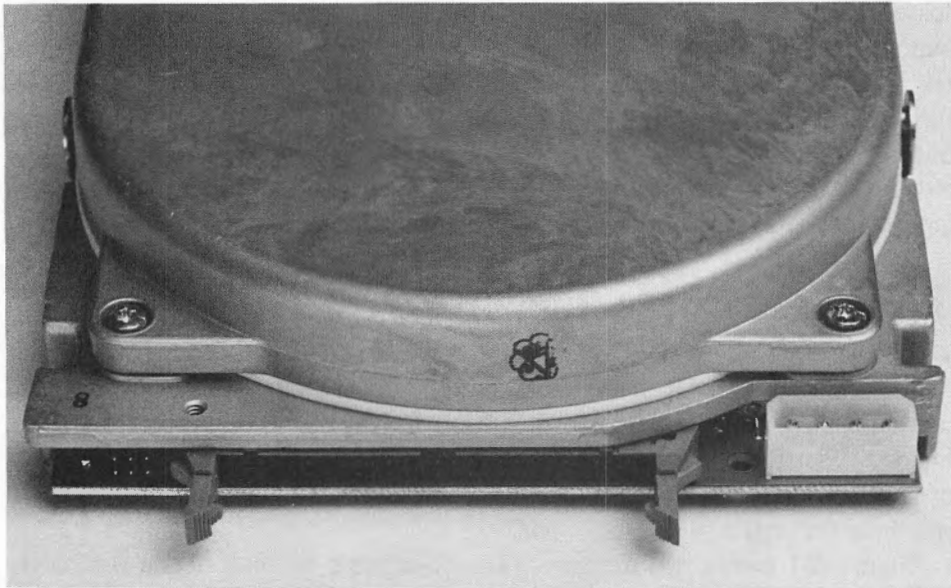
Hard disks I have known

From Table 6-1, you might assume I prefer Seagate and Quantum hard disks. Your assumption is correct. There are numerous other manufacturers of hard disks, and I am sure they provide the same quality. It is just that over the years, I have obtained consistently good results from these two, with only occasional lapses. I am familiar with their performance, idiosyncrasies, pricing, and also where to send them for repairs when they break.

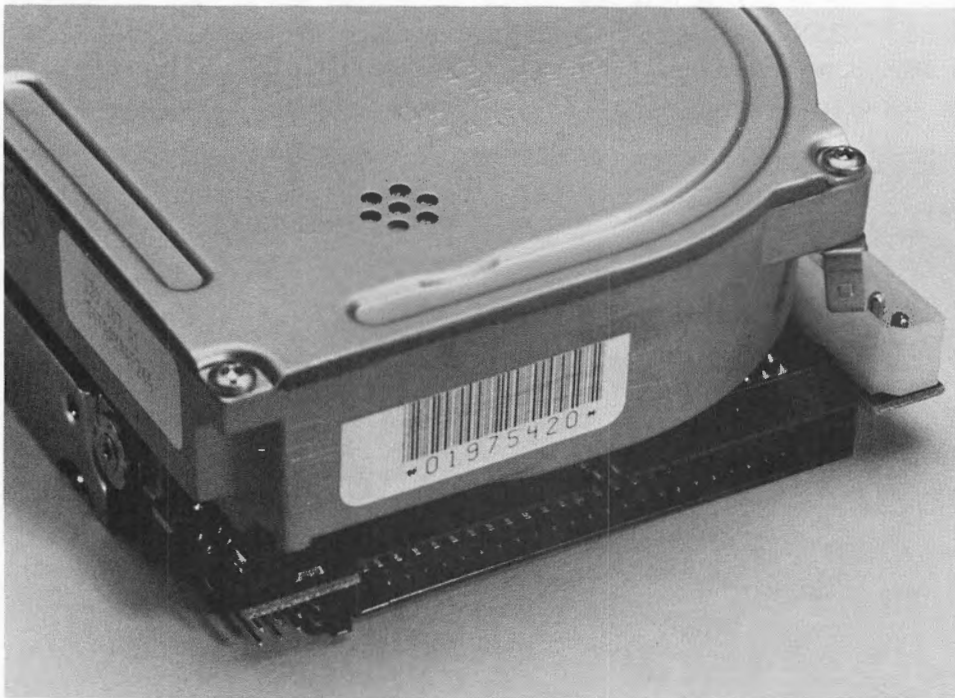
Figure 6-1 shows two members of the Seagate 5¹/₄" half-height disk drive family. The ST 296N to the left in the photograph and ST 225N in the center are identical in physical appearance. Two 5¹/₄" bezels in the available colors gray and black are shown in front of the disk drives. The Seagate adapter shown to the right of the ST 225N is used to mount 3¹/₂" drives in a 5¹/₄" drive opening. Either gray or black bezel is then bolted to the adapter frame. Figure 6-2 and Fig. 6-3 show the rear of the Seagate 5¹/₄" and 3¹/₂" hard disks respectively. Notice the almost



6-1 Seagate 80Mb and 20Mb 5¹/₄" hard disks, with 3¹/₂" to 5¹/₄" adapter bracket on right and bezels in front.



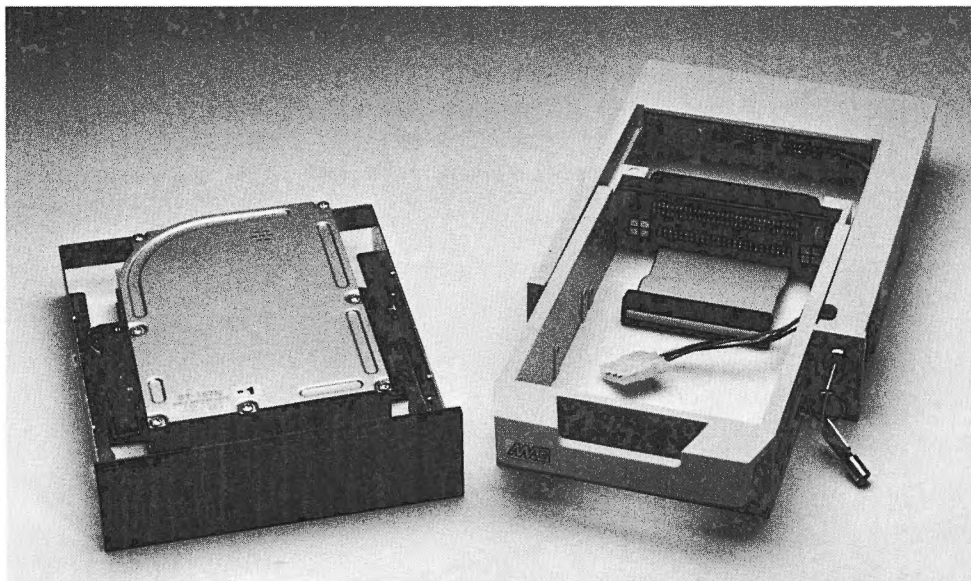
6-2 Rear view of Seagate 5 1/4" hard disk.



6-3 Rear view of Seagate 3 1/2" hard disk.

identical placement from left to right of the SCSI ID jumpers, SCSI 50-pin drive connectors and 4-pin power connectors on each.

Figure 6-4 on the left shows a Seagate ST157N 3¹/₂" drive mounted in the adapter frame shown in Fig. 6-1 with a black bezel added on the front. On the right is a Wetex removable hard disk pak I have found useful for clients who need to take their data back and forth between office and home and don't want to carry their Cat Mac back and forth, too. The 3¹/₂" hard disk of your choice bolts into the Wetex slide in adapter. Figure 6-5 shows the adapter pak set up with hard disk installed in a Cat Mac. You put together two identical Cat Mac machines, each with a hard disk pak adapter installed. Then each day at closing time, you shut down your office Cat Mac, unlock the hard disk, put the hard disk pak in its plastic and foam carrying case that comes with it, take it home with you, and reverse the process to install it in your home Cat Mac.

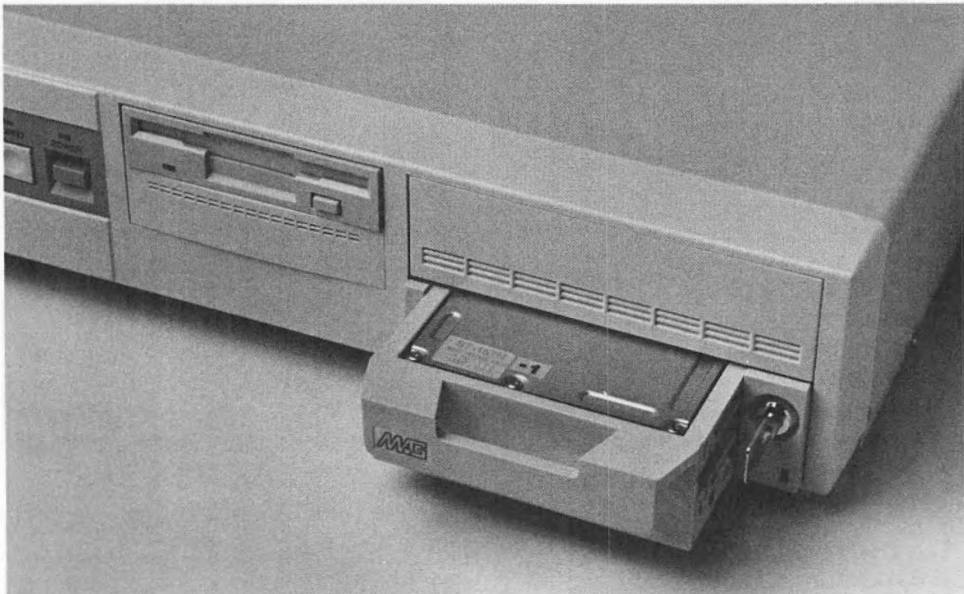


6-4 Seagate 3¹/₂" hard disk in adapter bracket with black bezel on left and Wetex removable hard disk pak on right.

Figure 6-6 shows a Quantum 80Mb 3¹/₂" hard disk installed in a Crate chassis on the left, an older Quantum 40Mb 5¹/₄" drive on the right. Identical versions of both drives may be found in Macintosh systems shipped directly from Apple: the 40 in Apple's Mac II and the 80 from Apple's IIcx or SE 30. The Crate chassis and those from other companies allows you to buy a 3¹/₂" or 5¹/₄" SCSI drive at the best price, then mount it in their case which comes complete with external cable and formatting software. Put a hard disk in a box and save a bundle!



6-5 Close up of Wetex removable hard disk pak installed in low-profile Cat Mac case with drive pak partially removed.



6-6 Quantum 80Mb 3 1/2" hard disk in Crate external disk drive case on left and Quantum 40 Mb 5 1/4" hard disk on right.

What's hard about a hard disk

If you are like most users, three steps stand out in your mind. First, what kind do you buy? There are so many specifications: size, speed, MTBF. Next, connecting it up to your hardware. Finally, the process of installing your software on it. Perhaps you also ask yourself a nagging final question about the reliability of the whole process? You've taken a lot of data off your floppy diskettes and put it in one place, your hard disk. Now that you've done that, what guarantees do you have that your hard disk won't head south with all your precious data on it?

There are, of course, no guarantees in life. The same goes for hard disks. But you can achieve a certain piece of mind. First, for the specsmanship. If you have been a computer user for several years, think about the number one complaint you have probably had—not enough disk space. When the first PCs came out with their 10Mb hard disks, they were considered huge. But when you used your PC for any length of time, you found out quickly that 10Mb of hard disk storage wasn't that much. As a rule of thumb, think about Parkinson's Law about data expanding to fill the space available on your hard disk and buy more than you need.

A byproduct of buying a larger disk is that speed and access time typically go down as disk capacity rises. Your larger disk will usually be faster than your smaller hard disk and faster is always better. So the second rule of thumb becomes buy as much speed as your wallet allows. Today, I would not advise any Cat Mac builder to buy less than a 40Mb capacity hard disk unless you are building a strictly low-end machine or price is a critical issue. Price, speed, which disk model, and what vendor you buy it from are pretty much up to you. Numerous choices await you in the pages of the Macintosh magazines. If this is your first attempt, just be sure to buy your hard disk from a high-profile vendor who gives you a liberal warranty and return privilege so you can sleep nights!

Installing your hard disk

Installing your hard disk is no more difficult than hooking up your stereo if you observe a few simple rules:

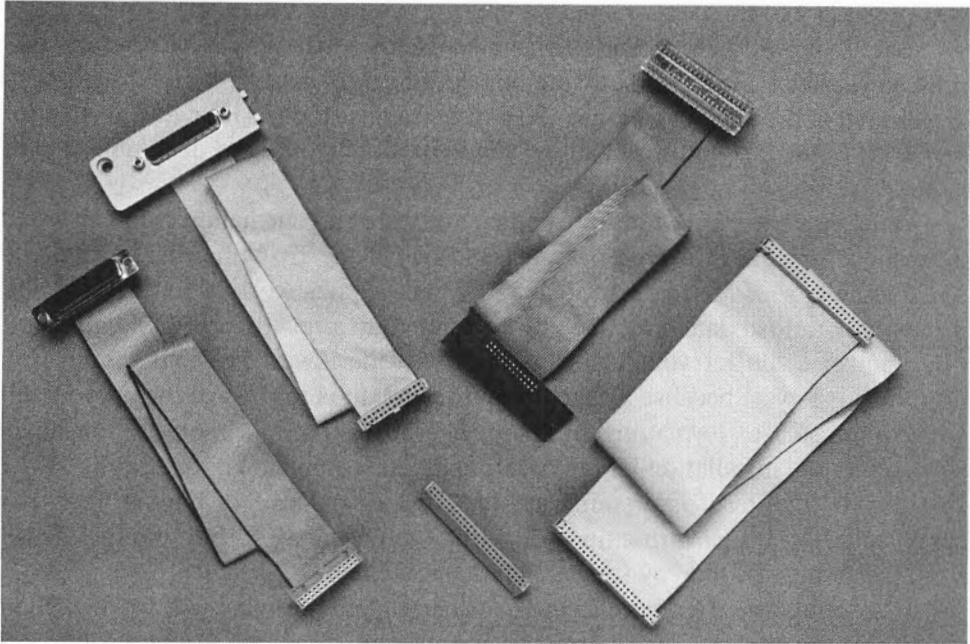
- Always connect and disconnect your hard disk cables and/or SCSI jumpers with the power off.
- Make sure you have discharged yourself of static electricity before you handle your hard disk and keep your fingers away from the controller board and connector pins.
- Do not drop your hard disk or bang anything sharply against it.

With those instructions emblazoned on your mind, there are really only five connections involved in hooking up your hard disk:

- First, the physical mounting of it. Heat, static electricity, lack of adequate air circulation, and an inadequate or unstable power source are really the only killers. So try not to shuffle across the rug before and during installation of your hard disk. Make sure you firmly, rigidly mount your hard disk in an area away from any heat source and where it will receive adequate airflow, adding a fan if necessary. If it requires 15 watts power, provide it with at least a 30 watt power supply so you can enjoy peace of mind. Opt for the kind of power supply that provides smooth DC voltages and consider putting it on a line with a surge protector to prevent damage due to transient overloads, spikes, or a trashy line.
- Next the SCSI cable. Attach your 50-pin ribbon cable connector to the middle connector on the back of the hard disk as shown in Figs. 6-2 and 6-3. If you have a Mac SE logic board, merely connect the other end of the 50-pin ribbon cable from the disk to the mating connector on the logic board.
- Next the power connector. The hard disk requires a source of +5v and +12v DC power and a solid ground. This would be the connector on the right in Figs. 6-2 and 6-3. It is keyed to accept the standard power plug from either the standard PC chassis power supply or a Crate type disk enclosure.
- Next the ground connector. Make sure the disk case is firmly attached to your chassis case so it is solidly grounded. If for some reason you have used plastic mounting rails or adapter hardware, connect the grounding tab or lug on the hard disk case to the chassis with its own wire. Improper grounding is the number one culprit to look for in all cases of intermittent hard disk performance problems and can, in extreme cases, actually be the cause of hard disk failure.
- Finally the SCSI jumpers. This would be the SCSI jumper connector shown on the left in Figs. 6-2 and 6-3. Up to 7 devices can be connected to the Macintosh's SCSI port. Each device therefore has an address between 0 and 6. You can set the address you want your hard disk to have by adjusting its jumper shorting blocks on its SCSI jumper connector or in the case of the Crate chassis connecting a cable to a thumb switch.

Killy clip

A Killy clip is available from NexSys at about \$79 retail, and besides being quite a handy device, it's a clip that comes in 64-pin and 40-pin varieties that clips on to processor chips such as the M68000 and the NCR 5380 SCSI chip. It creates an expansion bus that can then support all kinds of cards and peripherals. For example, when Rodime used to offer their terminal 20Mb hard disk for the Mac Plus, the Killy clip included in their kit attached to the Mac Plus NCR 5380 SCSI chip and the other end to a 50-pin connector that plugged into the hard drive. Slick and



6-7 SCSI cables for connecting to hard disk drives.

easy. It is the cable shown second from the right or at the one o'clock position in Fig. 6-7.

What this means to you is, if you don't cover up the SCSI chip on your Mac Plus logic board with an accelerator board, you can merely order a ready-made cable from Rodime or the Killy clip to connect to your SCSI hard disk inside your Cat Mac.

Figure 6-7 also shows other cables you might find handy. From left to right is a 26-pin ribbon connector from a SCSI option board inside the Cat Mac to an internal SCSI DB 25 male connector (for internal case wiring options); a 26-pin ribbon connector from a SCSI option board inside the Cat Mac (or Macintosh) to an external SCSI DB 25 female connector (mounts on the Mac 128/512/Plus case battery door); the Killy cable already discussed; and a straight 50-pin ribbon cable with an IDS female connector on each end. The IDS 50-pin female connector is shown in the center.

Formatting your hard disk

It used to be that you needed a resident software genius to format your hard disk and install your driver software on it. Ted Drude gives you a taste of this in his second SCSI drive article.⁷ The public domain program he describes is quite similar to the only offerings available just a few short years ago. You had to be familiar

⁷Ted Drude, "Macintosh SCSI Drive Secrets Revealed (Part 2)," *Computer Shopper*, October 1988, p. 60.

with ResEdit and the hexadecimal numbering system to use them.

But no more. Every finished drive manufacturer and most drive resellers now provide you with a piece of software that both formats your disk and installs their driver on it at the click of a mouse. So anyone can use today's hard disk formatting software. Some programs even allow you to partition your hard disk into separate volumes.

Once you have a piece of formatting software in your hands, you can use it over and over again. So you only need to buy it the first time. This software, which usually sells for around \$50 to \$100, makes quick work of getting your disk drive ready to load data on it and allows you to buy a raw drive, SCSI cable, and drive power cable for your Cat Mac project at the lowest possible cost to you. Your cost is lowest because all the drive resellers do is repackage the above items along with a case, formatting software, and an instruction booklet. You might have to buy the installation kit the first time; some complete kits sell for as low as \$50. But by putting it into your Cat Mac case and making or buying your own cables and having the formatting software, you only have to buy the raw drives from that point on, thereby saving significant money.

Every finished drive reseller has a formatting program that will work on their drives, not necessarily on any others. For example, you get a slightly different piece of setup and formatting software from each of these finished drive resellers, but they produce the same results:

- Apple's HD Setup
- Supermac's Dataframe Utilities
- CMS's CMS Utilities
- Rodime's Rodime Installer

Now some manufacturers or resellers sell software that is generic and works across many, but not all, drive manufacturers. Again, you get a slightly different piece of setup and formatting software from each of these companies, but they also produce the same results:

- Crate's MacCrate Utilities—Works best on Seagate drives.
- FWB's Hard Disk Partition—Partitions without reformatting, also encrypts.
- LaCie's Silver Lining—Works with many, partitions disks also.
- Tulin's Formatter—Works with many.

- UniMac's SCSI Installer—Installer works with many, comes in a kit with cable and mounting bracket.

OK, great. Now what do you do? With any of the products listed above, the steps are going to be very similar and quite straightforward. After you have physically installed your hard disk and connected the SCSI and power cables, you are ready to format it. Put your diskette with the formatting software that you received with your hard drive or that you obtained separately into the floppy drive, and turn on or boot up your Macintosh. When it comes on, notice you will hear the hard disk

rotating but only see the icon for the floppy disk on the screen. Great. Open the floppy icon window, find the installation software icon and click on it to start things rolling.

Now that you are in the program, select the step that says Format your disk and, *just this one time, ignore the warning that says*, Do you want to erase all the data on your hard disk? When you click on the Yes button, your hard disk ought to begin to whirl into action and a few minutes later—more or less, depending on the size of your disk—returns to your control.

At this point in the program you select the step that says Install your drivers on the disk. Click on the button, and again, *just this one time, ignore the warning that says*, Do you want to erase all the data on your hard disk? The hard disk will again swing into action for a few minutes and control will be returned to you, this time with a “done” message.

Click the Done button, and you will be returned to the desktop, this time with the hard disk icon appearing along with the name you have given it during the formatting process. Copy your system folder over to the hard disk from the floppy disk, eject your floppy disk, and reboot your Macintosh.

When the desktop again appears, you now have your hard disk icon in the upper right of your screen ready to have data and applications loaded on to it. There now, that wasn't so bad or was it? Again, all formatting software will have their variations on the above theme, but this is basically all there is to it.

Sources

Hard disks are available new and as upgrade replacements through Apple dealers. New and used Apple hard disks are also available through the Apple used equipment dealers. All other hard disks are available directly from the manufacturer and through the mail order distributors.

Manufacturers, hard disks and related products

AREAL TECHNOLOGY INC.
2890 N. First St.
San Jose, CA 95134
408-954-0360

CUTTING EDGE INC.
97 S. Red Willow Rd.
Evanston, WY 82930
307-789-0582

CMS ENHANCEMENTS
1372 Valencia Ave.
Tustin, CA 92680
714-259-9555

EHMAN ENGINEERING INC.
P.O. Box 2126
Evanston, WY 82931
800-257-1666

CRATE TECHNOLOGY
6850 Vineland Rd., # M
North Hollywood, CA 91605
818-766-4001

FWB INC.
2040 Polk St.
San Francisco, CA 94109
415-474-8055

IDS SYSTEMS, INC.
2107 N. First St., Suite 280
Can Jose, CA 95131

RODIME
901 Broken Sound Pkwy. NW
Boca Raton, FL 33487
407-994-5585

LACIE
19552 SW 90th Court
Tualatin, OR 97062
800-999-0143

SEAGATE TECHNOLOGY INC.
920 Disc Dr.
Scotts Valley, CA 95066-4544
800-468-3472

NEXSYS
296 Elizabeth St.
New York, NY 10012
212-995-2224

SUPERMAC TECHNOLOGY
485 Potrero Ave.
Sunnyvale, CA 94086
408-245-2202

QUANTUM CORP.
1804 McCarthy Blvd.
Milpitas, CA 95035
408-432-1100

TULIN CORP.
2156H O'Toole Ave.
San Jose, CA 95131
408-432-9025

Mail order, Macintosh add-on hardware dealers

BEVERLY HILLS COMPUTER
279 S. Beverly Dr., #1200
Beverly Hills, CA 90212
800-426-8166

MACLAND
5006 S. Ash Ave., #101
Tempe, AZ 85282
800-333-3353

DR MAC
14542 Ventura Blvd.
Sherman Oaks, CA 91403
800-825-6227

MACPRODUCTS USA
8303 Mopac Expwy., #218
Austin, TX 78759
800-622-3475

HARD DRIVES INTERNATIONAL
1912 W. 4th St.
Tempe, AZ 85281
800-234-DISK

MACWAREHOUSE
1690 Oak St.
Lakewood, NJ 08701
800-255-6227

MAC CONNECTION
14 Mill St.
Marlow, NH 03456
800-334-4444

MACZONE
6825 176th St. NE, #100
Redmond, WA 98052
800-248-0800

7

CHAPTER

Floppy disk

Floppy drives, the main devices used for getting data into and out of your Cat Mac, are not too difficult a subject for the Cat Mac builder. Especially not compared to hard disk drives. I will discuss the several types you might consider for your Cat Mac project, types that I have used and why, and strongly suggest there is one drive that best suits your needs.

The Macintosh 3¹/₂" floppy drive mechanism comes in three storage capacities: 400K or single-sided, 800K or double-sided, and 1.4M or high-density. Although the media, the 3¹/₂" floppy diskettes themselves, are identical and interchangeable, the physical drives for the Macintosh and PC are not, so this is one area of your Cat Mac in which you cannot use a PC solution.

400K floppy

Today the 400K floppy disk drive is inexpensive. You can probably pick one up for \$25 to \$50 and it makes an excellent companion to your Mac 128 system. However, it is slower, offers the least storage capacity, and at this point is a solution only if you are contemplating a hobbyist or low utilization word processing use on your Cat Mac 128 or 512 project.

800K floppy

The 800K floppy disk discussion for the Macintosh is simple. There are two 800K drives you can select from. The Sony drive is the one that Apple uses and sells. The Fujitsu drive is repackaged and sold by everyone else. The Apple external floppy drive lists for \$429. The Apple internal floppy drive for the Mac II or internal upgrade for the 128/512 lists for \$299. All have a one year warranty. The Fujitsu drive is available from various mail order sources for \$149. It comes with a one or two year warranty.

Compared to the Fujitsu drive, the Sony drive is noisier, slower, and of heavier mechanical construction (which suggests it would survive more rugged usage), runs all the Mac software, and has no problem reading Fujitsu written disks in any Macintosh format. On the downside, as Apple has packaged it to fit inside its cases, you will have to be more creative in finding a front cover bezel for the Sony floppy drive if you use it in your Cat Mac PC chassis.

Versus the Sony drive, the Fujitsu is quieter, faster, has the niceties of a drive light and push-button manual ejector (some repackaged models only), but it is of lighter mechanical construction with plastic parts in place of the Sony metal ones. Fujitsu says their brushless DC drive motor, helical gear head mechanism and ASIC (Application Specific Integrated Circuit) chip technology combine to reduce weight and parts count and increase reliability to a rated MTBF of 11,000 hours. It comes in a nice case with its own front bezel that you can easily adapt to your Cat Mac project. On the downside, the Fujitsu drive is more prone (than the Sony) to read errors when reading floppies produced on other drives with head alignment problems—this is most noticeable on backup software applications.

Apple's \$299 800K internal upgrade floppy kit for the 128/512 models also comes with 128K ROMs to replace the older 64K ROMs in the Mac 128/512 models. If you want to buy the Sony drive, this is the package you should buy it in because you get the 800K floppy, the 128K ROM chips, and a Mac Plus floppy drive mounting bracket that you can use or resell. Or if you have a friend who has recently put a hard drive into his or her Mac SE and removed the second floppy, perhaps you can strike an even better deal.

The leading repackagers of the Fujitsu drive (Cutting Edge, Ehman, Microtech International, and Mirror Technologies, to name a few) sell their products direct and also through the following resellers: Beverly Hills Computer, CDA Computer Sales, Dr. Mac, MacConnection, MacProducts USA, Mac Warehouse, MacZone, Programs Plus, and Telemart, among others. The repackagers all offer manual eject and LED disk access indicators and some offer a hinged door covering the disk insertion slot keeping the internal mechanism free from dust and eliminating the need for periodic cleaning.

1.4Mb high-density floppy

The 1.4Mb high-density floppy disk offerings have expanded since the first edition of this book. A *MacUser* February 1990 article summed up the subject nicely.¹ The 1.4Mb floppy excels where there is a requirement to transfer data back and forth between a Mac and a PC running MS-DOS. They also hold more data, but the higher density floppy diskettes are more expensive. On balance, don't expect a rush to this new media because its benefits will not outweigh its costs for many users. You can now choose from four 1.4Mb drives: Apple FDHD Superdrive, DaynaFILE, Kennect Drive 2.4, and PLI TurboFloppy 1.4. All of the drives can read and write Mac and PC high-density disks, but they are not all equal in other respects.

First a little background. PCs and Macs both use 3¹/₂" disks, but differences in recording techniques and drive mechanics make it impossible to swap disks between them without using a 1.4Mb floppy drive. PC 720K and 1.4M drives use the *MFM* (modified-frequency modulation) technique that rotates their diskettes at a constant speed. Apple Mac 400K and 800K drives use the *GCR* (group-coded recording) technique of different rotational speeds to write at a nearly uniform density over the entire diskette. The famous *IWM* (Integrated Wozniak Machine) chip adjusts the drive rotation speed as the read/write head moves across the disk. The Apple FDHD and the Kennect Drive 2.4 drives are able to switch to GCR when standard 400K and 800K Mac disks are inserted; the DaynaFILE and PLI TurboFloppy 1.4 cannot switch, so they can't read, write, or format Mac disks other than of the high-density type.

Apple's Floppy Drive High Density (FDHD), uses a Sony drive mechanism, and is also called the Superdrive. The same drive is used in all the current Apple Mac models except the Mac Plus and can be retrofitted to a Mac II or Mac SE. The disk-controller chip, called the *SWIM* (Super Wozniak Integrated Machine), allows the FDHD to read, write, and format 400K, 800K, and 1.4Mb Mac 3¹/₂" disks. Using the Apple File Exchange utility software, the drive also reads and writes MS-DOS 3¹/₂" disks formatted at 720K and 1.4Mb. The Apple FDHD drive lists for \$629 for the external version. The Apple FDHD internal floppy drive to upgrade the Mac II or Mac SE, including the ROM/SWIM kit, lists for \$599. The Apple FDHD add-on internal floppy drive for the Mac II, IIX, or SE, which presumes you already have an existing FDHD drive installed, lists for \$499. All have the standard Apple one-year warranty.

The Kennect Drive 2.4 is an alternative to the Apple FDHD. It lists for \$495 and its \$295 (roughly \$329 and \$199 mail order) drive controller plugs into the Mac's disk drive port. On the plus side, it has proprietary software that can

¹Owen W. Linzmayer, "High-Density Floppy Drives," *MacUser*, February 1990, p. 221.

squeeze up to 1.2Mb and 2.4Mb onto Macintosh 800K and 1.4Mb diskettes respectively. It can also attach to Macs that do not have the SWIM kit installed—a Mac Plus for instance. On the downside, the separate drive and controller pricing probably makes it more expensive than the Apple offering. It has a one year warranty.

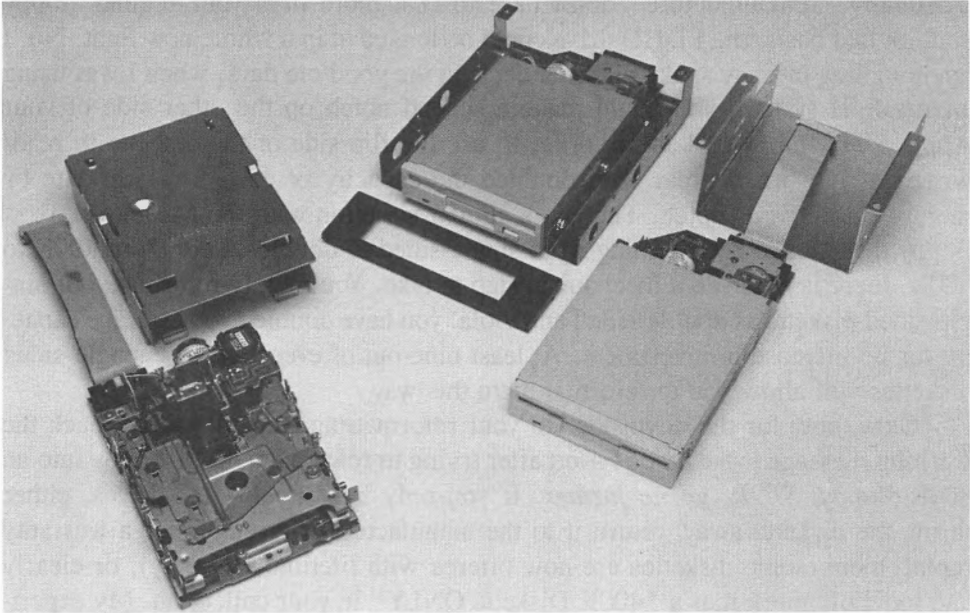
The DaynaFILE is really best suited for dedicated use in a PC intense environment. It has the highest list price at \$850 (\$695 mail order) but enjoys the added flexibility of also being able to add optional PC 5¹/₄" 360K or 1.2Mb drives to its mounting cabinet so you can transfer files back and forth to your Macintosh from either 3¹/₂" or 5¹/₄" PC floppy diskettes. It also mounts these drives directly from the Finder just as if you are working with a Mac disk. Other drives require Apple File Exchange or equivalent software. Unfortunately, as mentioned above, it can't read Mac 400K and 800K diskettes. Its 90-day warranty makes it an oddity among most third-party peripherals.

The PLI TurboFloppy 1.4 drive lists for \$499 (\$329 mail order). Unlike Apple's external FDHD, the PLI TurboFloppy 1.4 works with any Mac with a SCSI port. Like the Apple FDHD drive, it can read and write 1.4Mb Mac high-density diskettes, 720K or 1.4Mb 3¹/₂" PC diskettes, and users can access MS-DOS files through the Apple File Exchange utility. On the downside, unlike the Apple FDHD, it does not read 400K and 800K Mac floppy disks. PLI sweetens the deal by bundling TurboCache, a utility that gives up to a 300% increase in drive performance, and TurboBack, a rapid backup utility, with their drive. It comes with a one year warranty.

Floppy drives I have known

The Fig. 7-1 photograph contains just about everything the Cat Mac builder needs to use in the floppy drive department. Shown in the photograph from left to right: The Apple 800K Sony floppy, removed from its SE mounting bracket shown just behind it. From the angle in the photograph, you could not tell the difference between it and the Apple 1.4Mb FDHD drive; the Sony drive mechanisms look alike, and the brackets are identical (the easiest way to tell is to flip them over and read the label on the flywheel!) Next, the Cutting Edge Fujitsu 800K floppy installed in the PC case 5¹/₄" floppy adapter bracket with my handcrafted 3¹/₂" floppy bezel for the 5¹/₄" case opening shown in front of it. Last, the Cutting Edge floppy just prior to installation in the MT-304 chassis floppy bracket described in Chapter 11.

Not immediately apparent from the figure is the fact that the shape and construction of the Apple floppy also makes it harder for the Cat Mac builder to use. I have always used it in its mounting chassis, and I strongly suggest you do the same. The standard PC floppy plastic front bezels with the floppy disk opening are a little tricky to mount into because of Apple's disk eject mechanism placement. The PC 3¹/₂" floppy drives have the eject below the opening, on the Apple



7-1 Apple 800K floppy disk on the left, Cutting Edge 800K floppy disk in the center in 5¹/₄" adapter, on the right is Cutting Edge 800K floppy disk drive in front of a low-profile PC case bracket.

the eject mechanism is a wide tab located to the far right-hand side of the opening. That means you have to custom fabricate your own, very difficult in plastic.

Only when I absolutely had to do it, I have found an L-shaped metal bracket works best (aluminum 0.050" or thicker is best—easiest to work with!). You put the wide part across the front with the exact opening size you need punched out along with the eject hole (no burrs or metal filings please). The short end has a slot cut in it just past the bend to match up with the mounting hole in the Apple floppy chassis cover. This whole affair mounts behind another bezel if you place it in a 5¹/₄" opening or just fills the hole when mounted in a 3¹/₂" one. Either way, it's a labor intensive process.

Something for nothing

In my first look at Apple's newest high density FDHD floppy disk offering, I was not sure what it does for you as a Cat Mac builder. To use it fully, you have to use high-density floppies which cost two to four times as much as regular floppies. Apple needed this capability to break the lockout specs being imposed on it by PC-dominated Fortune 500 type MIS corporate decision makers. But how important is it to go back and forth between the PC or ProDOS world for the average Macintosh user? This is what the high-density drive was designed to do. Unless this factor is very important to you, why pay extra for the FDHD drive to begin with or for the more costly high-density floppies it takes to feed it?

Then I discovered something for nothing. The high-density floppies that you

personally “remanufacture” don’t have to cost more than your regular floppy and, on that basis, the FDHD drive could be looked at in a whole new light. No, I am not going into my snake oil pitch here. In the good ole days, when I was using an Apple II system, you could make a second notch on the other side of your Apple 5¹/₄” floppy diskette in order to use the flip side of the diskette to read/write on. It worked great. You doubled the capacity of each 5¹/₄” diskette by merely cutting your notch. There is a similar situation with the Macintosh 3¹/₂” floppy diskettes today. In going from single-sided to double-sided, from 400K to 800K, there is not even a mechanical step to take. You merely reformat your single-sided diskette as double-sided and viola! you have doubled your storage capacity for no increase in investment. At least nine out of every ten new single-sided diskettes will allow you to reformat them this way.

Okay, now for the downside. In your reformatting step, if you get back the warning message Initialization Failed after trying to reformat a 400K floppy into an 800K floppy, *STOP, go no further*. If you only have 800K disk drives, either throw the diskette away, return it to the manufacturer or vendor for a warranty replacement (some diskettes are now offered with lifetime warranty), or clearly and indelibly mark it as a “400K Diskette ONLY” in your collection. My experience has shown me that you are only courting disaster when you succeed in formatting an 800K diskette on the second try. Murphy’s law demands that somewhere down the road you only have that diskette available to put a valuable piece of information on. Then later, when you go to read the information, you get the This is Not A Macintosh Diskette message of a failed diskette. No thank you very much.

In going from single-sided to high-density, from 400K to 1.4Mb as the high-density floppy is basically just a regular floppy with what appears to be a second write-protect tab hole cut into it at the top opposite the normal write-protect tab, the process is the same as with the early Apple II. *WARNING: There is a specification difference between 1.4Mb and 800K floppy media*, but, on all of the high-density disks I personally have “manufactured” from the regular and double-sided ones in my collection by using a soldering iron to cut this notch, I have noticed no difference in performance. Each month, new notch cutter manufacturers regularly appear in the pages of Computer Shopper, so you don’t have to go the soldering iron route yourself.² Again, as the high-density floppies cost \$35 for a box of ten versus \$10 to \$15 for a box of ten regular floppies, it doesn’t take very long for one of these notch cutters to pay for itself. On the other hand, remember Murphy’s law if you have some really important data; don’t take a chance, spend the money for the high-density diskette. One last thing: If you format your high-density diskette as an 800K diskette, you lose it forever as a high-density floppy and waste the extra money you spent to buy it. Resist the temptation.

²“Double Disk Converter lists for \$39.95,” *Computer Reseller News*, 8/28/89, p. 86. A device that enables users to format and run 720K floppies in 1.4Mb drives has been introduced by Biological Engineering, Inc.

Cat Mac builders quandary

No quandary, an easy decision. Although many choices are offered to the Cat Mac builder in the floppy disk area, it narrows down rather quickly. The 400K drive is old technology. As a Cat Mac builder, you don't even have to deal with the 1.4Mb FDHD issue unless you are working in a mixed DOS PC environment and absolutely need the capability to read or write DOS-compatible floppies. The repackaged Fujitsu 800K 3 1/2" drive available new at \$149 with a one year warranty is hard to beat on price performance versus the Apple offerings, and the Fujitsu is much easier to build with.

Sources

Floppy disks are available new and as upgrade replacements through Apple dealers. New and used Apple floppy disks are also available through the Apple used equipment dealers. All other floppy disks are available directly from the manufacturer and through mail order distributors.

Manufacturer's, floppy disks

CUTTING EDGE, INC.
97 S. Red Willow Rd.
Evanston, WY 82930
307-789-0582

MICROTECH INTERNATIONAL
158 Commerce St.
East Haven, CT 06512
800-325-1895

DAYNA COMMUNICATIONS
50 S. Main St., 5th Floor
Salt Lake City, UT 84144
801-531-0203

MIRROR TECHNOLOGIES
2644 Patton Rd.
Roseville, MN 55113
800-654-5294

KENNECT TECHNOLOGY
120-A Albright Way
Los Gatos, CA 95030
800-552-1232

PERIPHERAL LAND, INC.
47421 Bayside Parkway
Fremont, CA 94538
800-288-8754

Mail order, Macintosh add-on hardware dealers

BEVERLY HILLS COMPUTER
279 S. Beverly Dr., #1200
Beverly Hills, CA 90212
800-426-8166

MAC CONNECTION
14 Mill St.
Marlow, NH 03456
800-334-4444

DR MAC
14542 Ventura Blvd., #200
Sherman Oaks, CA 91403
800-825-6227

MACLAND
506 S. Ash Ave., #101
Tempe, AZ 85282
800-333-3353

MACPRODUCTS USA
8303 Mopac Expwy., #218
Austin, TX 78759
800-622-3475

MACZONE
6825 176th St. NE, #100
Redmond, WA 98052
800-248-0800

MAC WAREHOUSE
1690 Oak St.
Lakewood, NJ 08701
800-255-6227

8

CHAPTER

Video display

After the hard disk, the next most rewarding area of your Cat Mac project is your video monitor and interface adapter. Regardless of which type you choose, chances are it will be larger than Apple's standard 9" offering. Not that there is anything wrong with the Apple offering, but in video monitors, bigger is almost always better.

To give you a framework within which to make your monitor and video adapter decision, this chapter will take a look at the monitor and video interface options available to the Cat Mac builder, their pros and cons, and my recommendations.

The Cat Mac benefit of a larger video monitor

While working in various computer stores, the complaint I heard most often about the Macintosh was its small screen. The complaints were heard from unsophisticated users, just walking in the store, directed at its physical small screen and were also heard from sophisticated corporate users directed at its loss of productivity. In 1988, this shortcoming was addressed by Radius, E-Machines, and then a multitude of other companies with monochrome monitor offerings in the 15" to 19" and up range. Supermac and others added color a short while later. Grayscale

monitor capability became available about that same time. In 1989 Apple legitimized the market by introducing its own big-screen monitors.

By offering its “open” Mac II family architecture, Apple gave monitor and video interface vendors the same opportunity to provide the wide variety of monitor choices as the DOS PC world had. Just pick the monitor you like and plug its interface into a slot in the Mac II. Even with this capability, now available to any Cat Mac builder who chooses the Mac II and up family as a building platform, not too much was available for awhile. Your only choices were the Apple high-resolution monochrome monitor at \$399 or the high-resolution color monitor at \$999, to which you added an interface card at \$499 or \$648 respectively. Both of these Apple monitors only gave you 640- \times -480 resolution so third-party vendors first addressed the high end of the market and monitor products that delivered full-page and two-page capability.

For the traditional Mac owners, the 128 through the Plus and the Mac SE, their initial choice was either what they had or two monitors (the Mac’s plus a much larger one) on their desk.

The Cat Mac changes the monitor picture. As a Cat Mac builder, you can choose the larger monitor you want to begin with. Some new products let you just add it to your 128 to SE 30 logic board Cat Mac project. It can be added to your Mac II and up Cat Mac projects just as always, using any number of readily available Nubus cards.

You can now put a relatively inexpensive monitor, identical to those used on PCs on your Cat Mac SE and enjoy all the benefits of a larger screen. Merely plug a video card into your SE logic board, then plug the monitor into this video card. And you only have one monitor—exactly the one you have chosen—on your Cat Mac.

Do you want a simpler solution? Use the Power R video module and any multisync monitor. It works out of the box across the 128 through SE 30 logic boards—it plugs between the logic board and its power cable—and gives you great results.

The trend is increasingly to put an accelerator card and larger monitor functionality on the same add-in board, as covered in the accelerator card chapter, because they usually are or quickly become, mutually dependent needs. Several new products in this area have been announced within the last few months.

Imagine my surprise the first time I opened up my Apple Macintosh SE computer and found a “Samsung” label on its video monitor tube. Needless to say, my “American as Apple Pie” notions were all destroyed in a glance. On the other hand, now I have no hesitancy at all in recommending a larger Samsung monitor for your Cat Mac project. Neither should Apple. After all, it’s just a larger version of the same type of tube they use in a different case with slightly different video drive electronics.

Monitor me

First, a brief detour to get our basic vocabulary straight. The *size* of the monitor does not determine its *resolution*. For example, the standard Macintosh 9" diagonal screen paints a picture that has a resolution of 512 picture elements (or pixels or dots or lines) across the screen and 342 pixels down for a total of 175,104 pixels.

By just wiring up larger 12" or 14" monitors of any type to your Cat Mac and not changing the amount of information fed to it, the Power R video module works great but it doesn't change the information; you can make this picture larger, but you don't increase the number of pixels or the amount of information displayed. To state it in another way, you are making your 512- \times -342 image viewing area larger, but not increasing your productivity, because it takes the same scrolling time to view information on the screen.

On the other hand, when you hook up a Lapis card and a standard TTL monitor to your Cat Mac you get a resolution of 720- \times -350 pixels for a total of 252,000, an increase of 144%. When you use the Lapis or Mobius video card, and add an Apple high-resolution, Princeton MAX 15, NEC multisync GS or other multisync monitor, you get a resolution of 640- \times -480 pixels for a total of 307,200, an increase of 175%. Other higher resolutions are supported when these cards are used with larger monitors. At the high end, add an E-Machines Big Picture 17" 1024- \times -808 monitor, and you increase the pixels by 473%. Add a full two page 21" 1280- \times -960 monitor, and you increase the pixels by 702%. You get the picture?

WYSIWYG (what you see is what you get) should also concern you along with dpi (dots per inch). The beauty of Apple's Macintosh interface is the benefit that what you see on the screen is reproduced faithfully by the printed output. To accomplish this, Apple dictated that Mac compatible displays have a one-to-one ratio between the 72 dots per inch on the display and the 72 dots per inch at what their low-end dot matrix printer (the Apple ImageWriter) prints. Third-party monitor vendors have bent this rule to suit their needs. Higher dpi is not necessarily better. The tradeoff is that a higher than 72 dpi fits more information on the screen, but shrinks the page; a lower dpi is easier to read, it enlarges the page. This directly affects all word processor software but page layout and drawing packages get around it (and Apple itself in its system 6.0 software) by offering software options to expand and contract the view area on the screen. Some monitor definitions follow.

Video monitor This is actually somewhat redundant but refers to the monitor reproducing a visual image on a television or computer screen. This is as opposed to an audio monitor, which would monitor sound frequencies.

Full page or portrait monitor This kind of monitor reproduces the vertical format 8½" by 11" (or A4 European) page you are used to working with on the screen. This is good for heavy word processing work where it is helpful to see the entire page at a glance.

Two-page or landscape monitor This monitor type gives you two side-by-side pages and is useful for doing page layout work. It is also useful for working with spreadsheets; it can either show many cells of a spreadsheet at one time or enlarge a few cells at a time for better viewing in group presentations.

TTL (transistor-to-transistor logic) Although, strictly speaking, this definition applies to a type of electronic interface, this label has also come to apply to the whole universe of the simplest and least expensive under \$100 monitors you can buy because they use that interface.

Multisync The ability of a more expensive than TTL monitor to adjust itself to a wide range of video input signal frequencies and thus be usable for a large variety of applications implemented over numerous computer platforms.

Grayscale Each pixel can display up to 256 shades of gray as opposed to the just black or white option available in a standard monitor. Many monitors can be converted into grayscale just by changing the interface card driving them. This is useful for working with scanned photographs; you can see much more of the tonal range.

All monitors are not created equal

One of the principal benefits of this book is the wide range of options from which you can choose. Nowhere is this more true than in the monitor area; it is a highly subjective decision. You can compare all you want with pencil and paper, but monitors are one area where seeing is believing. If possible, I would encourage you to always look at the results on the screen of the monitor you are thinking of buying before you make your final decision.

However, certain selection criteria can help you regardless of whether you are looking at the lowest-priced TTL solution, a large-screen color monitor at the other end of the price scale, or something in between.

Alexander Rosenberg's¹ article gave no fewer than 13 items to consider. My counsel would be that you should at least be aware of the following when you shop for a monitor:

- Brightness and clarity—Do mid-range settings produce crisp readable text?
- Black-and-white contrast—Dark blacks and bright whites with good contrast?

¹Alexander Rosenberg, "In Focus: Apple, Radius monitors," *MacWEEK*, 4/4/89, p. 34. The article also features a sidebar on "What makes a good monitor?"

- Refresh rate and flicker—High refresh rate reduces flicker, no flicker is best.
- Pin cushioning—Wavy edges or distorted, cramped corners?
- Compatibility—Can the monitor be used across all Macs?
- Software—Are useful items provided on high-end monitor packages (i.e., tear-off menus)?
- Phosphor—Is the color close to the blue-white standard with no ghosting?
- Geometry—How straight are the edges of the raster?
- Ergonomics—Does it come with a tilt swivel stand and/or other extras?
- Price—What price performance are you getting?
- Density (dpi)—What dots per inch are you getting?
- Glare coating—If it has any, does it interfere with image?
- Flatness—Flatter is better; how flat is the tube?

After pointing out the mind-boggling fact that more than 50 display systems are available specifically for the Macintosh, Ken Milburn's² article (now dated; the new boards add PC monitor compatibility to the Mac extend that figure into the hundreds) presented some key points. To summarize a few of them:

- *Match your machine to the monitor you need at the outset.* Yes, you can now add color capability to the traditional Macs, but it really is better to start off with a Mac II and up to begin with if you need color.
- *Bigger monitor screens definitely enhance productivity.* Numerous studies have proven it; even a 14" monitor will give you significant benefits over a standard Mac 9" screen since it cuts down the scrolling time to view information on a page. Obviously the 15" full-page displays and 19" two-page displays even more so if you can afford it.
- *Corporate users prefer color despite cost.* Basically this is aesthetics but many corporate users cite further productivity gains with color.
- *Grayscale is a worthwhile investment if your business justifies it.* Corporate publishing departments that work with halftones are justification.
- *Avoid obsolescence.* Look for features that let you expand later and don't lock you in. What is the next step you are likely to take with your display?
- *Quality/vendor.* It's worth it to pay more for quality. Buy the best quality you can get from a vendor you can trust.

Finally, in a more recent article by Robert C. Eckhardt,³ although he reviewed numerous black-and-white and grayscale monitors against identical objective criteria, he too had to reflect on how personal and subjective the monitor choosing process can be—echoing my opening comments on the matter. Numer-

²Ken Milburn, "Evaluating display systems: There's more than meets the eye," *MacWEEK*, 7/25/89, p. 36.

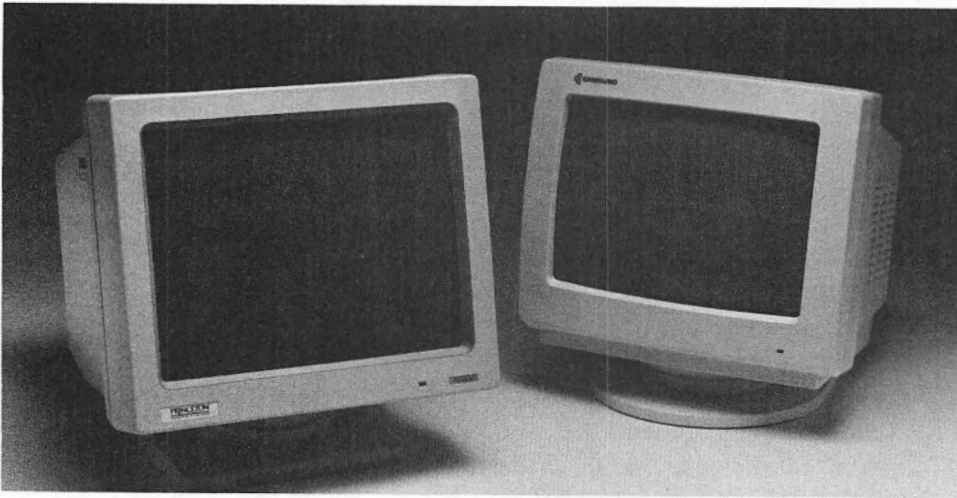
³Robert C. Eckhardt, "Monochrome Monitor Mania," *Macworld*, April 1990, p. 123.

ous articles cover video monitors and features. Both *MacUser* and *MACazine*⁴ had August 1988 articles about monitors worth reading.

TTL monitors and cards

As mentioned earlier, you can put a relatively inexpensive TTL monitor identical to those used on PCs on your Cat Mac. For 128 and 512 Cat Mac builders, you can add a video board from ATS (it's part of a complete kit). For SE Cat Mac builders, you can merely plug a video card from Lapis into your SE logic board, then plug the TTL monitor into it. Alternately, you can build your own video interface to drive your TTL monitor (not my first choice).

Your least expensive monitor option is a 12" to 14" monochrome TTL monitor with either a green, amber, or paper-white screen. A Samsung 12" Amber TTL is shown on the right in Fig. 8-1. The 12" monitors can be had from a number of manufacturers at various prices ranging from \$70 to \$130 depending on the particular monitor you select and your source of supply. The 14" monitors can typically be had for \$120 to \$150.



8-1 Cat Mac monitor Princeton Max 15 on left and Samsung TTL on right.

If you are a 128 or 512 Cat Mac builder, you can buy a ready-made video interface, with chassis and 800K floppy and, optionally, an already set up, ready-to-run pretweaked TTL monitor from ATS. All you do is add your logic board, keyboard, mouse, and hard disk. Going this route sets you back about \$375 for their built-up chassis with video card and another \$150 for their monitor. The

⁴Philip Robinson, "Black & White & Read All Over," *MacUser*, August 1988, p. 102; Savant Labs, "Introduction to Monitors," *MACazine*, August 1988, p. 41.

ATS people are undoubtedly working on options to extend the use of their package to other Macintosh logic boards for the future.

You can build your own TTL video interface; not what I would recommend, but it is the least expensive route. This combination should cost you just under \$100.

Understand what you are and are not getting when you elect to build your own or go the ATS route: You get the exact same Macintosh 9" screen 512 × 342 pixel displayed at 9" on your 12" TTL monitor screen. If you want to fill more of your 12" screen, you tweak the monitor, but you are only making the pixels larger, not adding more information. At around 10" or so you lose the ability to tweak any more because distortions wipe out your gains.

Buying a ready-made video card from Lapis Technologies that you add to your Cat Mac SE logic board is another story. When driving your TTL monitor from the Lapis card, no monitor adjustment is required, and in addition, a number of higher-resolution display modes are available. This route sets you back about \$350, but opens up the world of DOS PC monitors to you. They are the only manufacturer that I am aware of that lets you use your TTL monitor right out of the box without any tweaking and also gives you the desirable option of increased resolution on it. Because numerous PC monitors are around, this board helps any Cat Mac builder with access to existing PC monitors starting with the SE logic board as a building platform. I look forward to future Lapis announcements supporting the market they have established in this area.

Multisync monitors and cards

For a slightly higher initial outlay, you can add a multisync monitor with a video card and receive the added benefit of 640 × 480 resolution on your screen—almost twice that of the original 9" Mac screen.

On my first project, a Cat Mac SE, a video card from Mobius Technologies, that plugged into the SE logic board made short work of hooking up my video monitor. Mobius promised to give Mac SE users access to a wider choice of mid-range pricing, high-resolution and bigger screen monitors, and they delivered on their promise. I first ran across this card, shown installed that project in Chapter 11 Fig. 11-1, while visiting MacWorld Expo in January 1989.

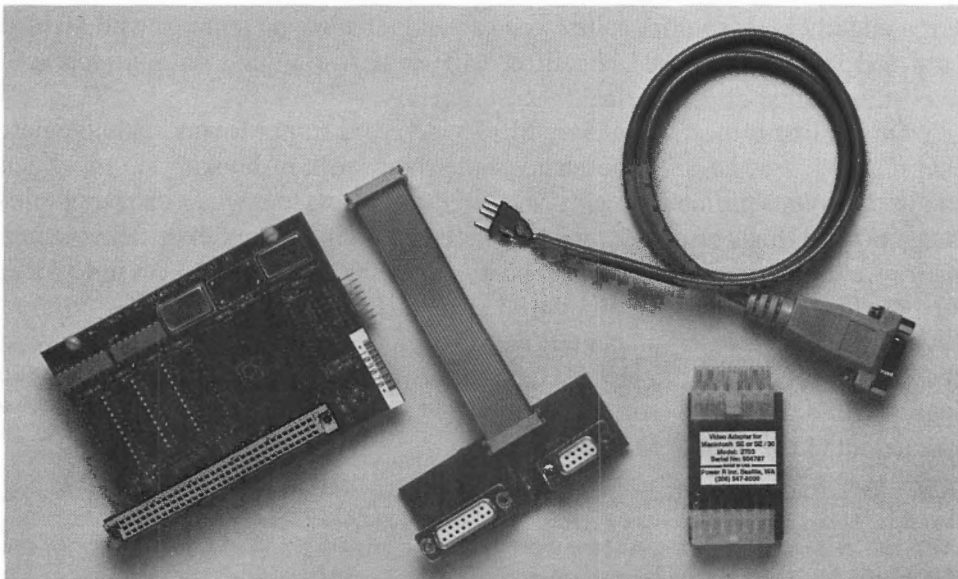
Lapis Technologies announced an SE-compatible video card that does what the Mobius video card did plus TTL on the low end and VGA/Super VGA on the high end. So the whole world of formerly PC compatible only monitors is now opened up to the SE Cat Mac builder.⁵

⁵Mobius and Lapis share a common heritage from Beck Tech. The Mobius designers passed on the TTL compatibility and opted for allowing additional cards to be attached to its SE connector slot. Lapis went for the broader monitor attachment market and TTL.

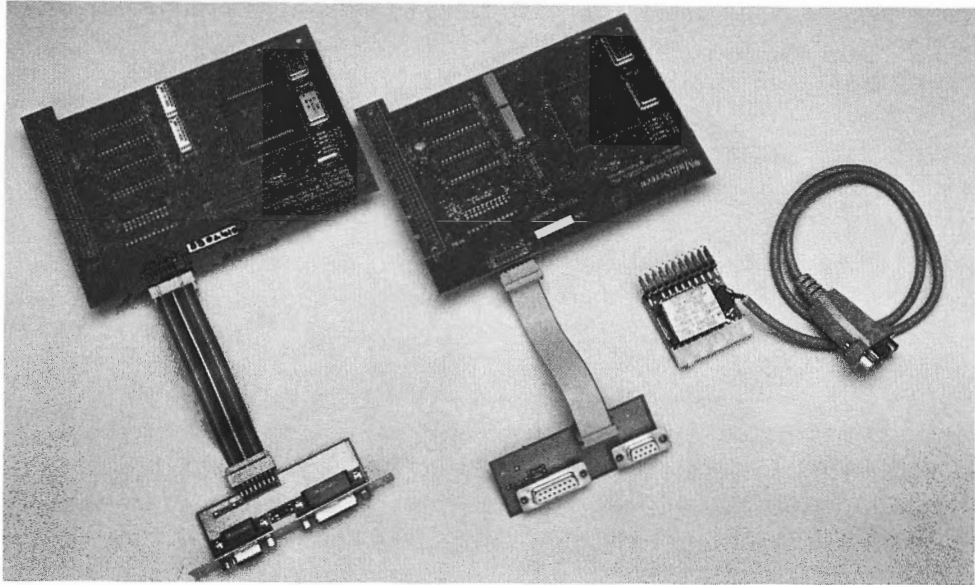
In addition to the Apple Hi-Res monochrome monitor, the Mobius and Lapis cards drive the following multisync monitors: NEC MultiSync GS and MultiSync II, Princeton MAX 15, Samsung Full-Page Display MP 5671, Sony Multiscan, and Tatung MM 1495. Many other monitors are also supported.

The Apple hi-res monochrome monitor produced outstanding results with the Mobius or Lapis card and is available for a street price of about \$250; it would be my second choice. The Princeton Max-15 monitor, shown on the left in Fig. 8-1, won my personal monitor evaluation contest on features and overall performance. Although the Apple produced a slightly more readable, more blue-white screen image, the Princeton has more controls, more features, and more utility; comes with two cables and a tilt and swivel stand; and is priced at around \$240. The NEC Multisync GS at around \$230 or the Samsung Full Page Display 15" portrait monitor at around \$500 would be my third choices.

The new Mobius video card is shown on the left side of Fig. 8-2 with its dual connector adapter cable next to it on the right. Not only did the innovative people at Mobius improve its circuitry and make the card smaller than the first version, but, notice the lower edge of the Mobius card has an SE 96-pin connector on it just like the one on Apple's Mac SE logic board. This means you can now use the Mobius card with any SE accelerator board of your choice. Just stack the two boards on top of one another in your Cat Mac chassis. This is a real gain in flexibility and productivity. The dual connector cable, just as in the original board, offers a 9-pin output for PC monitors, and you can attach an Apple monochrome high-resolution monitor to the standard Apple compatible 15-pin connector.



8-2 Cat Mac SE options include a New Mobius card with SE expansion connector on left and a Power R SE video module on right.



8-3 Lapis and Mobius video cards with their dual connector cable, and a Power R Plus video module and its cable.

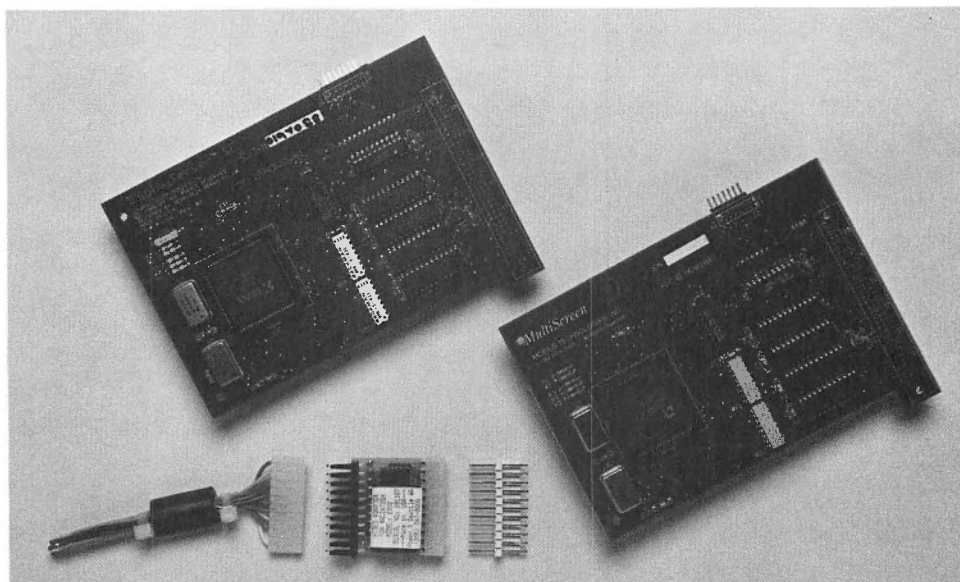
Figure 8-3 shows the original Mobius (no longer offered) card on the left, next to the Lapis Card with their dual connector adapter cables attached. Each manufacturer's dual connector adapter philosophy is different. The Mobius version contains the previously described 9-pin and 15-pin connectors. The Lapis version comes with two connector options. One offers the same capabilities as the Mobius version; the other has a 9-pin connector for attachment to IBM monochrome TTL, multiscanning TTL, and full-page TTL displays, along with a mini 15-pin connector for attachment to VGA and Super VGA.

Figure 8-4 shows a closer view of the Lapis Card on the left, next to the original Mobius card (no longer offered). Notice how similar they are.

The power R cable

The Power R video driver cable is an interesting alternative. It not only works with the entire family of 128/512/Plus/SE logic boards including the SE 30, but also enables the Cat Mac builder to use any accelerator board that works on the Mac Plus or SE including those that don't have video outputs and/or cover up the CPU chip or both. The downside is that you are wasting the full capability of the multisync monitor and limiting it to only 512×342 pixels, the same as the original Mac 9" screen. However, when used with the Princeton Max 15 monitor in its larger screen viewing option, it is my preferred choice and that of a number of my clients as well.

I now use this video driver module and cable from Power R for most of my Cat Mac projects, and I wish I had known of it earlier. The SE version module is



8-4 Closeup of Lapis and Mobius video cards and a Power R Plus video module with its mating cable assembly.

shown on the right in Fig. 8-2 with its video cable directly above it. The video cable that comes with it, plugs into the module and route signals out to a 9-pin connector, so you can take care of your video needs and power connections to your logic board in one pass. Model 2702 fits a Mac 128/512/Plus logic board and Model 2703 fits an SE/SE 30 logic board. Either model can be had for \$100 or so. It works right out of the box and comes with a one year warranty. You merely plug the module into the logic board power connector and plug your power supply cable into it; in lower-profile PC cases because of reduced vertical clearance, you might have make a small jumper cable to plug into the logic board first, then the module, then your power supply adapter cable.

Figure 8-3 shows the Power R Mac Plus video driver module and video cable on the right. Figure 8-4 shows how the Power R Mac Plus video driver module at the bottom fits between a connector equivalent to the Mac Plus logic board connector on the right and a cable equivalent to the Mac Plus power cable on the left.

Frankly, I enjoy the optional larger screen image mode of the original Mac screen when used on my Princeton Max-15 monitor in conjunction with the Power R cable; you can really read it. The Power R video module also provides multisync-monitor or LCD-display compatible RGB outputs if you ever want to use your Cat Mac for business presentations; it produces excellent results.

Big-screen monitors and cards

This is another fruitful area for the Cat Mac builder. There is a universe of big screen monitors to choose from. Most large screen monitor builders make video

cards to fit the Mac Plus. All make video cards to fit the SE and Mac II. Some are now making video cards to fit the SE 30. The story with accelerator cards that adapt to large-screen monitor video cards is nearly the same. The bottom line is strictly good news for the Cat Mac builder, especially in the price area. As you have seen, a 15" FPD monitor from Samsung can be on your Cat Mac for \$500. Ehman has entered the picture with its two-page monitor and card for \$899. It is only going to get better—prices will drop further and more new cost-effective products will be announced.

Having a large-screen monitor alongside your traditional Mac Plus or SE was unnecessarily wasteful of desktop workspace. Having one large screen monitor on your Cat Mac Plus or SE is a perfectly natural solution, just like it is on a Mac II.

Combination accelerator and video cards

The accelerator board makers originally accelerated the performance of existing Macs, which already had a video display built in. They then addressed the need for compatibility with the popular large screen monitors being offered. In recognition of the need, most of the popular accelerator cards have always supported the high end 15"+ Macintosh monitor market, either their own or the leading manufacturer's video displays. For example, the Gemini accelerator supported the E-Machines large-screen monitors.

Until recently, however, no combination cards existed to support the mid-range 12" to 14" video display market. Mobius's recent announcement in *MacWEEK*⁶ makes it worth the wait for a full-page display, a Zenith 15 inch 640-x-870 78 dpi model, combined with their own video card accelerated with a 16 MHz 68000 processor at \$695 (mail order direct from manufacturer price). Indicating it was available to fit the SE, Mac II, and IICx, this combination is \$800 less than the unaccelerated Radius full-page display. To me, this adds new meaning to the words improved price performance. I can hardly wait to get my hands on one. Other manufacturers will obviously have to adjust their pricing strategies, and this can be good news for all Cat Mac builders and Mac owners.

SE 30 video cards

At this point, these are of only limited interest to the Cat Mac builder because the 120-pin direct slot for add-on option boards on the SE 30 logic board is now designed for third-party vendor's boards to sit in vertically, i.e., mounted at a right angle to it. SE 30 optional boards are designed to extend vertically from the SE 30s logic board, acting as a motherboard, to nearly the full height of the traditional Mac case, which has a much higher vertical dimension than the standard

⁶News Briefs, "Mobius to offer single-page display system for SE," *MacWEEK*, 4/3/90, p. 12.

PC enclosure. The Cat Mac builder would need to utilize the mini-tower PC case shown in Fig. 10-1 or an equivalent.

I am sure vendors will solve this problem in the future as they adapt their existing SE video cards to the SE 30. You can solve this problem yourself by using a combination of available 96- and 120-pin right angle and straight through Euro-din male and female connectors plus a little wiring, but this task is outside the scope of this book.

Monitors I have known

You can produce an inexpensive (under \$100) TTL monitor and video card solution if you build your own video card and are not afraid to open up a video monitor to tweak the insides. This solution, attributed to David Yates of Conceptronics in the first *Computer Shopper* “Hackintosh” article,⁷ was improved upon in subsequent articles by Les Hall about a better monitor and how to tweak it, options on the video chip, and a bigger monitor with additional tweaking requirements.⁸ The lowest priced Cat Mac video solution owes its debt of gratitude to these gentlemen.

However, Fig. 8-5 shows you what you are up against in opening up the inside of the Samsung monitor for modification per their recommendations. The pencil shows the location of resistor R606 that needs to be modified. Don’t touch that high voltage capacitor on the left—oops, sorry!

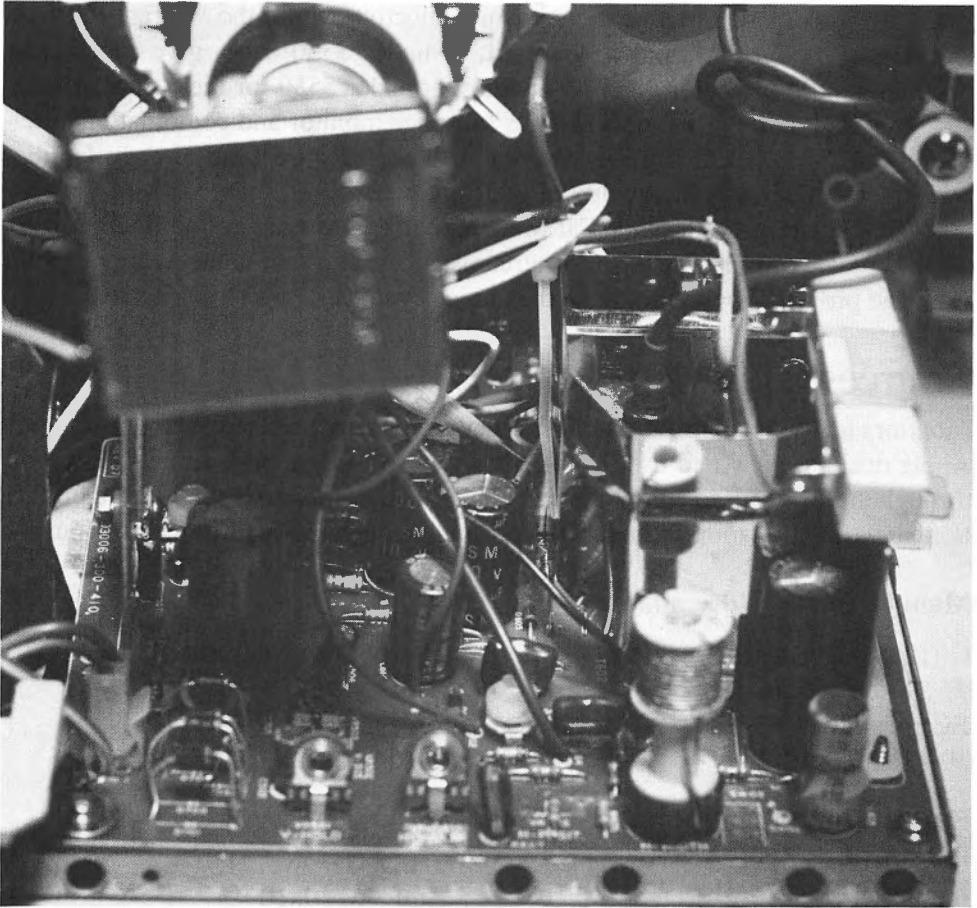
On the Samsung, it was easier to add a 10K pot rather than a fixed resistor at location R606; then I just dialed in the value I needed. However, I found every monitor was different and this process was tedious on most, nearly impossible on some, and only infrequently easy on others. That is why I don’t recommend it to Cat Mac builders; hackers enjoy.

The purpose of this book is to do it with off-the-shelf catalog parts that make it easy and have you up and running in a short time. My experimenting in the area of low-cost monitors and do-it-yourself video interfaces has only led me to one conclusion; it doesn’t allow that. Pass on this option unless you are prepared for a substantial investment of your time before you realize the final product of your labors.

Speaking of tweaking, no matter how I tweaked the intensity and adjusted the contrast of my amber TTL Samsung monitor, I found it harder on my eyes compared to the paper-white Mac screens I have viewed for years. But, it worked great. A green monitor screen was also harder on my eyes, and I never could get used to seeing the logo on the case—*IBM*. I know this is heresy to some Mac

⁷Stax, *Computer Shopper*, “Hackintosh,” p. 11.

⁸Les Hall, “Hackintosh Video Modifications,” *Computer Shopper*, March 1989, p. 229; “Hackintosh SE,” p. 237; “Hackintosh Upgrade: A Fourteen-Inch Monitor,” August 1989, p. 423.



8-5 Inside the Samsung TTL monitor, a pencil points to location of resistor R606

users, but the original green IBM mono monitor worked as good on my Cat Mac SE with the Lapis card as the Samsung did.

Video monitors—The envelope, please

I have yet to find a low-end monitor that gave me as good a result as the Princeton Max 15, which works exceptionally well with the simple Power R Cable and equally well with the Mobius card, Lapis card, and numerous other video board options at only about \$150 more than a low-end TTL monitor. Any money you might think you are saving on a lower-priced TTL monitor up front is a wasted effort later if you want to upgrade (not the Lapis card and TTL monitor option which is an equally attractive alternative).

I found I didn't mind paying a little bit more to get a superior performing solution that already worked out of the box and that I could return no questions

asked if I wasn't satisfied or if it became defective within the warranty period. Either the Lapis or Mobius video card, at under \$350 each, give satisfactory results with the Princeton Max 15 monitor, at under \$550 for the combination.

The availability of the new Mobius full-page monitor and combination accelerator card sounds like a good investment to me because I am already familiar with the company and the quality of their products.

Once again, as with other Cat Mac tradeoffs, you must be the final judge of what is best for your unique set of circumstances. But that is the beauty of your Cat Mac project. You get to make the choices yourself.

Sources

Monitors and video cards are available new and as upgrade replacements through Apple dealers. New and used Apple monitors and video cards are also available through the Apple used equipment dealers. All other monitors and video cards are available directly from the manufacturer and through the mail order distributors.

Manufacturers, video adapters

CUTTING EDGE, INC.
97 S. Red Willow Rd.
Evanston, WY 82930
307-789-0582

MOBIUS TECHNOLOGIES
5835 Doyle St.
Emeryville, CA 94608
415-654-0556

EHMAN ENGINEERING, INC.
P.O. Box 2126
Evanston, WY 82931
800-257-1666

POWER R
1606 Dexter Ave. N.
Seattle, WA 98109
206-547-8000

LAPIS TECHNOLOGIES
1210 Marina Village Pkwy., #100
Alameda, CA 94501
415-748-1600

Manufacturers, video monitors

E-MACHINES
9305 SW Gemini Dr.
Beaverton, OR 97005
503-646-6699

NEC
800-826-2255

MEGAGRAPHS
439 Calle San Pablo
Camarillo, CA 93010
805-484-3799

OPTIMAL TECHNOLOGY
650 Main St.
Amherst, MA 01002
800-637-0088

PRINCETON GRAPHIC SYSTEMS
601 Ewing St., #A
Princeton, NJ 08540
609-683-1660

SUPERMAC TECHNOLOGY
295 N. Bernardo Ave.
Mountain View, CA 94043
415-964-8884

RADIUS
404 E. Plumeria Dr.
San Jose, CA 95134
408-434-1010

TAXAN
800-544-3888

Mail order, Macintosh add-on hardware dealers, consulting

BEVERLY HILLS COMPUTER
279 S. Beverly Dr., #1200
Beverly Hills, CA 90212
800-426-8166

MACLAND
5006 S. Ash Ave., #101
Tempe, AZ 85282
800-333-3353

CONCEPTRONICS
P.O. Box 162
Waukesha, WI 51387

MACPRODUCTS USA
8303 Mopac Expwy., #218
Austin, TX 78759
800-622-3475

DR MAC
14542 Ventura Blvd., #200
Sherman Oaks, CA 91403
800-825-6227

MAC WAREHOUSE
1690 Oak St.
Lakewood, NJ 08701
800-255-6227

HALL, LES
P.O. Box 5732
Raleigh, NC 27605

MACZONE
6825 176th St. NE, #100
Redmond, WA 98052
800-248-0800

MAC CONNECTION
14 Mill St.
Marlow, NH 03456
800-334-4444

9

CHAPTER

Keyboard and mouse

The more things change, the more they stay the same as the saying goes. I doubt that anyone reading this book is unfamiliar with a typewriter. Computer keyboards perform the same function as typewriter keyboards and are patterned after them. For most of us, the keyboard is the main method of getting information into our computer, in addition to controlling what it does. We have to live with our choice of keyboard daily, therefore the keyboard selection process is quite personalized, and “aesthetic” variables usually enter into the decision process in addition to the normal “functional” choices. More about that in a moment.

Unlike the keyboard, few of us, if anyone, were familiar with pointing technology—the mouse—until Apple popularized it with first the Lisa computer and then the Macintosh family computers in the early 1980s. The mouse is an object about the size of a small bar of soap with one or more *buttons* on it that you typically hold in your hand and use to control the movement of a *cursor* arrow on the computer screen. When combined with software featuring pull-down menus and icons, it is the key element that makes the Macintosh easy to learn and easy to use. All you have to do is point and click.

When Apple first introduced the Macintosh, your choices were simple; there was one type of keyboard and one type of mouse. Not so today. Apple offers three types of keyboards and two types of mouse for their standard systems, and still

different versions of each for their portable. In addition, the third-party PC keyboard makers have expanded their horizons by offering alternative options to Macintosh owners. Mouse pointing systems are available from numerous vendors for nearly every type of computer. All this, of course, is a benefit. Chances are you can find a keyboard and mouse whose performance really pleases you and meets your specific needs. The downside is you have to wade through a bewildering array of choices. Let's get to it.

Similar yet different

A PC keyboard and mouse might look the same as a Macintosh one, but that's as far as it goes. They have different wiring and send out different codes. As with the discussion on floppy disks, a PC solution will do you no good on the Macintosh.

The only two games in town on both the keyboard and mouse are Apple Desktop Bus (ADB) and non-ADB. On the older Mac 128, 512, and Plus family machines, you're going to be searching for a non-ADB keyboard and mouse. For use with every other logic board, you're going to want an ADB keyboard and mouse.

The traditional Macintosh models, the 128/512/Plus, communicate with the keyboard and mouse over separate interfaces. The keyboard has its own cord, very similar to a coiled telephone handset cord with RJ-11 plugs on each end, that plugs into the front of the logic board. The mouse has a DB9 connector on the end of its cable that plugs into a mating connector on the back of the logic board, identical actually to the two printer/modem interface serial connectors.

The Apple Desktop Bus is now the Apple standard serial communication bus that allows you to connect up to 15 ADB input devices such as keyboard, mouse, joystick, puck, other pointing/motion devices, and graphics tablets to your SE and newer Macintosh. It allows the devices to be connected in daisy chain fashion. Your mouse can be connected to the side of the keyboard—left or right—easiest for you to work. Devices are interconnected using the mini 8-pin connectors, either one or two on the Mac SE and up logic board or the two on an ADB keyboard. Mouse-type pointing devices typically come with their own single plug. The bottom line to you is increased flexibility at minimal increase in cost. *Warning:* You don't ever want to disconnect your ADB device from your Mac while the power is on because you run a good chance of zapping the ADB board.

Keyboard

Non-ADB keyboards are available from Apple, Datadesk, and used equipment resellers. Apple Mac Plus keyboards with the numeric keypad are typically priced at \$99. The increased capability PC-look-and-feel extended keyboard from Datadesk goes for \$119 and up. Used keyboards can be had for \$50 or so.

I found a surprise when I opened up my Datadesk keyboard package. They don't include the coiled extension cable to connect it to your Mac on the theory that you are probably buying it to upgrade an existing Mac keyboard. Because this does not apply to a Cat Mac builder, you need to also get a keyboard cable at a cost of \$5 to \$20.

Apple makes the standard and extended ADB keyboards, priced at \$129 and \$229 respectively, as add-ons for its Macintosh SE and up models. For ADB keyboards, the main third-party providers are: Cutting Edge/Ehman,¹ Datadesk, and Keytronics. Cutting Edge, Datadesk, and Key Tronics keyboards are all available mail order at around \$119 to \$139; Ehman's extended keyboard is priced at \$99.

The Datadesk keyboard has been available since early 1988, Cutting Edge since mid-1988, and Keytronics announced theirs in September 1989. All these manufacturers offer at least two year warranties and, depending on where and when you purchase your keyboard, they might also bundle them with macro software for automating the functions of certain keys at no extra charge.

Look at Figure 9-1 to get an idea of the relative sizes and keyboard layouts. The three Apple keyboards are on the left, the Cutting Edge ADB is shown on the upper right and the Datadesk Mac Plus is on the lower right. The lower left model



9-1 Macintosh keyboard alternatives from Apple, Cutting Edge, and Datadesk.

¹Cutting Edge and Ehman are two sides to the same company. Cutting Edge sells to dealers and distributors who resell their products; Ehman sells direct via mail order. Sometimes Cutting Edge's price offered through dealers is lower!

is the Apple Mac Plus keyboard. The Apple standard keyboard appears above it and the extended ADB keyboard at the top left. Notice the Apple Mac Plus and ADB standard keyboards are quite similar in layout. The main difference, other than non-ADB versus ADB, is the profile of the Plus keyboard is much higher; i.e., its keys sit higher on your desk. The Apple extended ADB keyboard is likewise quite similar to the Cutting Edge and Datadesk ADB models. The main difference is the price.

Also notice the large key above the main keyboard layout on the Apple standard ADB keyboard. This key, as well as the upper right-hand key on extended ADB keyboards, is the “power on” key used to turn the Apple Mac II series computer on.

Great you say. Now tell me which keyboard to choose. Unfortunately, there is no easy answer here. Although you can order and read marketing literature on every keyboard made, there simply is no substitute for “hands on” experience. I can only say, I would never buy a keyboard without first trying it. If you live near a city populated with computer stores, your task is made somewhat simpler. Go into a store and try them out. The liberal return policies being offered by most mail order supplies also make the “try before buy” option easy, although if you return every keyboard you order, they will probably ask you to shop somewhere else.

I found the Cutting Edge keyboard satisfactory for all my needs. My big fingers especially found the oversized “Return” key welcome (see Fig. 9-1). My wife, who is a power typist, found it very comfortable. It almost had (perish the thought!) an IBM PC tactile touch to it, which IBM spent some time in trying to achieve. As for myself, a two-finger typing specialist, I don’t feel especially qualified to critique keyboards, but it did have a nice touch and feel to it, plus I liked the idea of the extra function keys, especially those which allowed me to easily move around in Word. On the down side, now that I’ve used it for awhile, the paint is starting to wear off my *E* key.

The Apple standard ADB keyboard is the smallest footprint and lowest profile of any of the ADB keyboards. If you intend to mount your Cat Mac in a low-profile mini AT case, the Apple standard keyboard will most nicely complement its appearance because of these two factors. It also has the lowest price, available typically for a street price of around \$90. On the other hand, it comes without special function keys.

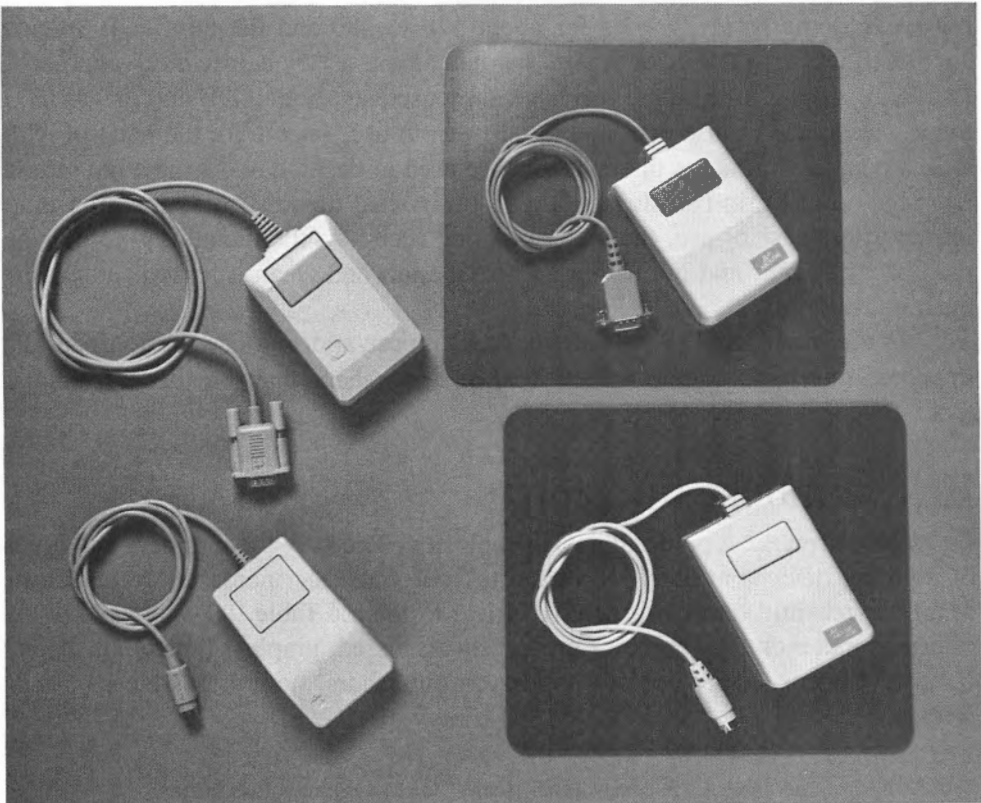
Before I discovered the Cutting Edge keyboard, I found small differences in the Apple Mac Plus keyboard made it easier for me to use than the ADB models. Its key striking areas were slightly smaller although the overall keyboard dimensions were similar. This produces the effect of putting slightly more space between adjacent keys. When combined with a slightly heavier tactile feedback made it a little easier for me to move about the keyboard. Again, just personal preference.

If portability or space on your desk are not considerations, then you will definitely find that the extra functions on an Apple or third-party extended keyboard come in handy.

Mouse

Before we get exotic, let's first talk about conventional mice. Apple and Mouse Systems are the main providers for both ADB and non-ADB mouse devices. (Mouse Systems Corporation has sold more than one million optical mice.) This would include Apple's *mechanical* mouse, a product of the early 1980s that, with minor improvements, they still sell today and Mouse Systems's *optical* mouse first introduced in 1982.

Look at Fig. 9-2 to get an idea of the relative differences between them. The two Apple mice are on the left, the two Mouse Systems mice are on the right. The upper left model is the non-ADB Apple mouse introduced with the Mac 128 and is used today on the Mac Plus. The Apple ADB mouse used on the SE and up Macs is at the lower left. The equivalent Mouse Systems non-ADB and ADB mouse offerings are at the upper and lower right respectively.



9-2 Macintosh mouse alternatives from Apple and Mouse Systems.

A rubber-coated steel ball in the mechanical mouse turns between two rollers as the mouse is moved and sends x and y direction electrical signals back to a chip on the logic board. It's a relative motion device that communicates the direction and distance it has moved, not its location. Typically, it is used on a *mouse pad*, purchased separately by the user that cushions and protects it, gives it a stable surface to roll on, keeps the mechanism relatively clean, and reduces wear.

As seen from Fig. 9-2, each of the optical mice come with its own special mouse pad. The special mouse pad has a nonreflective x - y grid laid over a highly reflective mirrored surface both sandwiched together under a layer of optically transparent plastic and bonded to a conventional mouse pad rubberized backing layer. Inside the mouse, a photodetector senses changes in the light reflected back off the mirror pad from its LED source, and sends relative motion x and y direction electrical signals back to a chip on the logic board. Because there are no moving parts and nothing to wear out or clean, Mouse Systems claims a 30-year MTBF and offers a lifetime warranty.

A brand-new Apple mechanical mouse is listed at \$99 and carries a street price of around \$75. The ADB version, part number 661-0338, is available from Apple dealers as a spare part for around \$90. Either version is available for a better price from used Macintosh equipment dealers. The A+ ADB Mouse from Mouse Systems typically goes for about \$70 to \$80 and the non-ADB version about \$10 less at \$60 to \$70. Again, I would advise a "try before buy" approach.

Being a long-time Apple mechanical mouse user, both ADB and pre-ADB, I found the optical mouse extremely gratifying to use, once I got the hang of it. It took a couple of days for the pads that are used to cushion and isolate the mouse from the optical grid pad surface it rests on to wear down a little; and after that, the effortless ease of use, the better pointing accuracy, the thought of no moving parts wearing out, and not having to take it apart and clean it periodically made me a convert.

On the other hand, Apple's new ADB mouse sports a new Teflon pad and improved internal design to reduce wear in a new shape that provides a real solid feel.

EEK, a mouse invasion

Or, more correctly, a pointing device explosion. Recently the numbers and types of pointing devices available to attach to your Cat Mac increased dramatically. *MacUser* recently devoted an entire article to them.² Table 9-1 summarizes the offerings, not including the mice previously discussed, graphics tablets, or special purpose devices. More devices appear on publishers' new press release stacks weekly.

²Jane Berliess and Peter Borden, "Building a Better Mouse," *MacUser*, October 1989, p. 124.

Table 9-1 Alternative Macintosh pointing devices and pricing.

Manufacturer	Pointing device	Technology	Price
Altra	Felix ADB	action area cursor	169
Practical Solutions	Cordless Mouse	cordless	149
Mirror Technologies	Cordless Mouse	cordless	99
Mobius Technologies	Mobius Mouse	cordless	149
Forte Communications	Remote Mouse	cordless	395
CH Products	Mach IV Plus	joystick	89
Information Strategies	Mouse Touch	touchscreen	1000
Micro Touch Systems	Mac N Touch	touchscreen	895
Abaton	Pro Point	trackball	86
Asher Engineering	quadLYNX	trackball	99
CH Products	CH Roller Mouse	trackball	160
Kensington	Turbo Mouse	trackball	169
Microspeed	MacTRAC	trackball	99

The Cat Mac builder's benefit

What it all boils down to is the keyboard and mouse are yet other areas in which your Cat Mac project will give you a superior solution—not that you can't add improved performance third-party input devices to your existing Macintosh, but you can choose exactly the keyboard and mouse you want initially. They become part of your original cost of building your Cat Mac project with nothing more to buy later.

Sources

Keyboards and mice are available new and as upgrade replacements through Apple dealers. New and used Apple keyboards and mice are also available through the Apple used equipment dealers and, occasionally, through other distribution channels. The third-party equipment mentioned is available directly from the manufacturer and through the mail order distributors.

Manufacturers, other

ABATON TECHNOLOGY
48431 Milmont Dr.
Freemont, CA 94538
415-683-2226

ASHER ENGINEERING CORP.
15115 Ramona Blvd.
Baldwin Park, CA 91706
818-962-4063

ALTRA TECHNOLOGY, INC.
5427 Telegraph Ave., # X
Oakland, CA 94609
415-547-7300

CH PRODUCTS
1225 Stone Dr.
San Marcos, CA 92069
619-744-8546

CUTTING EDGE, INC.
97 S. Red Willow Rd.
Evanston, WY 82930
307-789-0582

MICROSPEED, INC.
44000 Old Warm Springs Blvd.
Fremont, CA 94538
415-490-1403

DATADESK INTERNATIONAL
7651 Haskell Ave.
Van Nuys, CA 91406
800-826-5398

MICRO TOUCH SYSTEMS, INC.
10 State St.
Woburn, MA 01801
617-935-0080

EHMAN ENGINEERING, INC.
P.O. Box 2126
Evanston, WY 82931
800-257-1666

MIRROR TECHNOLOGIES
2644 Patton Rd.
Roseville, MN 55113
612-633-4450

FORTE COMMUNICATIONS, INC.
1050 E. Duane Ave., # J
Sunnyvale, CA 94086
408-733-5100

MOBIUS TECHNOLOGIES, INC.
5835 Doyle St.
Emeryville, CA 94608
415-654-0556

INFORMATION STRATEGIES, INC.
888 S. Greenville Ave., # 121
Richardson, TX 75081

MOUSE SYSTEMS CORP.
47505 Seabridge Dr.
Fremont, CA 94538
415-656-1117

KENSINGTON MICROWAVE
251 Park Ave. S.
New York, NY 10010
212-475-5200

PRACTICAL SOLUTIONS
1135 N. Jones Blvd.
Tucson, AZ 85716
602-322-6100

KEYTRONIC
P.O. Box 14687
Spokane, WA 99214
509-927-5515

SOPHISTICATED CIRCUITS, INC.
19017 120th Ave. NE, #106
Bothell, WA 98011
206-485-7979

Mail order, used Apple Macintosh equipment dealers

MACHEAVEN
Chantilly, VA 22021
703-263-2527

MAYA COMPUTER
P.O. Box 680
Waitsfield, VT 05673
800-541-2318

MICRO EXCHANGE
682 Passaic Ave.
Nutley, NJ 07110
201-284-1200

PRE-OWNED ELECTRONICS
30 Clematis Ave.
Waltham, MA 02154
800-274-5343

PERIPHERAL OUTLET
314 South Broadway
Ada, OK 74280
405-332-6581

SHREVE SYSTEMS
2421 Malcolm St.
Shreveport, LA 71108
800-227-3971

Mail order, Macintosh add-on hardware dealers

BEVERLY HILLS COMPUTER
279 S. Beverly Dr., #1200
Beverly Hills, CA 90212
800-426-8166

MACPRODUCTS USA
8303 Mopac Expwy., #218
Austin, TX 78759
800-622-3475

DR MAC
14542 Ventura Blvd., #200
Sherman Oaks, CA 91403
800-825-6227

MAC WAREHOUSE
1690 Oak St.
Lakewood, NJ 08701
800-255-6227

MAC CONNECTION
14 Mill St.
Marlow, NH 03456
800-334-4444

MACZONE
6825 176th St. NE, #100
Richmond, WA 98052
800-248-0800

MACLAND
5006 S. Ash Ave., #101
Tempe, AZ 85282
800-333-3353

10

CHAPTER

Chassis and wiring

Your first decision in any Cat Mac project is what kind of case do you want to put it in. Although many alternatives exist, this chapter shows you what the benefits are and why you are best served by choosing a PC case. It then discusses the pros and cons of alternate types of PC cases, gives my recommended PC case solution, and finishes by looking at the wiring and cables needed for your Cat Mac project.

Advantages of a PC case

When you build your new Cat Mac, you can exercise your creativity to the fullest. Put it inside anything you can imagine. I thought about putting it inside an old radio tuner case, a briefcase, a TV set, an old and dusty IBM Selectric typewriter (dastardly!), an old Compaq Portable case (heresy!), and a number of other spots too cute to mention. On the other hand, if you decide to put it into an inexpensive PC case, you can choose from a multitude of cases in all sizes, shapes, and colors containing internal power supplies which provide the exact voltages you need. I believe most Cat Mac builders will choose this option. Here are the advantages of

using a PC case to mount your Cat Mac logic board:

- *Readily available.* Computer Shopper pages are filled with alternatives and at least one company, Atlanta Technical Specialists, Inc., makes a case already custom-tailored for a Cat Mac.
- *Inexpensive.* Typically from \$30 to \$70. Mini Tower and other cases cost from \$50 to \$200 more. Power supplies are readily available with the voltages you need to drive the Macintosh logic board, typically from \$40 to \$80.
- *Ease of access mounting.* Adding memory, accelerator cards, larger displays, and other options to the Mac SE and especially to the Mac Plus requires that you jam the cards in; sometimes it's even difficult to close the case. The PC case gives ease of mounting components of all kinds: disk drives, logic boards, speakers, battery cases, accelerators, and video boards.
- *Ease of expansion.* The PC case gives you room to expand as your needs grow.
- *Components live longer.* No heat or air flow problems as in a small case because you're putting all of these components into an oversized chassis rather than in a small, crowded box, with a higher capacity power supply and an industrial strength fan that dissipates much of the heat generated.

The bottom line is that a PC case gives your Cat Mac all kinds of room, no mounting problems, and a longer life—all for a relatively low investment. These are some pretty good reasons for choosing a PC case, but again, you are limited only by your imagination in terms of what you mount your Macintosh logic board in. These are the modules you need to consider a place for in your Cat Mac case regardless of what style you choose:

- **Logic board**—About 9" square (128 through SE 30 Macs) and relatively flat, the logic board has most of its regular connections along the back edge and power/video connectors on its upper face where the circuits are mounted. Mac II family boards measure about 12" by 15" and Mac IIcx boards 12" by 11" (same depth, 4" narrower in width).
- **Power supply**—Typically your PC power supply will measure 3" × 4" × 5" or thereabouts and be in a self-contained metal enclosure along with its cooling fan.
- **800K floppy**—About 4" wide, 1" high, and 6" deep.
- **Hard disk**—Same as the floppy for 3¹/₂" drives. The 5¹/₄" half-height drives require about 5¹/₂" wide, 1³/₄" high and 8" deep.
- **Monitor**—You would probably go with a larger external monitor so the issue is one of aesthetics. Does your chartreuse monitor match your day-glow orange case?

- **Cabling**¹—How are you going to get at the connectors and switches and is there enough room for cabling? In your first attempt, trial mount your logic board in a box, and add the power and other cables (i.e., floppy, hard disk, monitor, etc.) to it to test the cabling layout.

Whatever kind of case you get, you want to be sensitive to emitted *Radio Frequency Interference* (RFI). The nice people at the Federal Communications Commission (FCC) do not take kindly to those individuals who interfere with their neighbors' TV sets and other electronic appliances. This is why putting it in a metal PC case is a natural choice and also why Apple sprays a metallic coating on the inside of its plastic cases.

Three types of PC cases which might suit your needs are the standard PC case, the mini tower PC case and the low-profile PC case. Each of these cases has advantages and disadvantages for your Cat Mac project.

Standard PC case

For my first Cat Mac project, I chose the standard PC case in a flip-top version shown in Chapter 11 in Fig. 11-2. With the standard PC case, either the slide or the flip-top version is an excellent choice because of its low price and the ease of mounting a wide variety of components. With the flip-top case, all components are easy to get at; just flip up the lid. After unbolting the rear connector panel frame on a standard PC chassis, you can cover this entire case back opening with a thin aluminum sheet to give you good RFI shielding except for where the Mac logic board connectors protrude. Aluminum foil or the foil that came with the Mac logic board can cover the remaining area nicely or else build a custom cover as shown in Chapter 11.

The downside of the standard case is, it is rather bulky on your desk, its power supply fan is noisy, and it doesn't look all that stylish. In addition, you need to get very creative when it comes to making a faceplate bezel for your 800K 3¹/₂" floppy drive if you want your finished product to look nice.

On my personal Cat Mac SE project, the first time through, I assembled it out of the boxes into a working unit in under two hours. This is without bolting everything permanently down. The cover plate bezel, that small piece of black plastic that went around the 3¹/₂" floppy drive and made it look pretty in the case, took more than four hours to make. Not having a fully equipped machine shop, I had only hand tools to do the job with and it was straightforward but very tedious, which is why I searched around for a case with an opening that already fit the 3¹/₂" floppy drive in later Cat Mac versions.

¹Salvatore Parascandolo, "Getting Wired," *MacUser*, February 1989, p. 155.



10-1 Cat Mac in mini tower PC case with Apple monochrome monitor on Ergotron tilt/swivel stand.

Mini tower PC case

The main advantages of the mini tower case, shown in Fig. 10-1 with the Apple monochrome monitor, are that it gives you a lot more room inside to mount components and it comes already equipped with cutouts, faceplates and mounting hardware for the 3 $\frac{1}{2}$ " and 5 $\frac{1}{4}$ " disk drives so there are no "designer" faceplate bezels you have to create yourself. Therefore assembly time is a lot faster. The back of the case also comes standard with knockout holes already present for 9-pin and 25-pin D submarine connectors to be mounted. It also has locking, reset power switches easily accessible on the front panel along with several colored LED lamps. These can be used, removed, or cannibalized by you for other projects as you see fit. As I have mentioned, this is a good case for a SE30 logic board if you want to use a color monitor and need to mount its video card vertically into the logic board—it has plenty of vertical room inside the case.

The downside of the mini tower PC case is that the rear chassis card mounting bracket is spot welded to the main chassis, leaving you, if you need more than the two 9-pin and 25-pin cutout holes, with little options other than to buy connector plates with the right size holes for your connectors or make them (definitely not my first choice—now you are working with steel!). Globe Manufacturing Sales or Olson Metal Products are excellent sources for the cutouts if you need them. Also, the placement of the connectors on the Mac 128/512 or Plus logic boards is such that you might have to make extra cables for inside of the case just

to bring your logic board's connections out to the rear of the case. No big deal; just extra effort, extra time, and extra expense.

Low-profile PC case

This is the case I found to be the best for all my later Cat Mac projects. It comes in many styles from different vendors, generally it is labeled their mini AT or PS/2 chassis or something similar. I found two different models of this case that I liked equally well.

One version, shown with the Apple monochrome monitor in Fig. 10-2 and also in Fig. 2-1, has room to mount three 3 $\frac{1}{2}$ " disk drives. It is also the case that ATS, the company that builds a ready made case for the 128 and 512 Mac logic boards, has standardized on.

The other version is the one used to build the Cat Mac project in Chapter 11. An identical unit currently houses my Cat Mac SE 30 shown in Fig. 1-1. In Fig. 10-3, it serves as shown, as an enclosure for a Cat Mac Plus project. It has room for two 3 $\frac{1}{2}$ " and two 5 $\frac{1}{4}$ " disk drives. I prefer this version because the combination of two different size mounting openings give you more flexibility. On the downside, I find the pushbutton power-on switch annoying because your finger has to push it all the way down in its opening to get it to latch on; because it is a narrow opening and I have large fingers, I have to be right on the button to make it



10-2 A Cat Mac in a low-profile PC case with an Apple monochrome monitor. Identical to case style ATS uses.



10-3 Cat Mac Plus with Princeton Max 15 monitor in my preferred low-profile PC case.

work right. This would not be a problem if I used the eraser end of a pencil as a finger extension, but I haven't yet dedicated a pencil to the task. The flip-type switch on the other chassis version is much easier to use. I think I'll just replace the power on switch in my Cat Mac someday.

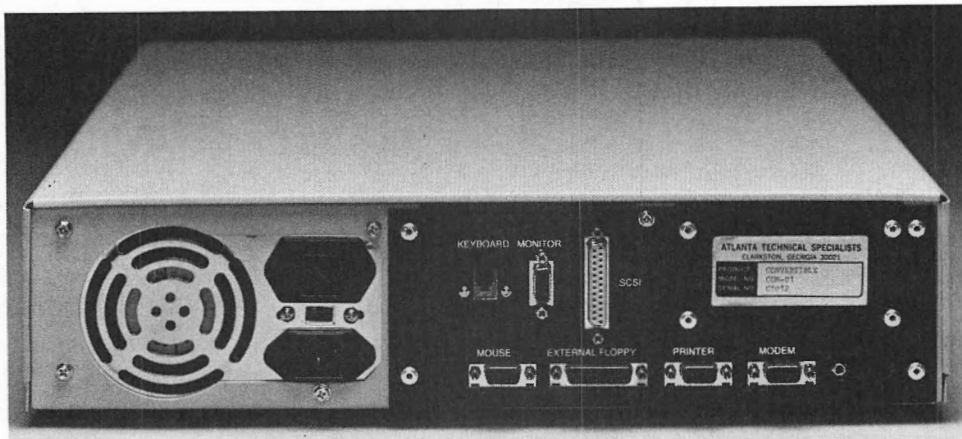
With either version, there are no "designer" faceplate bezels you have to create yourself. Both low-profile PC cases come already equipped with cutouts, faceplates, and mounting hardware so assembly time is faster. Even though it is a compact case, a lot of room is available inside to mount parts on. Also, unlike in the mini tower case, it is easy to get to any of the components. The rear connector panel frame is removable, as on the standard PC chassis, permitting you to add any type rear case covering you want. Plus, its low-profile look is the slickest and most contemporary, especially with the Apple or Princeton high-resolution monitors. One last item, the 200 watt power supply I receive when ordering either version has a fan only half as loud as the one in the smaller power supply you get with the PC flip-top chassis. I don't know the reason, but I like the results.

The downside of either of these cases is vertical clearance—they create a cramped mounting space for the Power R video adapter module. But, on balance, I would have to say that this form factor case is my preferred choice for any Cat Mac project.

If you want to build your Cat Mac around a 128 or 512 logic board, the Atlanta Technical Specialists case is the way to go. Their case, identical to the one shown with a Samsung monitor in Fig. 10-4, makes quick work of your Cat Mac project. It comes complete with case, 800K floppy, custom video card, all the cables (SCSI, floppy, power, battery, speaker, reset, front panel lights), and the other accessories you need (battery holder, speaker, mounting hardware) for only \$375. From the rear, a finished unit looks like the one I assembled with a 512 logic board in Fig. 10-5. The Computer Care memory upgrade and SCSI board is also available from them as mentioned in Chapter 5, and they have a matching video monitor as mentioned in Chapter 8. The only downside I had was their placement of the keyboard connector on the back panel. I either had to uncoil my standard cable to almost its full length or make an extension.



10-4 Cat Mac Plus with Samsung monitor in ATS style low-profile PC case.



10-5 Rear view of ATS case showing their custom rear panel connector plate with Mac 512 logic board in place.

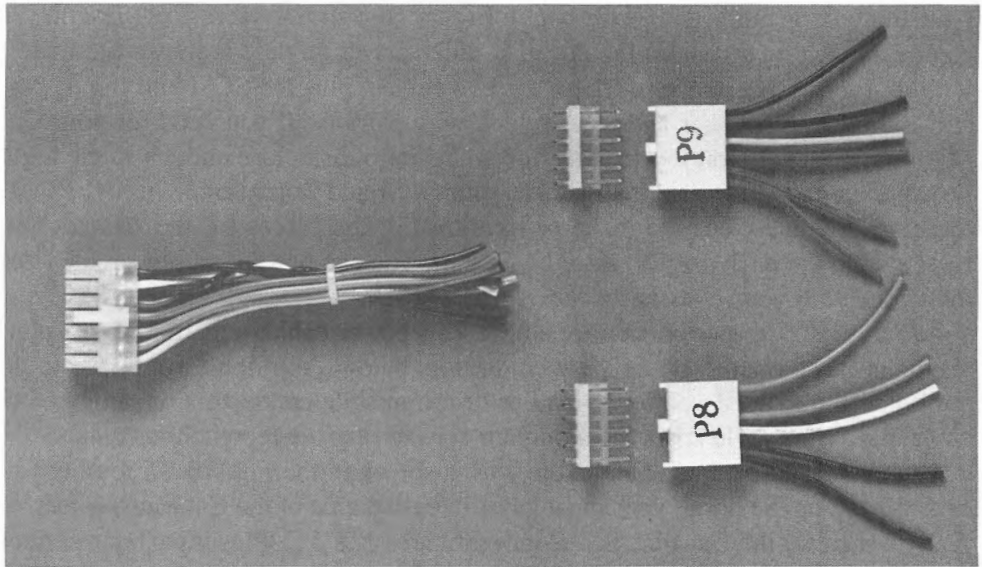
Wiring your Cat Mac

Your Cat Mac project's wiring tradeoffs are easy. You can either make your cables, make some and build some, or have someone else do all the work. They are definitely not difficult to make. The connectors and cables you will need are:

- **Power cable**—This powers your logic board and can also provide signal and power to your video monitor, depending on which video option you have elected. The connectors and signals on them are different, but the process is the same for all logic boards.
- **SCSI cable**—This goes between 50-pin male SCSI connector on the back of your hard disk and the 50-pin male SCSI connector on your SE or Mac II series logic board. On earlier, pre-SE Macs, you are talking about adding an SCSI interface plus a 25- to 50-pin adapter cable.
- **Floppy cable**—This goes between the 20-pin male connector on the back of your floppy disk and the 20-pin male connector on your logic board. This is the same for all logic boards.
- **Other cables**—Speaker, keyboard, battery, and reset. On the SE, only speaker and reset cables. Earlier Macs require all.

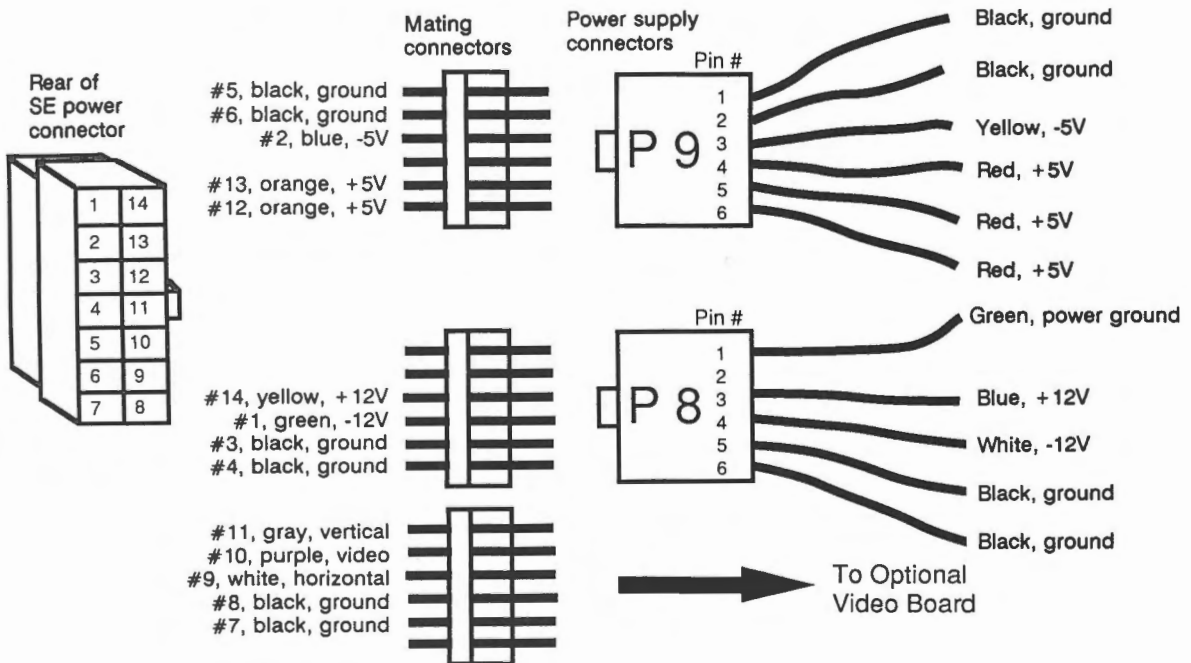
I have repeatedly stated that the SE (or SE 30—the power cables are identical) logic board is the best choice for your Cat Mac project. If that hasn't been made perfectly clear for a number of reasons already, then looking at Figs. 10-6, 10-7, and 10-8 should drive the point home. That's all the difficult wiring there is to it—a simple power cable.

Figure 10-6 shows you the parts you need and lays them out prior to assembly. At the left is one half of a standard Apple SE power cable. Next are the two polarized, locking header connectors. On the right are the connectors you would attach to from any standard PC power supply.



10-6 The parts for the Cat Mac SE power cable before assembly.

Figure 10-7 shows you the details of making the cable with the exact pinouts and connections as well as the color of the wires themselves. By the way, the numbering scheme on the connector shown might not agree with the numbers on your connector shell, so go by Fig. 10-7's numbers for the shell oriented as it is shown

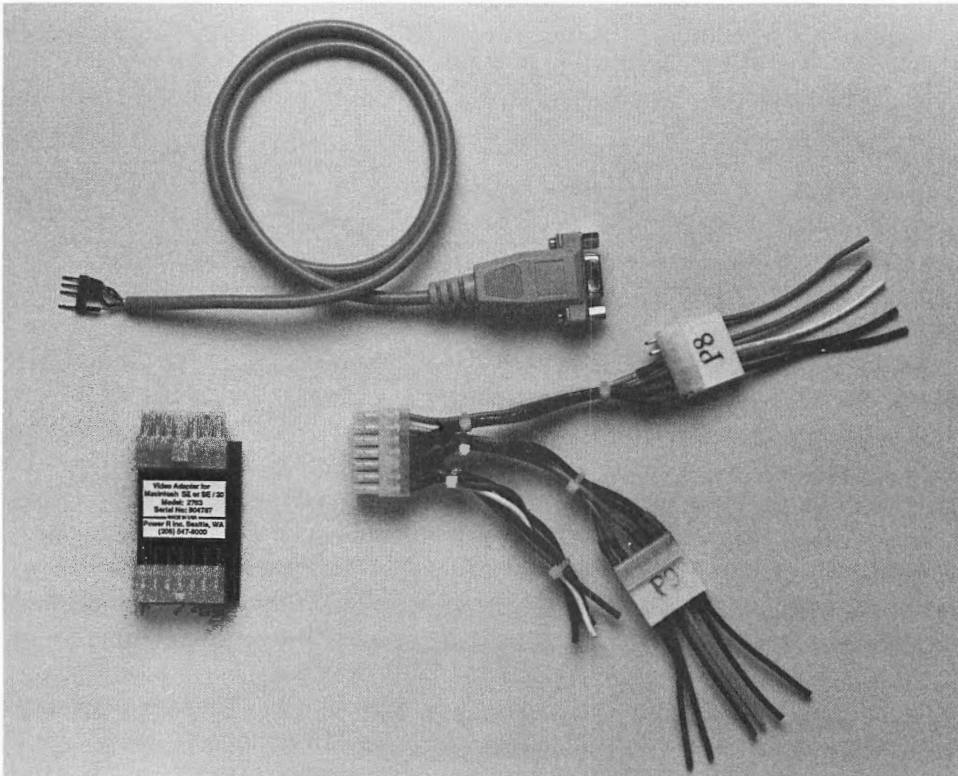


10-7 Cat Mac SE power cable connection diagram.

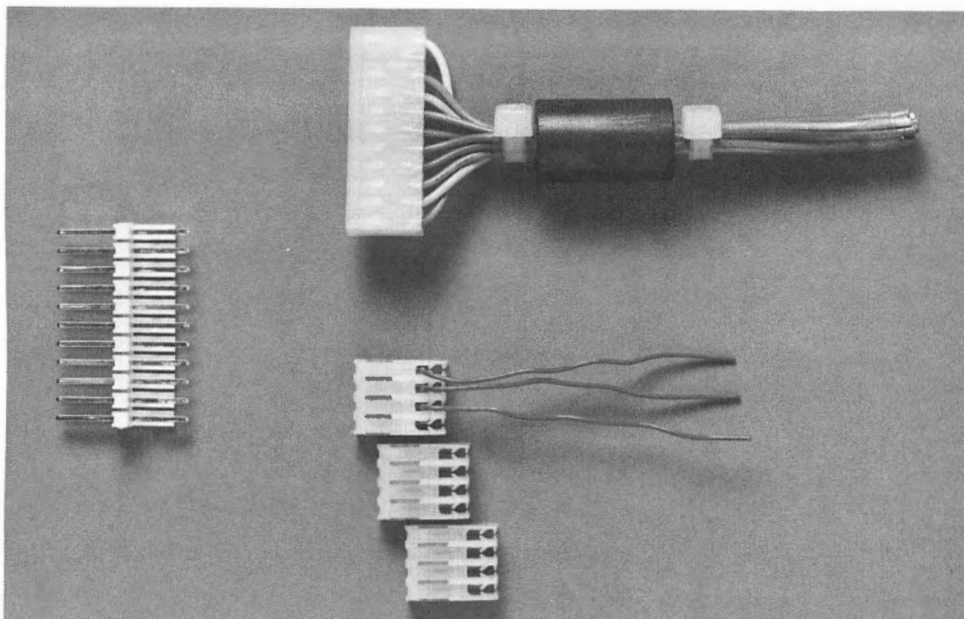
(you are looking at the connector back). Figure 10-8 shows the results. The power cable is shown on the right, the Power R video driver module is shown on the left with its video cable above it. These are two cables, plus the SCSI and floppy ribbon cables, and speaker and reset switch wire pairs is all you need for your Cat Mac SE project. If you locate your floppy and hard disk close enough to the logic board, existing Apple cables can solve your SCSI and floppy cable needs. If not, these are relatively easy to make or have made. The cables for the speaker and reset switch are each only a twisted wire pair. You can use an unused set of wires that came with your chassis for these.

Figure 10-9 shows one half of a Mac Plus power cable, a mating Molex connector to it, and some crimp style connectors below. You don't even have to do any soldering at all if you use twist ties or crimp style connectors on your power cable and crimp style spade lugs on your speaker and reset switch terminals.

Do you think you can handle the wiring shown in the Fig. 10-8? You bet you can! Wiring up the parts, your most labor intensive area of the Cat Mac project, is really a snap for the Cat Mac SE. Connecting to a 128/512/Plus logic board rather than an SE logic board, on the other hand, can easily eat up several more hours of



10-8 Cat Mac SE power cable after assembly. SE Power R video adapter is at the left with video cable above it.



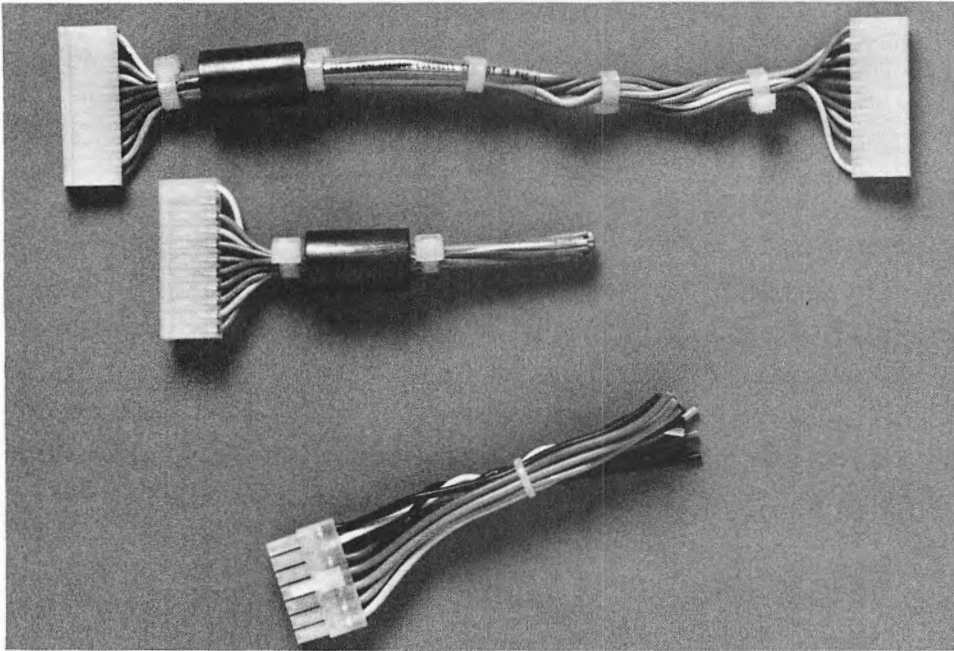
10-9 Alternative Cat Mac Plus power cable parts with solderless crimp style connectors shown below.

your time unless you go with the pre-engineered case from Atlanta Technical Specialists—your choice.

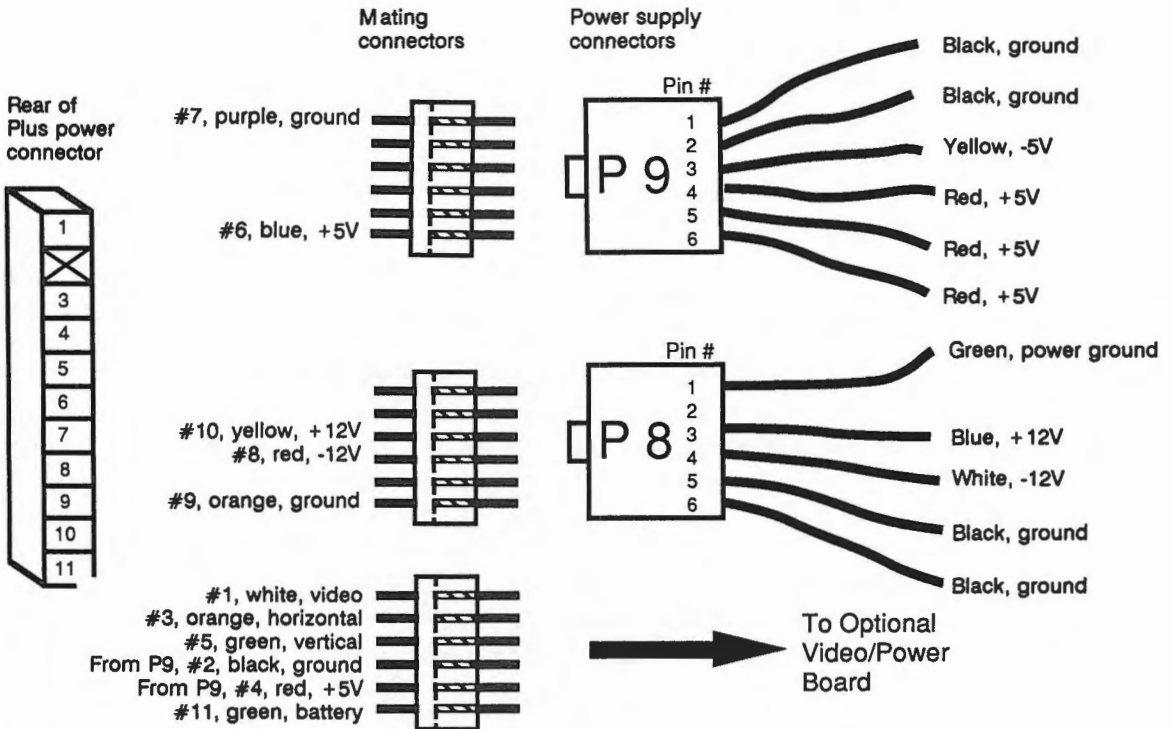
In *Computer Shopper* in an article by Les Hall,² one of the earliest innovators of that magazine's Hackintosh series, Les offers cable kits already built for an attractive price.

Power cable

If you are using a video card or another video solution your best source for the Apple SE power cable with the Molex connectors on each end is your local Apple Dealer, Pre-Owned, Shreve, or one of the other used Macintosh equipment dealers. Ask for Apple P/N 590-0392, the SE Logic Board Interconnect Cable. After you cut this cable in half, save the other end for another Cat Mac project, wire it up to your power supply and, if needed, to your external video adapter. If you are building a 128/512/Plus Cat Mac, the above also applies. In this case, you want to ask for Apple P/N 590-0184, the Mac Plus Power Supply to Logic Board Cable. Figure 10-10 shows the original Apple Mac Plus cable at top. Below it are half-cable sections of the Plus and SE cables. Total Systems, the accelerator card people, also make a heavy-duty Mac Plus power cable using 18 gauge instead of the 22 gauge wire that comes standard with a Macintosh Plus, and you wind up paying about the same amount of money. Figure 10-11 shows the details of making the Cat Mac Plus power cable. Table 10-1 shows the pin connections for making any Cat Mac power cable from a 128 up to a Mac IIx logic board.



10-10 Cat Mac power cable assemblies: full and half Plus cables, half SE cable.



10-11 Cat Mac Plus power cable connection diagram.

Table 10-1 Cat Mac power connector pinouts for Macintosh logic boards.

Pin	128/512/Plus	Pin	SE/SE 30	Pin	Mac II, IIx, IIcx	Pin	Mac IIcx, IIci
1	Composite video	1	-12 volts	1	+12 volts	1	+12 volts
1	key (no pin)	2	-5 volts	2	+5 volts	2	+5 volts
3	horizontal sync	3	ground	3	+5 volts	3	+5 volts
4	speaker	4	ground	4	+5 volts	4	+5 volts
5	vertical sync	5	ground	5	+5 volts	5	ground
6	+5 volts	6	ground	6	+5 volts	6	ground
7	ground	7	ground	7	ground	7	ground
8	-12 volts	8	ground	8	ground	8	-5 volts
9	ground	9	horizontal sync	9	ground	9	-12 volts
10	+12 volts	10	composite video	10	ground	10	/PFW
11	battery	11	vertical sync	11	ground		
		12	+5 volts	12	ground		
		13	+5 volts	13			
		14	+12 volts	14	-12 volts		
				15	/PFW		

SCSI cable

If you are building an SE Cat Mac, ask for Apple P/N 590-0566, the Mac II Internal Hard Disk Cable. Apple P/N 590-0211, the SE HDA I/O cable, will also work. If your needs are for a cable greater than 10" to 12", you need to go to your local cable supplier and get the length of 50 conductor ribbon cable you need plus a 50-pin female IDC ribbon connector for each end.

If you are building a 128/512/Plus Cat Mac, your problems are a bit more interesting. All SCSI hard disks have a standard 50-pin connector on the back in conformance with the ANSI X3T9.2 SCSI definition document. Apple has chosen to bring out its SCSI port into a 25-pin subminiature D-type connector. This is the SCSI connector that the world sees mounted near the edge of the Mac logic board. Your mission as a Cat Mac builder is to figure out the easiest way to get between these two worlds.

Table 10-2 shows you the magnitude of your mission. The easiest method is, of course, to buy a cable already built. This suggests the Les Hall option above or taking your requirements to a local cable supplier. Not shown in the table but something I learned from my own experience, if you are making this cable, you need to ground all the unused inputs. Otherwise, you could spend days finding out why your cable doesn't work.

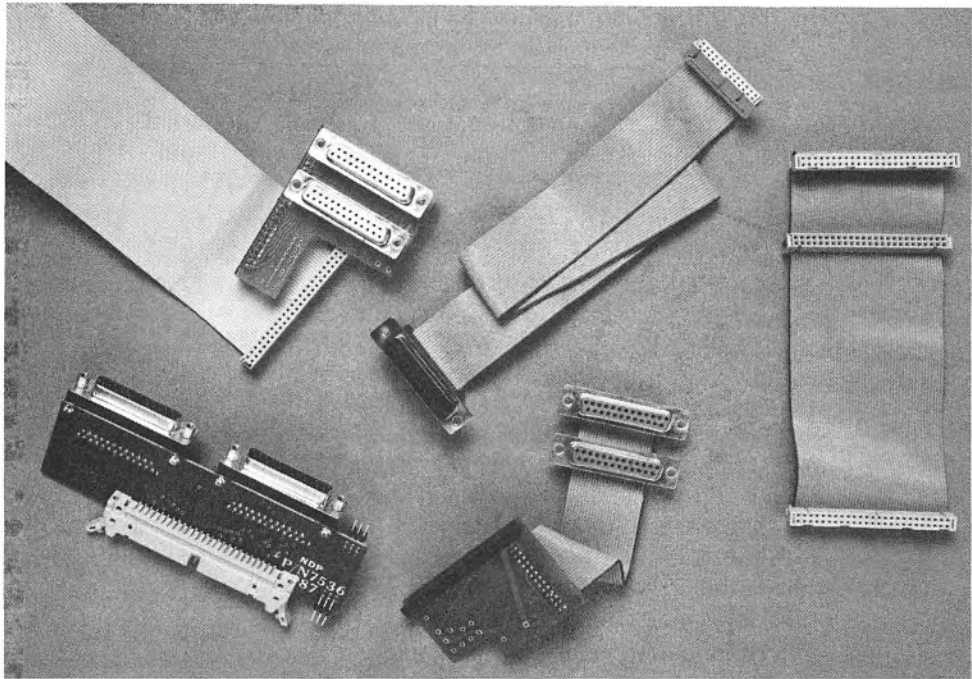
The other tidbit I would offer is Apple standard SCSI cables occasionally come with the /RESET signal line (pin 40 on the SCSI connector or pin 4 on the external 25-pin connector) cut. The ribbon cable just has a notch cut in it eliminating this wire. I have found it to be helpful in solving certain SCSI problems involving newer disks with older generation logic boards and, conversely, older disks with newer logic boards.

Table 10-2 Cat Mac SCSI internal 50-pin and SCSI external 25-pin connector pinouts.

Signal	Internal 50-pin	External 25-pin	Signal	Internal 50-pin	External 25-pin
ground	1	7	+5V term power	26	25
SCSI data bus 0	2	8	ground	27	—
ground	3	9	ground	28	—
SCSI data bus 1	4	21	ground	29	—
ground	5	14	ground	30	—
SCSI data bus 2	6	22	ground	31	—
ground	7	16	/attention	32	17
SCSI data bus 3	8	10	ground	33	—
ground	9	18	ground	34	—
SCSI data bus 4	10	23	ground	35	—
ground	11	24	/busy	36	6
SCSI data bus 5	12	11	ground	37	—
ground	13	—	/acknowledge	38	5
SCSI data bus 6	14	12	ground	39	—
ground	15	—	/reset	40	4
SCSI data bus 7	16	13	ground	41	—
ground	17	—	/message	42	2
SCSI DB parity	18	20	ground	43	—
ground	19	—	/select	44	19
ground	20	—	ground	45	—
ground	21	—	/control data	46	15
ground	22	—	ground	47	—
ground	23	—	/request	48	1
ground	24	—	ground	49	—
not connected	25	—	/input/output	50	3

Figure 10-12 shows some of my collection of SCSI cable adapters you might find useful. Most SCSI upgrades to the Mac 128/512 give you the cabling hardware to bring it out to the external 25-pin female connector, just like Apple's. Unfortunately, as a 128/512 Cat Mac builder with a desire to put your hard disk on the inside of your chassis, that does you no good. The 25-pin connector that the SCSI upgrades give you still have to go back into the 50-pin world to connect with the hard disk.

To do that you take the 25-pin ribbon cable (shown folded neatly in the center of Fig. 10-12) which ends in a male 25-pin connector, and connect it to an external hard drive chassis adapter racket (like any one of those shown around the 25-pin ribbon cable in Fig. 10-12). Disk drive enclosure manufacturers use these brackets to go between the 50-pin and 25-pin worlds inside their disk drive enclosures. Plug the male cable into the other end of the chassis bracket and plug the SCSI drive ribbon cable or the other end of the bracket itself into the hard drive. The result is an instant solution with no cables to build.



10-12 Useful SCSI cables and adapters.

Rodime, a disk drive manufacturer, used an interesting cable for their now out-of-production internal 20Mb hard disk mounting kit that might give you some ideas. One end had a Killy clip on a small printed circuit board that attached to the Mac Plus NCR 5380 chip, the other end had a 50-pin IDC connector on a small printed circuit board that attached to the hard drive, and a 25-pin ribbon cable ran in between. (See Fig. 6-7.) IDS Systems offers a similar Mac Plus internal drive kit today. Remember, these are both for the Mac Plus, which already has an external SCSI 25 pin connector, so if you are starting with a Mac 128 or 512 logic board you must cross a still further bridge.

As I have been saying, for the Cat Mac builder who starts out with less than a Mac SE logic board, it is just not as easy—even if you believe the journey is the reward.

Floppy cable

The floppy cable situation for your Cat Mac is infinitely easier to solve than the SCSI cable. Yet, even here there are wrinkles that you should be aware of as Table 10-3 shows.

Apple has kept the external floppy interface the same. What Table 10-3 shows is that if you are using an older floppy drive cable in your SE Cat Mac or using an Apple floppy drive from an SE or Mac II in a Mac Plus upgrade to a Mac 128/512

Table 10-3 Floppy connector pinouts internal 20-pin for the Mac SE and earlier Macs.

Signal	SE	128/512	External 19-pin
	Internal 20-pin	Internal 20-pin	
ground	1	1	1
control line CA0	2	2	11
ground	3	3	2
control line CA1	4	4	12
ground	5	5	3
control line CA2	6	6	13
ground	7	7	4
register write strobe	8	8	14
-12 volts	not connected	9	5
write data request	10	10	15
+5 volts	11	11	6
control line select	12	12	16
+12 volts	13	13	7
drive enable	14	14	17
+12 volts	15	15	8
read data	16	16	18
+12 volts	17	17	—
write data	18	18	19
+12 volts	19	19	—
motor speed control	not connected	20	10

and things are not working out, cut the cable to pins 9 and 20 and see if that doesn't fix the problem.

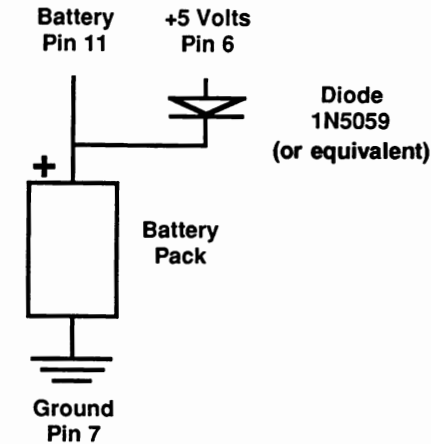
The above niceties notwithstanding, if you are building an SE Cat Mac, ask for Apple P/N 590-0188, the Mac II 3¹/₂" Drive Internal Cable. This is the same cable used by the upper floppy in the dual drive Apple Mac SE models. If your needs are for a cable greater than 10" to 12", you need to go to your local cable supplier and get the length of 20 conductor ribbon cable you need plus a 20-pin female IDS ribbon connector for each end.

Other cables

If you are building an SE Cat Mac, your next project is the speaker and reset cables. The speaker cable requires a miniature 2-pin female logic board connector to mate with the male speaker connector on the SE logic board, the other end of the wires going to your high impedance speaker. The reset switch is also easy. Just attach spade lugs to the tabs which protrude from the reset switch (and the next switch further back from it on the logic board, the programmer's interrupt switch, if you are so inclined) and run the other end of the wires to the back of wherever your new reset switch is located. The SE Cat Mac builder is now done with the wiring phase of the project.

If you are building a 128/512/Plus Cat Mac, the procedure is the same for the reset switch. The speaker and ground wires, as Table 10-1 shows, now come from pins 4 and 7 respectively, of the power connector cable.

The battery circuit is another wrinkle the Cat Mac 128/512/Plus enthusiast has to tackle. The simple circuitry of Fig. 10-13 keeps the battery from draining when the power is on.



10-13 Diagram of typical 128/512/Plus battery circuit.

Finally, the Cat Mac 128/512/Plus builder has to deal with the keyboard connector. The keyboard connector on the Mac logic board is similar to, but slightly narrower than, a standard RJ-11 female connector socket. You can use a straight telephone handset cable as an extension, but you will have to very carefully file the ends to fit both the keyboard and logic board receptacles. If you are not making an extension but an original keyboard cable from a telephone handset cable, you will have to be aware that the connections are reversed. In a handset cable, pins 1-2-3-4 go to pins 4-3-2-1 on the other end. In a Mac cable, pins 1-2-3-4 go to pins 1-2-3-4. The Cat Mac 128/512/Plus builder is now finished with the wiring phase of the project.

Other cases, other solutions

This chapter wouldn't be complete without mentioning a few nonconventional packaging solutions available to you as a Cat Mac builder. Here are a few ideas to get your thinking started.

Portable PC case In the tradition of Compaq and many other vendors, they packaged their portables inside a suitcase-looking case with carrying handle and keyboard attached. Usually these portables had 9" monitors in them. Hmmm, the same size monitor as is the Apple Macintosh 128/512/Plus models. In the Macs

and Compaqs, the circuitry to drive the video monitor is part of the power supply/analog board. The very idea of an Apple Mac in a Compaq portable case is pure heresy, but nothing stops you from taking this board along with the 9" CRT tube from your existing Mac and putting them into a package with a different shape.

Flat panel display portables We talked about this earlier, and there really is a need for this product—you can bet that Apple is working in this area now. Other vendors already offer portable Macs packaged with various combinations of Plasma, EL, or LCD flat-screen displays. Your mission is to find one you like in the PC world, or any other world, either as a kit or as a finished product to which you can add the Mac logic board to make your own Cat Mac Portable. The pages of *Computer Shopper* are filled with ads from case and housing providers—portable, laptop, you name it. All you need to do is find a case you like and add “sweat equity.”

Larger TV monitor Several vendors offer driver boards which enable you to display your Macintosh screen image on much larger TV monitor screens. Typically you attached them to your existing Mac 128/512/Plus/SE and ran the drive cable over to your large display monitor. I wouldn't advocate sitting right on top of a relatively low-resolution TV display. But nothing stops you from approaching these vendors, purchasing one of their boards and using it across the room from you with a keyboard in your lap. If it's a larger monitor, nothing really stops you from putting your entire Cat Mac inside the monitor housing. Or try this with a larger high-resolution Mac monitor.

Experiment Don't worry, somebody's probably thought of it before.

Sources

PC Cases are available new from numerous sources. Used Apple Mac cases for a Mac II project and Apple cables are best obtained from the Apple used equipment dealers. Atlanta Technical Specialists and Business Technology Manufacturing make ready-to-use cases. Brant Associates Group offers complete SE/SE30 cable kits and pre-punched back panels for an attractive price. The third-party case, cable, and connector suppliers list below is intended as a starter; there are numerous others.

Manufacturers, cases, cables, connector and other parts

ALTEX ELECTRONICS
10731 Gulfdale
San Antonio, TX 78216
800-531-5369

AMTA
Montebello, CA 90640
213-724-9480

ASLAN
El Monte, CA 91733
818-575-5271

ATLANTA TECHNICAL SPECIALISTS
3550-F Clarkston Blvd., #B
Clarkston, GA 30021
404-292-6655

AXION
El Paso, TX
915-772-0088
800-828-6475

BRANT ASSOCIATES GROUP
4420 SE Mark Kelly Court
P.O. Box 68708
Portland, OR 97268

BUSINESS TECHNOLOGY
MANUFACTURING
42-18 235th St.
Douglaston, NY 11363
718-229-8094

GLOBE MANUFACTURING SALES, INC.
1159 Route 22
Mountainside, NJ 07092
201-232-7301

IDS SYSTEMS, INC.
2107 N. First St., Suite 280
San Jose, CA 95131

JAMECO ELECTRONICS
1355 Shoreway Rd.
Belmont, CA 94002
415-592-8097

JDR MICRODEVICES
110 Knowles Dr.
Los Gatos, CA 95030
800-538-5000

OLSON METAL PRODUCTS COMPANY
Crossroads Industrial Center
Seguin, TX 78155
512-379-7000

Mail order, used Macintosh hardware and parts suppliers

CRA
700 S. University Parks Dr., #600
Waco, TX 76706
800-950-8212

PERIPHERAL OUTLET
314 South Broadway
Ada, OK 74280
405-332-6581

HWH MICROSYSTEMS
Hammond, LA
800-673-0586

PRE-OWNED ELECTRONICS
30 Clematis Ave.
Waltham, MA 02154
800-274-5343

MACHEAVEN
Chantilly, VA
703-263-2527

SHREVE SYSTEMS
2421 Malcolm St.
Shreveport, LA 71108
800-227-3971

MAYA COMPUTER
P.O. Box 680
Waitsfield, VT 05673
800-541-2318

THIRD WAVE COMPUTING
4412 Spicewood Springs Rd.
Austin, TX 78759
800-284-0486



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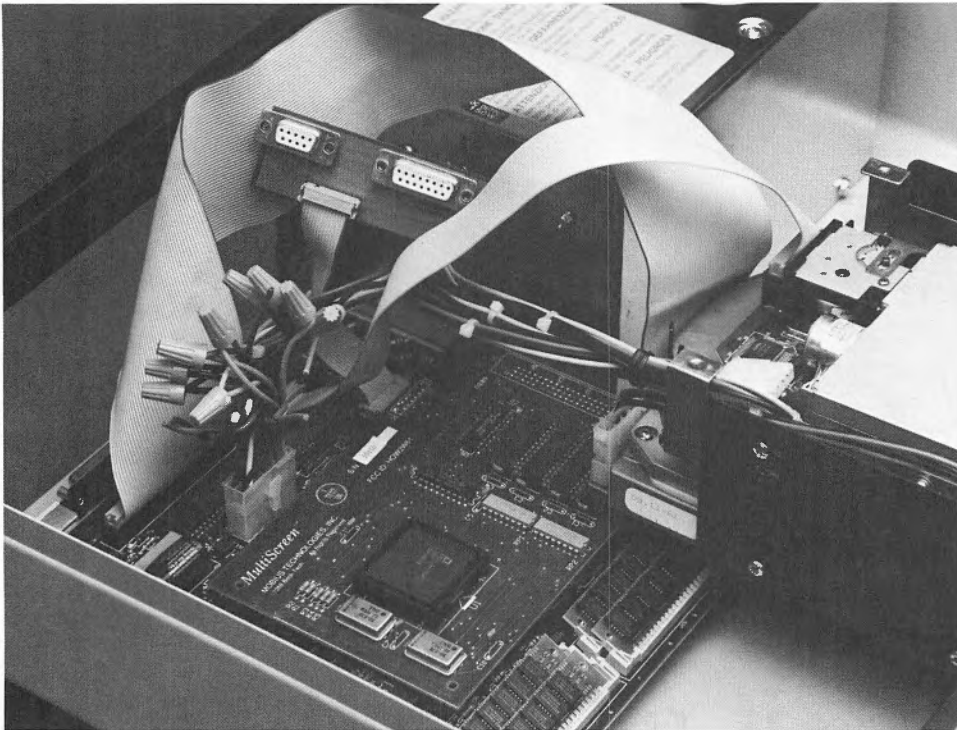
CHAPTER

Putting it all together

When I received all the parts for my first Cat Mac, an SE version, like a new kid with his presents at Christmas, I could not wait to put it all together. So I went the simplest route. I started with a simple, flip-top PC/XT chassis, and drilled holes in it to mount the logic board. I mounted my Macintosh SE logic board in it on standoff spacers and bolted it down between insulated washers. Then I bolted in my floppy and hard disks.

Next, I used electrical twist connectors to tie the chassis power supply wires to the wires of a standard Apple SE power cable I had cut in half, attached the floppy and hard disks to the SE logic board using standard Apple ribbon cables, plugged the Mobius video card into the SE logic board, and attached its dual connector mounting panel using the ribbon cable provided. The inside of my project looked like Fig. 11-1.

I then closed the lid on the case and connected my Apple high-resolution monochrome monitor, hooked up my ADB keyboard and mouse, and I was in business. Elapsed time: under two hours. Figure 11-2 shows the results—my first Cat Mac SE.



11-1 Inside my first Cat Mac SE.



11-2 My first Cat Mac SE with an Apple monochrome monitor, Cutting Edge ADB Keyboard, and A+ ADB Optical Mouse.

It all worked when I turned the power on. Staring back at me was the most beautiful picture of a Macintosh desktop on an Apple high-resolution monitor screen. I was amazed! The most difficult part was making sure the wires of the power supply went to the right wires on the Molex logic board connector. I took my time and carefully made sure that it was done right the first time, thinking mostly of the money I had just spent for the logic board, not to mention the cost of the other pieces.

Now to be honest, I did do some other things not included in the two hours. I carefully read my Mobius manual and preinstalled the required software driver on the hard disk. The hard disk itself was previously formatted and had software installed on it using my other Macintosh SE before putting it into my Cat Mac. Hey, so I cheated a little. Some of the parts came early, and I was anxious.

Of course there was still “cleanup” work to be done: adding the speaker, wiring the reset switch and making the covers for the front and back panels. All these steps took several hours more. Yet the satisfaction of doing these steps to an already working Mac took all of the edge off.

Another element of the above story is that I was lazy. I didn’t want to do any extra wiring. Using the SE logic board was the ideal solution. Not only do you get the fastest platform in the Apple classic Macintosh family, because you have 256K ROMs instead of the 128K ROMs of the Mac Plus, but you also get ADB bus connectors which both the keyboard and mouse plug into, a 96-pin expansion connector (which the Mobius video adapter card plugs into), a 50-pin SCSI connector to the hard drive, two 20-pin floppy drive connectors, and a battery already on the logic board. I just had to plug it in and go.

Now you don’t have to copy me. Somehow I doubt that will be a problem because I have yet to find any two Macintosh owners who can exactly agree on anything. Yet there is a certain sequence to the assembly of your Cat Mac that, if followed, will make things a lot easier. Guaranteed that no matter what my experience was, yours will be different.

In terms of any fear of the unknown, only three things can hurt you when you assemble your own Macintosh: Lack of attention or carelessness (e.g., reversing the wiring of the power and ground connections); lack of proper grounding before handling certain sensitive components (e.g., shuffling across the rug and then installing your SIMMs before discharging yourself or using a static guard wrist strap); and lack of cleanliness (e.g., failure to clean up your metal or plastic filings from your work, work area or hands prior to handling electronic parts such as disk drives or floppy disks). If you pay attention to these three areas and take your time in assembly—go back over a step if you are not sure—you will have no problems.

Once you have Cat Mac working, you will swell up with a sense of accomplishment. “Hey, look at the computer I just built!” Onlookers will hold you in respect and awe and extend new deferential treatment to you. Heck, all you did

was drill a few holes and connect a few wires. (And you don't have to tell them that!)

After you get your Cat Mac working comes the best part. If you don't like the results you can change them. Modify the case, add a new disk drive, change the back mounting panel; you can innovate and experiment to your heart's delight.

Okay! Let's get to it. You are going to look over my shoulder and watch as I put together the Cat Mac SE shown in Fig. 11-3 step by step. After you observe my assembly process, you will have the understanding to go off and undertake an identical, simpler, more complex, or entirely different Cat Mac project of your own choice with a high probability of success.

Assembling the Cat Mac step by step

As with anything in life, it helps if you introduce just a little planning and organization first. This is by no means the only or even the best way to build your Cat Mac—you will discover that for yourself. Let's just say that it was adopted because as Fred Dryer says on the "Hunter" TV series, "It works for me." So the organization is:



11-3 The finished Cat Mac SE.

Before You Build

- Ordering the parts.
- Before you start.
- Tools you will need.
- Receiving your parts.

Assembly

- Making the logic board template.
- Making the rear cover plate template.
- Drill the chassis case.
- Drill the rear cover plate.
- Drill anything else you need to drill.
- Mount the power supply.
- Mount the logic board.
- Mount the accelerator and video cards/modules.
- Mount the hard disk.
- Mount the floppy disk.
- Mount the speaker and cable.
- Make the logic board power cable and connect it.
- Connect the other cables.
- Connect the case to the other parts.
- Power on (Phase 1 “Liftoff and Earth Orbit”).
- Connect your hard disk.
- Power on (Phase 2 “Moon Orbit and Landing”).

After You Build

- Finishing thoughts.
- New worlds to conquer.
- Troubleshooting.

Before you build

The big difference, to some it might even be a disadvantage, in building your own Cat Mac is that you can't just go out and buy one and bring it home with you today. You have to order the parts, wait for them to arrive, and then put them together. On the other hand, you can custom-design your Cat Mat, there are no friendly salesmen to put detours in your path, all you are working on is how to get exactly what you want at the best price. So you wind up with looking through catalogs and magazines and talking to vendors on the phone. It's a real learning and broadening experience and, for me, it was fun. You might enjoy it too.

The parts in my first Cat Mac SE are laid out for you in Fig. 11-4. It was built in the flip-top case shown in Fig. 11-2. However, I recommend you build one with the case shown in Fig. 11-3 because it is more compact, some would say more stylish, you don't have to cut out special bezels, and it comes with a larger power supply and quieter fan. You have ready made two 3¹/₂" and two 5¹/₄" drive slot bays which should accommodate just about any disk drive or backup option you



11-4 Here's all there was to my first Cat Mac SE.

want to add. The other low-profile PC case shown in Fig. 10-2 is also suitable if you are going to use only 3 $\frac{1}{2}$ " floppy and hard disk drives. On the downside, these cases have less vertical clearance inside, and you have to unscrew four screws to get inside, rather than the luxury of just flipping the lid up. The choice is always yours.

Ordering the parts

Here are the parts I used to build the Cat Mac SE shown in Fig. 11-3. For your Cat Mac project, feel free to substitute parts of your own choice.

- Apple Macintosh SE logic board with 1Mb RAM SIMMS, 256K ROM.
- Hard disk—Seagate ST 296N, 80Mb.
- Floppy drive—Cutting Edge Extended ADB.
- Mouse—A+ Optical Mouse ADB.
- Video adapter cable—Power R SE video adapter and cable.
- Video monitor—Princeton Max-15 multisync (comes with cables).
- PC case & power supply—AMTA MTA-304 Mini AT/XT Slim Case.
- Apple SE power cable—Part number 590-0392 (you only need one end).
- Mating PC power supply connectors—GC Electronics part number 41-246 or equivalent (specify locking polarizing, straight header, 6 position with 0.156" centers or just tell them what you need it for).

- SCSI ribbon cable—For a 5¹/₄" hard disk drive you need 15" to 18" of 50 conductor ribbon cable and two standard 50-pin IDC female ribbon connectors. If you are using a 3¹/₂" hard disk drive mounted in the near bay, an Apple SE internal SCSI cable (Part Number 590-0437) can be used.
- Floppy drive ribbon cable—You need 12" to 15" of 20 conductor ribbon cable and two standard 20-pin IDC female ribbon connectors. An Apple Mac II internal floppy cable (part number 590-0188) works just great.
- Rear cover panel—Aluminum sheet measuring 9¹/₂" by 3⁹/₁₆" for the "full" cover plate. (The "partial" cover plate measures 9¹/₂" by 2¹¹/₁₆" but its exact dimensions are determined by the standoffs you use.)
- Apple RFI shroud for logic board—Part number 805-5060. (Comes with logic board or make your own from foil. Not needed if rear panel covers opening completely.)
- Speaker—Do not use the 8 ohm speaker that comes standard with case hardware—you need 32 ohms or greater! I used a 4" 45 ohm model, but you can use any equivalent of Apple SE Speaker (part number 600-0393).
- Software—Apple System Software Kit (part number M0681/A). You will also need hard disk formatting software like Silver Lining from La Cie.
- Miscellaneous—Box of floppy disks, standoff spacers, mounting screws, wire, solder, etc. (Most PC cases come with all the mounting hardware you need. You might want to get some cable ties and heat shrink tubing to make your work neater.)

To make your life easier, use the checklist inside the front cover of the book.

Before you start

After ordering the parts, relax. Be patient. Everything will arrive. Read a book. Reread this book. Believe me, it's less frustrating than getting to a key step and finding out that the critical part you need hasn't arrived yet and you have wet, rapid setting glue on the two pieces that connect to it. Wait. OK?

Where are you going to build your Cat Mac? A well lighted 30" by 60" desktop or folding table works best because then you have plenty of room to spread out the parts. Pick your spot in a low traffic area with space around to accumulate the parts and boxes as they arrive. That way no one will be overly inclined to mess with your "stuff," and you will not accidentally misplace your hard disk in the kitchen cabinet drawer. Everyone has their own idea of how they like their workplace. One word says it all for me—*organized*—because then I can find things.

What about software? Other than the system software from Apple, for all other software decisions use the same criteria as if you were buying a brand new Macintosh from a retail store. No difference. If you already own a Macintosh, use it to prepare a "startup" disk as described in the "Power On" section (the last step in the assembly process). If you do not own a Macintosh, have a friend who

owns one or the store you purchased your Apple system software from prepare your “startup” floppy for you from the Apple system software you purchased.

Tools you will need

Two tool kits plus some extras cover the tools you will need. To assemble your Cat Mac you need the Curtis small tool kit, Mac Warehouse ACC 0304 or equivalent at \$19. You will also find the static grounding strap, case spreader, and torx driver in the Dove Mac tool kit, Mac Warehouse DRI 0040 or equivalent at \$15, will come in handy. A small soldering iron, Radio Shack 64-2051 or equivalent at \$7.50, will be needed to make the power cable. For the bezel, if you elect to go the make-your-own route, a fully equipped machine shop would be nice, but you can get by with an electric drill, a hacksaw, and some small metal files in assorted sizes.

To make the logic board and rear cover panel templates (and floppy cover bezel if your Cat Mac case requires it) you will need some cardboard, plain 20 lb. bond copier paper, rubber cement, razor knife, ruler, and straightedge.

Notice you do not need an oscilloscope, digital voltmeter, signal generator, digital logic probe, DC power supply, or other electronic test equipment. If your Cat Mac works, you will know it. If it doesn't, you will know that, too. In either event, no test equipment is required. Your eyes and ears will tell you the story, and if you work carefully, your nose won't even get involved—no smoking wires or components!

Receiving the parts

Check what you received against what you ordered. Occasionally, people do make errors. For your Cat Mac project, did you really order that PC compatible 10Mb full height hard disk you received yesterday? Check it out before you can no longer return it.

As you receive the parts, check to see that they are not damaged. Familiarize yourself with them, and read the instruction manuals. You might find something of vital importance for later on.

Also, keep all receipts in one place. If you find you need to return or replace a part later on, it makes it a lot easier. Most vendors require an RMA (Return Merchandise Authorization) number before they accept returned parts back and that step usually requires your original vendor paperwork for the invoice number, shipping date, etc.

Assembly

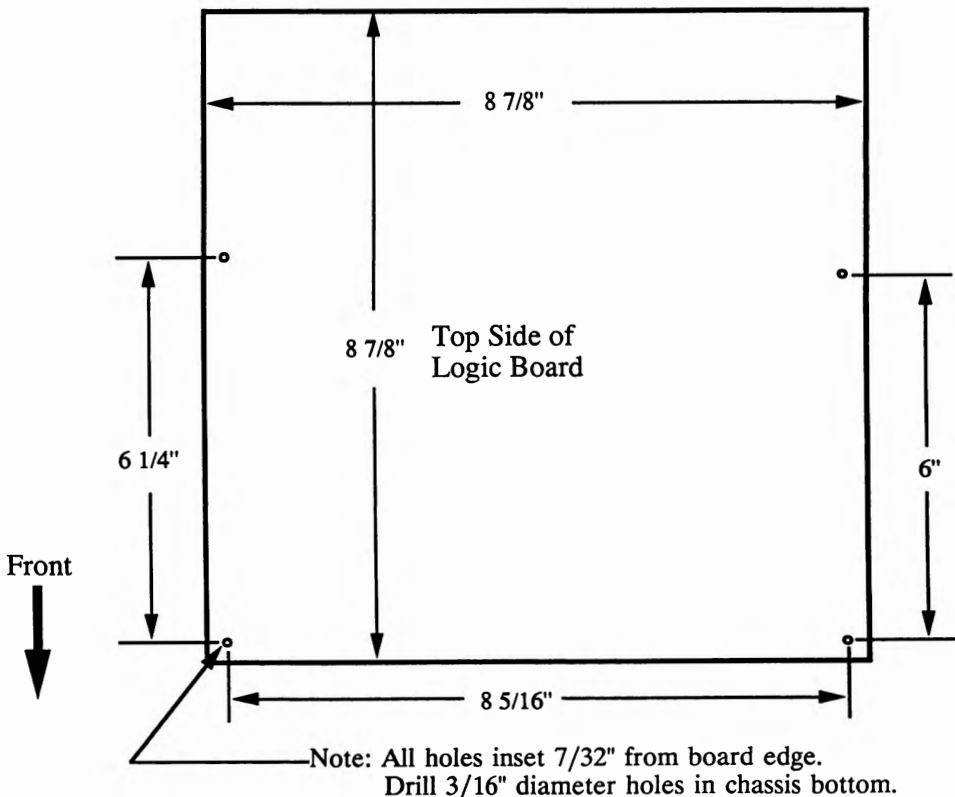
The assembly process breaks down into a few basic steps: preliminaries—making templates; drilling steps—the chassis, rear cover plate, and “anything else” you

need to drill; mounting steps—the power supply, logic board, accelerator or video cards, hard disk, floppy disk, and speaker; wiring steps—the logic power cable, everything else, and external chassis connections; “power on” steps—before and after the hard disk is connected; and the “finishing touches” step of tying down the wires inside the case and putting the cover on.

Making the logic board template

The most amazing ideas are sometimes the simplest as the saying goes. A plain piece of cardboard can save you loads of time when laying out your chassis and back panel drill holes. The reinforced kind you get from a shipping box works best. The kind you get back from the laundry with your shirts also does the trick.

To make your logic board template, first carefully take your logic board out of its anti-static shipping bag and lay it on your piece of cardboard. Then outline around it with a pencil and mark the location of the two middle and two front board edge holes (closest to the SIMMs) on your cardboard. If you want to bypass this step, just use the dimensions shown in Fig. 11-5 to make your cardboard logic board template. Mark the holes with crosshairs. You will use these to guide your

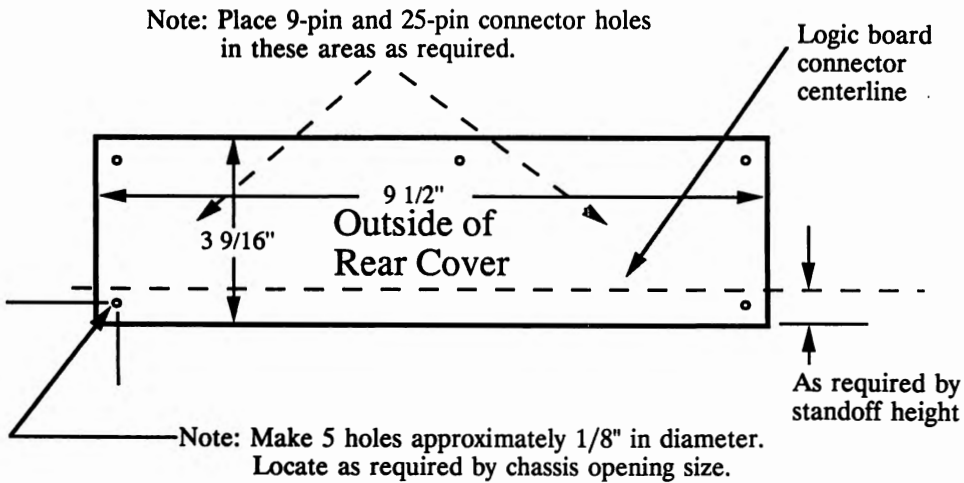


11-5 Logic board mounting template.

standard metal centerpunch later on. Cut your cardboard to the correct shape per your measurements or the template shown in Fig. 11-5.

To make your rear cover template, rough cut your cardboard to the approximate dimensions by laying the metal card guide you removed from the rear of the chassis over it and marking its overall dimensions as well as mounting hole locations. Figure 11-6 shows the dimensions for the back panel.

Important: If you are using the power R video adapter module in the AMTA MTA-304 chassis, the chassis stiffener bar that runs from the front to the back of the case will sit right over the top of your power connector unless you move your logic board from a position that would “center” it behind the back panel opening to a new position $\frac{3}{8}$ " to $\frac{1}{2}$ " closer to the side of the case. Looking at the rear panel from the outside of the case, the SE logic board “sound-out” or speaker jack on the far right of the logic board is now almost next to the edge of the right-hand side of the rear case opening. This affects both where you place your logic template to drill your holes in the case and where your logic board holes are located on the back panel.

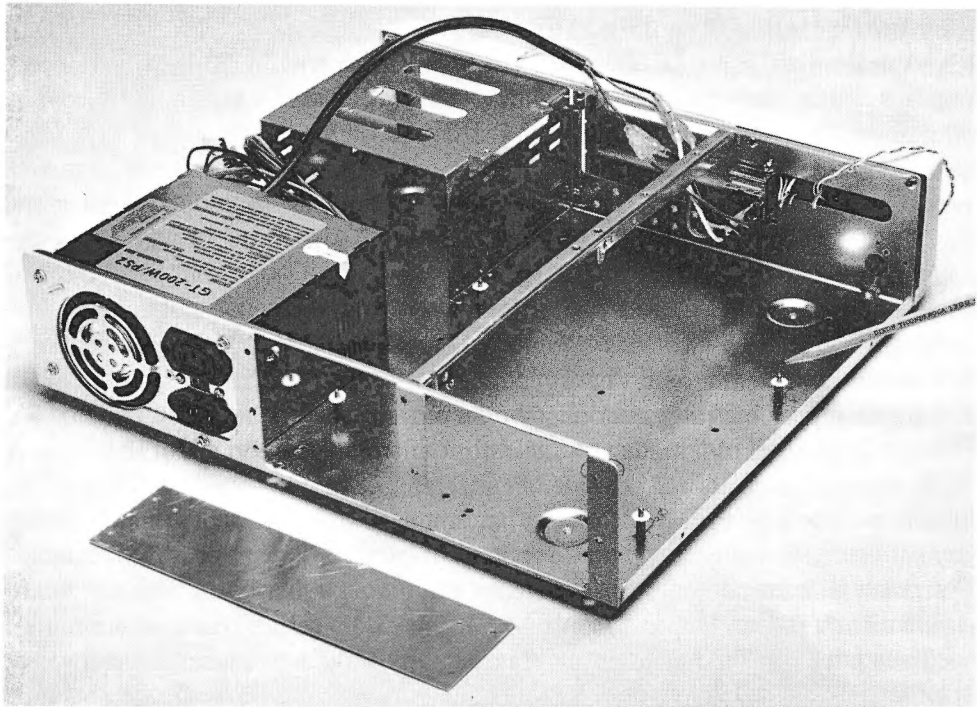


11-6 Rear cover plate template.

In a pinch, I was able to get around this in the photo session by bending the bar slightly, but to do the job right, you just need to shift the location where you mount the logic board and change the placement of your logic board connector holes in the back panel. Other alternatives are bending the bar slightly as I did and drilling a new hole for it in the rear of the case or having your local sheet metal house fix you up a small angle iron extension with a small U in it to go around the connector that you bolt on to the sawed off original bar. Neither of these alternatives is as desirable.

The width of the rear cover plate is fixed. It must cover the opening and mate with the location of the mounting holes. But you can either elect to *partial* or *full*

cover the opening down to the connectors. Either way, the location of the connector holes or the vertical dimension of the cover plate will be determined by the height of the standoff mounts you use. Regardless of the standoff type you select, be sure to allow at least $\frac{1}{4}$ " clearance between the highest object protruding from the bottom of the board and the chassis. I prefer the plastic or metal standoff with screw threads shown in Fig. 11-7 because they are easier to work with. The "clip type" plastic standoffs that come in your chassis mounting kit permit faster initial mounting, but you pay for it later on if you ever want to remove your logic board.



11-7 Cat Mac chassis with "partial" rear cover plate. The pencil points to metal standoff with plastic insulating washer.

For the MTA-304 Mini AT/XT Slim Case used in Fig. 11-3, the $\frac{3}{8}$ " plastic standoffs give the partial cover plate a $2\frac{11}{16}$ " vertical dimension. The *full* cover plate has a vertical dimension of $3\frac{9}{16}$ " and the $\frac{3}{8}$ " standoffs put the logic board connector mounting bolt centerlines $\frac{5}{8}$ " from the bottom edge. In either case, a $9\frac{1}{2}$ " width leaves enough room to drill the side mounting holes. For your own template, measure the standoff, case, and logic board to be sure of the dimensions.

Put at least one additional hole for the video connector in either style cover plate. A rectangular opening $1\frac{3}{16}$ " \times $\frac{7}{16}$ " with $\frac{1}{8}$ " holes 1" apart centered on the axis of the larger opening accommodates the 9-pin submin D video connector nicely. If you are using a 128/512 or Plus logic board and want to also add a SCSI connector, a rectangular opening $1\frac{21}{32}$ " \times $\frac{7}{16}$ " with $\frac{1}{8}$ " holes $1\frac{27}{32}$ " apart

centered on the axis of the larger opening accommodates the 25-pin submini D SCSI connector. For these logic boards, you might also want to add a small rectangular opening to mount the RJ-11 plug for the keyboard connector. I preferred horizontal placement of the opening(s) and located high enough away from the logic board so it did not interfere with plugging in cables to the board; i.e., I did not put the video connector so close to the floppy drive connector that I had to remove the video connector from the panel every time I wanted to unplug the floppy cable from the logic board!

Making the rear cover plate template

Like the example of the cardboard, a simple piece of plain 20 lb. bond copier paper, a copier machine, and some rubber cement can save you a lot of time when you do your rear cover plate and floppy disk bezel.

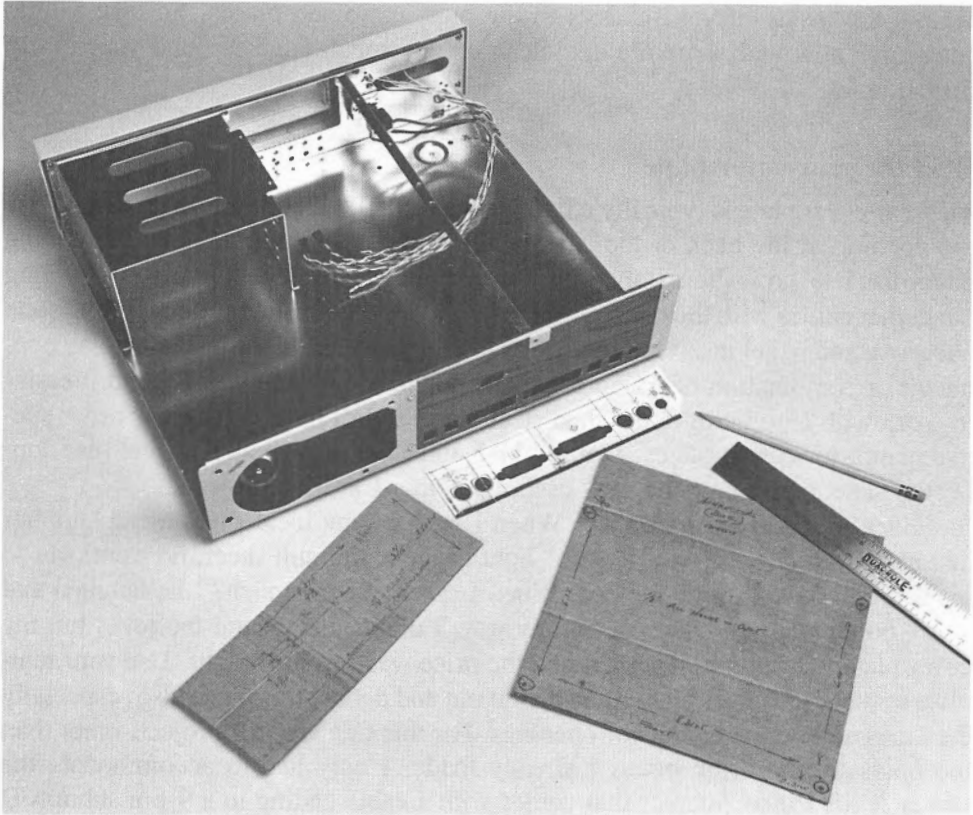
Want to know the exact dimensions of the holes you should make in your back panel? Put an Apple Mac SE case back flat on the glass of a copy machine and push the copy button. Or trace outline it in pencil if you don't have access to a copier. You get an exact template for the holes you need to cut. For the full enclosed option you can either use the neat holes from the paper template or plain rectangular ones. The important thing is that your holes give enough clearance around the connectors to permit the mating connectors can fit snugly to them.

Rectangular holes for the connector openings will work perfectly fine and are easier to make except for the sound-out jack, which is simply a round hole. I made outline boxes around the openings with a pencil and transferred these outlines to the back panel. Mount your paper template on the back panel with rubber cement using the connector mounting centerline to assist your vertical placement. The result is an instant cutting guide template! Figure 11-8 shows both cardboard templates, the "copy paper" Apple SE case back template, some of the tools I used, and the finished rear cover plate already bolted in place in the chassis opening.

If you are using another case style with only 5¹/₄" openings and need to make a floppy disk bezel template, paper and rubber cement can also save you. Draw a 1" × 4" rectangle on the paper and use the rubber cement to attach it to the blank panel plastic bezel that came with your PC case. Measure your floppy drive placement in the opening to make sure you have exact vertical and horizontal location for the paper rectangle on the plastic bezel.

Drill the chassis case

Now that you have made the templates, you're ready for the first real step in putting your Cat Mac together. Locate your logic board inside your Cat Mac chassis so that its connectors to the outside world on the rear edge of the card barely protrude from out of the back of the chassis, just like on a real Macintosh. Your cardboard logic board template does all the work for you if you just bring its rear edge in contact with the inside of the rear of the case.



11-8 Cat Mac chassis with finished rear cover plate attached. Notice templates and tools in the foreground.

As described earlier, if you are using the Power R video module, offset your template at least $\frac{3}{8}$ " to $\frac{1}{2}$ " toward the side of the case (i.e., move it away from the power supply location) to a position which would "center" it behind the chassis rear opening. Mark the chassis for the logic board mounting holes using a center punch, nail set, or metal scribe. Although my plastic standoffs used 4-40 bolts, I drilled oversized $\frac{3}{16}$ " holes in the chassis to compensate for any alignment/tolerance errors in my layout.

The MT-304 chassis and most others come predrilled with many holes, but if you are adding a speaker or other options, such as a battery holder, etc., in a special location for which it is necessary to drill holes in the chassis, now is the time to also drill these. **Warning:** *Do not drill any holes in the case with the logic board anywhere near it.* If the power supply comes already mounted in your chassis you need to also remove it before drilling the case. Put the logic board in its own foil wrapper or carrying holder, set the power supply aside, and then have a good time with your drill.

After you drill your holes, be sure there are no burrs or rough edges. These can create metal shavings or particles later on which might wind up floating

around the inside of your chassis in the most unwanted places. So take a little extra time now with your file and clean up any rough edges around your newly drilled holes.

Drill the rear cover plate

The rear cover plate is typically a light gauge (0.050") aluminum sheet that covers the opening in the back of the chassis where the rear connector plate mounting panel used to go. Alternately, you can use the steel connector plate mounting panel that comes with the chassis. The plus side is the finished product looks quite attractive and panel insert cutouts are available ready made for just about any connector or combination of connectors. The down side for me was I found it easier to work with aluminum rather than steel, and I didn't have to make or order special connector cutout plates. Figures 11-5 and 11-6 show how the steel rear connector plate mounting panel was used in another Cat Mac project.

Back to the aluminum plate. When I went by my local sheet metal supplier and asked him for a $3\frac{9}{16}$ " \times $9\frac{1}{2}$ " light gauge aluminum sheet, he went over to his scrap bin and cut me a piece. When I asked, "How much?" he laughed and said "no charge" and sent me on my way. I didn't understand the joke, but my cover plate fits fine, works great and the price was certainly right. Use your template to mark the cover plate, then drill it out and deburr this piece also, especially the areas around the connector openings. For this Cat Mac SE project, other than the holes for the logic board I already made, I only had to accommodate the Power R SE Video Adapter that comes with a cable ending in a 9-pin submin D connector and my work was completed. I mounted it on the left side of the panel leaving room on the right side of the panel for other items later if I need to expand. Figure 11-8 shows the finished panel already bolted in place using 4-40 bolts and nuts.

If neatness or resalability (if you want to sell your Cat Mac someday) is not important to you, there is no need to cut the slots in the rear cover plate at all. Merely connect the monitor signal cable to the Power R connector module and tie down or otherwise provide some sort of strain relief for this cable inside the case. Feel free to carve up your chassis cover plate to your heart's delight to accommodate the wires coming out. Just remember to stuff some foil in the openings to minimize interference with your neighbor's cable channels.

Drill anything else you need to drill

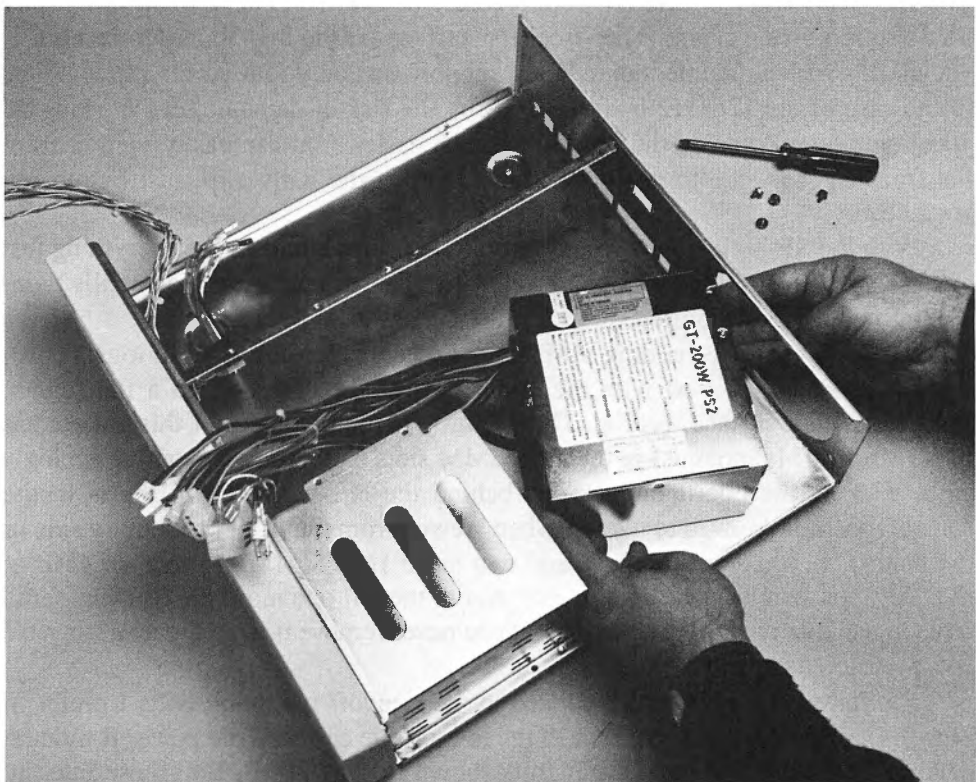
If you are mounting speakers, battery holders, reset switches, keyboard connectors, disk drive mounting brackets, special cutouts for keyboard or mouse connectors, or anything that doesn't come already fabricated and predrilled with your chassis kit mounting hardware, now is the time to drill, cut, bend, deburr, make sure everything fits right, and clean up as done in the previous drilling steps

before going into the electrical phase. *Resist the temptation: Do all metal work before you add electronics.* Actually I had a much simpler method. I just thought of the money my SE logic board had set me back, then laid out and worked with all the pieces I needed to mount before I took the logic board out of its shipping pouch. “Works for me,” as the man says.

Mount the power supply

Some writers have advised to lay out your parts and apply power outside the chassis first. Although this step is fun and will certainly amaze your friends, it’s actually kind of dangerous because you end up handling your logic board quite a bit in the process; mount your logic board safely in your chassis before applying power to it. Take another look at Fig. 11-4, which shows all the parts laid out for my first Cat Mac SE, to relieve your curiosity and bypass this step.

The power supply is big, bulky, and heavy compared to all the other electronics; you do not want it sliding around and bumping into the delicate electronics. That is why I recommend you always install your power supply first—unless you need extra room to make installing your logic board easier. If it came already



11-9 Moving the power supply into place.

mounted in your chassis, you had to remove it before drilling the case. Now is the time for you to put it back.

Some chassis designs, this one included, skimp in certain areas and attach their power supply with screw tips that protrude outside the case. So you don't mar your family heirloom mahogany writing desktop later, take the time now to fasten the power supply in place from the outside of the chassis with less dangerous round head bolts. After bolting your power supply in place, you are ready for the next step. Figure 11-9 shows the power supply, with its maze of wires protruding, being moved into place.

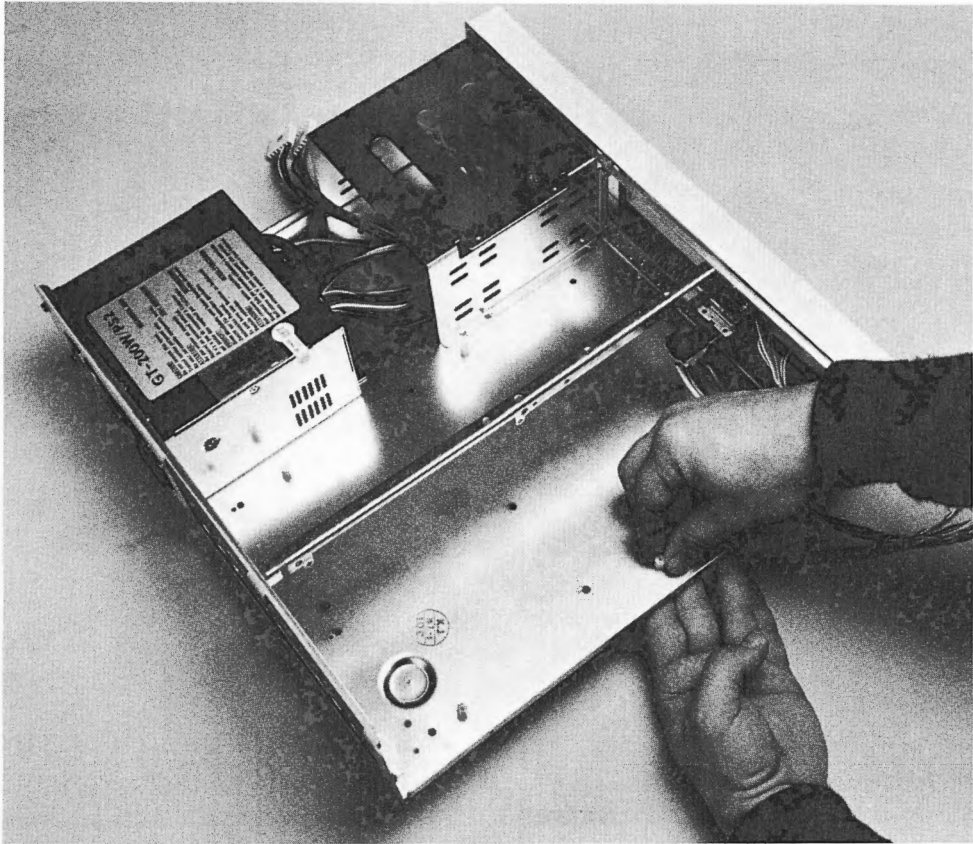
Mount the logic board

Your logic board is the platform for everything else you will be mounting in your case. That is why it usually gets installed right after the power supply. However, if you are attaching anything else (i.e., memory, memory upgrades, accelerator cards, video adapters, etc.) to the 68000 processor chip or 5380 SCSI chip using a Killy clip, this must be done before you mount the logic board in the case. The MacSnap series of memory upgrades from Dove would be another good example. The Killy clip and MacSnap require pressure be applied to snap them into place. To do so requires a clean, static-free, flat surface for the logic board to rest on. If you do this with a mounted logic board supported at only four points (three points in the case of the 128/512 boards), you run the risk of damaging it. Working on your logic board outside the case is so much easier. You can easily view it from the front and the side to position it for mounting the Killy clip, just by moving your head.

With the SE logic board, you don't have any problem because everything just smoothly attaches to the 96-pin connector with no extra pressure (potentially damaging to the board) required.

Even if you are just adding SIMM memory chips to your Mac SE logic board, this is initially done best with the board outside the case and on a flat, clean, static-free work surface. As Fig. 11-11 shows, the logic board for this project has two 1Mb SIMMs mounted in the two SIMM slots closest to the front of the logic card. The on the board jumper just behind the left bank of SIMMs is in the "2/4Mb" position (moved to the left when viewed from the front or memory side of the board). If you were going to add two more 1Mb SIMMS, a total of 4Mb of memory, you would move this jumper over to the left one more pin (the jumper is now on just one pin), but I recommend you never remove it from the board in case you want to change something later on.

You have already been introduced to the standoff mounting bolts I prefer in Fig. 11-7. In this project, because of the low-profile case and the Power R module height, I used the 3/8" plastic standoffs shown in Fig. 11-10. Bolt these into the chassis initially only finger tight, then put the SE logic board in place over them and finish up with another insulating washer and bolt. Figure 11-11 shows the



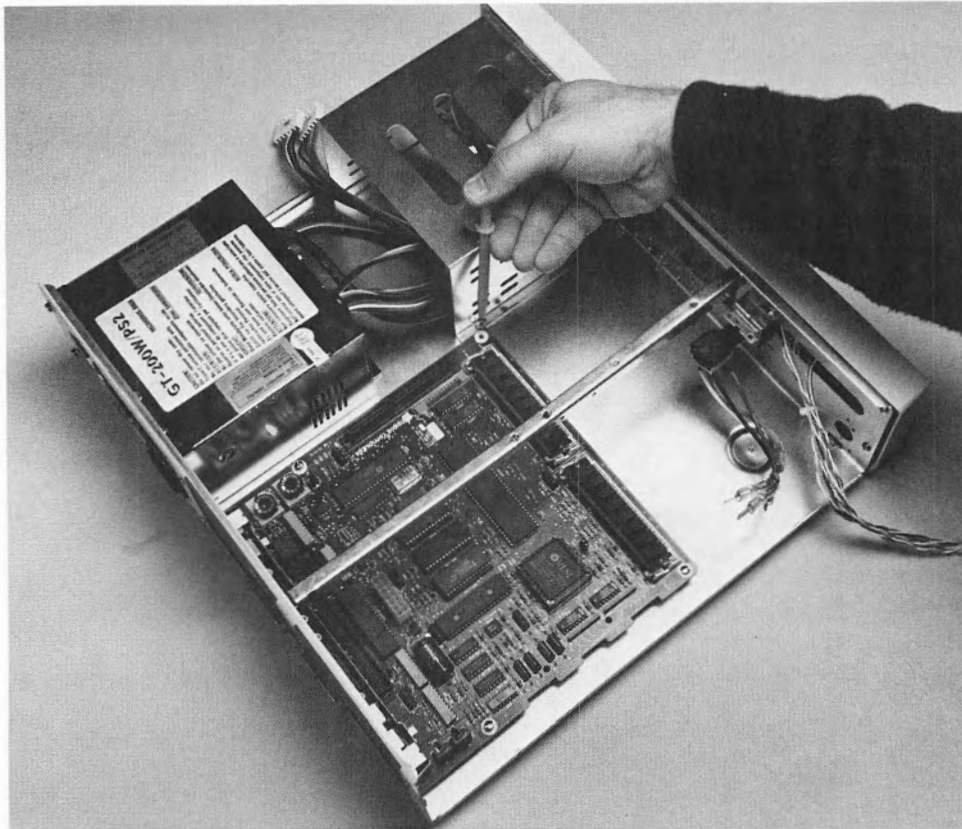
11-10 Installing the plastic standoffs.

logic board installation process with a handy extractor tool being used to maneuver one of the logic board bolts into place. Don't overtighten the bolt—just a little more than finger tight to hold the logic board in place. As mentioned in the drilling the chassis case step, the oversize $\frac{3}{16}$ " holes in the chassis gives you a little room for moving the 4-40 standoff bolts around and makes the logic board mounting process easier.

Many types of alternate standoffs can be used. A simple and effective solution if you cannot find my recommended type is to just use a plain bolt of the proper length covered with a piece of neoprene tubing *sleeve* around the bolt, long enough to leave no more than about $\frac{1}{8}$ " of thread exposed above the top of the logic board.

To summarize, use whatever standoffs you want, tie down whatever standoff arrangement you are using with plastic insulating washers on both sides of the logic board, and don't overtighten the nuts. And never use lockwashers!

In the wiring steps coming up next, be careful to keep all other boards, disk drives, cables, and wires in the case away from the SIMMs module area in the front of the logic board. During construction, you might even consider covering



11-11 Bolting down the logic board. Extractor tool helps to get bolt started in a tight place.

this area temporarily with an anti-static plastic sheet just to keep your fingers out of harms way while routing other wires, etc. My first Cat Mac in the flip-flop PC/XT case allowed the Seagate hard disk to almost rest on the DIP SIMMs when it was installed in the lower inside bay. I had to use a piece of plastic just for sanity in that instance.

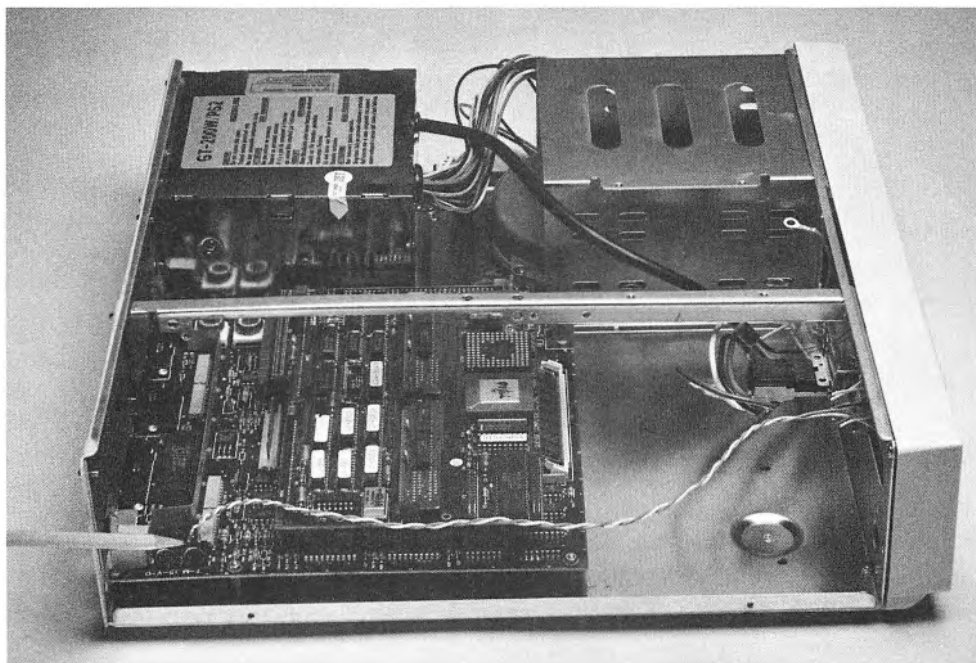
A brief but important note here: If something looks too close, do something about it now, not later. Resist the temptation to say, “Don’t bother, let’s move ahead.” Plan to be safe, not sorry. Otherwise, when you least expect it, you’ll move your working Cat Mac and the case flexes just enough to short the drive into the logic board or video card or something else. Trust me, do it right now or you leave the door wide open for Murphy’s Law to strike you down later.

Mount the accelerator and video cards modules

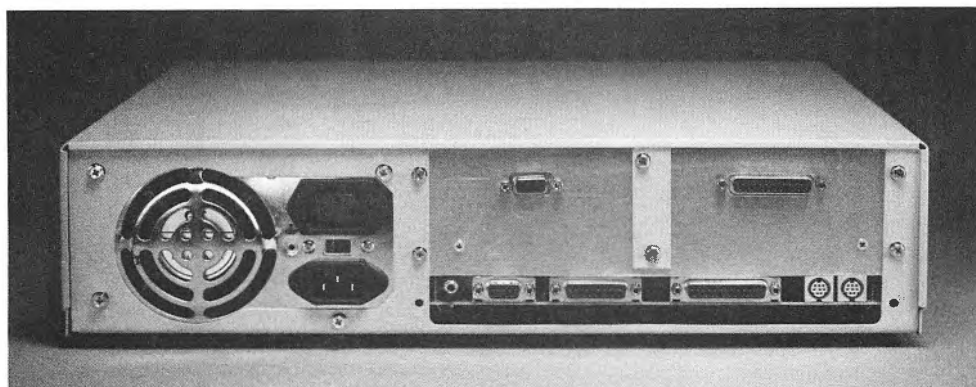
You add these cards next because they sit on top of your Cat Mac SE logic board and plug it into its 96-pin connector. This allows you to route any video/accelerator cables without extra cables in the way and also determine cable clearances for

your disk cables. This Cat Mac SE project has no extra boards, so this step is easy!

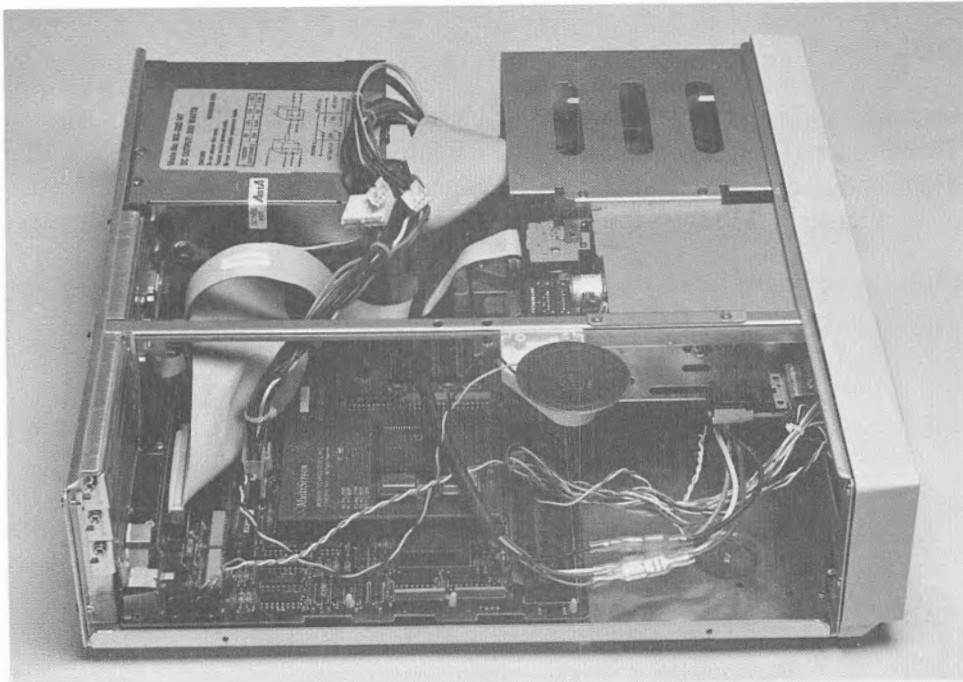
Here are a few examples of other projects that did require extra work due to the additional cables and/or special connectors involved. Figure 11-12 shows a Total Systems Gemini accelerator board mounted on a Plus logic board. The Total Systems board needed an additional SCSI connector slot cut into the back cover plate. Figure 11-13 shows the completed partial back cover plate for this project.



11-12 Total Systems Gemini accelerator board mounted on a Cat Mac Plus logic board.

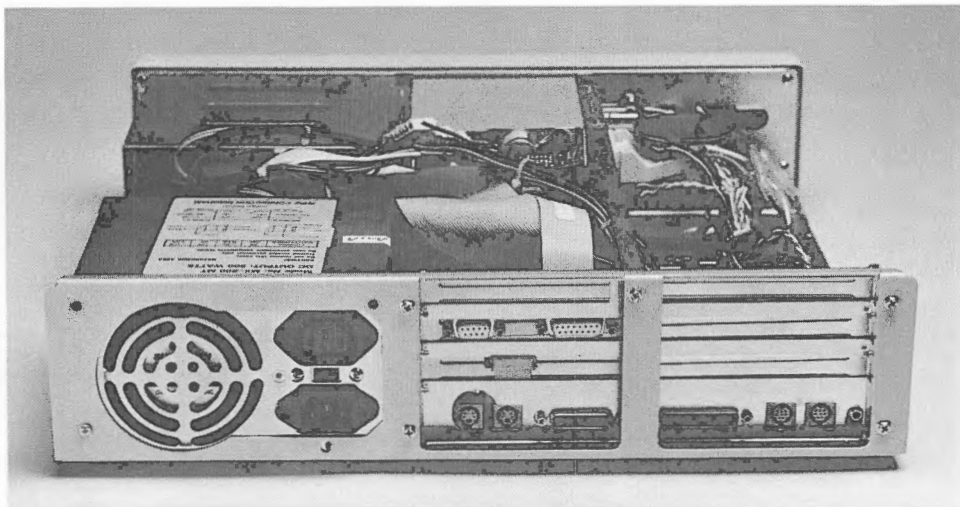


11-13 Finished partial rear cover plate for Cat Mac Plus. Video connector at top left and SCSI connector at top right.



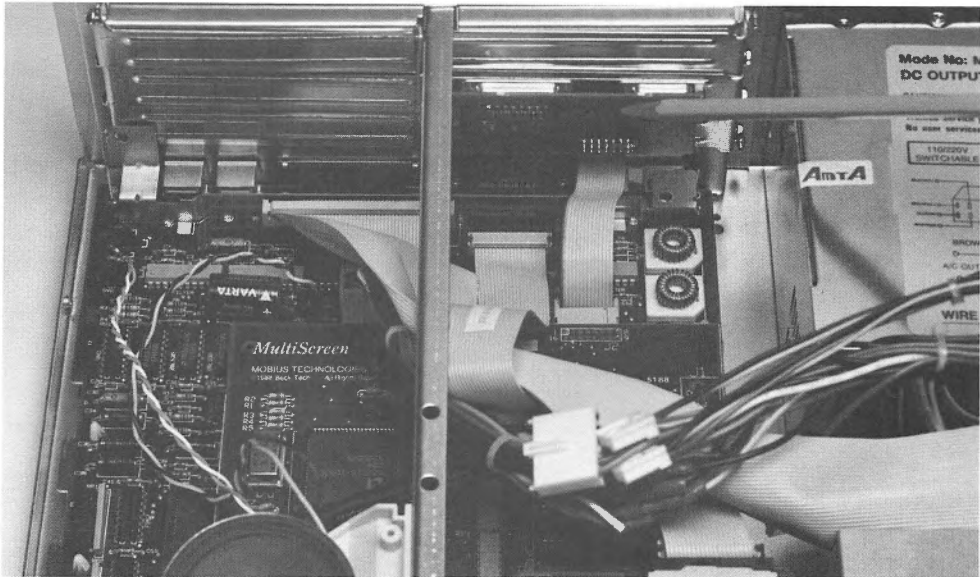
11-14 Another Cat Mac project with Mobius card mounted on a SE logic board.

Figure 11-14 shows a Mobius video card mounted on an SE logic board using the original steel connector plate back. The Mobius card required special slots for the small PC board with 9-pin and 15-pin submin D connectors to be mounted on the rear cover plate. This was a lot of extra work which the outside view of Fig. 11-15



11-15 Rear view of Cat Mac SE finished with original steel rear cover plate and Mobius video connectors in place.

and inside view of Fig. 11-16 does not show. No external drives were ever going to be used for this project, otherwise the metal reinforcing plate down the middle of the connector opening would have to be removed so you could access the logic board connectors.



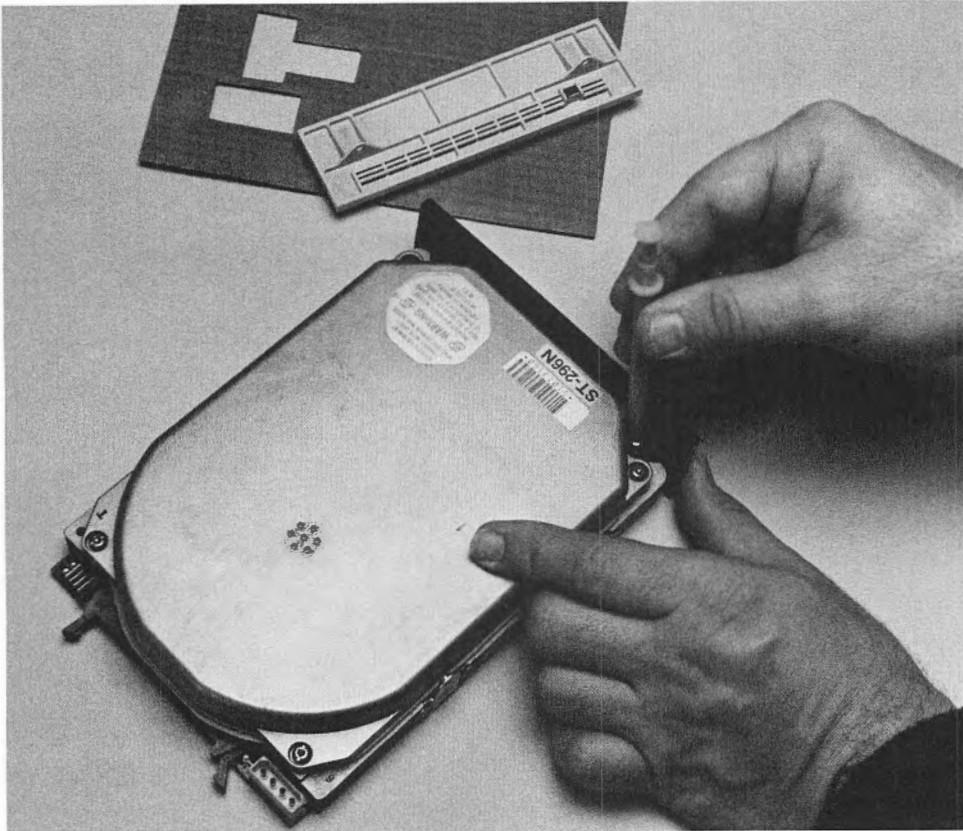
11-16 Inside view of Cat Mac SE finished with original steel rear cover plate. The pencil points to Mobius video connectors.

I used the Power R video module, discussed earlier, which just snaps into place in the logic power plug socket. You see it installed in Fig. 11-18. If you followed the earlier instructions, the top of it should rest just next to the chassis stiffener bar. Bend the cables over at a 90 degree angle and route them under the stiffener bar to make it easier and to close the case later. It is a very tight fit!

Mount the hard disk

Trial fit your hard disk drive into the chassis at this point to see what you are up against. This chassis can accommodate either 3¹/₂" or 5¹/₄" drives easily. In addition, I have the option of adding backup drives later on: another half height disk drive, CD ROM, tape/hard disk backup, or extra floppy drive.

The floppy bracket next to the hard drive bay obstructs access to its mounting screws so the 5¹/₄" hard disk definitely has to be installed first. I used a Seagate 80Mb 5¹/₄" drive which fit the opening perfectly. I replaced its normal black half-height front bezel with a gray front bezel which matches the chassis color scheme quite closely as shown in Fig. 11-17. Only two screws hold it in place and, once again, the "extractor" tool came in handy. The cardboard that ships with the drive shown in Fig. 11-17 should be kept with the drive whenever you handle it because it protects the exposed embedded SCSI controller on the bottom of the drive case.



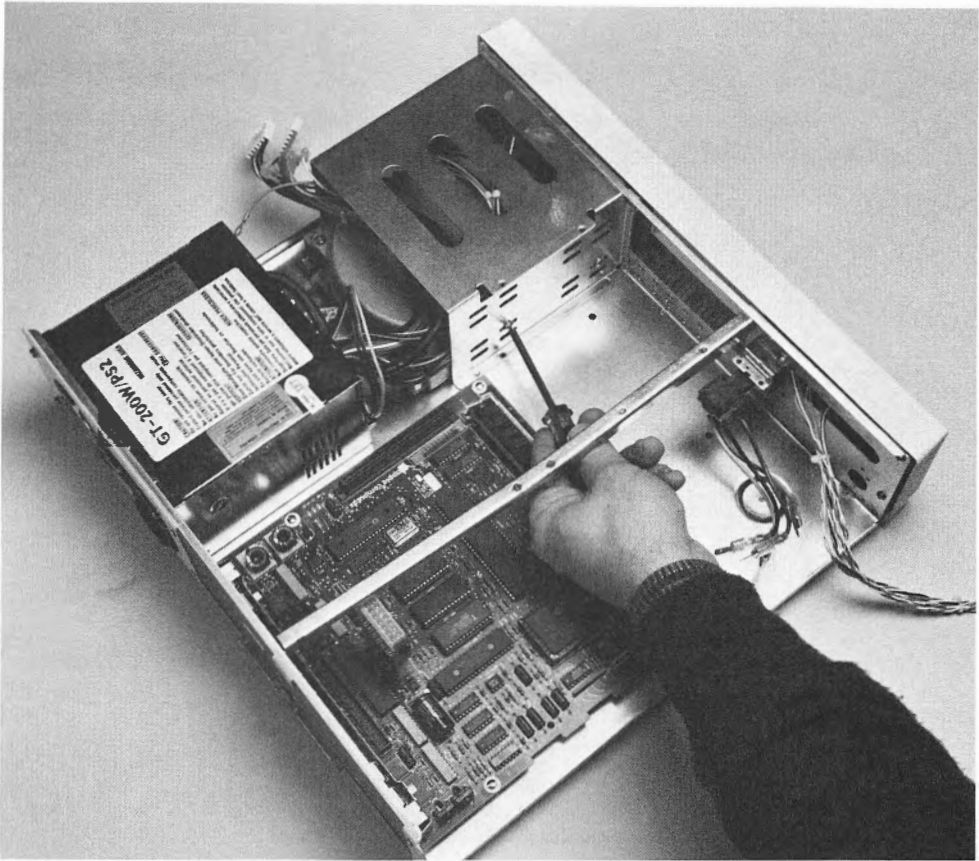
11-17 Changing the Seagate hard disk bezel. Again the extractor tool comes in handy.

If everything clears okay, bolt the hard disk into the location you have chosen for it in the chassis, making sure that you have room to get at its power, SCSI, and SCSI ID connectors later on. For this project, it was mounted in the lower 5¹/₄" drive bay as shown in Fig. 11-18. Do not attach any cables to it yet.

Mount the floppy disk

If this project had used the PC/XT flip-top case shown in Fig. 11-2, you would have to mount your 3¹/₂" floppy disk drive in a 5¹/₄" chassis opening and, additionally cut a bezel opening for the floppy. A mounting bracket such as the Toshiba 3¹/₂" Universal Floppy Disk Mounting Kit, Part No. ND 352/356KU, or Citizen's OSDA 3¹/₂" mounting kit for their 1.44Mb IBM PC floppy each at about \$15 or so makes quick work of the mounting, but you are strictly on your own as far as the bezel is concerned.

Using the MTA-304 case bypasses both steps. The 3¹/₂" floppy disk mounts in its own bracket next to the hard drive bay and its own bezel protrudes through the case front with nothing extra to add. To mount your floppy disk, first remove it from the external mounting case it came in. Set aside the case, cable and external

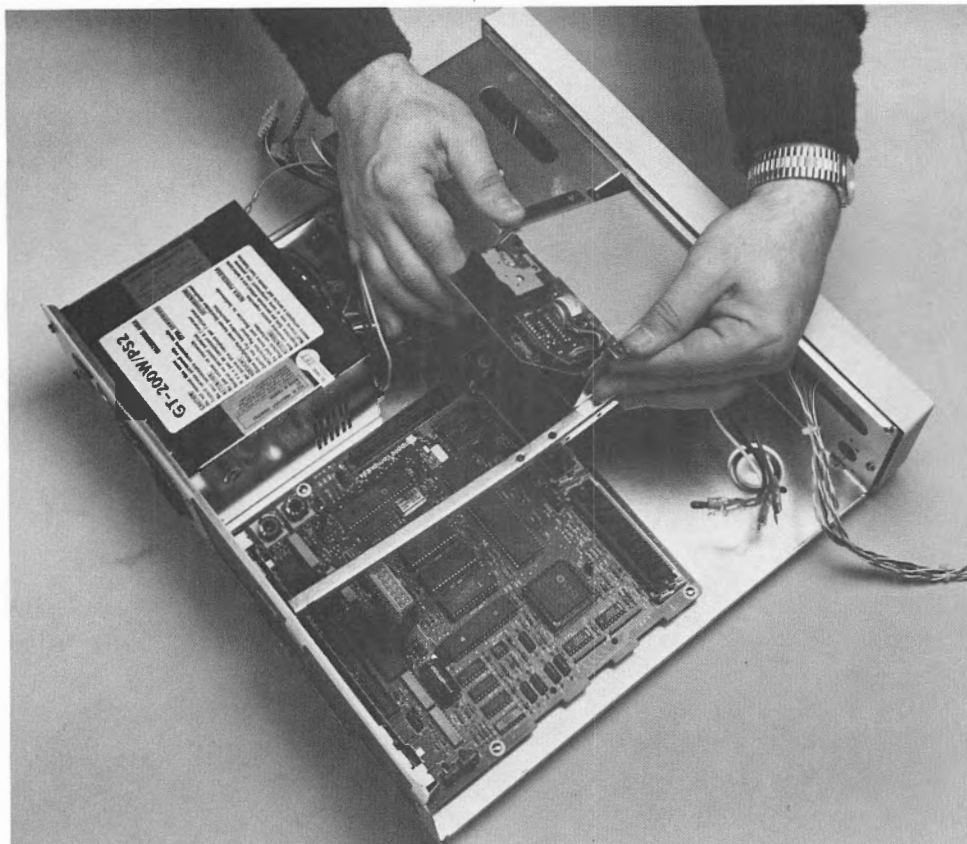


11-18 Bolting the Seagate hard disk into the 5 $\frac{1}{4}$ " lower drive bay.

case screws for later use, but use the mounting bolts and washers that held the floppy in the external case for this project. Test fit your floppy into the case first until you get the disk to set in the chassis the way you want it and hold it in place by tightening one bolt on the bracket. Then remove the bracket, add and tighten the other three bolts and reinstall the bracket in the case. You will have to angle the drive down into the opening at a 45 degree angle to get the bracket in place as shown in Fig. 11-19. When in place, the bracket holes align with the chassis mounting holes. Use four flathead bolts to hold it in place; these allow the case top to fit flush with the internal chassis frame parts. The green chassis ground wire from the power supply fits under the front flathead screw closest to the chassis front as shown in Fig. 11-21. Do not attach the ribbon cable to the floppy yet.

Mount the speaker and cable

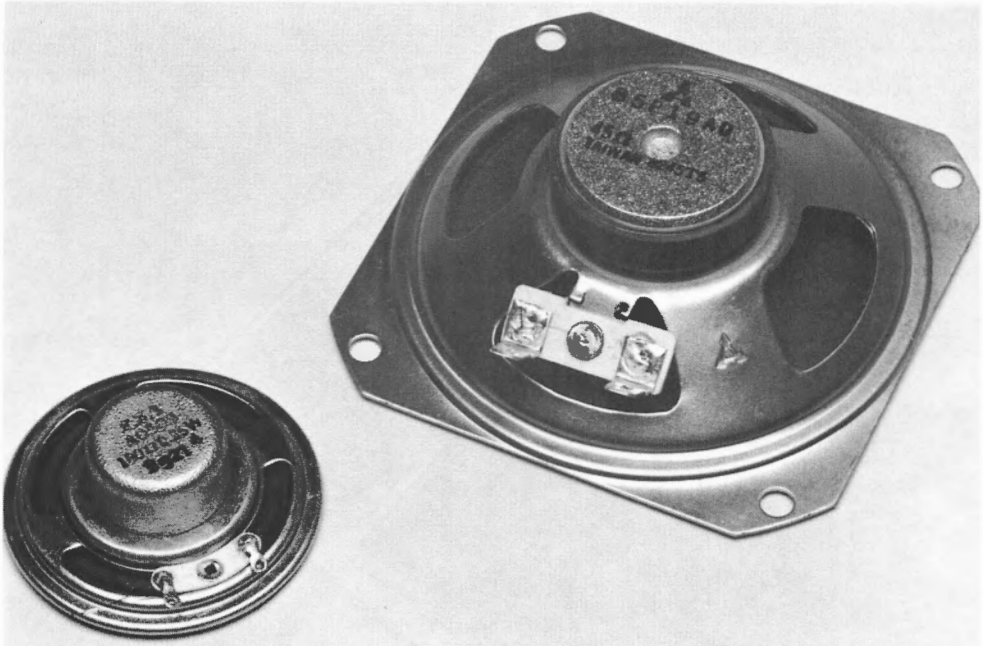
An 8 ohm speaker comes standard with your PC case mounting hardware. Don't use it! You need to get a 32 ohm or higher impedance speaker of the type Apple uses in its Macintosh SE. No kidding, you do. Otherwise, you risk ruining a per-



11-19 Installing the floppy disk in its mounting bracket in the chassis.

fectly good logic board that you paid big bucks for. For a better sound, you can get a larger speaker, but make sure it's a 32 ohm or higher impedance version. I used the larger of the two speakers shown in Fig. 11-20, the 4" diameter, 45 ohm version that produces a good sound. The other speaker, a smaller 100 ohm unit, will also work. Both are available from local electronics parts houses for a few dollars each. Apple also offers a selection of speakers to choose from. All the Macintosh speakers are 32 ohms or greater impedance, so take your pick from a used Apple parts dealer.

The speaker was the only other area of the Cat Mac project that required soldering—two minutes worth. Depending on which one of the chassis LEDs you use, if any, you will usually have an extra twisted pair cable ending in a 2-pin connector. This is excellent for wiring your speaker. Clip it off near the switch, solder the clipped end to the speaker terminals, and plug the connector end into Mac SE logic board speaker connector pins. As shown in Fig. 11-21, the speaker is attached to the chassis via a single bolt and held in place via two washers and a



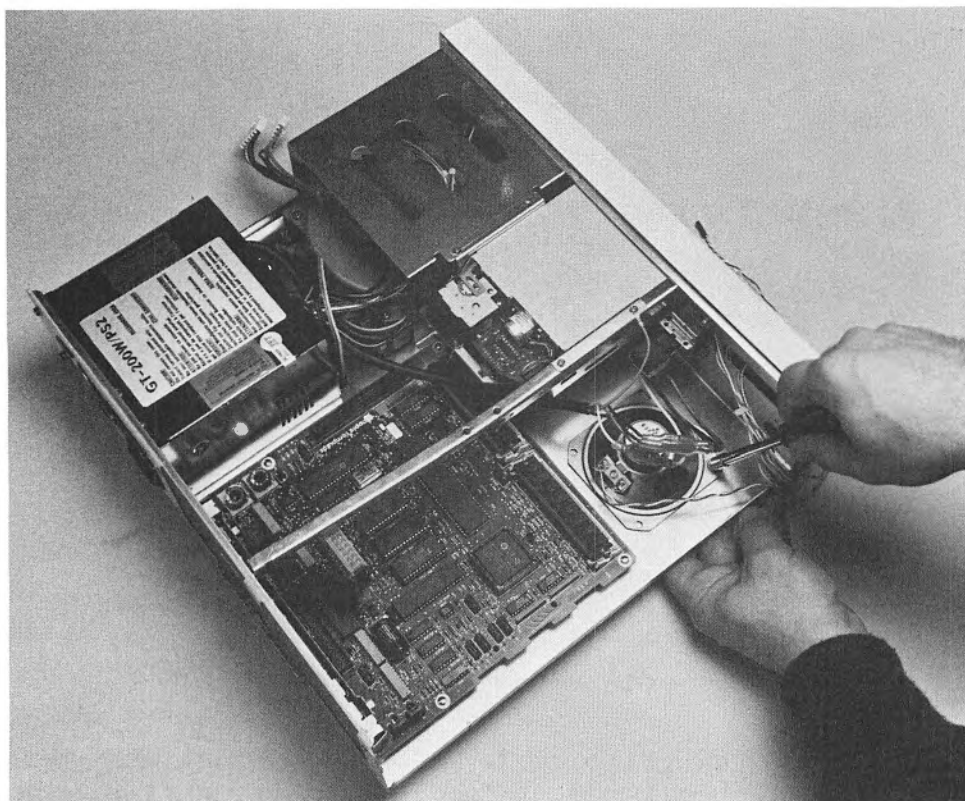
11-20 Two Cat Mac SE speaker candidates: the smaller 100 ohm unit at left, the larger 45 ohm, 4" unit at right.

nut. The bolt passes through an existing hole in the case. Then add a thick washer, add the speaker using the mounting hole in its frame, another washer and then the nut. Tighten it up very tight. During the installation process be sure to keep the speaker away from the case so you do not accidentally magnetize it with the speaker's voice coil magnet.

You can forget about the speaker entirely if you just plug your earphones or amplifier into the external sound jack on the logic board, or if you fall into the class of users who disable their own standard Apple Macintosh speakers with a dummy audio plug or simply work all the time with the volume on the control panel turned completely off.

After installing the speaker, wire the power supply on/off switch to the thick power cable coming out of the power supply. All the wires are color coded and end in spade lugs so there is little room for error. Either the color codes are identical or you will receive a card with your chassis showing you how to hook up the on/off switch wires or a decal on the power supply itself will tell you the connection scheme. With the MTA-304 chassis it was simple: blue to blue, white to white, brown to brown, and black to black.

Any other hardware to be mounted (i.e., the battery case if you were building a 128/512 or Plus version, or special custom video cards) should be mounted now before the wiring phase.



11-21 Installing the speaker. One bolt holds it in place. Notice chassis ground wire attached to floppy drive bracket.

Make the logic board power cable and connect it

Figure 10-8 in Chapter 10 shows you the power cable for this project and Fig. 10-7 shows the connection details. Now I will show you how to make it. It represents the only other time in building your Cat Mac you will have to go near a soldering iron. From a standing start, it should take you or anyone in your family 10 years of age or older less than 30 minutes to make. It can even take less time and be done without soldering if you use crimping style connectors or merely cut the connector ends off the power supply cables entirely and use twist ties. I opted for the direct route, left my power supply wires intact, and invested the minimal effort to make the cable with my soldering iron.

I started with a standard Apple SE power cable and cut it in half, saving the other end for another project. You can just get the connector and wire to it and save yourself a few dollars but it might take a little more of your time. Another benefit of the Apple cable was the wires were color coded to minimize my chance of error. There are 14 wires coming from the connector. You are going to set aside five of them (video, horizontal, vertical, and two grounds) in a bundle—unless you are building a custom video card—and work with just the other nine wires.

Table 11-1 Cat Mac SE logic board to power switch connectors.

SE Molex Pin #	Signal	SE Molex Cable	PS Cable (Connector #)
1	-12V	green	white, pin #4, P8
2	-5V	blue	yellow, pin #3, P9
3	ground	black	black, pin #6, P8
4	ground	black	black, pin #5, P8
5	ground	black	black, pin #2, P9
6	ground	black	black, pin #1, P9
7	ground	black	to video card
8	ground	black	to video card
9	horizontal	white	to video card
10	video	purple	to video card
11	vertical	gray	to video card
12	+5V	orange	red, pin #6, P9
13	+5V	orange	red, pin #5, P9
14	+12V	yellow	blue, pin #3, P8

Using Figs. 10-7 and 10-8 in Chapter 10 and Table 11-1 as your guides, separate the five wires that go to one connector from the four that go to the other. I found that putting a piece of masking tape on each connector with its mating power supply connector label P8 or P9 was helpful to get things started.

After separating the nine wires, go to the two connectors, cut yourself nine 1/2" lengths of 1/8" shrink wrap tubing (in the color of your choice!), and place them on the wires, sliding them out of the way down toward the connector before beginning the soldering step. On each connector, start at one end and trim about 1/8" of insulation off the wire that goes to the exposed pin. Temporarily hold it in place with a pair of pliers, solder it, and move on to the next pin over. Repeat the process for the rest of the pins until all wires are soldered to both connectors.

After you are done with the soldering step, slide the heat shrink tubing pieces down and cover your solder connections. Now take your almost completed cable assembly to the kitchen and hold your heat shrink tubing over your hot air electric popcorn popper, turning it so that the tubing shrinks evenly around the connection. If you don't have the hot air popper, a hair dryer, range top burner, or just plain matches can be used as a substitute. Dress up your cable assembly with cable ties and you are finished with the cable building step. Fun, wasn't it? And think of how much money you just saved.

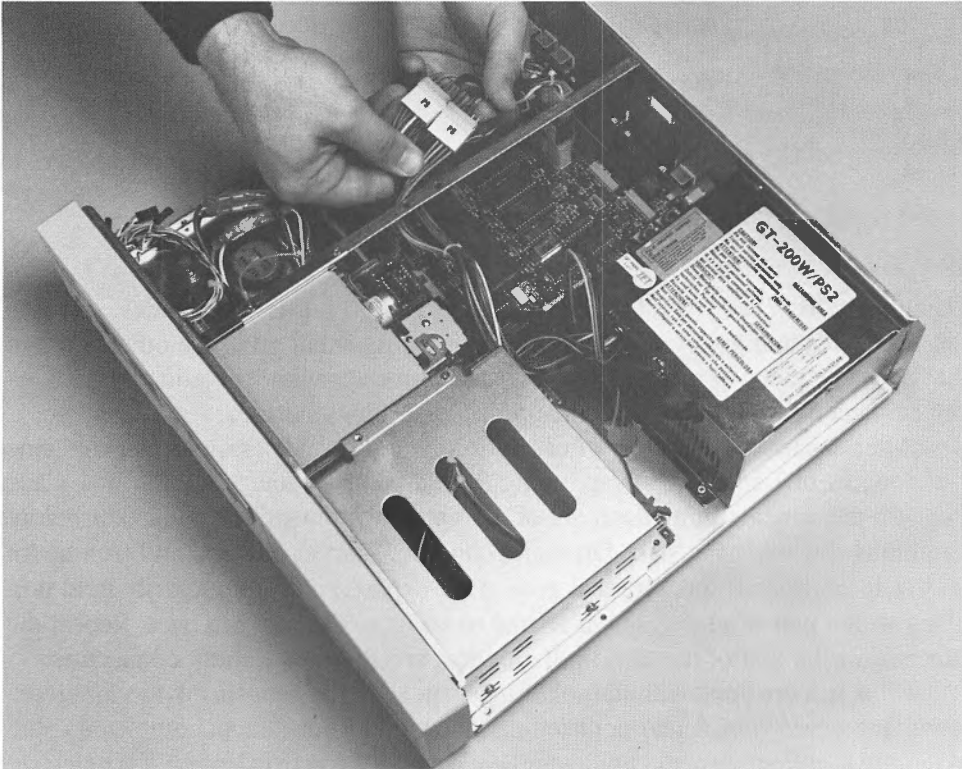
Now back at your Cat Mac SE chassis, plug the Power R video adapter module into the power connector on the logic board and plug the mating connector on the cable you just built into it. If you used masking tape to identify your P8 and P9 connectors on the other end, take it off, one connector at a time, and plug these into the matching connector from the power supply. Up to this point, everything is keyed so it is rather difficult to plug things together backwards unless you have a

gorilla assist you. If you notice anything taking an undue amount of effort or force to connect, recheck your premises. Are you doing it correctly?

Here is the biggest warning of the project so it gets its own paragraph and bold letters:

Check to be sure you have not switched connectors P8 and P9!

Double check your cable connection before you apply power. Figure 11-22 shows the power connections being carefully rechecked before moving to the next step.

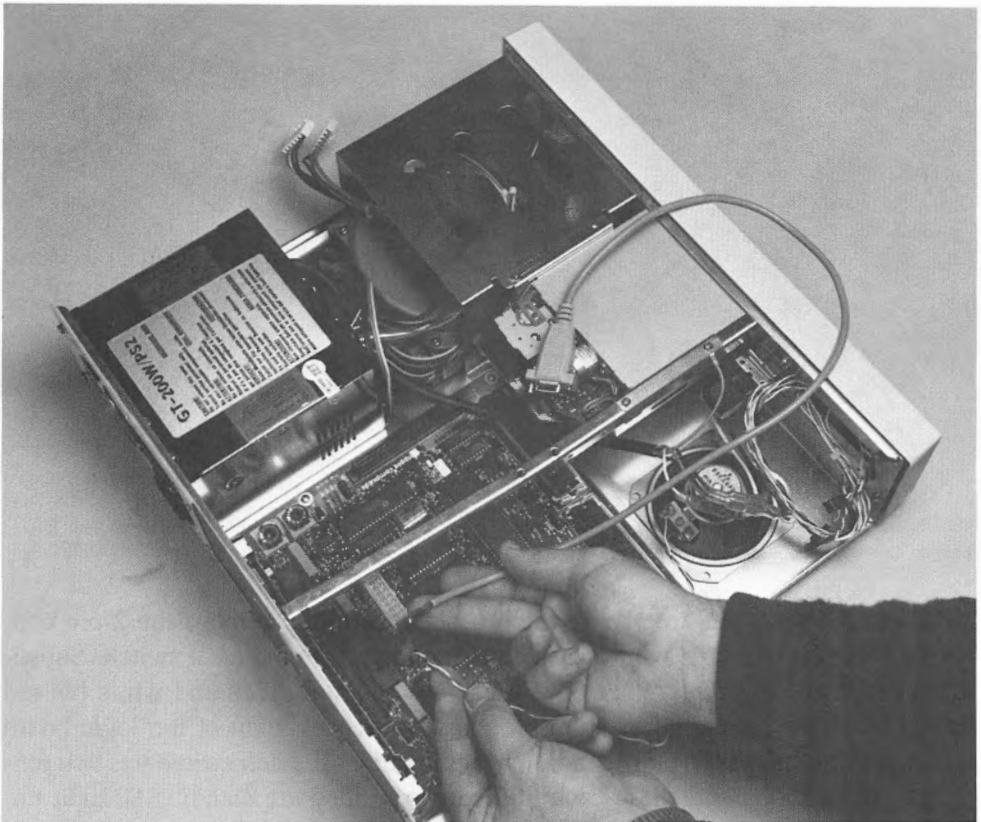


11-22 Installing the power cable. Recheck P8 and P9 and route power cable under stiffener bar.

While it might not be fatal, depending on the type of power supply you use, it is potentially the only step that can wipe you out completely in the twinkling of an eye and cost you big bucks for your logic board repairs. Why? Because the ground wires on one connector go to the same pins as the power wires on the other connector. You could possibly emerge unscathed from making a mistake of wiring to the wrong pin on either connector—depending on the pin. But *plugging P8's cable into P9's connector and vice versa is usually fatal. Zap. Kaput.* I believe you get the message. Just think of the money you've saved by being careful. Now onward.

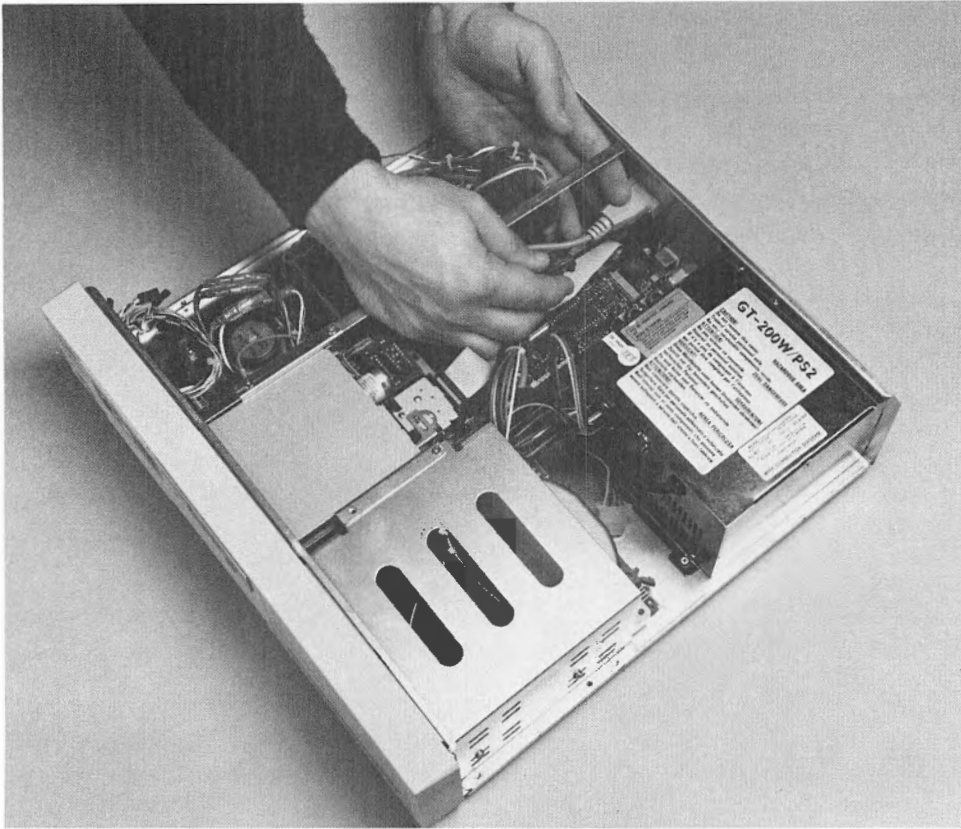
Connect the other cables

Plug the video cable into the Power R module as shown in Fig. 11-23, and bolt the other end to the rear connector plate on the chassis as shown in Fig. 11-24. The pins on this cable that go into the Power R module are small and can sometimes shake loose when moving your Cat Mac around, so tie this end of the cable in place securely with a cable tie to restrict its movement without connecting it permanently so you cannot remove it again if you have to in the future.



11-23 Connecting the video cable to the Power R video module.

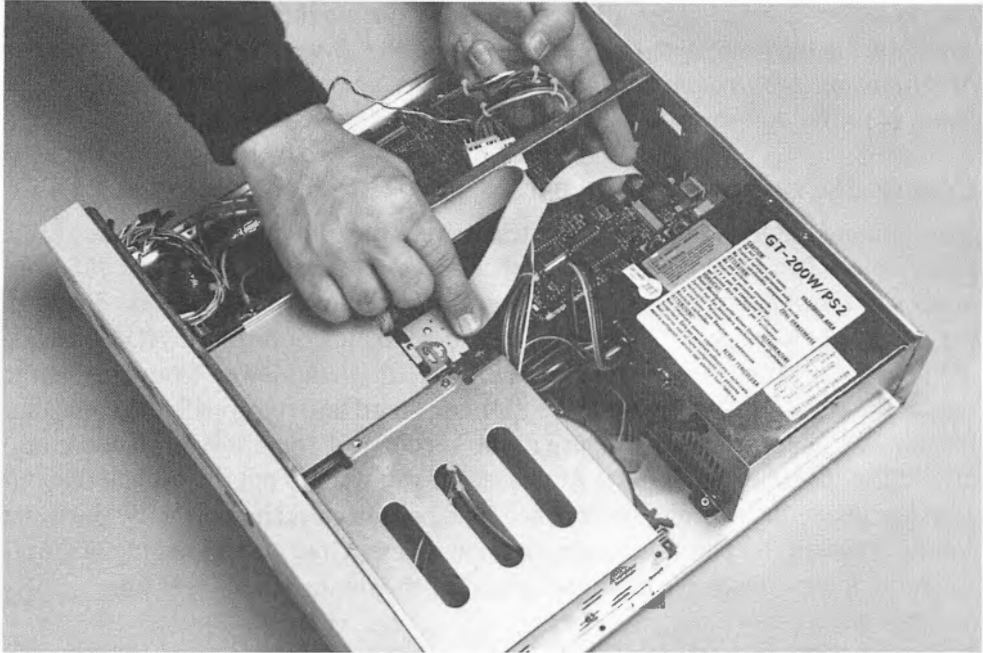
Now connect the floppy cable between the floppy disk drive and the Mac SE logic board as shown in Fig. 11-25. The floppy cable is a 12" to 15" length of 20-pin ribbon cable with a standard 20-pin female IDC connector crimped onto each end. If you use the standard Apple Mac II floppy cable, the connectors are keyed. If you do not, don't worry; just remember there are no twists in the cable (i.e., if the red stripe on one edge of the ribbon is left at the back of the floppy disk, it is also on the left at the logic board connector). The cable goes into the "lower drive" connector on the logic board. If you add a second floppy later, it uses the other slower "upper drive" connector.



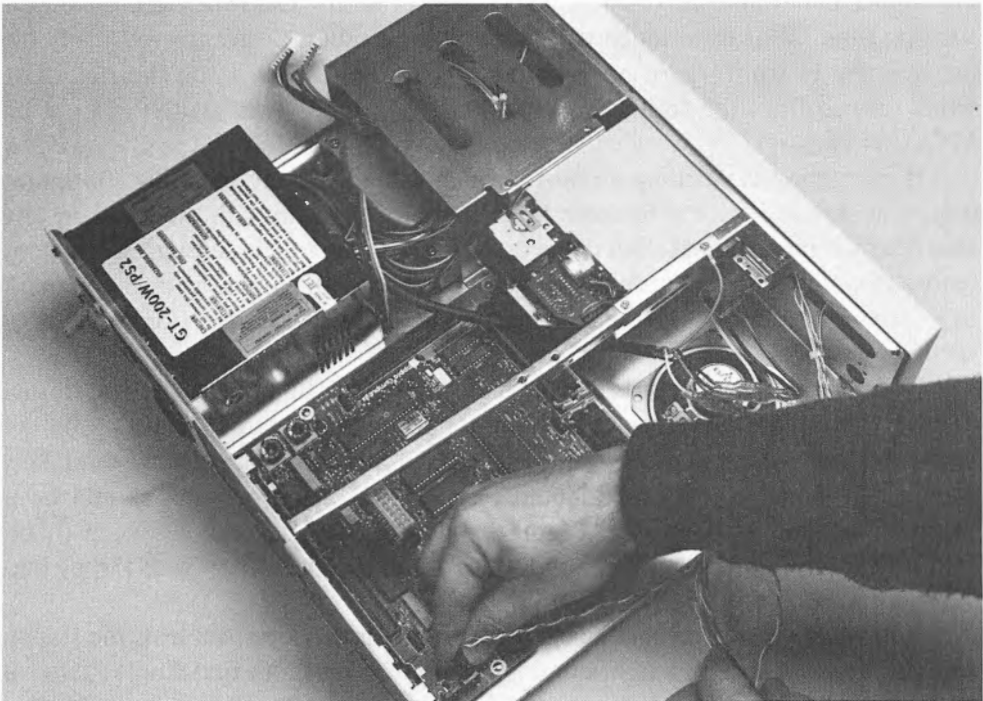
11-24 Attaching the video cable to its rear cover plate connector opening.

Next the reset and interrupt switch cables. Carefully remove the 2-pin connector from the blue and white twisted pair coming from the reset switch. Substitute in its place a 3-pin connector you have taken from green and white twisted pair. Locate the reset and interrupt switches at the back right of the logic board (viewed from the rear) near the radio the audio out jack. Each switch has two pins or tabs at its top. Bend these each 90 degrees so they are standing straight up. Now attach the orange, white, and black twisted wires from the turbo switch onto the chassis to the rear switch on the logic board, and the blue and white twisted wires from the reset switch to the switch right in front of the rear switch on the chassis logic board as shown in Fig. 11-26.

A word of caution here. The reset switch works normally. You push it, and it makes something happen. But the turbo switch on the PC chassis was intended to perform a different function than the interrupt switch on the Mac logic board it is now connected to. Your turbo switch is a push to hold type. If you push it once, it will definitely perform its function and interrupt the computer. *But you must push the turbo switch again* to release the Mac logic board back into its normal state; if



11-25 Connecting the floppy cable.



11-26 Connecting the reset switch cable.

you do not hit it twice, you will hang your Cat Mac up indefinitely. The only reason for using the switch is to assist in programming. *If you are not going to do any programming, don't connect the turbo switch.* The reset switch, on the other hand, is useful and saves having to power your Cat Mac off and on.

Connect the case to the other parts

Now you are ready to take your first test drive. Hook up the monitor video cable to the Power R cable connector on the back connector panel. *Make sure this connection is absolutely tight and the connector is fully seated all the way.* Hook up the monitor power cable. Connect the keyboard to either one of the ADB ports on the logic board (the pair of connectors on the left when viewed from outside the rear of the chassis). See Fig. 4-7, the SE logic board layout to verify the connector locations. Connect the ADB mouse to the keyboard if you are right-handed; otherwise use the other ADB port. At this stage, you want to put the eyeball on your creation to see that all obvious connections have been made correctly, parts are solidly attached, no parts short against another, etc. Give it a thorough going over so you will experience pleasure, not pain, when you turn the power on.

Power on (Phase 1 “Liftoff and Earth orbit”)

I don't believe the Apollo Moon landing astronauts had a level of apprehension any higher than mine when it was time to power on my Cat Mac SE creation for the first time. Your experience will probably be similar. Okay, are you ready for the moment of truth? Turn on your monitor (power switch is on the right side when viewed from the front). Turn on your Cat Mac (power switch in front on MTA-304 chassis).

If everything is working properly, which is highly likely with this configuration, you should hear the familiar Mac “bong” sound through the speaker, and also hear the power supply fan come on and the screen toggle through a few steps before stopping with a picture of a floppy disk icon with a blinking question mark in it. If you get this result, great. If not, go to Table 11-2 in the troubleshooting section.

Now you need to use your Startup disk. This is the floppy diskette you format to 800K, name it *Startup* (put a label on it and write the name “Startup” on the label) and load a copy of the System, Finder, and Silver Lining software onto. Just these three icons. The system should be at least version 6.0 and should be a “skinny” version without a lot of fonts and desk accessories in it so fits easily on your floppy along with the Finder and Silver Lining software. Put your floppy into the drive as shown in Fig. 11-27.

Now what do you see and hear? If everything is working, you hear the floppy whirring and see its drive light coming on while it reads its first floppy. After a while, the monitor screen bounces to life with its friendly “Welcome to Macintosh” dialog box. You should now be looking at the standard Apple Macintosh



11-27 Loading the "Startup" disk. Notice question mark icon on screen and disconnected SCSI cable on top of disk drive bay.

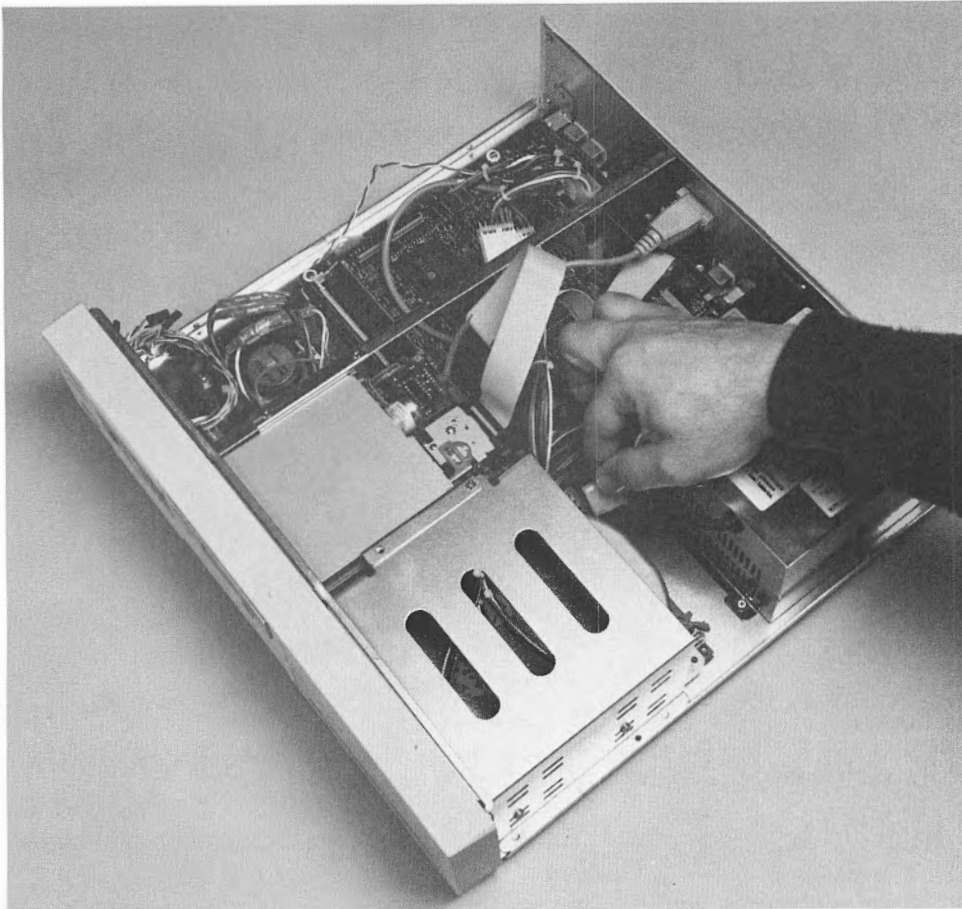
desktop. If you get this result, great. If not, go to Table 11-2 in the troubleshooting section.

Congratulations, you have just passed Phase 1 testing and you are now in orbit around the earth in Apollo space program parlance. Your Cat Mac and monitor are working along with your floppy disk drive, and you are now ready to activate your hard drive. Shut down your Cat Mac and unplug the power cables, or if you like, stop and play awhile.

Connect your hard disk

The correct power cable is already provided for you by the power supply; you merely have to hook it up. Actually, four power connectors are available, two with smaller and two with larger connectors. Just plug in the nearest yellow, black, black, red cable from the power supply into the connector that matches up with it on the disk drive as shown in Fig. 11-28.

The SCSI cable is 15" to 18" length of 50-pin ribbon cable with a standard 50-pin female IDC connector crimped onto each end for connection between the Mac SE logic board and disk drive. If you are making it yourself or having it made, leave a little bit of slack so you can easily attach and detach the cable without having to unbolt the drive. If you are using a Seagate ST 296N hard disk,



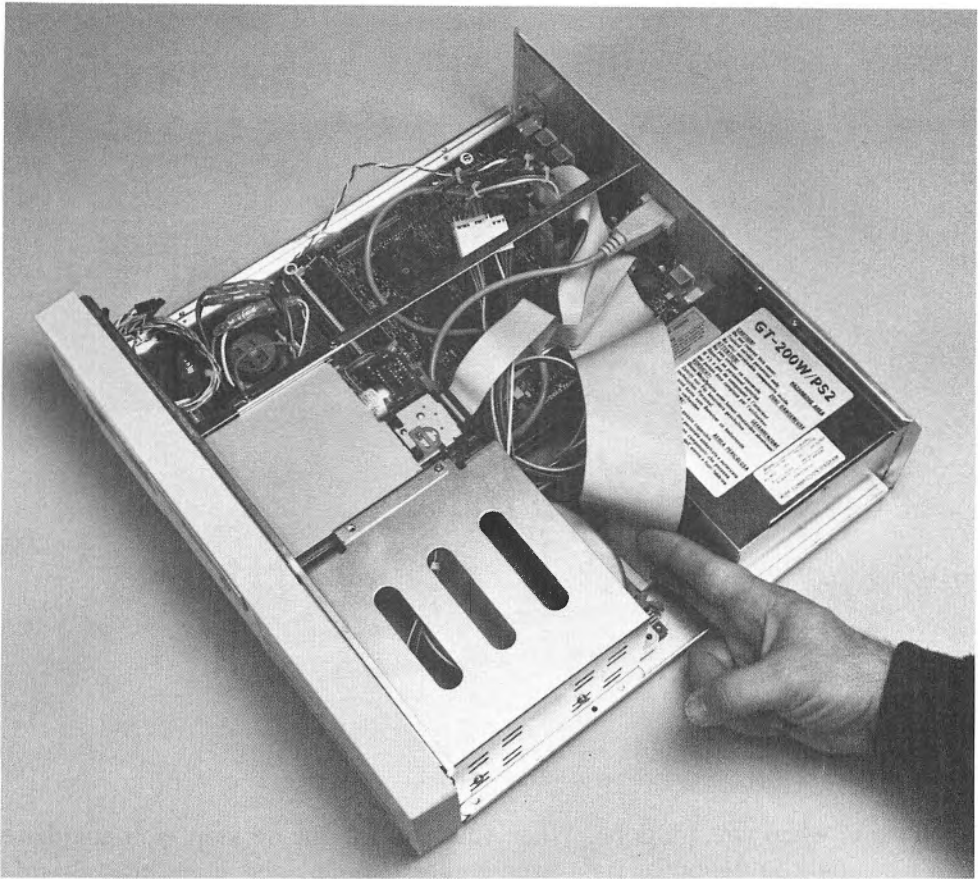
11-28 Connecting the hard disk power connector.

mounted as shown in Fig. 11-29 with its embedded controller card facing down or the shiny cover side facing up, then the SCSI ribbon cable has a single 180 degree twist in it after you connect it. (This is shown more clearly in Fig. 11-1.) Notice the red stripe is on the left side at the back of the disk drive, but on the right side when plugged into the logic board.

In the next step, when you turn the power on, if your drive turns on but you are not able to initially communicate with your hard disk, or the hard disk write LED just periodically blinks on and off, do not worry. You have connected your SCSI cable in backwards. Turn the power off, reverse the SCSI cable and try again. *Always turn the power off before changing SCSI connections to your hard disk!* Please.

Power on - (Phase 2 “Moon Orbit and Landing”)

Turn on your monitor and Cat Mac and insert the Startup disk. Your fan and monitor should come on, you should again hear the “bong” sound from the speaker,



11-29 Connecting the hard disk SCSI connector.

the hard disk wind up to speed and your floppy drive should begin reading its diskette. The little hitch or delay in the boot up process occurs because the Mac automatically checks out your Cat Mac memory before turning over control of the machine to you. The more memory you have, the longer the delay. I am talking a few seconds here. You should arrive at a picture of the Macintosh desktop as in Phase 1.

Now double click on the Silver Lining icon, and you should have the screen shown in Fig. 11-30. If you do not, go to Table 11-2 in the troubleshooting section. Notice the cursor arrow points between Drive: SCSI Drive (85M) and Port: 0. Cancel out of any intermediate dialog boxes that come up until you get the screen shown in Fig. 11-30. In the SCSI Drive Tests dialog box, click on the button called Tests... and let it take you through the steps of formatting your drive. Choose an interleave factor of 2 for your SE logic board (Plus interleave = 3, Mac II or SE 30 interleave = 1). This should take about 10 to 15 minutes. Name your drive HD85 or whatever you like, mount it (click until two check marks appear) and initially don't partition it into smaller volumes: leave it as one volume. Quit the



11-30 Using the Silver Lining software to format your disk.

application when you are done. When you return to the desktop, you now have two icons on it in the upper right-hand corner: a floppy disk icon called Startup and a hard disk icon called HD85 (or whatever). The hard disk is now ready for you to load software onto.

Start by loading your system software. The Apple System Software Kit (part number M0681/A) at list price \$49 has all the tools you need. Follow its instructions, load your system software, and you are almost in business. After you have loaded your system software on your hard disk, eject any floppy disk remaining in the drive and reset your system either from the front panel switch or from the menu on your screen. The hard disk now reboots, and you return to the desktop, this time with only one icon HD85 on it. You have reached your destination—you've landed on the moon. Your Cat Mac is now ready for you to load your favorite software applications onto it.

At this point, you might want to extend this occasion to include champagne for everyone in the building if you are so inclined

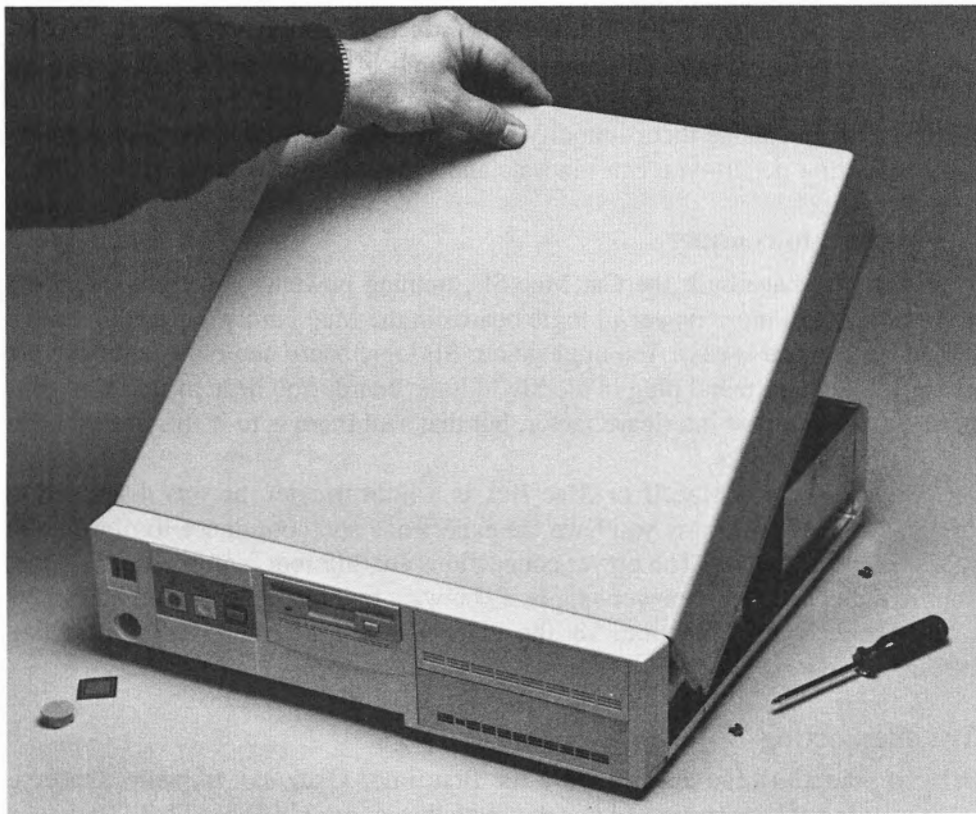
After you build

If you had started your Cat Mac project with an earlier Macintosh 128/512/Plus logic board or were attempting to do the custom video board, you would still be

working now while I kicked back and sipped a tall iced tea. As a Cat Mac SE builder, you have done your finishing touches already while others must fiddle with mounting battery holders (including a diode so that your batteries don't drain when the power is on), keyboard connectors, building all the other necessary cables, and have their heads into their custom video board and probably into a disassembled video monitor tweaking it to get the display just right. The kit from ATS mentioned earlier makes it easier on them but they still have to do the extra steps. Still thirsty? Ready for a refill on your iced tea yet?

Finishing thoughts

After you have a working Cat Mac, including your hard disk, you can put your cover on as shown in Fig. 11-31. Before you close the cover, double check that all connections are tight, that no wires are loose, and especially that no wires dangle around the area of the SIMMs chips. If you use the Power R video module, it will be a very tight fit to close the cover of the case, so make sure nothing gets pinched or comes undone in the process. Use cable ties to make your wiring inside the case neat and secure. This will help prevent the wires from accidentally coming



11-31 Putting the cover on your case. Small objects at left plug opening in chassis front. At the right are two of four cover screws.

loose if you should move your Cat Mac. When you do a “look what I built” at your local Mac user group, and your Cat Mac is suddenly DOA (dead on arrival), the wiring is the first thing to check (before checking the components). You probably wonder how I know this. . . .

If you used a Mobius video card or other video board rather than the Power R module, which requires no additional software, you need to add the Mobius Card init software (or other product’s init software) to your Startup disk. Without this init software, you would only get a blank screen upon startup. Don’t forget to also put this init software into the system folder on your hard disk after you format it. This is also true of accelerator card init software, if you used one of these in your Cat Mac.

You do not need to mount your floppy and hard drives inside the case. The floppy already comes in its external case so you merely wire it into its logic board SCSI connector. Yes, you do have a few more chassis boxes around but your assembly time is shortened, you can move your hard disk to another machine if you have to, and your Cat Mac really runs cool because now there is only a logic board in the chassis.

As mentioned at the beginning of this chapter, seeing your Cat Mac working is a really great experience. You feel like you have really accomplished something. The mystique of what’s inside a Macintosh is gone forever, and you are probably thinking of new worlds to conquer. You know that if you don’t like the results you can change them—modify the case, add a new disk drive, change the back mounting panel—you can innovate and experiment to your heart’s delight.

New worlds to conquer

Now that you have built the Cat Mac SE, nothing prevents you from extending your platform to more powerful logic boards in the Mac family. Upgrading to the SE 30 logic board is easy. You unplug your SE logic board and remove it from the chassis, then bolt in and plug in the SE 30 logic board. You need to reformat your hard disk with a new interleave factor, but that’s all there is to it. Instant SE 30—everything else works.

Upgrading to a Mac II or Mac IICx is a little trickier, as was discussed in Chapter 4. However, now you have the experience and confidence to move on to this as a future project. The power connections are different, and you need a more sophisticated and costly power supply if you want to implement the full ADB keyboard power control function. Yet the concept is still the same. Put a board in a box and save a bundle.

Troubleshooting

What if your Cat Mac doesn’t work the first time? Okay, not to panic. Observe what is or is not happening and match it with the cause(s) in Table 11-2. Then take

the corrective action recommended in Table 11-2 to make it happen. It is highly likely with this configuration for everything to be working properly, so you only need to keep a cool head while you methodically and logically isolate where the problem is, using Table 11-2 as a starting guideline.

Table 11-2 Cat Mac SE troubleshooting guide.

Problem/symptom	Cause(s)	Corrective action
Cat Mac does not turn on, no power supply fan noise	<ol style="list-style-type: none"> 1. No power 2. Internal short 3. On/Off switch 4. Power supply 	<p>Check power cord and outlet.</p> <p>Check wiring, reverse plugs P8 and P9.</p> <p>Check wiring is per enclosed diagram.</p> <p>Possible defective power supply.</p>
No video display	<ol style="list-style-type: none"> 1. Cable 2. Monitor 	<p>Check that the monitor cable is turned on.</p> <p>Possible defective monitor.</p>
Power but no video display	<ol style="list-style-type: none"> 1. Cable 2. Turbo switch 3. Brightness 	<p>Check that the monitor cable is tight at both ends.</p> <p>Press Turbo switch and reboot Cat Mac.</p> <p>Check brightness level, increase setting.</p>
“Sad Mac” icon on monitor	<ol style="list-style-type: none"> 1. Bad SIMM 2. Logic board 	<p>Replace SIMM</p> <p>Replace logic board. This is unlikely, check all connection to logic board first.</p>
Hard disk doesn’t come on	<ol style="list-style-type: none"> 1. No power 2. Hard disk 	<p>Check if the power cable to the hard disk is tight.</p> <p>Possible defective hard disk.</p>
Hard disk on, but can’t talk to it (format software says no connect)	<ol style="list-style-type: none"> 1. SCSI cable 	<p>Reverse one end of SCSI cable.</p> <p>Check that the SCSI cable is tight at both ends.</p>
After formatting hard disk, reboot gives blinking question mark icon	<ol style="list-style-type: none"> 1. No software 	<p>Check that System and Finder are installed on hard disk.</p>
Floppy disk doesn’t work	<ol style="list-style-type: none"> 1. Cable 2. Floppy 	<p>Check floppy drive cable not reversed.</p> <p>Possible defective floppy disk.</p>
No keyboard	<ol style="list-style-type: none"> 1. Cable 2. Keyboard 	<p>Check that the ADB cable is tight at both ends.</p> <p>Possible defective keyboard.</p>
No mouse	<ol style="list-style-type: none"> 1. Cable 2. Mouse 	<p>Check that the ADB cable is tight.</p> <p>Possible defective mouse.</p>

12

CHAPTER

The end of the beginning

The famous news commentator Walter Cronkite used to start his broadcasts with the rhetorical question, “Well, what kind of a day has it been?” Now that you have read the book, what do you do next? The next step is up to you. Is the Cat Mac a viable solution for you? Maybe you only want to tackle the step about adding the hard disk to your present Apple Macintosh. Fine. You can read all you want, and it is just words on paper until you tackle the building step. Then you know. As Darwin Gross said in several of his books, “When you know, you know.” The only sure-fire way to reap the benefits from any book is to put its principles into practice. No, this is not a sales pitch as much as it is an invitation to test the waters for yourself. What I am saying here is to bite off a piece of what you have read and try it. If you do, I can almost guarantee that you will find out a different or even a better way to do it, and that is all part of the fun. In addition, you will probably have saved yourself some money and gained some practical experience that can be put to even better use in the future.

On the other hand, maybe you’ve already followed the advice of this book through the first 11 chapters and you are wondering what to do next? That’s why I titled this chapter “The end of the beginning.” Whether you are an experienced

Macintosh user or a brand new one, I can only counsel you as a Cat Mac builder to continue to experiment and “push the outside of the envelope.” For myself, I have found it a rewarding experience from which there has been no turning back.

The remainder of this chapter will focus on equipment, software and some housekeeping items to help you after you are up and running that I have found useful and newer Macintosh users might also find helpful.

Peripheral equipment you will need

Dot matrix printer Selecting a printer for most people is a very personal decision. Fortunately, this is less of a problem in the Macintosh world. Apple, in their wisdom has only one low-end dot matrix printer, the Imagewriter II. For many of my clients, it’s the best solution I could have possibly recommended for them even if I spent a lot more time searching. It is very reliable, has nice tractor feed and sheet feed options, lets you feed single sheet stationary and #10 size business envelopes through it once you get the hang of it, and does an excellent job on mailing labels. Equipped with the Beverly Hills and Palatino fonts, it does a credible job on business correspondence though it is obviously not letter-quality output.

Yes, there are many good low-end dot matrix printers, but by the time you get the cables, the software, and find out about all their little quirks in working with each individual Macintosh software program, you are better off to have paid a little more for the Apple Imagewriter II to begin with. It is a rugged, bulletproof workhorse. Just feed it a new ribbon and vacuum it out now and then. Works for me, as the man says. Your initial hardware investment is under \$500.

LaserWriter Notice I didn’t say laser printers. There are many laser printer offerings. Hewlett-Packard owns the market today. But in the Macintosh world there still is only one—the Apple LaserWriter. But Hewlett-Packard who owns the market in laser printers today, might change that with their newest Hewlett-Packard LaserJet III offering.

Similar to the Cat Mac logic board, the original LaserWriter declined in price when the new LaserWriter II was introduced, but that didn’t make it any less desirable—only more attractive. A dot matrix printer will let you get hard copy output from your Cat Mac, but the LaserWriter will put you on the map and will earn you respect in the business world. No one can tell whether you generated your letter on the older, original LaserWriter or the newest top of the line LaserWriter II NTX. It’s laser output, period.

The big reason why all laser printers are not created equal is PostScript. The intelligent CPU and ROM chips inside the LaserWriter that recreate the data after you send it across your serial AppleTalk or LocalTalk cable make the jagged edges you get on your dot matrix printer type faces disappear; your graphics look professionally drawn. Although other laser printers in the DOS PC world do a slick job,

and can be tricked into running much faster, and even run PostScript, it is very difficult to replicate the simplicity of working with an Apple LaserWriter across multiple font types, multiple graphics types, and multiple application types—just press the Print command and you're there.

Unless you are a printer or in the graphic arts business, it's hard to tell the difference between 300 dots per inch resolution that you get out of the LaserWriter at five cents per page and the 1200 dots per inch that you get out of a typesetter at \$5 per page. All of it looks better than a dot matrix printer at 72 dots per inch. For most uses, the lower 300 dots per inch is perfectly acceptable. When combined with the latest versions of the world-class text processing, graphics, and desktop publishing packages, you are able to output all sorts of slick brochures and newsletters, on up to complete books that are camera-ready for printing.

Your investment is under \$2500 for the Apple LaserWriter Plus (the one with all the fonts) and under \$3500 for the LaserWriter II NT (Apple's improved model that gives you more memory, performance, and paper path options). You are still better off buying a used Apple LaserWriter Plus PostScript printer than a new less expensive non-Postscript laser printer.

Original LaserWriter and LaserWriter II toner cartridges cost about the same at just under \$100. These toner cartridges produce 3000 and 5000 copies respectively. You can refill the original LaserWriter's toner cartridge multiple times for under \$50. The LaserWriter IIs, made with more sensitive drum materials, are more costly to refill. The bottom line is your output costs are the same, about two cents per copy for the toner.

Now let's talk about the Hewlett-Packard LaserJet III alternatives. Up to this point, there really was no viable alternative to the Apple LaserWriter offerings. Today Hewlett-Packard, the leader in the laser market has taken dead aim on Apple's laser printer market with its LaserJet III product by offering a product that gives users better performance at a lower price.

Here's how you do it. First, you get the Hewlett-Packard LaserJet III basic unit with its new Resolution Enhancement print technology at \$2395 list. Then you add the Hewlett-Packard PostScript cartridge at \$695 list and Hewlett-Packard AppleTalk interface kit at \$275 list. Next, the PostScript module requires 2Mb of memory to run and the basic LaserJet III only comes with 1Mb, so you can either add a Hewlett-Packard 1Mb module at \$495 list (Hewlett-Packard also offers a 2Mb module at \$999 list) or a third-party expandable 2Mb module at \$595 list. If you go Hewlett-Packard all the way, your total list is \$3860 which translates to a street price of roughly \$2900, \$600 less than Apple's current LaserWriter II NT and \$400 more than Apple's original LaserWriter.

What have you done? Versus the Apple LaserWriter II NT, the Hewlett-Packard LaserJet III gives you a less expensive solution with superior variable dot print technology that improves print quality, more memory capability (up to 4Mb of Hewlett-Packard or 8Mb of third-party memory may be added as needed as

opposed to the 2Mb fixed Apple total) the same number of genuine Adobe type-faces (35), and the identical 8 page per minute printer engine using the identical toner cartridge.

I have used the various Apple LaserWriter models for years, and they are outstanding products. My bottom line on them is buy the lowest-priced model that meets your needs. I have yet to see the Hewlett-Packard PostScript interface in operation yet (it wasn't shipped until after this book went to press), therefore it is impossible to say if there will be any glitches with it running real world software. But on paper, Hewlett-Packard certainly seems to have come up with a better idea that you should look into as a possible LaserWriter alternative.

Networking Although the Macintosh was only available from Apple as a closed box for many years, the beauty of it was you could communicate with it better than any other computer because the networking interface hardware was built right into the box. The epitome of the KISS (keep it super simple) principle, you can have an entire Apple five-user network up and running in less time than it takes to take one popular DOS PC network's hardware out of the box and install it onto one computer. Its networking capabilities have only grown with time. Although you really don't see the benefits as a single Cat Mac user connected to a LaserWriter, the minute you add the first additional station to the network the benefits grow. Not only can you easily share the LaserWriter (or ImageWriter II if you just add an option board), but easy-to-use software exists, like TOPS, to share files between two or more Macintosh computers. Adding a DOS PC computer to the network is as simple as adding a board to the PC and its text, spreadsheet, or database files can be shared on the network via easy-to-use translation software from Dataviz. Your investment here is under \$50 per node to share a printer and under \$250 per node to share files.

Modem After the printer, a modem is your most important peripheral. It lets you communicate with the outside world. Whether it's your client in Germany, salesperson on the road anywhere in the United States or a publisher or typesetter or employee working at home, across town, or across the street, you are equally able to transmit and receive text, graphics, and audio data. Recent versions of traditional Macintosh communications software such as MacTerminal, Red Ryder's Public Version, or Microphone are extremely easy to use and loaded with features. Many other software packages to choose from let you access on-line services and public databases, download stock information automatically, establish your own internal company mail network, or just set up a personal bulletin board. Legendary software packages like Stuffit let you pack your data prior to transmitting it to get the lowest line of rates. I would not buy a modem with less than 2400 baud speed capability today or 9600 baud if you want to pass information between sites on a dedicated basis. Your initial hardware investment is under \$250.

Scanner A scanner lets you convert printer page data—text and graphics—into electronic form. You then can manipulate this data in your Cat Mac and send the results to a LaserWriter or to another computer over a modem. The primary benefit of this powerful capability to you is time savings. You can scan in graphics such as artwork, logos, and forms, and you can modify and improve them in much less time than if you had to perform the entire process from scratch. The text reading process, called *optical character recognition* (OCR), was originally either very crude or very expensive. Early OCR could hardly keep up with a typist and fell far behind after correction time was factored in. New versions of OCR software packages like Omnipage from Caere adds multiple language (English, Spanish, etc.), dot matrix (read in your ImageWriter output), to multiple font (Times, Helvetica, etc.) reading capability in automated modes at 98% and above recognition rates. Only a bionic typist could keep up with these products today. Apple and Hewlett-Packard provide the best solutions; their scanner hardware is reliable, and bundled graphics software packages are easy to use. Your investment is under \$1500 for the combination. OCR software is available for under \$500.

CD ROM When it comes to compactly storing and conveniently distributing large volumes of data, nothing beats the CD ROM (*compact disk read-only memory*). They are identical in appearance and size to their audio counterparts that set a new standard for listening and are now available in music stores everywhere. Standard is the operative word here. The lack of standards has blocked more widespread application of this technology to computers. Not to worry, it will happen. If you are a researcher, a single CD ROM disk puts over 500 megabytes of text, graphics, or sound data at your fingertips. Volumes of niche market data with updates are offered on a subscription basis by some vendors. Manufacturers have already put numerous dictionaries, encyclopedias, and directories on CD ROM, and new products and services are announced daily. Apple set the standard when their CD ROM player was first announced. Today newer products from Toshiba and others are even faster. Your investment is under \$900.

Hardware backup Without background into your setup and application(s), it's difficult to give you specific advice here. Only that as a single user Cat Mac builder, yet another storage solution will undoubtedly have been introduced by the time you need to worry about this—such is the speed at which technology is moving. Your choices are tape cartridge, tape cassette, Bernoulli, syquest, magneto optical read-write, WORM (write-once read-many), or floptical; even reel-to-reel tape might still be a good solution for some users. Let me just leave you with the thought: If you expand your operation, you need to research and investigate storage backup alternatives—at that particular time. Meanwhile, enjoy the 800K floppies you are using with the backup utility of your choice for its simplicity and low cost.

Software you will need

System software Much has changed in system software since the early days of Macintosh. As mentioned earlier, your hardware goal is to at least bring your earlier Cat Mac platforms up to the standard of the Mac Plus logic board. The reason for this is so you can run Apple System 6.0 or later software. Available as an upgrade kit from your friendly local Apple dealer, this software in its latest form simplifies whatever you might want to do and does so with fewer bugs or hitches than earlier versions.

You may have heard of the virtues of MultiFinder and its benefits. The Apple 6.0 System package brings them to you; just choose MultiFinder from the desktop menu and reset. Now you are working in the MultiFinder rather than the Finder environment. Your ability to switch back and forth between multiple applications is limited only by the amount of memory you have. My experience has shown you really need at least 2 megabytes to be happy with its performance.

You might also have heard of the new Apple 7.0 System software. Again this will run on your Mac Plus or up Cat Mac with 2Mb of memory or more. You will get neat features like outline fonts and integrated typesetting capabilities, better window control, and the inclusion of many additional utility applications as part of the standard system interface. But to take full advantage of its features, you will need a 68030 Macintosh or a 68020 with a PMMU chip.

Then you get to use neat things like virtual memory, where a portion of your disk is set aside as an extension of your Cat Mac's RAM memory. You can run larger, slicker programs because of the parts of them that you need being able to be swapped in and out of memory from the disk area as you need them. You also get true multiprogramming under MultiFinder. You can open multiple applications concurrently and run one or more of them in the background while you work in an application in the foreground. Mainframe, minicomputer, and Unix platform users have had these capabilities for years, but the ability to do them on your Cat Mac, combined with the powerful graphic, easy-to-use Macintosh interface, puts an enormous amount of computer power on the top of your desk.

Applications software Without knowing your specific application, there is little I can tell you here except to point to the volumes of books which have already been written on the subject. Anything I could say about a specific vendor's product could and would be used against me by another vendor. Why didn't you mention my product? And they would be right. So I will duck the entire subject. For the Macintosh, know that numerous off-the-shelf software solutions exist, and one is just right for you in just about any application area you can think of. Beyond that, anything else can be done to accomplish specifically and uniquely what you want to do. All it takes is time and money. Macintosh magazines and user groups should also help to get you started. If you are running a business and need to get up and running quickly and get it right the first time, by all means hire a compe-

tent and qualified consultant. As you would in choosing any other business professional, interview a few first before making your hiring decision.

Now that you are up and running

As a new Cat Mac user, let me give you some hints to maximize your enjoyment. If you are already a Macintosh owner, you can empathize with me in some points and undoubtedly have learned other hints from your own experience.

Cleanliness Locate your Cat Mac on your desk, stand it on its side, just keep it in a clean environment. Excessive dust, dirt, or smoke will eventually work its way into your Cat Mac and create problems for you. If you have used your Cat Mac for quite awhile and one day it quits working, before panic sets in, open the case (remember static!), gently blow or vacuum the accumulated dust layer off your logic board, reseal all the connectors, and see if that doesn't solve the problem.

Voltage Power your Cat Mac from a clean voltage source. Buy a surge protector or, better still, a small UPS (*uninterruptible power supply*—it has surge protection plus a battery which drives an inverter when AC power goes away). If nothing else, you will sleep better at night. In my case, the UPS paid for itself in only one power outage.

I was working at my Cat Mac SE one day, minding my own business, when in the middle of a sunny day, the power went out. When it came back on, my Cat Mac power supply came on, the screen came on, but I got that sickening feeling in the pit of my stomach as the screen sat there with the dreaded blinking question mark icon. No hard disk. The power hit knocked out my hard disk. The hard disk still rotated, but some of the data was scrambled. Luckily, the data was backed up, but I still had to go through all the steps to restore it.

Cut to the same scene about six months later, this time at night. The power went out, the UPS came on, and I continued working in the dark. Well, not exactly! By the light of my Princeton monitor screen. My next step was to save what I had been doing.

Without a UPS, your safest course of action is to turn off your computer after a power hit. Sometimes the power surges a few times before the power company fixes the problem. None of these surges does your computer any good.

Static Some people are just naturally highly charged individuals. Seriously. While some have no problem with their computers ever, others are constantly losing the data on their floppies, their hard disks, and encountering strange error messages and system bombs. For these people I recommend a three-step solution. Put an anti-static mat on your desktop under your computer. Put another anti-static mat on the floor under your chair in front of your desk. These anti-static mats are the type that come with a wire that attaches to the ground wire of

your wall electrical outlet. Then, make two backups of everything. If this doesn't work, I have more drastic measures I have used.

Maintenance Maintenance contracts are unnecessary for most people. The pros and cons were well reviewed in an article by Jim Seymour;¹ for some they are good, for others not. For the Cat Mac project you assemble yourself, you don't even have to think about it. But do get a contract if you are using your Cat Mac in a critical application in your business. Remember that fellow Murphy!

As a Cat Mac owner, you have certain safeguards. You already have a beefier power supply to begin with and an industrial strength fan for air flow. Your video is in its own ventilated case with its own power supply. The logic board, the most vulnerable part of your system, is much better ventilated and much better powered, due to the increased space available. Since it is never going to wear out, it should have a long and useful life if you don't mess with it and, failing that, if you take precautions whenever you do work around it, like when adding memory or other options. You have a brand new hard disk, floppy disk, keyboard, mouse, and monitor and case, and have automatically obtained at least a one- or two-year warranty with them.

Disks and backup Keep your backup diskettes next to your Cat Mac to remind you to backup regularly. The number one "thank you" I receive from every client sooner or later is "thank you for telling me to backup my data." There are many good books on the subject, many theories of how to do it best. Take your pick. My counsel is just do it!

¹Jim Seymour, "Maintenance Contracts Are No Longer a Joke," *PC Week*, May 31, 1988, p. 44.

APPENDIX

The world of Macintosh

Whatever Macintosh you are now using or plan to use, it is certain that a slicker, faster, cheaper, or lighter one will be developed in the future. The same statement, only more strongly, can be made for Macintosh software. Yet the avalanche of new products coming regularly from Apple and third-part software and hardware manufacturers requires that you adopt some sort of procedure, tailored to your own set of circumstances, ensuring your Macintosh setup is reasonably up to date. How do you do it? It's easy: Read, talk with others, visit shows. Then formulate your own opinions and procedures.

The Macintosh world is unique. The Macintosh user benefits from a combination of dedicated, focused media, events, distribution methods, and user groups unlike those found in any other industry. A wide variety of information sources can assist you. This is not intended to be an all inclusive list. I can only touch on the highlights here, so many other excellent sources will not be included—but you will undoubtedly find them in your search.

Mail order

Some geographic areas have an unusual concentration of good dealers to assist you and that you assist in return by buying from them. But you can benefit from the mail order channel regardless of where you are located. Virtually anything can be purchased through the mail: books, magazines, software, hardware, accessories, even complete systems.

How do you deal with this channel? I have found a very simple process works for me. If I am buying a commodity item and I am not already buying that item from a vendor I am familiar with, I'll stick with one of the major mail order suppliers who advertises in the pages of the Macintosh magazines. If it's a new item on the market or a new item for me to buy, I'll go directly to the manufacturer or supplier, large or small, and place a small order for it. If the product, their service, and the price measure up, I'll favor them with a larger order. If not, I'll buy from another source or even return the product.

The mail order sources for the products mentioned in this book have already been listed at the end of each chapter so they will not be repeated here.

Magazines

The Macintosh community is blessed with an amazing selection of outstanding weekly and monthly magazines to suit every palette. They, as much as the enthusiasm of the Macintosh users themselves, are responsible for the spread and absorption of the Macintosh into the mainstream of computer culture.

I have referenced the monthly magazines *Macworld* and *MacUser* repeatedly in the text. I cannot say enough about them. From the beginning, they were a cut above any other computer periodicals I have ever received.

MacWEEK is another outstanding publication, perhaps the best weekly I have ever received. They are legendary in the Mac community for reporting the facts just as they happen, straight off the cuff—even if they absorb a little heat in the process from Apple and others for being a little too soon and too accurate in their reporting.

As a minimum, you should be subscribing to:

Macworld
P.O. Box 51666
Boulder, CO 80321-1666
800-234-1038

MacWEEK
P.O. Box 5821
Cherry Hill, NJ 08304
609-428-5000

MacUser
P.O. Box 56986
Boulder, Co 80321-6986
800-627-2247

Three other magazines you should subscribe to (although they are not Macintosh specific, but will make you a well rounded individual) are:

Byte
P.O. Box 555
Hightstown, NJ 08520
800-257-9402

InfoWorld
P.O. Box 5994
Pasadena, CA 91107
818-577-7233

Computer Shopper
P.O. Box 52568
Boulder, CO 80321
800-274-6384

Two shoppers' guides are available to assist you quarterly and annually:

Macintosh Buyer's Guide
5615 W. Cermak Rd.
Cicero, IL 60650-2290
800-826-9553

Macintosh Product Registry
660 Beachland Blvd
Vero Beach, FL 32963-1794
407-231-6904

You might benefit from many other magazines that serve niches in the Macintosh market and other aspects of the personal computer field, but these I've listed should get you started.

Computer shows

Again the Macintosh community is blessed. No other industry has a dedicated user event which you can attend once a year and actually see and hear it all. The Macworld Exposition, held in the spring in San Francisco for the West Coast and in the fall in Boston for the East Coast is the one event every Macintosh user should plan to attend at least once if not annually. It normally attracts around 50,000 people and, unlike other trade shows, caters specifically to Macintosh products and, except for one industry day, specifically to the Macintosh end user. To learn more about it, contact:

MITCH HALL ASSOCIATES
P.O. Box 4010
Dedham, MA 02026
617-361-3941

User groups

Although every industry has its user groups, this phenomena has been raised to an art form in the Macintosh community. Nothing else can give you as high a return on, and as much benefit from, your low annual dues investment. Only minutes of

networking at a monthly general or special interest group meeting can save you hours, if not days, of time. Later on, when you have established relationships within the group, you can accomplish the same over the telephone.

The user groups are a marketing force to be reckoned with also. The monthly meetings of the larger user groups such as Berkeley, Boston, and Portland (OR) regularly attract industry leaders who know this fact very well. An auditorium full of experienced, opinionated, and intelligent Macintosh users is also a force to be reckoned with. But it is a two-way street, and the industry leaders go back with much useful marketing feedback. A simple phone call to Apple Computer gets you the number of the Macintosh User group nearest to you. Call 800-538-9696, ext. 500.

Books

History Books on the history of the Macintosh include:

Jeffrey S. Young, *Steve Jobs: The Journey Is the Reward*, Scott, Foresman and Co., 1987

John Sculley with John A. Byrne, *Odyssey*, Harper and Row, 1987.

Frank Rose, *West of Eden: The End of Innocence at Apple Computer*, Penguin Books, 1989.

Guy Kawasaki, *The Macintosh Way*, Scott Foresman and Co., 1990.

Jean-Louis Gasse, *The Third Apple*, Harcourt Brace Jovanovich, 1987.

Hardware In addition to this book, you might find these books helpful:

Apple Computer, *Macintosh Family Hardware Reference*, Addison-Wesley Publishing, 1988.

Peter Norton and Robert Jourdain, *The Hard Disk Companion*, Simon and Schuster, 1988.

Aubrey Pilgrim, *Build Your Own 80386 IBM Compatible and Save a Bundle*, TAB Books, 1988.

Larry Pina, *Macintosh Repair & Upgrade Secrets*, Howard W. Sams & Co., 1990.

Charles Rubin and Bencion Calica, *Macintosh Hard Disk Management*, Hayden Books, 1988.

Gene B. Williams, *Macintosh Repair and Maintenance*, Chilton Book Company, 1986.

Software A list of Macintosh software books could by itself fill a chapter. A visit to your favorite local bookseller or reseller that stocks software products and books gets you started. Enjoy.

Glossary

- A/UX** Apple's version of Unix, the near industry standard multiprogramming, virtual memory operating system. Apple's advantage is their Unix version has a front end of a Macintosh interface making it more user friendly and easier to use while retaining all its powerful features.
- access time, average** The amount of time it takes the computer to find and read data from a disk or from memory. For a hard disk, it is defined as seek time (time to find the track) plus settling time (time to stabilize over the track) plus latency time (time to bring the sector data on the track under the head). Some manufacturers ignore both the average consideration and the latency factor to publish better times.
- ADB** Apple Desktop Bus is now the Apple standard serial communication bus that allows you to connect up to 15 input devices such as keyboard, mouse, joystick, puck, other pointing/motion devices, and graphics tablets to your SE and newer Macintosh. It allows the devices to be connected in daisy chain fashion. The bottom line is increased flexibility at minimal increase in cost.
- alphanumeric** Data that has both numerals and letters.
- ANSI** Abbreviation for American national Standard Institute. A standard adopted by MS-DOS for cursor positioning. It is used in the ANSI.SYS file for device drivers.

- ASCII** Abbreviation for American Standard Code for Information Interchange. Binary numbers from 0 to 127 that represent the upper- and lowercase letters of the alphabet, the numbers 0–9, and the several symbols found on a keyboard. A block of eight 0s and 1s are used to represent all of these characters. The first 32 characters, 0 to 31, are reserved for noncharacter functions of a keyboard, modem, printer, or other device. Number 32, or 0010 0000, represents the space, which is a character. The numeral 1 is represented by the binary number for 49, which is 00110001. Text written in other systems, such as WordStar, has several other characters added and is very difficult to read. Another 128 character representations have been added to the original 128 for graphics and programming purposes.
- ASIC** Stands for Application Specific Integrated Circuit.
- assembly language** A low-level machine language, made up of 0s and 1s.
- asynchronous** A serial type of communication where one bit at a time is transmitted. The bits are usually sent in blocks of eight 0s and 1s.
- baud** A measurement of the speed or data transfer rate of a communications line between the computer and printer, modem, or another computer. Most present day modems operate at 1200 baud. This is 1200 bits per second or about 120 characters per second.
- benchmark** A standard type program against which similar programs can be compared.
- bezel** The plastic or metal plate typically covering the front of a floppy or hard disk mounted in a computer case or chassis.
- bidirectional** Of or relating to both directions. Most printers print in both directions, thereby saving the time it takes to return to the other end of a line.
- binary** Binary numbers are 1s and 0s.
- bits** A contraction of binary and digits.
- boot or bootstrap or reset** The process of the Macintosh turning on, checking if its memory is okay, checking its stored parameters are set as they should be, and turning over control to the user. A small amount of the program to do this is stored in ROM. Using this, the computer pulls itself up by its bootstraps. A reset is sometimes necessary to get the computer out of an error message or bomb dialog box if it is hung up for some reason.
- buffer** A buffer is usually some discrete amount of memory that is used to hold data. A computer can send data thousands of times faster than a printer or modem can utilize it. But in many cases, the computer can do nothing else until all of the data has been transferred. The data can be input to a buffer, which can then feed the data into the printer as needed. The computer is then freed to do other tasks.
- bug** The early computers were made with high voltage vacuum tubes. It took rooms full of hot tubes to do the job that a credit card calculator can do today. One of the large systems went down one day. After several hours of troubleshooting, the technicians found a large bug that had crawled into the high volt-

age wiring. It had been electrocuted, but had shorted out the whole system. Since that time any type of trouble in a piece of software or hardware is called a *bug*. To debug it, of course, is to try to find all of the errors or defects.

bulletin boards Usually a computer with a hard disk that can be accessed with modem. Software and programs can be uploaded or left on the bulletin board by a caller, or a caller can scan the software that has been left there by others and download any that he likes. A great source of help for a beginner.

bus Wires or circuits that connect a number of devices together or a path over which signals travel. Typically refers to the input and output paths to the Macintosh such as the Nubus cards in the Mac II family and the expansion bus slot in the Mac SE.

byte A byte is 8 bits, or a block of 8 0s and 1s. These 8 bits can be arranged in 256 different ways. This is $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$, or 2^8 . Therefore, one byte can be made to represent any one of the 256 characters in the ASCII character set. It takes one byte to make a single character.

cache memory High-speed memory placed in front of regular processor memory to speed up the computer. When the computer writes data in main memory, it leaves a copy of it in cache memory, too. When the computer goes to read data, it looks first in cache memory. If it finds the data there, it doesn't bother with looking in main memory. If the cache and program loops are of the right size, the computer hardly ever looks in main memory. The result is that everything runs a lot faster.

capacity This refers to the amount of binary data in 8 bit bytes that can be stored on the hard disk's multiple surfaces. Be aware: Not all hard disk capacities are stated equal. It is difficult to state accurately until after the disk is installed in the computer and formatted because different computer types, controllers, formatting software, and disk drives themselves produce different results.

Cat Mac This book is about building your own Macintosh from catalog parts. Catalog Macintosh has been shortened to Cat Mac throughout the book.

CD ROM Stands for Compact Disk Read-Only Memory. A convenient and compact way of storing and distributing large volumes of data.

character A letter, a number, or an eight-bit piece of data.

chip An integrated circuit, usually made from a silicon wafer. It is microscopically etched and has thousands of transistors and semiconductors in a very small area. The 80286 CPU used in the AT has an internal main surface of about $1/2$ " square. It has 120,000 transistors on it.

clipboard A holding place for temporarily storing text or graphics.

clock speed The operations of a computer are based on very critical timing, so they use a crystal to control their internal clocks.

clone Computer slang for a copy of another manufacturer's computer. IBM defined the DOS personal computer with their model in 1981. All the copies of it today are clones; other companies copy its ROM and other features. In contrast, no Apple Macintosh clones exist because Apple has not licensed its

ROM; therefore it is illegal to copy. The Cat Mac is not a clone, it is a Macintosh (often mounted in a PC case).

CPU Stands for Central Processing Unit. Today the engine or chip that drives your Macintosh.

consultant Someone who is supposed to be an expert who can advise and help you determine what your computer needs are. Similar to an analyst. There are no standard requirements or qualifications that must be met, so anyone can call themselves an analyst or consultant.

coprocessor Usually an 8087 or 80287 that works in conjunction with the CPU and vastly speeds up some operations.

cursor The blinking spot (also called the *insertion point*) on the screen that indicates where next character will be.

database A collection of data, usually related in some way.

desktop The screen or environment that the Apple Macintosh initially presents to the user, just like working at a real desk.

dialog box A window or full-screen display that pops up in response to a command.

DIP Stands for dual inline package, a type of packaging for a chip.

DMA Stands for Direct Memory Access. Some parts of the computer, such as the disk drives, can exchange data directly with the RAM without having to go through the CPU.

DOS Stands for Disk Operating System. Also shorthand for MS-DOS and PC-DOS the software engines that drive the majority of the IBM-compatible clone computers. Totally transparent to the user in the Macintosh environment.

DOS PC Denotes a personal computer that utilizes the IBM DOS operating system as opposed to utilizing the Macintosh operating system, Unix or something else.

double density Original Mac diskettes were 400K capacity single-sided diskettes, then 800K double-density disks were introduced, then today's highest density standard the 1.4Mb capacity drive used by Apple's FDHD Superdrive.

dot matrix printer A printer that represents each character using a series of dots in a closely spaced matrix. The Apple ImageWriter printer is an example.

DRAM Stands for Dynamic Random-Access Memory. A type of memory that must constantly be refreshed, or recharged. Primary type of memory used in PCs.

expansion boards Boards that can be plugged into one of the 8 slots on the motherboard to add memory or other functions.

FDHD Stands for Floppy Disk High Density, Apple's latest floppy drive 1.4Mb standard.

finder The part of the Apple Macintosh software that creates and maintains the user environment track of files on the desktop, etc.

fonts The different types of print letters such as Gothic, Courier, Roman, Italic, and others.

- formatting** The formatting step puts specific track and sector “pockets” into the hard disk. Formatting builds exact locations where you can later find data. To quickly move data on and off the disk, it identifies certain tracks as “directory” tracks. These contain information tags, or flags or pointers that point to or identify the location of data on the disk.
- FPU** Stands for Floating Point Unit. An additional processor working in parallel with main CPU that speeds up processing time for numerical calculations.
- fragmentation** If a diskette has several records that have been changed several times, bits of the files are on several different tracks and sectors. This slows down writing and reading of the files because the head has to move back and forth to the various tracks. If these files are copied to a newly formatted diskette, each file will be written to clean tracks that are contiguous. This will decrease the access time to the diskette or hard disk.
- gigabyte** One billion bytes.
- glitch** An unexpected electrical spike or static disturbance that can cause loss of data.
- gray market** The practice of dealers selling their product to other dealers without adding value in order to meet their manufacturer’s delivery quotas and keep their discount levels.
- handshaking** A protocol between systems, usually the printer and the computer, to indicate readiness to communicate with each other.
- HFS** Stands for Hierarchical Filing System. With System 3.2 and later version software allows you to see and keep track of multiple levels of files at one time and to keep track of files and folders within folders. HFS has a tree file structure.
- hi-res** High Resolution. A 640×480 or greater capacity monitor as opposed to Apple’s standard $9" 512 \times 342$ display.
- IC** Stands for integrated circuit. Virtually all the components on today will soon be in IC form to improve efficiencies and achieve manufacturing economies.
- icon** A graphical representation of an application program, program file, or a file folder (to hold either) on the Apple Macintosh desktop. A mouse can be pointed to an icon and double clicked and the application or file. A key feature of the easy to use Macintosh graphical interface.
- interface** A piece of hardware or software that follows a distinct set of rules and allows communications between two systems.
- interleave** Depending on the speed of the computer attached to the hard disk, it might not be fast enough to read all the data from one sector transferred by the disk interface or to write it in one rotation of the disk. To avoid this problem, disks initially being formatted to work with slower Macintoshes have their sectors “interleaved.” A “slow” Mac Plus requires a 3:1 interleave. That means the next “logical” sector from which the controller reads or writes data actually skips two sectors over from the last “physical” sector located on the disk. A “faster” Mac SE requires a 2:1 interleave. The next logical sector read or

written actually skips one sector over from the last physical sector located on the disk. Mac IIs, Mac SE 30s, and up use a 1:1 interleave. The next logical sector read or written by the controller is identical with the physical sector located on the disk.

Killy clip A clip type device useful for its special ability to securely attach a ribbon cable to a 68000 or 5380 IC chip.

K, kilobyte 1024 bytes or 2^{10} .

LAN Stands for Local Area Network, a system in which several computers are tied together or to a central server.

LaserWriter The Apple proprietary laser printer with the intelligent 68000 based PostScript engine.

LCD Stands for Liquid Crystal Display.

logic board A printed circuit board of several layers that contain all the Macintosh electronic components and circuitry.

M, meg, megabyte Stands for one million bytes or 1,048,576 bytes to be precise. A measurement of disk or memory storage capacity.

MFS Stands for Macintosh Filing System. Before System 3.2, MFS was the basic filing system on the desktop at one level. MFS is a flat file structure.

MHz Stands for one million cycles per second, a measurement of frequency.

mainframe A large computer that can serve several users.

memory A high-speed temporary storage area next to the main computer used to store data and its location information.

menu A list of choices or options. A menu-driven system such as the Apple Macintosh makes it very easy for persons new to computers to learn how to use them.

microsecond One millionth of a second or 10^{-6} seconds in math notation.

modem A device which converts digital signals to analog form for transmission over a phone line and reverses the process on the other end.

Molex A type of electrical connector useful for its properties of being able to be keyed, polarized or locking.

monitor A device to look at a picture—video monitor or listen to a sound—audio monitor.

mono Stands for a monochrome monitor with one-color capability.

mouse A pointing device that controls the movement of a cursor on the screen.

MTBF Mean Time Before Failure. An average of the time between failures, usually used in describing a hard disk or other components. An MTBF rating of 50,000 hours does not mean each hard disk will last that long before needing repair. It means that in a population of 50,000 hard disks, one will fail every hour, 24 hours per day. This means that about 18% of the drives will have to be repaired before year's end. Over a three-year period, over one half (54%) of the original 50,000 hard disks will require some amount of service.

multisync The ability of a more expensive than regular TTL monitor to adjust

- itself to a wide range of video input signal frequencies and thus be usable for a large variety of applications implemented over numerous computer platforms.
- nanosecond** One thousandth of a microsecond or in math notation 10^{-9} seconds—a very short time. Used to measure speeds of SIMM memory chips, i.e., an 80 nanosecond SIMM is capable of operating faster than a 120 nanosecond SIMM.
- network, networking** The ability to connect two devices together, similar or dissimilar, or the resultant product after it has been done.
- PC** Stands for Personal Computer.
- ports** Access connections to gain entry to the Macintosh to instruct it what to do and give or receive data from it, usually serial, SCSI, or ADB but can be via direct attachment to the CPU chip or a special connector interface.
- PMMU** Stands for Paged Memory Management Unit. Used with A/UX and Apple system 7.0 software to give multiprogramming and virtual capabilities.
- price performance** A measure of efficiency when one factor is divided by the other. Also enables different types of objects to be compared easily by setting up a standard of price and performance.
- RAM** Stands for Random Access Memory. A volatile memory. Any data stored in it is lost when the power is turned off.
- RGB** For Red, Green, and Blue, the three primary colors that are used in color monitors and TVs. Each color has its own electron gun that shoots streams of electrons to the back of the monitor display and causes it to light up in the various colors.
- ROM** Stands for Read-Only Memory. It does not change when the power is turned off.
- SCSI** Stands for Small Computer System Interface. A fast parallel hard disk interface system developed by Shugart Associates and adopted by the American National Standards Institute (ANSI). The SCSI system allows multiple drives to be connected. It supports a transfer rate of 5.0 megabytes per second. Since a byte is 8 bits, this is about the same as the ESDI 10 megabit per second rate.
- scanner** A device that converts printed information to electronic. It works similar to a copier machine except the information is stored electronically.
- sector** A section of a track on a disk or diskette.
- serial** The transmission of one bit at a time over a single line.
- SIMM** Stands for Single In-line Memory Module.
- slots** Refers to the connectors or connections used for additional boards to be added to a SE, SE 30, or Mac II family computer.
- SOJ** Refers to Surface Mount, a method of attaching chips or components to a circuit board without having to make holes; they are soldered onto the surface of the board.
- SRAM** Stands for Static Random-Access Memory. It is made up of transistors that remain in whatever state they are placed in, either on or off, until changed

or power is removed. SRAM can be very fast and does not need to be refreshed.

static Refers to an electrical charge picked up by a user that can be very damaging to delicate electronic computer circuitry, and magnetic media. Precautions need to be taken against it.

submin D A connector type typically used with the logic boards of Macintosh computers for SCSI, floppy, and video monitor connections.

SWIM Stands for Super Wozniak Integrated Machine and is the latest in the family (following the IWM) of chips that reduce complex floppy disk controller circuitry onto a single chip.

system, system icon, system software The Apple's Macintosh operating system software, totally transparent to the user, that is merely an icon in a folder which resides on a graphical desktop. The user doesn't even know of its presence, just utilizes its features.

System 7.0 The latest in the family of Apple systems and the first one to introduce multiprogramming and virtual capabilities to the Macintosh environment.

throughput The amount of data input a device is able to handle. It is a measure of capacity.

tracks The pattern of concentric circles or rings on the hard disk's surfaces, established by the formatting software, onto which the data is written.

trash icon The icon which is part of the process that allows the Macintosh user to delete a file by pointing to it on the screen and performing a simple operation rather than a command as in the DOS world.

TTL Stands for Transistor Transistor Logic. An electrical interface definition but also applies to the simplest, lowest cost class of monitors.

Unix The industry standard, multiprogramming, virtual operating system developed and supported by AT&T.

user groups Usually a club or a group of people who use computers. Often the club will be devoted to users of a certain type of computer. Usually though anyone is welcome to join.

video Visual or screen or picture-oriented data.

virtual memory A feature that allows certain operating systems to designate a portion of the disk space as a part of memory in a manner totally transparent to the user so that larger programs are apparently memory-resident all the time.

volatile Refers to memory units that lose stored information when power is lost. Nonvolatile memory would be that of a hard disk or tape.

wait state Slower devices on the bus might not be able to respond at the same speed as the CPU. For instance, if a memory access by the CPU requires more than one clock cycle, then the CPU is slowed down by having the CPU sit idle for one or more cycles while the procedure is accomplished.

WYSIWYG Pronounced wizzywig. Stands for What You See Is What You Get.

An inherent feature of the Apple Macintosh graphical interface and an attribute used by many of the software applications like desktop publishing to produce high-quality output in less time because intermediate steps are saved when the layout for the final print product is done on the screen.

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CAT Mac SE Troubleshooting Guide

Problem/symptom	Cause(s)	Corrective action
Cat Mac does not turn on, no power supply fan noise	<ol style="list-style-type: none"> 1. No power 2. Internal short 3. On/Off switch 4. Power supply 	<p>Check power cord and outlet.</p> <p>Check wiring, reverse plugs P8 and P9.</p> <p>Check wiring is per enclosed diagram.</p> <p>Possible defective power supply.</p>
No video display	<ol style="list-style-type: none"> 1. Cable 2. Monitor 	<p>Check that the monitor cable is turned on.</p> <p>Possible defective monitor.</p>
Power but no video display	<ol style="list-style-type: none"> 1. Cable 2. Turbo switch 3. Brightness 	<p>Check that the monitor cable is tight at both ends.</p> <p>Press Turbo switch and reboot Cat Mac.</p> <p>Check brightness level, increase setting.</p>
“Sad Mac” icon on monitor	<ol style="list-style-type: none"> 1. Bad SIMM 2. Logic board 	<p>Replace SIMM</p> <p>Replace logic board. This is unlikely, check all connection to logic board first.</p>
Hard disk doesn't come on	<ol style="list-style-type: none"> 1. No power 2. Hard disk 	<p>Check if the power cable to the hard disk is tight.</p> <p>Possible defective hard disk.</p>
Hard disk on, but can't talk to it (format software says no connect)	<ol style="list-style-type: none"> 1. SCSI cable 	<p>Reverse one end of SCSI cable.</p> <p>Check that the SCSI cable is tight at both ends.</p>
After formatting hard disk, reboot gives blinking question mark icon	<ol style="list-style-type: none"> 1. No software 	<p>Check that System and Finder are installed on hard disk.</p>
Floppy disk doesn't work	<ol style="list-style-type: none"> 1. Cable 2. Floppy 	<p>Check floppy drive cable not reversed.</p> <p>Possible defective floppy disk.</p>
No keyboard	<ol style="list-style-type: none"> 1. Cable 2. Keyboard 	<p>Check that the ADB cable is tight at both ends.</p> <p>Possible defective keyboard.</p>
No mouse	<ol style="list-style-type: none"> 1. Cable 2. Mouse 	<p>Check that the ADB cable is tight.</p> <p>Possible defective mouse.</p>

Users of DOS-based computers know that, no matter what a PC manufacturer does, it's always possible to get lower-priced components and add-on peripherals from third-party vendors. Now, Mac-lovers can put together the same low-cost homebuilts that have been available to the IBM world for years. **Build Your Own Macintosh® and Save a Bundle** contains all the information you need to assemble your very own "CAT Mac" — a Macintosh made up entirely of inexpensive, easy-to-obtain mail order catalog parts.

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C

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illustrated instructions
for building or
upgrading Macintosh
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About the Author

Bob Brant is a full-time Macintosh consultant, specializing in providing hardware and software solutions to a wide range of business clients. After working for ten years with Digital Equipment Corporation and Data General in the minicomputer industry, Brant gained experience in a variety of sales and management positions with Businessland, Nynex, Microage, and a national reseller in the northwest. He holds a bachelor's degree in electrical engineering from the University of Denver.

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