

# The **ENTREPRENEUR'S** Guidebook Series™

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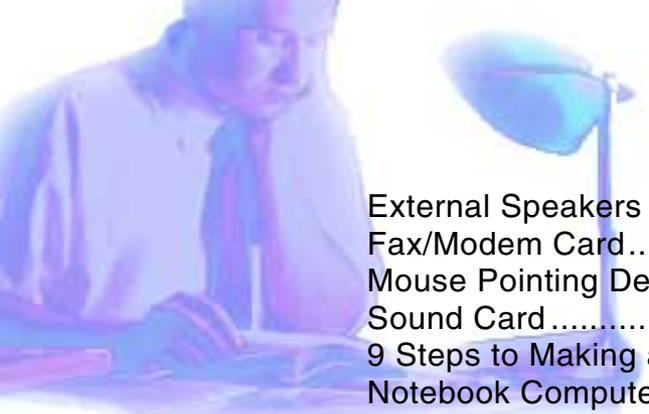
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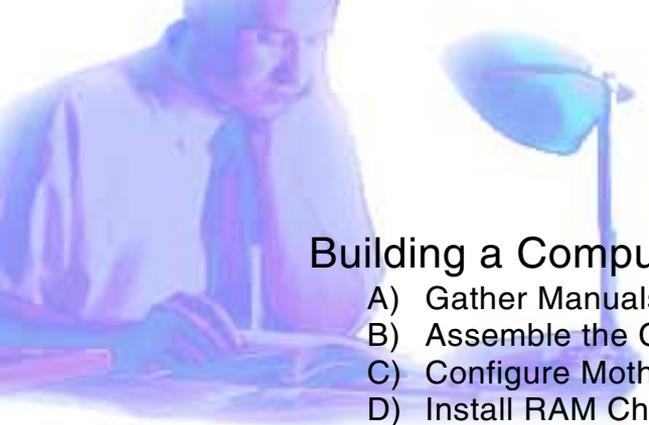
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*“Look honey – according to our fancy new 600 MHz Pentium computer . . . we’ve just run out of BEER!”*

Smallbusinessstow.com

## ***BUYING COMPUTER HARDWARE***

**IF** your business is just getting under way, the purchase of a full-blown computer system can seriously tax your cash reserves. And perhaps worse, the time and energy required to learn how to use it to its best advantage could be better spent finding customers.

However, properly incorporated into your everyday workflow, a computer can greatly improve the efficiency and effectiveness of your business. It is the *wheel* of the modern age.

Thus, for most entrepreneurs it is not a question of whether you should computerize, but when and how much should you spend – and then more specifically whether you should buy a brand name, upgrade an old beast, or build your own computer from scratch?

# BUYING A COMPUTER

---

BUYING a computer is easy if you follow this advice:

**FIRST**, choose you're operating system and software by trying out as many different platforms and titles as you can.

**SECOND**, list the "minimum" and "preferred" hardware requirements for the software you have chosen.

**THIRD**, limit yourself to a budget.

**FOURTH**, stick to your budget.

*Atari or Amiga owners might immediately challenge you to a fist fight, thinking you're about to belittle their purchase and question their sanity.*

**FIFTH**, don't let any salesman fast-talk you out of your decision unless you can verify their information from another source.

**SIXTH**, don't ask advice from other computer owners unless you understand that:

Macintosh owners will usually shake their heads and chuckle quietly if you ask them what's good about IBM compatibles; UNIX owners will squint, furrow their forehead, and then break into a long ranting speech about how superior UNIX is to all other systems combined; and Atari or

Amiga owners might immediately challenge you to a fist fight, thinking you're about to belittle their purchase and question their sanity.

**SEVENTH**, realize that more than 85% of the business world is IBM compatible, and since you're going into business, unless you have very specific needs that IBM compatible systems cannot meet, you should choose no other.

## Types of Computer Systems

There are presently four main types of computer systems for the entrepreneur to choose from:

- Amiga & Atari Systems
- IBM Compatible Systems
- Macintosh Systems

*Although overall, computers based on Intel Pentium processors, and running Windows out-sell Apple about eight to one, Apple still claims more than half the computers installed in schools. Apple is also the clear leader in the publishing industry, and it owns about 75 percent of the "electronic press" market.*

**EDMONTON JOURNAL**  
(1996)

- Unix Systems

**Amiga & Atari Systems** – In the future, it might not matter which computer you buy because operating systems will be interchangeable among various platforms (for a price of course). However, in the immediate future buying a less popular system means you'll find fewer software and hardware options, technicians rare and expensive, and resale value disappointingly low.

It is true that at one time, Amiga systems had a reputation for displaying great on-screen graphics with more colors and at a higher resolutions than either Macintosh or

IBM, and likewise Atari offered revolutionary music sequencing and sound editing packages, but that was then and this is now. Today, unless your needs are very limited, or you get the deal of the century, you should avoid both Atari and Amiga systems.

**IBM Compatible Systems** – If you're looking for the most widely used personal computer, buy an IBM compatible. IBM compatibles are cheaper than other systems because the marketplace is almost totally price-driven. Vendors do everything possible to stay competitive. Furthermore, buying an IBM compatible means you'll be able to find all sorts of software, books, newsletters, users groups, repair centers and any other sup-

port that you need to help you learn and develop your skills.

*Brand Names* – Without question, the most important benefit of buying a brand name computer is its warranty. If you buy a name

*Buying a system that has won an Editor's Choice award in a publication like "PC Magazine" is a safe bet.*

**SUPERTIP**

brand computer such as Compaq, IBM or NEC, you can take your computer to any authorized dealer in any city in North America and they will honor your warranty service. A second benefit of buying a name brand computer is you can expect reasonable to excellent levels of quality and higher resale value. Reputable manufacturers will

only cut corners so far. However, local clone dealers may advertise a machine that looks like a real bargain, but will be made up of the cheapest possible components, the slowest hard drive, an out-of fo-

cus monitor and a lousy keyboard.

**Clones** – The word clone describes an IBM compatible computer usually assembled by a local computer dealer. Clone computers have the same status as generic food – they cost less, but may not offer the same quality as the name-brand compatibles (some clones are actually superior to their name-brand counterparts depending on who’s making them – they put more money into making their computers than into marketing them).

The main disadvantage of buying a clone is getting the dealer to honor their warranty. With a clone, your warranty is good only as long as you live near the dealer (if you move you’re out of luck) and as long as the dealer stays in business.

*With a clone, your warranty is good only as long as you live near the dealer.*

Another disadvantage of buying a clone is their lower resale values.

**Macintosh Systems** – If you don’t buy an IBM compatible, your only other real choice is a Macintosh. Macintosh is the *King* when it comes to producing well-

integrated computers that look good, sound good and are user friendly (many movie stars have Mac Power books).

Mac is also one of the key originators of the GUI (graphical user interface) that has been duplicated in some fashion or another by almost every existing operating system. Many people still believe that it is the best graphics computer around because it uses WYSIWYG (What-You-See-Is-What-You-Get) graphics to show you on-screen ex-

actly what your text and graphic images will look like when printed. As well, all Macs use a system of graphic images to represent the files and programs you work with. These images, called icons, look like small pictures of familiar objects, such as manila folders, sheets of paper and even a trash can. To make its interface run effortlessly, many of these GUI files are burned into special ROM disks on the motherboard. No other PC computer can claim this feature as of yet.

**NOTE** Apple Computer Inc. in an effort to maintain its market share, has recently licensed its Macintosh operating-system software to other clone-makers, notably Power Computing Corp. of Round Rock, Texas, and Motorola.

*According to Dataquest, in 1995 Mac had about 6 percent of the business market share, compared to 14 percent in homes and 28 percent in schools world-wide.*

### **DATAQUEST**

*Why choose a Mac?* If you are buying your very first computer or if you're planning on getting a computer for the office that's

easy for everyone to learn, or if you need to produce desktop publishing or graphic images, a Macintosh is a good choice. The Macintosh also excels in multi-media applications: almost all models have 16 bit stereo sound output and music recording features built in, as well as fast CD-ROMs. Beginners will particularly benefit from a Mac because it comes preconfigured with the operating system, mouse, etc., already set up (although in all fairness more and more PCs are also being shipped ready to run as well).

Furthermore, PCs have many hidden costs. Many applications run on both PCs

and Macs, but PCs require more time to set up, configure and maintain (PCs also need larger hard drives because programs tend to be hard drive hogs compared to Macs).

In addition, the Mac is much easier to network in small workgroups with other Macs and printers than PCs are.

*The bottom line?* The Mac deserves a second look from managers and entrepreneurs who may have dismissed it several years ago because it was too expensive and lacked performance – the price/performance balance has changed considerably. Also, the Mac's easy setup and low maintenance are only now becoming appreciated by PC users struggling with the

outdated PC architecture. For people starting businesses and working out of their homes, with no on-site computer departments to turn to for help, these people need computers that aren't a hassle to set up and maintain.

*Several independent studies show that Macs are less expensive to set up and maintain in the long run.*  
**FUNFACT**

*Types of Macs* – Macs come in two basic models – compact and modular. Compact Macs incorporate the screen, disk drives, and other circuit boards in one unit. Some people like this because all you have to do is plug in the keyboard, mouse and power cord and away you go. Modular Macs separate the monitor from the main system unit like most PCs.

*Power Macs* – Power Macs use the Power PC chip (designed and produced by IBM, Motorola and Apple) as their chief power

plant. RISC (Reduced Instruction Set Computing) technology is the foundation of the Power PC architecture, and as far as Apple and IBM are concerned, the future of personal computing because of its faster performance and lower cost compared to Intel's x86 CISC (Complex Instruction Set Computing) micro-processor architecture.

Intel's CISC chips are based on technology of the 70's and some believe will soon peak in performance while the Power PC chip is based on technology of the 90's and won't even come close to reaching its full potential for another fifteen to twenty years. It is being predicted that if a significant amount of software designers produce Power PC native format software, the Power PC industry will pose a serious

*The main disadvantage of buying a Mac is there are over a million software titles for IBM and only one tenth of that for Macintosh.*

threat to Intel's domination of the computer chip market.

**NOTE** *SoftWindows*, from Insignia Solution (Mountain View, CA), offers IBM software emulation on a Power Mac. This software allows you to run Windows programs, however at a slower speed. Another alternative is an x86 add-on card, available either from Orange Micro or Apple called the *Houdini* about \$700.

*Why You Shouldn't Choose a Mac* – The main disadvantage of buying a Mac is there are over a million software titles for IBM and only one tenth of that for Macintosh. And although, Power Macs can use a windows emulation program like *SoftWindows* to run windows programs, you need more than 16 MB of

RAM and you will reduce your blazingly fast Power PC chip to 486-25 MHz or even 386 speed. The fact that Apple Inc. is currently undergoing serious restructuring, and has an uncertain future, doesn't help either.

**UNIX Systems** – UNIX is a popular, multi-user operating system. PC users can use a special version called EXNIS and Macintosh computers can use their own version called A/UX. UNIX is also used for workstations where the computer hardware being used can vary greatly from traditional systems. For the typical small business owner, due to limited software choices, it's best to stay away from UNIX.

*Overall PCs outnumber Macs on business desktops by about seven to one.*

***FUNFACT***

## Essential Computer Components

The basic components of a computer include:

- case
- floppy drive
- hard disk
- keyboard
- motherboard
- multi-I/O card
- power supply
- RAM chips
- video controller
- video monitor

When buying your components, select those of high quality with proven track records from companies with decent warranty service and technical support. Avoid buying cheap parts from companies of questionable reputation.

**NOTE** It is crucial that you acquire all manuals for each of your components. Components without manuals are next to useless.

### Computer Case

There are six basic computer case styles:

- desktop
- mini tower
- mid-size tower
- full-size tower

*Desktop cases are cramped, difficult to cool, hard to work on, and in the opinion of many, a bit homely looking.*

- industrial
- rack-mounted

Your personal preference will be based on some of the following factors:

- cost
- size
- footprint,
- portability
- storage device capacity
- method required to open cabinet (cabinets that require many screws to open and offer poor access are not good choices)
- whether the case is FCC approved

Whichever case you choose remember you will live with it far longer than any other

component.

**Desktop** – Desktop cases are cramped, difficult to cool, hard to work on, and in the opinion of many, a bit homely looking. However, if you like the idea of putting your monitor on your computer, or have specific space requirements, perhaps a desktop is your soulmate.

**Mini Tower** – Mini tower cases are sexy, handsome, cheap, and ideal solutions for computers that will perform only one function, such as word processing or accounting. However, being only 14 inches high, they tend to be cramped, even more so than desktop models and for that reason can be more difficult to upgrade. In fact, many designs limit your choice of

*In all fairness to mini-towers, as many of the basic components inside a computer shrink, their lack of space may no longer remain a serious concern.*  
**SUPERTIP**

motherboards as well as the full use of all expansion slots due to interference from drive bays and other innards. Mini towers and desktop cases have only four or five drive bays, some of which are hidden inside the case and only good for hard drives, and others which are half size and only good for 3.5 floppy drives.

**Mid-size Towers** – 16 to 17 inch-high midsized towers provide ample space inside for computer components. And being that they don't overwhelm single user environments, as does perhaps a 21-inch tower, they might make an ideal compromise between the space restrictions of the mini tower and the colossalness of a full sized tower.

**NOTE** Being that full-height disk drives, have virtually vanished, half-height devices are becoming scarce (except for 1.2 MB floppy drives and CD-ROM drives), and considering that a 300-watt power supply with internal fan is available in a 3.5 x 6 x 5.5 inch form, it has become child's play to pack a modern high-end computer into a 16 x 15 x 7 inch enclosure.

**Full-size Tower** – If you don't have any particular restricting space requirements, or if in the future you plan to add extra goodies to your machine, such as a tape drive, a CD-ROM, a 2.88 MB floppy, a sound card, a modem, a ZIP drive or something not yet invented, then consider getting a full-size tower. A full size tower has six accessible bays. It also keeps your components cooler than in other cases (cables don't coil up and re-

*Industrial cases are usually used as File Servers for networking systems.*

strict air flow and natural convection in the tower aids cooling), gives you easy access to your components making assembly and servicing easier, provides enough room to install a giant 500 watt power supply or even an internal uninterruptible power system (UPS), and can sit on your floor so it doesn't take up any desk space. For upgraders and people who really want to reap the advantages of building their own machine, a full tower case is well worth considering.

**NOTE** You may have to get longer keyboard, printer, and mouse cables depending on where you put your computer case.

**Industrial** – Industrial cases are usually used as File Servers for networking sys-

tems. However, they have some distinct advantages that may make them useful for small business owners. Firstly, they usually have at least three cooling fans to help keep today's hot running super fast high clock speed chips from melting. Secondly, they have locking front and side panels that provide quick and easy access to all internal parts. Thirdly, they can be designed to hold multiple motherboards and have more than 20 separate drive bays. Fourthly, they often come with rolling casters that allow easy mobility. And fifthly, they can be custom designed in almost any shape or configuration imaginable. However, to their disadvantage industrial cases tend to be noisy (having at least three fans going all at once), are heavy and bulky, and

*The music industry has long recognized the benefits of using rack mounted cabinets and equipment for portability, protection and ease of access.*

### **POWERPOINT**

can easily cost up to ten times more than a regular case.

**19" Rack-mounted** – Rack-mounted cases tend to be pricey but can be fitted into both large or small cabinets, offer good protection and portability, and can be even designed to slide in and out for unparalleled ease of cleaning and access to expansion slots.

### **Floppy Drive**

Floppy drives, not that long ago, came in two main sizes: 5.25-inch and 3.5-inch. A 5.25-inch drive uses either 360 KB or 1.2 MB floppy disks, while a 3.5-inch drives uses either 720 KB, 1.44 MB, or 2.88 MB floppy disks (a floppy disk is a flexible magnetic disk

permanently sealed in a thin plastic envelope). However, being that 5.25 inches drives have virtually vanished, there is little point in having both unless you want to exchange data with an older model computer.

**NOTE** When choosing your drive brand, be aware that there is a rather high probability that your read heads will be misaligned and unless you have the proper tools, you won't be able to correct this. To protect yourself from this, buy from reputable floppy drive companies like Panasonic, Teac and Fujitsu.

*As is noted in this month's PC survey, by the end of the year (96) the entry-level home PC processor will be a Pentium 133, representing a near doubling in processor speed over the course of one year.*

**COMPUTER PAPER**

## Hard Disk

A hard disk drive contains one or more rapidly spinning magnetic platters that can store massive amounts of data. Hard disks are usually installed internally and require some kind of controller card to properly connect them to the rest of the computer.

**NOTE** Most storage devices have shrunk to about 5 x 6 x 1 inches. Thus, three such drives fit easily into the space once taken by a single full-height drive.

**Types of Hard Disks** – Hard disks fall into two general categories: IDE and SCSI (pronounced scuzzy). IDE stands for Integrated

Drive Electronics and SCSI stands for Small Computer Systems Interface. Cur-

rently, the battle for the desktop hard drive market is raging between the fairly new Enhanced IDE (EIDE) (a.k.a. Fast ATA and Fast ATA-2) standard and the classic Small Computer System Interface (SCSI) standard in its newest Fast SCSI (a.k.a. Fast SCSI-2 and Fast/Wide SCSI (a.k.a. Fast/Wide SCSI-330 forms.

*IDE* – Not too long ago, most disks sold were of the IDE type. IDE disk drives are fast, inexpensive, and cheap to manufacture however limited in size to 528 MB. Drives that follow the ATA standard such as Maxtor, Fujitsu and Conner, can be mixed and matched with drives from other vendors without creating a whole bunch of hardware or soft-

Hard Drive Requirements	
APPLICATIONS & OPERATING SYSTEMS	STORAGE REQUIRED
Windows 95, Windows OS/2	50-150 MB
Business, graphics & utility software	150-500 MB
Games/education	100-400 MB
USER DATA: 3 YEAR LIFE	
Graphics, presentations, spreadsheets, etc.	300-600 MB
MULTIMEDIA & INTERNET	
Sound – 30-40 min., high fidelity	225-450 MB
Video – 30-40 min. compressed	270-540 MB
On-line services, Internet; downloaded files	100-500 MB
Why a Higher Capacity Hard Drive is Important?	
This chart illustrates how much hard drive space an average computer user would require over a three-year period (over 2 GB).	

ware incompatibility problems.

**NOTE** If the drive does not follow the ATA standard, it may still work with a different model drive, but don't count on it.

**EIDE** – Enhanced IDE drives, like SCSI, supports drives as large as 8.4 GB. EIDE also supports up to four other storage devices such as a CD-ROM or tape drives, however, some product categories, such as magneto optical drives, remain mostly loyal to SCSI.

EIDE saves you \$200 to \$300 compared with SCSI because there's no need for a costly controller, the electronics are built onto the drive itself, and EIDE interfaces are already built into most modern motherboards. Just make sure your new system's

motherboard connector and BIOS support Enhanced IDE and PIO Mode 3 (preferably Mode 4) transfer rates.

**NOTE** It should be noted that EIDE doesn't support imaging peripherals.

**SCSI** – A SCSI drive is like a high performance racecar engine – expensive, some what fussy, but very fast and impressive once installed and fine tuned. The main advantage of installing a SCSI drive is that the special (and often expensive) controller card used to drive it, allows you to attach hard disks, magnetic tape drives, CD ROMs, optical disks, scanners, mice, and printers – all from different manufacturers – to the same SCSI bus. Ordinarily you would need a slot and controller for each of

*Wide SCSI drives generally have higher sustained transfer rates needed for those working with sound and video, particularly musicians and animation artists.*

**SUPERTIP**

the above devices instead of only one.

You can also add a second drive very easily, and mix and match SCSI drives from different vendors. However, it should be noted, that for the longest time that all the above was possible only in theory and not in practice. It wasn't until Adaptec and Corel created a standard called ASPI, that software drivers written by different companies, could finally peacefully coexist.

**NOTE** SCSI drives are still solid choices for some high-end systems, but the advent of EIDE makes them probably best-suited for network file servers because the SCSI specification's advantages are irrelevant to most

*In hard drive parlance, 1 MB is only 1 million bytes, while in computing terms, 1 MB is 1,024,000 bytes. Thus, a 540 MB hard drive is really 527.34 MB.*

**FUNFACT**

desktops. If you do however decide to take the SCSI route, make sure the model you choose follows the ASPI standard, and be aware that you will constantly need software drivers to keep SCSI working in the future just like you need drivers for printers. A reasonably good 16 bit SCSI-2 controller can be found for as low as \$150.

*SCSI or EIDE* – For a long time, computer buyers have had the choice between SCSI and IDE. Consequently, debates about which technology is better have ensued for years. However, since most motherboards currently in production include Enhanced IDE interfaces, EIDE drives should be your first choice. Remember that a SCSI drive requires an additional interface, and that adds to its over

all cost.

**NOTE** The performance between EIDE and SCSI drives are very close with SCSI holding a slight edge in certain situations.

**Capacity** – At one time a 40 MB hard drive cost \$3,000 and was considered HUGE. With it, you could create word processing and spreadsheet documents for years without fear of ever running out of room.

However, nowadays massive programs can quickly fill up a 250 MB hard disk in no time. To make matters worse, new types of data, such as sound and video, require enormous amount of memory (18 MB for a single minute of CD quality Audio), making

even a 540 MB drive seem cramped. Unless you have very specific needs, it seems oversighted not get at least 3 or 4 GB. The savings from opting for a 2 GB drive or smaller are insignificant. If you drop down to a 1 GB drive, you'll indeed save a few bucks, but you'll be looking for more storage space before a year has passed.

**NOTE** Although it is wise to buy more disk space than you think you need now, don't go overboard. In the future, disks will be faster, larger and cheaper. Therefore, when you need it, simply upgrade by adding a second drive.

**How Fast** – Hard disk speed is normally defined two ways: average access time and transfer rate.

*“Coretest 3.03” and “Qbench” are two hard disk benchmark programs which can measure access time and transfer rates. They are freely available on the Internet.*

**SUPERTIP**

*Average Access Time* – Average access time measures how long the read heads take to hop from one part of the disk to another. Good access times are below 12 milli seconds, with faster drives have average access times below 8 ms.

*Transfer Rate* – Transfer rate, which is a little harder to get specs on, refers to how fast the drive can shovel data into the CPU once the heads get to the right place. Usually, the only way to accurately find this out is to install the hard disk in your system and test it. Specifications are usually overly optimistic.

Expect transfer rates ranging from 1 MB to 3 MBs per second for older IDE drives. Anything slower should be avoided. How-

*The arrival of EIDE/Fast ATA drives was an instant success. Capacities on even entry-level systems went up almost overnight.*

**FUNFACT**

ever, with the new EIDE Programmed Input/Output (PIO) Mode 3 interface, standards have been raised to burst data-transfer rates of a whopping 11.1 MB/sec from IDE's 3.3 MB / sec – a revolution that presented a challenge to Fast SCSI/2's 10 MB/sec rate. Furthermore, new EIDE and Fast ATA-2 drives supporting PIO Mode 4 have a 16.6 MB/sec maximum transfer rate. These high transfer rates are important for multi-media applications and full motion video.

**NOTE** When purchasing a hard-drive for multi-media applications it is also important to consider not only its burst transfer rate, but its sustained transfer rates. Although, new EIDE drives have faster burst transfer rates, SCSI drives have better sustained transfer rates

needed for accessing sound or video data. Remember, too, that your system's host adapter also must support the quoted transfer rate to take full advantage of the drives' capabilities.

## Keyboard

When choosing your keyboard you should consider: touch, layout, size of keys, and comfort.

**Touch** – Make sure the keyboard has a tactile feedback – in other words, a sudden click when you have pressed the key far enough. Keep in mind that though a light touch is faster, if you rest your fingers on the keyboard, you are more likely to trigger off a flurry of unintentional keystrokes.

*BIOS, an acronym for Basic Input/Output System, is a special program burned into a ROM chip that tells your micro-processor how to communicate with its hardware.*

**Layout** – Depending on what you are used to, you may prefer your function keys on the top, left or both. As well, you should note the placement of the \ ' / [ ] keys.

**Size of Keys** – Keyboards with large Backspace, Enter, Shift, and Ctrl keys are easier to use.

**Comfort** – It is important to note how the keys feel against your wrist. Some keyboards have extra length where the wrists are normally placed, while others tend to dig in if you rest your wrists on them. It is strongly recommended that you test your keyboard for at least five to ten minutes before making your purchase decision.

## Motherboard

A Motherboard is a highly complex circuit board filled with integrated circuits (ICs) and other electronic wizardry. It is the brains of your computer and for that reason demands careful selection and attention.

**BIOS** – BIOS, an acronym for Basic Input/Output System, is a special program burned into a ROM chip that tells your microprocessor how to communicate with its hardware (printer, monitor, keyboard, floppy drive and hard drive). Without it, your motherboard would be useless.

BIOS will also perform a sequence of diagnostic tests every time your computer is turned on or rebooted (if a test fails, the BIOS program will issue an un-

usual sequence of beeps and most likely display an error code on the monitor hinting as to the source of the problem).

*The control bus is a series of wire connections on the motherboard which allow data to move back and forth from the microprocessor to each of the systems expansion slots.*

Respected brands of BIOS include IBM, Phoenix, Award, and AMI (American Megatrends International). However, most programmers test their code with AMI BIOS making it by far the most widely accepted brand. If you are building your own computer, and since BIOS is the single most important factor in determining compatibility of your computer's components with software, you should choose nothing else.

**NOTE** Give extra points to those motherboards using a software upgradable flash BIOS rather than a conventional

ROM BIOS.

**Control Bus** – The control bus, also known as the Peripheral Input/Output Bus, is a series of wire connections on the motherboard which allow data to move back and forth from the microprocessor to each of the systems expansion slots.

A few years ago there was much speculation and development of control bus architecture due to the fact that CPUs became 150 times faster than they used to be, but most were still plugged into motherboards with 8 MHz Industry Standard Architecture (ISA) buses that are far too slow (especially

*The VL-Bus standard was popular for 486 motherboards. However, if you're considering a used DX solution, steer clear of combo motherboards with both VLB and PCI slots. Add-on cards generally take a performance hit in these systems. Stick to either VLB for a 486 or PCI for a Pentium.*

**SUPERTIP**

when handling graphics). For example, a 25 MHz 486 can move data at about 74 MB/sec but an ISA bus can only handle 16 MB/sec, hence an enormous bottleneck is created. Even the Extended Industry Standard Architecture (EISA) bus had only a top speed of 32 MB/sec.

To solve the bus problem, the Video Electronics Standards Association (VESA) developed a local bus standard called VL-Bus that allowed the CPU to talk to up to three devices at a sustained transfer rate of 130 MB/sec. (VL-bus runs at the speed of the processor, up to 33 MHz). Although this bus was by no means perfect – it was difficult to configure and in most cases was designed to

supplement an ISA bus rather than radically change it – VL-bus took the computer market by storm boasting video speeds almost six times as fast as non-local bus systems. However, VL-bus systems have all but disappeared, existing only on cheap 486 systems. The new standard is Intel's PCI (Peripheral Connect Interface).

**ISA** – ISA will be around for a few more years. A huge number of accessory cards fit this bus. Many motherboards still have an ISA computability slot or two to handle old style adapter cards (however, this is changing). ISA adapter cards are also cheap to manufacture, which assures them a long life.

**VESA** – VL-bus was a quick and cheap so-

lution to the bus bottleneck problem. Unfortunately though, low-cost design techniques limited the bus to either two or three slots, and because it hadn't been around as long as the ISA bus, had more potential

for creating computability problems.

If you do pick up a used VESA motherboard (for \$20) make sure to try and get your VL-bus adapter card from the same company that designed your motherboard (adapter cards designed for one type of local bus might not work in a different computer).

**PCI** – The PCI bus is more expensive than VL-bus. However, it is also technically sounder, can operate at higher speeds, can drive more circuit cards, and can be designed to allow automatic configuring of IRQ's and addresses for all com-

*Putting an ISA bus in what is essentially a PCI-based machine screws everything up..*  
**JIM SEYMOUR**  
*PC Magazine 98*

patible expansion cards. Most computer builders didn't like Intel's monopoly on the 486 chip and were hesitant to give Intel exclusive control over another part of the computers anatomy, however this bus is the dominant bus in the computer industry.

**NOTE** The Peripheral Component Interconnect (PCI) bus is the design of choice for Pentium systems as well as Apples' Power Macs. New versions of the PCI bus offer no ISA compatibility slots. Many experts in the industry are very excited about this. Adding ISA slots slows down the PCI bus and creates IRQ conflicts.

**Expansion Board Slots** – On most motherboards you will find eight expansion

slots. Into these expansion slots fit half-size, three quarter-size or full size expansion cards, often called controller cards or adapter cards. When choosing your motherboard, if you have a couple of ISA cards kicking around that you still want to use, to be safe, buy a board that contains two or three ISA slots. Better yet, trash the old ISA cards and upgrade to PCI cards.

**Microprocessor** – The microprocessor or CPU (central processing unit) is the part of the motherboard that performs the basic operations and calculations of the computer. It is the most expensive and the most

complex integrated circuit (IC) on the motherboard.

**NOTE** An integrated circuit (IC) is a highly

*The microprocessor or CPU (central processing unit) is the part of the motherboard that performs the basic operations and calculations of the computer.*

miniaturized electronic circuit fabricated in specially prepared silicon. These silicon chips are sealed in plastic or ceramic packages and typically provided with two paralleled rows of pins for insertion into circuit boards.

**Clock Speed** – The speed at which a microprocessor performs calculations, measured in megahertz (MHz). Common clock speeds range from 4.77 MHz to more than 300 MHz.

**DX Microprocessors** – Old DX 486 microprocessors contained special circuitry to help perform mathematical calculations. A 486 DX chip is better than a stripped down 486 SX chip.

*The Cyrix 6x86 166+ outperforms the Pentium 166 in the BabCo NT and ZD Winstone 96 test by about 5%. However, the Pentium Pro 166 beat the Cyrix P166+ by 58% when operating in 32-bit code, even though it is actually slower in a Windows 16bit/32bit code environment.*

**FUNFACT**

**x86 Series CPUs** – Made by Intel, AMD and Cyrix. Intel dominates the market but both AMD and Cyrix make reliable copies and in some cases of superior design. In terms of speed, a 586 (Pentium) chip is faster than a 486 chip, which is faster than a 386 which is faster than the old 286 chip.

**486 Chips** – While it not quite time to eulogize the 486, its lifetime is winding down in an ever-tightening spiral. At this point, the only sub-Pentium chip worth considering for a desktop is the IntelDX4/100 or its AMD Am486-DX/100 counterparts.

**AMD, Cyrix and NextGen Chips** – The Pentium is currently ruler of the desktop,

but there are several would-be successors hoping to push it off its throne including Advanced Micro Devices K5; Cyrix's 586 and 686; and NexGen's Nx586 and The AMD and Cyrix chips are designed to be pin-compatible Pentium competitors, requiring only some additional chipset support to become plug-in replacements for Intel's fifth-generation CPU.

*Motorola Chips* – Motorola's 68030 and 68040 chips used in older Apple, Amiga and Atari computers should be avoided by novice computer builders. There is little written material and third party product support to help get this kind of system going.

*Pentium Chips* – Intel's 3.3 volt, second-generation 90 MHz, 100 MHz, 120 MHz

133 MHz and 166 MHz Pentiums are solid bets in used machines. Stay away from the original 5-volt 60 MHz and 66 MHz Pentiums are out of the high-end PC picture for good.

*Pentium MMX Chips* – MMX chips have extra circuitry to speed up the handling of graphics and sound. For a high-end system, MMX is the way to go.

*Pentium Pro Chips* – Intel's own P6 (Pentium Pro) is blazingly fast when processing 32-bit applications. However, if you are using Windows 3.1 or Windows 95 you're better off sticking to Pentium 166 and 233 MHz MMX systems.

*PowerPC Chips* – The PowerPC chip made by Apple, IBM and Motorola, despite a

*MMX chips have extra circuitry to speed up the handling of graphics and sound.*

mountain of hey over its introduction, has so far has proven to be the lion the squeaked.

**RAM Slots** – The most widely used, cheapest and easiest to install RAM chips are SIMMs. SIMMs RAM chips are on miniature cards (modules) that hold 256 KB, 1 MB, 4 MB, 16 MB or 32 MB in total and have to be added four at a time. These cards clip into slanted racks on the motherboard. When buying your motherboard, make sure it supports SIMMs RAM chips.

**External SRAM Cache** – SRAM is super high-speed 15 to 20 ns memory added to motherboards to keep up with CPUs that are too fast for regular 60 to 70 ns RAM. With it, you can create an SRAM cache

*Most motherboards have 8 racks (two groups of four) that hold up to 128 MB of RAM.*  
**FUNFACT**

that uses a special cache controller to keep track and duplicate the parts of regular RAM the CPU uses most often. This can greatly improve the performance of your computer. However, SRAM is very expensive compared to regular RAM and thus motherboards are designed to hold only 32 to 512 K (with rare exceptions holding a full MB or more).

Choosing the quantity of external cache for your high-end system is relatively easy. Although a 512K level 2 cache is appropriate for maximum performance with 486 machines, the efficiency of the Pentium's internal cache makes and L2 cache larger than 256 k overkill.

**NOTE** Motherboards also contain a small amount of even faster 10 to 15 ns TAG

RAM that tracks which part of the main RAM are duplicated in the SRAM cache.

### Support Chip Set –

The support chip set helps the CPU interface with the rest of the computer, handling such tasks as copying data from the hard disk to RAM or tapping the CPU on the shoulder when being accessed by a peripheral device. The support chip set should be a well known brand made by Intel, OPTI, or C&T (Chips and Technologies: most programmers test their code on C&T). If you select motherboards

*To get a good understanding of RAM and Hard disk space, think of a desk. The amount of room you have on top of your desk is like your RAM space. The more room you have the more files (applications) you can look at. Think of your hard disk as the space you have in the drawers under the desk to store these files. The larger your hard disk, the more storage space you have inside.*

### **SUPERTIP**

with anything else, you are more likely to run into compatibility problems.

**NOTE** While there are plenty of Pentium motherboards using Intel's Neptune II chip set or some third party, work-alike brand, your target for a high-end, single-processor system should be Intel's new Triton chip set. Moving data quickly is the whole point of high-end computing. Triton allows for roughly 150 percent more bandwidth between the CPU, memory bus, and data bus – (translating into) 100 MB per second compared to 40 MB per second for Neptune.

Triton also offers enhanced cache and main-memory support, including compatibility with the newest RAM architectures. This can mean as much as a 30 percent overall performance increase over a comparable Pentium PC without Triton to manage its affairs. Triton chips also raise the number of available PCI expansion slots from Neptune's two to three.

**Upgradability** – Although, some people change their entire motherboards about every three years, it is possible to add new ICs, faster CPUs and other gadgets to existing motherboards to increase their performance. There are at least four ways in which you can upgrade your motherboard.

*Overdrive Chips* – Also called an overdrive

*Clock doublers give off a lot of heat. If you add one to your motherboard, you may also have to upgrade your cooling system.*

IC, essentially doubles the clock speed of your CPU, turning for example, an old easy going 486 25-MHz machines into a screaming 486 100-MHz hot-headed monster. Intel, Cyrix and AMD make doubling chips. If you hope to upgrade with this chip in the future, make sure your motherboard has an overdrive socket and supports these newer chips.

**NOTE** Clock doublers give off a lot of heat. If you add one to your motherboard, you may also have to upgrade your cooling system.

*Math Coprocessors* – act as a slave to the CPU taking over certain processing functions to speed up performance. People running CAD systems usually benefit most from installing a math coprocessor. If you

need this feature, make sure the motherboard you purchase has a math coprocessor socket.

*Upgradable ZIF Sockets* – (zero insertion force sockets) accept Intel’s new Pentium chip.

**Other Considerations** – In addition to all the features listed above, motherboards should be selected based on the following design and construction features.

*Battery* – The motherboard’s battery keeps the time and date clock-calendar running, even when the power is off. It also keeps the computer’s configuration information stored in CMOS. When it dies, the computer forgets all its previous settings and has to be reconfigured. The best battery to have on your motherboard is a Lith-

*The best battery to have on your motherboard is a Lithium battery.*

ium battery. Lithium batteries once installed can be forgotten about for years before being replaced. On the other hand, other types require periodic attention and replacement, especially the so-called rechargeable ones.

*DIP Switches* – DIP switches are a set of small on/off switches mounted on circuit boards used for choosing different options for the circuit board. A good motherboard makes these switches easy to access and hence change without having to remove a whole bunch of computer components.

*Four-layer Boards* – Four-layer boards are slightly more expensive than two-layer boards; however, the additional layers provide more immunity to electrical noise that

might otherwise adversely affect the operation of your computer especially, your sound card.

*Size* – Over the years, motherboards have shrunk from an average size of 12 x 14 inches to a more compact 8.5 x 13 or even 8.5 x 10 inches. Make sure the board you choose actually fits in your computer case.

*Special ROM Chips* – Special ROM chips are memory ICs that can be read from, but once factory programmed, cannot be written to. Some computers include a programming language in ROM, as well as a user-accessible ROM monitor programs for performing extended diagnostics, and even writing machine-level programs directly into the machine. The old Radio Shack 1100

*Intel's processors are used in nearly 80 percent of existing PCs.*

### **FUNFACT**

FD portable included a simple graphical interface and word processor burned into a ROM chip. The advantage of this was there was no need to access a hard disk or floppy disk making it seem much faster than its chip speed suggested.

*Quality Workmanship* – Workmanship on a board can usually be determined by examining the soldering and the copper traces of the motherboard in question. If they do not look neat and clean don't buy it. Miniature cracks and bad connections, invisible to the eye can cause you endless problems. Reputable manufacturers of motherboards include: IBM, Jayco International and Dell.

## Multi - I/O Card

The multi-input / output card, or controller card as it is often called, is a strange beast. In older model computers it provided one parallel DB-25 port to attach your printer, two serial RS-232 ports to attach a modem and a mouse, and a joystick port, as well as, support for two floppy drives and two IDE hard drives. However, considering, the scope of its responsibilities, it may be surprising to find out that most Multi I/O cards being used today, no matter how expensive the computer is, are 8-bit cheapies. \$16 IDE multi-I/O cards can

*If any area of PC evolution has lagged over the last decade, it's memory design. While CPU and bus speeds have been soaring, dynamic RAM speeds have been locked in amber. We've been stuck with 60-nanosecond (ns) DRAM for years. Even the slightly faster, somewhat offbeat 54 ns variety has been around for a least two years now.*

### COMPUTER SHOPPER

cause nothing but trouble in \$3,000 machine. Therefore, if you want to be safe, choose a quality Multi-I/O card such as the

Everex Brand. Everex has a well-deserved reputation amongst custom computer builders as being very reliable and compatible.

**NOTE** Make sure you buy a Multi-I/O card that takes advantage of higher speed PCI bus. It should also be noted that most of the motherboards being manufactured today have built in I/O interfaces.

**PC Serial Ports** – Make sure your new PC serial ports are controlled by 16550C universal asynchronous

receiver / transmitter (UART) chips; this will allow you among other things to get the most out of your external modems.

**Enhanced Parallel Ports** – To get the most from the latest Windows-based printers, which can alert you to paperjams and similar problems make sure the PC's parallel port meets the bi-directional Enhanced Parallel Port (EPP) standards.

### Power Supply

The power supply is a box that converts 110 volt AC current from your wall outlet to 12 volt and 5 volt DC battery-style power that your computer uses. To work properly, your computer needs this DC power to be smooth, even when the AC power coming

in is rough. In fact, the faster your computer is, the more sensitive and prone to damage it is due to *rough* or *dirty* power. When buying your power supply you should thus consider:

*The power supply is a box that converts 110 volt AC current from your wall outlet to 12 volt and 5 volt DC battery-style power that your computer uses.*

- your present and future power requirements (power supplies are rated by wattage – the higher the wattage, the stronger the power supply)
- the amount of space available in your case
- the number of power connectors provided to hook up components
- the quality of the fan provided (most power supplies now have *smart* fans which turn off when not needed)
- the actual *purity* of the power the power

supply provides regardless of AC conditions

**Quality Power Supplies** – Quality power supplies use big heavy capacitors to provide power during brief voltage sags and to absorb voltage spikes often caused by office copiers, fans, other motors, or even fluorescent lights on the same circuit. Most cases come with power supplies already installed, but these power supplies tend to be of low-end quality, having noisy fans and providing very little protection from AC glitches.

Since your power supply is the engine of your computer, and like your case, will be with you for a long time, this is no place to scrimp. You have two choices: buy a case and power supply separately and then in-

*The best quality “Turbo Cool” power supplies are made by PC Power and Cooling in the USA.*

stall the power supply yourself; or ask the company you’re buying your case from to upgrade your power supply (naturally at additional cost to you).

The best quality “Turbo Cool” power supplies are made by PC Power and Cooling in the USA, although they cost more than twice as much as an ordinary power supply. Other reasonable intermediate brands are Senstron, Jaba and Maxpower all of which have UL (Underwriter’s Laboratories) approval.

**Making Your Own Cables** – Most prefabricated ribbon cables that come with your power supplies, motherboards, hard disks and other peripherals are usually of low quality. Cheap cables, poor connec-

tions on the cable ends, or even damaged cables, can lead to computer malfunctions.

To prevent this problem, build your own cables using high-quality gold-plated connectors (U.S. – made connectors such as Robinson, Nugent or Amphenol have much stronger springs to grip tightly), and 3M flexible ribbon cable. By making your own cables, not only will the conductivity of your connections be superior, but you can also make the cables exactly the right length. This reduces the antenna effect that attracts electrical noise into the cables.

## Ram Memory

Whenever you load a program into your computer, the computer reads the informa-

tion from the disk and copies it into what is called Random Access Memory. RAM is made up of high-speed memory chips that can hold data and program information only as long as the computer is on.

### What kind of RAM should you buy?

There are two factors to consider when buying RAM: type and speed. In regards to RAM type and even brand name, buy only the type of RAM your motherboard recommends. See your manual. The second factor you must consider when buying RAM is how fast it is. Most

RAM nowadays is 60, 70 or 80 ns (nanoseconds). 60 ns RAM is faster than 70 and 80 ns RAM but costs more (not to long ago RAM used to run at speeds between 100 and 150 ns). The speed of RAM you buy will depend upon the type your mother-

*A serious PC without at least 16 MB of memory is like a day without sunshine.*

**FUNTIP**

board supports. If your motherboard gives you the option of configuring at different speeds, use the fastest type of chip you can afford, however don't mix RAM of different speeds in the same rack.

**NOTE** RAM does not deteriorate with age, so old RAM, providing it's the right type and speed is just as good as new RAM. Consider buying old RAM through a memory dealer, especially if the seller has stored it in a static bag. Also, although most brands of RAM are quite safe, it is better not to mix RAM chips made by different companies.

*EDO RAM and Pipeline Burst Cache* – It wasn't long ago that improved types of memory features such as EDO and pipeline burst cache, were found only in high-

*RAM does not deteriorate with age, so old RAM, providing it's the right type and speed is just as good as new RAM.*

end systems. However, today these features are standard giving new PCs a significant speed boost.

**NOTE** Make sure your motherboard supports these features if you want to upgrade them later.

**How much RAM should you buy?** Buy a minimum of 16MB if you don't have precise RAM requirements (this allows you to easily upgrade to 32MB without selling your old RAM). Or buy as much RAM as you can afford keeping in mind your present and future needs.

For DOS word processing, 4MB should suffice. For Windows 3.1, 8 MB is comfortable if you usually only open one application at a time. For Windows95 12MB to 16MB is a good starting point. Anything

less will be noticeably slower. For graphics intensive programs such as games, spreadsheets, drawing and page layout programs, or for heavy administration tasks where two or more applications are open at the same time, 32MB is recommended. If you are running Autocad or graphics software such as CorelDRAW, and especially if you run both applications at the same time, 64MB is recommended. In general the more RAM you buy, the more powerful programs you can run, and the more programs you can run at the same time.

**Hard Disk Caching** – is one of the easiest and least expensive ways to increase the performance of your computer. A hard disk cache use RAM memory set aside for temporarily holding data stored

*Microsoft first demonstrated its unreleased Windows 3.1 using 14 MB of RAM. Although 14 MB sounded like a lot then, today it sounds a bit cramped.*

#### **FUNFACT**

on your hard drive. By letting the CPU access data direct from its memory (the RAM cache) instead of the slower hard drive, it can run much faster.

To install a RAM or hard disk cache you need a hard disk caching program and free RAM. The cache program then monitors the use of your hard disk, and attempts to keep the hard disk data you use most often in a private “cache” stash. When the CPU needs this data, the caching program intervenes and hands it over to the CPU hundreds of times faster than it would take to retrieve this data from your hard disk. Similarly, when writing data, the CPU writes first to the cache, and only when the cache is full does the I/O processor transfer data to your hard

disk.

The most reliable caching program is Super PC Kwik. Norton Utilities also comes with a fast cache called *ncache*. Microsoft's DOS version, *smartdrv.sys* is a little slow in comparison. However, its Windows cousin, *smartdrv.exe* is much improved.

**NOTE** Hard disk cache sizes usually range from 512 KB to 2 MB.

**Adding Ram** – To add more RAM to your computer, you have two choices. You can plug the memory chips directly into the motherboard to create *extended memory*, or you can plug them into a memory expansion board and then plug this board into an open expansion slot on your motherboard to create *expanded memory*. In either case, you'll

*Older motherboards often only accepted magic combinations of RAM.*

need a memory management program that controls the additional memory.

**NOTE** Older motherboards often only accepted magic combinations of RAM. For example, some machines would not allow 6 MB total RAM, only 4 or 8 MB. This became further distressing to you if you want to upgrade your RAM at a later date. For example, on some machines to go from 2 MB to 4 MB, you didn't simply add 2 MB. You had to remove all 2 MB of your old RAM and replace it with 4 MB of a different type. Similarly, when you grew from 8 to 16 MB, again you had to throw out all 8 MB of your old RAM and replace it with 16 MB of a different type. Unfortunately, you could not just start off with one 4 MB SIMMs module, and expand in 4 MB increments (older computers like to have at

least 4 full banks of RAM).

**NOTE** Make sure your new PC is configured to use the fewest possible number of SIMM memory sockets.

### Video Controller Card

A video card is a controller card added to your motherboard via an expansion slot to generate the video signal needed to produce a picture on your monitor. When buying your video card you must weigh price with features such as lines of resolution, depth of color, refresh rate, and speed. Don't settle for anything less than a PCI graphics adapter with at least a 64-bit graphics accelerator chip.

**Lines of Resolution** – Resolution, refers to the number of columns, pixels, or dots,

displayable across the screen and the number of rows of pixels displayable down the screen. When you see the term 640 by 480 resolution, this refers to a graphics adapter capable of showing 640 pixels across the screen in 480 horizontal lines from top to bottom. The higher the resolution, the more you'll be able to display on the screen and the smoother the characters, because the pixels in each character will be closer together at a higher resolution than they are at a lower resolution.

*Make sure your new PC is configured to use the fewest possible number of SIMM memory sockets.*

The different types of resolutions you should be familiar with are VGA resolution (video graphics array: 640 x 480) SVGA resolution (super VGA: 800 x 600) or the newest and not yet fully accepted EGVA resolution (extended VGA 1,024 x

768).

When choosing your video card, unless you are doing professional publishing, VGA and SVGA resolution are fine (many windows owners prefer SVGA resolution).

**NOTE** High-resolution cards are good if you want to view more than a couple of columns all at once on a spreadsheet or database. However, as you increase your resolution, you tend to lose depth of color and increase your flicker rate.

**Depth of Color** – The number of distinct colors you can see on your monitor, often

*A top rated graphics card is Diamond Stealth 64. Other popular and reputable accelerator cards are the ATI Advantage and Ultra series, the S3 series made by Baballo and the more elaborate and more expensive TIGA boards which use the TI TMS34010 or 34020 chips (these chips are true auxiliary graphics coprocessor that runs its own programs to draw the screen).*

**BUYING TIP**

referred to as color depth, is determined by the number of bits used to create each pixel. The more bits, the more colors. A 4-bit video card gives you 16 different color shades, while 8 bit gives you 256, 16 bit 32,768 and 24 bits 16.7 million colors (true color).

The lowest standard you want supported in your video card is the VGA standard. The VGA standard demands a card that can display up to 256 colors at 640 x 480 lines of resolution (VGA cards can be found for less than \$50). It is generally accepted that 256 color is fine for mainstream

business users. Compared to 4 bit, it vastly improves the appearance of gray scale

photographs, color bitmaps and color blends.

However, the standard most computer cards presently follow, is the SVGA standard. The SVGA standard is much more loosely defined and can range from cards that display 800 x 600 line of resolution at 256 colors to 16.7 million colors.

Read your cards specifications carefully. High performance 16 and 24 bit cards are overkill for most users unless you are doing for example high-end color publishing and photo retouching.

**NOTE** If you choose to get a 16 or 24 bit card you will also need extra computer processing power and memory to handle it.

*It is generally accepted that 256 color is fine for mainstream business users.*

**Refresh Rate** – Your video card redraws the picture on your monitor many times a second. The faster it does this, the less flicker it creates and the less fatigue on the eyes (the steadier and more stable the image). Refresh rates typically vary from 60 Hz to 120 Hz and higher with higher being better. In an effort to eliminate low refresh rates and establish a reasonable standard of quality the industry group VESA (Video Electronics Standards Association ) has established minimum refresh rates for popular resolutions. Current VESA specifications are for a 72 HZ minimum refresh rate in VGA and SVGA and 70 HZ at EVGA. That means the picture is refreshed at least 70 times per seconds and you will be spared the eyestrain and headaches of a flickering screen.

**NOTE** For you eyes sake, a card capable of non-interlaced refresh rates of 75 Hz to 100 Hz throughout the range of resolutions you plan to use is mandatory.

**Video Memory** – The more memory on a graphics card, the faster the computer displays images and the more realistic those images. Video memory determines how screen resolution and depth of color. Two megabytes of onboard video memory will let you display 24-bit true color (16.7 million colors at resolution up to 800 x 600 pixels), the maximum a 15-inch monitor realistically can support. For a 17-inch or larger monitor, you'll want a

*CAD users will want a graphics card with built in 3-D acceleration, while multimedia mavens should look for one able to accelerate and enlarge motion-video playback as well as general-purpose graphics.*

graphic card with 4 MB of memory to support true color at resolutions up to 1,280 x 1,024.

While DRAM-based graphics cards are less expensive, VRAM-based models are faster. You should also consider graphics cards with Windows RAM (WRAM), which is slightly cheaper than VRAM, but has been optimized to be as fast or faster for graphical environments.

**Type of Card** – PCs equipped with VL-Bus (VLB) video cards are virtually extinct. Many vendors sell only PCI-based graphic cards. Thus, if you're buying a new PC, consider only those systems with PCI architecture.

## MPEG and 3-D Acceleration Boards –

CAD users will want a graphics card with built in 3-D acceleration, while multimedia mavens should look for one able to accelerate and enlarge motion-video playback as well as general-purpose graphics. Look for boards that offer enhanced MPEG full-screen video playback and motion-video and capture facilities.

## Graphic Accelerator

**Boards** – When running windows, your video card has to paint 112 individual dots on the screen every time you hit the letter “A.” (DOS programs, by contrast, can paint the “A” in a single stroke). This slows the ability for your computer to scroll and manipulate pictures.

*Monitors are enormously better now than they were six or seven years ago. They are much easier on the eyes, have much higher resolution, and are generally cheaper and offer better value for the lower prices.*

**COMPUTER SHOPPER**

To solve this problem, many people install video cards with special circuitry that speeds up the handling of graphics.

A graphic accelerator works by using mathematical formulas to paint characters and line art instead of painting each individual dot, and in the more expensive models, uses separate coprocessors to take over the task from the CPU.

## Video Monitor

Although your computer chip may be obsolete in less than a year, a good monitor will last 3 to 5 years and still be quite competitive. This is partly evident in the increasing trend for computer stores to advertise

prices of their computers without monitors more and more frequently. A monitor is thus more of a long-term investment than a computer's motherboard.

**Dot Pitch** – Monitors arrange color phosphors or pixels in groups of three. Dot pitch refers to the size of a dot made up of one red, yellow and green pixel each. Specifically, it is the distance from the center of one dot to the next. The smaller the dot pitch the crisper and cleaner your image. Typical dot pitches measure from 0.24 to .51 mm. Exactly what pitch you need for a resolution depends on your screen size. Putting more dots on a smaller screen require a tighter pitch. For a monitor 17 inches or smaller, 0.28 mm is generally considered the mini-

*The more memory on a graphics card, the faster the computer displays images and the more realistic those images.*

imum. 20 and 21 inch monitors should have a dot pitch of 0.31 mm or less.

**NOTE** 0.28mm dot pitch provides an effective resolution of 100 DPI on the screen.

**Focus and Convergence** – Focus and convergence determine how sharp or fuzzy the characters in your text document or spreadsheet look (as resolutions get higher, this issue becomes even more important because characters get smaller).

**Focus** – Refers to how sharp the transitions are between dark and light: when you look at a black dot on a white background on a good monitor, the edge of the dot will be sharp.

**Convergence** – Refers to the overlap of the three primary colors, red, blue and green

that form white: good convergence means the three colors overlap perfectly so there is no ghost or shadow around the image. Although for the most part, focus and convergence is determined by the quality of electronics in a monitor (it has nothing to do with dot pitch), when judging its performance, believe your own eyes not spec sheets.

**Refresh Rate** – With the help of a video card, monitors draw pictures one horizontal line at a time, going from the top to the bottom. How fast they accomplish this task is referred to as the horizontal scan rate and is measured in kilohertz (KHz). However, when talking about refresh rate most people are referring to the vertical refresh rate (usually lower) which determines how

*Focus and convergence is usually best in the middle of the screen, but a good monitor also remains clear and sharp on its edges.*  
**SUPERTIP**

long it takes to completely redraw the screen.

When buying your monitor, keep in mind that horizontal and vertical frequencies are related to each other. At any given resolution, the longer it takes to write each line on the screen, the longer it will take to write or refresh, the whole screen. With a slow vertical refresh rate, your monitor suffers from screen flicker because the phosphor loses its glow before the CRT's electron gun gets back to the same spot to refresh it. However, increasing the refresh rate also shortens the time available for painting pixels on the screen, boosting the required line scan rate. Only high quality monitors can do both.

Your monitor in conjunction with your video card should be able to refresh at a non-interlaced rate of at least 72 Hz (the more the better) for 800 by 600 and 70 Hz for 1024 by 768. If the monitor (and/or graphics card) won't support at least 72 Hz, then the user is more likely to have eyestrain problems.

**NOTE** Multi-frequency monitors can operate at more than one set of refresh rates. It is wise to invest in such a monitor so when new standards and video cards are developed your monitor will be able to synchronize with them.

**Interlaced vs. Non-Interlaced** – An interlaced monitor scans line 1,3,5 and then when it gets to the bottom of the screen goes back and scans 2,4,6. This is a

*While monitors for computer displays range in size from 9 to 39 inches, the most popular sizes are between 14 and 17 inches.*

cheap way to get higher resolution, however, it also creates flicker. In a non-interlaced monitor, the electron gun paints each line in turn as it moves down the screen. When selecting a monitor, make sure your monitor can handle the highest resolution you want in non-interlaced mode (i.e. your monitor should be capable of displaying SVGA without flicker).

**Size of Monitor** – While monitors for computer displays range in size from 9 to 39 inches, the most popular sizes are between 14 and 17 inches. However, the actual viewing area on any given monitor can vary quite a bit from its 14-inch or 17-inch label. Monitor sizes are given as diagonal measurements, corner to corner, of the cathode ray tube (CRT) itself, rather than of the glass

visible within the frame around the perimeter of the screen. A so called 14-inch monitor's actual screen can vary from 13 to 13.8 inches while so-called 15-inch have screen sizes measuring 13.4 to 14.2 inches and 17-inch monitors have screen size measuring just over 17 inches.

Ideally, everyone should go out and buy a 17-inch monitor. With the world marching toward graphical interfaces that put more and more information on-screen, a 17-inch display is a better buy. Such a screen can put 1,024 x 768 or 1,280 x 1,024 pixels in your field of vision. In corporate settings and small businesses where one PC performs many

*Early computer monitor originally shred a lot of features with NTSC television monitors. Most of them had low 15.75 KHz frequencies and interlaced video display. This meant that they flickered so badly that they were extremely difficult to watch for any length of time.*

### **COMPUTER SHOPPER**

tasks, a 17-inch monitor is better. A 17-inch monitor is also extremely well suited to demanding graphic display requirements, such as CAD, desktop publishing, animation, video and spreadsheet use. However, 17-inch monitors are more expensive (prices are usually 50% higher). Thus, settling for a 15-inch monitor seems to be a popular solution nowadays, even though their optimum usability stops at 800x600 resolution.

For most businesses and home uses, 15-inch display are adequate; though heavy game users might complain. On the other hand, \$1,500 21-inch monitors are an unnecessary expense unless you are perhaps a graphic artist and can really make use of a

large screen.

**NOTE** The 14-inch monitor is diminishing quickly, as the price of 15-inch monitor has continued to decrease. However, fourteen-inch monitors are still common in budget PC configurations.

Many of the 14-inch monitors remaining on today's market are indeed extremely well-priced, but they may lack current features such as Energy Star power savings and MPR-II low radiation emission, and have fewer display control options on the front panel. They also typically can't display at the highest resolution levels and refresh rates that a current graphics accelerator can produce. The simplest reason for this is that the detail in

*There is concern that low level emissions pose a subtle, long term risk to people - but MPR-11 compliant monitors may not be any more dangerous than the clock radio next to your bed.*

#### **FUNFACT**

higher resolution screens, (1,024 x 768) would be too tiny to see clearly on a small monitor, so there's no point. However, on a 17-inch monitor, the extra detail becomes noticeably more useful.

#### **Compatibility with Video**

**Card** – When buying a monitor, you must buy one that matches your video card and vice versa. For example, if you have a SVGA video card, and buy a plain used VGA monitor, you won't get 16.7 million colors at 1024 x 760 resolution. As well, if you have a card that only supports a refresh rate of 60 Hz and a monitor that has

a maximum refresh rate of 72 Hz you won't get that crystal clear image you've been searching for either.

**Energy Star Low Power Options** – The better quality monitors have Energy Star power saving features (a so-called “Green” monitor) to reduce power consumption.

**MPR -II Standards** – High quality monitors follow the MPR - II standards set in Sweden that limit the amount of radiation coming out of a computer. Although, there is no direct evidence that this radiation can damage your body, better safe than sorry.

**Types of Monitor Tubes** – Conventional tubes have a bulge in the middle and rounded corners. These tubes are cheap to manufacture but because of their shape, have less room to display images. Conventional tubes typically have large black frames around their

*Monitors that use Sony, Toshiba or other high quality tubes are simply better than those that use run-of-the mill, bargain tubes.*

images. However, Trinitron and flat-screen displays are much improved.

The *Trinitron* display, developed by the Sony corp., has removed the bulge in the middle and replaced it with a consistent curve from side to side and no curve from top to bottom. On the other hand, flat-screen displays, which came into their own in 1992, are specifically designed to be much flatter, provide a larger image area, and have very square corners. Although, Trinitron or Flat-screen monitors are more expensive than curved monitors, to their advantage they also have less glare, brighter images, and improved focus and convergence.

**NOTE** Monitors that use Sony, Toshiba or other high quality tubes are simply better

than those that use run-of-the mill, bargain tubes.

**Other Considerations** – Make sure your monitor has a swivel base to allow users to adjust the angle of viewing to the most comfortable position and easily accessible controls for size, position and brightness – preferably digital. Also, make sure it offers automatic power reduction and shutoff.

**Editor’s Brand of Choice** – The *ViewSonic 15GA* monitor includes built in speakers and OnView controls which allow you to make image and audio adjustments right on the screen. With the latest dome speaker technology and microhole speaker grills integrated into the monitor bezel you can hear high fidelity stereo sound. There is also a built-in mi-

*In the 17-inch monitors, take a look at the Mitsubishi Diamond Pro 17 TX.*

crophone, headphone jack and external microphone port. And, when the phone rings, you can mute the sound with the touch of a button.

This monitor also exceeds MPRII and EPA Energy Star requirements, and has also adopted the most stringent Swedish TCO standards for reduction of heat emissions and exposure to electromagnetic fields. It also features a Super Contrast screen and 0.27 dot pitch resolutions. This monitor is also Plug & Play for Windows ‘95 and comes in a 17-inch version.

Other superb monitors, which meet the budget requirements of the average home/office include the NEC MultiSYNC EP15, the Sony 15SF and the Samsung (Syncmaster 15 GLI).

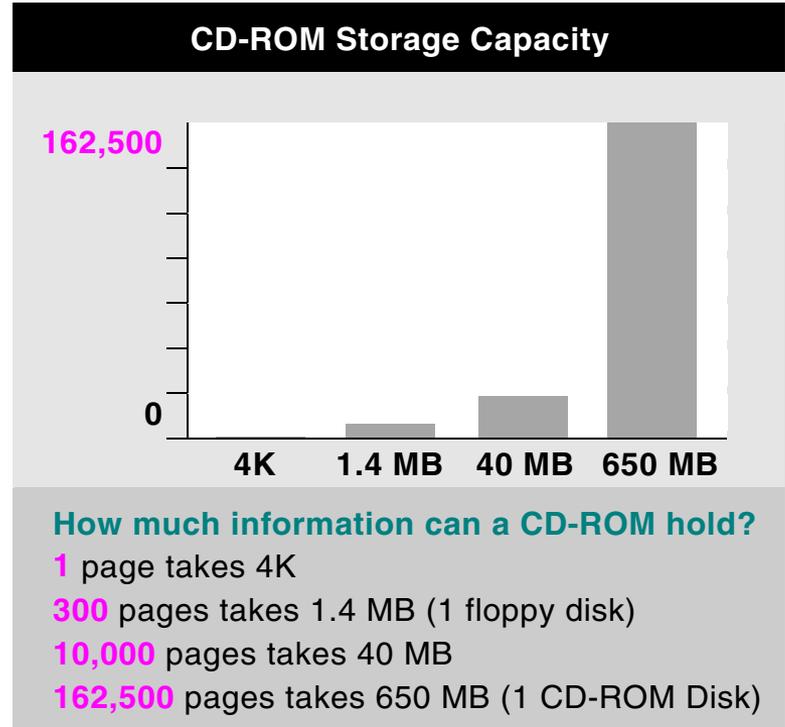
In the 17-inch monitors, take a look at the Mitsubishi Diamond Pro 17 TX. It has a fabulous image, with perfectly square display in the corners, superb, easy to use controls, and wide compatibility with a broad bandwidth of video signal. Very close to the Nokia 447x and Mitsubishi are the Sony (Multiscan 17SE, MAG (MXP17f, Nanao (T2 17) and the Samsung SyncMaster 17 GLSI).

### Highly Recommended Options

Although this list is by no means complete on the number of goodies you can add to your computer, it should give you a good idea of the most popular computer add-ons to both desktop and portable systems.

### CD-ROM Drive

The CD-ROM (Compact Disk – Read Only Memory) drive has become a stan-



standard component in all computers much like the floppy and hard drive is today. While the read-only nature of compact discs does not make the CD-ROM drive an adequate replacement for a magnetic hard drive, in most applications, it does lend itself to the distribution of all sorts of pre-packaged data including:

- collections of computer software
- database files
- dictionaries
- digital music samples
- encyclopedias
- entire movies complete with soundtracks (with the advent of sophisticated data compression techniques)

*Even in modest quantities, the physical cost of a CD-ROM is well under two dollars a copy, making it the most inexpensive form of mass storage ever.*

- interactive pornography games
- interactive video games
- midi files
  - novels
  - photographs
  - sound files
  - world atlases

It should be noted that not only can CD-ROMs store massive amounts of data (about 650 MB worth equivalent to over four hundred and fifty 3.5-inch high-density floppy disks, see chart on previous page), but they can do it very cheaply. Even in modest quantities, the physical cost of a CD-ROM is well under two dollars a copy, making it the most in-

expensive form of mass storage ever. When shopping for a CD-ROM make sure you discuss the following features:

**Access Time** – Access time refers to how long it takes the read head to find the piece of data you’re looking for. At one time CD access times were so slow they were measured in seconds. Now a respectable access time is well under 300 ms, with fast CD ROMs closer to 150 ms.

**CD-ROM Interfaces** – The most cost-effective option is an IDE or ATAPI CD-ROM drive connected to your motherboard’s EIDE interface. If you’re buying a PC configured with a SCSI hard drive or want an external CD-ROM drive or some reason, you’ll probably opt for a SCSI unit instead.

*By 2000, we do not expect to manufacture any CD-ROM drives.*

**KEN JONES**

*Toshiba*

**NOTE** ATAPI (Advanced Technology Attachment Packet Interface) is the standard that makes it easy to connect CD-ROM drives and other devices to an IDE interface.

**CD-ROM Kits** – There are many packaged CD-ROM drives that include sound cards and a handful of CD-ROM titles. Be careful though that the actual components included meet up to your standards of quality.

**Data Buffer** – Also known as RAM cache, a data buffer can help ease bottlenecks in the data stream and enhance access time by storing frequently accessed information. Bigger is better (256 K is good).

**Frequency Response** – Ideally, your CD-ROM drive should reproduce frequencies from 20 Hz to 20 KHz, so you can experience sparkling highs and rumbling lows.

**Photo CD Compatible** – CD-ROM drives that are photo CD compatible can read Kodak's photo CDs. If you want this feature, make sure the drive is multi-session photo CD compatible.

**Portable CD-ROM Drives** – Sony and Panasonic are known within the industry for offering good quality portable CD-ROM Drives. Panasonic's older KXL-D745 can be purchased for under US\$200 refur-

*As you increase performance, you are going to increase the power consumption and the heat load applied to the system. "Some portable get so hot they can take a crease right out of your pants."*

**GERRY PURDY**

*Analyst at Mobile Insights;  
Quoted from Computer-world*

bished via mail order. It is a good choice for users with older notebook computers. It comes complete with sound and speakers.

It connects to your notebook via the provided Type II PCMCIA card. Although, it's slow compared to newer 20x CD-ROM drives, having a slow 600-Kbps transfer rate and 250-ms access speed, to its advantage it can play music CDs like a portable CD player.

### **Recordable CD-ROM Drives**

– The Pinnacle RCD-1000 is 3 drives in 1. It features a 2X Recordable CD System, a Double-speed CD-ROM player, and can function as or replace a tape Backup Replacements. The RCD-1000 is perfect for creating and mastering your own multime-

dia titles, interactive games, or even mixing your own audio CD of your favorite tune. You can backup accounting records, business plans, charts and graphs or confidential information on CDs for decades - safe and secure.

**NOTE** Recordable CD ROM drives can be found for under \$1,000.

**Signal-to-Noise Ratio** – Refers to how much background noise you'll hear during quiet passages. If you plan to listen to CD's on your computer like you would your home stereo, look for signal-to-noise ratios of 80 DB or greater (even cheap home stereos typically have signal-to-noise ratios of 90 DB or better).

**Transfer Rate** – Transfer rate tells you how quickly your sample data can be

loaded. A fast transfer rate can go a long way toward eliminating jerky video playback. Double speed CD-ROM drives have transfer rates of 300,000 KB per sec, quad-speed 600,000 KB per sec and 8 x Speed 1,200,000 KB per sec.

*One machine can do the work of fifty ordinary men. No machine can do the work of one extraordinary man.*  
**ANON**

**NOTE** Most applications will yield only a 40 percent rather than a 100 percent real-world performance boost from a quad-speed drive vs. dual speed drive.

### **Types of CD-ROM Drives –**

There are two kinds of CD-ROM Drives – those that fit on a standard SCSI bus, and those that fit on some low-cost proprietary interface. If you go for the premium SCSI type, make sure the vendor offers an ASPI driver so that it can share

the SCSI bus trouble free with your other SCSI devices such as your hard disk.

### External Speakers

Most speakers are usually attached to your motherboard and produce poor sound quality at best. If you want better sound, in addition to a sound card you should consider buying some external speakers with specially shielded speaker magnets (these speakers usually have amplifiers built in as well).

**NOTE** Most internal speakers are worth about 50 cents apiece. Upgrading to a Radio Shack internal stereo speaker pair with a volume control may be a cheap solution.

*One computer manufacturer was so successful he had to move to smaller premises.*  
**ANON**

**Powered Speakers** – You’ll need powered speakers, magnetically shielded so they won’t distort images on your nearby monitor. If you’re designing a desktop for an audiophile, consider a high-end PC speaker set that includes a separate sub-woofer for booming bass notes. Altec-Lansing and Bose make some excellent products in this area.

**NOTE** Look out for multimedia monitors such as The ViewSONIC 15GA and 17 GA Perfect-Sound(TM). Without separate speakers, you’ll save on valuable desk space.

### Fax/Modem Card

Not too long ago fax/modems were considered optional items. But with the increasing draw of the Internet, along with

sound cards and CD-ROM drives they have become standard additions to desktop systems (see Guidebook #25 “Getting Connected” for more information on the benefits of purchasing a fax/modem).

**Modem Speed** – Although 28K and 33K modems are widely available at bargain prices, the newer 56K fax/modems are worth the extra costs.

**Voice Mail** – Many vendors now sell or bundle fax/modems that also double as phone-answering/voice-mail systems. They work best in small-business and home office environments. Also, watch for new simultaneous voice and data modems that let you squeeze the most use out of a single phone line. Pay close attention to the fea-

*Most voice-mail packages require that the PC remain turned on for them to answer the phone.*

tures of bundled software when buying a voice-mail system. Business users, especially, will want to make sure the software offers enough mailboxes for their office needs. Many full-featured packages, including 16 bit audio and speakers now available for less than \$200.

**NOTE** Most voice-mail packages require that the PC remain turned on for them to answer the phone.

**External Modems** – External modems are easier to install than internal modem. They can also be switched from one computer to the next and disconnected (if your computer crashes) by simply turning its power switch on and off).

## Mouse Pointing Device

A mouse is a hand held device that you move across your desktop to move an indicator, called a mouse pointer, across your screen. It is used instead of the keyboard to select and move items (such as text or graphics), execute commands, and perform other tasks. Without it, your performance in a Windows, Macintosh, OS/2 or any GUI environment is greatly reduced.

The best 3-button mouse support comes from Logitech. Microsoft makes their own expensive 2-button mouse, which is also popular. On the other hand, some people prefer using a trackball instead of a mouse for it requires less desk space and less manual dexterity to double click. However, they are harder to move diagonally.

*... Man is still  
the most ex-  
traordinary  
computer of all.*  
**JOHN F.  
KENNEDY**

**NOTE** The problem with using an inexpensive or no-name mouse is that although they don't look or feel substantially different than a brand name, their software drivers are usually of inferior quality.

## Sound Card

Sound cards allow you to record and play back .wav files, record and play back .mid (midi) files via built in musical instruments, hear music and sound affects with your games, and even control your computer with your voice. Features you should look for in a sound card include:

- Sound Blaster and Ad Lib computability (for games)
- 16 bit recording and playback quality
- a sample playback sound chip (usually

a Yamaha OPL 3 chip; better chips include the Yamaha OPL 4 chip or the EMU systems chip)

- an interface for a CD-ROM
- a DSP (Digital Signal Process) chip which processes your sound directly instead of tying up the CPU.

Cheap 16-bit sound cards (usually used for games) can be found for under a hundred dollars but really are not worth it. For real knock'em dead sound, consider buying Turtle Beach brand sound cards or the Soundblaster AWE64.

**NOTE** The best way to test a sound card is to hear it live, in fact this is the only way to test a sound card. Specs usually mean

nothing. Also, keep in mind that without a fully debugged software driver, all sound cards are rendered useless.

**Wavetable Sound Cards** – If your really serious about your sound you'll want an audio card that uses wavetable rather than FM syntheses. The difference is clearly audible because of the use of digitized recording of actual instruments to generate MIDI sound rather than mimicking instruments with electronic tones.

*When buying a PC try and get all the configured hardware components you think you'll need rather than a bare-bones system.*

### 9 Steps to Making a "Smart Purchase"

Use the following 9 steps to help make your computer purchase the best value for the money:

1. **Compile a list of expenses for the**

**computer system you would like to purchase including peripheral hardware and software.** If necessary, prepare both a short-term or preliminary and a long-term or ideal system configuration.

**NOTE** When buying a PC try and get all the configured hardware components you think you'll need rather than a bare-bones system. Usually you can get better deals. Furthermore, not only are peripherals some times difficult to add, but getting them to work properly can be a nightmare. When you buy the components already in the computer, you know that they are matched and compatible.

2. **Set a realistic budget.** Use the following price categories to help figure

out how much money you need to spend on your computer.

- *\$500 Used Systems* – You can probably save yourself a bundle if you can find an old 486 with a decent sized hard drive and at least 8 MB of RAM.

Solid state electronic components last a long, long time. There are many fifteen-year old XT clones out there chugging away faithfully, but they're only worth about a hundred bucks each today.

- *\$1,000 Systems* – Will get you a brand new Pentium 166 MHz clone with MMX technology.

- *\$1,500 System* – Won't get you top of the line, but will generally be last year's top selling computer chip.

*To err is human  
but to really foul  
things up requires  
a computer.*

**FARMERS  
ALMANAC**

- *\$2,000 System* – Over \$2,000 and you are usually paying for the latest and fastest chip like Intel’s Pentium 233 MHz chip with MMX technology or a 300 MHz Pentium II processor. For \$2,000 you can also get moderately featured notebook.
  - *\$3,000 System* – Over \$3,000 and you are getting the latest technology including all the goodies like high-speed CD-ROMs, fax-modems, bundled software, top of the line sound card, powered speakers and maybe even a laser printer. For \$3,000, you can also get a full-featured notebook.
- 3. Compare mail order advertisements with your local area vendors.** Focus on configurations and

*To get and keep track of price quotes use the “OrderMaker” on page 108.*

prices doing your best to match your planned PC as closely as possible to various vendor’s configurations. If a vendor doesn’t have what you want, see if they can customize one of their stock configurations and how much it costs.

**NOTE** Going to more than one vendor is highly recommended before making a purchase. Not only should you compare prices, but you should also compare their recommendations to sift out who really is giving you the best advice.

- 4. Get price quotes in writing for the exact system you want.** Be sure every component you’ve order is detailed, right down to the amount of secondary (L2) cache on the mother-

board, speed of the CD-ROM. If the vendor said it would include a Diamond Viper video card, make sure it's written.

**NOTE** To get and keep track of price quotes use the “Order-Maker” on **page 108** at the end of this guidebook. Use it to record product configurations and [ice quotes for each vendor you call or see. You can also fax the form to certain vendors (check in advance) as some will fill it in for you and return it with their quotes.

**5. Evaluate each system.** Use the following criteria. Listed in order of importance to evaluate the purchase of a minicomputer system from a vendor.

*Never buy the best. When you buy the best, you finance the manufacturers' R&D. Instead, buy second best. Your computer will be suitable for your business for two or three years and will still have a small resale value.*

**SUPERTIP**

- *What is the hardware capacity of the system?* Does the hardware have adequate processing capability to meet your requirements within acceptable time frames?
- *What is the systems performance?* Measuring computer performance can be pretty tricky. The problem is that there is no real standardized approach. However, an excellent Freeware program called “The Windows User Benchmark System Version 1.0” can be downloaded off the Internet (wubench.zip). This program was designed back in 1993 by *Windows User Magazine* to help their staff measure the performance of Windows

3.x computers (it also works on Windows95 machines). The program conducts the following five separate tests to create its benchmark average:

**Processor Test** – The processor tests checks the speeds of general CPU operations.

**Memory Test** – Tests both global and local memory.

**Graphics Test** – The graphics display is the biggest single factor in the perceived speed of a Windows system and may well make the difference between a computer with a fast CPU seeming sluggish or quick. This test checks bit map drawing, scrolling, vector graphics and text output.

*Memory, hard drives, and graphic cards play a significant role in determining a computer's overall performance.*

**Hard Disk Test** – The hard disk is another crucial element in a Windows system since Windows relies heavily on re-loading code segments from disk as memory is discarded. In enhanced mode, the efficiency of a swap file set up to allow virtual memory usage also depends upon the hard disk speed.

**Windows Test** – The final test checks general Windows specifics which were not covered in the previous tests.

The scores in the chart on **page 107** show the results of a number of tested computer systems ranging from fast Pentium notebooks to old 286 chuggers.

**NOTE** Memory, hard drives, and graphic

cards play a significant role in determining a computer's overall performance. For instance, if any of the systems were equipped with 16MB of RAM instead of 8MB, you could see a performance jump of 30% or more in the Windows Test.

- *What is the quality of the system software?* Your system should come with the operating system you want pre-installed.
- *How good is the systems documentation?* Your system should contain all the manuals including those for you video cards, motherboard and even I/O cards.
- *Is the system easily expandable and compatible?* What are the technical limits of your system and how close to those limits is your current

*Always use a credit card to buy if possible, never a check or cash.*

configuration? Is there software compatibility among the vendor' product lines.

- *Does the system have the security features you want?* What security features will your system have to prevent unauthorized use of the system or unauthorized program modifications.
- 6. After short-listing your choice of possible vendors, review each vendor in more detail.** Below are 8 questions that you need answers from, before you buy a computer system from any computer vendor.
- a) *What payment options does the vendor offer?* The more flexible the payment possibilities, the better the vendors.

Ads usually show which credit cards the dealer accepts.

**NOTE** Always use a credit card to buy if possible, never a check or cash. And never pay a surcharge for credit-card use. Credit cards often extend warranties and provide more buyer protection.

**b)** *Does the vendor pre-install all computer software?* If your new PC includes bundled software, but none of the applications were preinstalled by the vendor, beware. Opening up the software boxes and doing your own installation might make those products nonreturnable during your money-back guarantee period. If the system vendor won't give you or fax you an agreement to waive this potential problem, return the PC.

## Buying Mail Order Computers

**ONCE YOU START** shopping, it won't take long to realize that the products sold by mail are generally the most current hardware models and up-to-date software version on the market. You'll find a wider range of products in the direct channel than in the biggest computer superstore. Even if you don't buy from direct channels, it is wise to check out their offerings and do some comparison shopping.

**NOTE** The best place to start your mail order shopping is through the Computer Shopper available at most stores that sell magazines. Also, take a look at the many free circulation magazines such as the *Computer Paper* in Canada.

**c)** *How committed do you think the vendor will be after you buy?* Where will your commissioned sales rep be after the contract is signed? How many technical experts does the vendor have in your area? Be sure the vendor has the staff to provide training, answer your questions while you are setting up and solve any problems you encounter. Find out if the vendor has any software training facilities.

**d)** *How financially stable is the vendor?* Satisfy yourself about the financial stability of your vendor. Are there lots of visible customers?

**e)** *What kind of return policies and warranty service does the vendor offer?* Make sure you fully understand

*Make sure you fully understand the warranty and service policies before you buy a system.*

the warranty and service policies before you buy a system. For example, a two-year warranty on parts could require that you return the system to the manufacturer and pay shipping and stiff labor fees to have the vendor replace the failed part. On site service may be at the vendor's discretion

**NOTE** A 30-day money-back guarantee with no restocking fee should be the minimum protection you accept from any vendor. If they don't offer that, move on.

**f)** *What is the reputation of the vendor's service and maintenance support?* If your system breaks down, how long will it take to get it fixed? Who will do it? Will it be subcontracted? Are there

any provisions for backup during down time?

**g)** *If the vendor is a mail order vendor, when, and for how much will the system be shipped?* Some vendors pick up the tab for certain methods and charge you extra for quicker delivery. Some charge you not matter what you want.

**h)** *If the vendor is a mail-order vender, do they charge a restocking fee?* Never buy a system from a vendor that charges a restocking fee, even when told it applies only to an “unreasonable” return. Such fees can be as much as 15 percent or more of the total system’s costs.

*The leading notebook manufacturers are Toshiba, IBM, Compaq and NEC.*

**ers.** If you’ve never dealt with a specific vendor, check out their history with the Better Business Bureau. Also, ask each vendor for the names and telephone number of customers who have purchased a system, particularly those with needs similar to yours.

**8. When you receive the system, immediately set it up and turn it on.** Don’t wait for your 30-day money-back guarantees to expire.

**9. If buying by mail order, open the case and check inside for any parts that may have come loose during shipping.** Re-seat them and then turn on the system.

## 7. Obtain references from other us-

## Notebook Computers

If you need a computer to use in your car, on the road, in an airplane, at the library, when making client calls, or perhaps while camping, then you should consider buying a notebook. However, keep in mind that portable computers have limited upgradability, slower performance, poorer screens, and are more expensive than similarly equipped desktop models.

**NOTE** The leading notebook manufacturers are Toshiba, IBM, Compaq and NEC.



## Rule-of-Thumb PC Configurations

USAGE	CPU/RAM	Storage	Graphics/ Display	Peripherals	Software
Home (no games)	P166/16MB	2GB	PCI, SVGA 14"-15"	Printer, fax/ modem	MS Works, personal finance
Home (games used)	P233 with MMX/32MB	4GB	PCI 16M 15"-17"	CD-ROM Printer, fax/ modem	MS Works, games
Small Business	P166/ 32MB	4GB	PCI 65K 15"	CD-ROM Printer, fax/ modem	Office suite, voice mail
Power User	P200II/ 64MB	8GB	PCI 16M 17"-21"	ALL	Mix
LAN client/server	P200II/ 128MB	8GB	PCI SVGA 14"	Network cards, modem	LAN OS

## UPGRADING YOUR COMPUTER

ONCE YOU have bought your basic computer, you may want to add a few extra goodies to increase its functionality and performance. However, be forewarned that an innocent “Trip Down Upgrade Street” can quickly turn into a “Nightmare on Upgrade Street” if you fail to heed the advice contained in the following six upgrading guidelines:

1. **Don’t ADD a component that is too powerful for the rest of your machine** – Ideally, a computer system is a collection of components matched

*A good rule of thumb is to allocate at least a quarter of the computer’s purchase price to buying peripherals – printers and fax/modems and dedicate an equivalent amount for software that does not come bundled with the PC.*

### **SUPERTIP**

in their levels of performance – you wouldn’t put a 200 pound fireproof door on a wooden hut, would you?

Be forewarned that getting carried away could create the following unpleasant situation . . . you replace your old 12 MHz 80286 motherboard with a brand new 486 DX-100 MHz motherboard. Then you discover your old multi-I/O card cannot quite keep up with the new CPU, so you end up replacing it too. Then you find your new machine is painfully slow after you install windows so you end up replacing the video card and adding more RAM. Then you find out that some of

your favorite old software doesn't jive with your new fast CPU so you have to upgrade all your old software. Then after adding a CD ROM, you find out that your computer starts acting totally bizarre, until you realize that your old power supply just can't handle all the new power hungry devices you've added. After upgrading your power supply, you realize you've spent close to \$3,000.

To top it all off, next week your computer fails, and you have to pay \$300 to get it fixed, because all though your parts are under warranty, the labor isn't. And if that wasn't enough, while waiting in the lobby, you strike up a conversation with a bright eyed 17 year-old who just

bought a full-blown Pentium 233-MHz multi-media system with MMX technology for \$1350 including a three year warranty.

**REMEMBER** Your computer is only as fast as your slowest part.

*A 133 MHz Pentium notebook will likely give you more battery life than a screaming 233 MHz Pentium.*  
**SUPERTIP**

2. **Don't ADD a new component without making sure you have all the components it needs to work properly.** Even though, a new part might seem cheap, you might soon find out after bringing it home and reading its manual that you also need a new software driver, a special controller card, or even three other parts to make that part work properly in your system. Always watch out for addi-

tional hidden costs when you upgrade.

3. **Don't ADD a new part that hasn't proven itself compatible with your old parts.** This can't be over stressed. Incompatible parts can easily paralyze a once smooth running machine and cause you to pull out large clumps of your own hair.

Before you buy, it is wise to make sure that the combination of components you desire, *already works well* in someone else's machine. Otherwise, you might find yourself being bounced around like a Ping-Pong ball as you e-mail and phone tech staff trying to isolate the problem. And if you are lucky enough to actually get help, free help that is, than be prepared for

*Heat dissipation is always a challenge in a laptop.*

**DAN COOLIDGE**  
*Computerworld*

responses like, "Hmm, that's interesting, haven't heard of any trouble with anyone using our Turbo Accelerator Board with that Fujitsu drive you've got there – it must be some conflict with that other gizmo you got from Beach

Bum Mini Systems. Better Give'em a call. Sorry I can't help you much more than that but you have a nice day anyway!"

4. **Don't BUY products from companies going out of business.** Unless you don't mind that you won't be able to get technical or warranty support.
5. **Don't BUY revolutionary new technology – buy proven technology.** Buying a new fangled product that hasn't yet found market accep-

tance can become a very expensive luxury, especially when the product turns out to be a market loser. Before making any purchases, wait for consumer reports, watch media for overall reactions, and learn how to ignore small innovations and instead recognize major changes in the core technology.

6. **Don't REPLACE components if the total of all the components needed cost more than an entire new system.** Anyone with a small sack of cash can upgrade a computer in a matter of minutes, and often cheaper than buying a new computer. But upgrading has definite limits, after which you'll throw money into a machine that will never deliver

*Selling the machine as is, means that the old parts find a new home, while replacing an existing part, usually means the old part gets thrown in the garbage.*

the performance of a later generation platform.

Therefore, the dilemma that will plague you for the rest of your computing life, is should you upgrade parts or upgrade computers? If you plan extensive upgrades on core parts, it is usually more economical to sell your old machine, get some salvage value, and buy a completely new machine. Other times, it is best to add or replace parts especially if the new components are much cheaper than when they first came out and really do increase the performance of your machine. Whatever you do, keep in mind that selling the machine as is, means that the old parts

find a new home, while replacing an existing part, usually means the old part gets thrown in the garbage.

## Selecting Upgrade Parts

Although this list is by no means complete on the number of goodies you can add to your computer, it should give you a good idea of the most popular computer add-ons to both desktop and portable systems.

### Backup & Removable Storage Devices

All small business owners need a backup device of some sort to ensure against data loss. A system's not really

complete without one. Backups can be used to restore data lost though human error or hardware failure, and in the event of a disaster such as a fire or robbery.

Backup devices come in four different varieties:

- magnetic tape
- DAT tape
- removable cartridge drives
- removable optical drives

**NOTE** Removable storage devices are often used to transport large graphics files. If you also plan to use your removable

storage device for this purpose make sure you find out first what your service bureau uses. Zip and Syquest drives have become very popular and are in wide-

*In 1995, the worldwide PC market shipped 59.7 million units. Compaq was the market leader shipping 5.99 million, IBM shipped 4.78 million, Apple shipped 4.66 million, Packard Bell Shipped 3.65 million and other shipping 40.61 million Source Dataquest, San Jose, Calif.*

### **FUNFACT**

spread use at many service bureaus.

**Magnetic Tape Backups** – If you completely lose the contents of your hard disk, it will cost an average of \$35,000 to replace that data. And now with magnetic tape drives becoming so cheap (under \$200), it seems foolish not to buy one. You just insert a tape the last thing at night, and come back the next morning and the entire disk is backed up. You can also keep an extra backup tape off site in case you are robbed. Magnetic tape backups come in sizes from 120 MB to 1.2 GB.

**DAT Tape Drives** – Digital audio tape (DAT) drives can store 2B to 8GB on a single tape, and therefore are a good pick of network-wide backups or to back

*If you think can backup your hard drive with floppy disks don't kid yourself. It takes up to 67 diskettes to back up a measly 80 MB drive.*

**SUPERTIP**

up a large drive (more than 300 MB) without swapping tapes.

**Removable Cartridge Drives** – Removable hard drives are good if you need to secure information in a safe or transport large amounts of data. The big names in removable hard drives are Syquest, Bernoulli, and Kaylor.

*SyQuest Drives* – SyQuest has been in the removable storage business for a long time. They sell a wide variety of models including entry level drives such as the SyQuest EZ235 which competes with Iomega's Zip Drives and high-level drives such as Syquest SyJet with a 1.3GB capacity, which competes with Iomega's 1GB Jaz drive. However, it is their median-

level removable cartridge drives including their 5.25" platter models with capacities of 44MB 88MB and 200MB and their 3.5" platter models with capacities of 130MB and 270 MB that have brought them their fame and fortune. These drives are used extensively in desktop publishing and service bureaus.

**Optical Disk Drives** – Optical disk drives have better than 30 ms access time, can be removable, and unlike CD ROM drives are recordable and often used to back up hard drives. They come in size ranges from 120 MB to 1.2 GB. Optical drives are pricey but this is likely to change in the future as they gain more widespread acceptance. Recommended brand names are Iomega, Maxoptix, Ricoh and Fujitsu.

*Many people feel that Zip drives are destined to become the storage device of choice in the very near future.*

*Iomega Zip Drives* – Many people feel that Zip drives are destined to become the storage device of choice in the very near future. The disks are only slightly larger than a 3.5 inch floppy but store up to 100 MB on a single disk (that is the equivalent of 70 1.4MB disks). Performance wise, Zip drives run only slightly slower than an average hard drive having a seek time of 29 milliseconds and a sustained transfer rate of up to 1.4 MB per second. This means that you can now install and run applications off of a Zip disk saving you valuable hard drive space, in addition to backing up your hard drive or important files.

*Iomega Jaz Drives* – Jaz drives have a 1 GB capacity. Compared to their little cousin the Zip drive they have a faster ac-

cess speed (15ms) and triple the sustained transfer rate. They truly can function as an extra hard drive.

*SyQuest EZ235* – The SyQuest EZ235 has 13.5 ms seek time and a sustained transfer rate of 1.4 to 2.4 MB/sec. It has a 230MB capacity. To its disadvantage however, it is much heavier than Iomega's Zip drive and its cartridges are more expensive. For these reasons, it has not gained as much market share as the Zip drive and has all but disappeared.

*120 MB Floppy Drives* – Watch out for the newer 120 MB diskette being developed by 3M. This may become the next standard in diskette technology within the next few years. Up to five times faster, it holds 80 times more than the standard

*Top CD-ROM brand names are Toshiba, Sony, Plextor, Diamond, Texel, Teac, NEC and Mitsumi.*

### **BUYING TIP**

1.44 MB floppy. Look for the new LS-120 drives built into new Compaq PCs. These drives also read 1.44 MB floppies as well and thus are downward compatible.

## **Cooling Fans**

Fans can be added to help cool your system in four ways: located conveniently nearby, attached outside, mounted inside, or added to your motherboard via an expansion slot. However, before you jump on the cooling fan bandwagon, realize that interior fans suck in dust. This dust not only causes electrical connection problems, but also ends up coating all your electrical components like a blanket (this “blanket affect” reduces the ability of the chip to cool itself making it more likely to overheat). Therefore, unless you

clean your computer regularly and install dust filters on all your fans, adding additional fans may not be the best solution.

**NOTE** Computers of the future may use freon to keep cool.

### DVD Drives

Say good-bye to your old CD-ROM drive, and a big hearty welcome to the new storage standard – the DVD. The dawning of the new DVD age promises to change the way the world stores and uses information. DVD combines the high-quality sound and images of stereo systems and TV (three times sharper than VHS cassettes) with the interactivity of computers. It is the first storage technology designed from the ground up to

*Apple had 10% of the market share. Apple, Compaq and IBM are virtually tied for the position of the world's leading computer vendor. Apple has always been a technology driven company.*

### COMPUTER PAPER

work with ALL types of electronics – televisions, stereos, computers and video-game players. Plus, all DVD drives will be backward compatible, meaning that your old audio CDs and CD-ROMs will still work in a DVD player.

DVDs, unlike CDs, can hold data on both sides. In addition, each side can accommodate two layers of information. A single-sided, single layer DVD holds 4.7 gigabytes of data – seven times the amount of conventional CD-ROM and sufficient for 133 minutes of full-motion, full-screen video. A single-sided, double layer DVD holds 8.5 gigabytes, and a double-sided, double-layer DVD hold 17 gigabytes. Initially, DVD players will be a few hundred dollars more than CD-ROM

players, but within a few years prices will most certainly drop.

### Electrical Protection Devices

High quality electrical protection starts with a good power supply, but doesn't end there. To tame the electricity in and around your computer, you should also consider investing in protection from large power surges, small fluctuations in voltages, complete loss of power, and static electricity. The following devices can help solve the static electricity problem:

**Antistatic Devices** – If you can zap yourself on a filing cabinet or something of that sort every time before you sit down to compute, and if you spray *Static Guard* on any carpeting in your work area,

*High quality electrical protection starts with a good power supply, but doesn't end there.*

you probably won't need any other static protection. However, to play it safe, you might want to attach a *3M First-Touch Keyboard Strip* to your computer keyboard.

### Constant Voltage Power Regulators –

CV power regulators, also called line conditioners, maintain correct and constant voltage regardless of varying input and output demand conditions. The big name in such devices is *Sola*.

**Surge Suppressers** – These are multiple-outlets strips or boxes that provide electrical protection from power surges and some degree of line filtering. NO computer should be without them. Reliable protections costs between \$50 to \$100 (quality brands are *Power Trax* and *Isobar*).

**NOTE** Products being sold as *Master Control Units* are often only fancy multiple-input / multiple-switch surge suppressers. Get number. Check the unit's clamping voltage and energy absorption. The lower the clamping voltage the better e.g., 140 volts. The higher the energy absorption the better e.g., 1000 joules.

**Uninterruptable Power Supplies** – An uninterruptable power supply (UPS) is a battery-powered device that protects your computer from power spikes and power outages. If the power goes out, the UPS continues supplying power to the computer so you can continue working or safely turn off your computer without losing any data. If you're willing to spend about \$100 and up, this is the electrical

*An uninterruptable power supply (UPS) is a battery-powered device that protects your computer from power spikes and power outages.*

protection of choice, eliminating the need for anything else but an ordinary multiple-outlet strip. Dynatech's *Powerhouse/300* is first rate.

**NOTE** Besides the UPS boxes that go between the wall socket and the computer, there are two types that fit right inside your computer case. These are simpler and cheaper than a standard UPS since they feed the innards of the computer directly off batteries, rather than using DC from the batteries to generate AC which is then fed to the power supply to convert it back to DC again.

### Expansion Cards

Half-size, three quarter-size and full-size expansion cards can be plugged into your expansion slots on your motherboard. Ex-

pansion cards include, multi-I/O controllers, SCSI controllers, sound cards, video capture board cards, fax/modems, scanning boards, digitizing boards, and almost any other gadget that man has yet to invent.

Expansion cards typically come in ISA or PCI formats. Some boards on some computers must be plugged into designated slots. Some require internal cabling. Others are cabled to external devices via serial or parallel ports. For some, you must set or change configuration switches and/or jumpers, and install special software or drivers, which are generally supplied with the board.

**WARNING** The more expansion cards you add the more likely you will have hardware

*The more expansion cards you add the more likely you will have hardware and software incompatibility problems.*

and software incompatibility problems.

## Multifunction Telephone Cards

Multifunction telephone cards can give your small business or home office a big-league sound – they manage fax, voice, modem and sound all in one card (see Guidebook #26).

## Multi-Media Accessory Kits

Multi-media is a term loosely used to describe computer systems that can use and manipulate, in addition to ordinary computer word files, sound files, large graphic files and video files.

The old MPC I standard called for systems to have 8-bit sampling, a music synthesizer, MIDI, and a CD-ROM drive that

can play audio CDs. However, this standard was quickly replaced with the MPC II standard.

Currently, the new PC98 standard calls for a machine to be powered by at least a 200-MHz or faster MMX CPU with 32 MB or more of RAM. Systems will also need USB and Fire Wire (IEEE 1394) ports, 1,024 by 768 pixel or better video with full-screen MPEG-2 and support UltraDMA/33 hard disks. PC98 computers must also have high quality 16-bit sound cards and high speed CD-ROM drives.

**NOTE** Multi-media also includes voice command and voice recognition hardware and software. When this technology matures, it will enable people to dictate to computers, have interactive computer

learning facilities, and run software using voice commands.

### PCMCIA Cards

PCMCIA stands for Personal Computer Memory Card Industry Association which has defined an interface standard for peripheral devices for portables.

*PCMCIA stands for Personal Computer Memory Card Industry Association.*

PCMCIA slots serve the same function on portables that expansion slots do on full-size PCs. They are essentially the functional equivalent of full-size expansion card. They come in three sizes, designated

Type I, II and III cards. The cards are the same length but different thickness (3.3 mm, 5.0 mm and 10.5 mm respectively). Memory is the most common use of Type I devices. Type II formats include fax modem cards, Ethernet adapters and even

sound cards. Type III cards are often hard drives. Used mainly in portable computers, flash memory PCMCIA cards may eventually replace the 3.5 inch floppy.

**NOTE** Many companies are now switching from using PCMCIA card to the more simpler “PC card.”

**Local Card Bus** – 34 bit cards on the Toshiba Tecra will become the next notebook standard (move to notebooks).

## Printers

(see Guidebook #26).

## Scanners

With prices ranging from \$200 to \$1600 you can purchase flat bed scanners with optical resolutions of 300 x 1200 DPI for

the cheaper models and 600 x 2400 DPI for the more expensive models. However, if your needs are very specific it is a good idea to see the results yourself as the specifications offer only ballpark results.

If you just need a scanner for optical-character-recognition (OCR) work – translating text on paper into electronic form – buy a flatbed grayscale scanner. Many inexpensive models are available for less than \$200.

If you need a scanner to take with you on the road, buy a handheld scanner. However, according to many experienced users, they can be a waste of money. They are difficult to use.

If you need a scanner for DTP and even presswork, buy a 24-bit color scanner. Ex-

*Many companies are now switching from using PCMCIA card to the more simpler “PC card.”*

cellent color scanners with high-quality bundled image-editing software can be found for under \$500.

**NOTE** If you really think a fax/machine is a waste of money, you can replace it with a fax/modem, a flatbed scanner and the necessary software. It should also be noted that quality software is the key of successful scanning, so pay close attention to the bundled package. It's better to pay more to get good software.

### Upgrade Processors

A hot new industry has matured allowing 286, 386, 486 and Pentium computer owners to upgrade their processors, in many cases doubling or even quadru-

*If you really think a fax/machine is a waste of money, you can replace it with a fax/modem, a flatbed scanner and the necessary software.*

pling the power of their CPU. Spearheading this technology are companies like:

- Platinum Upgrade Technologies Inc.
- Corporate Upgrades Inc
- Gainbery Computer Products Inc.

Although Intel does offer its own line of upgrade overdrive processors, these upgrades tend to be pricey. In many cases, you are better off buying a whole new motherboard. However, the real interest in these newer companies is stems from the fact that for the first time, they offer viable upgrade paths for portable systems.

**Desktop Upgrades** – The processor upgrade path for desktops is quite extensive.

For about \$200 you can upgrade your 486 SX25 to a AMD 586 or your Pentium 75 to a Pentium 150 using Gainbery's GB686G-150 chip. For a similar price you can upgrade a 286 or 386 system using IBM's 486 Blue Lightning chip.

**Laptop Upgrades** – If you love your present laptop, though find it a little slower than you would like running newer system resource hungry software, and you don't want to fork out two to three thousand dollars for a new machine, then perhaps you should consider upgrading your processor. For about \$500, a company like *Platinum Upgrade Technologies* will upgrade a DX2/50 machine to an AMD 586 processor effectively boosting its CPU benchmark almost two and a half times (from 169 to 404 for a NEC Versa E). This price includes all labor.

**NOTE** 286, 386SX and 386DX machines can be upgraded to a 486SLC/2. It is also possible to upgrade a Pentium chip to a Cyrix 686 overdrive chip.

**Upgrade Manufacturers** – Below is a list of third-party companies who specialize in upgrading numerous computer parts, ranging from CPUs to hard drives.

#### Corporate Upgrades Inc.

P.O. Box 289, Fair Oaks, CA, 95628

Tel: 800-240-6190, or 916-536-3710

Fax: 916-536-3719

Web site: <http://www.ns.net/upgradesinc>

#### Gainbery Computer Products Inc.

165 Steelcase Rd.

East Markham, Ontario, L3R 1G1

Tel: 800-415-0480

Fax: 905-415-9970

Web site: <http://www.gainbery.com>

Platinum Upgrade Technologies Inc.  
1420-855 W. Georgia St.  
Vancouver B.C., VC 3E8  
Tel: 888-302-4444, or 604-257-0507  
Fax: 604-608-0999  
E-mail:platinum@res.com

### Video Capture Board

A video capture board allows you to plug your VCR tapes into your computer, store images from this tape, and then using software to manipulate these images.



*Man is a slow,  
sloppy and bril-  
liant thinker; the  
machine is fast,  
accurate and  
stupid.*

**WILLIAM M.  
KELLY**

## BUILDING A COMPUTER IN 14 EASY STEPS

---

DESPITE the complexity of computer theory and design, building one from its components is not much more complex than building a Lego castle or a Tinker Toy bridge.

Nowadays, a computer is essentially a collection of standardized parts housed in a box with a power supply. Almost everything snaps in, pulls out, screws in, screws out, or unplugs and reassembles, so that all you really need to build one is a few screwdrivers, perhaps an integrated circuit installer (which can be inexpensively purchased at Radio Shack), and a lot of patience.

*The real benefit to building your own computer comes from the knowledge it brings.*

However, if you're hoping that building a computer from scratch will save you a pile of money up front, be prepared to be disappointed. Unless you buy a kit from a company that buys its parts in bulk and passes the savings on to you, or have access to perfectly good used parts (possibly through friends or a local computer repair shop), your dream machine will likely cost about the same as if you had bought a similarly equipped clone. In fact, in many cases, it will cost more.

The real benefit to building your own computer comes from the knowledge it brings, knowledge that will enable you to fearlessly upgrade, troubleshoot or repair your system at a later date (this is where you can save the BIG money).

**WARNING!** No vendor can assure you that their component will work seamlessly in your system in combination with other vendors' products. 100% compatibility is often claimed but rarely achieved. Considering the staggering exponential potential for conflict that occurs every time you combine products from different companies, test it first. And if you can't test it, or in the least verify the companies claims through other sources, don't buy it.

**WARNING!** Although, the assembly of a computer from its basic components (case, power supply, motherboard, RAM chips, hard disk, floppy drive, multi-I/O card, video controller, monitor, and keyboard) can be accomplished in less than ten minutes by an experienced assembler, the inexperienced assembler should proceed with caution making sure each step and

procedure is understood and executed properly.

## 14 Steps to Building a Computer

1. Gathering Manuals, Tools, & Installation Materials
2. Assembling the Case & Installing Power Supply
3. Configuring Motherboard
4. Installing RAM Chips
5. Attaching Motherboard to Case
6. Installing Floppies, Hard Drives & Other Storage Devices
7. Installing Expansion Cards
8. Attaching Power Cables & Grounding Straps
9. Powering Up

10. Setting-up CMOS
11. Formatting, Partitioning & Burning-in Hard Disk
12. Configuring & Testing Hardware
13. Installing & Testing Software
14. Getting CSA or UL Approval if Necessary

## A) Gather Manuals, Tools, & Installation Materials

Before assembling your computer, you will need to gather the following tools and materials:

*When making your decision on what kind of computer to build, keep in mind that older model machines are much cheaper to build than newer models. Also, keep in mind that lower clocked chips are not as fussy about power, and don't demand the extremely tight tolerances that machines of higher clock speeds do.*

### **SUPERTIP**

**Cable Making Tools** – If you decide to make your own cables you will need a vise, an X-Acto knife, a right angle triangle and a good technician's book on how to make cables.

**Contact Preparation Materials** – To prepare all electrical contact points so they provides years of faithful service, you will need a small bottle each of Cramolin Red (or electrical contact spray), Isopropanol Alcohol, and Stabilant. Also, buy a half-dozen foam scrubbies (foam scrubbies

look like Q-tips except they are lint-free). Use *Cramolin Red* to clean electrical contacts (the teeth where cards insert into the motherboard, all cable ends, hard and

floppy disk connectors, all rear connectors, all connectors on the printer, modem and mouse). Use *Isopropanl* to rinse these contacts. Use a small amount of *Stabilant* to treat the contacts. Stabilant is a semi-conductor gel that fills in any gaps in a contact. Without this treatment, you sometimes get contacts that are temperature sensitive and as the machine warms and cools, create glitches. The Stabilant also keeps air away from the contact, which prevents it from oxidizing.

**Diagnostic Software** – You will also need a collection of diagnostic software such as: Dysan Interrogator for testing floppies; SpinRite and HDTEST for burning in disks; and RAM Test and QA Plus for testing the keyboard

*Additional diagnostic software may come with your multi-I/O card, video card and mouse. You should may also be able to find some shareware diagnostic software on the Internet.*

and ports. You might borrow these software titles for one-shot use since the whole bundle is expensive.

**NOTE** Additional diagnostic software may come with your multi-I/O card, video card and mouse. You should may also be able to find some shareware diagnostic software on the Internet.

**Labeling Tools** – It's a good idea to have handy a fine point permanent marker (good for labeling motherboards), a Dynamo label gun, and a small flashlight.

**Manuals** – The successful assembly and configuration of your computer and components will depend primarily on the quality of instructional material furnished by your component vendors, and

whether or not you have actually read this material. Make sure you *read* before you *roll* up your sleeves. A computer that is not set-up properly might still function but will seem at times to be possessed by Grem-lins.

**Needle Nose Pliers** – Needed for working in cramped corners.

**Nut Drivers** – You will also need a collection of nut drivers to affix serial and parallel interfaces or expansion cards to the back of your case.

**Screwdrivers** – You will need at least one normal size Phillips and one normal size slot head screwdriver preferably made of quality hard molybdenum steel.

**Static Mat** – Needed for handling ICs.

*All manufacturers report the rapid decline of the 14-inch monitor, and the rapid growth of 17-inch monitor sales.*

**FUNFACT**

## B) Assemble the Case & Install Power Supply

Fasten power supply to case if not already done so by manufacturer.

## C) Configure Motherboard

The key thing to remember when configuring your motherboard is that the dip switches, the CPU selection jumper settings, and the oscillator must all agree with the type of CPU you have just installed or that came pre-installed with your motherboard (in the case of the latter, configuration has normally already been done). Your motherboard may also have to be configured according to how much RAM you install, how much cache RAM you install, and the size of cache memory desired. All specifications should be listed in

your motherboard manual.

**NOTE** If you have a front-mounted speed display and you're changing to a faster oscillator and chip, you will also have to change the jumper or dip switch settings on the back of this display.

## D) Install RAM Chips

Before installing any required memory chips, you should ensure that each chip is correctly positioned for insertion into their sockets on the system board on a anti-static mat or an anti-static bag. To find proper alignment look at other chips on board, consult diagrams in manual, or use another similarly equipped motherboard as a model.

*There will be a distinct click when the SIMMs are pushed into place.*

To install a SIMMs chip, you will notice that it is held by four plastic or metal tabs, two from the back and two around the front edges. Starting on the right side, snap the SIMMs into the your motherboard, sliding them first down (at about a 45 degree angle), aligning the two placement holes on

either end with the board's slot tabs and then snapping them back against the tabs. There will be a distinct click when the SIMMs are pushed into place. Ensure that the edge tabs are fully around the edges of each chip (to remove a

SIMM chip gently push the edge tab back on one side and then the other, pulling the SIMM away from the back tabs and up).

**NOTE** Installing RAM chips is a rather simple procedure if you remember one thing: static electricity destroys IC chips.

Even taking RAM out of their special *anti-static conductive grid bag* to look at can be enough to permanently damage them if you haven't taken the proper precautions. If you get a shock walking across the floor where you are working on your computer, consider moving a humidifier into the room and using anti-static fabric spray on any carpets present.

Many experts even recommend that you should not handle RAM unless you first ground yourself with a wrist strap and work on a static mat, however, grounding yourself by touching the metal case of your system unit or a similar object (with it plugged in but turned off), seems to be an accepted practice.

*Installing RAM chips is a rather simple procedure if you remember one thing: static electricity destroys IC chips.*

## E) Attach Motherboard to Case

Normally, the base or side of most computer cases are manufactured with a number of plastic prongs, onto which you first guide the motherboard into a semi-secure position. This will take a firm, but no excessive amount of pressure. After that you simply secure the motherboard to the case using two or more screws. If there are no plastic prongs, just line up the screw holes and install the location screws, making sure you don't lose their attached fiber washers.

**NOTE** Installing and upgrading a motherboard is less tedious if you have a tower case where you can access both sides and have ample room for maneuvering. Smaller cases are much more difficult

since you may have to align washers and spacers without being able to see them.

## F) Install Floppies, Hard Drives & Other Storage Devices

Once your motherboard is installed you should partially install all storage devices including CD-ROMs and magnetic tape drives. This means attaching all devices to your case using only finger pressure to tighten screws. At this point you may also want to attach a 4 pin power supply connector to each storage device and any cabling required from controller cards to the storage devices. The reason for this is in some computer cases there is only a small amount of room between the rear of each storage device and the power supply,

*The greeting card that sings Happy Birthday contains more computer power than existed on Earth before 1950.*

### **FUNFACT**

which can make the cabling of power supply connectors to the power sockets on each storage device almost an impossible task if the storage device is placed completely into the device housing area.

## G) Install Expansion Cards

Before you install expansion cards (fax/modem, video, multi-I/O, sound, etc.) make sure you have set all jumpers according to their manual's specifications and have prepared the contact points. To install, start with the multi-I/O card (closest to the bus), then the video card and so on. Carefully push each card in, using slightly more force at one end than the other. Once it starts to move, push straight in. After, tighten all screws necessary to secure the cards to the back of the case.

## H) Attach Power Cables & Grounding Straps

After your power supply, motherboard, storage device and expansion cards have been installed, connect the two 12 pin power supply connectors to the power connector sockets normally located in the upper right corner of your motherboard. These go in at an angle and then straighten up with a click (the ends with the black wire should be on the inside close together).

Next, attach your case feature connectors which usually include your turbo and hard drive light. If your turbo pin has a jumper on it which locks the board into its highest speed, take this jumper off and attach the connector from

*The Sega Genesis game machine has a computer more powerful than a multi-million-dollar 1976 Cray supercomputer.*  
**FUNFACT**

your display (your motherboard manual should go through this process on a pin-by-pin basis). Your HDD connector usually labeled HDD on your front panel can go either to your controller card or directly to the drive itself. If you have two drives, you'll have to decide which one to hook up to the panel light.

Next, if you haven't already done so, fasten a 4-pin power connector from the power supply to each storage device and any other appropriate cables from your multi-I/O card or storage device controller cards required to operate each storage device.

## I) Power Up

Before powering up, secure on-line storage devices, press on all expansion cards to

make sure they're firmly seated, make sure all connectors from the power supply are accounted for and left over ones neatly tucked away, plug in your monitor and keyboard, and finally plug in your case and power supply.

## J) Set up CMOS

When your computer is turned on, since there are no settings in the CMOS, it will default to a setup screen. Here is where you enter the date, CMOS information your motherboard manual recommends, and other information particular to your computer's hardware like the size of your floppy drive, a special two-digit hard disk setup number, and settings for CYLS, HEADS, SECTORS, PRECOMP and

*Whenever you make changes to your CMOS setting (for example when upgrading a motherboard) make sure you note all the old CMOS settings in case you need to go back to the original settings.*

LANDZONE for each of your hard drives. When all settings are entered save them and reboot.

**NOTE** Whenever you make changes to your CMOS setting (for example when upgrading a motherboard) make sure you note all the old CMOS settings in case you need to go back to the original settings.

## K) Format, Partition & Burn-in Hard Disk

Now that your computer is somewhat alive and running you may have to format and partition your hard disk if it has not already been done so by the manufacturer. Burn-in in your disk involves using programs like HDTEST and SPINRITE to test for bad

spots on your hard drive. Some experts recommend running these programs for three or four days as part of your initial burn-in and then once a month afterwards.

## L) Configure & Test Hardware

If you have ever attempted to install a mouse, video card, CD-ROM, hard disk controller, sound card, modem, multi-I/O card, or scanner, you will likely have had a minor nervous breakdown. All these devices conflict and very rarely work together the first time. They fight over intangible computer resources called IRQs (Interrupt Requests), I/O (Input/Output) port addresses, and DMA (Direct Memory Access) channels. Thus by far, the most difficult part of build-

ing your own computer will be configuring it and then testing it (usually most problems stem from multi-I/O cards that have not been set-up correctly).

*As computer hardware and software mature, eventually this painful and time wasting configuration process will become completely automated or software driven.*

**NOTE** As computer hardware and software mature, eventually this painful and time wasting configuration process will become completely automated or software driven. This automation already exists on the Macintosh platform and is slowly being perfected on the Windows95 platform (Plug'n Play).

**IRQs** – Keyboards, modems, pointing devices, hard disks etc., – pester the CPU hundreds of times a second, each demanding immediate service. However, the CPU can only handle one device at a time. It works something

like this: every time you type a character on your keyboard, the keyboard driver taps the CPU on the shoulder and says, “Excuse me mister, but something very interesting has just happened. A character is waiting to be processed. Please stop whatever it is you were doing and save this character in RAM. And HURRY because if another one comes along before you handle this one, I will lose it.”

Therefore, to avoid losing important time sensitive data, you must assign each device its own private IRQ number (if two devices want service at the same time, the CPU always handles the lower IRQ number first). Some devices don’t need IRQ numbers because they are already hard wired into a special one. Other devices, can use

*Keyboards, modems, pointing devices, hard disks etc., – pester the CPU hundreds of times a second, each demanding immediate service.*

one of a half-dozen choices (there are 15 in theory on the AT). However, the problem is, there are five popular IRQs (all of which are lower numbers because every device seems to think it deserves priority).

With a whole pile of devices fighting over these few IRQs, and with no arbitration scheme, other than the skill of the technician doing the installation, often two cards end up trying to use the same IRQ at once with disastrous results.

**NOTE** Each adapter card may have to be told which IRQ to use by arranging the patterns of little jumper plugs over pin pairs on the adapter cards.

**DMA Channels** – Some devices such as floppy drives use a faster method than interrupting the CPU every time a character

comes in. They make use of a small auxiliary computer called the DMA controller to direct incoming data to RAM.

There are two DMA controllers. Each can service four devices at once. When you install an adapter card, you must specify which controller you will use and which of its four channels you will be working with. Again, if two devices try to use the same channel, it would overload the brain of the DMA controller. Channels 0, 2, and 4 are reserved. 1 and 3 are 8-bit channels — the most popular ones. 5, 6, 7 are 16-bit and are rarely used. Don't assign different devices to the same channel.

**I/O Port Addresses** – The computer bus is like a telephone party line. Every adapter

card hears the commands from every other card. When the CPU sends out a command, it prefixes it with a “Hey PRINTER, this is for You.” All the cards hear it, but only the printer's parallel report responds (the CPU is actually a little more terse than that. It would just say “3FG”) All the devices have three-character names called port addresses, made of the digits 0 to 9 and letters A to F from 000 to #FF. This gives 1024 possible names.

You would think that with 1024 possible names, you would be unlikely to accidentally assign two devices the same name. Unfortunately, duplication is a common problem because the installer usually hasn't the foggiest idea which names are already in use. Thus, they randomly try different names till they find a set

*List all IRQs, DMA channels and port addresses for each device on a piece of paper.*

that appears to work.

To make matters worse, some devices need a dozen or more names. For example, a modem might use one name for sending, another for receiving and another to hang up the phone.

**Set-up Strategy** – List all IRQs, DMA channels and port addresses for each device on a piece of paper. Make sure there are no conflicts.

**NOTE** Modems on COM 1 must use IRQ 4. Modems on COM 2 must use IRQ 3. The LPT 1: printer must use IRQ 7, but in a pinch, it can do without. IRQs 0, 1, 6, 8 and 16 are reserved.

## M) Install & Test Software

Follow recommended software set-up procedures outlined in manuals of all applica-

tions being installed.

## N) Get CSA or UL Approval if Necessary

At some point after you've built your computer, tested it and broken it in, you may want to take it to the Canadian Standards Association or the American Underwriter's Laboratories to have them inspect it for safety (you may also need this for insurance purposes). They don't care if it works. All they care about is "will it catch fire or will it electrocute anyone."

**NOTE** Although building your own computer is a great learning experience and in some cases can be cheaper than buying, it has a number of disadvantages.

*A computer doesn't charge for overtime and doesn't get health care benefits.*

**ADAM SMITH**

*First*, it can take a great deal of time to collect compatible components.

*Second*, if something goes wrong, even though your individual parts are warranted, the whole computer is not. This means, you will have to find which part is malfunctioning to get the warranted defective part repaired or replaced and if you can't find it, you'll have the additional task of paying and trying to find a competent and reliable technician who can.

*Third*, your finished masterpiece will often have little resale value.

*One disadvantage of building your own computer is your finished masterpiece will often have little resale value.*



## Buying the “Perfect Computer”



**TO HELP YOU** make a solid purchasing decision read through the following suggestions and component considerations for buying a computer.

**Computer Microprocessor** – For a solid middle-end system, don't buy anything less than a 166MHz Intel Pentium CPU. A Cyrix 686 CPUs is also a good choice. The only used 486s worth considering, for low-end systems, are Intel's DX4/100 and its AMD equivalent.

**Motherboard** – PCI is the bus of choice for Pentium motherboards, VL-Bus for old DX4/100s. Insist on a motherboard with a software upgradable flash BIOS.

**Chip Set** – With its extra speed and support of three instead of two PCI slots, Intel's *Triton* PCI chips set is a superior successor to its *Neptune* and third parties' Neptune-alternative chip sets.

**RAM Memory** – Shoot for 32 MB of system memory, with 16 MB as a bare minimum. Make sure RAM is installed in 16 MB SIMMs, to leave other SIMM sockets free for future expansion.

**NOTE** Try and get EDO (extended-date-out) DRAM for main memory. The *Triton* chips set supports this more expensive but significantly faster memory type.

**Cache Memory** – An external cache of 256k is all you need for a Pentium PC; a larger 512K cache will give you a performance boost on an old 486 PC.

**Hard Drive** – Get at least a 2 GB EIDE (a.k.a. Fast ATA) hard drive. Choose the more expensive SCSI storage system if you need to use imaging peripherals such as scanners.

**Video Card** – Don't scrimp on your video card. Get at least a 32-bit PCI-bus graphics adapter with a 64- or 128-bit graphics accelerator. To display true color (16.7 million colors) on a 15-inch or smaller display in 800 x 600 mode you need 2MB of video memory. On a larger screen monitor (17-inches and above), you need 4 MB of video memory. Try and get the faster V-RAM for your video card.

**Monitor** – Buy a 15-inch if you're content to work at 800 x 600 resolution. However, keep in mind that a 17-inch screen will give you more room to display multiple applications. The monitor's dot pitch should be 0.28 mm or less and support a noninterlaced refresh rate of 75Hz to 100 Hz (the higher the better) at each of the resolutions you plan to use.

**CD-ROM Drive** – An EIDE or ATAPI 12X or 20X-speed unit is your best buy among CD-ROM drives. However, a SCSI 12X-speed drive is also a fine choice.

**Sound Card** – Look for sound cards with wave-table synthesis. These cards produce real instrument sounds and are a cut above older FM synthesis sound cards.

**Shielded Speakers** – To complete your multi-media system, you'll need powered, magnetically shielded speakers. Add a sub-woofer for deep bass sounds to make your games and presentations really rumble.

## Measuring Computer System Performance

The Windows User Benchmark System						
Computer System (higher is better)	Processor Test	Memory Test	Graphics Test	Hard Disk Test	Windows Test	Windows User Benchmark
Average 286						2.2
Average 386 SX						3.1
Average 386 DX						4.8
Clone 486 DX- 25 4MB, Win3.x	7.2	8.1	5.6	6.1	3.9	6
Clone 386 DX - 40 8MB, Win3.x	6.1	8.8	6.2	6.3	4.0	6.1
Toshiba Notebook 1960 T 486 DX2-50 4MB, Win3.x	12.6	7.8	9.5	5.8	6.4	8.1
Reference System 486 -33 8MB, Win3.x	10	10	10	10	10	10
T. I. Notebook Extensa 455 486 - DX 75 4MB, Win95	17.1	10.1	9.7	16.8	3.5	10.0
Toshiba Satellite 2130 CS 486 - DX75 8MB, Win95	20.0	16.2	37.2	9.1	9.4	15.7
Compaq Contura 430 486 - DX100 8MB, Win95	24.4	15.6	20.8	27.6	8.4	17.9
IBM Notebook 345 486 - DX75 8MB	21.3	17.0	32.1	14.8	13.2	18.7
Clone Pentium - 75 8 MB, Win3.x	40.0	23.3	16.6	15.3	11.0	19.2
NEC Notebook Versa 2000C 486 - DX75 8MB, Win3.x	17.9	12.3	43.9	27.3	13.3	20.9
T.I. Notebook Extensa 550 Pentium - 75 8MB Win95	39.9	20.8	21.1	26.7	9.4	21.3
NEC Notebook Versa 550 D Cyrix 586 8MB, Win95	34.6	17.5	61.7	32.7	10.8	26.5
Toshiba Notebook 100CS Pentium - 75 8MB, Win95	43.6	21.8	60.1	32.7	8.8	27.7
Toshiba Notebook Tecra Pentium - 120 8MB, Win95	66.9	33.4	32.7	45.7	13.4	33.9
IBM Aptiva Pentium - 133 8MB, Win95	75.4	33.9	90.5	34.4	18.3	42.9
HP Pentium -166 16MB, Win95	93.1	38.0	81.9	52.4	24.5	51.8

# BUYING A COMPUTER ORDER FORM

## Vendor Statistics

Company Name			Sales#		Fax#		
Street Address			Tech. Support#		Sales-person		
City	State	Zip	Support <input type="checkbox"/> 7 days <input type="checkbox"/> 5 days	Hrs <input type="checkbox"/>	a.m. to	p.m.	

## PC Configuration Checklist

Name of PC \_\_\_\_\_ CPU type \_\_\_\_\_  
 Amount of RAM \_\_\_\_ Max. RAM \_\_\_\_ SIMM chip size \_\_\_\_\_ RAM Speed \_\_\_\_  
 Cache size (L2) \_\_\_\_\_ Flash BIOS  yes  no ZIF socket  yes  no  
 System expansion-bus architecture  VLB  PCI  
 Case size  Desktop  Slimline  Tower  Notebook  
 Energy Star -compliant  Yes  No Power supply unit \_\_\_\_\_ wattage  
 Number of available expansion slots (after configuration) \_\_\_\_\_  
 Floppy disk drives  3.5 inch/1.44MB  Other \_\_\_\_\_  
 Hard drive capacity \_\_\_\_ Speed \_\_\_\_ Transfer rate \_\_\_\_ Interface  IDE  EIDE  SCSI  
 Graphics card brand \_\_\_\_\_ Graphics RAM \_\_\_\_ Bus type  VLB  PCI  ISA  
 Monitor brand/type \_\_\_\_\_ Diagonal screen size \_\_\_\_  
 Max. noninterlaced resolution  1,024x768  1,280 x 1,024  other \_\_\_\_\_  
 Refresh rat @ max. resolution \_\_\_\_\_ Hz Dot pitch \_\_\_\_\_  
 CD-ROM drive brand/model \_\_\_\_\_  
 CD-ROM speed  2X  4X  6X  8X Interface  EIDE  SCSI  
 Sound card brand/model \_\_\_\_\_  8 bit  16 bit  Wave table  
 Sound Blaster-compatible  Speakers included Brand/model \_\_\_\_\_  
 Fax/modem  Yes  No Speed  14.4 Kbps  28.8 Kbps Brand/model \_\_\_\_\_  
 Voice-mail system included  DOS included  Win3.1 included  Win95 included  
 Other software included \_\_\_\_\_  
 Other hardware included \_\_\_\_\_

## Quotes

Make copies of this sheet for each quote you receive from the same vendor for different configurations.

Write base configuration total here \$ \_\_\_\_\_ (cross out any items noted at left that are not included)

Write customer configuration total here \$ \_\_\_\_\_ (circle any crossed-out items that are included in this quote. Write in any additional features/ products included)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## PC ADD-ONS

Software: Price\$

Scanner: Price\$

Backup device: Cap. Price\$

Network card (including interface & cables)  Ethernet  Token ring Price\$

Printer: Price\$  (price includes cables)  yes

## Guarantees & Service

Money-back guarantee:  yes  no  
 Return period  30 days  other \_\_\_\_  
 Restock fee  Yes  No Percentage \_\_\_\_% Cost \$ \_\_\_\_  
 Standard warranty on parts  1 yr  2 yr  3 yr  \_\_\_\_  
 Standard warranty on labor  1 yr  2 yr  3 yr  \_\_\_\_  
 Repair policy:  Ship to vendor; no charge  Ship to vendor, with charge  Onsite  Phone service with parts replacement  
 Who pays for return shipping?  Vendor  Customers  
 Extended warranty available  Yes  No  
 If yes, cost/ terms \$ \_\_\_\_\_  
**Bottom Line:** Total cost of system ordered, including tax, shipping, warranties, pre-installed software (no additional charges will be made to customer) →

## Shipping & Delivery

Shipping options:  
 Overnight \$  
 Two-day \$  
 Ground \$

Freight company: \_\_\_\_\_

Order date \_\_\_\_\_  
 Date system will ship \_\_\_\_\_  
 Date system will arrive \_\_\_\_\_