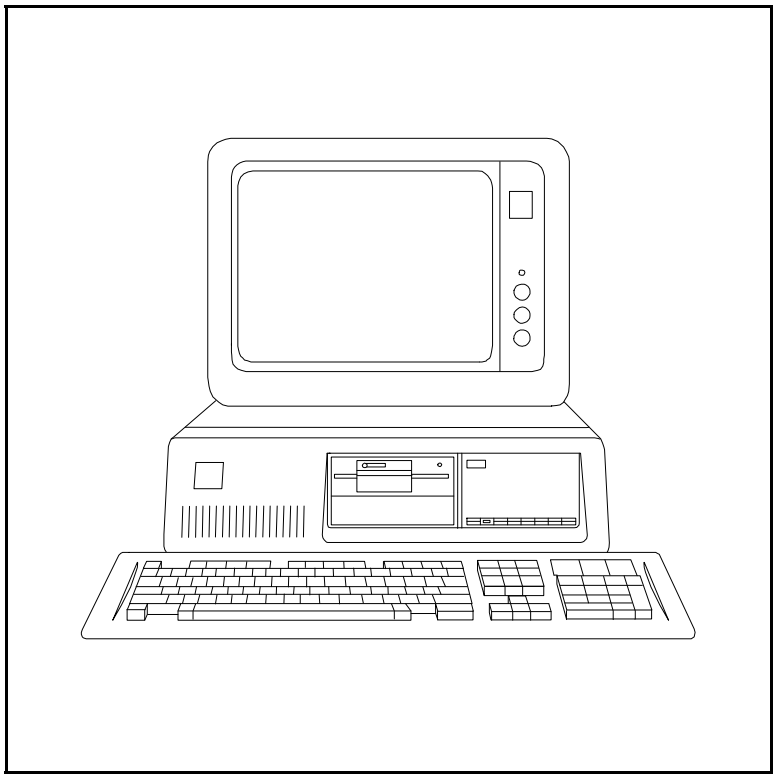
BUILDING YOUR OWN PERSONAL COMPUTER
RESEARCH TECHNOLOGY ASSOCIATES, INC.



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FOREWORD

These course materials were originally developed for use in the PC Hardware, PC Repair, Repair and Maintenance of Personal Computers, and the Build-Your-Own PC courses which I taught at Prince George's Community College, in Largo, Maryland. I developed these materials myself, with a view towards making complex issues in PC hardware and maintenance easy to understand. Through several years of teaching these courses and refining these materials, I believe this manual will be a useful resource for the reader.

I would like to express my deep gratitude and sincere thanks to a number of people who have made the development and implementation of this course possible over the years:

- My wife, Joyce, and my three children (Christina, Matthew and David), who have shared me with hundreds of students over the years;
- William Lauffer, the dean of Engineering Technology at Prince George's Community College, who gave me the opportunity to develop and teach these courses;
- Dirk Faas, Bradley Faas, and Darrell Mattheis, my engineering assistants, who have made me look good so many times and have helped so many students when there wasn't enough of me to go around 20 students at a time; and
- The board of directors for my non-profit organization, Research Technology Associates, which includes Jess Smith, Francis Ennels, Dirk Faas, Darrell Mattheis, Doug Bishop, and my wife Joyce. They are people to whom I give permission to tell me what to do, and their advice is invariably always excellent.

Reproduction of these course materials without the express written permission of the author is prohibited. If you would like to obtain a copy of these materials, if you would like to have me come and teach my courses for your organization, or if you would like to license this curriculum for use with your school or non-profit organization, please contact me at the following address:

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COURSE SYLLABUS: BUILDING YOUR OWN PERSONAL COMPUTER

TEXTBOOKS AND TOOLS:

REQUIRED TEXT: Upgrading and Repairing PCs, **10th** Edition, by Scott Mueller; published by Que Corporation. Approximate Cost: $49.95

The purchase of a computer repair toolkit (usually under $20.00) is REQUIRED. I have included details of how to get such a kit in your class notes.

CLASS TIMES:

Classes are held as listed in the Semester Course Listing.

MISSION STATEMENT:

This course will enable you to do the following things:

1) Identify major components and sub-systems of an IBM-class microcomputer;
2) Have a basic understanding of what takes place with the computer's hardware when the computer is turned on;
3) Understand how MS-DOS operates and uses memory in an IBM-class computer;
4) Understand the concept of fault-isolation, and be able to isolate the most typical kinds of faults found in malfunctioning IBM-class computers;
5) Be able to successfully repair faulty IBM-class computers in at least a rudimentary fashion;
6) Identify what components are needed to build your own IBM-class microcomputer, estimate the price of those components, and inform you of where in the local area to buy this equipment;
7) Develop a basic understanding of what steps are necessary in order to correctly and safely build your own computer;
8) Observe the building of a PC from scratch, so that you will be better prepared to do the job yourself;
9) Build your own PC in class, with my assistance and the help of engineering students who will be available to guide you through the process; and
10) Check and test all systems for proper assembly, setup, operating system / software installation, and correct operation.

CLASS RULES:

Feel free to ask lots of questions;
Food and drink are permitted in lecture class, but NOT in the lab;
Have fun!

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PLACES TO GET A TOOLKIT

The toolkit you need for these courses should be simple, and cost less than $20.00 It should include at least the following things:

- Phillips and flat blade screwdrivers (small and medium size)
- A 3-claw part grabber
- A chip inserter and chip extractor
- A TORX head screwdriver
- A 1/4" and 3/16" nut driver
- Perhaps a container to hold small parts and screws

Things you do NOT need include:

- A soldering gun
- Magnetic tools
- Drills

If you have a small voltmeter, that's good; it may be useful in some instances. We have voltmeters in the lab, so you don't have to run out and buy one.

WHERE DO I BUY SUCH A TOOLKIT?

Look in places like:

- Sam's Club
- Egghead Software
- CompUSA
- Radio Shack
- MicroCenter
- Office Depot
- Staples
- PC Shows

Call before you go!! Make sure the store has the kits before you travel out there.

NOTE: I share NO financial stake in any of the above-mentioned companies. I simply give them as sources other students and colleagues have used in the past to find decent toolkits for these courses.

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CLASS READING ASSIGNMENT

By the fourth class session of this course, you should read the following chapters in the Mueller textbook (**10th** Edition):

Chapter Number	**Subjects Covered**
Chapter 1	Personal Computer Background
Chapter 2	Overview of System Features and Components
Chapter 3	System Teardown & Inspection
Chapter 4	Motherboards
Chapter 5	Bus Slots and I/O Cards (skim)
Chapter 6	Microprocessor Types and Specifications (skim)
Chapter 19	Building a System from Scratch
Chapter 20	Preventative Maintenance, Backups & Warranties
Chapter 21	Software and Hardware Diagnostic Tools
Chapter 22	Operating Systems Software and Troubleshooting

Optional Readings

Chapter 10	Video Display Hardware
Chapter 12	Audio Hardware
Chapter 14	Hard Disk Drives (please skim read)
Chapter 17	CD-ROM Drives

Isn't this a lot of reading?

Yes, it is. However, what you will read here will be covered in the lecture AND in this course manual. It reinforces what we talk about in class, and will give you good questions to ask.

What if I don't understand something?

Don't worry. Make a note of your questions, and bring them up in class. This is your opportunity to fill in gaps in your understanding of how PCs work. The textbook is written in fairly non-technical English, so it will serve as a good tool for learning.

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SECTION 1: LEARNING THE BASICS

In the first part of the course, we will focus on learning the essentials about personal computer hardware. You will learn about the following kinds of things:

- Electrical power and surge suppressors
- How do computer viruses affect your PC, and how do you deal with virus problems?
- What are the major components inside your PC, and what do each of these components do?
- How do different types of the same components compare, one with each other? (for example, why is an 80486DX processor better than an 80486SX, or an 80386DX?)
- What is the Power-On Self Test, or POST, and what does it do for the computer user?
- What are error codes and audio error codes, and how can you decipher these codes?
- How do you open and disassemble a PC, and how can you identify the major components?
- What guidelines should you use when testing or checking a PC?
- How do you fill out a "toe tag", which is an identification sheet labelling each tested PC?
- How do you visually identify specific computer components?
- What software can you use to test and identify components in your PC?

This course manual covers all of the topics that will be discussed in the lecture portion of the class. Your instructor will follow the outlines laid out in this manual. The manual has been designed to free you from needing to take lots of notes during the lecture sessions ... the lecture notes for the instructor contain the same kinds of information as your course manual. As the lecture progresses, review the manual and add any explanatory notes into the space provided on each page.

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FACTS ABOUT ELECTRICAL POWER AND SURGE SUPPRESSORS

The voltage you get from the wall socket is NOT always what you expect ...

There are periodic fluctuations in voltage from devices going on and off in your building, problems in the transmission line, electrical storms, bad or faulty transformers, etc. Sometimes these fluctuations in voltage may exceed several thousand volts. When this happens, bad things can happen to good computers (or any other kinds of electrical devices).

Surge Suppressor

A **surge suppressor** provides a way to deal with voltage spikes (but not loss of voltage). The surge suppressor has a metal-oxide varistor (MOV) that will shunt excess voltages to ground, thereby saving your PC.

When buying a surge suppressor, the most important thing to check for is the clamping voltage of the unit. The clamping voltage is that point when excess voltage will be diverted to ground. A good suppressor will have a clamping voltage of approximately 300 volts, and will have a Underwriter's Laboratory (UL) listing of UL 1449. This is sufficient to protect your PC from harmful excess voltage.

Reliable surge suppressor are made by the following companies:

- APC - TrippLite - Curtis

As long as the suppressor has the UL 1449 rating and a 300 volt clamping voltage, it will serve you well. These should cost you between $30 and $60 in the local stores.

Uninterruptible Power Supply

An **uninterruptible power supply (UPS)** will have this same technology, but it contains a battery in it as well. The battery in the UPS will allow your PC to continue to operate if power has been cut off to your building. HOWEVER, it will only last for a few minutes (5 - 30 minutes). An UPS allows you to shut off your PC in a normal fashion in the event of a power failure. These will cost at least $100 for a low-end model, and high-performance versions can cost thousands of dollars.

If you have intermittent voltage failures in your area (i.e., the power frequently cuts off for only a second), consider getting a low-end surge suppressor. It will save you immense amounts of grief when using your PC, since all the information stored in RAM is wiped out when power is cut off.

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HOW DO VIRUSES AFFECT YOUR PC

Viruses will affect your PC in 4 different ways . . .

1) **The Boot Sector:** The boot sector is where your operating system files reside on your floppy or hard disk. A virus will go to that location on your disk and corrupt these files (IO.SYS, MSDOS.SYS, and COMMAND.COM) so that your PC will NOT boot up as expected.
EXAMPLE: the STONED virus.

2) **The File Allocation Table:** The File Allocation Table (FAT) is a list of all the files on your floppy or hard disk, and where the files are physically located on the disk. A virus will corrupt the FAT so that you cannot locate or access your files.
EXAMPLE: the CASCADE virus.

3) **The Partition Table:** The partition table on your HARD DISK tells MS-DOS how big your hard disk is, and what percentage of it is used by MS-DOS. A virus can corrupt your partition table, which wipes out ALL of your files in an instant.
EXAMPLE: the MICHELANGELO virus.

4) **.COM and .EXE Files:** Files with these extensions are EXECUTABLE files, which perform a specific action. A virus can attach itself to one of these kinds of files and corrupt the way it operates.
EXAMPLE: the 4096 virus.

3 THINGS A GOOD VIRUS PROTECTION PROGRAM SHOULD DO

1) **SCAN for viruses:** A good program should be able to check your floppy and hard disks for viruses, as well as the RAM of your computer, and detect the presence of a virus in the 4 locations mentioned above.

2) **CLEAN up the virus:** A good program must be able to get rid of the virus it finds in any of the 4 places mentioned above; otherwise, it's useless.

3) **PROTECT YOU from viruses:** A good program must have the ability to load a piece of the program into memory at boot-up time, to protect you from getting a virus in the first place. This type of program is called a "Terminate-and-Stay-Resident" (TSR) program.

Good programs include McAfee's SCAN, and F-Prot. Both of these are shareware programs, and are available from the instructor upon request.

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DEFINITIONS OF BASIC COMPUTER COMPONENTS

MOTHERBOARD: The main board (guts) of computer; the central processor chip (CPU) is on the motherboard; all adapter cards plug into the motherboard; it is the largest single board in computer.

There are several types of CPU chips found on motherboards:

8088 CPU; inputs 8 bits of data	Processes 8 bits of data	Outputs 8 bits of data
80286 CPU; inputs 16 bits of data	Processes 16 bits of data	Outputs 16 bits of data
80386SX CPU; inputs 16 bits of data *	Processes 32 bits of data	Outputs 16 bits of data at a time
80386DX CPU; inputs 32 bits of data	Processes 32 bits of data	Outputs 32 bits of data
80486SX CPU; inputs 32 bits of data	Processes 32 bits of data	Outputs 32 bits of data
80486DX CPU; inputs 32 bits of data **	Processes 32 bits of data	Outputs 32 bits of data
'586 CPU: inputs 32 bits of data	Processes 32 bits of data	Outputs 32 bits of data
Pentium/P6/K5 CPU: inputs 64 bits of data	Processes 64 bits of data	Outputs 64 bits of data
Pentium Pro CPU: *** inputs 64 bits of data	Processes 64 bits of data	Outputs 64 bits of data

* The 80386SX CPU takes 2 clock cycles to input 32 bits of data to process; this CPU is a hybrid between an 80286 and an 80386DX.

** The 80486DX is the first CPU to integrate a math co-processor chip into the CPU itself. All CPUs before this had separate math co-processors.

*** The Pentium Pro will only run 32-bit applications.

The Mueller textbook has further information on the different CPU chips that can be installed onto a motherboard.

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DEFINITIONS OF BASIC COMPUTER COMPONENTS (PAGE 2)

POWER SUPPLY: Provides electrical power to motherboard, disk drives, and occasionally to the monitor also. Has a fan on it to cool the computer.

VIDEO CARD: Adapter card that sends video signals to the monitor; 4 main kinds of video cards:

Hercules: Monochrome & high-res graphics
CGA: Color & low-res graphics
EGA: More colors and high-res graphics
VGA: Lots of colors and very-high-res graphics
(VGA and Super VGA are compatible)

HARD DISK: Stores large quantities of data for use at a later time. Uses a **HARD DISK CONTROLLER** to connect hard disk to motherboard.

MFM and RLL drives: Typically have separate controllers and hard disks. RLL controllers can store up to 30% more data on the same disk than MFM controllers. Uses 34-pin AND 20-pin cables to transmit data.

IDE Drives: Have hard disk controller and hard disk in ONE unit; slightly more difficult to install additional hard disks to IDE systems. Uses 40-pin ribbon cable to transmit data.

SCSI drives: Uses separate controllers, like MFM & RLL drives, but can transfer data at a much faster rate. SCSI drives are also more expensive. Uses 50-pin or 66-pin cable to transmit data.

FLOPPY DISK DRIVE: Stores smaller quantities of data than a hard disk. Uses a **FLOPPY DISK CONTROLLER** to connect drive to motherboard. 4 main floppy drive types:

5 1/4" 360K: Stores 362,496 bytes of data
5 1/4" 1.2M: Stores 1,213,952 bytes of data

3 1/2" 720K: Stores 720,112 bytes of data
3 1/2" 1.4M: Stores 1,457,664 bytes of data

PARALLEL PORT: Connects printer to computer; sends 8 bits of data (1 byte) at a time.

SERIAL PORT: Connects serial devices (mouse, modem, plotter, digitizer) to computer; sends 1 bit of data at a time.

RAM: Random Access Memory; this is the workspace or desktop of your computer.

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DEFINITIONS OF BASIC COMPUTER COMPONENTS (PAGE 3)

EMS CARD: Expanded Memory card; adds extra RAM memory to computers that have no more expansion capacity on the motherboard.

NETWORK INTERFACE CARD (NIC): Connects your computer to a network of other computers.

MS-DOS (OR PC-DOS): The Disk Operating System; controls all of the disk drives as related to the computer.

APPLICATIONS: Any programs you use in the DOS environment (Lotus, WordPerfect, etc.)

NETWORK OPERATING SYSTEM: Like DOS, but allows the computer and you to use software on the network hard drives.

CD-ROM DRIVE: Reads data from Compact Discs (CDs); up to 688MB of data can be stored on 1 CD; READ-ONLY technology - generally, you can't write to a Compact Disc.

SOUND CARD: Provides stereo sound from your PC, through EXTERNAL speakers.

If you wish to find additional information about the different types of hardware inside your PC, refer to the Mueller textbook.

You can also use the hypertext program called UPGRADE.EXE, which is found in the workbook that came with the Mueller textbook. It contains information about all of the hardware components defined above, in an easy-to-use automated format. Refer to the Workbook for details on how to install and use the hypertext program.

You will need to know the definitions listed on these pages in order to answer specific questions on the first exam.

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WHAT IS POST, AND WHAT DOES IT DO FOR YOU?

POST is the Power-On Self Test which your computer performs when you turn it on and/or re-boot. Below is listed what POST checks:

100 Series: Motherboard checks

200 Series: Memory chip checks

300 Series: Keyboard checks

400 Series: Monochrome monitor checks

500 Series: Color monitor (CGA) checks

600 Series: Floppy Disk Drive checks

700 Series: Math Co-processor checks

900-1000 Series: Parallel Port Adapter Checks

1100-1200 Series: Serial Port Adapter Checks

1300 Series: Game Port Adapter Checks

1400 Series: Printer Checks

1700 Series: Hard Disk/Disk Controller Checks

You may also hear a series of beeps when you turn on the computer, IF SOMETHING IS WRONG. Normally, you hear only one short beep. Here is what the DOS Audio Error codes mean:

No display, no beeps: No Power
Continuous beep: Power supply failure
Repeating short beeps: Power supply failure
One long and two short beeps: Display adapter (video card) failure
One long and three short beeps: Display adapter (video card) failure

See the Mueller textbook for a more extensive list of PC error codes.

You will want to memorize this page in preparation for the tests in these courses.

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STEPS IN THE BOOT PROCESS

1) When the PC is powered up, the CPU resets itself, clears out any left-over data, and looks to an address in memory called F000 ...that is where the ROM BIOS chip is located. The ROM BIOS chip is what makes your PC IBM-compatible. When the CPU finds the ROM BIOS chip, it invokes the first program found in memory, which is POST: the Power-On Self Test. This self-test ensures that all of your components are operating properly BEFORE you begin working with the computer.

2) As POST checks your computer, it looks to a record of data stored in CMOS RAM that tells what kinds of components are in your PC. Specifically, it records what type of video card, floppy drives, hard disk, memory and so forth are contained in your PC. POST will test your computer based on what it believes is in your PC ... if the information is missing or incorrect, the PC may not be able to recognize or use certain components in your system. It's important to keep a record of what specifically is inside your computer, and that you have a record of what is written into CMOS RAM.

3) If POST finds that there is a problem with your PC, it will display an error message or an error code that tells specifically what is wrong with the unit. If it cannot display such a message, it will beep in a specific pattern that indicates exactly what is wrong. If everything is OK with the computer, POST will sound one beep to the system speaker, indicating that all of the tests passed normally with no errors.

4) The ROM BIOS will then look to the boot sector of either a floppy disk or a hard disk to find IO.SYS, the boot loader program of your operating system. If it can't find this file in that location, the PC will give an error message to the screen. When it does find the file, it loads the file into RAM, and then your operating system takes charge of the computer.

5) MSDOS.SYS then loads into memory (for both DOS and Win95). It contains the bulk of the operating system code that makes DOS or Win95 operate. Specifically, it lets you manage file names, execute programs, and allows hardware and software to manage interrupt (IRQ) requests.

6) Then, CONFIG.SYS configures your system for the specific kinds of hardware that are contained in the system. Lines like DEVICEHIGH=C:\MOUSE.SYS tell DOS where to find the mouse driver, and where to load it into memory. DOS and Win95 both use a CONFIG.SYS file.

7) Then, COMMAND.COM loads into memory. It is your command interpreter, and it allows you to input commands at a DOS prompt. DOS and Win95 both have COMMAND.COM as one of the system files.

8) Finally, AUTOEXEC.BAT loads into memory any programs you wish to run every time you start or reboot your computer. Usually at the end of the AUTOEXEC.BAT file, the PC will call up Windows, or a menu program, or will allow you to log into a network, so that you can begin working with the computer as you would wish. Both DOS and Win95 use AUTOEXEC.BAT.

If any of these steps do not occur in a normal manner, your PC may not boot up as you would expect. Knowing the steps in the boot process will help you when trouble-shooting or analyzing problems with your PC.

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GENERAL GUIDELINES FOR REPAIRING COMPUTERS

Use these following ten rules when repairing or trouble-shooting a computer:

1) **Gather together your toolkit and any necessary documentation for that specific computer.** You may also want to have the Mueller textbook available ... it is a good resource for technical specifications and system disassembly guidelines.
2) **Check for power FIRST, before doing anything else.** 10 - 15 percent of all trouble calls are for nothing more than a popped circuit breaker or a loose plug. Check these things BEFORE doing anything else.
3) **Check your external connections to the computer.** Specifically, check the mouse, keyboard, monitor, modem and/or printer cables, making sure that all are secure and in the right sockets.
4) **If the computer is still malfunctioning, go ahead then and open the case.** Check to see that all of the cards are fully pressed down into the bus connections, that any socketed chips are fully pressed into their sockets, and that all cable connections are fully attached. Make sure that the drive cables are attached so that the colored stripe on the cable is positioned next to pin 1 on the connector.
5) **Clean any dust or foreign material out of the case while it is open.** Dust can cause overheating problems and electrical shorts. Sometimes, insects will nest inside the case as well. All of this needs to be cleaned out before you close up the case. Use compressed air and non-conductive materials to clean out the inside of the case. Take precautions to avoid inhaling excess dust, and consider using protective eyeware if necessary.
6) **Try to boot the computer to the hard drive, or to a bootable floppy disk if necessary.** Sometimes the hard disk will become corrupted by a user, or by a virus. If you can't access the hard drive directly, have a bootable floppy disk available. This bootable floppy disk should have a copy of your CONFIG.SYS and AUTOEXEC.BAT files on it, as well as any drivers necessary for devices like your sound card, CD-ROM drive, and mouse. Have a good disk diagnostic program available (SCANDISK, Norton Utilities), and a good virus checking program as well. If your data is severely damaged, you may need to wipe the disk and reload the data from original or backup disks.
7) **Check the CMOS setup program, and correct any configuration problems.** If the information in CMOS RAM about your PC's configuration has been changed, or if the battery has died, your computer will not boot correctly, or it will not recognize certain components. Keep a copy of your setup program information handy, so that if something changes, you can correct the problem. Replacement CMOS batteries are about $15.00, and are readily available. Such batteries should last about 2-3 years.
8) **Look for unwelcome changes.** Someone may have turned the brightness down on a monitor, or the LAN staff may have changed your PC's configuration without your knowledge (or approval), or an installation program may have corrupted something in your software. Look for recent changes in your system's operation. You may need to run an uninstaller program to remedy software-related problems.
9) **Isolate the problem to one piece of hardware, or one software package.** The problem you are encountering may occur only in one software package, which means the problem has a very limited scope. If the problem occurs in all programs, then it's a systemic problem. Refer to software and operating system manuals as needed, and have the original software disks available, in case a driver needs to be reloaded. If the system just won't fire up, remove all non-essential components, and see if you can cause the problem to re-appear by re-installing components one-at-a-time. This process is usually quite helpful in trouble-shooting even the most stubborn problems.
10) **When all else fails, read the manual.** There may be something unique about your computer that requires special attention as directed by the manufacturer.

If, after trying all of these things, the computer still does not work, bring the computer here to the college for attention. We will put a staff member and several student trainees on the case, and do everything possible to correct the problem while you wait. There is no charge for this service, but we do ask for a $20.00 donation to cover the expenses related to offering this service. Please contact the instructor for details on when and where to bring the computer.

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COMPUTER RECLAMATION PC REPAIR GUIDELINES

1) Assemble a PC, monitor, and keyboard combination as a set. Make sure you have the right components to make the unit operate correctly (i.e., correct keyboard type, correct monitor, etc.) Use the parts identification worksheet to visually identify the components in each PC.

2) Make sure you have the right software to test the PC; this would include:

   - IBM XT diagnostic disk
   - IBM AT diagnostic disk
   - bootable DOUBLE DENSITY floppy disk with the following DOS programs on it: FDISK, FORMAT, SYS, CHKDSK, and DEBUG
   - a generic diagnostic/informational program like SI.EXE, SYSCHK, or some similar type of program
   - a full-blown diagnostic program such as Checkit or Microscope 2000
   - a formatted, BLANK scratch disk to be used for floppy drive write/read testing

3) Run any hardware-specific diagnostic software (like the IBM XT or AT diagnostic disk) first before running anything else on the PC

4) KEEP WORKING ON ONE PC UNTIL YOU ARE COMPLETELY FINISHED WITH IT; don't get sidetracked working on several PCs at a time.

5) FILL OUT AN EVALUATION SHEET FOR EVERY PC YOU WORK ON, AND TAPE THAT SHEET TO THE CASE. Fill out the sheet as accurately as possible; indicate any problems or special needs for each PC on that sheet.

6) If you become stuck, or can't figure out a problem, ASK FOR HELP. Someone will be there shortly to help you. Refer to the Mueller textbook or any hardware documentation you have available. It may help you find the solution yourself.

7) Don't randomly "jab and stab" replacement parts into a PC. Figure out what would be best to install in the PC, assemble the parts, and perform the repair. Try to replace a defective part with an exact replacement whenever possible.

8) If a PC is really dead, consult with someone before proceeding. Some old PCs need a LOT of work; it may be better to use a dead PC for salvage parts, rather than trying to completely resurrect it. We will try to fix every PC we receive, provided we have the parts to do the job. If the parts are unavailable, we may shelf the PC until a later date.

9) If you are spending more than 30 minutes on a PC, you are probably spending TOO MUCH TIME on it. If you can't get it to fire up and test in 30 minutes, either get some help, or get another PC that needs less love & attention. Make a note on the PC of what it does or doesn't do, and then move on. DON'T let yourself get too frustrated; sometimes PCs are a pain.

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GOOD DIAGNOSTIC AND PREPARATION SOFTWARE

1) **Norton Utilities:** Analyzes and reports on computer's main systems; can repair/recover lost data from hard & floppy disks.

2) **Spinrite:** Analyzes and repairs media of hard disks; EXCELLENT PRODUCT.

3) **Speedstor or Disk Manager:** Prepares hard disk initially for use; re-formats disk when used, so use only when needed.

4) **IBM, Compaq, or that brand's own diagnostics:** Most companies provide diagnostic software designed for their own hardware; usually comes with their version of DOS.

5) **AMI or Award ROM BIOS:** Newer computers display their configuration information at boot-up; **COPY THIS INFORMATION FOR REFERENCE IN CASE PROGRAM GETS CORRUPTED**. The information is held in the computer's BIOS chip, powered by a battery. If the battery dies, ...

6) **AMIDIAG:** Like System Sleuth, but for motherboards with AMI BIOS chips. Program is built into newer AMI BIOS chips.

7) **Checkit Pro:** Checks all components in the PC, identifies problems, and it has a very good low-level disk formatting utility.

8) **Syschk:** A simple shareware utility available in the ENT 184 lab that gives a quick look at what's "under the hood" of your PC.

9) **MSD:** A program available in MS-DOS 6.0, 6.2, and Windows 3.1 that tells you what's "under the hood". Useful for identifying misconfigured equipment.

10) **MicroScope 2000:** Excellent diagnostic program. Also comes with a POST card, which allows testing of dead or intermittent PCs. It is expensive, however!

11) **QAPlus Pro:** Excellent diagnostic program. Used by many PC manufacturers and authorized repair facilities. DiagSoft, the manufacturer, provides significant discounts to students in PC repair courses; see the instructor for details.

Use the space below to list any other programs that would be helpful to you in diagnosing computer problems, repairing software or disk-based problems, or preparing a new PC for use.

NOTES

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HOW TO FILL OUT A TAG ON A TESTED COMPUTER

Listed below is a sample of a tag you will fill out when testing computers in the lab:

80386DX	4MB RAM
VGA Video	2S / 1P
1.44 Floppy	320MB H.D.
Network card	Modem
DOS 6.22	
5/31/97	B. Lloyd

When testing out computers in the lab, you must tag each computer to indicate what it has under the hood. Please use the following guidelines when filling out a tag on the PC. Specifically, indicate the following kinds of things on a yellow post-it note or an evaluation sheet:

- **Type of CPU (80286, 80386SX or DX, 8088, etc.)**
- **How much RAM it has**
- **Type of video card (Mono, CGA, EGA, VGA, 3270)**
- **Number of SERIAL and PARALLEL ports on the PC**
- **Type of floppy drive**
- **Size of hard drive**
- **Any other devices (network card, modem, etc.)**

Place the post-it note or evaluation sheet on the front of the PC; tape it on, if necessary. Then, date and sign your work to let others know what's been done.

Next, assemble a PC, monitor, keyboard and 2 power cords AS A SET. This ensures that the recipient of the PC gets a set of stuff that has been tested together and works. If available, use some strapping tape and tape the unit together as a set.

Finally, be sure that the PC gets to a C:\> prompt when you turn it on. The future user of the PC needs to plug it in, turn it on, and get nothing but a C:\> prompt. The PC should have a version of DOS on it, as well. If it doesn't, install it before you move on.

Use your software toolkit of evaluation programs (SYSCHK, MSD, Checkit, SYSINFO, etc.) to identify the contents of each PC, and write down the information from these programs onto the tag.

The instructor will provide you with a bootable system disk that has FDISK, FORMAT, DEBUG, and SYSCHK on it, so that you have something to start evaluating PCs with right away.

On the next page is a sample of a workable system identification worksheet. Make copies of this sheet, and use them when evaluating PCs in this course.

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SYSTEM IDENTIFICATION WORKSHEET

CPU type: 8088 80286 80386SX 80386DX 80486SX 80486DX Pentium

BIOS Manufacturer: IBM Compaq AMI Award Phoenix DTK Other

Does system power-up? Yes No

Base RAM Memory: _____ Kbytes

Extended Memory: _____ Kbytes

Expanded Memory: _____ Kbytes

Is all available RAM OK? Yes No Error messages? _____

Does keyboard work? Yes No Broken keys? _____

Video adapter type: Mono CGA EGA VGA

Does video card work? Yes No

Number of floppy drives: _____

A: 5.25" HD 5.25" LD 3.5" HD 3.5" LD

B: 5.25" HD 5.25" LD 3.5" HD 3.5" LD

Do floppy drives work? Yes No Which drive(s) failed? ____

Math co-processor? Yes No

Does co-processor work? Yes No

Serial port (modem/mouse): Yes No Number of ports: _____ Are ports OK? Yes No

Parallel port (printer): Yes No Number of ports: _____ Are ports OK? Yes No

Supports a hard drive? Yes No

Is hard drive installed? Yes No _____ Megabytes

Does hard drive work? Yes No Error messages? _____

Is PC ready for use? Yes No

_____ _____

Evaluated by: Date

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HARD DRIVE TESTING GUIDELINES

1) Locate a hard drive; notice the appearance of the hard drive.
There are 5 kinds of hard drives: MFM. RLL, ESDI, IDE and SCSI hard drives.

   Notice the model number and manufacturer of the drive; use that information to identify the correct specifications **and** drive type for that hard drive (i.e., cylinder & head count, sectors per track, etc.). **Refer to the Mueller textbook or some other reference book to find the correct information**.

2) Plug the hard drive into the appropriate test PC and turn on both the monitor and PC.

3) Run the ROM BIOS setup program and set the correct drive type.

4) Try to access the drive. If it says "Invalid drive specification", run FDISK and then the DOS FORMAT program. If that doesn't work, attempt to low-level format the drive using Disk Manager.

4) Use some kind of software to test the hard drive's operation; (Disk Manager, Checkit, XT or AT diagnostics, etc.)

5) **If the hard drive works properly**, label the drive and store it in the appropriate place in the lab.

6) If the hard drive does not work correctly, test and make sure that the hard drive is correctly attached to the PC.

7) If the hard drive is REALLY DEAD, **indicate this on the dead hard drive log and dispose of the hard drive**.

8) If you need assistance, let someone know.
If you're unsure of whether a hard drive is OK or not, label the hard drive as such and move on.

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MONITOR TESTING GUIDELINES

1) Locate a monitor; notice the appearance of the monitor. **If the cable has a 9-pin connector**, it's either Monochrome, CGA, or EGA.

   If there is a label with 3-colors on it, then it's probably CGA or EGA.

   If the monitor has the word "Enhanced" on it, it's probably an EGA monitor.

2) **If the cable has a 15-pin connector**, it is a VGA monitor.

3) Plug the monitor into the appropriate test PC and turn on both the monitor and PC.

4) Use some kind of software to test the monitor's display capability (Checkit, PC Probe, SYSCHK, etc.)

5) **If the screen displays properly**, label the monitor and store it in the appropriate place in the lab.

6) If the monitor does not display correctly, test and make sure that the monitor is attached to the correct video card.

7) If the monitor is REALLY DEAD, **indicate this on the dead monitor log and dispose of the monitor**.

8) If you need assistance, let someone know.
   If you're unsure of whether a monitor is OK or not, label the monitor as such and move on.

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KEYBOARD TESTING GUIDELINES

1) Locate a keyboard; notice the appearance of the keyboard.

   There are 2 kinds of keyboards: XT and AT keyboards.

   XT keyboards are usually 83-key keyboards.
   AT keyboards are usually 101-key keyboards.

   Some keyboards have an XT/AT mode switch on the bottom.

2) Plug the keyboard into the appropriate test PC and turn on both the monitor and PC.

3) Use some kind of software to test the keyboard's operation (Checkit, XT or AT diagnostics, etc.)

4) **If the keyboard works properly (that means ALL the keys work)**, label the keyboard and store it in the appropriate place in the lab.

5) If the keyboard does not work correctly, test and make sure that the keyboard is attached to the correct PC.

6) If the keyboard is REALLY DEAD, **indicate this on the dead keyboard log and dispose of the keyboard**.

7) If you need assistance, let someone know.
   If you're unsure of whether a keyboard is OK or not, label the keyboard as such and move on.

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PARTS IDENTIFICATION WORKSHEET

How can I tell what kind of adapter card I have in my hand? You must first look for clues ...

If it has a 9-pin or 25-pin port with pins showing:	You have a serial port on the card.
If it has a 25-socket port with NO pins showing:	You have a parallel port on the card.
If it has a small 9-socket port with NO pins showing:	You have a Mono, CGA, or EGA video card.
If it has a small 9-socket port with NO pins showing and one small RF output socket near the port:	You have a CGA video card.
If it has a small 9-socket port with NO pins showing and two small RF output sockets near the port:	You have an EGA video card.
If it has a small 15-socket port with NO pins showing:	You have a VGA video card.
If it has a barrel connector:	You have a network card.
If it has two telephone jacks on the back:	You have an internal modem.
If it has a larger 15-socket port with NO pins showing:	You have a game port on the card.
If it has a ROUND socketed port:	You have a PS/2 mouse port or PS/2 keyboard port (ports are identical)
If it has a 37-socket port with NO pins showing and 1 card-edge connector on the card:	You have an XT-class floppy drive controller card with an external floppy drive port.
If it has 3 sets of stubs (1 set of 34, and 2 sets of 20 pin stubs:	You have an XT-class hard disk controller.
If it has 4 sets of stubs (2 sets of 34, and 2 sets of 20 pin stubs:	You have an AT-class hard disk/floppy disk controller.
If it has 2 sets of stubs (1 set of 34, and 1 set of 40 pin stubs:	You have an AT-class floppy disk controller with an IDE interface port.
If it has several rows of socketed chips, with 9 chips in each row:	You have a memory card.
If it has several rows of socketed chips, a 25-pin port with pins showing, a small battery, and 1 - 2 sets of stubs on the card:	You have a multifunction card.

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HOW TO IDENTIFY A MOTHERBOARD

When examining a motherboard, look for the following clues to properly identify the board:

1) Look for the CPU chip (i.e., 8088, 80286, 80386, etc.). This is the biggest single clue.

2) Look at the bus connectors: if there are only 8-bit connectors, it is an XT-class (8088 based) motherboard. If there are 8-bit and 16-bit bus connectors, it is an AT-class motherboard (at least an 80286-based motherboard). If there are light-brown colored bus connectors that look sort of like 16-bit connectors, it's probably an EISA bus motherboard (with an 80386DX or higher CPU).

   If there is a small brown connector at the end of a 16-bit bus connector, that would be a VESA Local-bus (32-bit) connector. If there is a small white bus connector on the board, that would be a PCI (32/64-bit) local bus connector. These are found on 80486 and Pentium-class motherboards.

3) Also look for signs of conservative design; is the power supply connector standard, is the keyboard plug standard, etc. Non-standard motherboards have options like video cards or drive controllers built into the motherboard, or have non-standard connectors. This will be an issue for upgrading the PC.

4) Look for proprietary connections to the motherboard, like a special 32-bit memory card that only Everex '386 computers use that provides room for more memory on the motherboard. Many manufacturers use proprietary devices on their motherboards that won't work on motherboards built by other companies.

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TIPS TO REMEMBER WHEN RUNNING A CMOS SETUP PROGRAM

Getting In to the Setup Program

Pressing the Delete key gets you into the setup program for AMI and Award BIOS. Phoenix BIOS uses the F1 key, or F2, or Ctrl-Alt-Esc, or Ctrl-Alt-S. Look at the screen for a message explaining what keystroke you should use to enter the setup program.

Standard Setup

Here is where you will set date, time, floppy/hard drive types, video type, and memory size. Be sure you have the hard drive specifications (the number of cylinders, heads, and sectors per track) to enter into the setup program.

Use the left/right arrow keys to move from field to field on the screen. Use the PageUp/PageDown keys, or the plus/minus keys to modify the values in each field. These rules apply in all setup program screens.

Advanced/Extended Setup

The advanced setup lets you set the boot sequence, or perform a full or partial memory test, or enable/disable shadow RAM, or enable/disable cache memory, or enable features like block mode and LBA mode, or to set wait states on the CPU or memory. If you don't know how to set up these features, there should be a keystroke you can press that reloads the factory default settings (look at the bottom of the screen for details). You can try modifying different settings to get better performance on your PC. There is no magic formula ... trial and error works best.

Integrated Peripherals

Some motherboards have the drive interfaces and I/O ports built into the motherboard. This option lets you enable or disable any of these features.

IDE HDD Auto-Detect

This feature allows you to read the drive parameters from the IDE hard drive's diagnostic cylinder into the setup program. Use this feature to input the drive specifications, and to assure that the drive is connected and functioning properly.

Green (Sleep) Features

This option allows you to enable features that shut down certain PC components after a set period of inactivity. You can select which devices get powered-down and when in this screen. Use of green features is NOT recommended for PCs on a network, since a "sleeping" PC may be viewed as shut down by the network file server.

Exiting the Setup Program

You can either save the values you have just changed, or you can exit the program without saving the changes. Both options should be apparent to you on the main setup program screen.

AMI WINBIOS Setup

The newest version of AMI's BIOS looks like Windows 3.1. Use the same rules as you would in Windows to point, click, and change values on the screen.

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BASIC DOS COMMANDS NEEDED FOR THIS COURSE

1) DIR - Gives a directory of the disk and/or subdirectory you are currently in.
   DIR/W - Gives the same as above, but WIDE across the screen.
   DIR/P - Gives a directory of the disk and/or subdirectory 1 page at a time.

2) FDISK - Used to create, erase, or view a partition table on a hard disk.
   FDISK/MBR - Re-writes Master Boot Record, eliminating most boot-sector viruses.

3) FORMAT C: /S /V - Formats hard disk, making it bootable.
   FORMAT A: /F:360 /U - Formats floppy disk to 360k in a 5.25" high density drive.
   FORMAT B: /F:720 /U - Formats floppy disk to 720k in a 3.5" high density drive.
   FORMAT A: /Q - Performs a quick format of a previously-formatted disk.

4) CHKDSK /F - Checks your hard disk for free space, and eliminates lost clusters of data.

5) MEM - Shows how much **conventional, reserved, extended and expanded** memory is used.

6) MD (or MKDIR) - Makes a sub-directory on a floppy or hard disk.

7) CD - Change directory.
   CD\ - Change directory back to the root directory of a floppy or hard disk.

8) RD (or RMDIR) - Deletes a sub-directory on a floppy or hard disk; directory MUST be empty (without files or other directories) before deleting the directory.

9) COPY A:FILENAME.EXT C:\ - Copies a file from a floppy disk to a hard disk.
   COPY A:*.* C:\ - Copies all files from a floppy disk (or sub-directory) to a hard disk.
   COPY C:\DIRNAME*.* A: - Copies all files from a hard disk sub-directory to a floppy disk.

10) DEL FILENAME.EXT - Deletes a DOS file.
    DEL *.* - Deletes all DOS files in a disk or directory.
    DEL *.TXT - Deletes all DOS files in a disk or directory with the extension TXT.

11) SETUP (or INSTALL) - Program name used to install/configure software programs.
    Also the name of a disk-based CMOS setup program used on PCs that do not have a setup program built into the System BIOS.

12) CONFIG.SYS - User-developed file used by DOS to configure your PC's hardware.

13) AUTOEXEC.BAT - User-developed file used by DOS to run your standard startup procedures.

14) MSD - Gives the hardware configuration of your PC (DOS 6.0 or above).

15) MSAV - Checks your hard disk or floppy disk for viruses (DOS 6.0 and above).

16) DEFRAG - Re-orders files on a hard disk, re-assembling fragmented files and optimizing hard disk performance.

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STEPS TO PREPARING A HARD DISK FOR USE

1. **You must first perform a "low-level" format on the hard disk, so that the hard disk controller can read the physical media.** The low-level format places the initial magnetic markings on the disk, so that data can be accessed in a sequential fashion by the hard disk controller. You need a special program (like Disk Manager, Speedstor, Checkit, Disk Technician, etc.) to perform the low-level format. XT-class hard disk controllers usually have a low-level format program built into the ROM BIOS of the controller. AT-class controllers usually do NOT have such a program built into the hardware.

   When performing the low-level format, you will need to know some technical specifications of the disk. Specifically, how many heads and cylinders the drives has. The drive size is measured by how many read/write heads the drive has, and how many physical cylinders (concentric circles) are found on the disk. You may also need to know the write precompensation cylinder, the reduced write cylinder, and the landing zone where the hard disk's heads are parked at shut-down. You will also need to know at what rate the hard drive controller should interleave the disk; interleave is the rate at which data is laid down on the hard disk. All of the disk specifications can be found in your drive's manual, or even in the Upgrading and Repairing PCs book by Scott Mueller.

   If you have an IDE hard disk, you will NOT have to low-level format the disk; the low-level formatting is done at the factory for you. Normally, you will never perform a low-level format on an IDE drive, and some IDE drives prevent low-level formatting after it leaves the factory. Many SCSI disks now come already low-level formatted from the factory.

2. **Second, you must use the DOS program called FDISK to partition the disk.** FDISK partitions the disk; in other words, it tells DOS "How big is this hard disk?". For example; you could take a 100 MB hard disk and use it as one single drive (C:), or divide it into 2 50 MB drives (C: and D:), or into three 33 MB drives (C:, D:, and E:), or some other fashion as you choose. FDISK lets you divide your physical disk into several logical drives, or just partition it into one single drive.

3. **Finally, you must use the DOS program called FORMAT, so that DOS can store data onto the disk.** After you have low-levelled the disk and run FDISK on it, you will enter the following command from the A:\ prompt: **FORMAT C: /S/V**. This command formats the disk, puts the DOS system files on it (so that it is bootable), and the **/V** switch allows you to put your name on the disk.

Once you have done these three things, you will have a usable hard disk in your computer.

For more detail on this subject, refer to the Mueller textbook.

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SECTION 2: FOCUSING ON THE DETAILS

In the second part of the course, we will focus on learning essential details needed to understand how the PC's hardware operates, and how one can configure and test specific components for proper operation. You will learn about the following kinds of things:

- How DOS uses memory, and how memory is subdivided into 4 main regions
- What a typical CONFIG.SYS and AUTOEXEC.BAT file looks like
- How your PC supports specific serial and parallel ports by using standard IRQs and port addresses
- How to install a motherboard and build a computer system from scratch
- How to install multimedia components like sound cards and CD-ROM drives
- How to buy and support computer systems, and what makes a PC conservatively designed

There will be a "take-apart" lab during this portion of the class where you will learn how to disassemble and re-assemble a personal computer, and you will learn how to identify major computer components. You will need your toolkit during this class session in order to complete the lab exercises.

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MEMORY USAGE IN THE DOS ENVIRONMENT

A	This area of memory (Segment A) is referred to as the **Extended memory area**. It is the area of memory ABOVE 1 MB. This area of memory is found in AT-class computers, including 286, 386, 486 and Pentium computers. **It is NOT found in XT-class (8088) computers.** The DOS program HIMEM.SYS must be loaded into memory in order to access and use extended memory. The amount of extended memory in your PC depends on the way your motherboard is designed; check your hardware manual first.
B	This area of memory (Segment B) is referred to as the **Reserved memory area**. It is the area of memory between 640 KB and 1 MB. There is a memory block here that is 64K in size which is used by expanded memory drivers for memory swapping; it is called the **EMS window**. The rest of the area is used by your video card, ROM BIOS, and other hardware devices.
C	This area of memory (Segment C) is referred to as the **DOS/Conventional memory area**. This area of memory begins at 0K and ends at 640KB. All of your DOS programs run in this area of memory primarily. Windows programs use this area first also, and then they will use extended or expanded memory as well. MS-DOS is made up of three main program files, and two other files which you create. These files are listed below in the order in which they load into memory: a) IO.SYS b) MSDOS.SYS c) CONFIG.SYS User-defined d) COMMAND.COM e) AUTOEXEC.BAT User-defined

For more detail on this subject, refer to the Mueller textbook.

You will want to memorize this page in preparation for the tests in this course.

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A TYPICAL AUTOEXEC.BAT FILE LOOKS LIKE . . .

```
@ECHO OFF
CLS
PROMPT $P$G
PATH=C:\;C:\DOS;C:\BATCH;C:\WP51;C:\123;
LH GRAPHICS
SET GRAPHICS=VGA
LH C:\DOS\MSCDEX.EXE /D:MSCD001 /M:15
WIN **
```

@ECHO OFF informs the batch file NOT to display any of the following commands to the screen. CLS clears the screen. PROMPT PG modifies the DOS prompt to show your current directory, followed by the "greater than" symbol. The PATH specifies the directories DOS should look in to find your programs. GRAPHICS allows your printer to print EXACTLY what is on your video screen; the SET command tells GRAPHICS what kind of monitor you have. The LH before GRAPHICS loads the file into extended memory. The program MSCDEX.EXE loads the DOS driver for your CD-ROM drive.

** The last line(s) of your AUTOEXEC.BAT file will differ somewhat, depending on the user. Some users will have WIN as their last line, to invoke Windows. Network users will have listed the files needed to access the network and then LOGIN. Each user will have differing requirements and software to meet his/her needs.

A TYPICAL CONFIG.SYS FILE LOOKS LIKE . . .

```
DEVICE=C:\DOS\SETVER.EXE
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS
BUFFERS=20
FILES=50
DOS=HIGH, UMB
DEVICEHIGH=C:\DOS\ANSI.SYS
DEVICEHIGH=C:\MOUSE\MOUSE.SYS
DEVICEHIGH=C:\CDROM\CD_ROM.SYS /D:MSCD001 /P:170,15
SHELL=C:\COMMAND.COM /P/E:512
LASTDRIVE=C
```

The SHELL statement specifies explicitly the name of the command processor. SETVER.EXE assists older DOS programs that are incompatible with DOS 5.0 or 6.0. HIMEM.SYS is your extended memory manager. BUFFERS are 512-byte blocks held in memory; when all the buffers are filled, then DOS writes out to a floppy or hard disk. FILES specifies how many files can remain loaded into and active in memory. DOS=HIGH, UMB tells DOS to load MSDOS.SYS into the Upper Memory Area in the PC's hardware. DEVICEHIGH loads device driver files into extended memory, freeing up the conventional memory area. LASTDRIVE explicitly tells DOS what the last drive in the PC is. ANSI.SYS is a DOS driver software that allows "extended ASCII characters" (like hearts, diamonds, box-drawing characters, etc.) to be displayed to the screen. MOUSE.SYS loads the DOS mouse driver software, and the CD_ROM.SYS driver lets your PC recognize your CD-ROM drive.

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IRQ & PORT ADDRESS REFERENCE SHEET FOR PARALLEL & SERIAL PORTS

Interrupt levels allow your PC to Prioritize multiple accesses to the CPU.
DMA channels are pathways in your PC that allow data to travel from point A to point B.
Port addresses are like mailboxes, to which information is both picked up and dropped off.

If any of these settings are incorrect, your device (sound card, CD-ROM drive, fax modem) will NOT function properly.

Here is a list of the standard interrupt levels and port addresses for parallel and serial ports:

TYPE OF PORT	IRQ NUMBER	PORT ADDRESS
SERIAL PORTS		
COM 1:	IRQ 4	3F8 H
COM 2:	IRQ 3	2F8 H
COM 3:	IRQ 4	3E8 H
COM 4:	IRQ 3	2E8 H
PARALLEL PORTS		
LPT 1:	IRQ 7	3BC H
LPT 2:	IRQ 5	378 H
LPT 3:	IRQ 7, or 5, or NONE	278 H

COM 1: and COM 3: share IRQ 4, and COM 2: and COM 4: share IRQ 3. However, these COM ports each use unique port addresses, to make sure that each port is uniquely identified.

LPT 3: can share IRQ 7 or 5, but it MUST have a port address that is unique from LPT 1: or LPT 2:. In some systems LPT 3: will operate with no IRQ level; your software package (i.e., WordPerfect 5.1) will need to know how to directly address the port address being used for LPT 3:.

I have seen many computers that have LPT: ports with slightly different port addresses than shown above, yet the LPT: ports work just fine. Here is an alternate set of port addresses for LPT: ports only.

TYPE OF PORT	IRQ NUMBER	PORT ADDRESS
PARALLEL PORTS		
LPT 1:	IRQ 7	378 H
LPT 2:	IRQ 5	278 H
LPT 3:	IRQ 7, or 5, or NONE	3BC H

Please note that the IRQ settings for these LPT: ports are the same in both charts; only the port addresses are different. Refer to the Mueller textbook for further information.

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WHAT MAKES A MULTIMEDIA PC?

Several things are necessary to make a typical PC into a Multimedia class of PC:

1) At least an 80386DX CPU, preferably an 80486DX CPU.

2) An SVGA class video card, usually a high-performance card;

3) A CD-ROM drive, at least a double-speed drive that is XA-ready, Kodak Photo CD ready, and has at least a 300KB sustained data transfer rate;

4) A sound card of some kind, one that is Sound Blaster/AdLib compatible (I STRONGLY recommend a true Creative Labs Sound Blaster card - no clones);

5) Windows 3.1, OS/2, Windows NT, or some operating system/environment that will access and use CD-ROM drives and configure for sound cards.

6) In a DOS environment, you must load the DOS program MSCDEX.EXE, which enables MS-DOS to utilize a CD-ROM.

7) In a DOS environment, you must load a driver program for your sound card so that it will work with DOS. Some sound cards have drivers that work EXCLUSIVELY with Windows, and NOT in DOS.

8) A mouse, to make the graphical environment of Windows or OS/2 easier to use.

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TIPS TO REMEMBER WHEN BUYING A PERSONAL COMPUTER

1) Know what you want BEFORE you go looking or buying. Many people get convinced they need a more expensive or "powerful" computer, when in fact they do not. People who do word processing for a living do not need a Pentium-based computer necessarily; an 80486DX-based PC will do just fine when buying new, and in fact an 80386-based PC will really do just as well. DECIDE WHAT YOU WANT THE COMPUTER FOR BEFORE YOU BUY IT! Let your software choices and intended uses of the PC drive your purchasing choices, not what some salesman says. If necessary, bring a knowledgeable person along who can help to sort out the truth from the noise.

2) Comparison shop the area stores: DON'T buy on impulse. Write down what you want to buy, be as specific as you can. Compare the prices of several dealers in the paper; call the companies if necessary and have them give you a price quote. Many will even fax you a price quote. If you like a system and it's $40 more than a competitor's price, see if they will match the price - many will do this. Take at least 2 weeks to go through this process.

3) Get ALL promises for service & support IN WRITING before buying the PC. Verbal agreements between you and the salesman are never binding in a court of law, if things should get to that point. Therefore, get any warranties, service agreements, and support agreements IN WRITING before you buy your PC. Speak to a supervisor or manager if necessary, but don't accept any verbal agreements as binding commitments.

4) Test the computer before it leaves the store or house.

   Nothing is more frustrating to the new computer owner than to find that the 150Mhz Pentium system will only run at 90 Mhz, or that your 3.5" floppy drive doesn't work, or that your monitor has squiggly lines all over it when you leave it on for more than 10 minutes. The store should have already tested the computer before you pick it up, but this isn't always the case. It only takes 5-10 minutes to assemble the system and test everything; insist on doing this. Use a diagnostic program like Checkit or Norton Utilities to evaluate the operation of your computer. If something's not right, insist that they fix it BEFORE it leaves the store. Use the same rules when buying a used computer from someone's home: run diagnostic software on it BEFORE you fork over the cash.

5) Insist on getting some menu software installed on your PC, and have someone properly configure your application software BEFORE you venture into the PC world. The main reason new PC owners get so frustrated is that they have no easy way to get in and out of their new programs. MS-DOS is not an easy operating system for the novice to use. Therefore, make sure that you get some kind of menu software (Automenu, Direct Access, Windows, etc.) installed and properly set up on your PC before you start using all of your new software. Have the store or some well-trained PC maintenance person set up the programs on your hard disk as well as the menu program you choose. By doing this, you will be able to use your programs immediately, without having to struggle with DOS.

6) Never buy from the guy in New Jersey - ALWAYS BUY FROM LOCAL, REPUTABLE SOURCES. The guy in New Jersey is probably a reputable dealer, and probably sells quality parts. BUT, if your part breaks during the warranty period, where do YOU have to go (or mail the part) to get a replacement ... Always buy from local retailers that are reputable, that sell name-brand equipment, that give warranties, and that have a good name in the local industry.

Above all, CAVEAT EMPTOR (Let the buyer beware!).

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TIPS TO REMEMBER WHEN SUPPORTING COMPUTER SYSTEMS

1) Learn as much as you can yourself. The old adage goes "Give a man a fish, and he will depend on you for fish; teach a man to fish, and he will feed himself." The more YOU know of the technology and how to use it, the better off you will be. Remember, the PC is your friend and your tool, not your adversary. Plan to make computer courses and seasons of learning part of your normal work time.

2) Find a "guru" who you can turn to in times of need. Sometimes, you have to go to the Rock that is higher than yourself. When those times come, have a person (or persons) who will covenant with you to help you learn through problem situations. Have a hardware AND a software guru who will help trouble-shoot both kinds of problems.

3) Use the resources of a local college to help yourself, and to support your system. Community colleges have a wealth of training programs specifically designed to help adult and working learners. Take continuing education courses, or even credit courses for needed skills. Find out if there is a cooperative education program that might get you low-cost (or no-cost) skilled help for your computer system or internet site.

4) Tie into existing resources. Don't re-invent the wheel, unless the existing wheel is no good. If another compatible organization in your area has computer resources or internet resources that can be shared for lower cost, consider using them instead. Partner with other organizations that can get you more visibility or added-value to your service.

5) Predict failures as well as successes. Plan for problems, and have a plan when they occur. Have some spare hardware parts (hard disks, video cards, etc.). BACK UP YOUR IMPORTANT DATA EVERY WEEK. Expect jobs to take a little longer than they should ... expect the toner cartridge will need replacing.

6) Work your way out of a job. Train someone as you go along that will learn what you do, so they can do it if you can't. Make sure others know how to get all the jobs done, and encourage them to participate in the tasks you do. One day you may be called on to do something new ... make sure someone else can fill your shoes.

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WHAT MAKES A PC "CONSERVATIVELY-DESIGNED"?

A conservatively-designed PC doesn't have a lot of extra devices built into the motherboard, such as:

- Video cards
- Parallel/serial ports
- Network cards
- Drive interfaces (floppy or hard disk)
- SCSI host adapters
- Sound cards

It is better, from a repair standpoint, to have these devices plugged into the bus connectors of the motherboard as separate devices than to have them integrated into the motherboard. Why? These individual devices are easy to replace and much less expensive than replacing an entire motherboard for the failure of a single part on that motherboard.

Devices can also be "non-conservative" in their design; for example, many IDE interface cards have floppy drive controllers, parallel/serial/game port interfaces, and other devices built into a single card. This card has one primary chip that handles all these interfaces; when that chip fails (and it does frequently), then the entire card is trashed.

Manufacturers that make "non-conservative" motherboards and systems include:

Gateway 2000 Dell AST CompuAdd Compudyne

Tandy Packard Bell Compaq

Most local home-brewers build conservatively-designed PCs ... such companies in the Washington DC area include:

Microplus Intellicom Computech MicroPower PC

CCS

Refer to the Mueller textbook for a further discussion of this subject.

Use the space below to list additional manufacturers that build conservatively-designed PCs.

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SECTION 3: BUILDING YOUR NEW PC

In the final part of the course, we will focus on building your PC and installing the operating system, along with the multimedia components of the computer. We will also learn the essential details needed to understand how to configure and test specific components for proper operation. You will learn about the following kinds of things:

- How do I install a motherboard properly
- What are the steps needed to bring a new PC to life
- How do I install a CD-ROM and sound card correctly
- What are the step-by-step instructions I need to follow to build my PC (see the PC building checksheets)
- How do I install the video drivers for my video card
- How do I use the Defrag, Scandisk, and Memmaker utilities in Windows 95 (and DOS 6.22)
- How do I install Windows applications

This is the portion of the class where you will actually build your own personal computer, and you will install all of the major computer components. You will need your toolkit during this class session in order to complete the lab exercises, along with your own copies of DOS 6.22, Windows 3.11, or Windows 95. The instructor does not have software you can "borrow" ... you must buy and bring in whatever software you wish to install.

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IMPORTANT THINGS TO REMEMBER WHEN INSTALLING A MOTHERBOARD

Plastic Standoffs

When you install a motherboard, DON'T screw it directly down to the chassis of the case!

You mount it to the case, using the little **plastic standoffs** provided when you buy the case and power supply (if you don't have any, let me know, and I'll get you some). These standoffs keep the board from shorting out against the case, and they provide enough stability to the board so that you can push cards into the bus connections. If you don't install the standoffs correctly, any of the following things could happen:

- the board touches against the case and shorts out, potentially damaging the motherboard and other installed components
- you crack the motherboard when installing the cards into the bus connections
- you allow the board to warp into an unnatural position by leaving it unsupported

The plastic standoffs have 2 ends to them: one that snaps into the holes on the motherboard, and one end that goes into little slots or grooves on the case. The idea is to have the bottom part of the standoffs slide into the pre-made holes on the case.

If you find that there is a need for a plastic standoff, BUT there is no hole on the case for it, **cut the bottom off of the standoff**, and let the standoff rest on the chassis. This will ensure that the motherboard doesn't touch against the case.

Grounding Points

On most motherboards, there are CERTAIN holes that are designed as **grounding points**, that are intended for you to screw the motherboard down to a metal standoff on the case. ***These grounding point holes usually have a silvery-appearance around them***. They are designed to take either a metal screw or a plastic standoff when mounting the board. When using a new case, you will find a bronze metal standoff (or two) in the package of screws that comes with the case. You will usually mount ONLY ONE of these bronze standoffs on the case, and mount the motherboard with a metal screw AT THAT ONE POINT ONLY.

If you mount a metal standoff and a screw into a hole that is NOT a grounding point, you can short out the motherboard and PERMANENTLY damage it. Be very careful to notice the appearance of the holes in the motherboard, and never screw the board down to a hole that is not a grounding point.

Power Supply Connections

There are two power supply connections that connect to the motherboard. Each connector has a pair of black wires on them. The key in attaching these connectors is this: **put the black wires together so that there are 4 black wires next to each other**. This ensures that the power connections are installed correctly. Putting them on incorrectly can subject the motherboard to abnormal voltages and permanently damage the board.

When installing the power supply connectors to the motherboard, **swing them in at an angle, and then gently press them down onto the board**. The connectors have a design that forces you to hook them into the board, and then press them down. Some power supplies have these hook connectors cut off, allowing you to press the supply lines directly onto the board. In either event, be careful when installing power supply lines to the connectors on the motherboard.

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IMPORTANT THINGS TO REMEMBER WHEN INSTALLING A MOTHERBOARD (PAGE 2)

If possible, use a dead motherboard and power supply to practice installing power connector; also, practice installing a board to the case with dead components.

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STEPS TO BRINGING A NEW PC TO LIFE

Mount the motherboard and apply power first ...

When installing the motherboard to the case, use the proper guidelines for mounting the motherboard to the chassis. Then, attach the power supply connections and the PC speaker ONLY: no RAM, no video card, etc. Power the system up and listen for **3 low-toned beeps**. If you hear these beeps, the motherboard is OK (it powers up and finds the CPU). If you hear no beeps, check your power and speaker connections, ensure the CPU is installed OK, and make sure the board is not grounding out. If this does not resolve the problem, replace the motherboard.

Then, install the memory ...

Install the memory to the motherboard; be sure to put it in the right SIMM sockets (look for the designation "BANK 0"). You may need to set some jumpers on the board to get the memory to be recognized properly; also, many boards require more than one SIMM on the board at a time. Once you install the memory, power up the system and listen for a **different** set of beeps (usually 2 high short beeps and 7 or 8 lower-toned short beeps). These beeps are telling you that the video card cannot be found (mainly because it hasn't been installed yet!). If you get such a beep sequence, you can continue and install the video card. If you still get the three low beeps as before, check and re-install the memory. If the memory is installed correctly and you continue to get only the three low beeps, replace the memory.

Then, install the video card and monitor ...

When you have the motherboard and memory installed correctly, then you can install the video card into the system and attach a monitor. When properly installed, you should be able to see the computer going through POST on the screen. If not, then you may have a problem with the video card (check for 1 long and 3 short beeps) or the monitor. If the system hangs after installing the video card, the video card is probably defective, or not installed correctly. If you see no video on the screen after checking the video card, then either the monitor is off (or without power), or the monitor is defective.

Then, install the drives and drive controllers ...

Once you have motherboard, RAM, and video installed properly, attach the drives to the drive controller/interface. Be sure to get the cable stripes attached next to pin 1 on the interface connectors. Also, be sure to attach power cables to the drives. You may now also install the keyboard.

Then, power up and run the CMOS Setup program on the BIOS ...

When the drives are fully connected, then run the Setup program. Watch the screen to tell you what keystrokes to use in order to enter the Setup program. Use the "Auto-detect" feature to detect the IDE-class hard drive(s) in your system. If the auto-detect feature does NOT find the hard drive(s), then power down and re-check your connections. If the computer still cannot find the hard drives (or floppy drives), then either your cables are bad, the controller is bad, the power to the drives is bad, or the drives themselves are bad.

If the drives are recognized by the auto-detect feature, save the setup information and reboot. You can now begin loading DOS onto the PC, and begin software loading as well.

Let the instructor know if you have any questions about this procedure.

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NEW PC BUILDING CHECKSHEET

Tools and parts needed:

- o Flat/Phillips screwdrivers
- o Needlenose pliers and/or wire cutter
- o Case/power supply (including screws, plastic standoffs, and drive mounting hardware)
- o Motherboard and CPU, floppy and hard drives, memory, drive and /or audio cables, video card, CD-ROM drive, sound card, fax/modem, CPU cooling fan

Software needed:

- o Bootable floppy disk with FDISK.EXE and FORMAT.COM installed on it
- o Checkit or a comparable diagnostic program
- o Disk Manager on floppy disk (if low-level format or custom drive partitioning is needed)
- o MS-DOS or Windows95 operating system software
- o Any desired application software
- o Installation disks for the new sound card, CD-ROM drive, and video driver disk for Windows/Win95
- o An audio CD and a data CD-ROM disk (for testing purposes)

Step-by-step instructions:

1) Open the computer case;
2) Mount motherboard to case using plastic standoffs, as well as bronze standoffs and screws (be sure to use screws only on grounding points - use plastic standoffs elsewhere); the motherboard MUST be flat, steady, and not grounded out against the case;
3) Attach the power supply connection to the motherboard, and attach the speaker connection; test the motherboard to see that it is working correctly (it should give 3 long beeps, provided that no memory is installed); power down the PC;
4) Install the SIMMs (memory) onto the motherboard, and apply power again; you should get an audio error code (a series of beeps) indicating there is no video card installed; if there is no change, check the installation of the SIMMs; if correct, power down the PC;
5) Install the video card, and attach the monitor; power up the PC and watch the monitor to see that POST is testing the PC; if there is no change, check and/or replace the video card; if correct, power down the PC;
6) Mount all drives to the case; attach drive cables to the drives, and then attach the cables to the interface card or motherboard; be sure to install the cables so that the stripe on the cable is closest to pin 1 on the connector; be sure to attach power cables to all drives;
7) Power up the PC, and enter the CMOS setup program; enter into the program the exact types of hardware found in the PC (specifically video, memory size, floppy/hard drive parameters, etc.); save the information to CMOS RAM and reboot the PC;
8) Boot the PC from a bootable floppy disk; begin the installation process for the hard drives, and any other installed equipment (CD-ROM, sound card, fax/modem, etc.); install whatever desired operating system software and application software; use the installation checksheets for installing hard drives, CD-ROM drives, sound cards and fax/modems to assist you in the PC building process (see accompanying checksheets);
9) Run Checkit (or some comparable diagnostic software) to ensure that the PC is working properly; also, run a burn-in test program for 12-36 hours to check the system under load conditions;
10) Replace the computer case - do NOT install the cover until you know the system is working properly.

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NEW PC BUILDING CHECKSHEET (PAGE 2)

Installation tips:

1) Take things one step at a time. Do not rush, and do not proceed to the next step until you are sure that what you just installed is working properly;
2) Make notes of what you do, and observe the little things; for example, notice that the wires to the dashboard lights on the case usually are labeled to show what they are, and that the motherboard (and/or the motherboard documentation) indicates where the wires should be plugged; notice beep codes, error messages on the screen, and funny smells;
3) Be sure to have the 800-numbers for the hardware manufacturers available (whenever possible) for technical support if needed.
4) Refer to the various installation checksheets for different devices (hard disks, sound cards, etc.) to assist you in each step of the PC building process.

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HARD DISK INSTALLATION CHECKSHEET

Tools and parts needed:

- o Flat/Phillips screwdrivers
- o Screws, and perhaps drive mounting rails
- o Hard drive(s)
- o Correct drive cables (IDE or SCSI)

Software needed:

- o DOS and/or Windows95
- o Bootable floppy disk with FDISK.EXE and FORMAT.COM copied onto disk (the student disk will work for this job)
- o Disk Manager on floppy disk (if low-level format or custom drive partitioning is needed)
- o Any desired application software

Step-by-step instructions:

1) Open the computer case;
2) If installing an IDE drive, **set the master/slave jumpers on both the old AND new drives**; for SCSI drives, set the SCSI ID jumpers to a unique SCSI ID number;
3) Write down the drive parameters (cylinders, heads, sectors per track, etc.) before mounting drive into PC (consult documentation or Mueller book if needed);
4) Physically mount the drive into case; use screws and/or drive rails as needed;
5) Attach the cable to the drive(s); be sure to attach the power cable from the power supply;
6) Power up the PC; enter the BIOS setup program and enter the drive parameters into CMOS (note: set SCSI drives to drive type 0 - not installed; the SCSI host adapter will identify the drives); save the new information to CMOS and reboot PC;
7) Boot the PC from a bootable floppy disk;
8) Run the FDISK utility and create a partition table on the new drive; if partitions exist on the new drive, backup the old data, delete the existing partition and recreate a new disk partition;
9) Once the computer re-boots from the floppy drive, run **FORMAT x: /S /V** (where x is the new drive letter) to format the new drive and give the drive a volume label; if the new drive is a second drive, the /S option may be omitted;
10) Install operating system software and application software as needed;
11) Replace the computer case - do NOT install the cover until you know the drive is working properly.

Installation tips:

1) If the drive is larger than 528 MB, you will need to activate LBA (logical block addressing) mode in the system BIOS for the whole drive to be recognized. If your system BIOS does not have LBA mode built in, you will need to use Disk Manager to custom partition the drive, or you will need a controller card with a BIOS that has LBA mode built in, or you will need to upgrade the motherboard.
2) If the number of bad sectors on the drive exceeds 5 percent of the total disk space, replace the drive - it's defective.
3) Be sure to have the 800-number for the drive manufacturer available for technical support if needed.

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HOW TO INSTALL A SOUND CARD IN YOUR PC

1) Run a program like MSD.EXE or Checkit to find out what free interrupts you have in your PC BEFORE you install the sound card.

2) Read the manual for the sound card to see what interrupt level, DMA channel and port addresses you can use for the card; then set the IRQ jumpers (if necessary) for the sound card. (NOTE: some sound cards have their jumpers set by software, rather than by moving a physical jumper or switch; see your manual for details.) Most cards comes factory configured the "proper way".

   Standard IRQ settings are IRQ 7 or 5; standard DMA channels are DMA 1 AND 5 (a sound card will use 2 DMA channels); standard port addresses are 220 Hex, and also 330 Hex for the MIDI interface found on most sound cards.

3) NOW install the sound card.

4) Run your installation program for the card to load the software drivers that will enable the card to operate.

5) Attach your speakers to the sound card. Normally, the sound card will disable the stock speaker inside your PC; therefore, you will need external speakers for your sound card. These speakers cost anywhere between $20 and $50.

6) Run the test program that comes with your sound card; make sure it sounds right.

7) If the sound is scratchy, you may need to modify the DEVICE= statement in your CONFIG.SYS file (or the device-loader that is run in your AUTOEXEC.BAT file) to deal with this problem; consult your manual for details. You may also find you have a problem with one of the DMA chips (there are 2 in an AT-class PC) on your motherboard.

8) Make sure your sound card and your CD-ROM drive work together well; some sound cards conflict with each other and will cause one or both to malfunction. If this is the case, contact the manufacturer for assistance. You may need to replace the card with a different brand if the problem can't be solved.

9) Test the sound card in Windows; the installation program should have created a program group that has audio utilities, and it should have modified Windows to play sounds. You should also be able to play audio CDs through your sound card (and CD-ROM drive) while in Windows.

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SOUND CARD INSTALLATION CHECKSHEET

Tools and parts needed:

- o Flat/Phillips screwdrivers
- o Screws, and perhaps drive mounting rails
- o Sound card
- o Correct drive cables (IDE or SCSI)
- o Audio cable to attach CD-ROM drive to sound card

Software needed:

- o Installation disk for the new sound card
- o An audio CD disk (for testing purposes)

Step-by-step instructions:

1) Open the computer case;
2) Install the new sound card in any free 16-bit bus connection;
3) Attach the CD-ROM drive data cable to the IDE interface on the sound card (only if necessary);
4) Attach the audio cable from the CD-ROM drive to the sound card (if a CD-ROM drive exists);
5) Power up the PC; run the sound card installation/setup program from the floppy disk; when the install program is finished, reboot the PC;
6) **Perform an F8 boot on the PC**; go through the CONFIG.SYS and AUTOEXEC.BAT files to ensure that any sound card drivers load and recognize the card properly, and make sure that Windows (or Win95) has been modified to recognize and use the sound card;
7) Test the sound card by playing an audio CD (with the included software), or play back any wave or MIDI files with the software included with the sound card;
8) Replace the computer case - do NOT install the cover until you know the card is working properly.

Installation tips:

1) Be sure to plug the speakers into the right connector on the back of the sound card; also, be sure to check the volume of the speakers (either through the sound card software, or by adjusting the volume control on the speaker or card);
2) Be sure to have the 800-number for the drive manufacturer available for technical support if needed.

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HOW TO INSTALL A CD-ROM DRIVE IN YOUR PC

1) If you are installing a SCSI CD-ROM drive, install the SCSI host adapter (another name for a controller card) in an open bus connection on your PC.

   Standard interrupt levels for a SCSI host adapter are IRQ 10 or 11; standard DMA channel assignments are DMA 5, 6 or 7; standard port addresses are either 300 Hex or 340 Hex, and the standard memory range for the host adapter will be C800, or D000.

   MOST non-SCSI CD-ROM drives available today use the ATAPI interface, which is another name for the IDE interface used in most hard drives. With these drives, you can plug your CD-ROM drive into the same cable as your hard drive. These are much easier to install than SCSI CD-ROM drives.

2) Set the SCSI ID jumpers on your CD-ROM drive (if it's a SCSI drive), THEN install it into your PC's case; usually you will set the drive to ID #0, or #1 (depending on if you have another SCSI device in your PC already). Remember to attach the SCSI data cable and power cable.

   If you have an IDE CD-ROM drive, plug the drive into the primary (or secondary) IDE interface cable. Be sure to orient the cable so the colored stripe is closest to pin 1 on the drive's cable connector. Set the master/slave jumpers on the CD-ROM drive to the slave setting; you may or may not need to set the PC's hard drive to master, though.

   Finally, connect the audio cable from the CD-ROM drive to the drive interface OR your sound card.

3) Run the installation program that came with your CD-ROM drive; it will edit your CONFIG.SYS file to load the driver program needed to recognize the drive **at the correct IRQ level, DMA channel and port address**. Also, the installation program will load a program from your AUTOEXEC.BAT file called **MSCDEX.EXE**; this is the MS-DOS extension driver for CD-ROM drives that allows MS-DOS to use the drive.

4) Re-boot your PC; it should now recognize your drive.

5) Once the drive is working, get a print-out of your CONFIG.SYS file for safe-keeping. Many software installation programs for CD-ROM programs may change your CONFIG.SYS file, and accidentally render your drive inoperative! Have that copy hidden somewhere for safe-keeping.

6) You may now replace the lid on your PC's case: the drive is ready for use.

7) Be sure to keep your documentation handy; strange things often occur when using CD-ROM drives and their associated software.

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CD-ROM DRIVE INSTALLATION CHECKSHEET

Tools and parts needed:

- o Flat/Phillips screwdrivers
- o Screws, and perhaps drive mounting rails
- o CD-ROM drive
- o Correct drive cables (IDE or SCSI)
- o Audio cable to attach CD-ROM drive to sound card

Software needed:

- o Installation disk for the new CD-ROM drive
- o An audio CD and a data CD-ROM disk (for testing purposes)

Step-by-step instructions:

1) Open the computer case;
2) If installing an IDE-class CD-ROM drive, **set the master/slave jumpers on both the old AND new drives** (normally set the jumper to slave on the CD-ROM drive); for SCSI drives, set the SCSI ID jumpers to a unique ID number;
3) Attach the CD-ROM drive to the primary IDE interface cable, or install a new cable from the drive to the secondary IDE interface on the controller or motherboard (if one exists), or attach the data cable to the IDE interface on the sound card (if one exists); if the CD-ROM is a SCSI type, attach the data cable from the SCSI host adapter;
4) Attach the audio cable from the CD-ROM drive to the sound card; if no sound card exists in the PC, leave the audio cable attached to the CD-ROM drive (in anticipation of a future sound card addition); be sure to attach the power cable from the power supply;
5) Physically mount the drive into the case; use screws and/or drive rails as needed;
6) Power up the PC; run the CD-ROM installation/setup program from the floppy disk; when the install program is finished, reboot the PC;
7) **Perform an F8 boot on the PC**; go through the CONFIG.SYS and AUTOEXEC.BAT files to ensure that the CD-ROM driver (in the CONFIG.SYS file) loads and recognizes the drive, and that MSCDEX.EXE (in the AUTOEXEC.BAT file) assigns the CD-ROM drive a unique drive letter; if running Windows95, MSCDEX may not appear in your AUTOEXEC.BAT file (Win95 has built-in support for CD-ROM drives);
8) Test the CD-ROM drive by installing a program or reading a file from a data disk, or play an audio CD on the new drive;
9) Replace the computer case - do NOT install the cover until you know the drive is working properly.

Installation tips:

1) Be sure to note where pin 1 is on the cable connector - plugging in the cable backwards may cause the hard drive to shut down; also, be sure to set the master/slave jumper on the drive to slave, regardless.
2) Be sure to have the 800-number for the drive manufacturer available for technical support if needed.

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FAX/MODEM INSTALLATION CHECKSHEET

Tools and parts needed:

- o Flat/Phillips screwdrivers
- o Screws, and perhaps drive mounting rails
- o Fax/modem
- o Telephone cable (to wall jack)

Software needed:

- o Installation disk for the new fax/modem (for Windows95)
- o Modem software (i.e., Procomm Plus, Bitcom, WinFax, etc.)
- o Diagnostic software, such as Checkit (or a comparable diagnostic)

Step-by-step instructions:

1) Open the computer case;
2) Set the fax/modem to respond as COM2:, at IRQ3, port address 2F8H; you will do this by setting jumpers on the fax/modem;
3) If there is an existing COM2: on your system, DISABLE IT, either by re-setting jumpers on a card or motherboard, or by disabling COM2: in the BIOS Setup program;
4) Install the new fax/modem in any free 16-bit bus connection;
5) Attach the telephone cable from the wall jack to the jack marked "LINE", and attach your existing telephone to the jack marked "PHONE";
6) Power up the PC; if you are running Windows95, the operating system should detect a new modem; insert the install disk into the A: drive, and make sure Win95 locates the correct driver for the fax/modem;
7) Install any fax/modem software or on-line software you desire; then, test the fax/modem by attempting to go on-line with the modem software you just installed;
8) Replace the computer case - do NOT install the cover until you know the card is working properly.

Installation tips:

1) Be sure to plug the telephone cable into the proper jack on the fax/modem, and into the wall jack as well;
2) Be sure to have the 800-numbers for the modem manufacturer and/or on-line service available for technical support if needed;
3) If you had a modem previously installed in Windows95, delete the previous modem configuration BEFORE you install the new modem; otherwise, the new modem may not be recognized correctly;
4) NEVER INSTALL A MODEM AS COM3: OR COM4: - many on-line service programs do not adequately support modems working on COM3: or COM4:; As a rule, set your mouse up as COM1:, and your modem as COM2:.

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INSTALLING VIDEO CARD DRIVERS IN WINDOWS

When you buy a video card, it normally comes with a video driver disk. This disk contains video driver software that allows your video card to display higher levels of resolution with more colors than are available with the standard Microsoft-provided video drivers. To get these higher levels of resolution and additional colors, you need to run the install program found on this disk. If you don't have the install disk, contact the video card manufacturer or the dealer to obtain the disk.

Running the Install Program

To install the video card driver, put the first disk into the A:\ drive, then click on File - Run, then type in the name of the install program on the A:\ drive (usually SETUP or INSTALL) and press Enter. In Windows 95, click on Start, then Run, then give the name of the install program and press Enter. Follow the directions on the screen to correctly install the program. Usually, these types of programs will automatically make the changes in the Control Panel for you, thus saving you a few steps in the install process.

Setting the Resolution, Number of Colors, and Refresh Rate

Once the driver has been installed, some utility program will probably also be installed that lets you modify the resolution (640 X 480 to 1280 X 1024), the number of colors (64 to millions of colors), and the refresh rate of the monitor (the frequency at which the monitor operates; usually 60 or
72 Hz). Run the utility program, and then select the resolution, numbers of colors, and refresh rate you desire for your system. HINT: unless you have a "multisync" monitor, select 60 Hz as your standard refresh rate; check the documentation on your monitor to determine your monitor type. Normally, this is all you need to do to improve the video performance on your monitor.

But now my screen is all messed up ...

If you try to make your video card (or monitor) display at a rate greater than is possible, your screen may turn into a jumble, or Windows may just go blank and lock up. If this happens, reboot the computer and get to the DOS prompt; then, from the C:\WINDOWS DOS prompt, type SETUP and press Enter. Then, when the setup program is running, tell Windows to use the STANDARD VGA video driver. Then, go back into Windows, and re-run the video setup utility program, this time selecting the correct video resolution.

In Windows 95, re-boot the computer, then press F8 when the PC begins booting up; select
"safe mode" from the menu on the screen, and re-run the video setup utility program, this time selecting the correct video resolution.

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USING DEFRAG AND SCANDISK

With DOS 6 and above (including Windows 95), Microsoft gives you 2 tools to improve the performance of your hard disk (or floppy disks): DEFRAG, and SCANDISK. Here's what they do:

DEFRAG

- DEFRAG goes through your hard disk and finds the fragmented pieces of files throughout your disk, and re-orders them so that ALL of your files are in contiguous pieces. Fragmented files take longer to retrieve, and a badly fragmented hard disk slows down your PC.
- To run DEFRAG, simply type DEFRAG at the DOS prompt and press Enter. Select the disk you wish to defragment, and press Enter. It will tell you how much of your disk is fragmented, and it will tell you the recommended defragmenting procedure. Use DEFRAG's recommended procedure, and you can watch DEFRAG re-order the files on the display screen. When DEFRAG is done, it will beep to signal you to exit the program.
- ONE WARNING: do NOT turn off the PC while DEFRAG is running, or else you will lose any files that are currently being re-ordered. Also, you may want to run SCANDISK before running DEFRAG, in order to remove any incomplete files or lost clusters left over from when your PC "locks up".
- You should run this on a busy PC every 6 months or so, or whenever you are doing routine maintenance on a PC.

SCANDISK

- SCANDISK allows you to repair defects on a floppy or hard disk. It will repair bad file allocation tables (FATs) and partition tables, check for bad sectors on the disk, allow you to recover lost clusters (files with no end-of-file markers), and it will take care of files that have invalid filenames.
- To run SCANDISK, simply type SCANDISK at the DOS prompt and press Enter. If you wish to run SCANDISK on a specific disk (say the A: drive), type SCANDISK A: and press Enter. It will check out the disk, repair any errors, and prompt you if there are serious problems.

If you are a Windows 95 user, you will run DEFRAG and SCANDISK while in Windows 95; do not exit to the DOS prompt to run these programs.

As a general rule, run DEFRAG and SCANDISK on all PCs brought in for repair. These programs may alert you to the presence of other potential problems on your customer's PC, and may help you to diagnose the reported problems as well.

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USING MEMMAKER TO OPTIMIZE MEMORY

With DOS 6.0 and above (but **not** Windows 95 or NT), a utility called **MEMMAKER** was included to help you configure your conventional, reserved, extended and expanded memory areas in the most efficient manner possible for your PC. Here's how it works:

- It looks at the drivers and software that are being loaded in your CONFIG.SYS and AUTOEXEC.BAT files;
- it determines how memory is needed to load the drivers,
- it determines how much memory is available to load drivers in the Upper Memory Block (between 640k and 1MB) and the High Memory Area (the first 64k of extended memory);
- then, it uses the DEVICEHIGH and LOADHIGH (LH) statements to load programs and drivers into the UMB and HMA, thereby ensuring that your DOS and Windows programs have sufficient conventional memory (between 0k and 640k) to run properly.

If you have less than 560k of your first 640k of memory free, you should run MEMMAKER. Also, anytime you install a new device that requires a device driver (like a sound card, a scanner, etc.), you should run MEMMAKER to make sure your memory is optimized properly.

How do I run MEMMAKER?

At the DOS prompt, type MEMMAKER and press Enter. The program will do the rest.

- It will re-boot your computer, using a program called SIZER to determine the size of your driver software programs.
- Then, it will compute the most efficient way to load these drivers and programs into the UMB and HMA regions of memory.
- Then, it will re-write your CONFIG.SYS and AUTOEXEC.BAT files, loading these driver programs into specific regions of the UMB or HMA.
- Finally, it reboots your computer, and if all goes well, MEMMAKER asks you "**Does your PC appear to be working properly?**". If you get to this screen, then your memory has been optimized correctly. Answer "Yes", and MEMMAKER will then show you how much memory is being used for your drivers, and how much conventional memory is now available for your programs.

What happens if MEMMAKER locks up my PC?

Occasionally, MEMMAKER will try to load a driver into a memory area that is being used by some device. When that happens, the PC locks up or freezes when running certain programs.

- If this happens, re-run MEMMAKER with the /UNDO switch (this undoes the changes made by MEMMAKER), and try to re-run MEMMAKER normally again. Usually, this fixes the problem.

Also, MEMMAKER may lock up as it is trying to assess the sizes of your driver programs.

- If this happens, reboot your PC. MEMMAKER will give you a message explaining the error. You will have 2 choices: "**Try again with conservative settings**", or "**Cancel and undo all changes**". Use the "conservative settings" option first before cancelling the optimization process.

Consult your DOS manual or the HELP facility in DOS to answer any further questions about MEMMAKER.

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INSTALLING WINDOWS APPLICATIONS

Installing Windows application software is usually quite simple. Here's how it's done:

- Put the install disk in the CD-ROM drive, or put the first floppy disk of the install disks into the A: drive.
- For Windows 3.1 users, click on File, then Run, then type in the name of the install program (usually A:\SETUP or A:\INSTALL), and click OK. The install program should continue from that point, and it will prompt you as to what to do next.
- For Windows 95 users, click on START, then Settings, then Control Panel, then Add/Remove Programs, then Install, and then type in the name of the install program (usually A:\SETUP or A:\INSTALL), and click OK. The install program should continue from that point, and it will prompt you as to what to do next. If you have an install program on a CD-ROM, simply put the disk into the CD-ROM drive: the setup program will automatically execute.

What does the install program do, anyhow?

When an install program runs, it does the following:

- It creates a new directory on your hard disk,
- loads the program files into that directory on your hard disk,
- creates a new Windows group and/or program icon, and
- it modifies your WIN.INI and/or SYSTEM.INI files so that the program will run properly.

What should I do to prevent a disaster?

Occasionally, install programs corrupt your .INI files or make drastic changes to your CONFIG.SYS and AUTOEXEC.BAT files. To prevent disasters like this, make spare copies of your WIN.INI, SYSTEM.INI, CONFIG.SYS and AUTOEXEC.BAT files BEFORE installing a Windows (or DOS) program. That way, the damage can be undone by replacing the messed-up files with the known good files.

Other important tips

Be sure to check for viruses BEFORE you install the program, and only install from known clean original disks or backups that you made of the disks.

In some cases, you may want to run SCANDISK and/or MEMMAKER to fix system problems that might prevent the installer from working correctly. For example, if you have insufficient conventional memory, some install programs will terminate; running MEMMAKER should fix the problem. In the same way, running SCANDISK may fix disk-based problems that prevent the installer from running correctly.

If you have problems with the install disks (i.e., the installer won't run, disk 3 won't read, an error message appears on the screen, etc.), contact the software manufacturer for technical assistance.

Whenever possible, install software from CD-ROM disks. The disk media is much more reliable, and you need to feed only 1 disk into the computer. Further, CD-ROM drives transfer data much more rapidly than floppy drives.

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WHAT IS RESEARCH TECHNOLOGY ASSOCIATES, INC.?

Research Technology Associates, Inc. is a non-profit corporation, as stated in Section 501(c)3 of the IRS Code.

The goals of the Research Technology Associates, Inc. are simple:

- Locate and obtain surplus computer equipment in our community;
- Test and refurbish this equipment;
- Distribute this computer equipment to schools and various non-profit organizations in our community; and
- Provide quality training at an affordable cost to schools, charitable organizations, and the non-profit community.

Services provided by Research Technology Associates, Inc. include:

- Picking up unwanted and surplus PC equipment from individuals and corporations;
- Refurbishing computer equipment at our facilities;
- Placing this equipment in non-profit organizations throughout the world;
- Providing training and support to various organizations, and
- Teaching individuals computer repair techniques through the ENT 184 (PC Hardware) and ENT 284 (PC Repair) courses offered at PG Community College.

Engineering students at Prince George's Community College and other local community colleges provide much of the labor, resources and volunteer time needed to test and repair this equipment. Our volunteer base comes from a broad cross-section of people from throughout our community. Our Board of Directors is comprised of business leaders and computer technicians from all over the Washington DC area.

Research Technology Associates, Inc., gives individuals and corporations a way to give back to the community:

- The training opportunities offered through PG Community College provide students valuable job skills for today's computer-oriented business market;
- Computers end up in deserving schools and non-profit corporations, not in landfills; and
- Individuals and corporations receive tax deductions for donating their surplus equipment.

Volunteers are needed to transport computers from donor organizations to our offices in Upper Marlboro MD, and to our repair facility at Prince George's Community College in Largo MD. We also need volunteers who can test, repair and prepare computers for distribution to various charitable organizations.

For further information about Research Technology Associates, Inc., or if you would like to volunteer your services, please contact Bill Lloyd, Corporation Vice-President, on 301/372-2889.

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GUIDELINES FOR OBTAINING EQUIPMENT FROM RESEARCH TECHNOLOGY ASSOCIATES

If you want to obtain computer equipment from **Research Technology Associates, Inc.**, you will need to do the following things ...

1) **Send your request to:**

Research Technology Associates, Inc.
12221 Van Brady Road
Upper Marlboro, MD 20772-7924

FAX: 301/372-0086
E-mail: wlloyd@nheri.org

Our phone number is **301/372-2889**.

2) **Provide us with your non-profit organization's name, address and phone number;**

3) **Provide us with a record of your non-profit or charitable organization status, such as:**
- **o a 501(c)3 form which your organization filed with the IRS, or**
- **o a photocopy of your state tax exempt number.**

4) **Indicate as precisely as you can what you would like to receive**. We routinely receive the following kinds of PCs:

- o 80286, 80386 and 80486-class PCs with floppy and hard drives
- o Monochrome, CGA, EGA and VGA color monitors
- o Macintosh, Mac Plus, and Mac SE computers
- o Dot matrix printers and/or laser printers

Requests for more advanced equipment than this may take some time to fill. Also, requests for multiple PCs may be delivered on a flow basis.

Let us know if you need more than one PC, or if you just need a certain component (i.e., a monitor, a hard drive, a video card, etc.)

5) **Have patience**. Our waiting list is growing, just as our corporation is growing. Depending upon the request, you may have to wait several weeks to receive your PC. We are a volunteer organization: we receive no tax subsidies, and our volunteers and board members receive no compensation. We will fill your order for a PC as soon as possible.

6) **Make arrangements to pick up the PC when it's ready**. Once your PC is ready, you will make arrangements to pick it up. We can ship the PC to your location, but you will need to pay for the shipping. It's usually cheaper to come to our office and pick it up. Contact us at our main office for details.

7) **Write a check to Research Technology Associates**, Inc. We provide computers to non-profit organizations at greatly reduced prices. The price we charge for a computer defrays our costs in obtaining, refurbishing and delivering the PC to you. We receive no Federal, state or local funding for our program; therefore, we use the income generated from the sale of computers to sustain our work. A current price list is available from Research Technology Associates upon request; please call our main office for details.

8) **Let us know of organizations that are disposing of surplus PC equipment**. We are always looking for organizations that are disposing of their surplus computer equipment. Companies and individuals that donate equipment to our organization receive a letter which can be used for tax deduction purposes with the IRS. The more PCs we receive, the faster we can get you the equipment you need.

If you have further questions, please call us at 301/372-2889. We look forward to serving you.

GUIDELINES FOR DONATING EQUIPMENT TO RESEARCH TECHNOLOGY ASSOCIATES

If you want to donate computer equipment to **Research Technology Associates, Inc.**, you will need to do the following things ...

1) **Contact our organization at:**

Research Technology Associates, Inc.
12221 Van Brady Road
Upper Marlboro, MD 20772-7924
Our phone number is **301/372-2889**.

FAX: 301/372-0086
E-mail: wlloyd@nheri.org

2) **Indicate as precisely as you can what you have to donate**. We routinely accept for donation the following kinds of equipment:

- o 8088 XT-class PCs with floppy and hard drives
- o 80286 and above AT-class PCs with floppy and hard drives
- o Monochrome, CGA, EGA and VGA color monitors
- o Keyboards and mice
- o Macintosh, Mac Plus, Mac SE, MAC LC series and Power Mac computers
- o Dot matrix printers and/or laser printers
- o Scanners and/or other miscellaneous computer/office automation equipment
- o Software

The more we know about the equipment you have AND the condition of the equipment, the better we can service people who are currently on our waiting list.

3) **Make arrangements with Research Technology Associates, Inc. to deliver the PCs to us, OR arrange for us to pick up the PCs from your location**. If you can deliver your PC to us, that would be most helpful. We have three locations throughout the DC area where you can deliver your surplus equipment.

We CAN come to your site and pick up your equipment, also. You will need to contact us for details on picking up the equipment from your site. Volunteers with our organization will come to your site to pick up the equipment.

4) **Let us know if you would like a tax-deductible receipt for your records.** Research Technology Associates, Inc. is a non-profit corporation, as specified in Section 501(c)3 of the IRS Tax Code. Persons or organizations contributing equipment to Research Technology Associates will, upon request, receive a letter acknowledging the donation which can be used for tax deduction purposes.

Please let us know to whom the letter should be sent, including the person's or organization's name, address and ZIP code.

5) **Let us know of any other organizations that are disposing of surplus PC equipment**. We are always looking for organizations that are disposing of their surplus computer equipment. The more PCs we receive, the better we can serve the various non-profit organizations that look to us for assistance.

If you or your organization will have additional equipment to donate in the future, please let us know. We can make arrangements to pick up the equipment at that time.

6) **Consider volunteering with Research Technology Associates, Inc.** We are always in need of persons who can do the following things:

- o Test, repair and evaluate computer equipment
- o Pick up and deliver computer equipment (trucks and/or station wagons are needed, too)
- o Answer telephones and prepare correspondence for the mail

We encourage you or your organization's employees to contribute a few hours a week to the work of Research Technology Associates, Inc. Contact our office for details.

If you have further questions, please call us at 301/372-2889. We look forward to serving you.