Basic Troubleshooting

Technical Manual

This module will demonstrate the procedures that computer technicians use to troubleshoot and repair computer systems… as well as a variety of computer components. As a student in this course you've already been exposed to:

- The Paperwork Needed To Operate A Computer Service Center
- Basic Electronic Theory
- Computer Component Recognition And Theory Of Operation
- Tool Use And ID
- Preventive Maintenance
- Computer Disassembly And Assembly
- OS And Software Installation
- Hardware Installation And Upgrade

You have already developed important skills and acquired useful information. These experiences are the foundation you'll need to be a successful computer troubleshooter. Service manuals, troubleshooting diagrams, and repair guides are important tools of the trade. However, the ultimate tool in the troubleshooter's tool kit is simply knowing how a computer is supposed to work.

The procedures listed here are not meant to replace the hardware service manuals that are provided by the system manufacture. These are abbreviated instructions that augment equipment technical manuals and address general troubleshooting issues for PC based microcomputers.

Always remember that a customer has placed their faith in you as an expert. They trust that you return their equipment repaired, or at the very least, in the same condition in which they delivered it to you. Causing addition damage to equipment, even a scratch in the paint, betrays their trust and will cost you business from them and their friends in the future.

Basic Troubleshooting Tips

Fight the temptation to jump into every troubleshooting challenge as if it were a life-or-death situation. Keep your mind clear and try to relax. If you get overexcited or panic, you'll miss important clues that may lead to the easiest solution to the problem.

Think of yourself as a doctor of electronics. Doctors use their knowledge of the human body and run diagnostic tests to determine the cause of a patient's ailments. Only later do they use tools and medicine to try and cure the patient. It's really no different with computers. If a patient walked into a doctor's office with headache, the first thing the doctor does is collect information not open the patient's head and start ripping out parts.

Likewise… Don't start taking the system apart right away. Collect information from the customer and record it on the *work order*. Be sure you get the symptoms down correctly and verify them. Often the customer wants to offer solutions as well. This is one of those cases where the customer is not necessarily always right. This information may lead you down the wrong troubleshooting path. Of course you should be courteous and write down the information but remember that you are the technician. Use your experience and the troubleshooting process to determine the cause and solution of the problem without being swayed by this kind of advice. Consider the *work order* as a record of symptoms, causes, and solutions. Keeping the discrepancies, attempted remedies, and actual solutions on record will help you develop a systematic approach to repairing similar malfunctions should they occur in the future.

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1. Before you do anything, verify the malfunction and verify that the reported malfunction is the only problem. There's nothing more valuable in the troubleshooting process than the technician seeing the problem first hand. All to often, repair centers receive computers reported to have problems that are actually due to simple operator error. Additionally, some computers reported that have "small problems" are basket cases that are more likely destined for the computer grave yard. Verifying the malfunction while the customer is there is the best way to head-off these kinds of problems and therefore improve your chances of repairing the device with the least amount of effort and cost.
2. Verify operator controls such as power switches, intensity, contrast are set correctly. I once sent a technician on a job 125 miles away to repair a blank monitor screen. The only problem was that the operator had the intensity knob on the monitor turned all the way down. It's also not uncommon to arrive on the scene simply to find that the computer isn't plugged-in to the AC outlet.
3. Check the installation and configuration. Especially if the computer was just put together or the operator tried to "fix it themselves." Verify that the cables are connected correctly, jumpers are properly set, and the power settings set to the appropriate voltage. Double-check everything including the CMOS settings.
4. Look, listen, smell, and touch. Use your senses to observe the computer as it boots up. Look for normal boot-up messages. Listen for a normal sequence of beep tones or fans and drives whirling. Smell for electrical overheating and note the location of any smoke.
5. If there's still a problem, work your way through the system item by item starting with the components that are most likely the cause the problem. **Assume that there is only one problem.** Suspect the simplest, cheapest, and easiest-to-replace parts before the most complex, most expensive, hardest-to-replace items. For example:

    a. Check the format on a hard drive before replacing the drive.
    b. Check data cables before looking at adapter cards or drives.
    c. Check the memory before replacing the motherboard.

6. An accomplished computer troubleshooter will recognize system failures quickly and isolate malfunctions to specific subsystems right away. Localizing a problem to a component without systematically eliminating other components takes a great deal of skill… Skill that only comes with experience.
7. Check the environment, including incoming power, ambient temperature, humidity, static electricity, airborne contaminants, and electromagnetic interference. Environmental conditions can cause many problems with computers.
8. Always keep documentation and manuals close by when servicing computers. Use your *work order* to record notes such as jumper settings, cable connections, and other specifications. Documenting settings before you change them can save you tons of time and labor. Tracking the work performed on the equipment is very important. There's no assurance that you'll be dispatched to work on the same system tomorrow. Accurately completing a *work order* affords you or another technician the information needed to continue the repair without repeating work that's already been performed.
9. Isolating a faulty component is the ultimate goal of troubleshooting. Sometimes this is accomplished by component substitution. Using test equipment, diagnostic software, and simple observation are also effective troubleshooting methods. An experienced technician will know what methods to apply and when.
10. Repairing computer components can be as involved as troubleshooting them. Due to propriety designs, printed circuit board electronic components may not be available. Many computer cards are assembled using surface mounted components that require special tools for disassembly. Even if you isolate the problem to a defective integrated circuit, the board's manufacturer may not make the IC available for repair. Most computer repair work is done by replacing entire modules. Sometimes called Field Replaceable Modules (FRM), components such as power supplies, video cards, or motherboards are now replaced rather than individual chips, transistors, or resistors.
11. Don't assume that the repair work you performed actually fixed the problem. Test and verify your completed work thoroughly.

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Basic Troubleshooting Methods

The diagram in Figure 1 shows the components of a typical computer workstation. Each of these components are susceptible to failure and therefore will eventually require troubleshooting and repair. Remember that troubleshooting is a systematic approach. First you to gather clues and then you use deductive reasoning to isolate the problem. Many of these components are Field Replaceable Modules (FRM) and you'll need to know how to identify common symptoms, troubleshoot, and isolate them as defective components. Items such as monitors, printers, and plotters are too expensive to simply remove and replace and require troubleshooting procedures of their own.

Field Replaceable Modules

BIOS and CMOS
Memory Modules
Microprocessor
Video Card
Keyboard
Mouse
Floppy Disk Drive
CD-ROM Drive
Hard Disk Drive
Power Supply
Sound Card and Speaker
USB Adapter
Modem
Other Interface Adapters

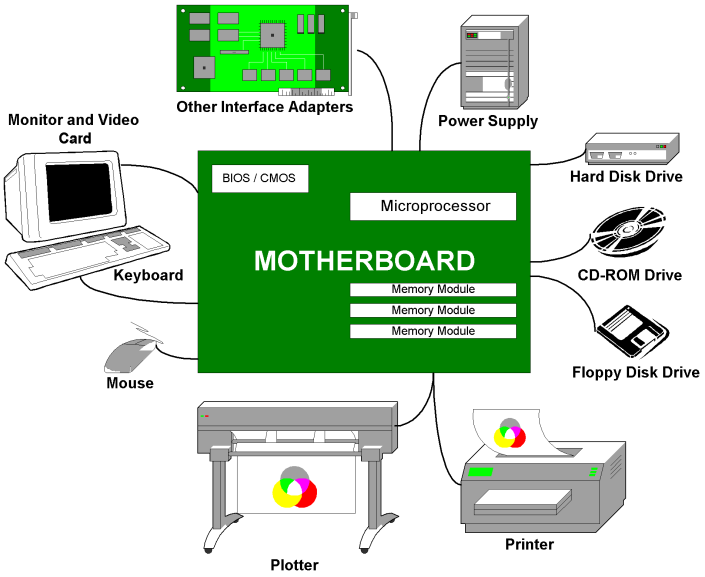

Figure 1. Typical Workstation Components

Power-On Self-Test (POST)

Each time a computer is turned on, a diagnostic program is automatically run to check the integrity of the computer system before the operating system is loaded. This test is called a Power-On Self-Test or POST for short. The POST is your initial troubleshooting tool and can provide key troubleshooting clues.

The Power-On Self-Test…

- *resets the microprocessor.*
- *reads the BIOS configuration*
- *checks system RAM.*
- *checks video RAM.*
- *resets all I/O ports and interfaces.*
- *talks to all disk controllers.*
- *reports any system errors.*
- *loads the operating system.*

Common POST Error Codes	
Code	**Description**
1xx	Mainboard Problems
2xx	Main Memory Problems
3xx	Keyboard Problems
5xx	Color Monitor Problems
6xx	Floppy Disk Controller Problems
14xx	Printer Problems
17xx	Hard Disk Controller Problems
86xx	Mouse Problems

Table 1. Some Common Post Error Codes

The entire purpose of the POST process is to detect errors and then boot the operating system if there are none. The POST process reports errors to the user by generating a signal or code to indicate where in the process the error occurred and which device had the error. It's important to note that not all POST errors are fatal errors. Generally, the POST process continues past nonfatal errors. However, if a fatal error is detected, the POST process halts the boot process immediately, but only if the BIOS is configured to do so. Normally the error is a three or four-digit code or error message displayed on the monitor screen. If the POST detects an error before the monitor device drivers are loaded, then the error signal takes the form of a beep-code through the PC speaker.

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The POST diagnostics program is loaded into the system's BIOS chip. There are quite a few BIOS manufacturers and since BIOS manufacturers differ… the POST programs will differ as well. Consequently, the error and beep codes may not be the same with a motherboard featuring an Award BIOS as compared to a Phoenix or AMI BIOS. Even if the rest of the computer is made up of identical components the POST error codes may not be the same. In fact, some POST processes may not even display an actual *"error code"* on the monitor's screen. Sometimes it's a simply error message like, "Stuck Keyboard" or "CMOS Battery Failure."

There are lots and lots of POST error codes and again… There may be significant differences between each BIOS. To be sure which ones you should use, you'll need to determine the BIOS manufacturer, date, and version. You'll then have to retrieve the error code listing from the manufacturer's web site. This identification information is displayed on the BIOS Startup Screen at the very beginning of the POST process. Watch the screen very carefully and write down all the information regarding the BIOS. It's a good idea to keep this information on file. You'll need this information later when it comes time update the system's BIOS. If you can't see the BIOS information during the POST process due to a video problem, the information may be printed on the BIOS chip itself. Some popular BIOS manufacturers include American Megatrends, Inc., Award, Phoenix, and IBM. Many computer manufacturers produce their own BIOS chips as well.

Table 2 shows some common POST error codes. Notice that the error codes are divided into classes. For instance, POST error codes 100 to 199 deal with problems on the motherboard. POST error code 161 indicates that there is a CMOS battery failure. Error code 164 indicates a memory size error. Since the CMOS battery and system memory are located on the mainboard, these error codes help the technician zero in on the motherboard as the defective component.

AMI BIOS Beep-Codes		
Beeps	**Error Message**	**Description**
1	DRAM Refresh Failure	The memory refresh circuitry on the motherboard is faulty.
2	Parity Error	A parity error occurred in system memory.
3	Bas 64K Memory Failure	A memory failure occurred in the first bank of memory.
4	System Timer Failure	A memory failure occurred in the first back of memory or Timer 1 on the motherboard is not functioning.
5	Processor Error	The processor on the motherboard generated and error.
6	Keyboard Controller Gate A20 Failure	The keyboard controller might be bad. The BIOS cannot switch to protected mode.
7	Virtual Mode Processor Exception Interrupt Failure	The processor generated an exception interrupt.
8	Display Memory Read/Write Error	Either the system video adapter is missing or its memory is faulty.
9	ROM Checksum Error	The ROM checksum value doesn't match the value encoded in the BIOS.
10	CMOS Shutdown Register Read/Write Error	The shutdown register for CMOS RAM failed.
11	Cache Error/L2 Cache Bad	The L2 cache is faulty.
1 Long 3 Short	Conventional/Extended Memory Failure	The motherboard memory is faulty.
1 Long 8 Short	Display / Retrace Test Failed	The video card is faulty; try reseating or moving to different slot.
1 Short	None	1 short beep before boot means the POST has completed normally and the system is OK.

Table 2. American Megatrends, Inc. Beep-Codes

The POST process is smart enough to know that the video may not be working on the computer you're trying to repair. In those situations, error beep-codes were devised to help technicians troubleshoot computer systems. Error beep-codes also differ from BIOS manufacturer to manufacturer. Table 3 lists the beep-codes for the AMI BIOS.

Power-On Self-Test (POST) Card

The Power-On Self-Test (POST) card makes quick work out of deciphering POST error codes. It's an interface card that's plugged into either the ISA or PCI bus (depending on the model you purchased.) It traps the test codes that the BIOS sends to port 80h and then shows them on an hexadecimal display on the card. POST cards are relatively inexpensive and are an essential tool in the technician's took kit.

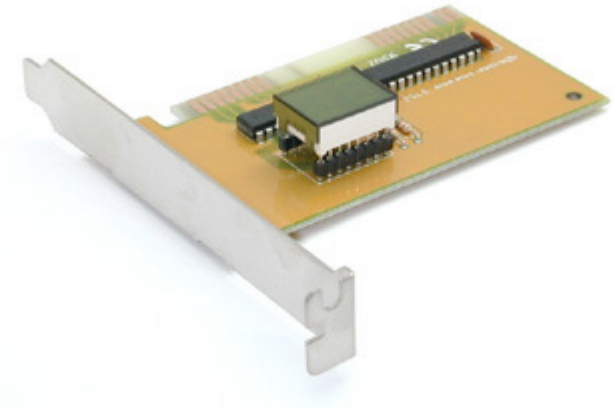

Figure 2. POST Diagnostics Card

To use the POST card, the technician installs the interface card in the computer system under test and then turns the system on. As the POST process continues, the POST card will display 2-digit codes indicating what test is being conducted. If the system fails a particular test, the error code will be shown on the display. The POST process will not always halt on an error so you have to read the display at the exact moment the error occurs. This moment could be instant the POST error code or message is displayed on the monitor or when the beep-code sounds off. The technician then looks up the error code on the listing that came with the POST card. As before, different BIOS's have different sets of error codes so you'll have to identify the BIOS manufacturer, date, and version to decipher the actual error for the code that's displayed. Once the tests are complete and the computer repaired, the technician removes the POST card and puts the computer back into service.

The clues you gather from the POST process are among the most important troubleshooting hints you'll receive. If you have an error code and the error code listing from the BIOS manufacturer, you can zero in on the problem and make short work out of common repair problems.

Reading Troubleshooting Diagrams

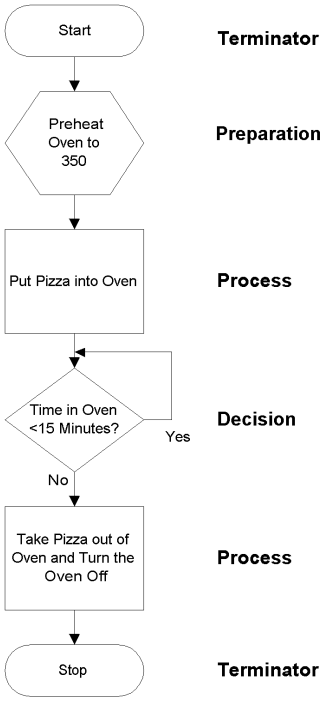

Figure 3. Traditional Flowchart

Troubleshooting procedures are systematic guidelines that guide the technician through a logical process for isolating computer problems. Troubleshooting diagrams, sometimes referred to as flowcharts, are schematics that represent a process. You may have realized that's it's easier for you to remember a pictorial or diagram rather than a paragraph depicting the very same information. That's why technicians prefer using troubleshooting diagrams over technical manuals when they service equipment.

Any process can be represented using a flowchart. Figure 3 shows a ***traditional flowchart*** detailing the process of cooking a frozen pizza. Although the two basic shapes in a traditional flowchart are the Process and Decision symbols, other shapes such as the Terminator and Preparation symbols are also used. The shape of the symbol has a specific meaning and technicians use

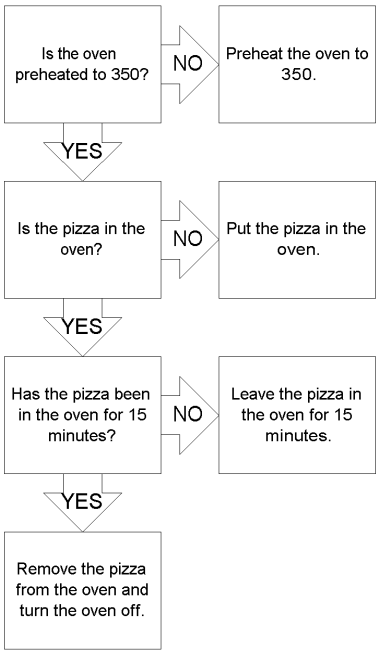

Figure 4. Another Flowchart Style

the symbols to scan complex troubleshooting diagrams. Otherwise, troubleshooting instructions would have to be written out making them more difficult to follow, review, and remember.

The start point for troubleshooting diagrams is always in the upper left-hand corner of the diagram. The decision boxes running down the left side of the diagram includes the basic tests and checks. If the system under test fails one of these checks, the technician is lead across the page to more in depth tests to isolate a specific problem. Figure 4 demonstrates another widely used model for troubleshooting systems. In this model, there are only two shapes. Although the flowcharts are functionally the same, the second model allows more detailed content and is easier for new technicians to follow. We'll be using this model when learning how to troubleshoot specific computer components later in this module.

It's important to realize that the troubleshooting diagram is only a tool used to isolate a problem. The technical manual is still required to repair the faulty component. These procedures are general at best so they can apply to all personal computer systems.

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Basic Troubleshooting

Exercise 1

Name:	
Period:	
Date:	

Exercise Objective:

Once you have completed this exercise, you will have used the troubleshooting process to isolate basic computer system malfunctions in your computer trainer. You will identify your trainer's BIOS as well as collect a list of its POST error codes. You will also use a POST Card to isolate the same basic computer malfunctions. Finally, you will read and draw troubleshooting and process diagrams.

Discussion of Fundamentals:

In the previous lesson you were exposed to basic troubleshooting information and methods. Practical application is necessary to turn this knowledge into skill. You'll be working with your computer trainer throughout this exercise. Be sure to ask for assistance from your instructor if needed. Review the lesson on Basic Troubleshooting frequently. You will also need to research information to find answers to some exercise questions. Useful internet links are provided to help you perform your research.

Research Resources:

Company	Web Site	Description
American Megatrends, Inc.	www.ami.com	Manufacturer of the AMI BIOS
IBM	www.pc.ibm.com	Manufacturer of the IBM BIOS
Award Software	www.award.com	Manufacturer of the Award BIOS
Phoenix Technologies	www.phoenix.com	Manufacturer of the Phoenix BIOS
Star Tech, Inc.	www.startech.com	Distributor for the StarTech POST Card
BIOS Central	www.bioscentral.com	Mega BIOS error and beep-codes site
Spacewalker	www.spacewalker.com	Technical Information for Spacewalker products

Required Materials:

- Computer Trainer
- Technician Tool Kit
- POST Card

Procedure:

Before you get started with this portion of the exercise, you'll need to sit at a completely assembled and functioning computer trainer. You'll also need to have a POST card and its POST error code listing available. Don't install the POST diagnostics card until directed to do so. Most of the work you'll do is simple observation and the tests you'll be conducting are nondestructive if performed correctly. Be sure to ask for assistance from your instructor when directed to do so. **Remember:** Not all BIOS chips have POST error or beep-codes for every malfunction. When the exercise directs you to write down an POST error code, there might not be one on the screen but there may be an error message. Write that down instead.

[ ] 1. Enter the CMOS configuration utility and set the BIOS to Halt on All Errors.

[ ] 2. You'll need to restart your computer trainer to collect information about your computer's BIOS. Restart the computer and record the BIOS information in the table below.

Tip: During boot-up, some BIOS chips allow the keyboard to pause the boot process. Try striking the Alt-Pause keys as soon as the BIOS information is displayed on the screen. This should freeze the screen. Otherwise, you'll have to keep rebooting the computer to collect the BIOS information you need.

	BIOS Startup Screen	BIOS IC Label
Manufacturer:		
Version:		
Date:		

[ ] 3. Remove the trainer's case, find the BIOS IC and record the information on the label in the table above. **Note:** POST codes may differ depending upon the BIOS model.

[ ] 4. Did the BIOS information on the monitor match the information on the IC's label? Why or why Not?

[ ] 5. Visit the BIOS manufacturer's web site and retrieve a listing of POST error and beep-codes to answer the following questions.

a.	What is the POST beep-code for a faulty monitor?	
b.	What is the POST error-code for a faulty monitor?	
c.	What is the POST beep-code for a faulty video adaptor?	
d.	What is the POST error-code for a faulty video adaptor?	
e.	What is the POST error-code for a defective keyboard?	
f.	What is the POST error-code for a defective mouse?	
g.	What is the POST beep-code for defective system memory?	
h.	What is the POST error-code for defective system memory?	
I.	What is the POST error-code for a defective CMOS battery?	

[ ] 6. Shut the computer off and unplug it.

[ ] 7. Install the POST Card. ***Have your instructor check your work before you continue.***
   a. Disconnect the monitor data cable from the computer and restart the trainer. Record the observed POST error and beep-codes in the table below.
   b. Shut the computer off and unplug it.
   c. Reconnect the monitor data cable to the computer.

[ ] 8. Remove the video adapter from the computer and restart the trainer. Record the observed POST error and beep-codes in the table below.
   a. Shut the computer off and unplug it.
   b. Reinstall the video adapter.
   c. ***Have your instructor check your work before you continue.***

[ ] 9. Unplug the keyboard before restarting the trainer. Record the observed POST error, beep-code, and POST Card error in the table below.
   a. Shut the computer off and unplug it.

[ ] 10. Disconnect the mouse from the trainer and restart the trainer. Record the observed POST error, beep-code, and POST Card error in the table below.
   a. Shut the computer off and unplug it.
   b. Reconnect the mouse to the trainer.

[ ] 11. Remove **all** of the system memory (RAM) and restart the trainer. Record the observed POST error, beep-code, and POST Card error in the table below.
   a. Shut the computer off and unplug it.
   b. Reinstall the system memory.
   c. ***Have your instructor check your work before you continue.***

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[ ] 12. Remove the CMOS battery and restart the computer. Record the observed POST error, beep-code, and POST Card error in the table below.
   a. Shut the computer off and unplug it.
   b. Reinstall the CMOS battery and restart the computer. Make sure the computer reports no POST error, beep-code, or POST Card error. You may have to reset the CMOS to the default settings and set the correct date and time.
   c. ***Have your instructor check your work before you continue.***

[ ] 13. Shut the computer off and unplug it.

[ ] 14. Remove the POST Card and reinstall the filler plate.

[ ] 15. Reinstall the computer case and straighten out your work area.

[ ] 16. ***Have your instructor check your work before you continue.***

Malfunction	Error-Code*	Beep-Code	POST Card	Screen Error Message
Monitor				
Video Adapter				
Keyboard				
Mouse				
Memory				
CMOS Battery				

** From Step 3*

[ ] 17. Did the manufacturer's BIOS error and beep-code listing match those from your experiment?

[ ] 18. Examine the following troubleshooting flowchart closely. Suppose the computer that you're working on may have a problem with the power supply. Determine the cause of the problem based upon the following observations.

So… What's happening here?
Although it's titled "Basic Troubleshooting," this exercise is great example of why it takes a good deal of experience to effectively troubleshoot computers. You should have noticed that some of the POST codes displayed by your computer didn't match codes in the user manual or the BIOS manufacture's web site. In fact, some of the bugs you sabotaged your computer with (disconnecting the monitor) generated errors on some computers but not others.

The big question might be… **Why?** Here's the answer:

Although big-name manufactures of BIOS chips like American Megatrends, Phoenix, and Award produce BIOS chips – More accurately, they license the BIOS program to the manufacturers of computers. When you purchase a computer, the BIOS is programmed with a version of the BIOS that's designed for that particular computer.

Computer and motherboard manufacturers often "tweak" the BIOS program to fit the design of their computer's architecture. That's why technicians always download the BIOS update from the computer's manufacturer instead of the BIOS manufacturer. There's also a limited amount of programmable memory in the BIOS ROM. If the computer manufacturer adds a feature to the BIOS, they'll also have to delete something. Some POST codes or other features like "Halt on All Errors" or "Memory Test" might be removed.

The important thing to remember is to expect the unexpected when troubleshooting computers. The more you know how computers work, the more you'll understand their complexity. They're not as predictable as you would think and they don't always conform to specifications. If they did, there would be no need for computer service technicians.

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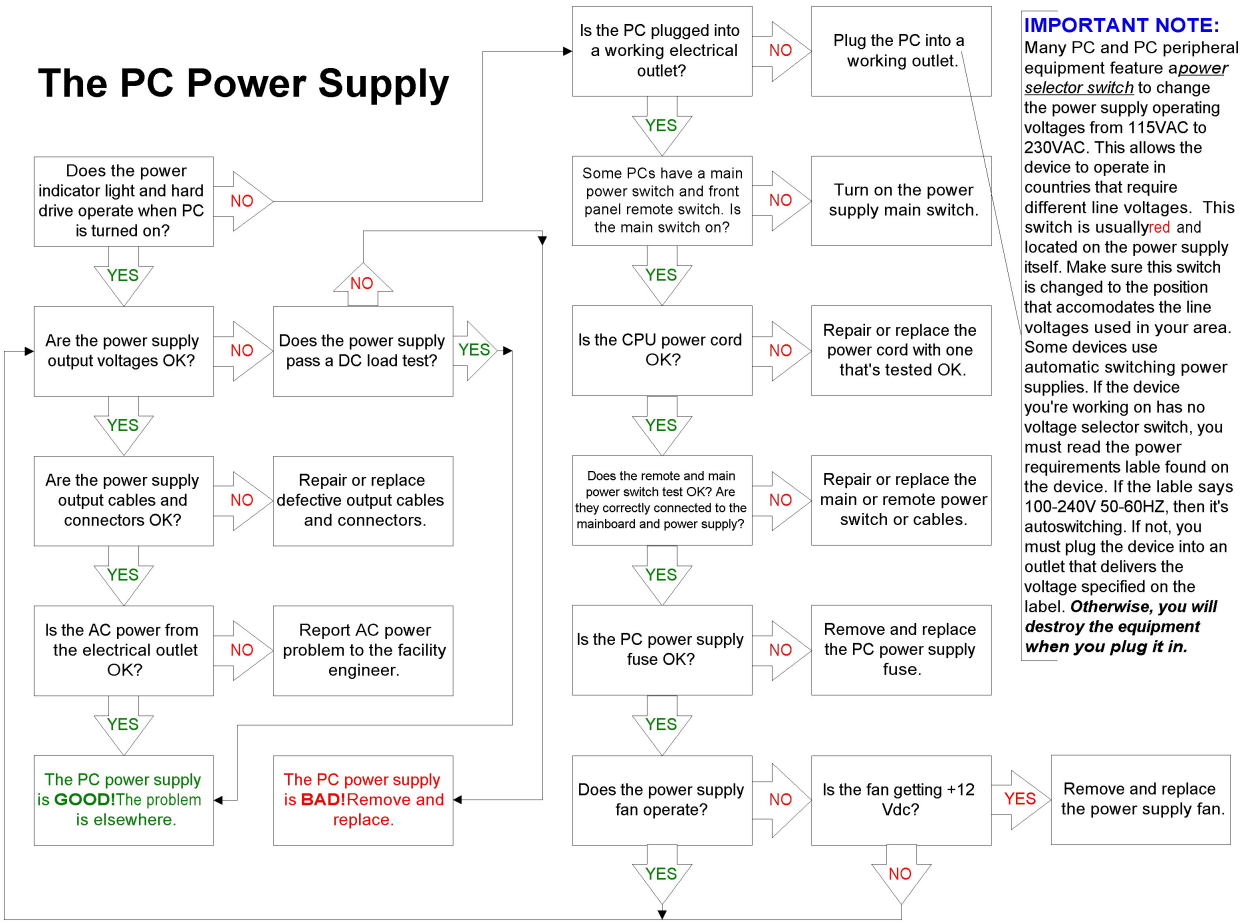

- The PC shows no sign of having power applied to it. The main power switch, power cord, power supply fuse, and remote power switch are all good. You removed the power supply and tested OK on a computer located in another room and it worked. What's the problem?

- You've ran through every check on this troubleshooting chart and everything's OK but the computer still looks dead. What's wrong with the power supply?

- The power indicator and drives operate. In fact, the entire computer works except the power supply fan doesn't spin. What's happening here?

[ ] 19. Draw a ***traditional*** flowchart for the following process. The flowchart must use terminator, process, and decision symbols.

- To install the POST diagnostics card you'll need to remove the computer case and find an empty ISA or PCI slot (depending on the type of POST Card you purchased.) You'll need to remove the filler plate before you push the interface card into the slot. Make sure the card is well seated before you secure it in place with the screw that held the filler plate. When you're finished testing the computer, make sure you remove the POST Card and then reinstall the filler plate. Finally, reinstall the computer cover and test the system to insure it still works.