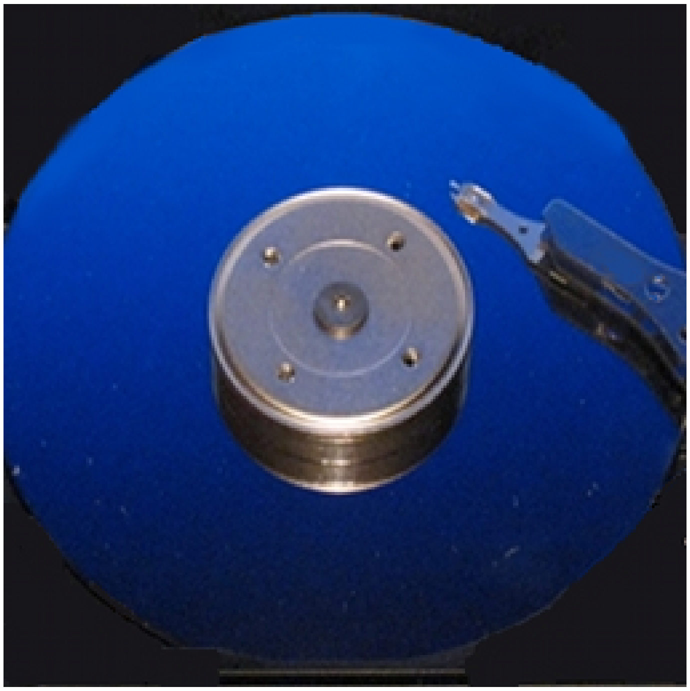

Hard Drive Troubleshooting

Software and Computer Systems Company, LLC

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Legal Information

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Chapter 1

Introduction

Overview

This document has been created by Software and Computer Systems Company, LLC (SCSC) to assist users in identifying problems related to hard drives and their supporting hardware. Because SCSC produces a product named ***Scannerz for Mac OS X,*** the examples and hardware addressed will typically be that associated with Apple® computer systems. This document, however, has been written in such a manner that virtually any user using a contemporary personal computer may find it useful, regardless of the manufacturer or the operating system.

Many people discover apparent problems associated with their hard drives, but fail to recognize that the problems may not be with the drive itself but rather the supporting hardware. A good example of this might be the failure of the cable connecting a hard drive to a logic board (motherboard). A user might purchase generic drive testing software which indicates there's a problem with the drive, purchase a new hard drive, replace the existing hard drive with the new hard drive, and then find the problems still exist. In some cases, the user may erroneously start a trial and error process of buying and replacing one component after another until the problem is solved, or they may simply assume the system is hopelessly broken and sell it for parts or throw it out. The purpose of this document is to instruct individuals how to avoid making these types of mistakes by providing a set of clear and logical procedures that will help a user properly identify the source of their problems.

Topics Covered in this Document

This document will cover many topics, but the focus will always be on troubleshooting problems with hard drives and their supporting circuitry. We'll start off with an overview of todays contemporary computer systems and how they interact with the hard drive. We will then identify the various types of failures that may occur in a system and their symptoms. Finally, we'll provide specific troubleshooting procedures to help you identify and isolate the source of your problems.

What's Not Covered in this Document

This document is about troubleshooting, and as such it will not provide extensive theory on the internal operation of a hard drive, the computer system, or the underlying operating system. There are already plenty of books and web sites dedicated to these topics, and we're not interested in wasting the readers time by providing them with yet another lengthy write up containing little, if any new information.

This document is not a manual for ***Scannerz for Mac OS X***. ***Scannerz*** will be used in this document in some of the examples we use to illustrate problems, and some overview information about ***Scannerz*** is provided throughout the document. Anyone interested in learning more about ***Scannerz for Mac OS X*** should visit our web site at:

http://www.scsc-online.com

Finally, when troubleshooting systems as complex as todays computers, it would be next to impossible for anyone to create a document accurately describing every single possible problem that can confront a user. What we put forth in this document are essentially our opinions based on our own research and experience in this field, and we hope it will be of value to you.

Chapter 2

Hardware Overview and Sources of Potential Problems

Overview

In this chapter we will identify the components of a computer system, how they relate to internal and external hard drives, and identify potential sources of problems. Although we will be going over the logic board and its components, our focus will be primarily on the interaction between the logic board and internal/external hard drives. In some case, software and other problems can cause symptoms to exist that are similar to hard drive failures, and these will also be covered at the end of this chapter.

Generic and Specific Failure Types

Prior to describing the hardware in any detail, we will identify how we classify possible failures associated with a system. We divide the failure types into ***generic failures*** and ***specific failures***. Generic failures will be addressed in the next section, with the rest of this chapter focusing on specific failures. Generic failures will, however, be an ever present possibility any time a problem is encountered.

We define a ***generic failure*** as a type of failure that is not specific to a particular component. This type of failure can occur on any components in a system. Generic failures most often are not caused by actual electrical or, in the case of the hard drive itself, mechanical failure, but are often the results of some other factor such as heat, age, poor assembly, or impact. This will be discussed in detail a bit later.

We define a ***specific failure*** as a failure that is specific to a component. For example, if a hard drive head crashes on the platter of a drive, it's a failure that is specific to the hard drive, since other components, such as the logic boards have neither heads nor platters. Specific failures are always uniquely associated with a specific component, and some specific failures can be specialized versions of generic failures.

Generic Failure Types

Problems associated with generic failures can often be among the most difficult to isolate because their nature is frequently erratic and sometimes not easily reproduced. Generic failures are responsible for a considerable number of problems with computer systems. If you've ever had experience with a system that would erratically lock up for no apparent reason, the chances are it's being caused by a generic failure, rather than an actual component failure.

Generic failures are classified as follows:

- **Intermittent Generic Failure:** This is a generic failure that exhibits intermittent electrical behavior.
- **Complete Generic Failure:** This is a generic failure which is a complete failure and does not exhibit intermittent behavior.

Below we will identify the types of generic failures, their symptoms, and their causes.

Bad Solder Joints

Bad solder joints exist when the solder connecting two (or more, in some cases) solder joints fail to make consistent electrical contact. This can be caused by either insufficient solder between adjoining electrical connections, or the joint has become damaged and cracked due to impact or localized extreme thermal variations on the hosting circuit board. Cracks most often occur on a joint that's weak, meaning the connection appeared functional when it left the factory, but as the end user used the system, the weakness in the joint allowed the crack to develop.

This problem, like cracked traces (discussed next), is one of the most difficult problems to isolate. Problems are often erratic because electrical contact exists most of the time, but the junction actually separates under certain circumstances, usually thermally related, causing the signals passing along the electrical connection to become interrupted. In this case, this is an intermittent generic failure.

If a solder joint is actually broken, which is rare unless the circuit board has experienced impact or undue flexing, the system component will usually fail to operate. This is a complete generic failure. For example, if there was an actual break on a solder joint connecting something like the CPU or the I/O controller chip to the logic board, the system would likely never boot properly. A system with a bad or cracked joint will likely make electrical contact most of the time and then fail intermittently, typically due to thermal variations.

Figure 2-1
This photo shows the tiny solder connections used to connect the J25 connector to the logic board as well as a number of traces running throughout the surface of the board. The dime is shown to illustrate the size of these components and connections.

Bad Traces
A trace (more formally, signal trace), for those unfamiliar with the term, is an etched metallic (usually copper) line on a circuit board that, for all practical purposes, functions as a wire (path of conductivity.) Figure 2-1 illustrates both solder connections and traces on a circuit board.

A trace is typically very thin in depth and if subjected to undue forces of some sort, it can crack, often yielding intermittent electrical contact to exist at the point where the crack exists. This is an intermittent generic failure. If a crack is severe enough, it can separate enough that once the crack has occurred, electrical continuity between both sides of the crack will cease to exist permanently. This will almost always yield a complete failure of some sort in the system, and is classified as a complete generic failure.

In the case of an intermittent generic failure, the electrical continuity of a cracked trace on both sides of the crack is very often a function of the temperature of the unit at the point where the crack exists. As a unit heats up, it expands, and as it expands, the crack widens, eventually forcing a complete electrical separation to exist on both sides of the crack, hence a failure. As it cools down, electrical contact may once again be restored.

If a cracked trace exists, in most cases it's due to impact or flexing of the circuit board, and it occurs most often in laptop computers. In rare cases, it can be caused by undue, localized extreme thermal variations on a circuit board. Cracked traces on logic boards are typically resolved by replacing the board due to the micro nature of todays circuitry.

Cable Faults
A cable fault can apply to any cables associated with internal or external devices. The faults can apply to both data cables and power cables. A cable fault typically indicates that one or more wires in the cable has essentially broken and is making either intermittent contact (an intermittent generic failure) or no contact at all (a complete generic failure) with it's counterpart on the other side of the break. If the contact is intermittent, the device in question will behave erratically, but if it's broken, in most cases the device receiving input from the cables will not function properly at all.

Cable faults most typically occur on external units when the connectors are put under strain, usually because they're being placed too far away from their hosting unit. Some internal cables are actually not cables but flexible circuit boards, usually mylar, with printed circuit traces taking the place of wires. This type of cable can experience cracks in traces due to aging, heat, vibration, and impact. They can be damaged quite easily if the unit is mishandled during assembly or re-assembly.

Connector Faults
A faulty connector can exist when one or more of the electrical contacts on the male side of the connector fails to make consistent contact with it's counterpart on the female side. If a connector relies on pins plugging into receptacles, such as an IDE drive, problems may exist if the connector isn't fully pushed in or during assembly/re-assembly, a misalignment error caused one or more of the pins to bend down or break rather than fitting into the receptacle. Connectors that rely on spring loaded surfaces to make electrical contact, such as USB and FireWire connectors, will typically have problems if they're not fully plugged in, the connector has been contaminated by a foreign substance, or the receptacle has lost it's spring loading ability due to overuse.

The failures, regardless of the connector type, will always yield either intermittent electrical contact (an intermittent generic failure), with results nearly identical to those associated with cracked traces and solder joints, or a flat out failure when the electrical contact is completely lost, as opposed to being intermittent (a complete generic failure.)

Short Circuits
Short circuits can happen anywhere, and the most likely cause is a small metallic object entering the computer (such as a metal filing), or more commonly, a screw coming loose and roving around the inside of the unit. Todays circuits are low power, and a short on the output of an integrated circuit can easily be blown without any smoke or accompanying burning smell. As you might guess, this effects much more than just the hard drive and its associated circuitry. Short circuits may also exist on damaged cables or be induced by impact damage.

Specific Failure Types

Specific failure types, as stated previously, are specific to components within a system. We divide these into four categories: the logic board, the power subsystem, internal hard drives, and external hard drives and their supplies. One thing to keep in mind is that all generic failures previously described are applicable to all of the items capable of having specific failures. For example, the generic failure type “bad solder joints” could apply to the logic board or the drive controller on a hard drive.

Logic Board Failures
Figures 2-2 and 2-3 show generic diagrams of a contemporary logic boards. The diagrams show only those items directly and indirectly related to internal and external drive processing, thus other components, such as video processing and networking have been eliminated. Figure 2-1 shows an older logic board using an EIDE/IDE based board that will connect to and EIDE/IDE hard drive, whereas figure 2-2 illustrates a newer logic board with drives utilizing a SATA interface.

As stated, these are generic diagrams. What's important is to recognize how data flows on the system primarily between the I/O controller and the drive being evaluated. Different systems will likely use similar, but not necessarily identical configurations. In some systems, the single I/O chip may actually two chips, such as a North Bridge and South Bridge instead of a combined chip.

Other systems may also have other items in the path between the I/O controller and the drive connections. For example, a Mac Pro will have an auxiliary front panel board with FireWire and USB ports connected to the logic board via a cable, and 15/17 inch PowerBook G4's will have some of their I/O ports on auxiliary circuit boards as well. Newer USB systems may have an on-board USB hub feeding the USB ports rather than connecting directly to the I/O controller. However, the signal flow is, for all practical purposes the same. People interested in troubleshooting their systems down to the component level should obtain the appropriate block diagrams and/or schematics.

Failures of the CPU, RAM, or I/O controller will generally cause the system to fault, usually not being able to complete a boot up. Partial failure of the I/O controller on specific output stages is a possibility, but due to the level of protection built into these chips, such damage, which would likely be caused by an electrical event, would likely be severe enough to render the IC useless. Intermittent generic failures in any traces or solder joints that exist on the logic boards will likely yield erratic behavior that can't be traced directly to the hard drive. Complete generic failures in any traces or solder joints will likely cause the system to fault during boot, if it is even capable of booting.

The FireWire PHY chip has been known to have its output stages blown fairly easily due to electrical transients. In many cases, this won't be detected by the system because it doesn't monitor or test the FireWire output stages, but the drive will not be seen or be accessible to the system.

If a USB port is segregated from the I/O controller via a USB hub IC, it's possible that output stages of the hub IC could be blown by an electrical transient. In this case, the hub may register as being available to the CPU while simultaneously failing to actually communicate with its attached devices. Software and system settings can also make USB devices “disappear,” so be cautioned not to assume there's a USB fault until the problem has been thoroughly evaluated.

Power Subsystem Failures

Every unit has at least one power source. If it's a desktop unit, it has a power supply either separated from or integrated into the logic board. If it's a laptop it has both battery power, plus an AC based power supply and charging unit, which may or may not be integrated into the logic board. We're not concerned with the actual power supply, charging system on a laptop, or battery power, just the types of faults that can affect hard drives specifically.

Power supply problems are classified into the following categories:

- **Actual power supply failure.** Unless a short in the drive or it's cabling is causing this to occur, it should be considered a system problem. Supply failure should be pretty obvious – you're unit won't turn on! A supply doesn't necessarily need to fail to stop providing power. Most supplies have sensors to detect too much current being drawn on the unit and simply shut themselves off instantaneously rather than attempting to provide power to a short circuit. If the short circuit can be identified and removed, in many cases the supply will once again start working.

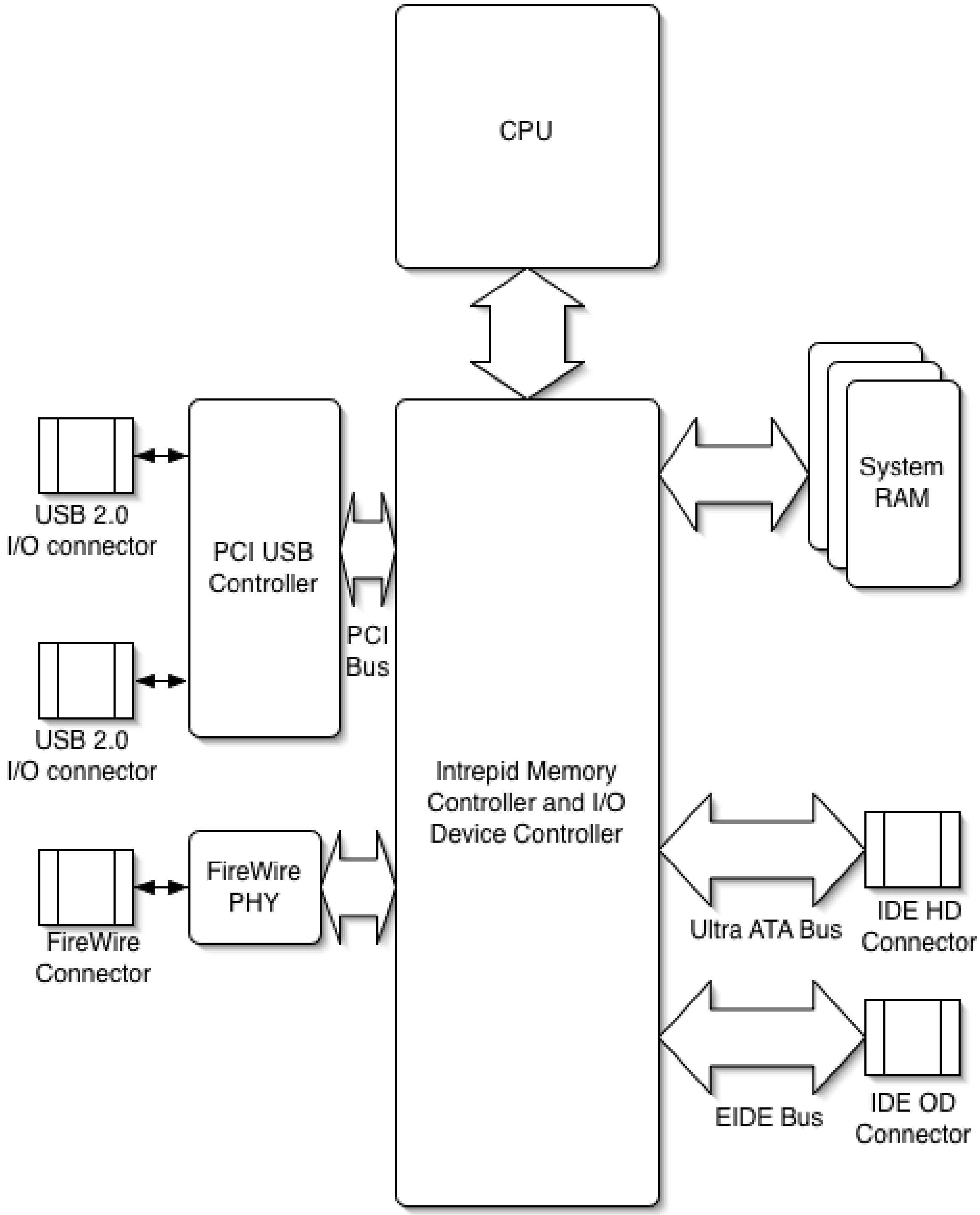

Figure 2-2
This block diagram illustrates a simplified configuration for an older Apple system. It would use a PowerPC processor and utilizes an UltraATA bus to interface with the internal IDE hard drive.

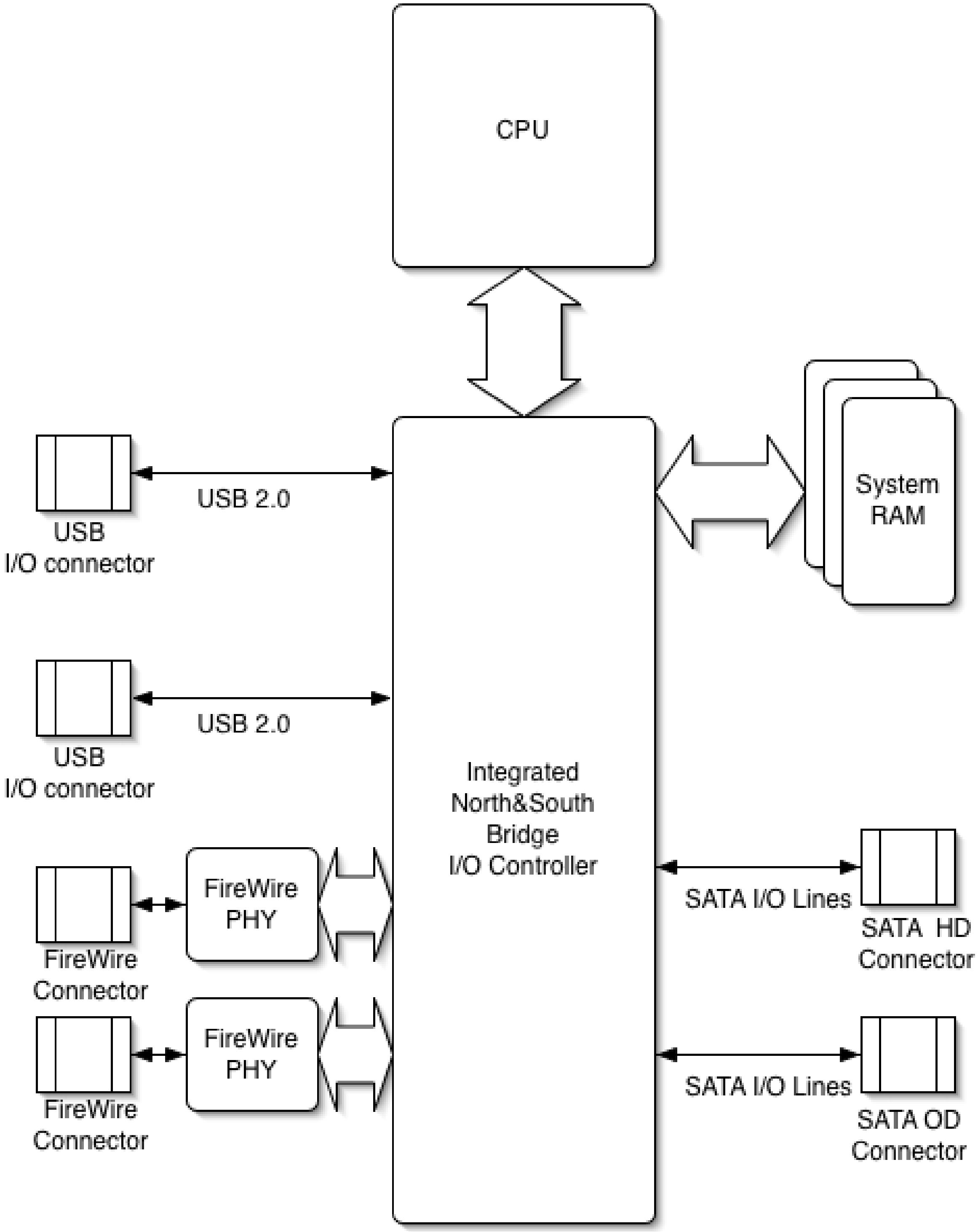

Figure 2-3
This block diagram illustrates a simplified configuration for a newer Apple system. It would use an Intel processor and utilizes a SATA interface with the internal SATA hard drive.

- **Power supply - logic board generic failures.** Virtually all internal drives receive their power from the logic board. The supply cables going to the drive originate from the power supply outputs and make their way to the drives power supply cables through a series of logic board traces, connectors, and cables. Any of these may suffer generic failures typically related to cracked traces, bad solder joints, or intermittent/failing connectors. As with all generic failures these are hard to isolate because they tend to be erratic. A typical sign of this type of problem is complete lock up of the unit often accompanied with odd looking but very short shifts in a video image. Problems of this nature are most common on laptop computers, likely because of heat, impact, or board flexing within the units housing.

Internal Hard Drives
The primary components comprising a contemporary hard drive consist of a controller, platters, hard drive heads, an actuator, and the spindle motor. Figure 2-4 shows a hard drive with it's top case removed. The controller board is on the bottom side of the drive and isn't shown in the figure. We're not going to cover the theory of operation because there's a wealth of information about hard drives in publications and on the web. We will only be focusing on the functionality of each component and what problems can develop with them. It should be pointed out that all we'll address here will also be applicable to external hard drives.

Excluding problems that can be caused by other system components, an internal hard drive may suffer from the following problems:

- **Drive Controller Failure.** All contemporary hard drives typically have a drive controller. During a write operation, the controller is responsible for accepting data from the computer and placing it in a buffer, serializing the data, positioning the drive heads to the appropriate portion of the drive via the actuators, and writing the data on the correct region of the surface of the spinning platters. Reading data is essentially the reverse procedure. The controller is also responsible for starting up and monitoring the spindle motor and all actuator activity.

A controller can fail in many ways. If it burns out for some reason and completely fails, the drive will not work at all and will appear as if it's not even attached to the computer. Board failures in the logic and control circuitry can cause the unit to produce unusual sounds, such as repetitive clicking, sounds like the drive is cycling through start up and shutdown routines, and a host of other noises. Corruption of the RAM used for buffering and cacheing can cause the data presented to the system to be little more than junk. Generic failures of the I/O connectors and power connectors (if applicable) can lead to very erratic (as usual) data transfer and even system lock up.

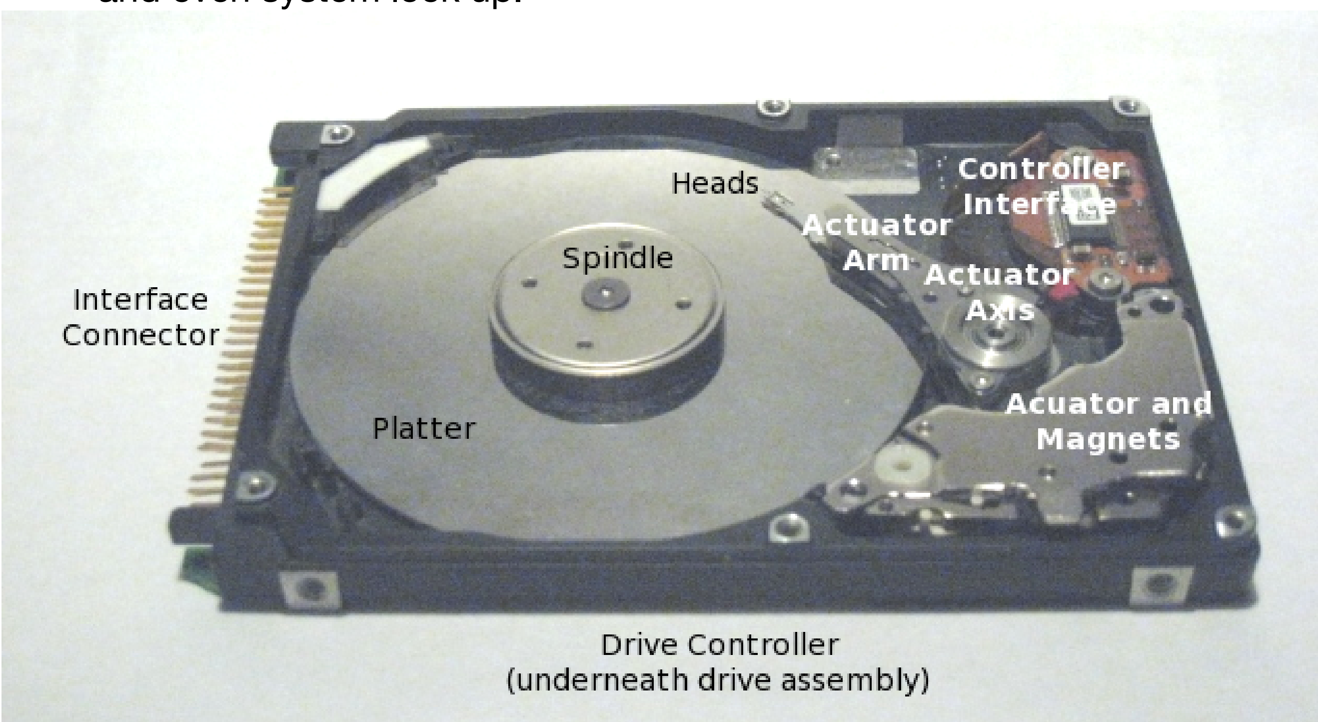

Figure 2-4
This photograph of an IDE 2.5 inch hard drive internal assembly shows the major electro-mechanical components of the drive, with the controller board being on the underside and not visible in this photo, and the spindle motor being obscured by the spindle and platters.

- **Actuator problems.** The actuator is responsible for moving the drive heads over the appropriate areas of the platters to read and write data via a winded coil (electro-magnet) sandwiched between actuator magnets. The controller board changes the current flow in the coil to cause an increase/decrease in magnetic field intensity of the coil, which in turn causes the actuator to make angular movements about the actuator axis. The angular movement about the actuator axis causes the actuator arms to move over the surface of the drive platters. In figure 2-4, the coils comprising the windings are obscured by the magnet.

Actuator problems can occur due to bearing failure in the actuator axis, which causes a problem in seeking from point-to-point on the surface of a drive, generic failures (think intermittent contact) between the drive controller and the connection to the coils feeding the actuator, and in rare cases, contamination of the drive such that the actuator binds on the surface of the drive, usually due to **severe** impact. The most likely causes of failure are the bearing wearing out due to wear and tear due to age and use, or a contaminant actually working it's way into either the bearings or the surface of the drive such that the heads bind on the surface of the platters.

- **Spindle motor problems.** The spindle motor drives the platters at a near constant angular velocity (rotation rate.) It is activated and controlled by the drive controller.

  Spindle motor problems can be caused by age, as in the motor just wore out, which will eventually happen over time, or they can be caused by generic failures, such as an intermittent contact existing between the controller board's electrical contact to the spindle motor. The end result is typically the same – the drive fails to be recognized.

- **Drive heads and platter problems.** The drive heads are located at the ends of the actuator arms and are connected to the logic board via wires, traces, and connectors. The platters are coated with a modifiable magnetic material that spins at a high rate of speed underneath the heads. The controller board can keep track of both the platter and the drive heads with an incredible degree of accuracy. Drives may have multiple sets of heads and platters, and the platters may be single or double sided.

  The drive heads are responsible for writing data to the platter(s) and reading data from the platter(s). When a write operation is performed, the actuator moves the heads over the appropriate region of the disk, and the heads induce a rapidly changing magnetic field onto the platter which modifies the magnetic surface of the platter as it rotates underneath the heads. These can later be translated to binary 1's and 0's during a read operation. During a read operation, the controller will position the drive heads to the appropriate location on the platter, and as the surface of the platter rotates underneath it, the moving magnetic field created by the rotating platter induces a signal onto the drive heads that can be converted into binary 1's an 0's.

All data conversion to and from the heads during read and write operations to actual data processed by the system's CPU(s) are handled by the controller. The drive heads ideally never make contact with the surface of the platter and actually ride over a tiny layer of air above the platter. Many people mistakenly think that the drive is completely sealed, but it isn't. There will always be a small “breather hole” located on a drive with a micro filter that prevents all but the tiniest objects from entering the interior of the drive.

The most common failure detected with the head/platter combination is a head crash. A head crash can be caused by impact or contamination. If a drive is in the process of reading or writing data and it's suddenly subjected to a jolt or impact, the drive heads can actually make physical contact with the platters during operation, damaging the platters surface and sometimes the heads themselves. If a contaminant manages to make it's way past the breather hole's micro filter and make its way between the heads and platters as they're operating, it too will end up damaging the platter and sometimes the heads as well.

When a head crash occurs, the most common result is sector damage. The damage usually extends sequentially over numerous sectors on a drive, and the data may or may not be readable depending on the severity of the damage. When a user is using a computer and it suddenly appears to lock up temporarily, and this occurs frequently after a head crash, it's worth the effort of the user to test the drive for this problem. When using our product ***Scannerz***, an unreadable sector is classified as an error, and a sector that is readable, but usually only after several retries, is classified an irregularity. Irregularities and errors, however, are not limited to drives.

Head crashes, although not commonplace, are probably the most common type of problem a hard drive will encounter. Fortunately, most hard drive manufacturers allocate an allotment of spare sectors so the drive can have the bad sectors displaced. This will be covered in the troubleshooting section of this document.

External Hard Drives
An external hard drive is essentially an internal hard drive that's been placed in an enclosure that allows the assembly to be easily removed from the system. The external hard drive can suffer from every single problem described in the preceding section on internal hard drives, plus those associated with the external hard drive enclosure.

The external hard drive enclosure will include an interface circuit board that allows its enclosed drive to communicate with the hosting computer via the I/O cable, cables or connectors inside the enclosure connecting the interface to the drive, and if an external supply is used, there will be connections between the supply and the drive. Many small external enclosures consist of a single circuit board that plugs directly into the hard drive, and then the assembly fits inside a small enclosure, and these are often powered directly by the I/O port from the hosting computer. Larger enclosures will have typically have the interface card completely separated from the hard drive with wires and cables running between the interface and power connections to the hard drive inside the enclosure.

When dealing with external hard drive, we will only be dealing with FireWire and USB types, since they're the most common currently in use. However, any other serial interface, such as eSata or Thunderbolt should be able to be analyzed using the similar techniques. The hard drive type inside an external enclosure can be either IDE or SATA, depending on what the interface card inside the enclosure uses.

The types of problems that an external hard drive can encounter are as follows:

- **Problems with the drive itself.** The drive inside an external hard drive enclosure can suffer from every single problem the internal hard drive suffers from as described in the preceding section since it's an internal hard drive that's been displaced into another housing. Because some external drives may be moved from one location to another frequently, the likelihood of the unit experiencing head crashes due to impact increases.

- **I/O cable failure.** The I/O cable connecting the external hard drive to the hosting computer is typically every bit as likely, if not more so, to cause problems as the hard drive enclosed in the housing. External cables suffer a higher probability of experiencing abuse than their internal counterparts because they “live in the real world” and can be subjected to various forms of strain or twisting that may cause some of the wires inside the cable to break.

  Most of these faults will fall under the “generic failure” classification of problems, with internal cable breaks manifesting themselves as either intermittent or consistent losses of electrical flow in the cable. If the cable line(s) with the breaks in them are data lines, the user may experience erratic periodic, lengthy delays as the computer tries to read or write data to/from the unit until the intermittent nature allows electrical contact to be re-established. If contact is not established in enough time (typically 60 seconds) a read or write error will occur. If the external unit is self powered and the cable lines carrying the power to the unit have erratic connections present, the unit may periodically lose power and “drop off the face of the Earth” for no apparent reason. If a cable is not fully or properly plugged in, it can effectively emulate a generic fault in a data line.

- **Connector contamination.** Cable connectors can often be subjected to contamination by foreign substances which are often easily overlooked by the user. For example if someone has an external drive's cable that's currently not in use sitting on their desk and they spill a soda, it will likely occur to them to hurry up and clean the spill up before it works it's way into other items, like papers on the desk, the keyboard, the mouse, etc., but it may not occur to them that some of that sugary substance made its way into the ends of a USB or FireWire cable and is now in the process of drying up. The result is a connector that, when plugged into the port of the computer or external drive suddenly has a new material with conductive properties that can't be predicted. Will electrical contact be present? Will it appear as a short to the hosting computer? It depends on the material. Moreover, once the contaminated cable is plugged into one or more units, they tend to transfer the contamination from connector to connector, spreading in a manner almost similar to a disease.

- **Interface board failure.** The interface board in an external unit may fail for a host of reasons. Undue strain or impact to the I/O connectors may cause generic failures such as cracked traces or solder joints connecting the port connector to the interface board to cause erratic or complete loss of data and/or power flow between the external unit and the hosting computer. The interface board itself could fail due to a circuit component failure. The cable (if present) inside a larger housing may go bad or develop generic failures such as intermittent contact, or even an assembly problem such as not being fully plugged into the hard drive. The board may develop cracked traces or solder connections, particularly if the enclosure is small and uses an “all in one” configuration where the I/O connectors, drive connector, and the interface card are a single assembly that fits, frequently tightly, into a very small enclosure.

- **Power supply failure.** External units with external power supplies can develop numerous problems. Generally, because the number of units available on the market is large, we can only address this in very general terms. Note that USB and FireWire units that are self powered can loose power, or receive it erratically if the cable is bad as was described above in the section *I/O cable failure,* and this includes the possibility of the appropriate cable(s) not being fully plugged in.

  First and foremost, the most likely causes of failure are, once again, the supply cables and connectors, not only going into the external unit, but also the wall, and frequently into any external power cubes that may be associated with the device. These are often placed on the floor in obscure places where accidental contact and impact can partially remove the connectors or damage them. The supply connectors going into the external drive itself often protrude, making them likely targets for accidental impact damage. Any of these types of problems may lead to erratic or complete power loss.

  Although somewhat rare in our experiences, the supply itself may fail. Failure may be absolute, as in it simply doesn't come on, or a transients may have caused an internal fuse or fusible link to blow. These types of problems would be specific to the supply, and thus won't be addressed in any detail in this document.

Errors, Irregularities, and Scatter

During surface or seek scan testing on a drive, a user may encounter *irregularities* and/or *errors* along with *scatter*. An *irregularity* is an event that occurs during a test on a hard drive that took longer to complete than it should have taken. An *error* is a bonafide failure that occurs during drive testing where the tests indicate the operation did not complete successfully at all. We use the term *scatter* to indicate whether or not a drive is experiencing consistent test results. A test performed on a drive with consistent, repeatable results has no scatter, whereas a test with test results that vary considerably from test to test is displaying scatter.

If a drive being tested using surface/seek scanning software has intermittent generic failures, errors and/or irregularities frequently appear with a considerable amount of scatter, and multiple tests on the unit will produce test results that usually vary widely from test to test. As you'll see in the next section, a fairly large number of problems can cause scatter to exist, and many of them occur without the drive actually having any problems. If the software being used to test a drive doesn't evaluate both irregularities and errors, the conclusion that the user will likely reach is that the drive needs to be replaced, and after wasting the time and money to replace the drive, the problem will often still persist. For Mac OS X based systems, ***Scannerz*** is the only product commercially available that detects both irregularities and errors.

If a system has a drive that's lost sectors due to a head crash or contamination, irregularities and/or errors may be present, but there will be no scatter – the tests will be repeatable from test to test. The loss of sectors on a drive isn't that odd, particularly as a drive ages, or in the case of laptops, the computer gets subjected to more movement, vibration, heat variations, and impact. Fortunately, most drive makers allocate spare sectors that allow a drive to remap bad sectors to spare sectors making the drive useable again.

Table 2-1 illustrates a summary of the partial test results of a drive experiencing scatter, and table 2-2 illustrates a summary of the partial test results of a different drive with bad sectors (no scatter.) In table 2-1, the test results indicate there are inconsistent failures and irregularities, which implies the problems are being caused by a generic intermittent failure somewhere in the system, and not necessarily being caused by the hard drive. In table 2-2, the problems are reasonably repeatable from test to test which indicates that the problems involve a bad sector on the hard drive. The tests in table 2-1 will require further analysis on the system and troubleshooting the problem to find the real cause. The results in table 2-2 tell the user that the drive itself needs work on a bad sector, and likely no more troubleshooting.

Scan Range	Test 1 Results	Test 2 Results	Test 3 Results
0 GB – 1 GB	PASSED	PASSED	1 ERROR
1 GB – 2 GB	PASSED	PASSED	PASSED
2 GB – 3 GB	1 ERROR	PASSED	2 IRREGULARITIES
3 GB – 4 GB	PASSED	PASSED	1 ERROR
4 GB – 5 GB	PASSED	PASSED	PASSED
5 GB – 6 GB	1 IRREGULARITY	PASSED	PASSED
6 GB – 7 GB	PASSED	1 ERROR	PASSED
7 GB – 8 GB	PASSED	PASSED	2 IRREGULARITIES
8 GB – 9 GB	1 ERROR	PASSED	PASSED
9 GB – 10 GB	PASSED	PASSED	1 ERROR

Table 2-1
A summary of tests results from a surface scan test with scatter

Scan Range	Test 1 Results	Test 2 Results	Test 3 Results
0 GB – 1 GB	PASSED	PASSED	PASSED
1 GB – 2 GB	3 IRREGULARITIES 1 ERROR	3 IRREGULARITIES 1 ERROR	3 IRREGULARITIES 1 ERROR
2 GB – 3 GB	PASSED	PASSED	PASSED
3 GB – 4 GB	PASSED	PASSED	PASSED
4 GB – 5 GB	PASSED	PASSED	PASSED
5 GB – 6 GB	PASSED	PASSED	PASSED
6 GB – 7 GB	PASSED	PASSED	PASSED
7 GB – 8 GB	PASSED	PASSED	PASSED
8 GB – 9 GB	PASSED	PASSED	PASSED
9 GB – 10 GB	PASSED	PASSED	PASSED

Table 2-2
A summary of tests results from a surface scan test with repeatable test results and no scatter.

The tables above are simplified results from tests run on two different drives and systems using ***Scannerz***. In table 2-1, the problem was traced to a bad I/O cable on a PowerBook G4. This particular unit uses a mylar type interface cable with copper traces used to replace wires, and either due to heat, impact, or aging, one of the traces in the data lines had separated off the mylar making inconsistent electrical contact. In table 2-2, the hard drive installed on a 2006 era iMac developed what was likely a minor head crash due to a contaminant entering the drive chamber after years of use. The results are obviously repeatable, the problem was then fixed, and the drive (and system) are now both up and working fine.

The results in both tables 2-1 and 2-2 are simplified. A ***Scannerz*** log file provides much more information as shown below in listing 2-1.

```
Scan start - Start Byte: 1048576000 End Byte: 2097151999 Index: 1
 SCAN FAILED - Start Byte: 1048576000 End Byte: 2097151999 Index: 1
     BAD DATA DETECTED BETWEEN 2059665408 AND 2059927552 BYTES.
                FAILED SCAN ALSO HAS IRREGULARITIES:
        Irregularity at byte 1125908480, response time 2.314475
        Irregularity at byte 1126432768, response time 3.329505
        Irregularity at byte 1154220032, response time 9.300946
```

Listing 2-1
Partial listing of the *Scannerz* log file in for data used in table 2-2

In the listing above, the response times associated with irregularities indicate how much time it took **Scannerz** to evaluate the sectors being tested. Response times for good drive sectors are typically in terms of milliseconds, not seconds, and yet in this listing, the irregularities are taking up to 9 seconds. The response times for irregularities associate with bad sector(s) will vary from test to test, but they are usually reasonably repeatable, and almost always occur at the exact same byte locations.

In contrast, the test results in table 2-1 are widespread, not repeatable from test to test, yielding results with errors and irregularities, for lack of better words, “appearing all over the place.” This could easily be anything as simple as a poorly connected cable, a bad drive, a logic board fault, or, as in this case, an actual hard drive I/O cable fault. This will be addressed in the next section.

Problems and Symptoms by Configuration Type

In this section we will take the information provided in the preceding sections of this chapter and apply it to the three specific types of configurations used in this publication. The configurations to be examined will be as follows:

- A computer system accessing an internal hard drive
- A computer system accessing an external hard drive via a USB port
- A computer system accessing an external hard drive via a FireWire port

Figures 2-5, 2-6, and 2-7 illustrate a system with an internal hard drive, a system with an external hard drive using a USB port, and a system with an external hard drive using a FireWire port respectively. In each of the diagrams, the color coding will identify the components as follows:

- **Light Blue:** Anything contained in the light blue regions of the diagram is on the logic board.
- **Light Yellow:** Anything contained in the light yellow regions is part of or inside the hard drive itself. This may also be referred to as the "raw hard drive."
- **Light Green:** Anything inside the boarders of a light green region is inside an external hard drive enclosure. This will include the hard drive housed inside the enclosure, the power/interface card, cables, etc. This will apply to external drives only.
- **Light Red:** All interface and power adapter cards inside an external hard drive will be inside light red regions. This will apply to external drives only.

Connectors to cables or wires are always illustrated using gray boxes. The diagrams are simplified but should adequately illustrate the problems that can occur with a given configuration as well as the symptoms.

The next three subsections will address each of the three systems above. Some of the text is redundant. For example, problems specific to a raw hard drive will be the same regardless of whether it's internal or housed in a USB or FireWire external enclosure.

Each section will start off with the name of the configuration followed by a listing of the appropriate reference diagram. Each component in the system will then have the possible faults identified and how they may manifest themselves. At the end of each element description is a small table identifying the work that will need to be done to correct a problem if the source of the problems may be traced to that component. We also identify how ***Scannerz*** will report this type of problem in test results (if applicable) and what the status of the hard drive itself will likely be in the event that the problem exists.

We have made the following assumptions with respect to faulty components:

1. Generally, any of the circuitry, such as a logic board or a drive controller board are not repairable.
2. The user will opt to replace a faulty component rather than repair it.
3. The hard drive is perceived as a dispensable unit, rather than a repairable unit.

This doesn't mean that the items can't be repaired, but the days of traces 1/16th of an inch wide and IC's separated by the corresponding amount of space are long gone. Attempting to repair most contemporary circuit cards requires specialized equipment that most people simply don't have access to. The cost of repairing such a circuit card on a one-time basis would likely cost more than the entire computer assembly itself.

The following sections will rely heavily on several terms previously described, but just for good measure, we'll provide a brief definition again:

Intermittent Generic Failure: A crack or break, typically in a trace, solder connection, or connector that allows intermittent electrical contact to exist, yielding erratic electrical contact.

Complete Generic Failure: A crack or break, similar to the intermittent failure above, but all electrical contact is lost, all of the time.

Scatter: This occurs most often with intermittent generic failures occur, yielding test results on surface scan data that are inconsistent from test to test. i.e., the test data “scatters” over a test range rather than being consistent.

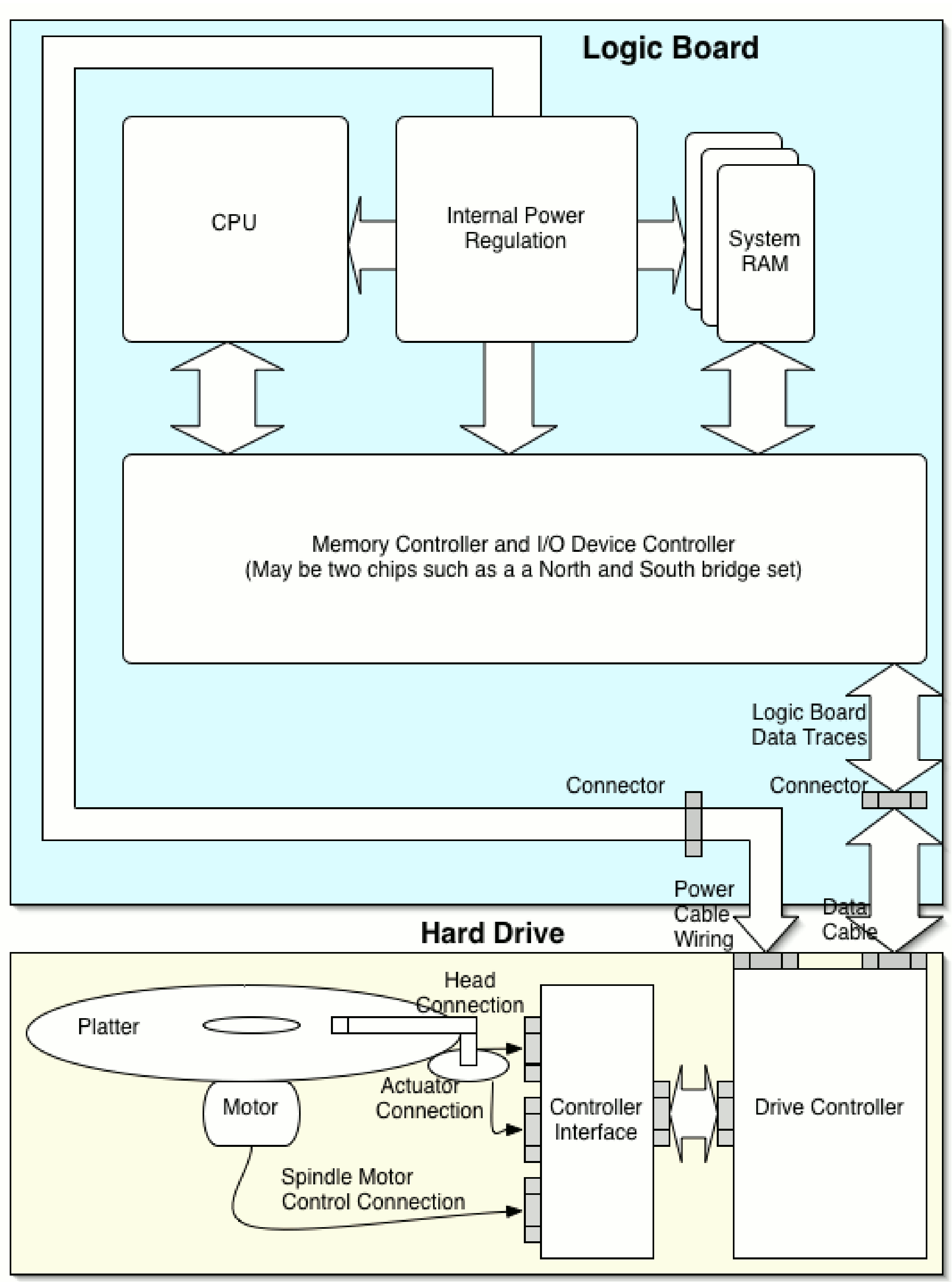

Figure 2-5
An Internal Hard Drive Connected Directly to a Logic Board

Possible Problems with a Drive Connected Internally

Reference Diagram: 2-5

Logic Board

Data paths between CPU, I/O Controller, RAM, and Power traces:
If generic failures exist in any of these lines they will not likely show up or give the appearance of being drive related. If the type of failure is complete, for example if a solder joint has separated and isn't making any contact with its counterpart, the system likely won't boot or start. If the failure is intermittent, such as a cracked trace that allows contact between both sides of the crack to be erratic, every time the crack separates enough to make electrical contact fail, the system will likely fault or lock up. If any of these components is damaged, the system will likely not boot.

Resolution	Replace the logic board
Scannerz Test Results	Irrelevant in this case - this is a system failure
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

Signal path between the I/O controller and the Drive Connector
If intermittent generic failures exist in these lines, the drive may produce test results with considerable scatter during a ***Scannerz*** test and be inconsistent from test to test. During normal operation, the data read and written between the drive and host may be corrupt while in use. If complete generic failures occur in any of these lines, in many (but not all) cases, the drive may not appear as being visible to the system, or the system may report an error.

The interface (IDE, EIDE, or SATA) isn't shown specifically on the simplified block diagram in figure 2-5, but the differences caused by faults can be significant. IDE and EIDE are parallel busses that contain not only data lines, but control lines. SATA lines are serial and send commands and data to the drive without control lines in the form of packets. The packets used by SATA drives can contain both data and control information and it's the responsibility of the drive controller on the hard drive to decipher and implement them.

In the case of IDE/EIDE drives, if there are intermittent generic failures in the control lines it may cause the drive to post data when it isn't supposed to, or fail to deliver data when requested. In some cases, system lockup may occur. If the generic failure on an IDE/EIDE interface control line(s) is complete, the drive likely won't be visible. If intermittent contact allows the drive to operate (although in a dysfunctional manner,) ***Scannerz*** will typically display test results with considerable amounts of scatter, and the system may experience periodic periods of delays, and even system faults and lockups.

If IDE/EIDE data lines are exhibiting intermittent generic failures, the data written or read to/from the drive may be corrupt. If the fault is a complete generic failure, in most cases the system should recognize the fault and report it, but there's no guarantee of that. In some cases, all data read and written could conceivably be erroneous, which would cause a system fault when booting the system (if it's a boot drive) or consistently read and write bad data on a secondary drive. During testing, ***Scannerz*** will typically yield test results with considerable amounts of scatter, and the system may experience periodic periods of delays, and even system faults and lockups.

Since SATA drives don't have control lines in the same manner as IDE drives do, intermittent generic failures can cause erroneous data to be sent or received from the drive, or the drive may receive packets it can't understand and demand a resend from the I/O controller. This will cause periodic system delays ("spinning beach balls") and system slow downs. In some cases it may write and read corrupt data to and from the system. ***Scannerz*** will typically display test results in this case with considerable amounts of scatter, and the system may experience periodic periods of delays, and even system faults and lockups. If the generic failure in any of these data lines is a complete generic failure, the drive won't be seen by the system.

Resolution	Replace the logic board
Scannerz Test Results	Considerable scatter is likely if intermittent
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

Power Traces Between the Logic Board and the Drive Supply Connector

Systems using 3.5 inch IDE hard drives will have a power connector that is separated from the data cable. Some older SATA units may exhibit this as will.

Most SATA units have their power supply connections integrated into the connector along with the data lines. Systems using 2.5 inch drives will typically have the supply lines integrated into the connector along with the data lines for both SATA and IDE drives. Although power and data lines may be integrated in this manner, the supply source typically, as shown in figure 2-5, is treated separately because it's typically sourced from the supply via logic board traces running back to the supply, not the I/O controller.

If complete generic failures exist *anywhere* in the supply path up to the point it makes contact with the drive's power connector, the drive will not be seen (the internal drive will not be powered.) If intermittent generic failures exist in any of these lines, it is not uncommon for the system to lock up when the defective trace or solder joint separates. This type of failure will be erratic in nature.

Resolution	Replace the logic board or troubleshoot the power system(s)
Scannerz Test Results	For complete generic failures, the drive likely won't be seen at all. For intermittent generic failures, Scannerz may experience error overflow and launch a dialogue indicating its error threshold was exceeded.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data and possibly index corruption.

Hard Drive I/O Cable and Power Cable

As stated previously, the I/O cable may or may not have the data and power lines integrated into it. The two should, however, be treated separately because they'll have considerable different effects in the event of problems.

If there are intermittent generic faults in the data lines, the drive will typically display considerable scatter during a ***Scannerz*** test, with results that can't be repeated from test to test. If the faults are complete generic failures, then the drive likely won't be seen by the system. On most laptop units, the I/O - Power cable is a set of traces on mylar film and they can break or crack fairly easily if mishandled or subjected to impact. Some drives require that a cable be used only once and supply a replacement cable with the drive.

If there are complete generic faults in the power supply lines to the drive, the drive will never power on and will obviously not be seen by the system. If the faults are intermittent generic faults, the drive may erratically come on and off line, typically followed by system lockup.

A common cause of failure occurs when the cables are not properly plugged into the system. In some units (G4 iBooks, in particular) the I/O cable has been known to work it's way off of it's connector over time yielding intermittent generic faults to exist at the connection between the drive cable and logic board connector.

Resolution	Replace defective cable(s)
Scannerz Test Results	For complete generic failures, the drive likely won't be seen at all. For intermittent generic failures, Scannerz may experience error overflow and launch a dialogue indicating its error threshold was exceeded.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

The Hard Drive

Drive controller and connectors

The drive controller on the hard drive can fail or appear to fail if the actual connectors that connect it to the I/O and supply cables are suffering from generic failures in the solder joints or traces yielding intermittent or a complete loss of electrical contact. If the contact is intermittent on the data lines, it will typically show up on ***Scannerz*** tests with scatter, or unrepeatable test results that show both errors and irregularities. If the electrical contact in the data lines is completely lost, the drive will not be seen by the system. If the power connections are intermittent, the drive will likely come on line and drop off line in a random manner, and likely lock up the system. If the power connections have completely failed, the drive will never power up.

If the drive controller circuitry itself is suffering from generic failures related to traces and solder joints on the circuit card, the drive will likely not be seen by the system. Additionally, it may display erratic behavior, such as periodic and repetitive clicking sounds that seem to appear without any reason.

The drive controller, like any other electronic component, can have components that malfunction. This is often due to electrical transients, but it can also be simply a component on the board has failed. The result is typically that the drive will no longer be seen.

Resolution	Replace the hard drive or replace the controller board
Scannerz Test Results	If the drive is accessible and appears working, Scannerz would yield test results with a high degree of scatter. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	Needs replacement or controller board replacement

Controller Interface

The controller interface connects the drive controller on the "outside world" to the internal chamber of the drive and makes connections to the actuator, heads, and spindle motor. Generic complete failures of any of these lines will cause the drive to stop working. Generic intermittent failures associated with any of these lines will cause the unit to operate in an incredibly unstable manner. If a component on the controller interface is blown, the drive won't be seen at all. In a nutshell, if there's anything wrong with this unit, whether the failure is intermittent or complete, the drive won't function.

Resolution	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Spindle Motor and Actuator

The spindle motor and the actuator not only face the possibility of having intermittent and complete generic faults, they can mechanically wear out and fail. When either of these fail or start to fail, it's often accompanied with loud and often unusual noises, which are obvious to most people.

Resolution:	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Head and Platters

Last but certainly not least is one of the most common problems, the loss of data sectors on the hard drive. This problem can often be remedied without opening the unit up. If this occurs, ***Scannerz*** will report irregularities and/or errors without any scatter – test results will be repeatable from test to test. The symptoms will be abnormally long times loading programs, sometime accompanied by a dialog stating a file can't be opened, and the "spinning beach ball." This can often be corrected by erasing the drive with the option to zero all bytes selected (see chapter 4.)

Resolution	Repair the hard drive if possible
Scannerz Test Results	Scannerz tests will show no scatter, and test results will be repeatable from test to test.
Status of Hard Drive	If the damage is minor, this can be fixed by forcing the drive to remap the bad sectors to spare sectors. If the damage is severe, it may be unrepairable and the drive may need to be replaced.

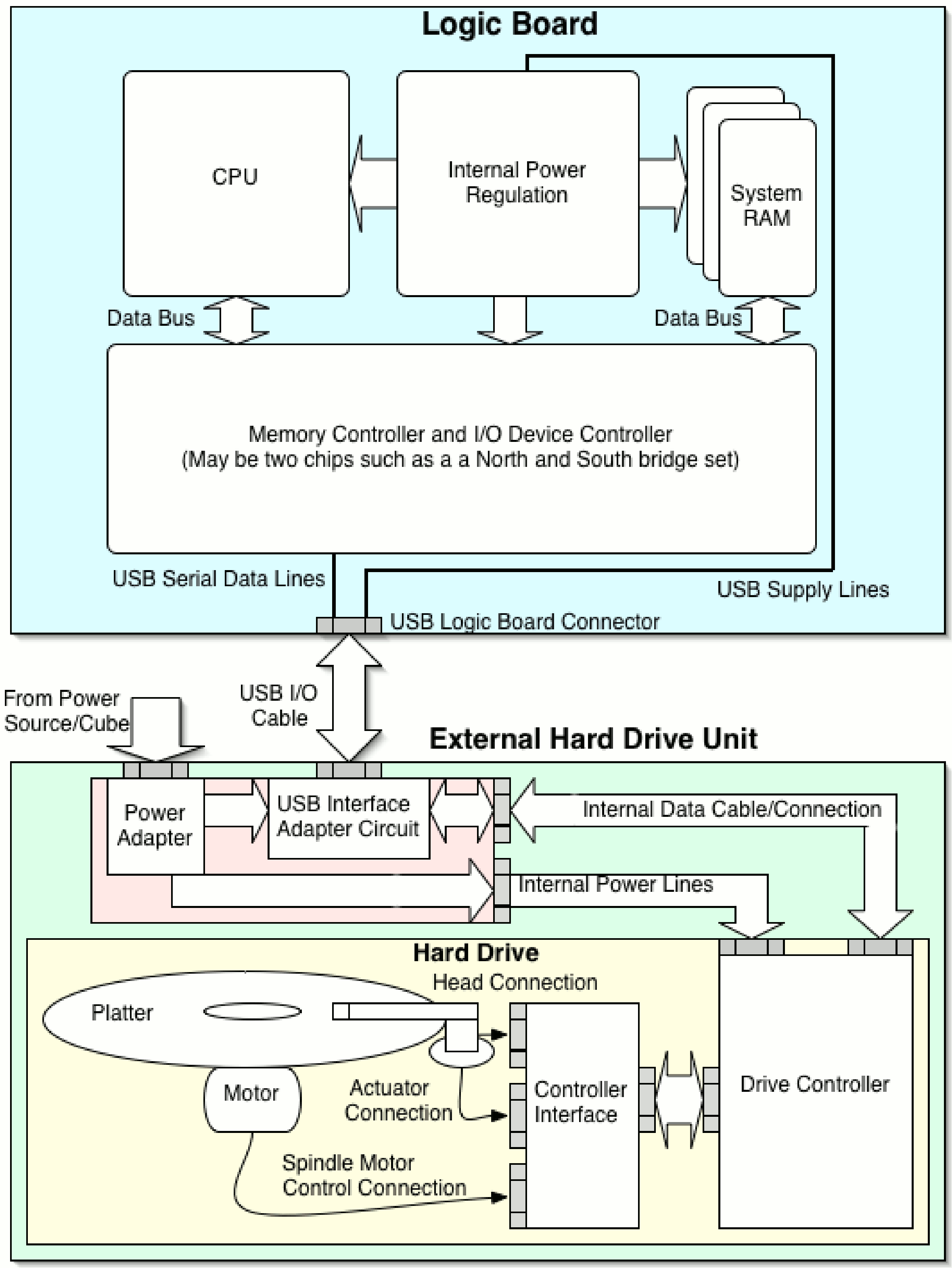

Figure 2-6
An External USB Hard Drive Connected to a Logic Board

Possible Problems with a USB External Drive

Reference Diagram: 2-6

Logic Board

Data paths between CPU, I/O Controller, RAM, and Power traces:
If generic failures exist in any of these lines they will not likely show up or give the appearance of being drive related. If the type of failure is complete, for example, if a solder joint has separated and isn't making any contact with its counterpart, the system likely won't boot or start. If the failure is intermittent, such as a cracked trace that allows contact between both sides of the crack to be erratic, every time the crack separates enough to make electrical contact fail, the system will likely fault or lock up. If any of these components is damaged, the system will likely not boot.

Resolution	Replace the logic board
Scannerz Test Results	Irrelevant in this case - this is a system failure
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

Logic board traces between the I/O controller and the USB Connector
If the data traces between the I/O controller chip and the USB connector have intermittent generic failures, ***Scannerz*** will identify this as scatter, with periodic irregularities and errors that are not repeatable from test to test. If the data lines have a complete generic failure, the drive will not be seen.

NOTE: Some newer systems may have an onboard USB controller in between the I/O controller and the USB port connector on the logic board. This won't be addressed in this manual because the errors that would occur would be redundant with those we are describing, and a failure will require the same repair (logic board replacement).

If the external drive is powered by the USB port and the supply traces have intermittent generic faults, the drive will likely come on line and drop off line, seemingly in a random error. This typically causes the system to generate a message indicating the drive has been ejected. If these lines have a complete generic failure, the drive will not receive power and won't start up. In most cases, this won't cause a true system fault because the USB unit was designed to be plugged and unplugged from the unit, but the system may block if a read or write operation was taking place when the fault occurred.

NOTE: Some USB ports do not supply enough power to properly operate a port powered USB drive. In such cases, many external drive housings will give the appearance that the unit is properly powered up when it isn't. An external drive like this will likely need an additional power source, or it may come with a secondary USB cable the plugs into the external drive's housing to provide additional power using another USB port. See your owners many and the appropriate technical specifications for details.

If the external drive is not powered by the USB port but powered by its own supply (as shown in the diagram) in most cases any faults in the supply lines, intermittent or complete, will likely have no effect since the supply line traces likely aren't used.

Resolution	Replace the logic board
Scannerz Test Results	For intermittent data lines, Scannerz will display test results with scatter if there are intermittent generic faults in the data lines. The drive won't be seen by the system or Scannerz if the problem is a complete generic failure. For port powered USB drives, if the fault is a complete generic failure, the drive won't be seen or powered, but if the failure is intermittent, the drive will likely come online and off line erratically trigger a flood of Scannerz errors when it goes offline.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

USB I/O Cable

Failures in the USB I/O cable running between the logic board and the External USB drive housing

The I/O cable will carry the data lines and the supply and ground leads. If the cable has intermittent generic faults in any of its data lines, ***Scannerz*** will identify this as scatter, with erratic test results that are inconsistent from test to test exhibiting both errors and irregularities. Data transferred between the system and the drives may be corrupt periodically when in use. If one or more of the data lines has a complete failure (break) the drive typically won't be seen by the system.

If the supply or ground wires in the cable are experiencing intermittent generic failures, a port powered unit will typically come on line and drop off line in an erratic manner. If the power lines are intermittent, the system may indicate that the drive has been ejected. If the failure is complete (a break) then a self powered unit will not power on at all. Externally powered units like that shown in the figure will likely be unaffected by any power line faults in the cable. If the unit is using two USB cables to derive port power, it's possible that one could be faulty and the other would not, leaving the user with the impression that the drive was up and running when in fact it isn't.

Resolution	Replace the defective USB cable(s) with a good one(s).
Scannerz Test Results	Scannerz will display test results with scatter if there are intermittent generic faults in the data lines. Scannerz and the system will not see the drive if it has complete generic faults in the data lines. For port powered USB drives, if the fault is a complete generic failure, the drive won't be seen or powered, but if the failure is intermittent, the drive will likely come online and off line erratically trigger a flood of Scannerz errors when it goes offline.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

External Drive Unit

Power Adapter and Electrical Source

The unit shown in the diagram is externally powered with the cable or wires shown as simply being fed into the power adapter via a connector. The function of the power adapter will vary considerably from unit to unit. If the supply wires/cables are from an AC outlet, the power adapter will be a full supply regulator. It it's being fed from a power cube, the function of the power adapter will likely be greatly reduced. It the unit is port powered (self powered) then the feeds into the power adapter would be from the 5V supply leads in the USB cable. The purpose of the power adapter is to supply and distribute the appropriate levels of electricity to the USB interface adapter circuit as well as the hard drive.

The power adapter itself is typically no more prone to failure than any other electronic circuit. The most common source of failure comes from the power supply cable not being properly plugged into the unit or being knocked loose accidentally. Another common cause of failure exists when the power line cable plugged into the power adapter is put under strain and develops intermittent or complete losses of electrical contact (generic failures) because some of the wires inside the cable break. In the case of a break that maintains intermittent contact, the drive will come on line and drop out erratically. In the case of a complete break with no electrical contact, the drive will not power on at all. Intermittent failures might actually be more damaging than a complete break because as the drive comes on and off line sporadically it can create indexing problems in the drive because the the power losses might occur during a read or write operation.

Power adapter circuitry itself can be subject to generic faults (bad solder joints, cracked traces, etc) exhibiting either intermittent electrical contact or complete loss of electrical contact (failure) or component failure. The end result is essentially identical to what was described in the preceding paragraph - the unit will come on line and drop out erratically for intermittent generic faults, or it will drop out completely if the fault is complete. It should be noted that in *most* cases, the power adapter and the USB interface adapter circuit are usually on one circuit board.

Resolution	Ensure the unit is properly plugged in and receiving power. Ensure the supply cable (for externally powered units) is not dysfunctional. If the internal supply is defective, it will either need repair or the drive should be transferred to another external unit.
Scannerz Test Results	If the drive drops out while Scannerz is performing a test, it will likely generate so many errors that Scannerz internal error limit will trigger and issue a dialog indicating that the error limit had been exceeded.
Status of Hard Drive	Likely alright unless the cause of the power supply failure was caused by an electrical transient, in which case it might be damaged as well. In any case, users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

USB Interface Adapter Circuit and Hard Drive Cables/Connections
The USB interface adapter serves the purpose of receiving data in USB format, reformatting it to a format suitable for the hard drive, sending the data and commands to the drive, receiving data from the drive, and then reformatting that data into USB format to be sent back to the hosting logic board. The USB interface adapter can have problems associated with its connector to the USB cable, its connector to the hard drive, generic faults on the circuit card or connectors that may be intermittent or complete failures, and component burn out.

The most common problems with a USB external unit associated with the interface adapter circuit occur when the cable isn't plugged in fully or the cable was bumped and came partially out. In most cases this will yield either intermittent electrical contact, which would yield scatter when testing the drive using ***Scannerz***, or a complete loss of electrical contact causing the drive to drop out. Damage to the pins on both the connectors feeding the USB connector should be checked for damage and contamination.

Connections between the hard drive and the USB interface adapter circuit may have generic failures yielding intermittent contact or complete loss of electrical contact. In the case of intermittent contact, scan results using ***Scannerz*** will yield scatter, and complete loss of electrical contact will cause the drive to be non-existent to the system. In the diagram, we illustrate both the paths for data and power between the circuit card(s) and the hard drive as being connected via cable(s), but in some small units, the drive will plug directly into the circuit cards and there will be no cables present. This type of setup is particularly prone to generic failures because it's fairly easy to use too much force inserting the drive into the onboard connectors - solder joints can crack or break, and traces can crack.

The USB interface adapter card itself can suffer from generic faults, either with an intermittent nature or complete loss of electrical contact (failure.) If the problems are intermittent, it can cause the data sent to the hosting unit to be corrupt during a read operation, and likewise write corrupted data to a hard drive during a write operation. The interface is typically "dumb" - it's not supposed to analyze data from the drive, its function is typically just translation from drive to USB and vice versa. A generic fault with intermittent characteristics will show up in ***Scannerz*** with test results exhibiting scatter.

If the USB interface adapter circuit has burned out components, the drive typically won't be seen by the system. If a component in this circuit is destroyed, it's often due to a transient electrical surge.

Resolution	Ensure the cables are properly plugged in and that the connector ends aren't damaged or contaminated. If the USB I/O cable is faulty, replace it. If the interface card is defective, it will either need repair or the drive should be transferred to another external housing.
Scannerz Test Results	For intermittent generic faults, Scannerz test results will produce scatter. For complete generic faults or component burn out, the drive will likely not be seen by the system even thought there may be nothing wrong with it.
Status of Hard Drive	Likely all right unless the interface card was damaged due to an electrical transient, in which case the drive will need to be evaluated for functionality as well. If the drive's problems are caused by intermittent generic faults, the user should be wary of possible data corruption.

The Hard Drive

Drive controller and connectors

The drive controller on the hard drive can fail or appear to fail if the actual connectors that connect it to the data and supply cables are suffering from generic failures in the solder joints or traces yielding intermittent or a complete loss of electrical contact. If the contact is intermittent on the data lines, it will typically show up on ***Scannerz*** tests with scatter, or unrepeatable test results that show both errors and irregularities. If the electrical contact in the data lines is completely lost, the drive will not be seen by the system. If the power connections are intermittent, the drive will likely come on line and drop off line in a random manner. If the power connections have completely failed, the drive will never power up.

If the drive controller circuitry itself is suffering from generic failures related to traces and solder joints on the circuit card, the drive will likely not be seen by the system. Additionally, it may display erratic behavior, such as periodic and repetitive clicking sounds that seem to appear without any reason.

The drive controller, like any other electronic component, can have components

that malfunction. This is often due to electrical transients, but it can also be simply a component on the board has failed. The result is typically that the drive will no longer be seen.

Resolution	Replace the hard drive or replace the controller board
Scannerz Test Results	If the drive is accessible and appears working, Scannerz would yield test results with a high degree of scatter
Status of Hard Drive	Needs replacement or controller board replacement

Controller Interface

The controller interface connects the drive controller on the "outside world" to the internal chamber of the drive and makes connections to the actuator, heads, and spindle motor. Generic complete failures of any of these lines will cause the drive to stop working. Generic intermittent failures associated with any of these lines will cause the unit to operate in an incredibly unstable manner. If a component on the controller interface is blown, the drive won't be seen at all. In a nutshell, if there's anything wrong with this unit, whether the failure is intermittent or complete, the drive won't function.

Resolution	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Spindle Motor and Actuator

The spindle motor and the actuator not only face the possibility of having intermittent and complete generic faults, they can mechanically wear out and fail. When either of these fail or start to fail, it's often accompanied with loud and often unusual noises, which are obvious to most people.

Resolution	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Head and Platters

Last but certainly not least is one of the most common problems, the loss of data sectors on the hard drive. This problem can often be remedied without opening the unit up. If this occurs, ***Scannerz*** will report irregularities and/or errors without any scatter - they will be repeatable from test to test. The symptoms will be abnormally long times loading programs, sometime accompanied by a dialog stating a file can't be opened, and the "spinning beach ball." This can often be corrected by reformatting the drive with the option to zero all bytes selected (see chapter 5.)

Resolution	Repair the hard drive if possible
Scannerz Test Results	Scannerz tests will show no scatter, and be repeatable from test to test.
Status of Hard Drive	If the damage is minor, this can be fixed by forcing the drive to remap the bad sectors to spare sectors. If the damage is severe, it may be unrepairable and the drive may need to be replaced.

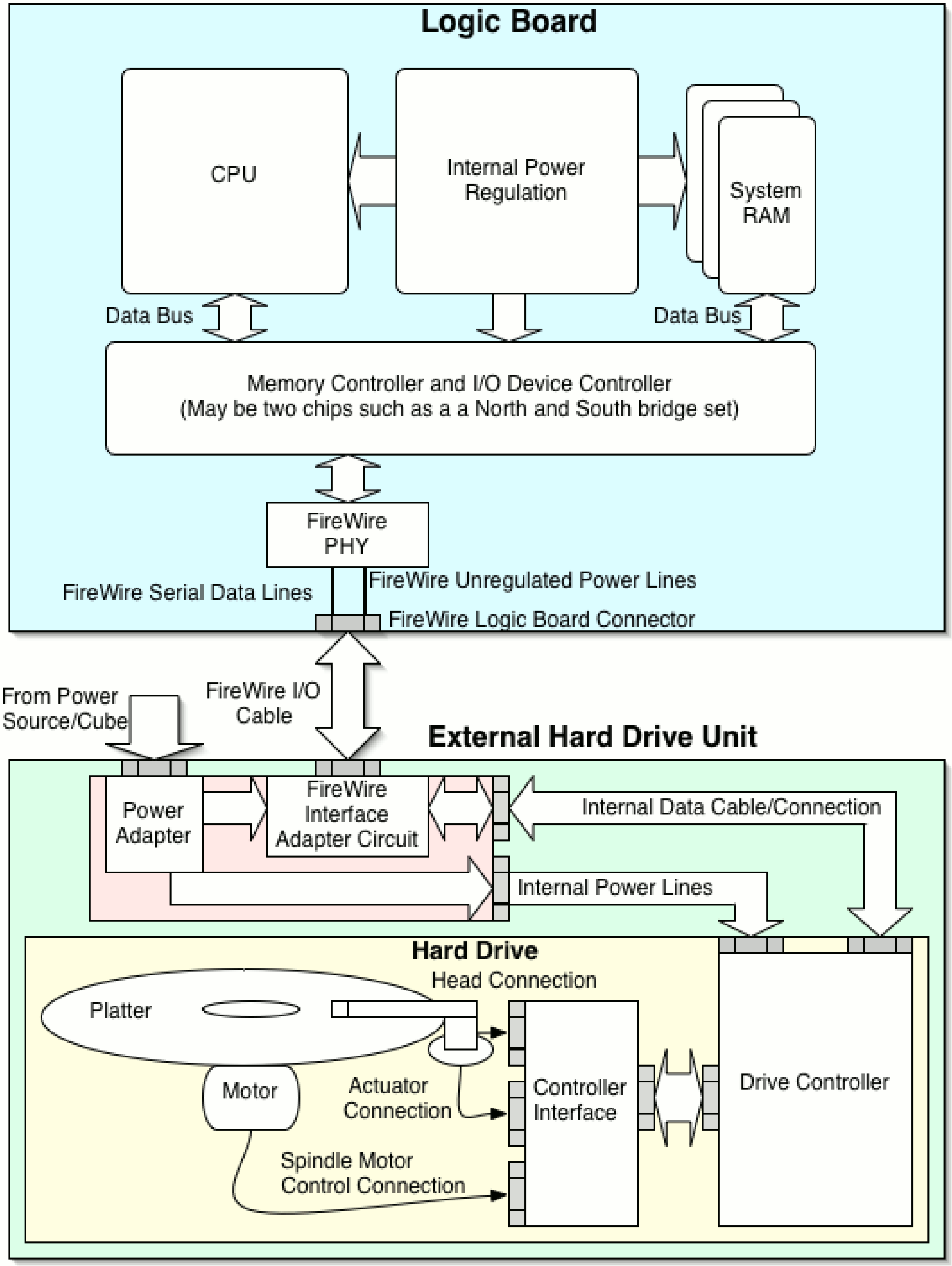

Figure 2-7
An External FireWire Drive Connected to a Logic Board

Possible Problems with a FireWire External Drive

Reference Diagram: 2-7

Logic Board

Data paths between CPU, I/O Controller, RAM, and Power traces:
If generic failures exist in any of these lines they will not likely show up or give the appearance of being drive related. If the type of failure is complete, for example, if a solder joint has separated and isn't making any contact with its counterpart, the system likely won't boot or start. If the failure is intermittent, such as a cracked trace that allows contact between both sides of the crack to be erratic, every time the crack separates enough to make electrical contact fail, the system will likely fault or lock up. If any of these components is damaged, the system will likely not boot.

Resolution	Replace the logic board
Scannerz Test Results	Irrelevant in this case - this is a system failure
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

Data path between the I/O controller and the FireWire PHY chip
If intermittent generic failures exist in these data lines, ***Scannerz*** will produce test results with considerable scatter and be inconsistent from test to test. During normal operation, the data read and written between the drive and host may be corrupt while in use. If complete generic failures exist, the drive will not be seen, nor will any other drive plugged into the unit.

Resolution	Replace the logic board
Scannerz Test Results	Considerable scatter is likely if intermittent generic faults are present. If the generic fault is complete the drive won't be seen by the system or Scannerz.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

FireWire PHY chip
Aside from the failures described above, the FireWire PHY output stages may blow. In this case, most diagnostic software won't recognize the fault unless it does end to end testing, however nothing plugged into the unit will ever be

seen by the unit. If this chip is completely blown, diagnostic software may or may not report the fault, and they may simply report that the FireWire port isn't present. If the FireWire drive is port powered, the drive may still appear to power up but remain invisible to the system.

Resolution	Replace the logic board
Scannerz Test Results	Scannerz and the OS likely won't see the FireWire drive because the output stage of the PHY chip is blown
Status of Hard Drive	Likely alright, but users should be wary of corrupt data

Logic board traces between the FireWire PHY chip and the FireWire Connector

If the data traces between the PHY chip and the FireWire connector have intermittent generic failures, **Scannerz** will identify this as scatter, with periodic irregularities and errors that are not repeatable from test to test. If the data lines have a complete generic failure, the drive will not be seen.

If the external drive is powered by the FireWire port and the supply traces have intermittent generic faults, the drive will likely come on line and drop off line, seemingly in a random error. The system may generate a message indicating the drive was improperly ejected. If these lines have a complete generic failure, the drive will not receive power and won't start up. In most cases, this won't cause a true system fault because the FireWire unit was designed to be plugged and unplugged from the unit, but the system may block if a read or write operation was taking place when the fault occurred.

If the external drive is not powered by the FireWire port but powered by its own supply (as shown in the diagram) in most cases any faults in the supply lines, intermittent or complete, will likely have no effect since the supply line traces likely aren't used. Four pin FireWire connectors do not have connections to any supply lines.

Resolution	Replace the logic board
Scannerz Test Results	For intermittent data lines, Scannerz will display test results with scatter if there are intermittent generic faults in the data lines. The drive won't be seen by the system or Scannerz if the problem is a complete generic failure. For port powered FireWire drives, if the fault is a complete generic failure, the drive won't be seen or powered, but if the failure is intermittent, the drive will likely come online and off line erratically trigger a flood of Scannerz errors when it goes offline.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

FireWire I/O Cable

Failures in the FireWire I/O cable running between the logic board and the external FireWire drive housing
The I/O cable will carry both pairs of data lines and the supply and ground leads. If the cable has intermittent generic faults in any of its data lines, ***Scannerz*** will identify this as scatter, with erratic test results that are inconsistent from test to test exhibiting both errors and irregularities. Data transferred between the system and the drives may be corrupt periodically when in use. If one or more of the data lines has a complete failure (break) the drive typically won't be seen by the system.

If the supply or ground wires in the cable are experiencing intermittent generic failures, a port powered unit will typically come on line and drop off line in an erratic manner, and in this case the operating system will likely indicate the drive was ejected improperly. If the failure is complete (a break) then a self powered unit will not power on at all. Externally powered units like that shown in the figure will likely be unaffected by any of these faults.

Resolution	Replace the defective FireWire cable with a good one.
Scannerz Test Results	Scannerz will display test results with scatter if there are intermittent generic faults in the data lines. Scannerz and the system will not see the drive if it has complete generic faults in the data lines.For port powered FireWire drives, if the fault is a complete generic failure, the drive won't be seen or powered, but if the failure is intermittent, the drive will likely come online and off line erratically triggering a flood of Scannerz errors when it goes offline.
Status of Hard Drive	Likely alright, but users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

External Drive Unit

Power Adapter and Electrical Source

The unit shown in the diagram is externally powered with the cable or wires shown as simply being fed into the power adapter via a connector. The function of the power adapter will vary considerably from unit to unit. If the supply wires/cables are from an AC outlet, the power adapter will be a full supply regulator. It it's being fed from a power cube, the function of the power adapter will likely be greatly reduced. It the unit is port powered (self powered) then the feeds into the power adapter would be from the unregulated supply leads coming in from the FireWire I/O cable. The purpose of the power adapter is to supply the appropriate levels of electricity to the FireWIre interface adapter circuit as well as the hard drive.

The power adapter itself is typically no more prone to failure than any other electronic circuit. The most common source of failure comes from the power supply cable not being properly plugged into the unit or being knocked loose accidentally. Another common cause of failure exists when the power line cable plugged into the power adapter is put under strain and develops intermittent or complete losses of electrical contact (generic failures) because some of the wires inside the cable break. In the case of a break that maintains intermittent contact, the drive will come on line and drop out erratically and the operating system may indicate the drive was ejected improperly. In the case of a complete break with no electrical contact, the drive will not power on at all.

Intermittent failures might actually be more damaging than a complete break because as the drive comes on and off line sporadically it can create indexing problems in the drive because the the power losses might occur during a read or write operation.

Power adapter circuitry itself can be subject to generic faults (bad solder joints, cracked traces, etc) exhibiting either intermittent electrical contact or complete loss of electrical contact (failure) or component failure. The end result is essentially identical to what was described in the preceding paragraph - the unit will come on line and drop out erratically for intermittent generic faults, or it will drop out completely if the fault is complete. It should be noted that in *most* cases, the power adapter and the FireWire interface adapter circuit are usually on one circuit board.

Resolution	Ensure the unit is properly plugged in and receiving power. Ensure the supply cable (for externally powered units) is not dysfunctional. If the internal supply is defective, it will either need repair or the drive should be transferred to another external unit.
Scannerz Test Results	If the drive drops out while Scannerz is performing a test, it will likely generate so many errors that Scannerz internal error limit will trigger and issue a dialog indicating that the error limit had been exceeded.
Status of Hard Drive	Likely alright unless the cause of the power supply failure was caused by an electrical transient, in which case it might be damaged as well. In any case, users should be wary of corrupt data. If the hard drive is experiencing intermittent power faults, index corruption of the drive is a possibility.

FireWire Interface Adapter Circuit and Hard Drive Connections
The FireWire interface adapter serves the purpose of receiving data in FireWire format, reformatting it to a format suitable for the hard drive, sending the data and commands to the drive, receiving data from the drive, and then reformatting that data into FireWire format to be sent back to the hosting logic board. The FireWire interface adapter can have problems associated with its connector to the FireWire cable, its connector to the hard drive, generic faults on the circuit card or connectors that may be intermittent or complete failures, and component burn out.

The most common problems with a FireWire external unit associated with the interface adapter circuit occur when the cable isn't plugged in fully or the cable was bumped and came partially out. In most cases this will yield either intermittent electrical contact, which would yield scatter when testing the drive using ***Scannerz***, or a complete loss of electrical contact causing the drive to drop out. Damage to the pins on both the connectors feeding the FireWire connector should be checked for damage and contamination.

Connections between the hard drive and the FireWire interface adapter circuit may have generic failures yielding intermittent contact or complete loss of electrical contact. In the case of intermittent contact, scan results using ***Scannerz*** will yield scatter, and complete loss of electrical contact will cause the drive to be non-existent to the system. In the diagram, we illustrate both the paths for data and power between the circuit card(s) and the hard drive as being connected via cable(s), but in some small units, the drive will plug directly into the circuit cards and there will be no cables present. This type of setup is particularly prone to generic failures because it's fairly easy to use too much force inserting the drive into the onboard connectors - solder joints can crack or break, and traces can crack.

The FireWire interface adapter card itself can suffer from generic faults, either with an intermittent nature or complete loss of electrical contact (failure.) If the problems are intermittent, it can cause the data sent to the hosting unit to be corrupt during a read operation, and likewise write corrupted data to a hard drive during a write operation. The interface is typically "dumb" - it's not supposed to analyze data from the drive, its function is typically just translation from drive to FireWire and vice versa. A generic fault with intermittent characteristics will typically show up in ***Scannerz*** with test results exhibiting scatter.

If the FireWire interface adapter circuit has burned out components, the drive typically won't be seen by the system. If a component in this circuit is destroyed, it's often due to a transient electrical surge.

Resolution	Ensure the cables are properly plugged in and that the connector ends aren't damaged or contaminated. If the FireWire I/O cable is faulty, replace it. If the interface card is defective, it will either need repair or the drive should be transferred to another external housing.
Scannerz Test Results	For intermittent generic faults, Scannerz test results will produce scatter. For complete generic faults, the drive will likely not be seen by the system even thought there may be nothing wrong with it.
Status of Hard Drive	Likely all right unless the interface card was damaged due to an electrical transient, in which case the drive will need to be evaluated for functionality as well. If the drive's problems are caused by intermittent generic faults, the user should be wary of possible data corruption.

The Hard Drive

Drive controller and connectors

The drive controller on the hard drive can fail or appear to fail if the actual connectors that connect it to the I/O and supply cables are suffering from generic failures in the solder joints or traces yielding intermittent or a complete loss of electrical contact. If the contact is intermittent on the data lines, it will typically show up on ***Scannerz*** tests with scatter, or unrepeatable test results that show both errors and irregularities. If the electrical contact in the data lines is completely lost, the drive will not be seen by the system. If the power connections are intermittent, the drive will likely come on line and drop off line in a random manner, and likely lock up the system. If the power connections have completely failed, the drive will never power up.

If the drive controller circuitry itself is suffering from generic failures related to traces and solder joints on the circuit card, the drive will likely not be seen by the system. Additionally, it may display erratic behavior, such as periodic and repetitive clicking sounds that seem to appear without any reason.

The drive controller, like any other electronic component, can have components that malfunction. This is often due to electrical transients, but it can also be simply a component on the board has failed. The result is typically that the drive will no longer be seen.

Resolution	Replace the hard drive or replace the controller board
Scannerz Test Results	If the drive is accessible and appears working, Scannerz would yield test results with a high degree of scatter.
Status of Hard Drive	Needs replacement or controller board replacement

Controller Interface

The controller interface connects the drive controller on the "outside world" to the internal chamber of the drive and makes connections to the actuator, heads, and spindle motor. Generic complete failures of any of these lines will cause the drive to stop working. Generic intermittent failures associated with any of these lines will cause the unit to operate in an incredibly unstable manner. If a component on the controller interface is blown, the drive won't be seen at all. In a nutshell, if there's anything wrong with this unit, whether the failure is intermittent or complete, the drive won't function.

Resolution	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Spindle Motor and Actuator

The spindle motor and the actuator not only face the possibility of having intermittent and complete generic faults, they can mechanically wear out and fail. When either of these fail or start to fail, it's often accompanied with loud and often unusual noises, which are obvious to most people.

Resolution	Replace the hard drive
Scannerz Test Results	If the drive was still functioning and able to be subjected to a test, tests will yield a high degree of scatter with abnormally high error and irregularity counts. Some irregularities may be as long as 50 or more seconds. It's abnormal for a drive to be operational with these problems.
Status of Hard Drive	The drive is essentially either unusable or rapidly approaching that state. The drive will need to be replaced.

Head and Platters

Last but certainly not least is one of the most common problems, the loss of data sectors on the hard drive. This problem can often be remedied without opening the unit up. If this occurs, ***Scannerz*** will report irregularities and/or errors without any scatter - they will be repeatable from test to test. The symptoms will be abnormally long times loading programs, sometime accompanied by a dialog stating a file can't be opened, and the "spinning beach ball." This can often be corrected by reformatting the drive with the option to zero all bytes selected (see chapter 4.)

Resolution	Repair the hard drive if possible
Scannerz Test Results	Scannerz tests will show no scatter, and be repeatable from test to test.
Status of Hard Drive	If the damage is minor, this can be fixed by forcing the drive to remap the bad sectors to spare sectors. If the damage is severe, it may be unrepairable and the drive may need to be replaced.

Software and Other Problems

Most people start believing they're having hard drive problems when, on Mac OS X systems, they start receiving the notorious “spinning beach ball.” The “spinning beach ball,” as illustrated in figure 2-8 indicates that the system is essentially completely tied up and attempting to process *something* – it's the *something* that's the problem. It's perfectly normal for this to occur once in a while, especially if an application is launching, but it is not normal for it to appear frequently and last for tens of seconds at time.

Figure 2-8
A so-called “spinning beach ball” indicates that the CPUs are locked up doing processing. In this case, a deliberate I/O channel failure was induced during an iCal session so we could take this picture.

This can occur when a drive error occurs because the CPU blocks on the I/O channel as it tries to read a defective sector on a drive. If the read succeeds, and it often will, the “beach ball” will go away and normal processing will resume. However, any time an attempt is made to read that sector, the same thing will happen every time. If the file is something that's accessed frequently, such as a cache file, it will happen very frequently. In most cases, as time progresses the file will likely become unreadable and an error will show up indicating that the file can't be read.

Problems like this, however, are not limited to the hard drive. As we stated throughout this chapter, any of the generic type failures we identified earlier can occur to any component on the system. The “beach ball syndrome” can also be a signature of intermittent contact between cracked solder joints or traces anywhere on the system. Inadequate memory can cause the problem because the CPU is continually swapping information from RAM to memory as it tries to multitask the OS and the running applications. Similar problems can occur if the drive is low on free space.

Finally, there are problems created by software itself. These can be caused by new OS releases, applications with bugs, applications that attempt to exploit specific hardware that may or may not be present, and ant-virus software.

New OS releases are often buggy because end users use their systems in manners, or with applications, that the OS maker didn't consider or didn't test. If you have a system that's working fine one day, then you install a new update or perhaps a completely new OS and the system seems to be malfunctioning, the odds are that the OS is problematic, not the hardware. Yes, it's possible that the hardware may have simultaneously developed a problem the very instance you installed the new OS or upgrade....it's just not very likely.

Applications with bugs can cause problems, and two more common problems are thread deadlocking and resource over consumption. Deadlocking occurs when two or more threads simultaneously contend for a resource (such as a file on a drive) and the developer fails to synchronize the threads. This type of problem usually causes partial lock up, meaning the OS may appear partially functional, and the only way to resolve the problem is typically via a forced shutdown. Resource over consumption is just what it says – a developer erroneously assumes that, at the instance his application starts, if there are so many blocks of free memory available, then they all belong to his application, which then proceeds to use everything it possibly can leaving nothing free for any other applications. The end result in this case is a memory shortage accompanied with continual swapping between memory and the hard drive.

Finally, antivirus software can be very problematic, particularly if it's not updated frequently. We've seen cases of some antivirus software doing such a good job of locking systems up that people have unwittingly gone out, replaced the hard drive, re-installed the backup, only to find the exact same problem there again. If you use antivirus software, keep it up to date, and if a problem that seems drive related occurs, terminate the antivirus program, at least temporarily, to ensure that the software isn't the cause of the problems.

S.M.A.R.T. Software

Before proceeding, we should say a word about S.M.A.R.T., which stands for self monitoring, analysis, and reporting technology. This technology is installed, to some degree, on many, if not all contemporary hard drives. On Mac systems, S.M.A.R.T. status is monitored only for internal drives. Some external drives or RAID subsystems may have built in features accessible via drivers that can report the S.M.A.R.T. status of an external drive. The only reporting that Mac OS X through 10.7 reports on internal hard drives is an imminent failure status. ***Scannerz*** monitors this as well during tests and will halt a test immediately if a failure of this nature is detected.

More extensive S.M.A.R.T. monitoring software is available freely or commercially on the web, and it can provide a user with a fair amount of information on the status of their drive. As a reporting technology, there is generally nothing wrong with it, and if the “imminent failure” status ever shows up, either in Mac OS X or when using ***Scannerz***, it should be taken seriously. We've never seen a drive that's received the “imminent failure” warning last any longer than two hours after receiving the warning. On the other hand, we've seen drives with a fair amount of damage to the platters from a head crash be erased with zeroing and last for several years, even though S.M.A.R.T. was reporting extensive damage. It will be up to the user to decide how much value there is in this technology.

Chapter 3

Troubleshooting Hard Drive Problems

Overview

In this chapter we will tell you how to troubleshoot problems associated with your hard drive and its supporting hardware. All examples in this section will be using Mac OS X, version 10.6 (Snow Leopard) and we will be using our product, ***Scannerz for Mac OS X*** to provide all example data. Any actual work done on the drive will be done using ***Disk Utility***, which comes with each version of Mac OS X.

Many of the problems we'll be evaluating require that whatever drive scanning tool you use, it needs to be capable of detecting not only errors, but irregularities as well. ***Scannerz*** is, to the best of our knowledge, the only commercially available tool available for Mac OS X that's capable of detecting both errors and irregularities. You'll find out why the difference is so important when trying to analyze a hard drive problem in the next few sections.

Tools Needed for Testing

To analyze hard drive problems, you will, at a minimum need a hard drive scanning tool, such as ***Scannerz for Mac OS X*** for Apple Macintosh systems, or if you're using another operating system, a comparable product. ***Scannerz*** has the following features that will allow you to diagnose problems on your Mac more easily:

- ***Full Drive Tests with Profiling. Scannerz*** can run a full scan on an entire drive, allow the user to stop a scan on a drive and resume it at another time, and compare the newest test data with previous tests to see if degradation is occurring. The ability to start and stop a scan is extremely useful for users with large drives since they don't have to lock their system up for hours on end doing a test.

- ***Cursory Scan Capability. Scannerz*** allows a user to perform limited scans over specific regions of the drive, thus being able to verify errors without needing to re-test an entire drive.

- ***Ability to Detect Irregularities.*** Irregularity detection is important in isolating problems properly. To the best of our knowledge, ***Scannerz*** is the only tool currently commercially available on the market for Mac OS X based systems with this capability.

- ***Performs both Surface and Seek Scans.*** Surface scans can detect head and platter problems, seek scans can assist in detecting potential mechanical failures.

More information on ***Scannerz for Mac OS X*** may be obtained on our web site at:

http://www.scsc-online.com

Users with other operating systems other than Mac OS X will have to find a tool with similar capabilities.

Depending on how extensively you wish to evaluate your problems, the following items will likely be useful, and in some cases, needed:

- **Another bootable drive.** To evaluate more complex problems, particularly those that may indicate there may be a problem with the logic board or the drive under evaluation is not seen by the system, another bootable drive (or USB Flash drive for Mac Intel systems) will be needed. If you're evaluating an internal drive, then the bootable drive should be an external drive using a USB, FireWire, or Thunderbolt port. If the problem is limited to an external drive, then using the internal drive should suffice. The idea is to be able to monitor activity on two different data paths (see figures 2-2 and 2-3), and possibly give a stable boot environment on an otherwise unstable environment. Mac users with PowerPC based systems are limited to FireWire as a bootable, external drive. Diagnostic software, such as ***Scannerz*** should be installed on the bootable hard drive. *If the bootable drive is external and it's a USB drive, it should be plugged directly into the computer, not through a USB hub. If it's a FireWire or Thunderbolt drive, it should not be daisy-chained through other connections.* The drive needs to be plugged directly into a port originating from the logic board.

- **A backup of your system.** This is something everyone should have anyway. Backups may be used by cloning your drive with drive cloning software, by using Apple's *Time Machine®*, or really, any other reliable backup software. In the event the drive turns out to be unrepairable, you will need this. However, make sure the data on the backup drive is reliable and hasn't been corrupted by the drive being evaluated.

- **Install media or access to install media.** This may be needed to re-install the operating system if needed. Because Apple has recently switched to network updates of the OS, this may not likely be on actual media, but an image that's downloaded onto the hard drive and then installed. In the latter case, there are numerous web sites that provide instructions for creating a DVD or USB Flash based installer, with the USB option limited to Intel based Macs only.

Backups and Backup Integrity

If a hard drive problem is suspected, the first thing that should be done, prior to anything else is ***verify that the backups you have are up to date and not corrupt.*** If you have a system or drive that has real problems, even if they're not drive related, it's possible that the data being written to your drive is not reliable. If the backup utility you use to make backups can verify file integrity, we suggest you do this before proceeding. There are too many applications available on the market for us to provide much detail on this topic in this document. In our opinion, a good backup utility should use multilevel incremental backups, with the ability to restore a specific backup level that may occur before a drive or system started producing erroneous data.

It is also a good idea to keep at least one critical version of backed up software off site. Cases have existed in the past where the unexpected has happened. For example, if your house burns down or you have a backup drive and system plugged into a power outlet that gets subjected to a severe (and we do mean *severe*) transient, all data could be lost. Storing a backup drive that's physically small in size and subjected to weekly or monthly backups in a safe deposit box is not that irrational if the data is truly critical. A possible solution is online backups, but security problems should be considered. These are topics that you need to evaluate yourself.

The Testing Process

In the last chapter under the section ***Problems and Symptoms by Configuration Type*** we outlined, for each configuration covered, a fairly detailed overview of all of the types of problems that can go wrong with a hard drive. If you review the summary tables for each component evaluated in that section, many of them report that the hard drive being tested is actually likely alright because the problem, although appearing to be drive related, actually isn't.

In this document, we divide troubleshooting into basic and advanced. To perform basic troubleshooting, all that will be needed is scanning software, such as ***Scannerz for Mac OS X*** (for Macintosh systems) or a comparable product if you're using a PC. For advanced troubleshooting, additional items, such as cables, internal and external bootable drives, as well as tools may be needed. Advanced troubleshooting will often require unit disassembly.

Barring cases where the drive is making excessive noise or isn't seen by the system, the testing process, in general terms, is as follows:

1. **Run a surface and seek scan on your entire drive.**
2. **Evaluate test the data.**
3. **Re-scan the drive in cursory mode, if needed.**
4. **Isolate and correct the problem.**

Specific details will be provided in each of the remaining sections as needed.

Basic Troubleshooting

This section will cover basic troubleshooting of a hard drive and its supporting components. None of the tests or procedures in this section will require opening the unit up or doing any advanced hardware diagnostics. However, in some cases, particularly when the nature of the problem is erratic and seems random, you will be forwarded to the ***Advanced Troubleshooting*** section. *Advanced troubleshooting will frequently require additional equipment, such as replacement drives and cables, and may require opening the unit being evaluated up. Review the **Requirements** section of **Advanced Troubleshooting** before attempting any steps in that section.*

Basic troubleshooting will cover the following topics:

- **Excessive drive noise.** This occurs when the drive itself is making considerable and/or abnormal noises.

- **Catastrophic failure.** This occurs when the drive, internal or external, isn't recognized by the system at all. This may not be as “catastrophic” as it sounds!

- **System slowdown.** This occurs when the user is using the system and it experiences periodic and very long delays loading programs or accessing data files, sometimes accompanied by read/write errors. This is one of the typical signs of a drive that has surface damage and is fairly common.

- **System lockup.** This occurs when the user is using the system and it either becomes partially or fully locked up. This may occur during booting, it may occur during the loading of a program, or it may appear to be random.

- **System crash.** This occurs when the user is using the system and a message comes up indicating that the system has crashed and needs to be rebooted.

- **External drive problems.** External drives can often easily have their problems identified without much work at all. Cheap and poorly constructed USB hubs can often lead a user to believe their system is in imminent danger, when in fact it's a failure of a poorly built hub. Cables can come loose or suffer from connector contamination, or perhaps the power supply is faulty. System firmware settings have also been known to be buggy, making a once available port act like it's fallen of the face of the Earth.

Excessive Drive Noise

Excessive drive noise is almost always a sign of imminent drive failure *if it's truly coming from the drive*. Unfortunately, other problems, such as loose mounting hardware, shielding making contact with the drive case, or failed drive mounts can also cause excessive noise that delude a user into thinking a problem exists when there may not be one. *If the drive has suddenly started making excessive noises and it's no longer visible to the system, in our opinion you should assume the drive has failed and needs replacement.* The rest of this section is for dealing with problems that are occurring on a drive that is (or appears to be) functional.

There are a number of web sites available that have libraries of sounds associated not only with drives in general, but in some cases specific drives. If you 're suffering from a noisy drive, it's well worth your while to see if any of the sounds you're receiving exhibit similar if not identical sounds to those found on some of these audio files. Some noises will clearly not be vibration related, such as repetitive clicking. Most drives that are making noises associated with a component that's in the process of failing will also fail ***Scannerz*** tests.

We classify noises emanating or related to the hard drive as follows:

- **Hardware induced.** Hard drive noises may be transferred to other system elements if the hard drive mounts are loose or defective, or the drive is making direct contact with other items, such as shielding. The only way to investigate this is to open the unit housing the drive, whether it be a computer or an external drive housing and verify such a problem doesn't exist, and correct it as needed.

- **Electro/mechanical failure.** Noises in this category are typically catastrophic failures that have occurred or are in the process of occurring. The noises are typically related to failed bearings, motors, actuators, and heads inside the hard drive. Noises can include extremely loud clicking which may or may not be repetitive in nature, grinding sounds, squealing sounds, and loud periods of vibration. It should be noted that when performing tests on a drive, if a bad sector is discovered, as the system tries to work with the drive it may in some cases produce periods of what seem like louder than normal noises, but in many cases the noises are generally limited to that single region of the drive.

- **Software/Firmware errors.** Although very rare, there have been cases where a manufacturer has released a drive with bad coding in the drives firmware. The result has typically been the data is either corrupted or in some extreme cases, the drive controller actually inflicts damage to the drive itself. We recommend doing a web based search for problems with your unit to see if such problems exist. Most drives with this type of problem become dysfunctional rather quickly.

- **Power Problems.** If the drive isn't receiving power continuously due to a faulty cable or supply, it can make noises and appear/disappear from availability in an almost random manner. This isn't really a drive noise problem, it's an electrical problem that's causing the drive to come on line and drop back off line, usually in a random manner. If the drive is an external unit, verify that all the data and power cables (if applicable) going to the unit are secure and verify that the unit is actually receiving consistent power. Most external units have some sort of indicator, such as an LED or light to show the drive is powered. You may need to refer to our section on advanced troubleshooting for more guidance.

In our opinion, the best way to evaluate this problem is as follows:

1. Ensure that you have ***reliable*** backups of all critical data.

2. Evaluate samples of drive noises from web sites that contain libraries of drive noises and their associated failures. If the noise can't be replicated and you suspect it may be vibration or mounting hardware related proceed to step 3. If the noises indicate that the drive is likely failing and you're confident of that, your troubleshooting is done – *replace the drive*.

3. In the case of external drives, ensure that the unit is receiving power and

remains running. Most external drive units have lights on them that indicate that they're receiving power. You may wish to go to the section ***External drive problems*** in ***Basic Troubleshooting*** before proceeding.

4. If the drive is functioning properly, or appears to be functioning properly, run a complete set of tests on it. If you're using ***Scannerz***, use normal mode with probing disabled.

    - If the drive passes these tests, the only solution is to open the unit in question up and try to find the source of the noise. In our experience, the most common cause of noise in this case is loose EMI shielding making contact with the surface of the drive housing. If you have an unused FireWire or USB enclosure available, you could place the drive in it and see if the noises persist. If it does, we would recommend replacing the drive.

    - If the drive fails the tests, even if the tests don't show any scatter, we would recommend replacing the drive.

There is no advanced troubleshooting associated with this problem. If the drive is genuinely making abnormal and loud noises, it's likely failing and needs to be replaced. If the noise is internally generated by contact with other components, or failed/missing mounts, the only solution is to open the unit up and find the source of the problem and correct it.

Catastrophic Failure

We use the term catastrophic failure to indicate that a drive, whether internal or external, isn't seen when the system is started, *and is not making abnormal noises*. This applies only in cases where the drive is consistently not visible, not cases where the drive appears one minute and the next minute it appears to be gone (see our section on system lockups for details.) If the drive isn't visible and it's making excessive noises, see the preceding section.

If the drive in question is a boot drive, you will likely see one of the following:

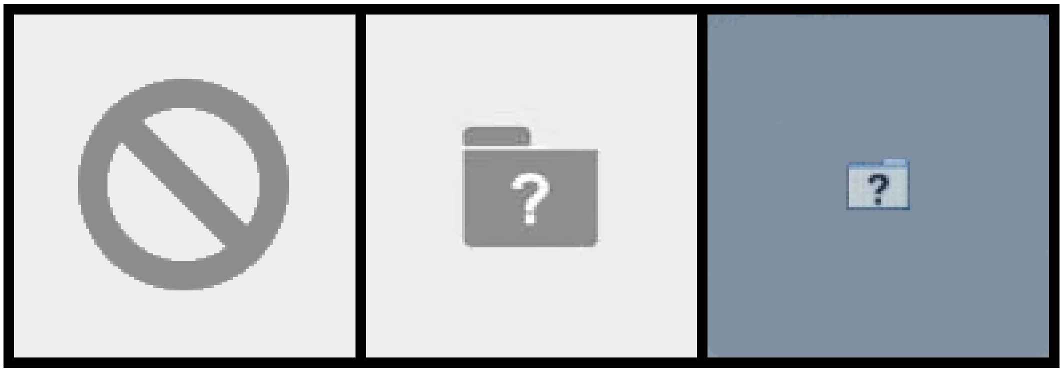

Figure 3-1
This figure shows three different types of indicators that may show up on your system if the boot drive fails or isn't seen by the system.

In figure 3-1, the leftmost image in the diagram is a “prohibited” sign. This can occur when the OS isn't recognized, the OS is seen as the wrong type (such as an Intel only operating system being used with a PowerPC system), or the OS simply sees the drive as inaccessible. The center and right most images in the figure occur when the drive isn't seen as bootable at all. The center image occurs on newer systems, while that on the far right is seen on older PowerPC based systems.

It should be noted that if you're using both an internal and external drive and they both have bootable partitions, if the primary boot drive won't boot, the system may select the other bootable drive and boot it without necessarily providing any indication to the user (the folder with a question mark may flash slightly.)

Before preceding with any further tests, try the following resets based on the type of system you're using:

- Reset the PRAM/NVRAM settings using the instructions in Apple Document HT1379 (do a web search for the string “HT1379” and you should easily find it). PRAM/NVRAM contains information telling the CPU which device to boot from. If this information becomes corrupted your CPU may not have any idea which drive to use as a boot drive, and thus may present the user with one of the images in figure 3-1. The possibility of this being the solution to your problem is quite real if the drive is (or was) in good working order.

Documentation note: We use the combined term PRAM/NVRAM because on some systems resetting PRAM also resets NVRAM.

- For Intel systems, attempt resetting the System Management Controller (SMC) as described in Apple Document HT3964. This might be helpful if the problem is sleep related, but don't be surprised if it doesn't work. Be sure to read the warnings about what parameters it changes that may need to be reset if this is done.
- For PowerPC based systems a Power Management Unit (PMU) or Systems Management Unit (SMU) reset may be of help. This will also likely reset the NVRAM. There is not a single document to cover all of the PowerPC based units, so if you're unit is not in the following table, you may have to search Apple's tech support site to obtain it. It should be noted that as PowerPC based systems evolved, Apple transitioned from PMU to SMU. When Intel models replaced the PowerPC, it became SMC (see above). When searching for any of the following documentation, make sure it applies to the model that you are using. The documentation should easily be located on the web by entering the reference document number into the search engine of your browser.

System Type	Apple Reference Document Number
PowerPC Based Mac Mini	HT2183
PowerBook G4 and iBook	HT1431
iMac G5	HT1767
iMac G4	HT1712
PowerMac G3, G4, G5	HT1939
eMac	See Users Manual
Xserve G5	TA27193

Table 3-1
PMU/SMU reference documents for PowerPC based systems.

Attempt the PRAM/NVRAM reset procedure first. If the drive is now visible and appears to be working properly, you may be done. However some systems have small, typically coin sized batteries installed on the logic board that may need replacement. If you power your system down, and the drive is once again not visible or it's not retaining information such as the time and date, it's most likely that this battery needs to be replaced. If the drive disappears after powering it off and then restarting it and another reset clears it up, the backup battery is the likely culprit.

If the PRAM/NVRAM reset doesn't work, try the SMC/PMU/SMU resets previously described. As above, if this clears the problem up then you're likely done.

If none of this worked, boot off the installation media and bring up ***Disk Utility*** and verify the following:

- **Is the drive seen at all with *Disk Utility*, and is it using it's assigned name?** If the drive is not seen at all by ***Disk Utility*** proceed to the section in this chapter titled ***Drive Not Seen by System*** in the ***Advanced Troubleshooting*** section of this document.

  If the drive shows up using a drive identifier (/dev/disk0s1 or disk0s1, for example) instead of its assigned name (Mac HD, for example), then the OS is essentially seeing this as an unformatted drive, or a drive whose format it doesn't understand. If you work in an environment where someone may work on your system without your knowledge, verify that they didn't replace the drive without your knowledge and forgot to install the OS and restore a backup (it happens!) If this is not the case, proceed to the next item in this list.

- **Is the drive properly partitioned?** Click on the drive holding the volume, then from ***Disk Utility's*** menu, select *File*, then select *Get Info* to obtain the *Partition Map Scheme.* A PowerPC based system cannot understand the GUID scheme used by an Intel based Mac. An Intel based Mac can read a file system from a PowerPC system, which uses an Apple Partition Map, but if the boot up code is PowerPC only, the Intel unit will never be able to read it. If this is your problem, you likely need to reformat the drive to the appropriate format before it's useable. If this isn't the problem, then continue.

- **Are the volumes on the drive seen?** If the volume shows up use ***Disk***

Utility to verify the disk. If it can't be verified, attempt to repair it with ***Disk Utility.*** In some cases, particularly where bad sectors may be present in the early regions of the drive, the indexing may be destroyed, and ***Disk Utility*** may convert this to a read only drive, which will allow you to recover what is possible to recover. If this occurs, after getting what you can off the drive, proceed to chapter 4. If the repair succeeds, the drive may be usable again and you may be done. If the volumes are not seen, you may need to proceed to ***Drive Not Seen by System*** in the ***Advanced Troubleshooting*** section of this document, but only after going through the remainder of items in this list.

- **Is the drive reporting the correct file system type and format?** Verify that the format is appropriate for your system. Although Mac's can typically read and write to a large number of drive formats, if the volume is in a non-native format, you will likely need to do some research regarding problems using non-native formats. Many people have had problems with drives formatted in NTSF.
- **Is the drive reflecting the appropriate amount of space used?** If the drive is seen and it has the correct name, verify that the space used and the size of the drive are correct. If your drive, which was once reasonably full now reports that it has nearly 100% of its space available, it's likely been erased or reformatted. If you're working in an environment where someone could gain access to your system without your knowledge, it's possible that drive may have been erased or reformatted. Although viruses on Mac's are rare, they aren't in PCs, and in our opinion it's only a matter of time before they become more prevalent on Mac's. A favorite “trick” of virus makers is to wipe hard drives. Another problem can be a “rogue program,” which is a program with bugs that create low level errors in the disk structure (among other things) and end up destroying partition and/or index information.
- **If it's an external drive, are all of its cables properly plugged in?** This is another mistake that can happen more often than people realize. Accidentally bumping an I/O or power cable can cause it to fail to make proper contact yielding intermittent or no contact. If you have access to another cable or cables for the unit, try swapping them out. Additionally, try using different I/O ports. If it's a USB unit plugged into a hub, take the hub out and plug the drive directly into the system.

- **Is the drive mountable?** Most drives when added to a Mac OS X system mount and become visible to the system. If the volume label is grayed out, it isn't mounted. Attempt to mount the drive. If it succeeds, and becomes useable, this is likely some type of configuration error. If it fails stating that the drive needs to be verified, attempt to verify it. If it succeeds, this is likely a configuration error, but the drive should be useable. If it fails, it will likely instruct you to repair the drive. You can attempt to repair it, but it might end up making the drive a read only drive with limited access and a lot of missing files. This can be caused by “rogue programs” as mentioned before, or it can indicate the presence of bad sectors in some of the regions of the drive that contain indexing information.

One of the biggest problems that can often happen is accidental erasure, reformatting, or repartitioning of the hard drive. If verifying and checking all of the items we've listed above has not yielded positive results, proceed to ***Drive Not Seen by System*** in the ***Advanced Troubleshooting*** section of this document. In many cases, there may be nothing wrong with the drive itself, but errors of some sort have occurred either by end user mistakes or application errors.

System Slowdown

System slowdowns can be caused by many things, including hard drive problems. The vast majority of system slowdowns are not drive, or even hardware related. The telltale sign of the delays being caused by the hard drive are as follows:

- System delay, often accompanied by the “spinning beach ball” when loading an application or certain applications
- The system returns reporting it couldn't read or open a file
- During certain, specific operations, the drive makes repetitive but light clicking sounds as it tries and tries to re-read a defective sector.

To evaluate this problem from a hard drive standpoint, and barring cases where the drive is making excessive noise or isn't seen by the system, the testing process is as follows:

1. **Run a surface and seek scan on your entire drive.** If you're using ***Scannerz***, do this in normal mode with probing disabled. If an excessive number of errors or irregularities appear, you can probably stop the test prematurely if you want to get right into troubleshooting. We would consider any more than three errors or ten irregularities per every ten gigabytes of a drive to be excessive. Excessive irregularities during a seek scan test are often the precursor of a drive about to begin catastrophic mechanical failure, but they may appear on very old (pre 2003) drives because they're response times are often slow.

2. **Evaluate test the data.** You'll be looking for the presence of both errors and irregularities. If you're using ***Scannerz***, the error and irregularity counts will be shown on the user interface, and if the values are zero for both, then reviewing the log files may not be needed, however the entire drive should be tested to make sure this is the case. If the test data doesn't indicate any problems but you feel there are problems of some sort, you may want to review the information on software problems a little bit later in this section. If test data indicates that there are no known problems and you're satisfied with that, then you're done.

3. **Re-scan the drive in cursory mode, if needed.** In the event errors and/or irregularities have been detected, what needs to be determined in a re-scan is whether or not the problems are repeatable. If the results are repeatable, the drive has likely experienced a hopefully minor and recoverable head crash. If results are not repeatable, it indicates the problems need more in-depth troubleshooting. ***Scannerz*** cursory mode allows you to re-scan areas with errors and irregularities without needing to re-scan the entire drive. If your drive scanning tool doesn't have this feature, you'll likely need to re-perform another set of complete tests on the entire drive or volume.

4. **Isolate and correct the problem.** If the test results had repeatable surface scan errors and/or irregularities, move on to the section in Chapter 4 titled ***Correcting Surface Scan Problems***. If the test results are not repeatable, review the remaining sections under ***Basic Troubleshooting*** and ***Advanced Troubleshooting***.

NOTE: Steps 1-3 will be used throughout this document.

If you're using ***Scannerz***, it can occasionally be subjected to a false irregularity.

A false irregularity exists when the system, for some reason, seized control of everything and interrupted all operations to handle an event, which can throw ***Scannerz*** event timing off. An example of this might be that the system kicks on the fans and temporarily monitors them because the CPUs are running too hot. Such irregularities are rare, but possible, and should never last any more than between one or two seconds, and usually much less. An irregularity lasting two or more seconds should be considered as a sign of problems. False irregularities are most likely to exist on older systems built before 2006.

Software problems can also generate false irregularities once in a while, but if they're happening frequently, it likely means there's either something wrong somewhere or the system is running drive intensive applications the user is unaware of. For this reason, ***Scannerz*** comes with the application ***FSE-Lite***, which can detect over zealous drive activity. ***Scannerz*** also comes with an upgrade to the more fully featured ***FSE***, which allows the user to monitor file system activity based on a number of different parameters.

This is not a document about software and application troubleshooting, so we're not going to spend a lot of time on software problems. Table 3-2 identifies some of the types of problems that may be software related. The term "Rogue application" generally describes an application that is running improperly, meaning it's either consuming too much memory or eating up drive space in an inordinate manner. Such an application might be something purchased, or it could even an operating system component.

The list in table 3-2 is by no means comprehensive. To isolate software problems, the tools ***FSE*** and ***FSE-Lite*** may be of help, along with the tool ***Activity Monitor***, which is included with the operating system. Used in conjunction with one another, ***FSE*** or ***FSE-Lite*** may allow the user to see which applications are modifying files and where the modifications are occurring, and ***Activity Monitor*** can identify, among other things, the CPU time, number of threads, and amount memory used by applications. ***FSE*** *is not intended to be used by novices and requires some degree of familiarity with the file* system. For more information on ***FSE*** and ***FSE-Lite***, visit our web site at:

http://www.scsc-online.com

Problem Description	Behavior if Fault Occurs During Boot	Behavior if Fault Occurs While in Use
Anti-virus software conflicts with applications	System may become very slow to boot or stop booting	Software may block or delay, scatter with irregularities but no errors (ever)
Spotlight indexing constantly intensive	May slow startup time	General system slow down, excessive times loading and running applications
Thread deadlock in faulty application	Not applicable unless application launched at boot	System becomes partially or completely unresponsive
User running out of free disk space from normal use	Very slow boot, not bootable in extreme cases	System will slow down excessively, possible lockup
User running out of memory from normal use	Usually not applicable unless the problematic applications launch at boot time	System slows down to a crawl, may lockup
Rogue or unknown application overly drive intensive	Usually not applicable unless problematic applications start at boot	Very slow response for all other applications running, scatter will occur during Scannerz surface scan test with irregularities but no errors. FSE-Lite may detect application name
Rogue or unknown application consuming too much memory	Usually not applicable unless problematic applications start at boot	As memory is consumed drive activity increases, lockup possible. FSE-Lite may detect application name as swapping becomes rampant
Rogue or unknown application consuming too much drive space	Usually not applicable unless problematic applications have used up entire drive	As drive space approaches limits, system gets slower eventually locking up. FSE-Lite may detect application name

Table 3-2
Software and Resource Problems

System Lockup

We define system lockup as being a partial or complete lock up of the system. A partial lockup occurs when an application or set of applications freeze, while other applications remain running and accessible. Complete lockup occurs when the system becomes completely unresponsive. Lockup, as we use it, does not refer to a system that locks up once and never restarts (which is likely a complete system failure) but rather a recurring problem.

There are a lot of possibilities that can cause partial or complete system lock out. We have identified what we, in our opinion, feel are the most likely causes of these problems *if they are related to internal and/or external hard drives*. These are identified in Table 3-3. Table 3-3 identifies the source of the problem, a description associated with it, and the typical behavior that occurs if this problem is present.

With respect to Table 3-3, please note the following:

1. The term "Raw hard drive" refers to an actual hard drive, and it could be in either an external housing or inside a computer. For example, if you opened up a laptop and removed the hard drive from the unit, you would be holding the "raw hard drive." Likewise, if you opened up an external drive housing and removed the hard drive inside it, you would once again be holding the "raw hard drive."
2. An asterisk (*) beside the *Source of Problem* entry indicates that ***Scannerz*** will likely detect this with test results containing scatter. See ***Errors, Irregularities, and Scatter*** in chapter 2 of this document to refresh your memory if needed
3. Virtually every entry describes an intermittent problem. If the failures were complete failures, the problem wouldn't be intermittent.
4. The term *External drive interface circuitry and cables* in the table is referring to the actual interface card, supply cards (if applicable) and cables connected to the actual hard drive inside an external enclosure.

Source of Problem	Problem Description	Behavior While in Use
Raw hard drive*	Intermittent faults associated with drive controller connectors, traces, cables, and solder joints	Periodic excessive delays, system lockup, drive may drop out, scatter in test results
Raw hard drive	Drive intermittently not receiving power	Drive will drop out, system lockup possible w/internal hard drives
Raw hard drive*	Boot region/indices corrupt	System may lock up during use, file loss, data corruption
Raw hard drive*	Minor head crash	Delays, file errors, I/O errors, very slow response, test scans provide repeatable results, no scatter
Raw hard drive*	Mechanically failing but not failed	Noise during use, delays, lockup, corrupt data, test scans may be consistent or inconsistent
Logic board*	Intermittent failures in data traces, connectors, solder	Intermittent delays, possible system lockups, test results display scatter
Logic board*	Intermittent faults in power traces, connections, solder	Intermittent delays, possible system lockups, test results display scatter
Logic board	Intermittent faults in power traces, connections, solder	Drive intermittently locks up, system may lockup
Logic board* (FireWire drives only)	FireWire port has intermittent faults in connectors, traces, or solder joints	Intermittent delays, possible system lockups, scatter in test results
Logic board* (USB drives only)	USB port has intermittent faults in connectors, traces, or solder joints	Intermittent delays, possible system lockups, scatter in test results
Logic board	Power supply has intermittent faults in connectors, traces, or solder joints	Intermittent system lock up or complete shut down

Table 3-3

Problems Associated with System Lockups
(continued on next page)

Source of Problem	Problem Description	Behavior While in Use
Internal cables/wiring*	Intermittent failures in data cable or connector ends	Intermittent delays, possible system lockups, drive may drop out, scatter in tests
Internal cables/wiring	Intermittent faults in power cables or connectors	Drive locks up, system may lockup completely, drive drops out
External drive I/O and power cables	Intermittent failures in data cable or connector ends	Intermittent delays, possible system lockups, scatter in test results
External drive I/O and power cables*	Data cable not properly plugged in allowing intermittent contact	Intermittent delays, possible system lockups, drive may drop out, scatter in tests
External drive I/O and power cables	Intermittent faults in power cables or connectors	System temporarily partially locks up, system typically states drive was improperly ejected
External drive I/O and power cables	Power supply cable not properly plugged in	Drive drops out, with possible partial lockup, system typically states drive was improperly ejected
External drive interface* circuitry and cables	Intermittent failures in interfaces, cables, and connections	Intermittent delays, possible system lockups, scatter in test results
External drive interface circuitry and cables	Intermittent faults in power cables or connectors	Drive locks up, system may lockup temporarily and eventually states drive was improperly ejected

Table 3-3 (cont.)
Problems Associated with System Lockups

Many of the items in table 3-3 will be covered in the ***Advanced Troubleshooting*** section of the manual, since isolating them will require unit disassembly. However there are many items that can be done by user. The following list is the procedure we recommend be followed to at least eliminate obvious problems.

1. **Remove all attached items, such as printers, external drives, USB hubs, etc. from the system.** If you are booting from an external drive, leave only that bootable external drive connected, and make sure it's connected directly to the computer. Plug any mice and keyboards directly into the computer. Use a system for a while in this configuration to see if the faults continue. If the faults continue, proceed to the next step. If the faults have stopped, systematically and slowly over time add all other items to the system until the faults start appearing again, allowing you to know what's causing the problems. If the problem is traced to another external hard drive, go to the ***External Drive Problems*** section in basic troubleshooting.
2. **With the system configured as above, perform a set of tests on the drive using steps 1-3 in the *System Slowdown* section of this manual.** If you have both an internal and external drive connected to the system, perform these procedures on both drives. Note the following:
   - If no irregularities or errors appear during any tests but the system continues to lockup, if the lockups are complete, the most likely cause is the logic board and/or power supply. If the lockups are partial and effect only certain applications, the most likely cause is corrupt software. We would recommend either attempting a clean install of the OS only (**NO** add-on applications) or if you have a FireWire port and access to another system with a compatible operating system, boot from it and see if the lockups continue. This could still be hardware related because some applications may access certain hardware functions that others don't, allowing the faults to present themselves to the user rarely.
   - If errors and/or irregularities appear, and they are consistent and repeatable from test to test (no scatter), the drive responsible has bad sectors. The lockup, whether partial or complete, is likely either reading bad data from corrupted sectors or failing to read them at all. Proceed to chapter 4 to see how to attempt to remap the bad sectors.
   - If the unit has considerable scatter (inconsistent test results from test to test with a high number of irregularities and/or errors) it indicates intermittent contact is being made in the data lines somewhere. If you have both internal and external drives connected to the system, and the results indicating scatter are limited to the external drive only,

proceed to the section of ***Basic Troubleshooting*** titled ***External Drive Problems***. If you have both internal and external drives connected to the system, and the test results with scatter are limited to the internal hard drive, proceed to the ***Advanced Troubleshooting*** section and review the section named ***Internal Drive with Intermittent Failure*** (this will require opening the unit up). If both the internal and external drives are showing errors and/or irregularities with scatter, this is likely a logic board problem and it will likely need to be replaced. As a last ditch effort, you could try reviewing the section titled ***External Drive Problems*** in ***Basic Troubleshooting***, and ***Internal Drive with Intermittent Failure*** and ***External Drive with Intermittent Failure*** under the ***Advanced Troubleshooting*** section of this document.

Aside from "common sense" items, such as verifying that cables are plugged in properly, batteries are charged, etc., this is about all the testing that can be done without getting into more detailed troubleshooting that will require disassembly.

System Crash

A system crash occurs when the system runs into a problem so severe that it can no longer process data. This is very similar to the problems described earlier in the section titled ***System Lockup***, and in some cases, the causes may be similar if not identical. Figure 3-2 illustrates the typical message that will appear if a system crash occurs.

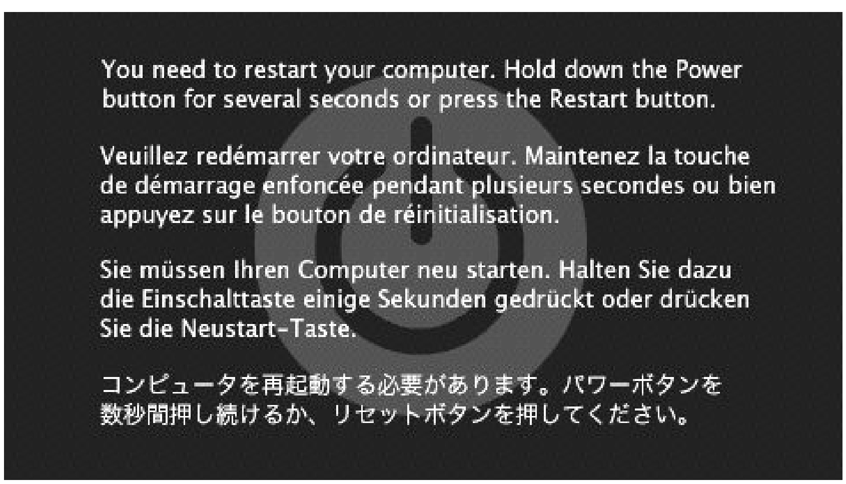

Figure 3-2
A System Crash Message

If a system crash occurs once in a rare while, such as a few times per year, it's likely a software bug, and hopefully nothing to worry about. If the crashes occur frequently, perhaps on a daily basis (or more often), then the problem definitely needs looking into.

Unfortunately, many system crashes are caused by true hardware failures, and going into their causes is beyond the scope of this document. What we will provide are procedures that you can follow that will allow you to determine whether or not the hard drive or related components is to blame or has anything to do with the faults.

Logic board related problems that have little or nothing to do with the drive can consist of the following:

- A true logic board failure
- Invalid, incompatible, corrupt, or poor quality RAM
- Improperly seated RAM
- Malfunctioning Airport card
- Poorly seated Airport card
- Poorly seated or improperly installed add-on cards (Mac Pro, Power Mac)
- Malfunctioning add-on cards (Mac Pro, Power Mac)
- In rare cases, some devices plugged into FireWire and USB ports, such as printers, scanners, or video cameras can cause this problem

In the list above, excluding the first item, many of these items can be checked by the user with little effort. ***Prior to proceeding with any drive tests, we strongly recommend checking and verifying as many of the items in the list above as possible. We would also recommend visiting Apple's support section on their web site.***

In our opinion, if the system crashes are drive related, they typically are caused by one of the following:

- **Bad boot code.** If the code the system reads from the drive to start the system is corrupt, a system crash will often occur every time the system is started. The corrupt files will likely be the kernel or other files loaded at startup. The system will *never* complete boot up, but in many cases, this can be repaired fairly easily. It may also be caused by bad sectors on the drive providing erroneous data to the system.

- **Bad application or library code.** This is really the exact same problem described above, but the error exists not in startup code, but in the application code or libraries it uses. If an application always causes a system crash every time it reaches a certain point or points during execution, then the application code is almost certainly the cause. If a class of applications that load a dynamic library all crash when the library is loaded from the drive, then this is a likely culprit, but it's also difficult to verify since dynamic libraries are frequently loaded by many applications at various times during their lives.
- **Intermittent generic failures in the data lines.** This problem can be caused by any of the items identified in table 3-3 in the section titled ***System Lockup*** of ***Basic Troubleshooting*** that have asterisks (*) beside the items identified in the *Source of Problem* column. The difference between this problem and the two mentioned directly above is that instead of being able to be consistently tied to an application or startup code being loaded, it will be totally random. Additionally, the problems more often than not will cause slow downs (see the ***System Slowdown*** section of ***Basic Troubleshooting***) and/or partial or complete system lockups. If the intermittent nature of the fault just happens at a given instance to allow data to be passed to the CPU with just the right amount of misinformation, instead of being a slow down or lockup, it generates a system crash.
- **Intermittent failures in the power lines.** This problem can be caused by any of the items identified in table 3-3 in the section titled ***System Lockup*** of ***Basic Troubleshooting*** that **DO NOT** have asterisks (*) beside the items identified in the *Source of Problem* column. In most cases, this will cause a complete system lockup, but in a rare while, it might cause a system crash as well. This is almost always a logic board problem, but it can sometimes be caused by a faulty power cable or connection.

If the problems you're having fit into any of the categories identified above, in our opinion, the best way to proceed is as follows (please read ***ALL*** instructions before proceeding):

- If your problem is similar to those described above in the **Bad boot code** or **Bad application or library code** sections, follow these steps. Both of these problems will be dealt with using the same techniques, since they're likely the same type of problem, just in different locations on the drive. To determine if the problem is drive related, do the following:

1. Disconnect all other devices from the system except those that are absolutely needed.
2. Boot from the install media. If the media boots, proceed to step 3. If the system crashes during this process, in our opinion, this is almost certainly a logic board fault. The reason we say this is that the optical drive and the hard drive both use different data paths out of the I/O controller, and if the fault is occurring when different data paths are used, it's almost certain that the logic board is the culprit. There's a remote (very, very remote) possibility that a shared cable on some models (such as iBooks) could simultaneously have intermittent faults, but it's extremely unlikely, so we won't even consider this here. If this check has failed, you could try some of the resets described previously in the ***Catastrophic Failure*** section, but chances are they won't work, and you should consider your troubleshooting complete (replace the logic board.)
3. If the install media boots, load ***Disk Utility*** and select the volume used when the problems occur. Select the *Verify Disk* option to verify the disk.

   If the *Verify Disk* option succeeds, proceed to step 5. If the *Verify Disk* option fails, it will either state that the drive cannot be repaired or that it needs repair. If it states the drive cannot be repaired, proceed to chapter 4 to reformat and zero the drive, which may or may not be succeed. If, after selecting the *Verify Disk* option, ***Disk Utility*** returns stating that the drive needs repair, select the *Repair Disk* option from ***Disk Utility*** and proceed to step 4.
4. If the *Repair Disk* option completes indicating that the drive was successfully repaired, proceed to step 5. If it fails and states the drive cannot be repaired, proceed to chapter 4 to attempt to reformat and zero the drive. If it states the drive can only be used as a read-only drive, attempt to recover as much as possible from the drive, and then proceed to chapter 4 to attempt to erase and zero the drive.

5. If the volume verifies properly, select the *Repair Disk Permissions* option. It is not uncommon for this to find errors and correct them. It also typically takes from 2-20 minutes, depending on the system and its speed. If this operation succeeds, proceed to step 6. If it returns stating that it couldn't repair permissions, it likely means that some operating system components are missing or were disposed of in the preceding steps due to corruption. If this occurs, proceed to chapter 4 to erase and zero the drive.
6. Exit the install media and select the drive that you've been working on in steps 1-5 above to be the bootable drive.
7. Reboot the system. Don't be terribly surprised if one of the images in figure 3-1 appears. If OS components on the drive were bad and the verification process marked them as garbage, they've been removed from the system. This would occur if the system wouldn't boot at all before this undertaking. If this has happened, proceed to chapter 4 to erase and zero the drive.

   If the system does boot, use it for a while to see if it's actually stable. If it is, the problem is fixed. If it isn't and the system is failing when certain applications were loaded, then they're probably corrupt and the OS should likely be re-installed. We would recommend proceeding to chapter 4 to erase and zero the drive.

   NOTE: If, during steps 3-5 above during verification or permissions checks on the drive, the system crashes again, it likely implies there's an intermittent generic failure somewhere in the system. The problem with an intermittent generic failure is that they are, as the name implies, intermittent and not necessarily easily reproduced. If this has happened, proceed to the ***Advanced Troubleshooting*** *s*ection and review the topics associated with intermittent failures (internal drive, external drive, and power supply.) If faults can't be traced to them, it's either the logic board or other peripherals (Airport, BlueTooth, RAM, keyboard, etc.) connected to the system.

- If the problems you're having fit into the **Intermittent generic failures in the data lines** category, the best thing to do is to attempt to run a surface scan (if the system stays up that long) by performing steps 1-3 in the previous section titled ***System Slowdowns***. If the data lines going to the drive are truly intermittent, then the test results will display scatter, and you should move to the ***Advanced Troubleshooting*** section and review the information on all types of intermittent failures. If the scan data has errors and/or irregularities that are repeatable, you should go to chapter 4 to review the section on reformatting and zeroing the drive.

- If the problems you're having fit into the **Intermittent failures in the power lines** category, about the only thing that can be done at the basic level is ensure that the power sources are plugged in properly, and the power sources are reliable, which can be tested by plugging your unit into another power outlet. Other than that, move to ***Advanced Troubleshooting*** and review the section titled ***Power Supply Problems***. This manual is about hard drive problems, not power supply problems, so that section is somewhat limited, but it may be of help.

External Drive Problems

The vast majority of external hard drive problems people encounter have nothing to do with the actual drive housed inside the external housing. When a problem occurs with an external hard drive, there are three general possible causes:

1. **The external hard drive is bad.** This could be the actual "raw" hard drive enclosed inside the unit, the interface and power circuitry connecting the drive inside the external enclosure to the outside world, or if it uses its own power supply, it might have failed
2. **The cables connecting the drive.** The cables can develop intermittent or complete generic faults, yielding intermittent contact in data/power lines or complete breaks, typically making the drive appear to the system as being unconnected.
3. **There may be a logic board fault.** Because the USB and FireWire ports connect to the outside world, they often get bumped, and the connections between the logic board and the connectors can crack or break. The end result is either intermittent contact yielding intermittent performance, or the drive simply isn't seen. FireWire ports can also be susceptible to an interface chip (PHY) blowing.

By far the easiest way to evaluate this problem is by swapping components. It does not require opening anything up and you may be able to isolate the problem quite quickly, but you may need to borrow some parts from others.

NOTE: If and external drive isn't working properly, don't assume the drive inside the unit is necessarily bad. The external unit should be opened up and the drive should be extracted and tested before assuming it's bad. There are a fair number of things that can go wrong with the supply and its connections inside the external drive housing without the drive being damaged. Throwing such a unit away might be a security risk since someone else may open the housing up, extract the drive, and have access to all the data on the drive.

The following list provides a number of checks that should be done before proceeding with any tests. This list covers every possible configuration we could think up for Mac's using standard configurations, and in some cases, some of these can't be done on some systems. Please go through the list and perform whatever procedures are applicable to your system. Here's the list:

- Make sure the data cables are securely plugged in and in working order. We recommend that you obtain some cables known to be in good working order and try them to see if the problems end. If they do, put your old cables back in and see if the problems resurface. If the problems resurface with the original cables back in place, your troubleshooting is done, with the solution being to replace the cables. This is a <u>*very*</u> common problem.
- If you're using a USB external drive that's “self powered” (port powered) verify that the drive is receiving adequate power. Some USB ports are low power and cannot provide enough power to actually run the drive, but often have a light that comes on making it *appear* that the drive is adequately powered when it isn't. Units like these often contain a split cable with 2 USB ports on one end with supply and data plugs on the other end.
- Ensure that the cable ends are not contaminated. Contamination might be anything from a spilled soda that worked it's way into the cable ends while it was sitting on a desk to a piece of lint inside the connector that it picked up in a computer case.

- Make sure the cable connector pins aren't damaged.
- Make sure the unit is receiving power continuously. It should come on and stay on. It should not come on, then go out, and possibly come on again. This would imply a fault in the power supply or the supply cables. If this is occurring with an external supply, swap the current supply with a replacement to see if the problems end. If they do, the problem is with the supply. If they don't the problem is somewhere in the external drive unit itself. One sure sign of this is that the system will issue a warning indicating the drive was improperly ejected.

  If the unit is port powered, it could be a problem with the cables or it could be a problem with the logic board that supplies the port with power. If you replace the I/O cables with cables known to be in good working order and the problem ends, the I/O cables were the problem and your troubleshooting is done. Likewise, if you replace your I/O cables with cables that are confirmed to be in good working order and the problem persists, then the problem is either in the logic board or the external drive's supply circuitry or connectors.
- If you're using a USB hub, remove the drive from the hub and see if it works without the hub in place. Low cost hubs are known to fail both electrically and because of poor workmanship which yields weak solder joints on the USB connectors which then crack at the solder joints connecting them to the hub.
- If the drive is USB and it isn't visible, try another port. This could be a software or hardware problem. You may be able to find information regarding software problems that disable USB ports for your system on the web.
- Try other ports on your system to see if the drive works. This applies to both FireWire and USB units. If the drive works fine on one port, but not another, then the problem is a logic board problem. Most Mac's have multiple USB ports so this shouldn't be a problem, but many have only one FireWire port, if any at all. Some early MacBook Air's have only a single USB port.
- Try to see if your unit is visible and working properly on another system. If it is, then there's likely nothing wrong with the drive or the cables, but there's a problem either with your logic board or the ports are being

disabled by software.

- Verify that the drive hasn't been accidentally reformatted, erased, or initialized using a format that the OS can't recognize.

If the drive isn't seen by the system, review the steps in the ***Basic Troubleshooting*** section titled ***Catastrophic Failure*** and implement them as needed. You may also need to attempt the procedures in the ***Advanced Troubleshooting*** section titled ***Drive Not Seen by System***.

If none of the checks above yield positive results and the drive is running and visible to the system, do the following:

1. Perform a surface scan on the drive in accordance with the section titled ***System Slowdown*** in the ***Basic Troubleshooting*** section of this document. Perform steps 1-3 of that test procedure.
2. If test data from the preceding step comes back without any errors or irregularities, the indications are that the drive is likely working fine. This could be a problem with software or possibly an index corruption problem. At the tail end of the section in ***Basic Troubleshooting*** titled ***System Slowdown*** there's a writeup on software problems and you might want to review it. You may also want to use ***Disk Utility*** to verify the drive. Although this problem isn't solved, it shouldn't be considered a hard drive problem, thus troubleshooting should be over as far as the hard drive goes.
3. If the test results indicate scatter, go to the ***Advanced Troubleshooting*** section titled ***External Drive with Intermittent Failure***.
4. If the test results show repeatable errors and irregularities (no scatter) back up and attempt to recover any files you can, then proceed to chapter 4 to reformat and zero the drive. In this case, the drive inside the external enclosure has bad sectors that will need to be remapped. You should consider the troubleshooting phase over, but if reformatting and zeroing the drive fails, the drive inside the external enclosure will need to be replaced.

Advanced Troubleshooting

If you're in this section of the document, you've been forwarded here from another, previous section. You typically shouldn't start here, you should start in the Basic Troubleshooting section, follow those steps first, and then move here as needed. Many of these steps require component disassembly and there's no need to do so if the problem could be more easily solved in previous sections.

Requirements

Advanced troubleshooting will, in many cases, require opening systems and components up to evaluate problems that are more difficult to isolate, and it will often require additional equipment. If you have little or no experience working on contemporary electronic circuits, in our opinion, you should only attempt the procedures in this section that do not require component disassembly. If you come across a section that requires disassembly, we recommend that you take whatever data you've gathered using this document to a qualified professional for further evaluation.

In order to use this section of the manual, you should have sufficient training, experience, or knowledge in the following:

- Electronic assembly, disassembly, and repair.
- Adequate safety training in dealing with electrical and electronic devices and be familiar with static discharge safety procedures.
- Familiarity with system utilities, such as ***Disk Utility*** and ***System Preferences.*** You should also have a copy of ***Scannerz for Mac OS X*** since that's what we'll be using for all testing.
- Know how to reconfigure a system and boot from alternate drives

NOTE: Any time any disassembly is required on a laptop computer, the battery and all power connections to it should be removed. *NEVER* perform disassembly or reassembly on a laptop system with the battery connected. On any units, such as desktop computers or external hard drives that are externally powered, the main power cord to the unit should be removed during disassembly and reassembly.

This section of the document further assumes that the reader will not need to be taught anything about specific system repair, replacement, and configuration. For example, if the instructions say "remove the hard drive from the unit under test and place it in the reference external enclosure," (defined later) this document assumes that the reader either has full knowledge how to do so, or knows where to obtain any needed instructions.

This is not a step-by-step guide for every specific Mac on the market. If you feel you're capable of these tasks, but perhaps not that familiar with Mac's per se, there are several web sites that allow not only step by step instructions regarding component replacement, but detailed videos as well.

For advanced troubleshooting, the following will be needed:

- **Tools**. If you're experienced with working on contemporary computer systems and you need to open up either your computer or an external drive housing, then you'll need a set of tools. Most Mac systems require the use of small and regular Philips head and Torx™ screwdrivers to open the unit up, and small flathead screwdrivers for carefully prying connectors off the logic board, if needed. Needle nose pliers will likely be an asset. Those considering doing repairs themselves should check out many of the numerous websites that contain more detailed information about performing actual repairs on a unit.

- **An external drive housing to put the drive under evaluation in.** If the drive or its associated system components during tests is showing erratic behavior inside either it's hosting computer or an external housing, putting the drive in an external housing known to be in good working order can be useful in isolating the problems. **NOTE**: The external drive should **<u>NOT</u>** be port powered, it should use its own power supply. An ideal candidate would have both USB and FireWire ports, but it <u>must, at a minimum</u>, have the corresponding type of interface that you expect to be working with. **This housing will be referred to in this section as the *<u>reference external enclosure</u>*.**

- **A bootable replacement drive for testing.** This "test drive" should have the same form factor and interface as the drive and system components being evaluated. This can be a good, but old drive, or perhaps a low cost drive that's large enough to hold the operating system and the drive scanning software, which typically means it needs to be 15GB at a minimum. Don't confuse this with an external bootable drive, this will be a “raw” hard drive and the *ONLY* thing installed on it should be the operating system and the drive scanning software. You will may need to swap this into and out of the unit during internal drive tests, or into and out of an external enclosure for external drive tests. The bootable drive can have the operating system installed using the reference external enclosure described above. PowerPC users will be limited to using FireWire devices, but those using Intel Mac's will be able to use USB, FireWire, or Thunderbolt (if available.) **This drive will be referred to in this section as the *reference hard drive.***

- **Cables**. If you suspect, after testing that the problems may be related to faulty cables, you will need to swap out, and probably replace the damaged cable if it's found defective. These can be any type of applicable cable, such as an IDE cable, SATA cable, USB cable, FireWire cable, power cables, etc. *Do not rush out and buy every cable that you suspect you might need until you confirm there is a reason to do so*.

Note that these items are things that may be needed. Don't rush out and buy a collection of items that you may not need, wait until you're confident you may actually need them.

Drive Not Seen by System

This section is a continuation of the section ***Catastrophic Failure*** in the ***Basic Troubleshooting*** section of this chapter. This may require using the reference external enclosure and the reference hard drive with the OS and drive scanning software installed on it. We will assume that the scanning software being used is ***Scannerz.***

Internal Hard Drive Not Seen

The following sections should identify the problem associated with an internal drive that is not visible to the system at all. This section assumes that the internal drive being evaluated is (or was) bootable with a full operating system installed on it.

The problems that will most likely cause this problem to exist are as follows:

- **Logic Board Problem.** These can include a number of problems, including a failed or failing I/O controller.
- **PRAM/NVRAM Problem.** If there's a problem with this, you may be able to isolate it, but it should be considered a logic board fault.
- **Hard Drive Has Faults on Platters in the Boot Sectors.** This will show up during a surface scan, which will be done from the external bootable drive. Another possibility is that critical regions of the drive were corrupted.
- **Hard Drive Failure.** The hard drive died.
- **Internal Drive Data Line Cut.** This could be caused by a bad drive cable or an actual complete generic failure in some of the data lines in the path from the I/O controller to the internal drive's cable connector on the logic board.
- **Internal Drive Supply Line Cut.** This could be a wire in one of the lines in the supply cable going to the drive from the logic board, a complete generic failure in one of the supply traces on the logic board, a fault in the power supply, or a bad cable or connection between the supply and the logic board.

Review the following procedures before attempting them. Follow the procedures in sequence and move on as directed based on the results you may obtain from a certain set of steps. Some of the procedures will instruct you to skip other procedures, so follow the instructions closely.

Logic Board Evaluation

To evaluate a logic board problem and a possible PRAM/NVRAM problem, proceed as follows:

1. **Boot from the reference external enclosure/hard drive.** Install the reference hard drive into the reference external enclosure, power it on, and attempt to boot the system. We're doing this to make sure the

system will boot at all. If it cannot boot off this external drive, put the install media in the optical drive and see if it can boot from it.

The internal drive, external drive, and the optical drive all use different data paths out of the I/O controller. If all three of these fail, in our opinion, it's most likely the logic board should be seen as failed and needs replacement. In all likelihood, your system may look like it's actually booting or going through proper startup sequences, but is never really successfully completing them. You should, in our opinion, consider the problem isolated, with the resolution being that the logic board needs replacement, and troubleshooting is complete.

If the system can boot off the external drive or install media, then it's best to evaluate a possible PRAM/NVRAM problem. Shut down the system and disconnect the external drive and any other bootable media connected to the system. Perform the following steps:

- Turn the power to the system on, even though you know it won't boot up.
- Leave the system on and idle for 5 minutes, even though it's not doing anything.
- After 5 minutes, quickly shutdown and restart the system and attempt another PRAM/NVRAM reset. The instructions for doing this are in the ***Basic Troubleshooting*** section under the ***Catastrophic Failure subsection***.

If the system comes up and the drive is visible, this implies that the support circuitry maintaining voltage to the memory used by PRAM/NVRAM is defective. If your system has a logic board backup battery (not to be confused with a laptop's main battery), then the battery or it's wiring may be bad. If it doesn't have a backup battery on the logic board, this should be considered a logic board fault. The drives are *probably* in good working order, however your logic board/backup battery needs work. The components needing work will need to be repaired or replaced, and there is no need to go any further troubleshooting this problem. This problem may require logic board replacement, but the system may be useable – starting it will just be an annoyance.

If the system does not come up with the internal drive visible, proceed to the next section *Surface Scan Evaluation*.

Surface Scan Evaluation

We will now attempt to determine if there are faults on the surface of the platter of the internal hard drive in the boot regions. To do this, perform the following steps:

1. **Re-connect the reference external enclosure/hard drive and restart the system.** Plug the reference external enclosure containing the reference hard drive back into the system, power it up (if needed) and restart the system.

2. **Start *Scannerz* from the reference external enclosure/hard drive.** If the internal drive is not visible to ***Scannerz***, skip the rest of the tests in this list and go on to the next section *Hard Drive Evaluation* to determine if the internal drive is even functioning. **NOTE**: The drive may show up but with an odd name or no name (but a drive ID) in ***Scannerz***.

   If the internal drive shows up in ***Scannerz*** list of available drives, do the following:

   a. Select the primary drive for the internal drive being test from ***Scannerz*** menu of available drives. It may not have any volumes showing up underneath it.

   b. Put ***Scannerz*** into cursory test mode to do a surface scan only by disabling the seek scan option.

   c. Disable the *Probe into sweep sections when an error is detected* option in the preferences settings.

   d. Perform a surface scan from 0-5 GB watching out for errors and irregularities. The data will be stored in ***Scannerz*** log files. If errors or irregularities show up, rescan the drive at least two more times to see if the results are repeatable.

   If, during the scan, ***Scannerz*** presents a dialog window indicating that S.M.A.R.T. status has failed, you should assume the drive has either failed completely or is in the process of failing. Because the drive failed to mount and it's in a failing state, it's highly unlikely that the drive can be recovered. ***Scannerz*** does not require that a drive be mounted to be scanned, just operational and visible as an unmounted drive. This drive will need to be replaced and the troubleshooting is complete.

If surface scan errors or very lengthy irregularities (greater than 1-2 seconds) appear and they are repeatable from test to test (no scatter,) it means the drive is visible but unmountable, likely due to damage in the initial regions of the drive. Proceed to chapter 4 to reformat and zero the drive, but don't be terribly surprised if the drive is totally unusable. Troubleshooting is most likely complete, and you need not do any more investigative work but you may need a new drive.

If surface scan errors or irregularities appear but they are not repeatable from test to test, the unit is likely suffering from generic intermittent failures, most likely in the data lines on the path between the I/O controller and the drive. Intermittent failures can cause corrupt data to overwrite regions of the drive making it appear invisible to the system. In this case, you should move to the section titled ***Internal Drive with Intermittent Failure*** in ***Advanced Troubleshooting.*** The drive will need reformatting and zeroing as well as described in chapter 4.

If the scans produce no errors or significant irregularities, we would recommend going to chapter 4 to re-format and zero the drive, but it may only be necessary to reformat and re-install the operating system. In this case, the most likely cause is that the boot code or structure of the drive was overwritten and/or corrupted by software, and is likely not a hardware problem. Your troubleshooting should be complete and you need go no further.

Hard Drive Evaluation

In this set of tests, we're going to determine if the hard drive is even working. To perform this test, you will need to remove the internal hard drive from the system and attempt to see if it's bootable inside the reference external enclosure used for testing. Perform the following steps in order:

1. **Remove the internal hard drive from the system.** Mark it if needed to uniquely identify it.
2. **Remove the reference hard drive from the reference external enclosure.** Take the reference hard drive out so we can put the drive from

the inside the system in it.

3. **Install the internal drive into the reference external enclosure.** Place the drive that was the internal drive into the reference external enclosure and connect it to the FireWire, USB, or Thunderbolt port on the system that you're using. This should be the only drive connected to the system. If possible, leave the cover off the external drive housing.

4. **Restart the system.** Holding down the *Alt* (*Option*) key on the keyboard, start the system while continuing to hold the *Alt* key down. If possible, see if the drive looks like it's active and actually starting. A menu of available boot drives should show up.

   If the drive does not show up at all, it's likely experienced a drive controller or power related failure, and will need to be replaced, thus completing this evaluation. Even if the drive sounds like it's powered up, if it still isn't seen by the system, it's likely the drive's controller has failed and the drive should be considered as failed. If this is the case, the troubleshooting is complete, and the drive should be replaced.

   If the drive is now visible as a bootable drive, boot from it and ensure that the drive truly is in good working order. It should be used for several days in this configuration to confirm this. If it isn't, replace the drive, but don't assume your work is done. You will need to proceed to *Data and Supply Line Evaluation* prior to replacing it.

Data and Supply Line Evaluation

In this section, we'll evaluate both the data and power supply lines to the internal drive. If you've gotten this far, you know that the drive is working, at least marginally, but it should still be a good candidate for testing the system. Do **NOT** use the reference hard drive for these steps because if there's some type of fault that can damage the drive, there's no need to risk damaging it for this test.

To perform this evaluation, do the following:

1. **Re-install the original hard drive into the system.** Take the original internal hard drive out of the reference external enclosure and re-install it back into the system. Plug in the existing data and power cables from the logic board into the drive (which may be integrated into a combined

cable.)

2. **Power on the system.** Pay attention to sounds originating from the drive to see if the drive actually powers on. The following possibilities will exist:
   - The drive doesn't start up at all.
   - The drive sounds like it's powered up, but it's still not seen by the system.
   - The drive is now, miraculously, working properly.

If the drive is now “miraculously, working properly” the cables to the drive either weren't connected to the unit properly, oxidation had built up on the connectors inserts and removing them and reinstalling them broke the oxidation, or there's potentially an intermittent generic failure.

An intermittent generic failure will resurface over time as either another intermittent or complete failure with the drive becoming “invisible” again, or the drive will be displaying erratic behavior. If this occurs, review the section titled ***Internal Drive with Intermittent Failure*** in ***Advanced Troubleshooting.*** Otherwise, you should consider the problem solved and your troubleshooting is done.

If the drive doesn't power on at all, the following possibilities exist:

- The power cable between the logic board and the drive needs to be replaced because there's a complete break (complete generic failure) in one of the lines. On many instances, the power and data lines are integrated into one cable.
- There's a complete break (complete generic failure) in one of the logic board traces feeding supply voltages to the internal drive.
- The supply itself is having problems. The supplies used by Mac's vary from system to system. Some are completely integrated onto the logic board, others have regulation and supply cards that plug directly into the system, and others have a completely separate supply system that connects to the logic board via cables. This document is about hard drives, not power supply troubleshooting, thus dealing with problems of this nature is beyond the scope of this document. We do, however, have a

section in ***Advanced Troubleshooting*** titled ***Power Supply Problems*** that may be of benefit.

How you wish to proceed with this problem is entirely up to you. If you don't have a set of replacement cables readily available like a repair shop might and you decide to replace the cables, you may very well find that after replacing them, the problem still exists. This implies the problem is logic board or supply related, and the logic board board will need to be replaced. If you replace the cables and the unit works, then the problem is solved. Either way, the problem has been isolated and at least the troubleshooting process is complete.

> **NOTE:** If your system is using drives that use multiple voltage lines, you can be deluded into believing the drive is actually fully active when it isn't. The only way to check this is by measuring the voltage output at the connectors with a voltmeter to ensure that all applicable supply lines are really active.

If you can confirm that the drive is fully powered (see the note above) then the data path is the likely culprit. The possibilities are as follows:

- The data cable connecting the drive to the logic board needs to be replaced because there's a complete break (complete generic failure) in one of the lines. Many units have data and power cables integrated into a single cable/connector combination.
- There's a complete break (complete generic failure) in one of the logic board traces feeding data or control signals to the internal drive.

This problem is similar to that described previously for power line problems. If you replace the data cables running between the drive and the logic board and the problem still exists, then the logic board is the problem. On the contrary, if you replace the cables and the problem is fixed, then you're good to go.

Troubleshooting this problem is now complete. If the end result is that there are faults associated with the power supply and/or its traces, or breaks in the data lines on the logic board, the odds are that the drive is still in good working order. The drive should be checked thoroughly first before using it again. Complete generic failures often start as intermittent generic failures that get worse in time, and in the intermittent state, corrupt data might have been written to the drive.

External Hard Drive Not Seen

In this section, we will try to isolate the cause of an external hard drive not being seen by the system. If you have not read the section ***External Drives*** under the ***Basic Troubleshooting***, please do so now before proceeding with any of these steps. We will assume that you have verified that the I/O cables and external unit's power supply (if applicable) are in proper working order. You may need to disassemble the external drive under evaluation in this section, and since there are so many units available on the market, if disassembly isn't obvious, you will need to obtain instructions for it.

Because we will be dealing specifically with USB and FireWire ports only, some topics will be specific to each type of interface, and others can be shared between them. This subsection may, however, be useful to anyone using external drives using Thunderbolt or eSata interfaces as well, they're just not specifically addressed. We assume that the external drive is at least giving the appearance of being active when plugged into it's port and powered on, that the system is bootable off the internal hard drive, and that the system will be booted off the internal hard drive for these tests.

The possible problems that could cause this condition are as follows:

Problems applicable to both USB and FireWire external units:

- **The hard drive failed.** This could be a controller failure, a burned out motor, or a power regulation problem inside the drive itself.
- **Bad sectors or file system.** The hard drive inside the external enclosure has bad sectors at the beginning of the drive or the file system has been corrupted.
- **Bad interface connections.** Connections on the interface board inside the external enclosure have failed or are disconnected
- **Bad supply connections.** Supply connections between the hard drive inside the external enclosure and the outside world have failed or are disconnected

- **Interface/Supply board malfunction.** The supply and/or interface card inside the external hard drive have failed.
- **Bad logic board ports.** Port(s) on the logic board are dysfunctional.
- **Logic board supply faults.** Supply lines, connections, or traces on the logic board are broken**.**
- **Logic board data line faults.** Data lines running between the I/O controller and the external ports on the logic board are broken.

Problems unique to USB external units:

- **The USB port has been disabled by software.** This can be caused by an add on application that wants to seize control of a port, or a bad system setting.

Problems unique to FireWire external units:

- **Bad PHY chip.** The FireWire PHY interface chip has blown output stages.
- **The FireWire interface port has been disabled by software.** This can be caused by an add on application that wants to seize control of a port, or a bad system setting (unlikely.)

In the following subsections, we will not treat each of the above explicitly, but rather combine them into several different groups. In our opinion, if someone finds that the problem with an external drive is related to the circuitry inside the external enclosure that “talks” to the drive, rather than spending possibly an incredible amount of time troubleshooting the circuitry, it's likely cheaper and easier for most people to just replace the enclosure with a new one. Likewise, if logic board faults are caused by breaks in the actual connections between the logic board and an I/O connector, it may be more worthwhile for the user to just live with the problem rather than replacing the entire logic board.

We will start off doing the evaluation by attempting to verify the easiest things first. The following instructions should be followed sequentially, and in some cases, the instructions may tell you to jump over other sections based on the results you obtain in a specific test. Review the instructions carefully before proceeding.

Logic Board Port Functionality

If the external unit is a USB drive, take another USB device, such as a mouse, keyboard, or USB flash drive and plug it into each and every USB port available on the system to verify that they all work. If one or more of them doesn't work, the most likely cause is a complete generic failure (break) in one of the solder joints or traces connected to the offending USB port. This is most often due to impact, however there are reported cases of the OS settings and some applications disabling the USB ports. Troubleshooting should be considered complete. You will need to determine if software is causing the problem, which is possible but somewhat rare. Damage to the USB ports due to impact is common.

If the external unit is a FireWire drive and you have more than one FireWire port, plug the external drive being evaluated into each and every FireWire port available to see if the unit will start up and be a recognized drive. If the drive is recognized and working properly in other ports then the likely culprit is either a complete generic fault (break) in one of the solder joints or traces connected to the offending FireWire port on the logic board, or the PHY interface chip has blown output stages. Troubleshooting should be considered complete. If it's critical that the port be available then the offending components should be replaced, but the system will likely function with the port in a damaged state.

If you have only one FireWire port on your system and the reference external enclosure used for testing that we described earlier in the ***Requirements*** section of ***Advanced Troubleshooting*** has a FireWire interface, use that with reference hard drive installed to see if it will start up. If it will, you will need to diagnose the actual external drive being evaluated in this test, and you should move immediately to the section below titled *Evaluate the External Hard Drive Enclosure*. If it doesn't then the port has likely suffered a bad PHY chip or a connector failure as previously described. Troubleshooting should be considered complete. If it's critical that the port be available then the offending components should be replaced, but the system will likely function with the port in a damaged state.

If the reference external enclosure/hard drive obtained for testing are USB-only, and the external drive being evaluated is a FireWire drive, the easiest way to test the external drive being evaluated is to plug it into a different computer that has a functioning FireWire port to see if the drive comes up. If it comes up on another system, the port or PHY chip on the logic board are bad. This would conclude troubleshooting with the solution being to either replace the logic board or live with the dysfunctional port.

Both the USB and FireWire ports are capable of supplying power to a so called “self powered” external drive. If the FireWire PHY output stages are blown or the data line connectors or traces on the logic board have failed due to impact, the FireWire drive may power up but still be invisible to the system since data can't be transferred between the FireWire drive and the CPU. Essentially the exact same thing can happen to a USB drive. If the USB drive is externally powered, it will power up, but not be seen (and neither will anything else using that port).

If the external drive is “self powered” and it isn't powering up, you should attempt to test it on another system to see if it will power up on that system. Aside from the possibility of physical damage to the connections between the logic board and the I/O connector to the external drive, another possibility is an actual break or fault in supply traces on the logic board, or a failure in one of the connections between the supply and the logic board. Unless there are other system problems, the most likely candidate would be a failed supply trace feeding one (or more) of the I/O ports, probably due to impact. If this proves to be the case, troubleshooting is complete, and you must either live with the system minus the defective port, or replace the logic board.

If the ports on the logic board, whether FireWire or USB are dysfunctional due to impact, in most cases it won't show up on diagnostic software because USB and FireWire ports were intended to be removable. Any of the breaks or failures we've described simply make the port appear to the system as if nothing is plugged into the unit. In the vast majority of cases, this has no impact on the system, it simply can't use those ports any more.

Some systems, such as Mac Pro's, Power Mac's, 15 and 17 inch PowerBook G4's, and 15 and 17 inch MacBook Pro's have an additional complications in the form of auxiliary I/O boards that are connected to the logic board via a cable. These little boards can experience every problem we've just described, but they can also suffer from a failure in the cable that connects the card to the logic board. The cables can suffer from having a break in one (or several) of the lines, the cable not being properly plugged in, or the cable has come off (unlikely.) In our opinion, the only way to really verify a fault with one of these cables is to ensure that it's properly connected, and if needed, replace it. If every port on these cards is dysfunctional then either the cable is bad, disconnected, or there's a fault in the logic board supply lines that provide power to the ports on these cards.

As a final check, install the reference hard drive into the reference external enclosure to be used for testing and boot off it (if possible) and retest any bad ports to see if they've come to life. As identified in the ***Requirements*** section of ***Advanced Troubleshooting***, this should have a “pristine” OS installed on it without any add-on applications. If the port needed to boot the external test drive is bad, then boot off install media in the optical drive and see if any of the ports have come to life. In either of these cases, if the ports are now visible, then the problem is due to software. Either OS components (unlikely) or add-on software are seizing ports for their own use. If this is the case, you will need to try and find out what software is causing the problem to exist.

If any of the logic board problems we've identified above are confirmed, the logic board will need to be replaced, or the unit can likely be used as is (just minus some ports). If the system is equipped with the auxiliary I/O ports, the cable and the board must be checked and/or replaced as needed. If the problems can be traced to software, the source of the software problems must be identified. If none of these has identified the problems with your system, proceed to the next section to actually evaluate the external drive itself, otherwise your troubleshooting is over, albeit likely with a problem that isn't fixed.

Evaluating the External Hard Drive for Bad Sectors or Corruption

If you've gotten this far, you've confirmed that the I/O ports on your system are working properly, and now it's time to actually troubleshoot the external hard drive being evaluated itself. Since there are far too many brands and variations of enclosures available on the market, the instructions provided will be general in nature. If you need instructions on disassembling the external hard drive, you can likely find them on the web or from the manufacturer. If your unit is still under warranty, you may want to return it to the vendor you purchased it from for servicing.

We will now attempt to determine if there are faults on the surface of the platter of the internal hard drive in the boot regions. To do this, perform the following steps:

1. **Re-connect the external hard drive and restart the system.** This is the external hard drive being evaluated, not the reference external enclosure with the reference hard drive.

2. **Start *Scannerz* from the internal boot drive.** If the external drive does not show up as being visible to ***Scannerz***, skip the rest of the tests in this list and go on to the next section *Hard Drive Evaluation* to determine if the hard drive inside the external unit under evaluation is even functioning. **NOTE**: The drive may show up but with an odd name or no name (but a drive ID) in ***Scannerz***.

   If the internal drive shows up in ***Scannerz*** list of available drives, do the following:

   a. Select the primary drive for the external drive being test from ***Scannerz*** menu of available drives. It may not have any volumes showing up underneath it.

   b. Put ***Scannerz*** into cursory test mode to do a surface scan only by disabling the seek scan option.

   c. Disable the *Probe into sweep sections when an error is detected* option in the preferences settings.

   d. Perform a surface scan from 0-5 GB watching out for errors and irregularities. The data will be stored in ***Scannerz*** log files. If errors or irregularities show up, rescan the drive at least two more times to see if the results are repeatable.

   If surface scan errors or very lengthy irregularities (greater than 1-2 seconds) appear and they are repeatable from test to test (no scatter,) it means the drive is visible but unmountable, likely due to damage in the initial regions of the drive. Proceed to chapter 4 to reformat and zero the drive, but don't be terribly surprised if the drive is totally unusable. Troubleshooting is most likely complete, but you may need to replace the drive contained in the external housing of your external drive, and it will need to be reformatted and zeroed.

If surface scan errors or irregularities appear but they are not repeatable from test to test, the unit is likely suffering from generic intermittent failures, most likely in the data lines on the path between the interface card inside the external hard drive enclosure and its drive. Intermittent failures can cause corrupt data to overwrite regions of the drive making it appear invisible to the system. In this case, you should move to the section titled ***External Drive with Intermittent Failure*** in ***Advanced Troubleshooting.*** The drive will need reformatting and zeroing as well as described in chapter 4.

If the scans produce no errors or significant irregularities, we would recommend going to chapter 4 to re-format and zero the drive, but it may only be necessary to reformat and reinstall the operating system. In this case, the most likely cause is that the boot code or structure of the drive was overwritten and/or corrupted by software, and is likely not a hardware problem. When your system starts it can't make sense of the drive, so it ignores it, but it should be visible under ***Disk Utility*** as an unmounted device. Your troubleshooting should be complete.

You might want to try running ***Disk Utility*** on the drive to verify, possibly run a drive repair, and repair the permissions on the drive to see if it can be made useable, but don't count on receiving positive results. If you have problems after doing the above, proceed to the next section.

<u>*Evaluate the External Hard Drive Enclosure*</u>

You will need to open up the external hard drive for this test. Once open, do the following:

1. **Look for disconnected cables, loose connectors, and obvious damage.** If the external drive has cables connecting it to the drive, inspect them to make sure they're completely plugged in. If the interface and power circuit board are integrated into a board and the drive plugs directly into the card, make sure it's seated properly. Look for any obvious cracks or bad solder joints in any of the circuit cards (including those on the hard drive.) Look for any components that show signs of overheating or burning out. We recommend completely disconnecting and

reconnecting the drive to the system once to break any oxidization that may have developed on the connectors.

2. **Reassemble the unit enough to power it on.** Reassemble the unit enough so you can power it on. Only reassemble what you need to in order to power the unit up safely. Plug the unit back into the computer, connect the supplies, if applicable, and power on the system. See if the drive is now visible.

   If the drive is now visible, this might have been a loose connector, oxidization on the connectors, or a cable/connector somewhere in the system with an intermittent generic failure. If it's the latter, over time this problem will likely present itself again sometime in the future and you will need to open the unit up and try to determine which cables or connectors are at fault.

   Most intermittent generic failures remain intermittent until something (such as a cables orientation, impact, or vibration) forces them to behave as complete generic failures. The only way to evaluate this is to use the drive with the system for a while to see if the problems have actually disappeared. An intermittent generic failure will resurface over time as either another intermittent or complete failure with the drive becoming "invisible" again, or the drive will be displaying erratic behavior. If this occurs, review the section titled ***External Drive with Intermittent Failure*** in ***Advanced Troubleshooting.***

   If the drive appears to be working properly, you might want to consider the evaluation and troubleshooting complete at this point, but you might want to attempt the next step anyway. If you decide that the work done so far is good enough, finish reassembling the unit and use it.

   WARNING: If the failure is or was an intermittent generic failure at one point, some of the data stored on the drive may be corrupt, and it might be worthwhile either validating it's integrity, or reformatting the drive before using it again.

   If the drive is not visible, power it down and proceed to the next step in the subsection <u>*Hard Drive Evaluation*</u>.

Hard Drive Evaluation

In this set of tests, we're going to determine if the actual hard drive in the external unit is even working. To perform this test, you will need to remove the hard drive from the external hard drive being evaluated and attempt to see if it's usable inside the reference external enclosure used for testing. Perform the following steps in order:

1. **Remove the hard drive from the external enclosure being evaluated.** Re-open the external hard drive from the external hard drive being evaluated and remove the hard drive.

2. **Relocate the drive.** Put the drive just extracted from the external drive being evaluated into the reference external enclosure but *do not* connect it to the FireWire, USB, or Thunderbolt port on the system that you're using yet. If possible, leave the cover off the external drive housing.

3. **Restart the system.** Without the external drive connected to the system, start the system up, open ***System Preferences***, and select the bootable drive as the internal drive on the system from the *Startup Disk* option. Once done, shut the system down, plug the reference external enclosure into the applicable I/O port, power it up (if not self powered), and then turn the system on.

   If the drive in the reference external enclosure shows up as a valid drive, open it up in ***Finder*** and see if everything looks alright. If the contents of the test drive look alright, then there's likely a fault somewhere in the external enclosure from the external drive being evaluated, most likely in the power circuitry or it's lines/connections.

   If the contents of the drive don't look right (garbled, missing files, etc) then there was probably an intermittent generic failure somewhere in the data path between I/O connector and the hard drive that went from an intermittent generic failure to a complete generic failure. This drive will need to be reformatted. You should consider your troubleshooting complete, but you will either need to repair the interface and/or power cards and/or cables in the external enclosure, or replace the entire external enclosure with a new one.

   If the drive isn't seen, it's likely dead. This could be caused by a drive controller failure, supply fault in the drive, burned out components, etc.

The drive will need to be replaced. You might want to confirm this by taking the reference hard drive used for testing and placing it into the external enclosure from the external drive being evaluated, but be forewarned that if there's some type of supply fault in that enclosure that can damage or burn out the drive, it might burn out/damage the test drive as well. In our opinion, the best thing to do is simply replace the *entire* external drive under evaluation with a completely new one.

If you've gone through the previously described instructions, your problem should now be isolated, and you should now know how to address it.

Internal Drive with Intermittent Failure

If you've been redirected to this section, you have a system that likely has intermittent generic failures present somewhere in the data paths from the I/O controller on the logic board to the connection between the drive heads reading and writing data from and to the hard drive platters themselves. The problem with an intermittent generic failure is that it can occur anywhere on the system. They can be present in any cable, on any trace on any circuit board on any component in the system, in any solder joint anywhere on the system, or even in some of the connectors. These are difficult to trace, but if you follow the procedures identified in this section, you should be able to isolate the problem.

Intermittent generic failures associated with data lines lead to the following results when performing a test on a drive using ***Scannerz***:

- **Scatter in Test Results.** Scatter, if you haven't read other sections of this document, is the presence of errors and/or irregularities that vary, typically widely, from test to test.
- **Data corruption.** Some of the data written or read between the hard drive CPU are corrupt.
- **Unexplainable delays.** These are typically random and often appear without any apparent reason. The typical signature of this problem is the “spinning beach ball” indicating the system is temporarily locked up.
- **Files that are readable one minute, and not the next**. If the system reports that it can't open a file one minute, and then it can a moment later, this is a sure sign that intermittent generic failures exist somewhere in the system.

Intermittent generic failures can also exist in any of the power supply lines that run from the power supply, through the logic board, and to the hard drive, but the characteristics are typically different. Among other things, intermittent power faults typically yield system lockup or secondary drives “ejecting” themselves for no apparent reason. If problems of this nature exist, you should review the section under ***Advanced Troubleshooting*** titled ***Power Supply Problems***.

In order to isolate problems associated with data lines, the unit will need to be opened up. There are really only a few possibilities that can cause this problem. The possibilities are:

- **The hard drive has an intermittent generic failure in it somewhere.** If this is the case, the drive should be seen as unusable, unless you have the skill to actually repair the hard drive. Since most people don't possess such skills, if this is the problem our advice will be to replace the drive.
- **There's an intermittent generic failure in the cables or connectors.** This can be caused by a crack or partial break in one of the data lines in the cable, oxidization of the connectors, or improper contact in the connector pins.
- **There's an intermittent generic failure in the logic board.** If this is the problem the logic board will need to be replaced, or the drive will need to be moved so it's using a different I/O port. This could be done by putting the drive in an external enclosure and leaving the internal drive area empty.

Please review the following instructions carefully before proceeding. In some cases, we may instruct you to jump over other sections of the instructions if a particular problem is found, but you should generally follow these sequentially unless instructed to go to another section. This will require disassembly of the unit.

Inspect Cables and Connectors

With the unit opened up, remove all connections from the hard drive cable to the logic board and remove the hard drive from the unit.

> **NOTE:** A few hard drives and SSDs come with drive cables that cannot be removed from the drive without replacing the cable – you will need to find this out beforehand. This section generally applies only to units with cables that can be reused.

Remove the cable from the hard drive. Inspect all cables and cable connections for any signs of damage, such as cracks, breaks, or tears. Also observe if the cable connections were properly seated. In the case of MacBook Air's with ZIF socketed drives, make sure the locking bar is securing full contact between the cable and the drive's connectors. In the case of ZIF socketed drives, check the cable ends fitting into the ZIF socket for possible oxidization and correct if needed.

If you find bad/broken/cracked cables or connectors, you will obviously need to replace them. Your troubleshooting should be considered complete until this repair is made and the unit can be reevaluated.

If there appear to be no problems with the unit, do the following:

1. Reconnect the drive. Reconnect the drive to the system.
2. Start the system. Once reconnected, install all power cords, batteries, etc. and start the system.
3. Scan the drive. Using ***Scannerz***, and perform a scan on the drive . The scan should be done in cursory mode, surface scan only, with probing disabled, and allowed to scan the drive in the external housing. The following conditions may occur:
    - **The drive exhibits the same errors and irregularities.** In this case, proceed to the *Evaluate the Hard* Drive section that follows.
    - **The problems appear to be gone.** In this case, the cables/connectors were probably not seated properly or there was some oxidization on some of the connectors that was probably disrupted by removing and installing the cables and connectors.

      Unfortunately, generic intermittent failures can be induced by heat or have their behavior changed by physical relocation if it's cable related. The best thing to do in this case is use the unit for a while and see if

the problems re-appear. If the problems do not reappear, the system is now likely
Evaluate the Hard Drive section (next.)

Evaluate the Hard Drive

In this section, we'll verify that the hard drive is the cause of the problems. To do this, do the following:

1. **Place the internal hard drive into the reference enclosure**. Remove the internal hard drive from the system and place it into the external reference enclosure.
2. **Boot off the reference hard drive**. Plug in all the power cables and batteries (for laptops) as needed, and power all components up. Boot from the external reference enclosure now housing what was the internal hard drive. You may need to hold the Alt (Option) key down when booting and select it make sure it boots. Install ***Scannerz*** onto this drive if it isn't already installed. If the unit appears to already exhibiting its previous problems, the drive is failing in some way, your troubleshooting is complete, and the drive needs to be replaced. If it appears to be working properly, continue with the next step.
3. **Run a scan on the drive in the reference enclosure.** Start ***Scannerz*** and perform a scan on the drive now in the reference external enclosure (the drive that used to be internal to the system). The scan should be done in cursory mode, surface scan only, with probing disabled, and allowed to scan the drive in the external housing. The following conditions may occur:
    - ***Scannerz* starts detecting errors and/or irregularities again once the scanning starts.** In this case, the drive is the source of the problems. It will need to be replaced, and troubleshooting should be considered complete.
    - **There are no intermittent problems detected.** This implies the problems are related to the cables or logic board traces. Proceed to the next section, Evaluate the Logic Board and Cables.

Evaluate the Logic Board and Cables

If you've gotten to this point, the problems have been isolated to either the data cables between the hard drive and the logic board, or an intermittent generic failure on the logic board itself. The only way to evaluate this is to swap out the data cables running between the hard drive and the logic board with an known good set, perform some scans on the unit, and see if the problems persist. If the problems persist, the only item left that could be causing this is the logic board itself.

To evaluate this, do the following:

1. **Replace the drive cables with a good set.** Shut down the system, disconnect the external reference enclosure from the system, unplug all batteries and power cords, open the unit, and replace the drive cables with a known good set. You should still be using the reference drive.
2. **Boot the system.** Reconnect the power cords and battery (if applicable), power the system on, and once started, launch ***Scannerz***.
3. **Scan the reference drive**. The reference drive should be inside the unit where the original internal hard drive used to be. From ***Scannerz*** list of available drives, select the reference drive's primary drive, not a volume. Scan the entire reference drive in cursory mode with probing disabled. The results will be one of the following:
    - **Intermittent errors and irregularities have disappeared.** If this is the case, there was a fault somewhere in the cables, and the problem should be considered identified. Power down the system, remove the reference drive from the system, remove the original internal hard drive from the external reference enclosure, and place it back into the unit. If you intend to use the known good cables now in the unit as the cables, use them. Otherwise obtain another new set of good cables and use them. Reassemble the unit and it should be working properly, and this problem should be considered solved.
    - **Intermittent errors and irregularities continue.** This implies the problem is in the logic board . The two possible solutions to this problem are to replace the logic board, or not bother using an internal drive and use the system only with an external drive. The troubleshooting should be considered complete, but probably not with

the results you were hoping to obtain (bad logic board.)

In any of these tests, the degrees of intermittency may vary because that's the nature of the problem. Before proceeding with a logic board replacement, you may wish to rerun numerous scans on the drive to ensure errors and irregularities simply weren't caught in the initial scans.

External Drive with Intermittent Failure

If you've been redirected to this section, you have a system that likely has intermittent generic failures present somewhere in the data paths from the I/O controller on the logic board to the connection between the drive heads reading and writing data from and to the hard drive platters on the hard drive enclosed in the external drive enclosure. The problem with an intermittent generic failure is that it can occur anywhere on the system. They can be present in any cable, on any trace on any circuit board on any component in the system, in any solder joint anywhere on the system, or even in some of the connectors. These are difficult to trace, but if you follow the procedures identified in this section, you should be able to isolate the problem.

Intermittent generic failures associated with data lines lead to the following results when performing a test on a drive using ***Scannerz***:

- **Scatter in Test Results.** Scatter, if you haven't read other sections of this document, is the presence of errors and/or irregularities that vary, typically widely, from test to test. In a test on the drive the results are typically unrepeatable from test to test.
- **Data corruption.** Some of the data written or read between the hard drive CPU is corrupt.
- **Unexplainable delays.** These are typically random and often appear without any apparent reason. The typical signature of this problem is the “spinning beach ball” indicating the system is temporarily locked up.
- **Files that are readable one minute, and not the next**. If the system reports that it can't open a file one minute, and then it can a moment later, this is a sure sign that intermittent generic failures exist somewhere in the system.

In order to isolate this problem, the external unit under evaluation *may* need to be opened up. There are really only a few possibilities that can cause this problem. The possibilities are:

- **The hard drive inside the external enclosure has an intermittent generic failure in it somewhere.** If this is the case, the drive should be seen as unusable, unless you have the skill to actually repair the hard drive. Since most people don't possess such skills, if this is the problem our advice will be to replace the drive.

- **There's an intermittent generic failure in the cables or connectors inside the external drive connecting the drive to the outside world.** This can be caused by a crack or partial break in one of the data lines in the cable/connectors, oxidization of the connectors, or improper contact in the connector pins.

- **There's an intermittent generic failure in the logic board.** If this is the problem the logic board will need to be replaced, or the external drive will be limited to another port (if available.)

> **NOTE**: We assume that you've already evaluated the I/O cables and their connectors in the ***External Drives*** section of ***Basic Troubleshooting*** in this document. If you haven't done so, do so now before proceeding. The easiest way to do this is swap the existing I/O cables out with other cables known to be in good working order. We also assume that problem has been isolated to a single port.

Please review the following instructions carefully before proceeding. In some cases, we may instruct you to jump over other sections of the instructions if a particular problem is found, but you should generally follow these sequentially unless instructed to go to another section. Some of these procedures may be redundant with previous instructions from the ***Basic Troubleshooting*** sections of the manual, but we recommend you follow them anyway. This set of tests may require disassembly of the the external drive being evaluated.

> **NOTE**: If the intermittent generic failures are traced to the logic board or the interface circuitry inside the external drive being evaluated, it's quite possible that the hard drive installed inside the external enclosure may be in good working order, but some of the data might have been corrupted due to the intermittent nature of the problem. If you decide to discard the external unit, in our opinion, it's best to extract the drive first.

Most of the people that end up in this section are having problems on a system with a single FireWire or USB port and swapping ports to test the device is impossible.

Logic Board Tests

We will start off by running a scan on the reference drive/enclosure to see if the problems are associated with the logic board. To do this, proceed as follows:

1. **Assemble and connect the reference equipment.** Install the reference hard drive into the reference external enclosure and plug it into the I/O port under evaluation.
2. **Boot the system, start *Scannerz*.** Boot the system from the internal hard drive. After the system has booted, start ***Scannerz***.
3. **Configure the Test.** With ***Scannerz*** up, select the reference drive as the scanning target, disable drive probing in the preferences section, and set ***Scannerz*** up to do a cursory surface scan (no seek scan) over the entire drive.
4. **Scan the referenced equipment.** Run a scan on the entire reference drive. Monitor the error and irregularity counts. If errors and/or irregularities are rampant, you can stop the test because the problem has just been identified.

   Because we know the reference equipment (drive, enclosure, cable) is in good working order, if errors and irregularities start appearing, then there's a logic board fault. It's assumed that the internal drive is in good working order. It might be a good idea to disconnect the reference equipment from the computer and perform a scan on the internal drive itself. If errors and/or irregularities with scatter occur there as well, the problem is not limited to just the I/O ports on the logic board, but rather most likely, one (or more) of the bus connections on the system is faulty and this is a system wide problem which will likely get worse in time. If it's a system wide, then the logic board will need to be replaced. If it's limited to the I/O port, then it's most likely that the connectors on the I/O port received impact cracking traces to the connector. In this case the port will be unusable, but the rest of the system should function normally. In either case, troubleshooting is complete.

If there are no errors or significant irregularities present in the test, this implies that the external drive unit itself is the culprit. Proceed to the next section to continue the evaluation of the unit. This will require disassembling the external hard drive being evaluated.

Evaluating the External Hard Drive

We've confirmed that the logic board isn't responsible for the intermittent behavior. Since the I/O cables should have been checked in the ***Basic Troubleshooting*** section, this leaves only the external drive unit itself. To evaluate the external drive (don't confuse this with the reference external enclosure), do the following:

1. **Open up the external hard drive enclosure.** If it isn't obvious how this is done, you may need to obtain instructions for it on the web or from the manufacturer. Once open, remove all connections from the hard drive inside the external drive housing to any internal circuit cards. If the external drive has cables connecting it to the drive, inspect them to make sure they're completely plugged in. If the interface and power circuit board are integrated into a board and the drive plugs directly into the card, make sure it's seated properly. Look for any obvious cracks or bad solder joints in any of the circuit cards (including those on the hard drive.) Look for any components that show signs of overheating or burning out. We recommend completely disconnecting and reconnecting the drive to the system once to break any oxidization that may have developed on the connectors.
2. **Reassemble the unit enough to power it on.** Reassemble the unit

enough so you can power it on. Only reassemble what you need to in order to power the unit up safely. Plug the unit back into the computer, connect the supplies, if applicable, and power on the system and the external drive.

3. **Scan the drive.** Using ***Scannerz***, select the external unit from the list of available drives, disable drive probing in ***Scannerz*** preferences, and set up a cursory scan with a surface scan only. If errors or significant irregularities start appearing, stop the scan and move on to the next section, *Evaluate the Hard Drive*.

   If the test results show no errors or significant irregularities, then there was likely either a loose cable/connection or possibly oxidization on the connectors causing the intermittency. In this case, you should assume that the troubleshooting is now done, but be careful. Intermittent generic faults have a nasty habit of disappearing and resurfacing, especially if the fault was altered physically by moving cables/connections around. We would recommend that you use the drive for a while to see if the problem is gone. If it isn't you'll need to return to testing and perform the procedures in *Evaluate the Hard Drive.* If it really is gone, you're good to go!

Evaluate the Hard Drive

In this section, we'll verify if the hard drive from external enclosure is the cause of the problems. To do this, do the following:

1. **Remove the hard drive from the external enclosure being evaluated.** Re-open the external hard drive from the external hard drive being evaluated and remove the hard drive.
2. **Relocate the drive.** Put the drive just extracted from the external drive being evaluated into the reference external enclosure.
3. **Run a scan on the drive in the reference enclosure.** Start ***Scannerz*** from the internal hard drive and perform a scan on the drive now in the reference external enclosure (the drive that used to be inside the external drive under evaluation). The scan should be done in cursory mode, surface scan only, with probing disabled. Scan the drive in the external housing. The following conditions may occur:

- ***Scannerz* detects errors and irregularities, just as it's done before.** In this case, the hard drive itself is bad and it needs to be replaced. Your troubleshooting is complete and the drive from the external unit under evaluation is bad.
- ***Scannerz* detects no errors or significant irregularities.** This indicates that the drive from the external unit under evaluation is fine, and the problem is inside the circuitry of the external hard drive. The troubleshooting is complete. Most people would opt to just replace the enclosure from the unit under test with a new one, but some might opt to actually replace the circuit cards, cables, or connectors. Going into the latter is beyond the scope of this document.

> **NOTE:** Since this problem was dealing with a problem of intermittent nature, some of the data on the drive may be corrupt. Before putting the drive back into service, you may wish to check the integrity of the drive, or simply reformat it and start "clean."

Power Supply Problems

If there's a problem related to the supply, whether in the supply itself, its connectors, its cabling, or traces running throughout the logic board, there are only a few things that can be done to isolate the problem as far as hard drive evaluation goes. This document is about hard drive troubleshooting, not power supply troubleshooting. Never the less, we can provide some information that may be of value to you.

The typical "signatures" of a power supply problem are as follows.

- **A mounted secondary or external drive drops out for no reason.** This is often accompanied by a dialog indicating that the disk has been ejected improperly.
- **The system undergoes a complete lockup for no apparent reason.** This typically occurs when the boot drive sees it's power removed. If the fault is system wide, then the CPU and other logic board components

might fault as well.

- **Thermal shutdown.** Most supplies come with thermal sensors that tell the supply to shutdown if they they sense too much heat. A thermal shutdown can be caused by a faulty thermal sensor, a bad supply, or overheating typically due to a short somewhere in the system or supply. Problems of these natures are beyond the scope of this document.

As stated, this document isn't about supply troubleshooting, but here are some tips that might help you identify a supply related problem:

1. **It effects only one drive.** If this is the case, whether the drive is internal or external, the problem is most likely related to bad cables, cable connections, of a logic board intermittent generic failure in one of the supply traces leading to the drive. If this is the case, try the following (as applicable):
    - If the drive is a port powered external drive, try it with it's cables on another port if one is available. If the problem goes away, it's likely there's a fault in the supply connections in the logic board leading feeding power to the port.
    - If the drive is internal, replace its cables with a known, good working set. If the problems end, there was a cable problem, otherwise it's likely the logic board.
2. **It effects all drives.** If this is the case, the fault is most likely system wide and is caused by either the logic board itself or the supply and/or battery system (if applicable.) Another (remote) possibility is that there's a short in a peripheral, which might be alleviated by removing all peripheral equipment from the system (including external drives) one by one to see if the problems end.

Power supplies, just like any other circuit in the system can suffer from complete or intermittent generic failures. It might be worth your effort to ensure that all supply components are properly seated and installed, that there are no obvious cable problems (such as cable ends being frayed or wires showing signs of shorting), and that connector oxidization isn't preventing the supply connections from making adequate contact.

Chapter 4

Resolving Hard Drive Problems

Overview

This section will deal almost exclusively with techniques to deal with drives that have bad sectors detected. In many cases, these techniques will render a drive completely useable again, but in some cases the if the damage to the drive is too extensive to be repaired, the drive will need to be replaced.

A Note on Security

If a drive contains critical information and it's been deemed unrepairable, in our opinion, the drive should be disassembled and the platters should be taken out and destroyed.

If an external hard drive unit has been deemed “broken,” it should be opened up and have its hard drive removed from the external housing. In many cases, as described in the preceding chapters in this document, an external hard drive unit may appear to be “broken” and yet the hard drive can be in good working order. If the drive from an external unit is truly unrepairable, if it stored critical or sensitive data, the platters from the drive should be extracted and destroyed.

Correcting Surface Scan Problems

This section of the document is for those that have run tests on their drive and the test software has reported bad sectors on the platter surfaces. If you've been using ***Scannerz*** and using this document, these will show up as repeatable surface scan errors and irregularities over specific regions of the drive.

Contemporary hard drives have the capability to remap bad sectors to spare sectors, if there are any available. The way we recommend you do this is by using ***Disk Utility*** to erase the drive drive with the *Zero Out Data* option identified in the *Security Options...* button on ***Disk Utility***.

The zeroing process writes binary zeros over every sector on a drive or volume. When the drive is confronted with bad or marginal sectors, it won't be able to write to them properly and it will, if possible, remap them to spare sectors, thus eliminating them from use. In the vast majority of cases, data cannot be recovered from a bad sector. If the drive is too extensively damaged, this process will fail, and in our opinion, you should consider the drive unusable and replace it.

WARNING: Using this procedure will overwrite and destroy every bit of data on the selected drive or volume. You will not be able to recover any data from the drive or volume once this is complete. If you need to back up or copy files from the drive, do so before proceeding with this process.

Once the zeroing is complete, you should rescan the drive using ***Scannerz*** to ensure the problem is truly fixed. If zeroing the drive completes successfully, you may still wish to replace the drive if any of the following conditions still exist after the process has been completed:

1. **The bad sectors are still present.** This can occur in rare cases when the drive is able to write to the surface of the platter (or it thinks it can) but the sector remains unreadable. In many cases, this is because the number of available spare sectors has been depleted. These types of problems are most commonly found on fairly old drives.
2. **There are lengthy, repeatable irregularities present.** Although this isn't really a fault, it can slow down your system. A lengthy, repeatable irregularity would typically be one that ***Scannerz*** reports as having a duration of over one second. Some remapped sectors may show up as repeatable irregularities in ***Scannerz***, but their duration should typically be less than one second, if detectable at all. These types of problems are most commonly found on fairly old drives.

How a specific drive behaves when it runs out of spare sectors is completely up to the drive manufacturer. Some system will literally cause the system to lock up, some will simply skip the bad sectors leaving them in place, but most will report an error to ***Disk Utility***.

Zeroing a Volume or an Entire Drive

Depending on the nature of the problem, you may either zero a single volume (part of a drive) or the entire drive. If your system has only one useable volume on it, which many if not most do, you should, in our opinion, opt to zero the entire drive. If you have multiple volumes, such as one for the Mac OS X and another for Windows, then it might be more practical to only zero the volume showing the problems. If this option is selected, you should confirm via testing that the other volume doesn't have problems as well.

In the next two subsections, we will show you how to perform both of these procedures. In the first case, we will be erasing and zeroing the entire drive on a unit with two volumes and then recreating the volumes. In the second case, only a single volume on a two volume drive will be erased and zeroed.

In some cases the process of zeroing will not succeed. This will be addressed in the subsection titled When Errors Occur, and we will attempt to describe the possible manner that the system may react to the problem. If any of these errors occur, regardless of how the system reacts to them during the erasing and zeroing process, it typically means that the drive should be considered too dysfunctional to use.

In the sections that follow titled **Erasing and Zeroing an Entire Drive** and **Erasing and Zeroing a Single Volume,** we will be using an externally connected FireWire hard drive that has two volumes on it named “First” and “Second.” In the section **When Errors Occur** we will be using a defective, unrepairable drive that cannot be practically or realistically repaired. If you've visited our web site and seen some of our videos displaying a drives with problems, this is one of the drives used to make the videos.

Erasing and Zeroing an Entire Drive

To erase and zero an entire drive, open up ***Disk Utility*** from the *Utilities* folder under *Applications*. When ***Disk Utility*** starts, it will appear as follows:

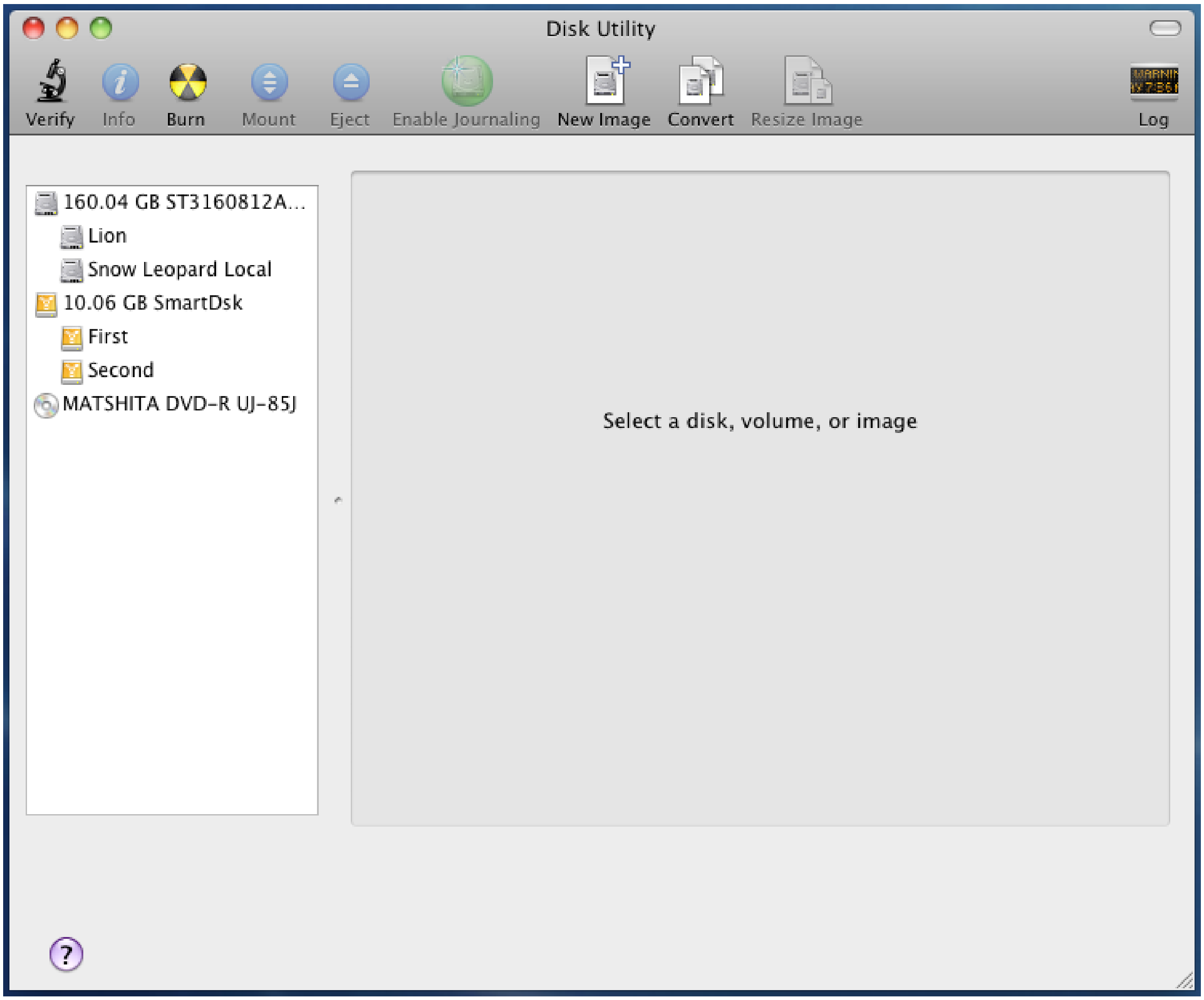

Figure 4-1
Disk Utility at Startup

The drive that we will be erasing and zeroing is the 10.06GB SmartDsk, as shown above.

In order to proceed with this process, select the icon associated with the entire drive, not one of the volumes underneath it.

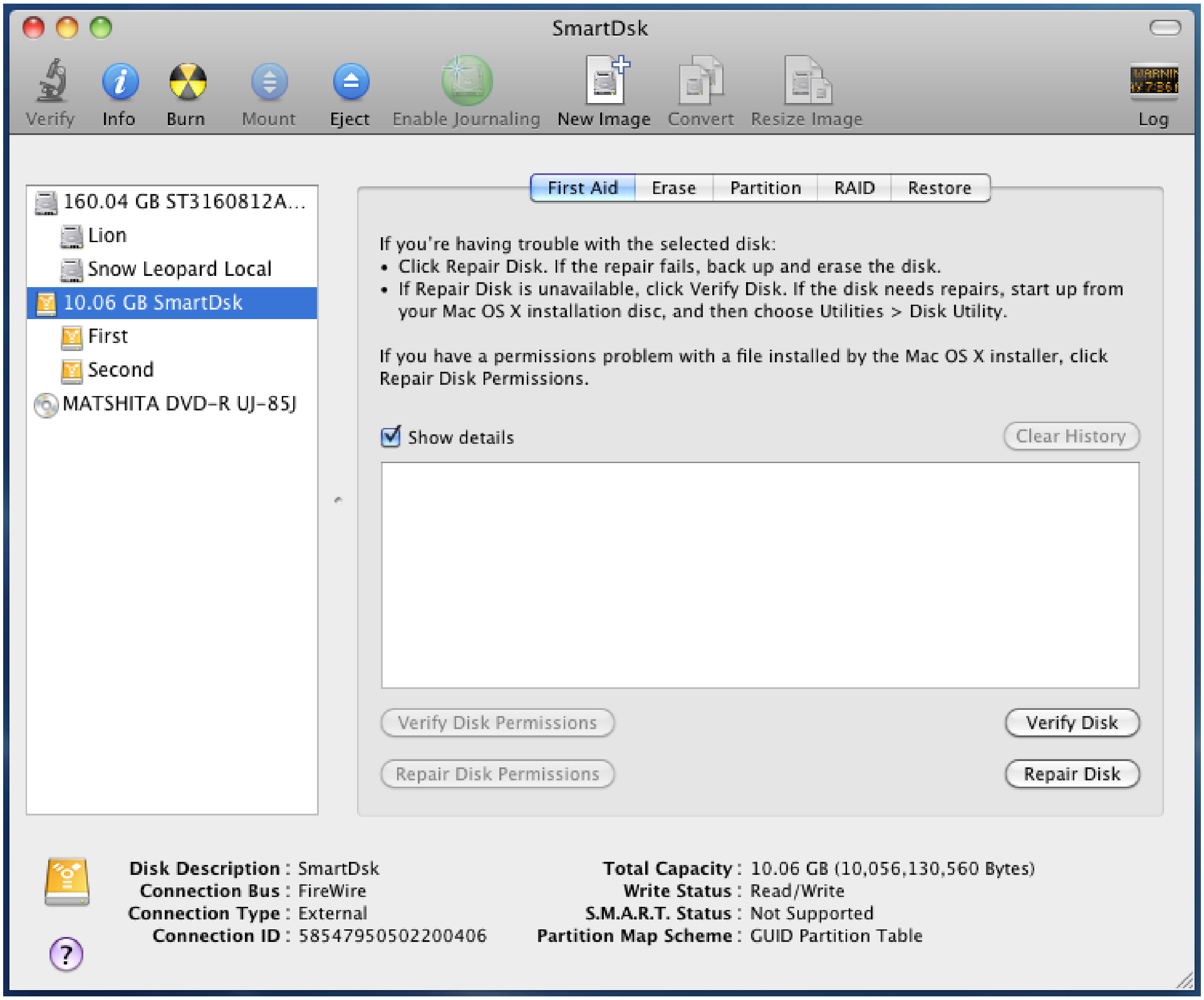

Figure 4-2
Selecting the Entire Drive

In this case, by default (Snow Leopard) the application comes up with the *First Aid* tab highlighted. You're not going to be performing first aid on the drive, you already know it needs zeroing. Click on the tab titled *Erase*.

After clicking on the Erase tab, the window should appear as follows:

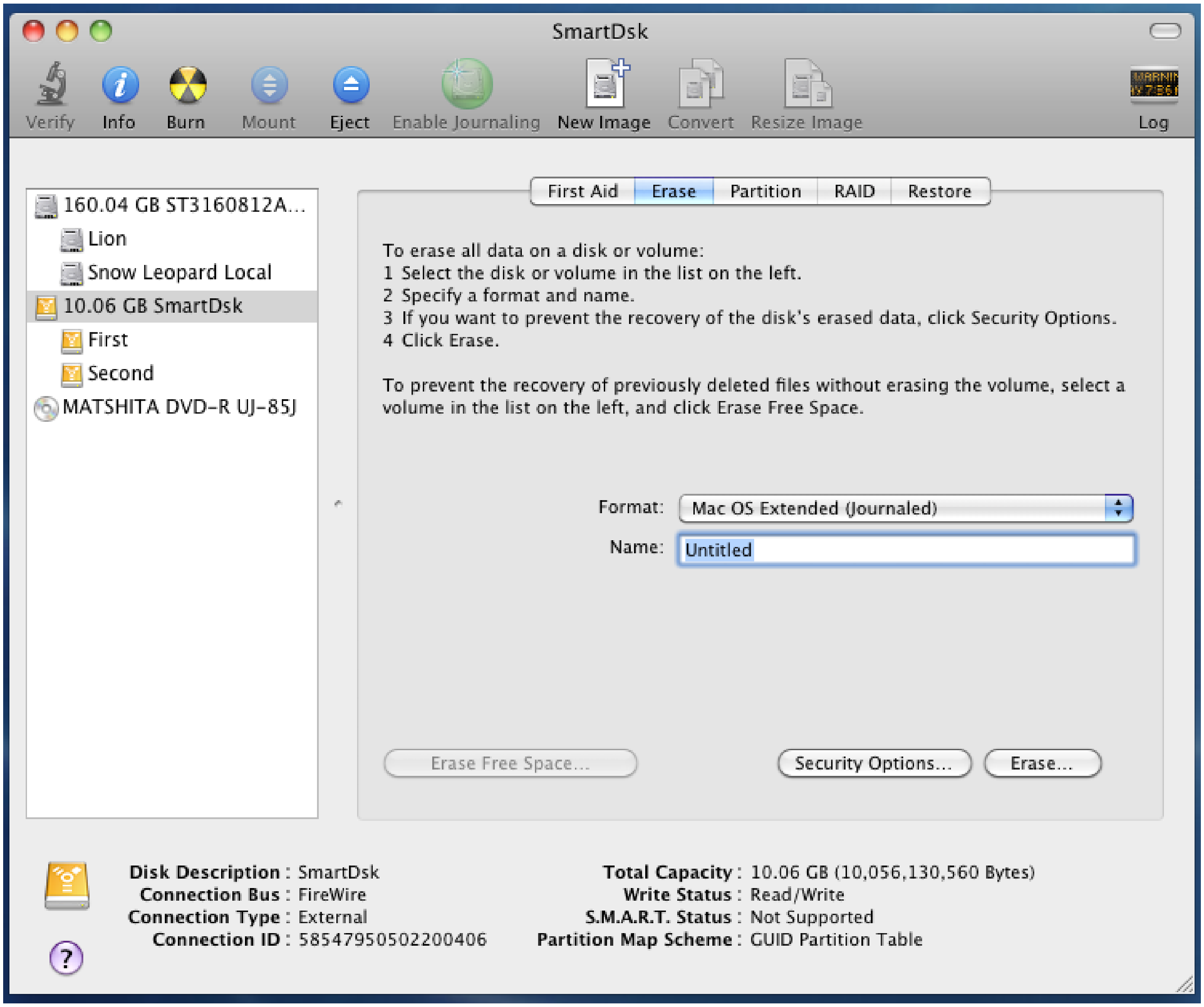

Figure 4-3
Selecting the Erase Option

In this example, we're going to replicate the original volume names. The highlighted field, “Untitled” should be renamed “First” in this example to do so. Once the erasing and zeroing of the partition is complete, we'll add the other partition named “Second.” Your names will almost likely be different. For example, if you had an Apple partition, it might be named “Mac” or “Mac HD” for the Mac OS X volume, and “Windows” for a Windows volume. We recommend that you use the format that existed on the previous installations if you will be restoring from backups, otherwise feel free to change it.

After the drive has been setup, click on the *Security Options...* button, the following dialog will be present:

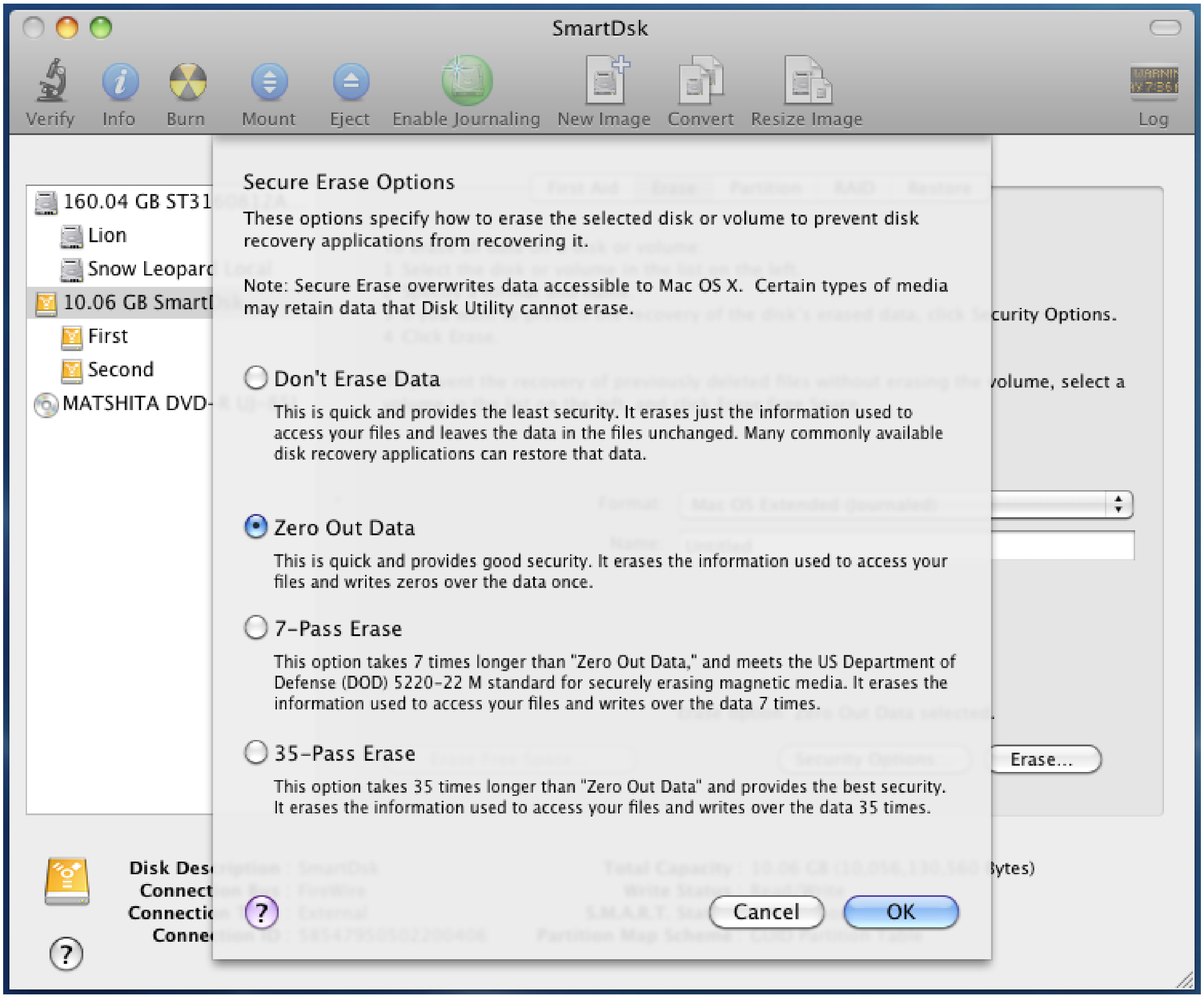

Figure 4-4
Selecting the Zero Out Data Option

This is a critical step. If the *Zero Out Data* option is not selected, you will be wasting your time. This option will write binary zeros to all sectors on the drive, thus forcing the controller on the the drive to (hopefully) remap them to spare sectors.

After selecting the *Zero Out Data* option and clicking the *OK* button, when ***Disk Utility*** returns, select the *Erase...* button. The drive we're using in this example is an old, 10GB drive and as the image below indicates, it will take 8 minutes to complete on a fairly fast system. Larger drives may take several hours to complete.

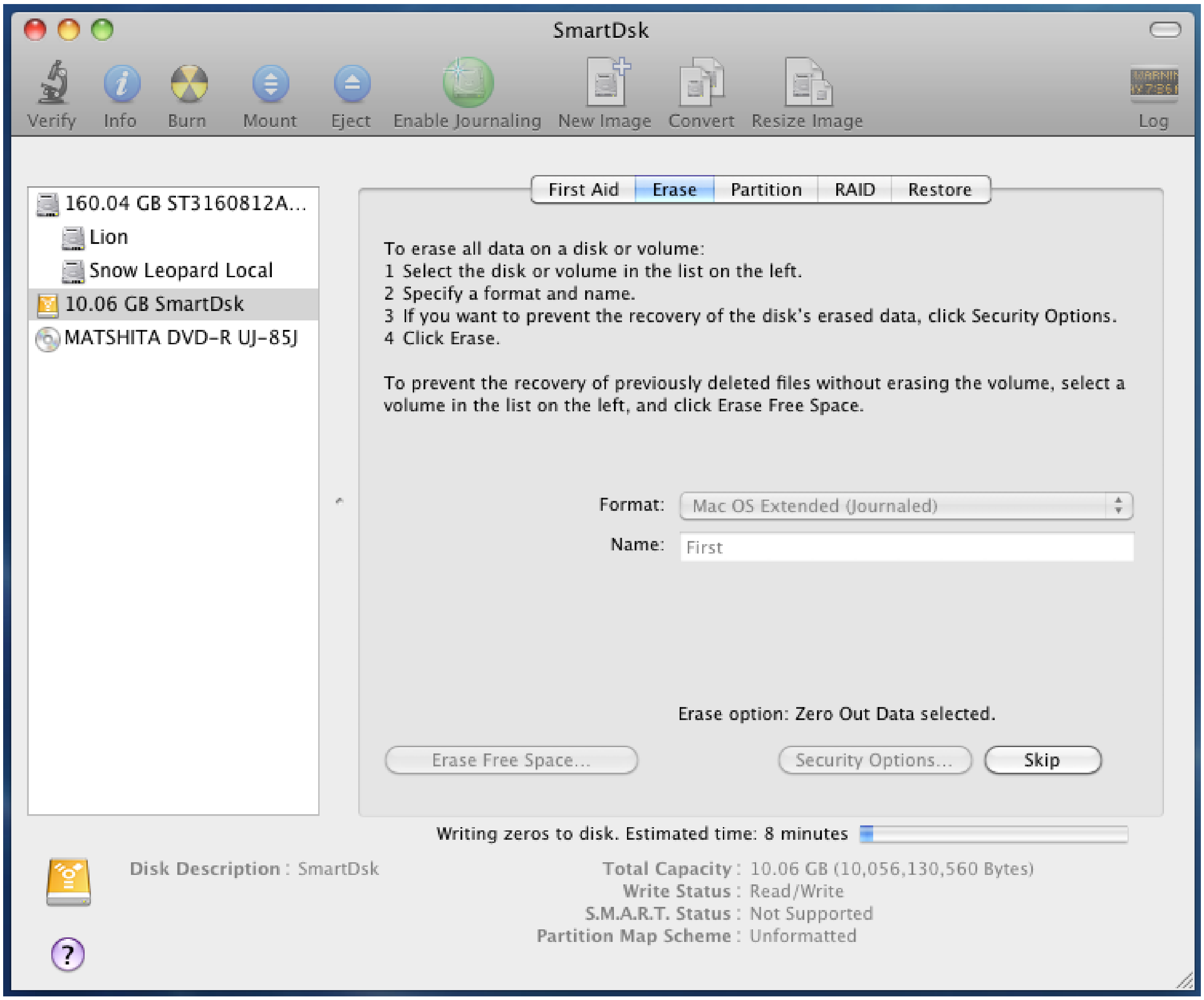

Figure 4-5
Erasing and Zeroing of Drive Underway

Notice in the left column, that the volumes *First* and *Second* have disappeared. When done, the volume named *First* will reappear, and will have to recreate the volume *Second*.

Once the erasing and zeroing has completed, click on the *Partition* option of ***Disk Utility*** as shown below.

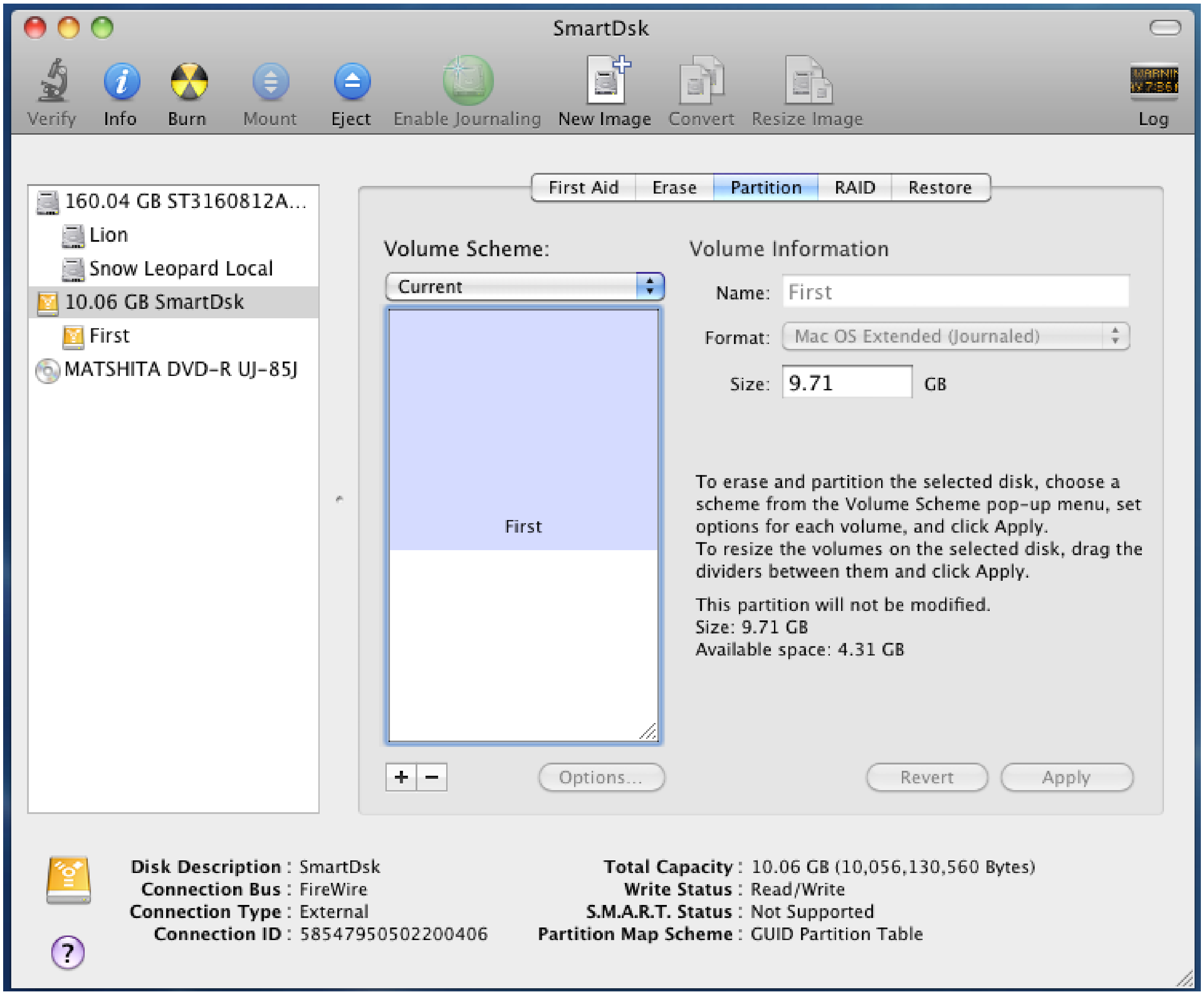

Figure 4-6
Partition Scheme After Erasing and Zeroing the Drive

On the left side along the bottom of the “First” partition shown above, are a “+” and “-” button which allow you to add and subtract partitions. To add (split) the partition, select the partition “First” by clicking on it (a blue ring will surround it as shown above, then click on the “+” button.

After the “+” button has been clicked, the partition will split. You need to give the partition a name, assign the format, and adjust the size of the partition.

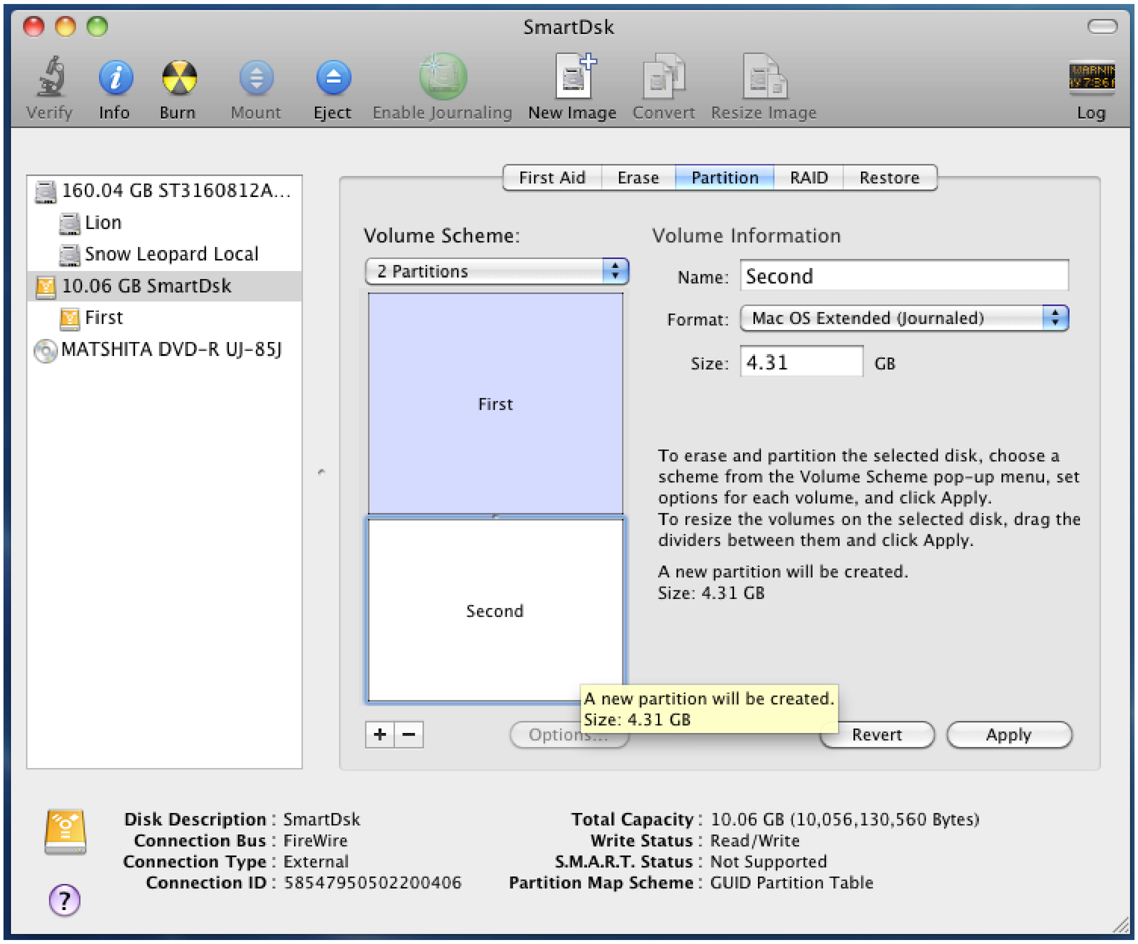

Figure 4-7
Adding a Second Partition Named “Second”

You can adjust the size of the partition by moving the bar separating the partitions up and down, although the utility will prevent you from making one too small. As it does so, the selected partition's size will adjust in the size field to the right. We've filled out the name field above for the new partition to be named “Second,” and we've selected a Mac OS Extended (Journaled) file system.

Once done, click the *Apply* button. ***Disk Utility*** will create the new partitions, and you may exit ***Disk Utility*** and restore the contents of the drive. Remember to retest the drive one last time to ensure it's truly fixed before using.

Erasing and Zeroing a Single Volume

If you have only a single volume that needs repair, it is not necessary to zero the entire drive. In this example, we'll be zeroing only the volume named “First” while leaving the volume named “Second” alone.

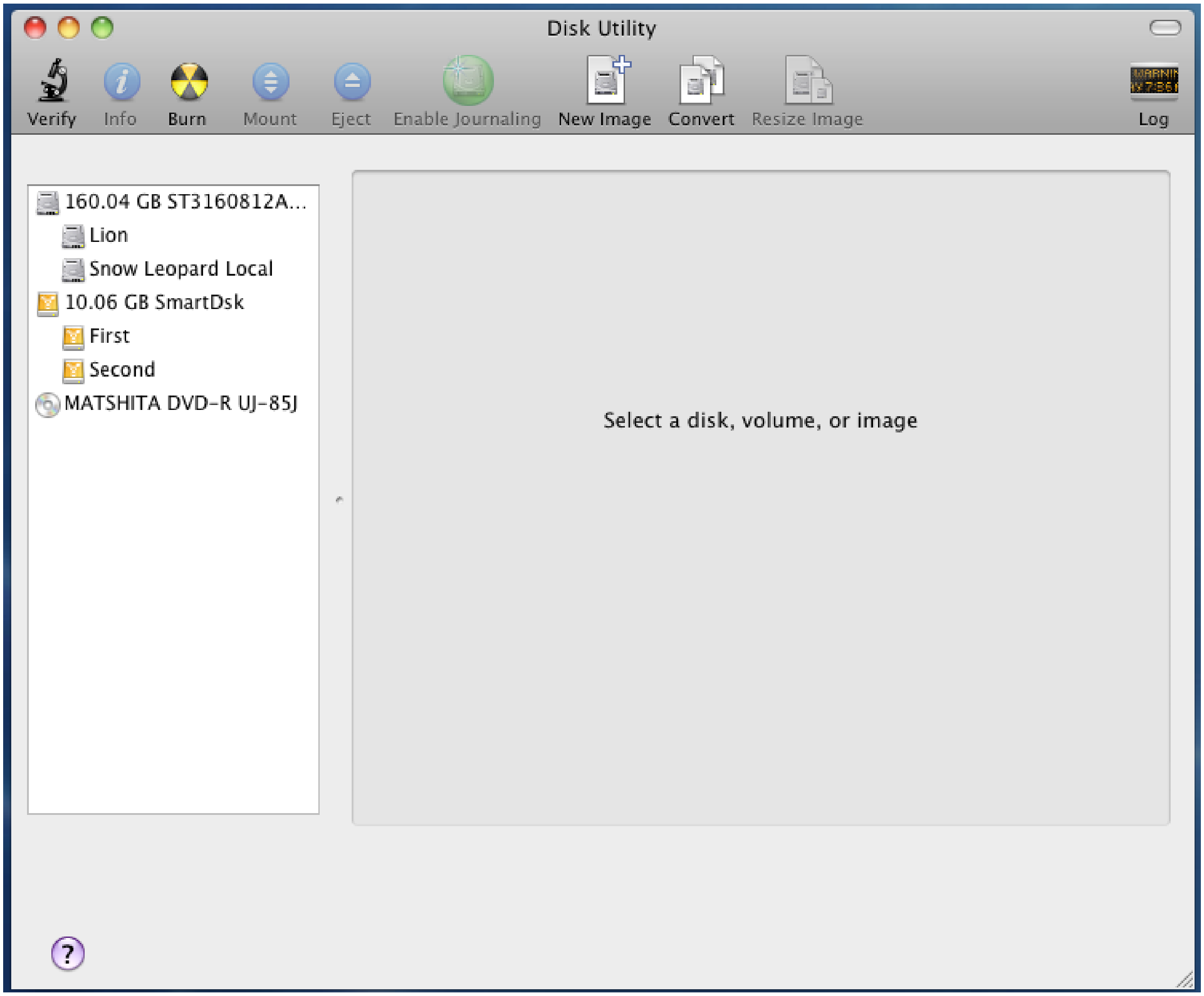

Figure 4-8
***Disk Utility* After Starting**

The image above shows Disk Utility right after being started. The drive is, like that in the previous example, the 10.06 GB drive with the two volumes named “First” and “Second” on it.

We start by clicking on the volume named “First” and then click on the *Erase* field (highlighted in light blue) in the right section of ***Disk Utility's*** interface as shown below.

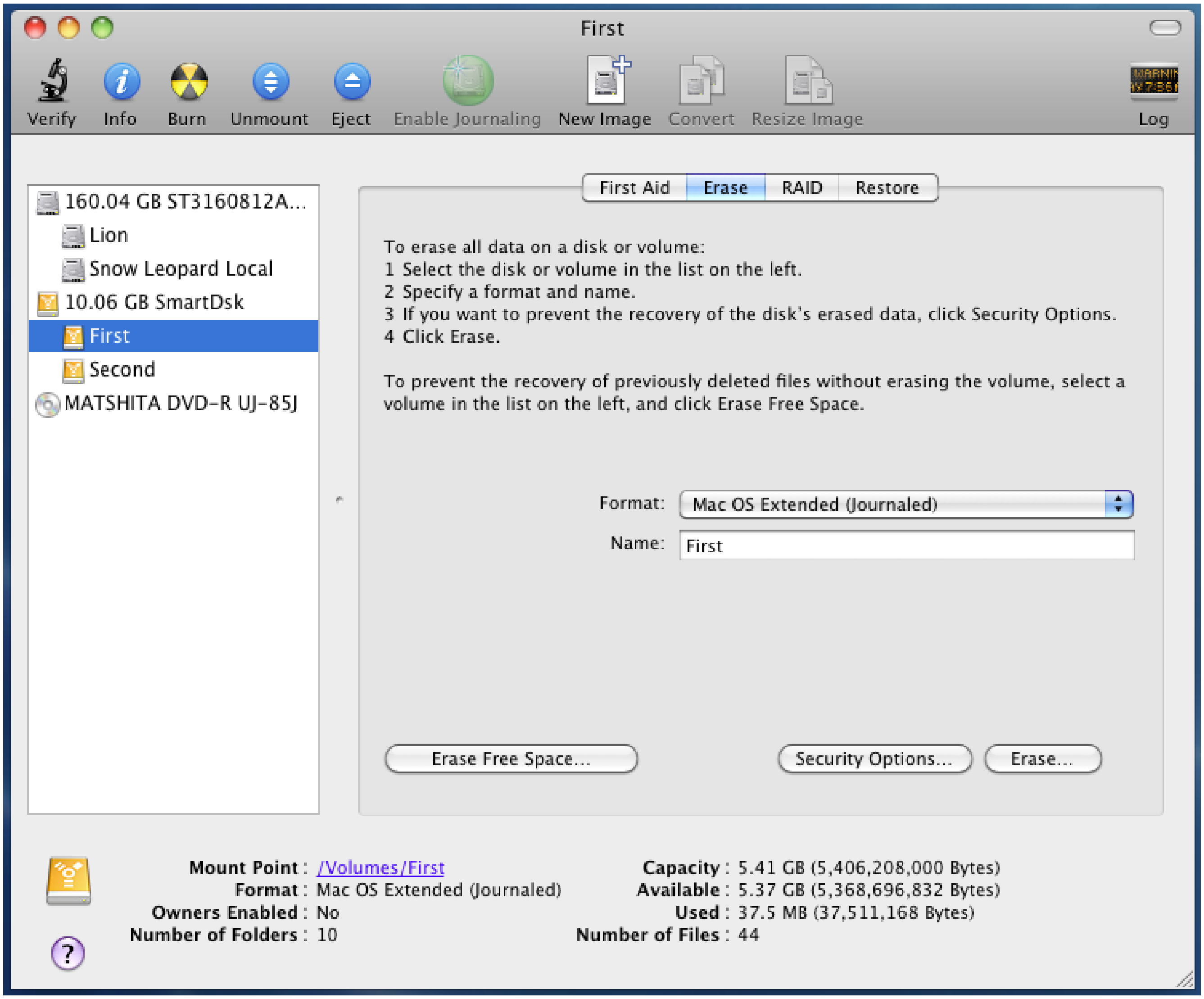

Figure 4-9
Preparing to Set Up Zeroing

Notice that the name of the volume and it's type are already filled in. If you wish to change the name of the volume or its format, this is the time to do it. When ready to set up zeroing, click on the *Security Options...* button.

As with the previous example, after the *Secure Erase Options* dialog appears, we select the *Zero Out Data* option and then click on the *OK* button.

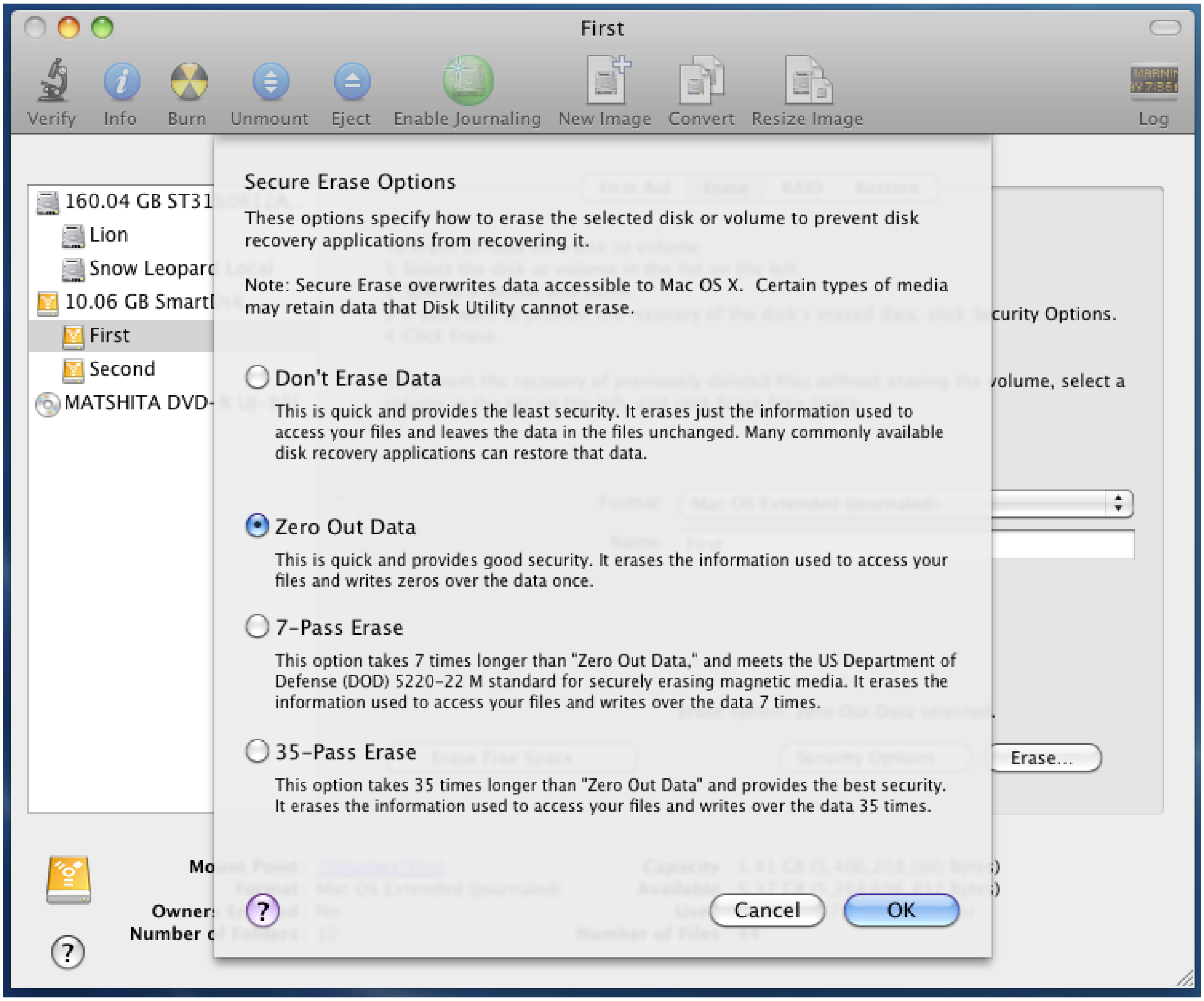

Figure 4-10
Set Up Zeroing

Zeroing in this case will take about half as long as it did in the preceding example because, in this case, the drive is virtually split into two equal parts and we will only be working on the first half.

When the dialog exits, click on the *Erase* button to start the zeroing process.

In the image below, we see the actual zeroing of the volume taking place. Notice that, unlike that in the previous example, both volumes, “First” and

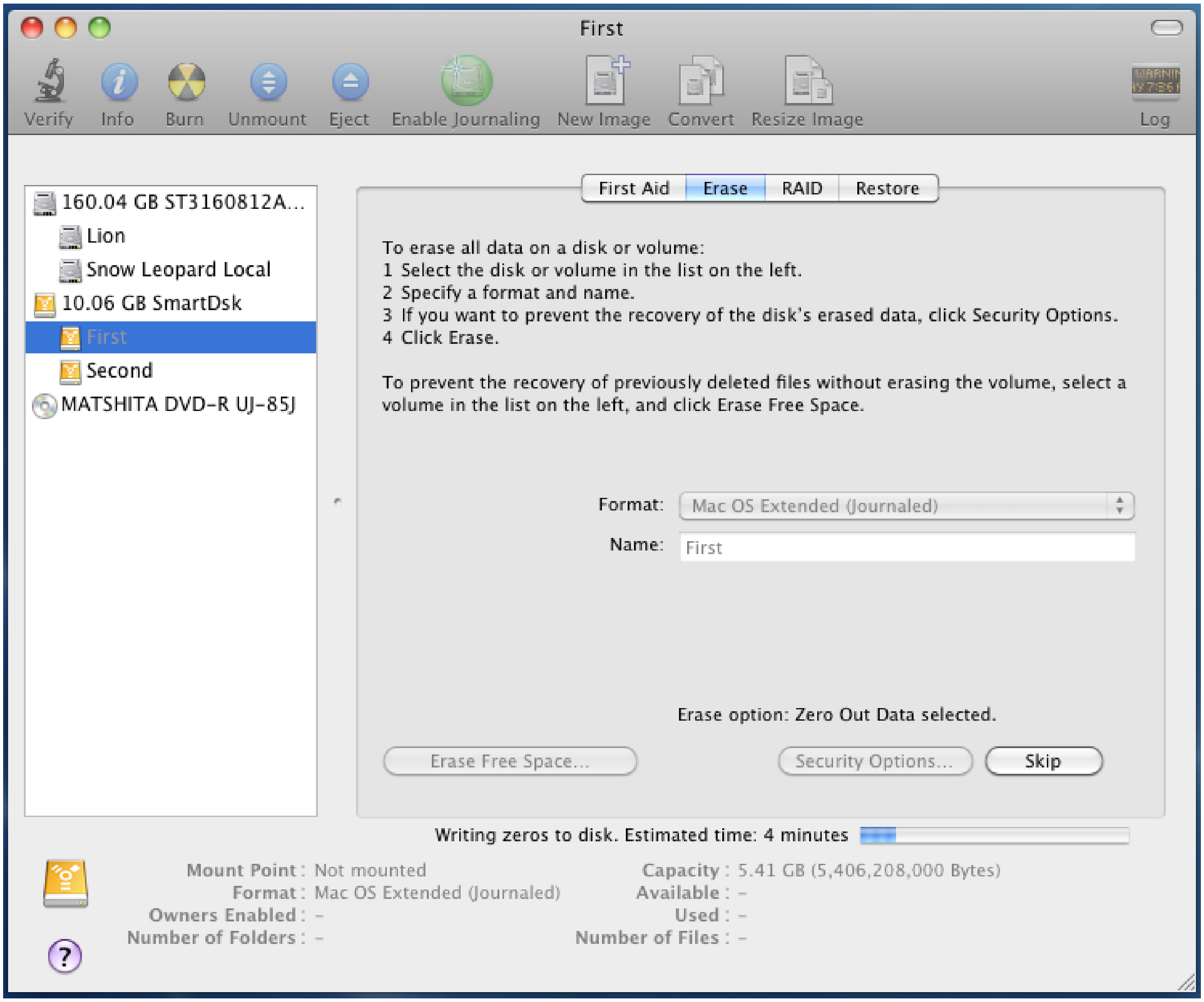

Figure 4-11
Zeroing Underway

“Second” are still visible in the column to the left, but the “First” volume is grayed out because it's not mounted during this process. When this operation completes, the volume “First” will be mounted, freshly zeroed, and should be ready for use. Remember to perform a rescan of the volume to ensure the repairs have been successful.

When Errors Occur

If the zeroing process, just described in the two preceding subsections fails, it may manifest itself in of the following:

1. **The system may lock up or *Disk Utility* may block.** This typically happens on older hard drives. Usually ***Disk Utility*** will block and appear to become unresponsive. ***Disk Utility*** may also be seen (eventually) as being unresponsive under the *Force Quit* option found by selecting the *Apple* icon in the upper left corner of the screen on the menu bar. You should force quit ***Disk Utility*** in this case and, if possible, remove the drive from the system and reboot.
2. **A message, usually in red, will appear stating the drive cannot be formatted (or similar text).** In this case, ***Disk Utility*** will allow you exit gracefully, but the drive is not repairable and needs replacement.
3. **An I/O error will be generated.** This is usually a drop down dialog box, often stating the error. In this case, ***Disk Utility*** will eventually get around to allowing you to exit the program, but it takes it's time doing it. As an FYI, an I/O error is almost always generated in any of the three items in this list, but this time ***Disk Utility*** decided to publicize it.

All three of the items above indicate that the drive needs replacement. If it's an external drive, all you need to do is disconnect it. If it's an internal drive, it should be removed from the system. In all likelihood if the drive is left in place/connected to the system, any time the system starts it will likely see this as uninitialized media and ask you if you want to initialize it. You should answer “No” to this question.

In the following example, we will show you what happens when a bad drive fails to be zeroed by ***Disk Utility***. In this case, the drive has severe impact damage and it's beyond repair. We've partitioned the drive so the areas containing the bad sectors are restricted to the volumes with the suffix “(BAD)” appended to their volume names. This example will replicate the types of problems identified in item number 3 from the list directly above. We used ***Scannerz*** to identify the bad regions and then partitioned the drive accordingly to set this demo up.

We started off by setting up the zeroing using the exact same procedures used in the preceding example, and then initiated the actual zeroing of the drive. As indicated below, just a few minutes after starting the zeroing process, all looks well.

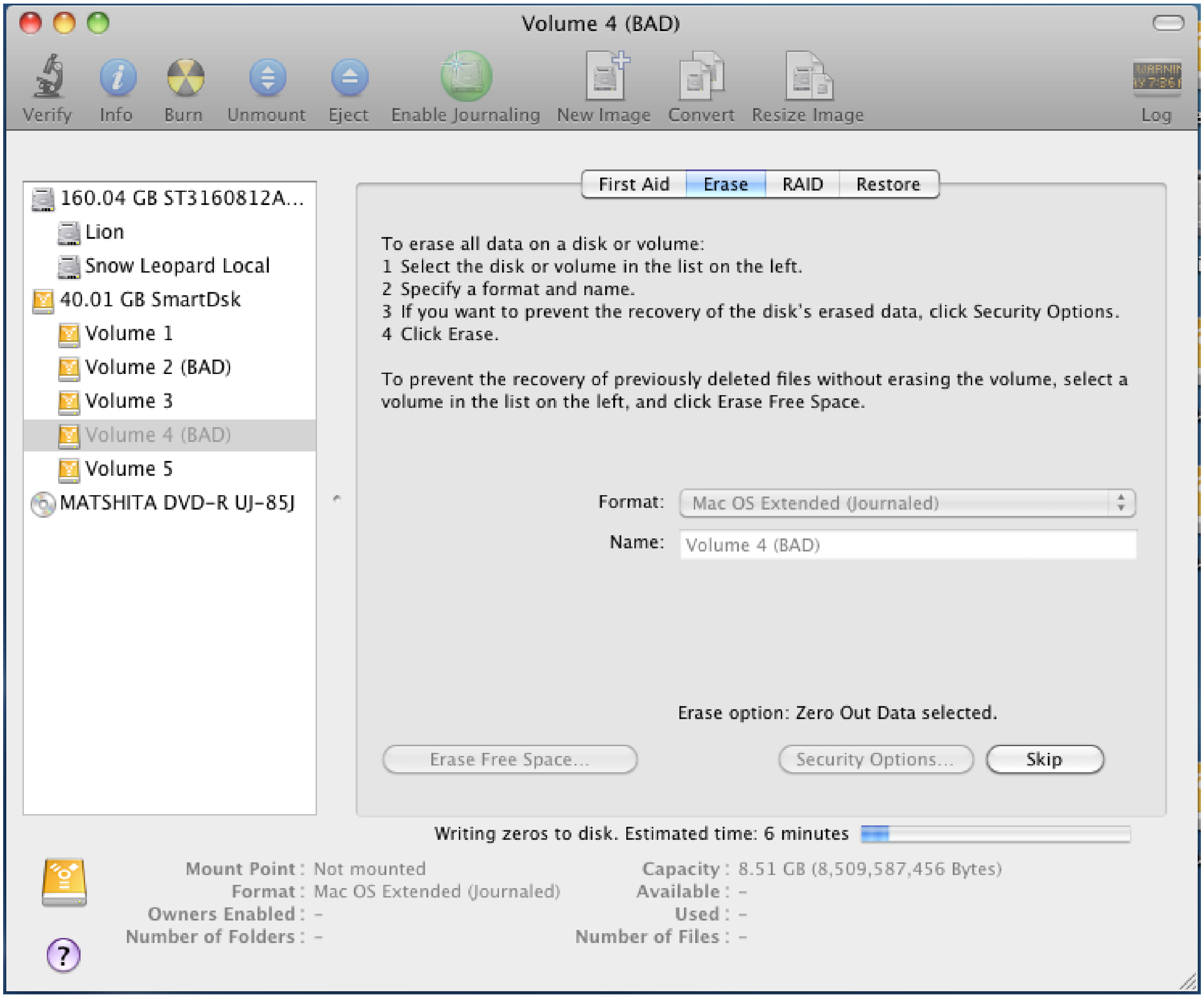

Figure 4-12
Zeroing Underway on a Bad Drive Volume

Notice that the text to the left of the progress bar indicates that it is writing zeros to the drive. Compare this text and the progress bar to that in the next screen shot.

In the screen shot below, the drive came across sector damage that couldn't be repaired. Audibly, we could hear the drive attempting and re-attempting to write sectors to the drive, until finally Disk Utility gave up on it.

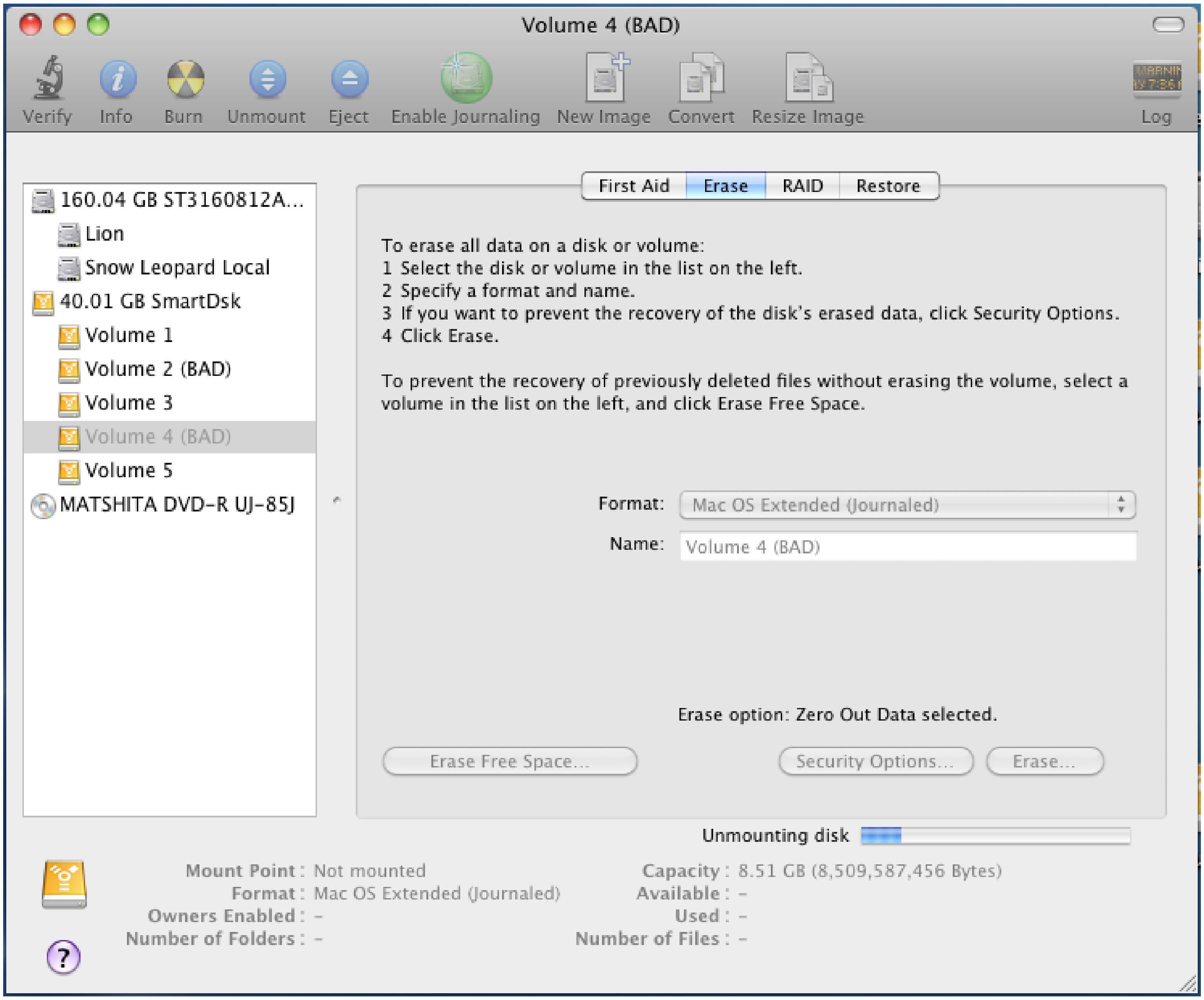

Figure 4-13
Zeroing Underway

Notice that the the text to the left of the progress bar has changed. It no longer says it's zeroing the drive, it says it's unmounting the disk, even though the progress indicator indicates the operation isn't complete. Disk Utility stayed in this state for roughly five minutes.

Finally, Disk Utility brought up the dialog shown in the screen shot below.

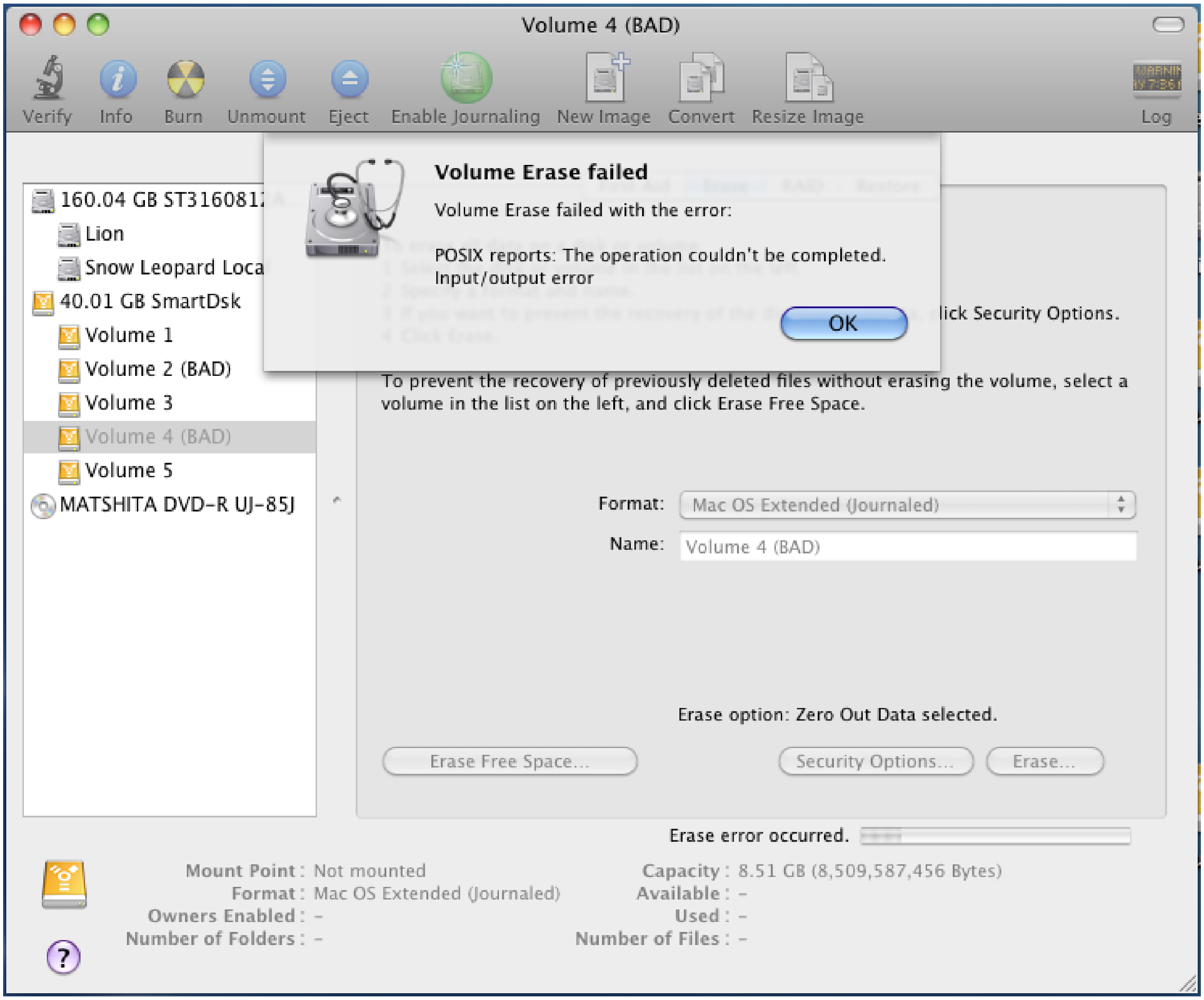

Figure 4-14
Failure Due to I/O Error Reported

This indicates that the drive can't complete the zeroing operation. It should be re-emphasized that a fair number of newer drives seem to be better equipped to report their failures to ***Disk Utility***.

Appendix A
Failure Tables

Tables A-1 through A-5 summarize the types of problems one might encounter when troubleshooting a hard drive problem. Each table has a column identifying how the problem will manifest itself at boot time after the event causing the problem occurred, and another column identifying how the problem will manifest itself if it occurs while the system is in use.

The term ***Raw Hard Drive*** refers to the actual hard drive being evaluated, whether inside a unit (internal) or housed in an external enclosure (external hard drive). Anything under that table thus applies to both internal and external hard drives.

Raw Hard Drive

Problem Description	Behavior at Boot After Fault Occurred	Behavior if Fault Occurs While in Use
Burned out controller or controller components	Drive and volumes not seen by system	Drive drops out permanently with possible system lockup
Complete electro-mechanical malfunction	Drive and volumes not seen by system	Drive drops out permanently, with possible system lockup, noise
Intermittent faults associated with drive controller connectors, traces, cables, and solder joints	Intermittent booting on bootable drives, erratic visibility on non-bootable drives	Periodic excessive delays, system lockup, drive may drop out, scatter in test results
Excessive physical damage	Drive and volumes not seen by system	Likely never accessible after being damaged
Drive never formatted	Drive not seen by system	Drive not seen by system, usually available w/Disk Utility
Unsupported OS or drive format	Drive not seen as bootable by system	Drive not seen by system, available w/Disk Utility and Scannerz
Drive has been erased	Drive not seen as bootable by system	Drive will be seen as an empty hard drive
Drive not receiving power	Drive not seen by system	Drive will drop out, system lockup possible
Drive not sending or receiving data	Drive not seen by system	Drive will drop out, system lockup possible
Boot region/indices corrupt	Drive not seen by system	System may lock up during use, file loss, data corruption
Minor head crash	Unless in start of drive, normal startup and access	Delays, file errors, I/O errors, very slow response, test scans provide repeatable results – no scatter
Mechanically failing but not failed	Periods of excessive noise	Noise during use, delays, lockup, corrupt data, test scans may be consistent or inconsistent

Table A-1

Logic Board Components

Problem Description	Behavior at Boot After Fault Occurred	Behavior if Fault Occurs While in Use
Intermittent failures in data traces, connectors, solder	Possible erratic boot, drive periodically not seen	Intermittent delays, possible system lockups, test results display scatter
Complete failure in data traces, connections, solder	Drive and volumes not seen by system	Drive drops out permanently, with possible lockup
Intermittent faults in power traces, connections, solder	Intermittent booting, drive may be invisible periodically	Drive intermittently locks up, system may lockup
Complete failure in power traces, connections, solder	Drive and volumes not seen by system	Drive drops out, system lockup likely
FireWire output stage blown	Drive not seen by system	Drive drops out, system lockup likely
FireWire port has intermittent faults in connectors, traces, or solder joints	Intermittent booting, drive may be invisible periodically	Intermittent delays, possible system lockups, scatter in test results
FireWire connector broken or damaged	Drive not seen by system	Drive will drop from system, port will be unusable
USB port has intermittent faults in connectors, traces, or solder joints	Intermittent booting, drive may be invisible periodically	Intermittent delays, possible system lockups, scatter in test results
USB connector broken or damaged	Drive not seen by system	Drive will drop from system, port will be unusable
Power supply has intermittent faults in connectors, traces, or solder joints	System will start and boot erratically	Intermittent system lock up or complete shut down
Complete failure of power supply component	System won't start, or appears to partially start	System lock up or instantaneous shut down
NVRAM/PRAM settings invalid	Some drives not seen by system at boot	Generally not applicable

Table A-2

Internal Drive Cable and Wiring Problems

Problem Description	Behavior at Boot After Fault Occurred	Behavior if Fault Occurs While in Use
Intermittent failures in data cable or connector ends	Possible erratic boot, drive periodically not seen	Intermittent delays, possible system lockups, drive may drop out, scatter in tests
Complete failure in data cable or connector ends	Drive and volumes not seen by system	Drive drops out permanently, with possible lockup
Intermittent faults in power cables or connectors	Intermittent booting, drive may be invisible periodically	Drive locks up, system may lockup completely, drive drops out
Complete failure in power cables or connectors	Drive and volumes not seen by system	Drive drops out, system lockup likely

Table A-3

External Drive I/O Cable and Power Cable Problems

Problem Description	Behavior at Boot After Fault Occurred	Behavior if Fault Occurs While in Use
Intermittent failures in data cable or connector ends	Possible erratic boot, drive periodically not seen	Intermittent delays, possible system lockups, scatter in test results
Complete failure in data cable or connector ends	Drive and volumes not seen by system	Drive drops out permanently, with possible lockup
Data cable not properly plugged in	Drive and volumes not seen by system	Drive drops out, with possible lockup
Intermittent faults in power cables or connectors	Intermittent booting, drive may be invisible periodically	Drive locks up, system may lockup completely
Complete failure in power cables or connectors	Drive and volumes not seen by system	Drive drops out, system lockup likely
Power supply cable not properly plugged in	Drive and volumes not seen by system	Drive drops out, with possible lockup

Table A-4A

External Drive Housing Interface and Supply Problems

Problem Description	Behavior at Boot After Fault Occurred	Behavior if Fault Occurs While in Use
Intermittent failures in interfaces, cables, and connections	Possible erratic boot, drive periodically not seen	Intermittent delays, possible system lockups, scatter in test results
Complete failure in interfaces, cables, and connections	Drive and volumes not seen by system	Drive drops out permanently, with possible lockup
Intermittent faults in power cables or connectors	Intermittent booting, drive may be invisible periodically	Drive locks up, system may lockup, partial or complete
Complete failure in power cables or connectors	Drive and volumes not seen by system	Drive drops out, system lockup possible.
Insufficient power to self powered unit	Drive and volumes not seen by system	Would require cable to disconnect, making drive drop out

Table A-4B

Software and Resource Problems

Problem Description	Behavior if Fault Occurs During Boot	Behavior if Fault Occurs While in Use
Anti-virus software conflicts with applications	System may become very slow to boot or stop booting	Software may block or delay, scatter with irregularities but no errors (ever)
Spotlight indexing constantly intensive	May slow startup time	General system slow down, excessive times loading and running applications
Thread deadlock in faulty application	Not applicable unless application launched at boot	System becomes partially or completely unresponsive
User running out of free disk space from normal use	Very slow boot, not bootable in extreme cases	System will slow down excessively, possible lockup
User running out of memory from normal use	Usually not applicable unless the problematic applications launch at boot time	System slows down to a crawl, may lockup
Rogue or unknown application overly drive intensive	Usually not applicable unless problematic applications start at boot	Very slow response for all other applications running, scatter will occur during Scannerz surface scan test with irregularities but no errors. FSE-Lite may detect application name
Rogue or unknown application consuming too much memory	Usually not applicable unless problematic applications start at boot	As memory is consumed drive activity increases, lockup possible. FSE-Lite may detect application name as swapping becomes rampant
Rogue or unknown application consuming too much drive space	Usually not applicable unless problematic applications have used up entire drive	As drive space approaches limits, system gets slower eventually locking up. FSE-Lite may detect application name

Table A-5