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**User's Guide and
Reference Manual**

TECHTOOL PRO

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Installation and System Requirements

Introduction

Thank you for purchasing TechTool Pro! We have worked hard to make TechTool Pro the most powerful and easy-to-use problem-solving utility available for the Macintosh. With TechTool Pro you will be able to:

- Protect your computer and data.
- Create an emergency repair partition.
- Diagnose and repair problems with your drives.
- Optimize your drives.
- Clone a volume.
- Recover data from damaged drives.
- See what devices and services are running on your local network.
- Test critical computer components and sub-systems.
- Perform routine maintenance on your computer.
- Determine the cause of problems that cause your Macintosh to crash.
- Test new equipment.
- Make sure that your computer is running as fast as it should be.

Most importantly, TechTool Pro allows you to test your computer like a professional without the need of years of experience or a computer degree. TechTool Pro allows you to check a variety of components in your Macintosh with a simple click of your mouse. When TechTool Pro finds a problem with your computer it will suggest steps you can

take to correct the situation.

Consider TechTool Pro your personal Macintosh technician—always ready to help and only a mouse click away.

System Requirements

- PowerPC G4 processor or newer.
- Mac OS X 10.5 or greater.
- DVD-ROM drive.
- 512 Megabytes RAM or higher.
- Quartz Extreme graphics support.
- Booting from TechTool Pro DVD requires support for Mac OS X 10.5 or greater.

These requirements may change with future updates.

Installing TechTool Pro

TechTool Pro uses an automated installer to place the TechTool Pro application and any ancillary files in their proper locations.



NOTE If you suspect that your hard drive is damaged or that there may be other computer problems, do not install TechTool Pro until it is repaired. We recommend that you run TechTool Pro before installation to verify that your desired installation volume does not have any problems. To do this, you may start up and run TechTool Pro directly from the program DVD. Instructions for starting up from

the DVD are printed on the face of the DVD. For instructions on running a check of the computer see the Sample Diagnostics Section under Using TechTool Pro later in this manual.

For instructions on burning a DVD from a downloaded copy of TechTool Pro, see below.

To install:

- Insert the TechTool Pro DVD.
- Double-click on the TechTool Pro Installer icon.



- Enter your administrator password when prompted.
- Read the explanatory text on the installer screens and follow the prompts.

TechTool Pro will be installed in the Applications folder on the startup volume.



NOTE The TechTool Pro Installer contains an Uninstall option. To Uninstall TechTool Pro, click the "Customize" button on the third page of the Main Install screen.



Then choose "Remove TechTool Pro..."



NOTE Next, uncheck “Install TechTool Pro,” and check “Remove TechTool Pro”



TechTool Protection

When you launch the installed TechTool Pro application, the program checks to see if the TechTool Protection is installed. If it is not, a dialog appears giving you the option to install TechTool Protection. TechTool Protection includes program functions that operate automatically in the background, such as periodic hard drive SMART checks, Volume Usage, Trash History, etc. These functions are configured via the TechTool Protection pane that is installed in the System Preferences. You can choose Cancel if you do not wish to install TechTool Protection at this time.

Burning a TechTool Pro DVD

If you purchased your copy of TechTool Pro as a downloadable DVD, you will need to follow these instructions to create a bootable DVD.

To create a physical bootable DVD from the TechTool Pro 6 DVD disc image you will need a blank DVD-R or DVD-RW disc. The DVD you create will contain Mac OS X 10.6.7 for Intel-based Macs as its operating system, or Mac OS X 10.5.8 as its operating system in order to boot PowerPC-based Macs capable of running Mac OS X 10.5.x.

To create the TechTool Pro 6 DVD (Intel):

1. Launch Disk Utility (located in the Utilities folder inside of your Applications folder).
2. Double-click the “.dmg” file disc image you downloaded and allow it to verify and mount on the Desktop.
3. In Disk Utility, select the .dmg file from the drive list.
4. Click the “Burn” icon (located in the upper left corner of the Disk Utility window).
5. Insert a blank DVD into your computer’s DVD drive and then click Burn.
6. Once the burning process has finished, your Mac should eject the DVD.

To create the TechTool Pro 6 DVD (PowerPC):

1. Double click the “.dmg” file you downloaded so that the TechTool Pro DVD image mounts to your desktop.
2. Copy the TechTool Pro 6 DVD (PPC).dmg file from the Extras folder to your Desktop.
3. Once the copy of the TechTool Pro 6 DVD (PPC).dmg has completed, eject the TechTool Pro 6 DVD image.
4. Launch Disk Utility (located in the Utilities folder inside of your Applications folder).
5. Double-click the TechTool Pro 6 DVD (PPC).dmg disc image and allow it verify and mount on the desktop.
6. In Disk Utility, select TechTool Pro 6 DVD (PPC).dmg from the drive list.
7. Click the “Burn” icon (located in the upper left corner of the Disk Utility window).
8. Insert a blank DVD into your computer’s DVD drive and then click Burn.
9. Once the burning process has finished, your Mac should eject the DVD.



NOTE The TechTool Pro DVD does not support Macs which shipped with Mac OS X 10.7 or newer. It is recommended to use the eDrive instead.

What's Installed

When you install TechTool Pro you install the TechTool Pro program package. This contains the main program components in one convenient location on your hard drive.



By default, the TechTool Pro package is installed in the Applications folder on your startup volume:

- Applications/TechTool Pro

The program's preferences are stored on a per user basis in:

- ~/Library/Preferences/com.micromat.techtoolpro.plist file

The TechTool Pro Report will be stored in:

~/Library/Application Support/TechTool Pro/
TechTool Pro.reports

If you install TechTool Protection, the following files will be installed:

- ~/Library/PreferencePanes/TechTool Protection.prefPane

Personalization and Registration

The first time you launch TechTool Pro, you will be prompted to enter your serial number. Your serial number is your proof of ownership of TechTool Pro. Keep it in a safe place since you may need it when you make future updates or upgrades. If you lose your serial number, we may be able to provide it to you if it is registered. In addition, registration is required to receive free technical support for TechTool Pro. (This is subject to change without notification.)

You may register your serial number online. Simply direct your browser to the Micromat web site at www.micromat.com.

If you do not have internet access, you may call Micromat Sales at 707-304-5993 and ask them to register for you.

Contacting Technical Support

Micromat provides technical support to its customers by telephone or email. For a current listing of telephone numbers and other contact information, please visit our website at www.micromat.com. Technical support is available Monday through Friday (excluding public holidays), from 9:00 AM to 5:00 PM PT.

If you wish to contact technical support by telephone you will need to have your TechTool Pro serial number and version number ready. Our automated phone attendant will require you to enter this information before connecting you to a technician. Please be near your computer when you phone, since our technicians will need to ask you questions about your system, and will attempt to guide you through solving any problems.

Please have the following information ready for the support technician, and be sure to include it in any email you send to Micromat.

- A brief description of your problem.
- Version number of your TechTool Pro software.
- Type of Macintosh and configuration. (Example: Intel iMac 3.06GHz, 2GB RAM, 500GB hard drive.)

About Micromat Inc.

Micromat Computer Systems Inc. has been developing Macintosh diagnostic utilities since 1989. As the first company to offer diagnostic products for Macintosh, Micromat has pioneered many new technologies for helping Macintosh users bring their computers back to life and to keep them running their absolute best.

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Overview of TechTool Pro

Summary of Features

TechTool Pro is a full-featured computer diagnostic and repair utility. It includes routines to check your computer's hardware, software, and peripherals. If TechTool Pro finds problems with your computer system, it will let you know and will provide straightforward advice on how to proceed. If the problems are of a type that may be repairable by software, then TechTool Pro will offer you the option to attempt repairs.

TechTool Pro can perform a number of automatic checks and routines. These are designed to forewarn you of impending problems and to increase the chances of successful data recovery and repair in the case of disaster. These automatic features are fully configurable by you.

TechTool Pro also includes a number of features that allow you to more effectively work with your computer and data. These include defragmentation and optimization to enhance drive performance, data recovery routines to rescue data from damaged drives, and Wipe Data to securely delete sensitive information. You may even set up an emergency boot partition on your drive (without reinitializing your drive) that includes TechTool Pro. Then, if problems arise, you can boot from the emergency partition and use TechTool Pro to attempt data recovery and/or repairs.

TechTool Pro Interface

Even though TechTool Pro is an extremely powerful program, it is designed to be easy to use. When you launch the program you will see the TechTool Pro application window.



There are three main categories available within the TechTool Pro program itself—Tests, Tools, and Reports. When you launch the program the Tests window appears. Use the Category Selector bar in the upper left corner of the window to change categories as desired.

At the bottom of the application window is a bar graph for each processor core. This graph displays processor use for each core in real time.




In addition to the three TechTool Pro categories, there is the TechTool Protection pane in the System Preferences. This is where you configure the automatic background routines of TechTool Pro.

The Tests category is where you configure and perform tests to check the functioning of your computer's hardware, check for volume corruption, etc. The Tools category is where you perform various stand-alone functions such as data recovery, file/volume defragmentation, eDrive creation, etc. The Reports window displays test results and other feedback from operations performed in the Tests and Tools categories. The report information is displayed in a tabular sortable format.

The Tests and Tools windows are divided into three main areas. The top half of the window is the Stage. This is where you view feedback about the currently running operation. Multiple tests can be queued up and the queue is displayed in the lower area of the stage. Tests are performed from left to right. Hovering the cursor above a queued item pops up a tooltip providing details about the particular test. Tools cannot be queued since they should not be interrupted as they perform their specific function. To the left beneath the stage is the Task Selection list.

Select the Test or Tool that you wish to use from the list. Configurable options for that function will appear to the right in the Configuration area. Once configuration is complete, click the appropriate button in the Configuration window to add the test to the queue or to begin using the selected tool. Items in the test queue are automatically executed in the order they were chosen—left to right. You can remove a test from the queue by clicking the cancel button to the lower right of the queued test icon. You can cancel all queued tests, including the currently executing

test, by clicking the Stop button  on the lower right side of the stage.

As TechTool Pro performs its various tests and other functions, it keeps track of what is done and what is found. This information can be examined in the TechTool Pro Reports window. The Reports window summarizes the results of all tests and is covered in detail in the Reference section of this manual. Select the Reports category from the Category Selector bar in the upper left side of the program window to view the report.



NOTE Because some TechTool Pro operations need low-level access to the computer, they require system privileges in order to run. When this is necessary, TechTool Pro will display a dialog requesting the password for an administrator account. For security reasons, Mac OS X only keeps system level privileges active for a certain amount of time. Consequently, you may need to re-enter the ad-

administrator password more than once as you use TechTool Pro.

Online help is available for TechTool Pro through the Apple Help Center. Simply choose TechTool Pro Help from the Help menu while running an installed copy of TechTool Pro. This will bring up the TechTool Pro Help screen with indexed and searchable online documentation. Note that online help is not available when running the program while booted to the TechTool Pro DVD.

TechTool Pro Manual

The TechTool Pro manual is written for the typical Macintosh user. It assumes that you are familiar with the basic operation of your Macintosh and Mac OS X. The manual explains the many features of TechTool Pro and how to use the program effectively.

The first five sections of the manual are introductory. They include installation instructions, an overview of the program, and general troubleshooting information. The following seven sections, from Tests to Menu Options, are the main reference portion of the manual. They provide detailed explanations about each of the program's features. The next two sections include commonly asked questions, tips, shortcuts, and hidden features. These are followed by an overview of the Macintosh file system. This section is fairly technical and may be of interest if you want more details about the inner working of the file system. An understanding of the file system provides a better

understanding of the types of problems that may occur with the volume structures and also the issues that must be addressed when repairing them. The manual ends with a glossary, which explains the technical terms used in the manual, and an index.

As you read through the manual you will encounter two special icons:



Pay close attention when you see this icon. It indicates that the information that follows is extremely important. You should read and understand it before proceeding. Failure to do so could lead to improper use of the program and possible loss of data.



This icon indicates that the information to follow provides clarification or supplemental information. Although the information may not be critical, it is highly recommended that you read it in order to use the program most effectively.

Troubleshooting Using TechTool Pro

Preventive Maintenance

One of the most valuable functions of TechTool Pro is its ability to assist you in finding and repairing problems with your computer before they get out of hand. For maximum protection, it is important that TechTool Pro is actually installed on your system. TechTool Pro includes automatic features that can regularly check your drive hardware and backup volume directories. These features are configurable from the TechTool Protection pane in the System Preferences.

In addition, it is a good idea to run the TechTool Pro tests on a regular basis (for example, monthly) to more thoroughly check your system. This will help ensure that your computer is running at its full potential and minimize the chance of crashes and data loss. Using TechTool Pro's Check Computer you can quickly and easily run a comprehensive set of tests to check your computer for proper operation.

It is critical to keep backups of valuable data. A hard drive will always fail at some point. Although TechTool Pro can often recover your data or bring your drive back to life when this happens, it cannot do the impossible. If the drive has failed mechanically or electronically, then no software can repair it. The insurance and peace of mind provided by a backup is important. A little time spent maintaining backups and checking your system regularly may save you many hours of recovery and repair down the road.

Troubleshooting Hints

Computers are complex electronic devices. Consequently, they can be difficult to troubleshoot. Their proper operation depends on the reliable functioning of both sophisticated hardware and software. TechTool Pro was designed to simplify the process of diagnostics and repair in the event of a computer problem. It can also help you find and correct small problems before they become big problems.

Be sure to backup your data regularly. Consider keeping archival backups. This means that instead of having only one backup you would keep several backups made on different dates. That way if you should discover a file was damaged, and was backed up damaged, then you might be able to locate an undamaged version in a prior backup. It is critical to keep backups since a drive may develop a problem at any time. If the problem is an electronic problem, a mechanical problem, or a volume structure problem that is so serious that it can not be repaired or the data recovered, then a valid backup would be your only recourse.

Following are a few tips to help ensure that your computer is up and running as soon as possible if problems do arise:

Backup Before Repairing

If you are experiencing problems, be sure your backups are current. If possible, immediately backup any important data that is not already saved elsewhere. You may need to

use the data recovery routines in TechTool Pro to do this if your volume does not mount. Do this before performing any repairs. It may be impossible to retrieve your data later if the problems get progressively worse as the computer is used.

Be Prepared

Set up a preventive maintenance routine so that you can locate and address problems before they get too serious. Know where the TechTool Pro DVD is stored in case you need it. Consider using TechTool Pro to set up an emergency eDrive on your hard drive before problems arise. That way you can boot and run the program from the eDrive in the case of problems on your normal startup volume. Keep current backups of your work. Know where to find your TechTool Pro serial number in case you need to call Micromat Technical Support.

Eliminate Easy Problems First

Use TechTool Pro to repair the startup disk's permissions. Log out and then log back in as a different user and see if the problems still occur. There may be a corrupted preference in the original user's account. Start up the computer in Safe mode (holding down the shift key during startup). This disables third party routines that may be causing problems during startup. Run TechTool Pro's Check Computer while booted to the TechTool Pro DVD to see if it reports any problems. It's possible one of the above items will help pinpoint or solve the problem.

Simplify/Isolate

Eliminate as many variables as possible. If your problem appears to be with an internal volume, then power down your machine and disconnect all external devices. If it is with an external drive/volume, then connect only that drive to the computer. Startup and run TechTool Pro from the TechTool Pro DVD or the eDrive. This will eliminate the possibility of system corruption on your normal startup volume when testing.

Keep Your Software Up-to-Date

Many computer problems are actually software problems. The producers of most software release regular updates to address incompatibilities and other issues that they discover. Do your best to have current versions of software, drivers, etc. Staying current may keep problems from developing in the first place. Updating an older piece of software may actually solve a nagging problem.

Make Use of Available Resources

There are many sources of assistance available to help you solve problems. These include local Macintosh Users Groups, specialized newsgroups on the Internet, websites, listservs, and technical support provided by software and hardware vendors.

Document What You Do

As you try to solve your computer problems, keep notes about what you do and the outcomes of these actions. This can be a valuable reference for you later and can be extremely helpful if you need to talk to a technical support representative. Knowing exactly what was done and the results (including any error messages) can make problem solving much easier. In addition, if you have problems at a later time, you may be able to spot a pattern that would otherwise elude you.

Recovering Data from Damaged Drives

Files are more likely to be recoverable by TechTool Pro's data recovery routines if its automatic Protection features have been enabled for your volumes. Configure these options within the TechTool Protection pane of the System Preferences.

Repairing Drive Problems

You probably already understand how critical the proper operation of your hard drive is for your computer. It contains the data that allows the computer to boot, as well as the programs you use and the files you've created. TechTool Pro includes powerful diagnostic and repair routines to keep your drives functioning correctly.

In most cases, this manual will refer to a drive as a "volume." A volume is simply a unit of storage that appears to the computer as one "logical device." The terms "hard

drive" and "volume" are almost interchangeable. Although a hard disk can contain more than one volume (multiple partitions), a volume cannot contain more than one hard drive. (This is not entirely true. Some forms of RAID disk setups can make many drives appear as one volume). DVDs and CDs may also appear as one or more volumes.

When you view the contents of a volume in the Finder, you're not typically seeing everything on the volume. Every volume contains many invisible files and data files. This allows the computer to access the data on that particular volume. Items such as the file catalog or directory, the extents B-tree, and a host of other objects, dictate how data is stored on a particular device (see the Glossary section of this manual for definitions of these terms). These items comprise the "volume structures" of a volume. In most cases, when a drive fails and then is repaired by a utility such as TechTool Pro, it is not the physical drive itself that is being repaired. It is the software that makes up the volume structures. If there is a problem with the structure of a volume, it can prevent the computer from being able to boot or prevent you from having access to your data. If there is an actual problem with the physical drive, like an electrical or mechanical problem, software will not be able to correct the problem. TechTool Pro is unique in that it can check the mechanical and electronic aspects of a drive, as well as repair the volume structures.

To check for disk problems, run the Surface Scan test, the SMART check (if applicable), and the Volume Structures test. These tests do a thorough check of the drive hard-

ware and should locate any problems within a volume's directories. If TechTool Pro finds problems, it will let you know and provide advice on how to proceed. It would be wise at this point to stop and make a backup of your important files if necessary. If the problem was a volume structure problem, you could attempt to repair it using the Volume Rebuild tool in TechTool Pro. If it appears that a repair is possible, TechTool Pro will provide feedback about the changes it proposes to make. If you're satisfied that the proposed repairs appear reasonable, then go ahead and accept them.

After a successful repair the volume will be in good shape. If the volume structures cannot be repaired, you should reinitialize the volume and restore your data.

Optimization

In order to gain maximum performance from a hard drive volume, it is a good idea to defragment/optimize it occasionally. This can be particularly important when working with multimedia files where maximum data throughput is critical. If a multimedia file is fragmented, then it may not be able to be read fast enough from the drive for smooth playback. This can lead to dropped video frames or to gaps in audio playback.

Optimization rearranges the data on the volume so that the data for each file resides sequentially on a contiguous area of the drive and the free space is consolidated. Optimization is available in the Tools section of TechTool Pro.

Before optimizing, always check the volume structures of the volume (and repair if necessary). The volume structure tests are found in the Tests section of TechTool Pro. Once the volume passes the volume structure tests it should be safe to optimize it.

Testing Components

For your computer to operate correctly its components must be working properly. TechTool Pro includes a number of tests that will exercise many of the chips and other critical components of your system and let you know if any problems are found. You can easily check your computer's memory, cache, processor, video memory, and much more. Many of these tests are run when TechTool Pro launches. Others, such as the Memory Test, can be performed from within the Tests area of the program.

Using TechTool Pro

Launching TechTool Pro

TechTool Pro will be installed in the Applications folder on your startup volume by default. Do not move the TechTool Pro application out of the Applications folder. To launch TechTool Pro simply double-click on the TechTool Pro program icon in the Applications folder.



The program Installer also adds a TechTool Pro icon to the dock. An alternative method of launching the program is to click on the program icon on the dock.



Sample Diagnostics Section

After launching TechTool Pro you will see the TechTool Pro Application window.



vide information on how to proceed. Information about more in-depth testing and additional features of TechTool Pro is available in the following sections of this manual.

TechTool Pro does a check of a variety of system components automatically on launch. The results of these tests are displayed in the gauges on the stage.

To do a more thorough check of additional components, including your computer's hard drives, as well as any other hard drive connected to your computer, select Check Computer from the Tests category and then click the Check Computer button on the right. This single mouse click initiates a suite of tests that run automatically, one after the other. If problems are found, the Report will pro-




Tests

TechTool Pro includes options to test various hardware components, drives, and other aspects of your computer system. These include tests that run automatically at program launch as well as tests that you select to run from within the Tests category. These testing options are covered below.

Automatic Tests

When you launch TechTool Pro, a group of five hardware tests run automatically. On completion, the test results are displayed on the gauges in the stage area at the top of the screen.

These tests can also be run and the gauges displayed after completion of manual testing by clicking the

refresh button  on the lower right side of the

stage or by pressing the return or enter key. Details of the five tests follow.

USB

USB stands for Universal Serial Bus. It is a medium speed protocol for connecting devices to a computer. USB can operate at 1.5 Mbps or 12 Mbps. The USB 2.0 standard has a raw data rate at 480 Mbps, and the latest USB 3.0 standard a rate of 5 Gbps. USB is present on all recent Macintosh models. In addition, USB ports may be added via PCI cards or as USB hubs attached to existing ports. Typical USB devices include keyboards, mice, joysticks, game pads, and other low-bandwidth, low-cost devices. Unlike FireWire, USB controls peripheral devices in a master/slave relationship. USB offers several benefits such as low cost, expandability, auto-configuration, hot-plugging and outstanding performance. It also provides power to the bus, enabling many peripherals to operate without the added need for an AC power adapter.

TechTool Pro checks the built-in USB bus in your computer to ensure that it is functioning. If the test passes, the speed of the USB interface is displayed in the USB gauge. If the test fails or if no USB interface is recognized, this will be indicated on the gauge. TechTool Pro cannot test the functioning of the USB ports since this would require additional hardware.

Cache

Cache is fast RAM (random-access memory) that is used to store data for CPU operations. Cache speeds up processing by storing frequently used instructions. Since the cache is built into the CPU itself, it can be accessed at a faster speed than memory attached to the standard system bus. A good analogy to the cache would be a bulletin board that holds frequently used phone numbers on Post-It™ notes. The numbers would be available on the board for quick reference. That way you would not need to take the time to look them up in the telephone book (analogous to main memory) every time they were needed.

TechTool Pro checks for the presence of cache and, if found, tests it and displays its speed on the Cache gauge. If the cache tests fail or if no cache is detected, this will be indicated on the gauge.

Processor

Every computer contains one or more CPUs (Central Processing Units). These are the “brains” of your computer. If more than one processor is present, they may reside on individual chips (such as in a dual processor G5), may exist as multiple cores on one chip (such as in an Intel Core 2 Duo iMac), or both (such as in a Dual Quad Core Mac Pro). The CPU is the main component that dictates a machine’s overall speed of operation. A slower CPU with an efficient instruction set may actually provide better performance than a faster CPU with a less efficient design.

Although the CPU is the master component in a computer, its function is easily understood. It takes data supplied by other components, moves it, does simple logical operations or math operations, and outputs the results. The magic lies in the vast amount of data processing it can do in a very short amount of time. Your CPU processes millions of instructions per second. Although each individual instruction is very simple, the fact that so many calculations are done so quickly allows your computer to perform extremely complex tasks within a reasonable amount of time.

TechTool Pro verifies the operation of your CPU chip(s) with both machine-level native instruction tests and more complex system-level data operations. When the Processor tests complete, the processor speed is displayed on the Processor gauge.

Network

All Mac OS X capable computers include Ethernet networking capability. The ability to print, communicate with other computers in your local network, and connect to internet services is dependent on proper configuration and operation of the networking components.

Ethernet is the most widely installed local area network (LAN) technology. Ethernet was originally developed by Xerox and is specified in the IEEE 802.3 standard. An Ethernet LAN may be hardwired using a variety of cable types or it may be wireless. The most common Ethernet systems

use 10Base-T cabling and provide transmissions speeds of up to 10 Mbps. Fast Ethernet or 100Base-T provides speeds of up to 100 Mbps, Gigabit Ethernet supports up to 1000 Mbps, and 10-Gigabit Ethernet goes all the way to 10 billion bits per second.

AirPort is Apple's name for the IEEE 802.11 wireless networking standard. The original AirPort implementation released in 1999 is based on the IEEE specification 802.11b. It transmits data at a maximum speed of 11 Mbps and has a typical range of 100 feet. The newer AirPort Extreme released in 2003 is based on the 802.11g specification. It has a maximum speed of 54 Mbps and range of 50 feet at full speed. The newest AirPort devices are based on the 802.11n protocol which increases performance even further to a maximum of 600 Mbps. Both AirPort and AirPort Extreme transmit on one of 11 channels in the 2.4 GHz band.

The Network test performs the following functions on the built-in network interface:

- Network Check 1—This test checks the availability of the network services for the system.
- Network Check 2—This test checks whether a network host name is reachable using the current network configuration.



NOTE It is necessary to have at least one other network device attached (printer, router, or another computer) to use these tests since it is necessary to query another device to determine communication abilities.

When the tests complete, the speed of the network interface is displayed on the Network gauge. For multiple network interfaces, the fastest one is displayed. If the test fails or if no network interface is detected, this will be displayed as well.

Note that TechTool Pro cannot test the networking hardware itself. This requires specialized test equipment. If the problem appears to be faulty hardware you will probably need to contact a qualified technician.

FireWire

FireWire is a cross-platform implementation of the high-speed serial data bus defined by IEEE Standard 1394. FireWire was conceived by Apple and then developed within the IEEE 1394 Working Group. It can move large amounts of data between computers and peripheral devices. It features simplified cabling, hot swapping, and transfer speeds of up to 400 Mbps. The newer IEEE 1394b specification, termed FireWire 800 by Apple, handles data rates of 800 Mbps.

FireWire is integrated into most recent Macintosh models. Most of these machines include FireWire ports that operate at up to 800 Mbps, although earlier models may use the 400 Mbps interface. FireWire ports may also be added via PCI cards or FireWire hubs attached to existing ports.

The high data transfer speed of FireWire makes it great for use with multimedia peripherals such as digital video cameras and other high-speed devices such as hard disk

drives and scanners.

TechTool Pro checks the built-in FireWire bus in your computer to ensure that it is functioning. Note that the program itself cannot check the FireWire ports to verify that data is being sent and received properly. This would require special loopback hardware not normally available.

If the tests pass, the speed of the FireWire interface is displayed in the FireWire gauge. If the test fails or if no FireWire interface is detected, this will be indicated on the gauge.

Manual Testing

To run any of TechTool Pro's manual tests, click the Tests tab if necessary to display the Test Selection window. Select a test from the Test Selection list and configure it as desired in the Test Configuration window to the right. Then click the Run button in the Configuration window to add the test to the test queue. An individual test can be stopped as it is running by pressing the Stop button



on the lower right of the test icon in the queue.

All queued tests can be stopped by pressing the large Stop button on the lower right side of the stage. As a test runs, progress information is displayed on the stage. Upon completion of a test or group of tests, the results are displayed in the Job Results From Last Run window on the left side of the stage. Selecting a test from this list displays

detailed test results on the right side of the stage. All test results are also stored in the TechTool Pro Report. The report can be viewed by selecting the Reports category. Details about the individual tests follow.



Check Computer

In addition to the hardware checks that are done automatically at program launch, you can use Check Computer to easily run a more intensive group of tests to check other components of your computer, including drive and volume tests. You might consider using Check Computer once or twice a month as part of a program of preventive maintenance for your computer. Even though problems with your computer may not be apparent, they could be developing in the background. It is best to find and correct them at the first opportunity, before they become so severe that you lose data and/or they may no longer be correctable. All that is required to do a comprehensive suite of tests with TechTool Pro is one click of the mouse.

Choose Check Computer from the Tests category to bring up the Check Computer Configuration screen.



The Configuration screen displays an image of your computer with the computer model and date of manufacturer listed below (this information may not be available if the computer's logic board has been replaced). An icon for each hard drive attached to the computer appears to the right of the computer graphic. Hover the cursor over a drive icon to reveal a tooltip displaying the drive identifier, connection type, and volumes on the drive.

Click the Check Computer button to queue up and run all tests on the computer and all available volumes/drives. Feedback about the tests is displayed on the stage as the tests are run. Progress and result information are listed there.

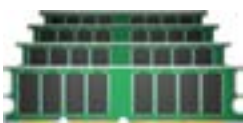


At the conclusion of the tests, all results are saved to the Report. Any test failures are listed there, along with advice on how to proceed.

The following tests are run by Check Computer.

- Memory Test—checks the computer's available RAM.
- Surface Scan—checks attached available hard drives for physical bad blocks.
- SMART Check—checks the built-in hard drive SMART parameters.
- Volume Structures—checks all attached available Macintosh formatted volumes for directory corruption. Note that this test cannot be performed on the current startup volume, since it requires unmounting the volume. Boot the computer and run the test from another location (such as an eDrive or the TechTool Pro DVD) to test the normal startup volume.
- Video Memory—checks the video RAM.
- File Structures—checks for specific file type corruption.

For further details about a test, refer to the specific test's description later in this manual.



Memory Test

Random Access Memory (RAM) is one of the most important components in your computer. Because almost every operation done on a computer passes through RAM, its

accuracy is critical to the proper operation of your computer. It is also one of the components most susceptible to damage and failure. This is because RAM upgrades are common and hence RAM is handled more than most other components. RAM is extremely susceptible to damage from static electricity and handling it can expose it to this hazard. Also, like any chip, RAM is susceptible to overheating and thermal fluctuations.

Most other failures on your computer are more obvious than a RAM failure. For example, if your hard drive begins to malfunction, you will probably start to see read and write errors appear via dialogs displaying messages like, “Could not write file because of a disk error.” However, RAM errors are much less obvious since software uses different areas of RAM at different times. RAM problems usually manifest as unexplained and inconsistent crashes. There is no clear error message indicating a RAM failure.

RAM is very susceptible to damage. Static, heat and even normal air moisture can damage the RAM used to store your Mac’s workspace. It is possible that damaged RAM will prevent your Mac from booting. However, the most common symptom of bad RAM is much more subtle. Usually, the symptom will be an inexplicable system freeze that is difficult to reproduce consistently. Conventional troubleshooting techniques won’t isolate the problem. In fact, standard techniques will prove to be more frustrating since the problem appears only intermittently, leading you to believe you’ve solved it only to discover later that the problem still exists and manifests somewhere else.

Unlike physically damaged storage areas on your hard drive that can be remapped by software so that they are no longer used, faulty RAM bits cannot be mapped out of use. While a technician with adequate equipment and replacement components can repair a RAM module, the cost to do this would greatly outweigh the cost to replace the entire module.

TechTool Pro offers one of the most comprehensive Mac OS X software-based memory testers available for Macintosh. A wide variety of RAM tests allow you to check the available memory in your Macintosh computer. TechTool Pro uses special read/write test patterns designed to exercise the RAM in such a way as to pinpoint specific types of RAM failures. TechTool Pro performs the following tests:

- Address Fault—On the first pass, this test writes the address of each memory cell to that cell itself. On the second pass, the address is read and verified to ensure address space uniqueness.
- Checkerboard—This test makes four passes. The first writes a pattern (different for each run). The second pass reads/verifies the pattern and writes the inverse of the original pattern. The third round travels downward back through memory as it reads/verifies the inverse and then writes the original pattern. Finally, the fourth round verifies the original pattern.
- Extended March C—This test uses a complex algorithm consisting of six passes through memory. It moves upwards through memory during the first three passes, writing and reading/verifying either zeroes or ones. The next two passes move downward, reading/writing ones and zeros again

(alternatively). The final pass may travel either direction, verifying that the last write was successful. This test detects address faults, coupling faults, stuck-at faults, stuck-open faults, and transition faults.

- **MATS++**—This test makes three passes through memory. The first moves downward writing zeroes. The second moves upward, reading/verifying zeroes and writing ones. The third moves downward, reading/verifying the ones written in the last pass and then immediately writes/verifies zeroes at each cell.
- **Moving Inversion**—This test first moves upward through memory writing an alternating pattern of zeroes and ones. The second pass moves upward reading/verifying the pattern and then writing the inverse of the original pattern. The third pass moves downward through memory reading/verifying the inverse and then writing the original pattern. The fourth pass moves back down through memory reading/verifying the original pattern.
- **Sliding (Walking 1's)**—Since bytes are eight bits and this test uses two passes to write/verify each pattern and two passes to write/verify the inverse of each pattern, it makes thirty-two passes through memory in eight rounds. Starting with the bit pattern 00000001, each memory cell is written and read to verify the pattern. This pattern is then inverted to 11111110 and written/verified. Then the 1 is slid up one position and the process repeated for a total of eight rounds. This algorithm was chosen to ensure that each bit of a particular memory cell can hold and maintain the value opposite that of its neighboring bits.

Choose Memory Test in the Tests category to display the Memory Test Configuration screen.



Select the length of time you would like the test to run from the Duration pop-down menu and click the Run Memory Test to add the test to the test queue. Memory problems are often intermittent, so the longer the test runs, the greater the chance of detecting an existing memory problem.

As the tests run, a graphic of the memory configuration for your computer is displayed on the stage, including how the slots are populated and the type and size of any memory installed. In particular, the following information is shown:

- Slot identifier and whether or not a module is installed.
- Module size at that location (if present).
- Type of module at that location (if present).
- Module model at that location (if present).

The individual memory test that is running and the time remaining to complete the testing is shown in the upper left area of the stage.



If you wish to stop the test, click the cancel button on the memory test icon in the queue.

When the tests complete, the results will be displayed in the Memory Results area on the right side of the stage (along with a graphical representation of the results) and in the Job Results From Last Run pane on the left.



Upon completion of testing, the test results are saved to the Report.



Surface Scan

TechTool Pro can do a Surface Scan test of your hard drives to check them for bad blocks. Bad blocks are areas of media that cannot store data reliably. All hard disks have a few bad blocks when they are created. These are “mapped-out” by the manufacturer at the factory or when a drive is reinitialized using the “zero all data” option. Mapping out bad blocks stores their location in a “bad block table.” Once a bad block is mapped out, data is no longer written to that defective area of the disk. Occasionally a good block will go bad. If this occurs in a block storing a file, the file may be corrupted.

The Surface Scan test in TechTool Pro scans your physical drives for bad blocks and reports if any are found. In addition, if a file resides in the area of a bad block, the program will let you know the file name. The Surface Scan test reads data from every block on the drive to check the integrity of the drive surface.

Choose Surface Scan from the Tests category to display the Surface Scan Configuration screen.



All recognized hard drives are displayed on the left side of the configuration screen with any partitions on them indented to the right beneath the drive name. Select the hard drive or volume (particular partition on the hard drive) you wish to test from the list and click the Run Surface Scan button to add the test to the queue. As the test runs, the program scrolls live data being read from the drive across the disk drive image displayed on the center of the stage.



NOTE The Surface Scan test may take several hours to complete on large hard drives since it must read and

check data from every block on the drive.

The pane on the left side of the stage displays information about the drive and test progress. This includes:

- Device description
- Device serial number (if available)
- Number of blocks on the device
- Number of blocks processed
- Elapsed time
- Estimated time to completion

If bad blocks are found, the pane on the right side of the stage displays the block number and, if a file resides in that area, the file name. This information will also be available in the Report once the test completes.

ATA and SATA are the most common types of hard drive. These are typically pre-installed in new Macintosh computers and are generally used in USB and FireWire enclosures. TechTool Pro should not normally report bad blocks for these types of drives. The drive controller in them automatically tries to map out bad blocks as they are encountered. It will do this unless either the bad block is in a critical area that cannot be mapped out at the moment or the bad block table is full. If this occurs, TechTool Pro will report a bad block and you will ultimately need to do a low level reinitialization of the drive. When the drive is reinitialized, the entire platter is accessible so that bad blocks can be mapped out if possible no matter where they occur.



WARNING Reinitializing a drive erases all data on the drive. If possible, be sure to backup your data before reinitializing.

You can use Apple's Disk Utility to reinitialize your drive. Be sure to choose the Security Option to "zero out data." Choosing this option will map out bad blocks, if possible, during the reinitialization. This may take several hours (depending on the size of your drive). If the reinitialization is successful, the drive should be fine at that point. We suggest, however, that you do a Surface Scan a few times in the next month or two just to be sure no new bad blocks are developing. If they are, then the drive is probably failing and you should consider replacing it. If a low level reinitialization fails, this indicates the drive is faulty and needs to be replaced.



SMART Check

SMART stands for Self-Monitoring Analysis and Reporting Technology. This technology was developed through the efforts of the SMART Working Group (SWG), a consortium of major hard disk manufacturers, to increase the reliability of hard drives. SMART routines are now incorporated into most new hard disk drives. Although the SMART

specification was developed by the SWG, each drive manufacturer uses their own proprietary routines in their drives. The routines monitor important drive parameters as a drive operates and stores the results in the drive's SMART registry. An examination and analysis of these parameters can aid in the prediction of drive failure. This could provide the warning you need to backup your data and repair or replace a drive before it fails. It is estimated that SMART monitoring can predict 70% of drive hardware failures before they occur.

SMART technology monitors a drive as it is used and looks for unusual behavior. The routines keep track of disk performance, bad sectors, calibration, CRC (data) errors, disk spin-up time, distance between the head and the disk, temperature, features of the media, heads, motor and servomechanism. For example, motor or bearing failure can be predicted by an increase in the drive spin-up time and the number of retries required to spin-up the drive. Excessive use of error correction routines could indicate a broken drive head or contamination on the head. Spotting these types of errors early may prevent future catastrophe.

The SMART specification also includes drive self-test routines that can be executed to verify that a drive is able to accurately read and write data. The TechTool Pro SMART routines execute a self-test on a drive as well as check on the results stored in its SMART registry. Problems found in either of these areas indicate possible impending drive failure. This advance notice might give you enough time to back up your data before it becomes inaccessible.

Choose SMART Check from the Tests category to display the SMART Check Configuration screen.



Select the drive you wish to test from the drive list on the left. Click the Run SMART Check button to add the test to the queue. As the test runs, a pane on the left side of the stage displays the name of the device being tested, as well as any volumes residing on the device. A pane on the right displays a bar graph showing the results for each SMART parameter.



The graph lists each parameter identifier (if available from the specific drive manufacturer) followed by the parameter number (in parentheses). A green bar indicates that the parameter is well above the failure threshold. As it approaches the threshold, it turns yellow. When the pa-

rameter falls below the failure threshold, it will be shown in red. Upon completion of the test, the results are saved to the Report.

If a drive fails the SMART test and you continue to use it, be sure to keep good backups of the data on the drive. It is possible the drive will fail within the near future. If the failure happens within the drive's warranty period, you might want to consider contacting the drive manufacturer. They will typically replace the drive if it fails SMART.



NOTE SMART is only available for ATA or SATA drives. SCSI drives do not support SMART. FireWire and USB drive interfaces do not pass the SMART calls necessary to perform the SMART test routines even though the drive in the housing may be an ATA drive.



Volume Structures

There are a number of invisible files, settings, and parameters that the Macintosh file system uses to locate files, free disk space, and for other maintenance and management routines on Macintosh volumes. These are known collectively as the "volume structures." The Catalog and Disk Directory are part of the volume structures. Among other things, the volume structures keep track of the folders

and folder hierarchy on a volume, what files are stored on a volume, and where all the individual pieces that make up those files are located. Individual files may actually be stored in many pieces scattered about across the surface of a disk. Damage to a volume's critical data structures can result in lost or damaged files and may even necessitate a complete reinitialization of the volume (which will erase it).

Volume structure damage may manifest in a number of ways. It can appear as missing files or folders. It can show up as file corruption, so that you receive an error when trying to open a file or launch a program. It can lead to problems when trying to copy a file from one location to another or when trying to empty the trash. In the worst case it may make a volume unrecognizable by the system. Generally, volume structure problems get worse over time. It is best to catch them early when chances of recovery and repair will be greatest. For this reason it is a good idea to check the volume structures regularly (perhaps monthly) as part of a program of regular preventive maintenance.

TechTool Pro can scan your volumes for problems related to the numerous structures that are necessary for the volumes to function properly. TechTool Pro will analyze and can often repair problems in the following attributes of a volume:

- **Boot Blocks**—The boot blocks are created when a volume is blessed. If they are corrupted, you may not be able to boot the computer from the volume.
- **Master Directory Block**—This block of data is created when the volume is created and contains important data about the rest of the volume. It is present on all HFS volumes and is similar to the HFS+ Volume Header. Because most HFS+ volumes contain an HFS wrapper, they will contain a Master Directory Block.
- **Volume Header**—This block of data is created when an HFS+ volume is created and contains important data about the rest of the volume such as its name, number of files and folders, and the amount of free space available on the volume.
- **Allocation File (Bitmap)**—This file acts as the main directory. It keeps track of the blocks that are allocated for use and the blocks that are free.
- **Extents File (B-Tree)**—This file contains the extent data for the entire volume. Extents are the separate pieces that make up a discontinuous file.
- **Catalog File (B-Tree)**—This file keeps track of all the files and folders on the volume.
- **Attributes File**—This file tracks all of the attributes of each file and folder on a volume. Some attributes include whether the file is locked and the last time the volume was backed up.

- HFS Wrapper—The parameters within this file contain the information used by the computer ROM to determine what program will boot the computer. In almost every case, this will be configured to point to the System.



NOTE For a detailed explanation of the volume structures see the Macintosh File Systems section later in the manual.

Select Volume Structures in the Tests category to display the Volume Structures Configuration screen.



Select the volume you wish to test and click the Run Volume Structures button to add the test to the queue.



NOTE In order to test the volume structures of a volume, it must be unmounted. This means that you cannot do a volume structure check of the current startup volume. To do this, you must reboot the computer and run TechTool Pro from another volume, such as from an eDrive or the TechTool Pro DVD.



NOTE TechTool Pro may be able to recognize and test volumes that are damaged and do not mount normally on the desktop.

As the test runs, feedback is provided on the stage.



The progress of testing and elapsed time is displayed in the Volume Structures pane on the left side of the stage. The particular area of the volume structures being examined is shown on the right side of the stage in the Validation Progress pane. When an individual test completes, the indicator to the right of the test will turn green if it passed or red if it failed. As the tests run, live data being read from the volume is scrolled across the drive displayed in the center of the stage.

If problems are found on a volume during testing, a failure message appears on the stage at the completion of testing and is also saved in the Reports. In the case of failure, be sure you have important data from that volume backed up (if possible). Then, proceed by using TechTool Pro's Volume Rebuild tool to attempt to repair the problem. If a

volume structure problem cannot be repaired successfully, the next step would be to reinitialize the volume (using Apple's Disk Utility) and restore the data.



Video Memory

VRAM (Video RAM) is memory that holds the image that is displayed on your computer's screen. Like the other critical components of your computer video circuitry, VRAM must always be fully functional for graphics to be correctly displayed. Damaged VRAM can cause missing bits, screen noise, system lock ups, or freezes.

The Video Memory tests employ the same tests that are used in the Memory tests. For test details please refer to the Memory Test section earlier in the manual.

Choose Video Memory in the Tests category to display the Video Memory Configuration screen.



Click the Run Memory Test button to add the test to the test queue. As the test runs, the computer's screen will display strange patterns and/or colors. This is normal. When the test completes, the results will appear on the stage in the Job Results From Last Run and the Video Memory Results panes.



The Video Memory test results are also saved to the Reports.



NOTE TechTool Pro tests the video memory for the main display. To check a second display you will need to designate it as the main monitor before testing. This is done via the Displays pane in the System Preferences.



File Structures

The File Structures test in TechTool Pro checks a variety of file types for corruption. The test checks each individual file to ensure it conforms to the specifications for that file type. If there is anything unusual, TechTool Pro lets you know which files may be corrupted. There is no way for TechTool Pro to repair a corrupt file, since there is no way to know what the correct data in the file should have been. If corrupt files are found, you should delete them and then restore them from a known good source.



NOTE If a file is flagged during testing, this does not necessarily mean the file is bad. It simply means that there is something atypical about the file based on its file type. If you are having problems with the computer or with an application that might be effected by that file, consider temporarily removing it or replacing it with a new copy if possible.

TechTool Pro checks the file type specifications to ensure they are valid. It cannot check actual data held within the file itself. For example, TechTool Pro can check to be sure that a GIF graphics file meets all specifications for that file type. However, it is not possible to tell if some of the pixels within the graphic image are incorrect, which could cause the image to display incorrectly.



NOTE A file's type is determined by its extension. This is a three or four character code appended after a period to the end of the file name. Mac OS X does not normally display the extension in the Finder (although you can change the Finder preferences to display this information). If a file has the wrong extension, the File Structures test will flag it since the file type will be mis-identified.

Choose File Structures in the Tests category to display the File Structures Configuration screen.



The File Structures Configuration screen lists each recognized Macintosh formatted volume attached to the computer. Select the volume you wish to test. To the right of the volume selection area are three check boxes. Check the boxes to indicate the type of files you wish to check. The choices are:

- Check Databases (e.g. plist and xml files)
- Check Image Files (e.g. bmp, gif, jpg, png and tiff files)
- Check Time-base media (e.g. MPEG, MP3, PDF files)

Once you have selected the file type(s) you wish to test, click the Run File Structures button to add the test to the queue. As the test runs, feedback is provided on the stage.



On the left side of the stage the File Structures pane displays information and test progress, including:

- Volume
- Current State
- Number of files processed
- Number of problems detected

TechTool Pro tests the following file types:

- PLIST, XML
- BMP, GIF, PNG, JPEG, TIFF
- MPEG, MP3

Additional file types may be added in the future.

The full file path name of the file currently being checked is displayed below the drive graphic. The right side of the stage displays any problems detected and the names of the corresponding files. Hover the cursor over a filename to display the full path to the file. A complete list of prob-

lem files is saved to the Report after the test completes.

Upon completion of testing, the stage displays the results in the File Structures pane on the right.



The volume name, number of files validated, and number of problems detected are listed in the File Structures pane. Select a filename from the File Problems Detected list on the right and press the Show File button bring up a Finder window with the selected file selected.



Tools

TechTool Pro includes a number of tools that you can select from the Tools category. These include:

- eDrive—create, remove, mount, or restart the eDrive partition
- Volume Rebuild—rebuild and repair a volume's directory
- File Optimization—defragment files on a volume
- Volume Optimization—consolidate free space on a volume
- Volume Cloning—create a clone or disk image of a volume
- Data Recovery—damaged volume or Trash data recovery
- Wipe Data—securely delete data from a volume
- Volume Journaling—enable or disable file system journaling
- Disk Permissions—verify or repair disk permissions
- Local Network— see what Bonjour enabled devices and services are running on your local network.
- Video—monitor calibration and iSight verification
- Audio—manipulate and monitor the audio signal

Select a tool from the list to display its configuration screen on the right.

Tools cannot be queued on the dock like Tests, since they cannot be interrupted while they perform their individual functions. The various tools are described in detail below.



eDrive

Use TechTool Pro's eDrive tool to create an emergency startup partition containing TechTool Pro on one of your hard drives. This new partition is created WITHOUT the need to reformat the drive on which it is created. The eDrive contains a basic Mac OS X system for your computer as well as a copy of TechTool Pro. If you ever have trouble with your normal startup volume, you can simply restart your computer from the eDrive. This will give you immediate access to the tools you need for recovery and repair. It eliminates the need for a bootable DVD or ancillary hard drive for system volume repair or maintenance. This may be particularly attractive for use on a portable computer. With an eDrive installed, you will not need to carry a repair DVD with you on the road. The eDrive can also be useful if you have updated TechTool Pro via download and do not have a copy of the newer program DVD.



WARNING Always remember to backup important data prior to performing major operations such as eDrive creation or removal, optimizations, and volume rebuilds.

Choose eDrive from the Tools category to display the eDrive Configuration screen.



Use the eDrive Destination Volume pop-down menu to select the volume on which you wish to create the eDrive. You may choose the active system volume or an external volume. The volume size and amount of free space on the volume is displayed beneath the pop-down menu.



NOTE On systems prior to Mac OS X 10.5, creating an eDrive on the main startup volume requires booting from the TechTool Pro DVD.



NOTE The eDrive partition takes up 12 GB on the eDrive Destination Volume (this may change with future updates). In addition, there should be at least 10% to 15% free space remaining on the eDrive Destination volume after the eDrive creation.



NOTE An eDrive cannot be created on a RAID volume since the partitioning of a RAID is controlled by the particular RAID software.

Use the Mac OS X Source Volume pop-down menu to select the volume containing the Mac OS X system components you wish to copy to the eDrive. The Mac OS X version and build will be listed beneath the pop-down menu.



NOTE FileVault must be disabled on the Mac OS X Source Volume prior to creating an eDrive. It can be re-enabled once the eDrive has been created.

eDrive status information is displayed in the field below the two pop-down fields. If an eDrive currently exists, this is indicated in the status information field and the two pop-down menus will be inactive. Only one eDrive is allowed at a time.

To create an eDrive, select the eDrive Destination Volume and the Mac OS X Source Volume from the appropriate pop-down menus. Then click the Create eDrive button. The eDrive creation process occurs in five steps.

- Partitioning—the drive is checked and the eDrive partition created
- Applications—included applications are copied to the eDrive from the Mac OS X Source Volume
- Users—the Users folder is copied to the eDrive from the Mac OS X Source Volume
- Mac OS X Files—the necessary System and Library files are copied to the eDrive from the Mac OS X Source Volume

Progress is displayed on the stage as the eDrive partition is created and files copied to it.



As files are copied to the eDrive partition, their names will flash by below the animated stage graphics.

It typically takes between a half hour and an hour to create an eDrive. However, if there is not enough contiguous free space on the eDrive Destination Volume to hold the eDrive partition, it may take longer since files will need to be moved out of the way during the Partitioning. You can press the Stop button on the lower right side of the stage to stop the eDrive creation. This will result in incomplete eDrive which you can remove using the Remove eDrive option discussed below.

Use the Remove eDrive button to remove an existing eDrive and return the space used by the eDrive partition back to the original volume.

Click the Restart eDrive button to restart the computer from the eDrive. (This button is not available when booted to the TechTool Pro DVD.) You can also restart from the eDrive using the standard Mac OS X method of choosing the eDrive as the startup volume after restarting while

holding down the "option" key. When the computer boots from the eDrive, TechTool Pro will automatically launch. When you quit TechTool Pro while started from the eDrive, the Startup Disk pane appears so that you can select the volume from which to restart.

TechTool Pro automatically unmounts the eDrive from your desktop when your computer boots from a startup volume containing a valid installation of TechTool Pro. This is to protect the eDrive from possible corruption during regular computer use. We strongly suggest that you do not alter the contents of the eDrive for this reason. Doing so may make it unavailable during an emergency. When the eDrive is unmounted, it will not appear as a startup choice in the Startup Disk pane of the System Preferences. You can click the Mount eDrive button if you wish to mount the eDrive volume on the desktop.



WARNING Do not use your computer for regular operations while booted from the eDrive. Use it for emergency recovery and repair only. The eDrive contains a minimal Mac OS X system. Programs other than TechTool Pro may not function as expected and this could cause problems and possible data loss when using other applications.



Volume Rebuild

The volume structures of a volume keep track of where every file and folder reside on a hard drive. This information is stored in a number of data structures, several of which are arranged as “trees”. As data is written to and read from a drive, the layout of the data in these tree structures may become lopsided. This complicates the data structures and causes a slowdown in accessing data as the lopsided tree branches are traversed. For further information about the volumes structures, refer to the Volume Structures test earlier in this manual or the Macintosh File Systems section later in this manual.

Volume Rebuild attempts to build new volume structures from scratch, fully optimizing the directory data structures as it does so. In addition, if the volume structures are corrupted (as determined by the Volume Structures test), a volume rebuild may be able to correctly reconstruct them, resolving the problem.

Select Volume Rebuild in the Tools category to open the Volume Rebuild Configuration window.



Select the volume you wish to rebuild from the volume list.



NOTE In order to rebuild the volume structures of a volume, it must be unmounted. This means that you cannot do a volume structure rebuild of the current startup volume. To do this, you must reboot the computer and run TechTool Pro from another volume, such as from an eDrive or the TechTool Pro DVD.



WARNING Before attempting to rebuild a volume, be sure any important data is backed up first if possible. Use the routines in TechTool Pro’s Data Recovery tool if you cannot backup files normally. Although TechTool Pro will do its best to repair a corrupted volume, this is not always possible depending on the extent and seriousness of the corruption. There is always the chance that an attempt at repair may make problems worse and recovery afterwards more problematic.

Click the Run button to start the volume rebuild. Progress is displayed on the stage as the rebuild progresses.

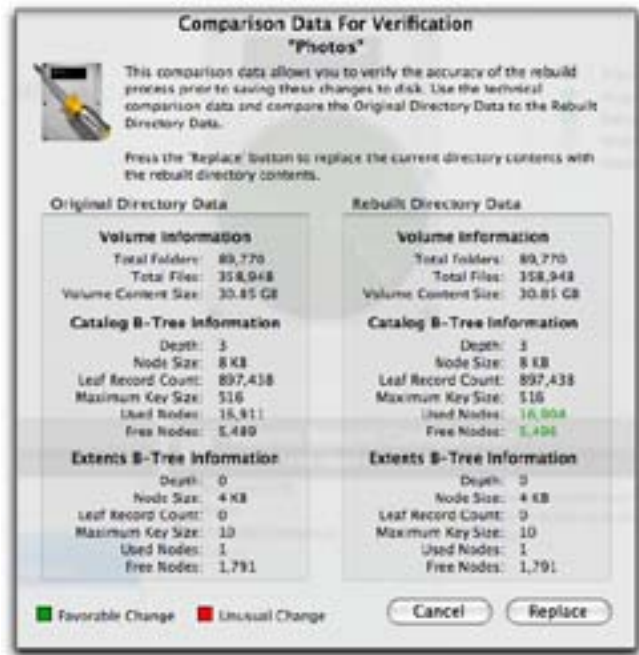


If you want to stop the volume rebuild, click the Stop button on the right side of the stage. This will safely terminate the rebuild and leave the original volume structures untouched.



NOTE Volume Rebuild does not officially support non-Apple RAID volumes. Your results may vary.

If TechTool Pro can rebuild the volume structures, it will display a Technical Comparison Data screen for the volume.



The Technical Comparison screen provides important technical information about both the original directories and the newly created directories. This includes details such as the total number of folders, files, etc. This data can help you decide whether or not to commit to the rebuild.

Differences between the new and old directories are highlighted in color. Green indicates a normal change and red indicates an unusual and possibly problematic change. Click the Replace button to replace the original directories with the newly rebuilt ones. Click the Cancel button to keep the original directories.

WARNING If there are RED changes in the Technical Comparison, it would be prudent to press the Cancel button and verify that important data is backed up before proceeding with the rebuild. An incorrect rebuild usually requires reinitializing the volume and restoring the data.



File Optimization

File Optimization should be used as part of a general disk maintenance routine for your Macintosh. Although a fragmented drive will not cause your Macintosh to malfunction, it may keep it from performing to its full potential.

As files are written to and read from a volume, the file system instructs the drive mechanism where to store the file data. It can place this information anywhere there is available free space on the volume. If there is not a contiguous free area large enough to store a file, then the file system will fragment the file. It will save pieces onto different areas of the drive. This is transparent to you. Although a

file appears as one complete logical item, in most cases it is actually physically scattered around the disk in many pieces. Fragmentation complicates the volume structures and makes the drive work harder to read the files, possibly slowing down performance. File optimization defragments the individual files on a volume.

Click File Optimization from the Tools category to display the File Optimization Configuration screen.



Select the volume you wish to inspect or optimize from the volume list on the left. Click the Preview Optimization button to display the amount of file fragmentation for the selected volume. Upon completion, the size and names of all fragmented files are listed on the right side of the stage, as well as the total number of fragmented files. Click on a file name from the list to show the full path to the file or click the Show button to open a Finder window with the file selected in it.



Click the Run File Optimization button to defragment any fragmented files on the selected volume. Progress is displayed on the stage during defragmentation.



NOTE Running File Optimization from your startup volume can only defragment inactive files.



WARNING Before optimizing, you should perform a Volume Structure test to be sure there is no corruption in the disk's directories. Optimizing a corrupted volume would most likely spread the corruption as file fragments are moved around on the hard disk.

File Optimization is fairly time consuming. It may take

several hours to complete (you might want to start it at the end of the day and let it run overnight). You can stop the process if you wish by clicking the Stop button on the lower right side of the stage. When you click this button, TechTool Pro will finish defragmenting any files it is working on and gracefully stop the process.



WARNING Do not force quit TechTool Pro when it is in the process of optimizing. An unexpected quit during optimization could cause file corruption.

To fully optimize a volume by defragmenting all individual files and consolidating the free space, run Volume Optimization.



Volume Optimization

Volume Optimization should be used as part of a general disk maintenance routine for your Macintosh. Although a fragmented drive will not cause your Macintosh to malfunction, it may keep it from performing to its full potential.

As files are written to a volume, they may be scattered around on the hard drive. This fragments the free space on the hard drive. The Macintosh file system sometimes needs to allocate large contiguous blocks of free space for

certain operations, such as for swap space. If it cannot do this, system performance may suffer. Volume Optimization displays a graphical representation of the free and used space and also optimizes the volume by consolidating the free space on it.

Select Volume Optimization in the Tools category to display the Volume Optimization Configuration screen.



Select the volume you wish to inspect or optimize from the volume list on the left. Click the Preview Optimization button to display information about the volume and a graph of the volume space usage on the stage.





Click the Run Volume Optimization button to perform a volume optimization of the selected volume. Progress is

displayed on the stage as the free space is defragmented.



The stage displays a dynamic bar graph showing the distribution of data and free space on the drive. The higher the bar, the more data is stored in that area of the drive. As the optimization progresses, the area of the volume currently being optimized will be displayed in flashing yellow in the bar graph. The goal of volume optimization is to move all data to the beginning of the drive and all the free space to the end.

 **NOTE** To optimize a volume, it must be unmounted. This means that you cannot optimize the current startup volume. To optimize the normal startup volume you must boot the computer and run the program from another location, such as an eDrive.

 **WARNING** Before optimizing, you should perform a Volume Structure test to be sure there is no corruption in the disk's directories. Optimizing a corrupted volume would most likely spread the corruption as file fragments are moved around on the hard disk.

Volume Optimization is fairly time consuming. It may take several hours to complete (you might want to start it at the end of the day and let it run overnight). You can stop the process if you wish by clicking the Stop button on the lower right side of the stage. When you click this button, TechTool Pro will finish relocating any files it is working on and gracefully stop the process.



WARNING Do not force quit TechTool Pro when it is in the process of optimizing. An unexpected quit during optimization could cause serious directory corruption.



WARNING Be sure to backup prior to performing any Volume Optimization. This is especially true when performing an optimization on non-Apple RAID configurations. Many non standard RAID configurations (5, 50, etc.) have not been tested, and your results may vary.



Volume Cloning

TechTool Pro offers the ability to create either a duplicate clone of an entire disk, or a file sync clone that copies every file on a disk to a backup drive, and then syncs changed files for subsequent clones. If the disk selected

for cloning is a startup volume, the clone can also be bootable. A duplicate clone offers the possibility (but not a guarantee) that files lost on the original volume may be recoverable from the clone.

Disk Image cloning saves the clone to a file. This is advantageous if another drive is not available. If a disk image of a bootable volume is created, the image may be restored to a disk using Apple's Disk Utility (located in /Applications/Utilities). The resulting drive can also be bootable.



NOTE Volume Cloning is only available on systems running Mac OS X 10.5 or later.

Duplicate Cloning



To create a Duplicate clone, select Duplicate Cloning from the drop-down menu. Only disks or partitions larger than the source partition will be available as a destination for the clone.

Checking 'Verify destination copy' performs a verification on the destination volume after the copy to ensure a proper duplication from the source volume.

Checking 'Restore destination name' restores the destination volume to its original name. Otherwise, the name of the source volume will be used.



WARNING Be sure to verify that the volume you are using as the destination for a volume clone does not contain any files before you erase it. All files on the destination volume will be lost.

File Sync Cloning



File Sync Cloning is another option. By choosing File Sync Cloning, the destination volume does not need to be erased. Subsequent clones will only copy files that are new or have changed since the last sync.

Choosing 'Skip newer destination files' ignores newer files on the destination volume. Files on the destination volume that have changed since last sync will not be replaced. If only the file size differs, the destination file will be replaced.

Choosing 'Enable destination ownership' copies owner and group permission settings from the source volume

to the destination volume. This allows the volume to be bootable after sync. Otherwise, the owner and group settings of the current user and group will be used.

Disk Image Cloning



Disk Image cloning saves the clone to a file, rather than a disk. To create a disk image clone, choose the source, the type of disk image. Clicking Clone to Volume... will display a dialogue box in order to choose where to save the resulting disk image file. TechTool Pro will then copy the contents of the target drive to a .dmg file. Double-clicking the resulting .dmg file will mount the image, giving the user access to the files and folders contained within.

Read/Write - Choosing this option creates a .dmg file that mounts as a virtual disk when opened. The .dmg file will be the same size as the disk being cloned, and files can be added to it when it is mounted.

Read/Write "sparse" disk image - Choosing this option creates a .sparseimage file. It is the same as Read/Write

option except that the size of the image file when unmounted will be close to the amount of data contained in the image, rather than the size of the disk.

Read/Write “sparse” disk bundle - Choosing this option creates a .sparsebundle file. It is the same as the “sparse” disk image, except that the file is saved in “blocks,” so as to be more efficiently backed up by tools such as Apple’s Time Machine.

Read-Only disk image - Choosing this option creates a .dmg file. It is the same as the Read/Write option except that it cannot be modified when mounted.



Data Recovery

TechTool Pro’s data recovery routines are designed to help you recover accidentally deleted files/folders or to recover files/folders from a corrupted volume that no longer mounts on the desktop. You should only try to recover personal data that is not already backed up. Don’t try to recover application or system files, since such files typically don’t operate properly by themselves. These files should be restored from their original source.

The options in Data Recovery work in conjunction with the data saved in TechTool Pro’s Directory Backup files and Trash History. Directory Backup files are backups of a volume’s directories. They contain important file location data, allowing TechTool Pro to easily find files that haven’t already been overwritten. The Trash History is a record of the location of deleted files. This information allows TechTool Pro to recover a deleted file, again assuming it hasn’t already been overwritten. Directory Backup and Trash History are configured via the TechTool Protection pane in the System Preferences. We strongly suggest enabling these features since they dramatically increase the chance of successful data recovery. However, even if the Protection features were not enabled prior to a problem, TechTool Pro may still be able to recover files from a corrupted drive by scanning the entire drive for directory data.

TechTool Pro’s data recovery routines consist of three parts:

- **Protection**—recover files/folders based on previously saved Directory Backup files
- **Drives**—recover files/folders based on scavenged directory data
- **Trash**—recover deleted files based on the Trash History

These options are covered in detail below.

Protection

Use this data recovery option to try to recover files or folders from a corrupted volume when TechTool Protection

had been configured to save Directory Backup files for the volume.

To display the Data Recovery Protection configuration window, choose Data Recovery from the Tools category and then click the Protection tab.



The left side of the configuration window shows the Directory Backups list. Each recognized volume along with its associated Directory Backup files indented beneath the volume name is listed here. The Directory Backup files are identified by the date and time they were created. Typically, you would select the most recent available Directory Backup file since it will most accurately represent the state of the volume contents. TechTool Protection saves a maximum of three Directory Backup files for each volume, deleting the oldest one when necessary to save a new one.



NOTE If a volume is badly corrupted, it is possible that the Directory Backup files cannot be read on it and it will not show up in this section of Data Recovery. In that case, try scavenging the entire hard drive in the Drives

section.

Once you have selected a volume from which to recover data, enter the search options on the right side of the configuration window. Enter a search string in the “Folder or file name to locate” field (the search is not case sensitive). Then select the desired Search Criteria from the bullet list. The options are:


- Contains—search for file/folder names containing the specified string
- Starts With—search for file/folder names beginning with the specified string
- Whole Words—search for file/folder names that exactly match the specified string
- Ends With—search for file/folder names ending with the specified string



NOTE When searching for a file using the Whole Words option, you must include the file’s extension (if present) as a part of the file name. This is a three or four letter identifier (which is normally hidden by the Finder) after a period at the end of the file name. If you don’t know the extension for the file, you might consider using the Contains search criterion instead. Press the Locate Files button to begin the search.

As the search is performed, progress will be displayed on the stage. When complete, the Data Recovery window will appear listing all files and folders that were found based on the search criteria, as well as other data about the

[illegible]

 NOTE Directory Backup files are copies of the volume structures at an earlier time. Consequently they are not a completely accurate map of the location of files and

Drives

To display the Data Recovery Drives configuration window, choose Data Recovery from the Tools category and then click the Drives tab.



Once you have selected a drive from which to recover data, enter the search options on the right side of the configuration window. Enter a search string in the "Folder or

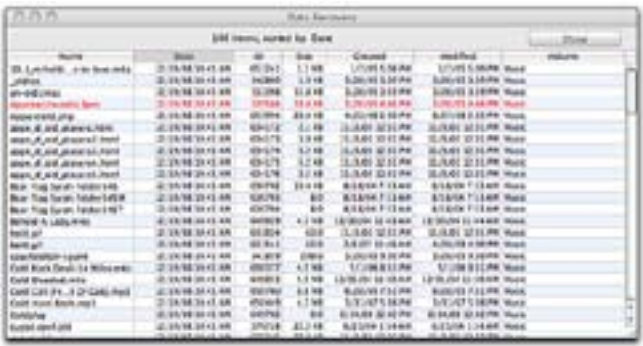
file name to locate” field (the search is not case sensitive). Then select the desired Search Criteria from the bullet list. The options are:

- Contains—search for file/folder names containing the specified string
- Starts With—search for file/folder names beginning with the specified string
- Whole Words—search for file/folder names that exactly match the specified string
- Ends With—search for file/folder names ending with the specified string



NOTE When searching for a file using the Whole Words option, you must include the file's extension (if present) as a part of the file name. This is a three or four letter identifier (which is normally hidden by the Finder) following a period at the end of the file name. If you don't know the extension for the file, you might consider using the Contains search criterion instead. Press the Locate Files button to begin the search.

As the search is performed, progress will be displayed on the stage. When complete, the Data Recovery window will appear listing all files and folders that were found based on the search criteria, as well as other data about the found item.




Select the file or folder of interest from the list. If the item is displayed in black, it is still available on the volume via the Finder. Click the Show button on the upper right to display it in a Finder window. If the item is displayed in red, it is not available via the Finder (the item has been deleted, the volume is not mounted, etc.). In that case, click the Restore button on the upper right to copy it to a folder on the desktop named TechTool Pro 6 Recovered Files. The item will be located in a subfolder whose name is the date and time of the recovery. (When booted to the DVD, a save dialog box will appear letting you choose a destination for the recovered items folder.)

Trash

Use this data recovery option to recover deleted files/folders. This will only work to undelete items from volumes for which Trash History was active prior to the deletion and which were deleted within the time frame configured

to record deleted files. . Trash History is configured in the TechTool Protection pane of System Preferences. You must run the installed copy of TechTool Pro when un-deleting files, since the Trash History is maintained by the current startup system. This option will not be available when booted to the TechTool Pro DVD.

 NOTE If the Finder is set to Empty Trash securely (set via the Finder Preferences under the Finder menu), deleted files cannot be recovered since they are immediately overwritten when the Trash is emptied.


To display the Data Recovery Trash configuration window, choose Data Recovery from the Tools category and then click the Trash tab.



Click the Show Trash History button to display the Trash History window.

The screenshot shows the 'Trash History' window, which is a table listing deleted files. The table has columns for 'Name', 'Location', 'Date Deleted', 'Size', 'Type', 'Parent', 'Modified', and 'Recovery'. The rows contain details for various files, including system files like '.DS_Store' and user files like 'Screenshot.png'. Some rows are highlighted in red, indicating they are no longer available via the Finder, while others are in black, indicating they are still available.

All items that were moved to the Trash within the time frame configured for Trash History will be listed. If the item is displayed in black, it is still available via the Finder on the volume. Click the Show button on the upper right to display it in a Finder window. If the item is displayed in red, it is no longer available via the Finder (the item has been deleted). In that case, click the Restore button on the upper right to copy it to a folder on the desktop named TechTool Pro Recovered Files. The item will be located in a subfolder whose name is the date and time of the recovery.

 NOTE Be sure to open or check a recovered file to verify that it is valid. Trash History keeps a record of the location of files deleted from a volume. A file that has been deleted from the Trash can be overwritten by the file system at any time. If this happens, the file data is unrecoverable by any standard means. When TechTool Pro recovers such a file, it will most likely be unusable.



NOTE Trash History displays the deleted files for the current user. If you want to recover files for a different user, you must first log into that user's account and run TechTool Pro from there.



Wipe Data

When a file is saved to a disk an entry is made for the file in the disk's directory. This directory entry records where the pieces of the actual file are stored on the disk. When a file is deleted from the disk, only its directory entry is deleted. The file data itself is still left on the drive and the locations occupied by the data are made available to be used to store other information. Until the data is actually overwritten by new information it is possible for the data to be recovered using a data recovery tool such as TechTool Pro.

There are times when one needs to permanently delete a file for security reasons. To permanently delete the data from the drive it must be completely overwritten. This is the purpose of Wipe Data. TechTool Pro offers a variety of methods to securely overwrite the data.

Select Wipe Data from the Tools category to display the

Wipe Data configuration screen.



The following functions and controls are available from the Wipe Data screen:

Overwrite Pattern

You may choose to overwrite selected data multiple times with the following patterns:

- Binary 0000–Overwrites the file with all zeros.
- Binary 1010–Overwrites the file with alternating ones and zeros.
- Binary 1111–Overwrites the file with all ones.
- Random ASCII Characters–Overwrites the file with pseudo-random pattern of zeros and ones. This can be helpful when trying to hide the fact that a file has been wiped.

Overwrite Level

Select the number of times the selection will be overwritten. The higher the number, the more secure the overwrite (and the longer the overwrite will take). Although overwriting the data once is normally sufficient to permanent-

ly erase the data, some government agencies specify that data must be overwritten a specific number of times to be considered securely deleted. The overwrite choices are:

- 1-Pass Overwrite
- 3-Pass Overwrite
- 7-Pass Overwrite
- 35-Pass Overwrite (referred to as the Gutmann method)

Select Item To Wipe... button

Click this button to select the item you wish to wipe. You can choose a file, folder, or entire volume. If you choose a volume, you can wipe either the entire volume or only the volume's unused free space. When you select an item its full path name will appear in the field below the buttons. This allows you to verify what item will be wiped before actually committing to the wipe.

Wipe Selection... button

Click this button to overwrite the selected file or folder the specified number of times with the selected pattern. Progress is displayed on the stage as the overwrite occurs.

Wipe Volume... button

Click this button to completely overwrite the entire volume's contents the specified number of times with the selected pattern. Note that ALL data on the volume will be lost. Progress is displayed on the stage as the overwrite occurs.

Wipe Free Space... button

Click this button to overwrite the free unused space on the selected volume the specified number of times with the selected pattern. Progress is displayed on the stage as the overwrite occurs.



WARNING Once the data is overwritten by TechTool Pro's Wipe Data routines there is no possibility of recovering the data. Confirm that you have made the correct selection by checking in the information field at the bottom of the Wipe Data Configuration screen before committing to the wipe.



Volume Journaling

Journaling is a feature of the HFS+ file system that provides protection against volume corruption and data loss. It is supported by Mac OS X 10.2.2 and above. When journaling is enabled for a volume, the file system logs read/write transactions as they occur. If the computer should unexpectedly quit, then the file system will have access to a record of incomplete transactions in its "journal" on the drive and can quickly return the file system to a consistent state.

This protects against volume structure problems and the need to test for or repair them after an improper shutdown.

Journaling adds a small amount of extra overhead to file reads and writes. In most cases the performance degradation will not be noticeable. However, for files requiring high transfer speeds, such as large video, graphics, or audio files, the reliability provided by journaling may not justify the performance slowdown when accessing the data. For more a more technical explanation of volume journaling, see the Macintosh File Systems section later in the manual.

The Volume Journaling tool in TechTool Pro allows you to turn journaling on or off for your HFS+ volumes. Choose Volume Journaling in the Tools category to display the Volume Journaling configuration screen.



Each available writable HFS+ volume will be listed in the configuration screen. When you select a volume from the list, the appropriate button on the lower right side of the screen will activate so that you can toggle the state of journaling for that volume.



Disk Permissions

The Macintosh operating system is based on the UNIX operating system. Like UNIX, it uses permissions in the file system. Every file and folder has a set of permissions associated with it that determine what users are allowed to read from, write to, or execute it. Permissions may become corrupt for one reason or another. Incorrect permissions can cause a wide variety of problems. They can make files or folders unavailable, they can keep applications from launching or working properly, and if the incorrect permissions are on system files, may even cause Finder problems or make the computer unable to boot from that system.

Each system volume contains a Library/Receipts folder. This folder holds package files that each contain a “Bill of Materials” file (with extension.bom). These Bill of Materials files store the correct permissions for the associated package—typically system and application packages. TechTool Pro makes use of this information to verify and repair permissions. Repairing permissions is easy to do and could well solve an annoying problem with the computer or an application.

To verify/repair the disk permissions for a volume, select Disk Permissions from the Tools category. This opens the Disk Permissions Configuration window.



In the configuration window, select the volume whose permissions you would like to check or repair. Then click the Verify Disk Permissions button to check the permissions or the Repair Disk Permissions button to repair any permissions that may be incorrectly set. Upon completion, any files with incorrect permissions or whose permissions were repaired will be listed in the Reports window.



Local Network

The Local Network tool displays what Bonjour enabled devices and services are running on your local network. This tool lists the IP addresses of all network devices as well as the port number of any services running on the selected device.



NOTE Handheld devices such as iPhones, iPod touches and iPads will only appear in the Local Network device list if they are running iOS 5 or later, which enables Bonjour support.



The Local Network tool can be helpful in debugging network problems (e.g. with a printer, AirPort Express, etc.). It can also help with security issues by revealing what ports are open and which applications are using them. Clicking on a given network device will reveal a list of services and their corresponding port numbers.

As a device becomes active or inactive, the green light will blink. Once the device is active, the light will stay green.



NOTE If you switch networks or a device is no longer part of the network, press the “Clear History” button.



Video

The Video area includes options for checking your computer's display and iSight compatible cameras. Choose Video in the Tools category to display the Video configuration screen. Use the tabs at the top of the configuration screen to choose either Video Geometry or iSight.

Video Geometry

Technicians use video geometry patterns and color screens as an aid in calibrating a monitor and checking it for defects. You may also find them helpful for confirming your monitor's color output and for making adjustments if your monitor has calibration controls.

Click the Video Geometry tab in the Video configuration window to bring up the Video Geometry configuration screen.



TechTool Pro offers a number of test screens. Each screen is available via a button that shows the color/pattern that will be displayed. Simply click on a button to display the test pattern. Click again anywhere to return to the Video configuration screen.

Use the Primary Colors area to choose among the following solid colors:

- Red—Paints the entire screen red.
- Green—Paints the entire screen green.
- Blue—Paints the entire screen blue.
- Yellow—Paints the entire screen yellow.
- White—Paints the entire screen white.
- Black—Paints the entire screen black.

Use the Animate check box to turn on or off an animated pattern within the solid colored screen.

Use the Test Patterns area to choose among the following effects:

- Bars—Displays a series of vertical color bars.
- Text—Displays a screen full of black on white text characters.
- Noise—Displays a constantly changing randomly colored noise pattern.
- Cycle—Displays changing colored, animated text on a solid colored background.

iSight

Use the iSight tool to display the output from any attached iSight compatible cameras. Output from up to four cameras can be displayed simultaneously so that you can compare the outputs from different cameras. You might find this tool handy to use in the case where a camera does not appear to be providing a signal when used in other software. TechTool Pro directly accesses the camera signal and displays it if present.

To use the iSight tool, click the iSight tab in the Video configuration window to bring up the iSight configuration screen.



When you press the Start button, a window will appear for each recognized camera displaying the output from the camera. Press the Stop button to terminate.



Audio

Mac OS X delivers today's professional standard for audio resolution—24-bit, 96 KHz. Core Audio manages all audio as 32-bit floating-point data. This allows your Mac to efficiently handle 24/96 as well as higher resolutions that may become common in the future. Core Audio also delivers highly optimized sample rate converters to allow programs that do not yet use this high-resolution format to provide data to Mac OS X without truncation.

Mac OS X delivers the best audio performance in desktop computing. The most fundamental measure of audio performance is throughput latency. That's the time it takes for audio to enter your Mac, travel through the system to your application and then pass back out to your monitoring system (speakers). Historically, Mac OS offered audio pros excellent latency of about 10ms.

The Core Audio HAL (Hardware Abstraction Layer) provides ultra low latency communications between applications and I/O devices that is measurably more efficient than previous solutions. M-Audio reports latency as low as 40 samples on Mac OS X from the company's audio interfaces. That translates into 1ms throughput latency—and you get this performance in a full multi-channel environ-

ment.

TechTool Pro's Audio tool lets you check the audio input and output of your computer. Like the Video tests, all Audio tests are non-qualified tests. This means that there are no pass/fail marks. It is up to you to determine whether the computer audio input or output is acceptable. The audio tests require stereo output to test properly. Without stereo output the tests will be monophonic.

Choose Audio in the Tools category to display the Audio configuration screen.



From this screen you vary the audio signal and monitor the outputs. The input and output sources are determined by the setting in the Sound pane of the System Preferences.

The left side of the configuration screen is the Audio Output area. In this area you can set various output options. The Sine Wave section has sliders that control the volume, frequency, and balance of a sine wave. Use the Start/Stop Tone button to begin or end the tone. To the right of the Sine Wave area is the Chromatic Scales button. Press-

ing this button plays back a series of chromatic scales. Beneath the above areas is the Speech Synthesis area. To hear synthesized speech, simply type the text you would like to hear in the text field and then press the Say Text button.

The right portion of the Audio configuration screen displays a dynamic frequency bar graph of the audio input signal.

By adjusting the varying the audio output you can subjectively determine whether or not your audio circuitry and speakers are working, whether the two audio channels are balanced, and whether the full frequency and volume range is being produced through each channel.

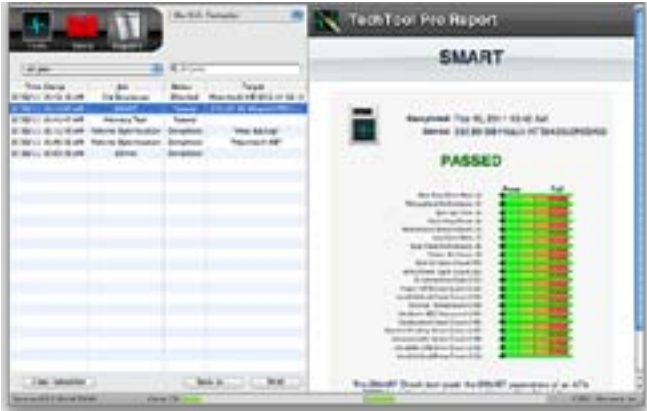


TechTool Pro Reports

As TechTool Pro performs its various tests and other functions, it keeps track of what is done and what results are obtained. This information is saved in Reports. Detailed results of every test can be displayed in the report, as well as advice on how to proceed if problems are found. When TechTool Pro is run from an installation on a hard drive, the results are saved cumulatively into the Reports. You can go back and refer to earlier results if desired. Having the results of previous tests available may allow you to pinpoint when a problem developed and also be helpful as reference should you need to contact technical support.

The Reports are both sortable and searchable, making it easy to locate results for specific tests, volumes, and drives. For example, you can choose to display only test failures if desired. The Report can be printed or saved as a webarchive document if desired.

Choose the Reports category to display the Reports window.



The Reports window is designed to provide convenient access to details about each test that was performed. The left side of the Report window contains the Report Summary in a standard columnar database format. The right side of the window displays the details for the item selected in the Summary area.

If TechTool Pro has been run on more than one computer (such as when booting and running the program from an external hard drive), you can use the pop-down menu at the top of the Summary area to choose the specific computer whose results you wish to display in the Report.

Use the Job Selector pop-down menu to select among the following:

- All Jobs
- Failed Jobs
- Cancelled Jobs From Last Run
- Jobs From Last Run
- Failed Jobs From Last Run
- Overall Summary

Type a string of characters in the field to the right of the Job Selector pop-down menu to search for specific items. For example, you might want to display results for all entries containing “SMART” or “Hitachi”.

Beneath the Job Selector pop-down menu is a columnar list of all items meeting the chosen criteria. The four columns are:

- Time Stamp—when the test/ tool executed.
- Job—the test/tool name.
- Status—test/tool result (Passed, Failed, Canceled, etc.)
- Target—component tested (volume name, hard drive name, etc.)

The list can be sorted in either ascending or descending order by clicking on the column descriptor at the top of the column. For example, you might sort by Time Stamp to see all tests run on a certain day or sort by Target to easily locate all tests performed on a certain volume. Columns can be re-ordered if desired by dragging the column

descriptor left or right to the desired location.

To display further information about a specific item in the list, simply click the list entry to select it. Details will be displayed in the area to the right. These include specific information about the item tested, results, and advice on how to proceed in the case of a problem. You may need to use the vertical scroll bar to view all the test/tools details.

The following buttons are available at the bottom of the Reports window:

- Clear Selection—deletes the current selection from the list.
- Save as...—saves a report as a webarchive document.
- Print—opens a print dialog box in order to save a report.



NOTE To select multiple consecutive items in the Summary Report, hold down the shift key while clicking on the items. To select multiple non-contiguous items, hold down the command key while clicking on the items.



TechTool Protection

TechTool Pro offers a number of features you can configure to run automatically in the background as your computer operates. The features are controlled by TechTool Protection. (For details about installing TechTool Protection, see the Installation and System Requirements earlier in this manual.) You can configure TechTool Protection to monitor the free space on your volumes, save pointers to deleted files to assist in their later recovery, backup your volumes' directories, check your hard drives' built in SMART routines, and send you e-mail alerts in case problems are detected. The automatic features are configured via the TechTool Protection pane in the System Preferences.



At the top left of the TechTool Protection pane is a button to either Run or Stop TechTool Protection's automatic

background routines. To the right of this button is a checkbox to control whether or not a TechTool Protection icon appears in the menu bar. Clicking this icon shows a menu displaying the status of TechTool Protection as well as an option to open the TechTool Protection pane.

The various TechTool Protection features are described in detail below.

Volume Usage

It is generally recommended that the amount of free space on a volume not fall below about 15%. Lack of free space can lead to serious volume corruption. TechTool Protection can be configured to automatically monitor the amount of free space on your volumes and to alert you it exceeds a certain threshold.

Click the Volume Usage tab in the TechTool Protection pane to bring up the Volume Usage screen.



Click the On button to turn on the Volume Usage options. Check the box beside each volume you want monitored.

Use the Free Space Warning Threshold to set the free space threshold for the selected volumes. If the free space threshold is exceeded, a popup message appears on the screen to alert you. If the E-mail Alerts option of TechTool Protection is active, an e-mail will be sent to the configured address with a warning as well. Below the configuration options is a graph showing the volume usage for the selected volume. The graph's bar will be green if the usage is below the threshold and red if the threshold is exceeded.

Directory Backup

The purpose of Directory Backup is to periodically save directory information for your volumes called Directory Backup Files. These are backup files of critical volume structure data. They are located in the main hard drive/Library/Application Support/TechTool Protection folder. Directory Backup files can greatly assist TechTool Pro with recovering data from corrupted drives. They may also help recover files that have been deleted if the Trash History in TechTool Protection was not enabled when the files were deleted. The Directory Backup screen allows you to select the volumes you wish to protect and how frequently they are protected.



NOTE Directory Backup files are not backups of your actual data. Rather, they are backups of the volume structures for the entire volume. It is very important to keep at least one backup (preferably two) of your actual data on another location to be safe.



NOTE Directory backups are not kept for drives encrypted by FileVault 2 for security reasons.

Click the Directory Backup tab in the TechTool Protection pane to display the Directory Backup screen.



Click the On button to enable Directory Backup. Check the box beside each volume you wish protect. Use the Backup Interval field to set the number of hours between directory backups. To backup the directories of the selected volumes immediately, click the Backup Now button. To have Directory Backup files saved to more than one location, click on the Locations... button, then click the + button to backup to another volume.

The Latest and Previous fields display the dates of the last two directory backups (if present) for the currently selected volume. TechTool Protection saves up to three directory

backups per volume. When newer directory backups are done, the oldest is deleted.

WARNING Be sure that each of your volumes has a unique name. This is especially important for removable media. The Protection file uses the volume name as an identifier.

Trash History

TechTool Protection can save pointers to deleted files for a specified number of days in a Trash History file. Assuming a deleted file has not been overwritten since it was deleted, you can use Data Recovery in the Tools category to easily “undelete” the file.



Use the Trash History field to set the number of days for which you would like to track the location of deleted files. As long as a deleted file has not been overwritten, you can undelete it within that time period. To undelete a file, go to Data Recovery in the Tools category of TechTool Pro. Click the Show Trash History button in the Trash section to bring up the Trash History window for the current user. Select the file you wish to undelete and click the Restore button. The selected file will be saved to a folder named TechTool Pro Recovered Files on the desktop.



NOTE If you have set the Finder Preferences to securely delete files when you empty the Trash, then deleted files are immediately overwritten and cannot be recovered by any means—including using TechTool Pro. The same is true if you empty the Trash using the Secure Empty Trash option, or have FileVault 2 enabled.

SMART Check

TechTool Pro can automatically query your drive's SMART registry on a regular basis and alert you if problems are developing. This may provide advance warning of drive failures before they become catastrophic. More information about SMART monitoring is available in the Tests section of the manual under the SMART Check.

Click the SMART Check tab in the TechTool Protection pane to bring up the SMART Check screen.



Click the On button to enable SMART Check. Click the box beside the drive name of each drive you want to be checked automatically. Use the Check Interval field to set the number of hours between SMART checks. To do a SMART check immediately, click the Check Now button. Below the Check Now button, the following information is displayed:

- Drive identifier
- Connection type
- Date and time of the last SMART check
- Result of the last SMART check (passed or failed)
- Names of volume(s) on the drive

When a SMART check failure occurs, a popup message appears on the screen to alert you. If the E-mail Alerts option of TechTool Protection is active, an e-mail will be sent to the configured address with a warning as well.

In the event of a SMART failure, you might consider running the SMART Check in the Tests category to get more detailed information about which SMART parameter(s) failed. This may help you determine the seriousness of the issue and would be valuable information to provide the drive manufacturer should you decide to contact them for assistance.

E-mail Alerts

TechTool Pro can automatically send an e-mail message alerting you if a volume exceeds the volume usage threshold or if the SMART Check fails. This allows you to monitor a computer even though you may not be physically present, providing an early warning of impending problems. This alert may give you enough time to backup your data and address the problems before experiencing a catastrophic failure

Click the E-mail Alerts tab in the TechTool Protection pane to bring up the E-mail Alerts screen.



Configure the following e-mail fields as required:

- E-mail Subject—Subject line to be included in E-mail Alert, The default subject is “TechTool Pro Failure Alert.”
- E-mail Address—E-mail address where the Alert e-mail should be sent.
- SMTP Server—SMTP server name.
- Port Number—Port number used by outgoing e-mail (default is 25).
- Use SMTP Authentication—Check this box if using an SMTP mail server and authentication is required.

- SMTP Account—SMTP username if using SMTP authentication.
- Password—SMTP password if using SMTP authentication.
- Use SSL/TLS - check this box if your email server requires SSL or TLS authentication. (Not supported for all email services)

After entering the configuration information, click the On button to enable E-mail Alerts. Check the appropriate boxes to send e-mail alerts notifying you of Volume Usage warnings and/or SMART Check failures.

Click the Send Test E-mail button to send an e-mail to the specified address. Do this to verify that mail is working properly on the computer and that the E-mail Alerts feature is properly configured.

If E-mail Alerts are enabled and a warning occurs in a selected option, an e-mail will be sent to the specified e-mail subject. The body of the e-mail will contain the following information:

- Date and Time of the Alert.
- Computer's User Name.
- Computer's IP Address(es).
- Computer's Mac OS X Version.
- Failure Category, Volume or Drive name, and Failure Type.

TechTool Pro Menu Options

When TechTool Pro is launched, a number of special TechTool Pro options are available from the menubar. They are:

TechTool Pro

This menu item contains the following choices:

About TechTool Pro

Select this option to display the TechTool Pro Information screen. It displays the version number of the program as well as copyright information.

Check for Update...

Selecting this option will attempt to connect to the Micromat website and let you know if a newer version of the program is available.



NOTE You must have an active connection to the internet in order for this option to succeed.

Hide TechTool Pro

Select this option to hide the TechTool Pro windows. Clicking the TechTool Pro icon on the dock will return the windows to their previous state.

Quit TechTool Pro

Select this option to quit the TechTool Pro application.



NOTE If you have booted from the TechTool Pro 5 DVD, quitting the program will return to the language selection screen with the option to restart the computer. Click Restart to reboot the computer back to its default startup location.

Mode

Use the Options menu to select one of the three TechTool Pro categories—Tests (command-1), Tools (command-2), or Reports (command-3).

Help

Use the Help menu when running an installed copy of TechTool Pro to search or open TechTool Pro's Help file.

Commonly Asked Questions

How do I start up (boot) the computer from the TechTool Pro DVD?

To boot from the TechTool Pro DVD, insert the TechTool Pro DVD into the DVD drive, restart the computer and immediately press and hold down the “C” key. Be patient. It takes longer to boot from a DVD than a hard drive since the DVD drive is so much slower. Note that the instructions for booting from the TechTool Pro DVD are printed on the front of the DVD. An alternate method of booting to the DVD is to hold down the “option” key at restart. This will instruct the computer to scan all attached devices and display an icon for each recognized startup choice. Once the scan is complete, select the DVD icon from the startup choices and press the right pointing arrow on the screen to startup from it (on PowerPC Macs) or click the arrow beneath the DVD icon (on Intel Macs).

Why can't TechTool Pro do a volume test of the current startup volume?

Mac OS X 10.2 and above allows changes to the volume structures of the boot drive in the background as it is running. Hence, it is not possible to correctly test the volume structures on the boot volume—and TechTool Pro will not allow this (nor will Apple's Disk Utility). You must boot the computer and run the program from some other location, such as the TechTool Pro DVD or eDrive, in order to test/repair the volume structures of your normal boot volume.

Is TechTool Pro able to check a UFS initialized volume?

No. TechTool Pro can only work on Macintosh initialized (HFS and HFS+) volumes.

Can TechTool Pro check a network volume?

No. TechTool Pro can only work on volumes of drives physically attached to the computer on which it is running.

How do I initialize a drive in Mac OS X?

Mac OS X includes a utility program called Disk Utility that allows initialization of disks. Disk Utility is typically located in the Utilities folder (inside the Applications folder). After launching Disk Utility, choose the Erase option. To check for bad blocks and lock them out (if possible), select the security option to “zero all data.” Initializing with this option will take much longer, but will ensure that the drive is in good shape.

How do I uninstall TechTool Pro?

The TechTool Pro Installer includes an uninstall option. Select Customize during the install process, and be sure the “Remove TechTool Pro” checkbox is checked. Doing an uninstall will delete all the TechTool Pro files from the selected volume.

Tips, Short Cuts, and Hidden Features

The Mac Cats

Mac OS X 10.0: Cheetah (March 24, 2001)

Mac OS X 10.1: Puma (September 25, 2001)

Mac OS X 10.2: Jaguar (August 23, 2002)

Mac OS X 10.3: Panther (October 24, 2003)

Mac OS X 10.4: Tiger (April 29, 2005)

Mac OS X 10.5: Leopard (October 26, 2007)

Mac OS X 10.6: Snow Leopard (August 28, 2009)

Mac OS X 10.7: Lion (July 20, 2011)

OS X 10.8: Mountain Lion (July 25, 2012)

TechTool Pro Key Commands

cmd-?: TechTool Pro Help

cmd-H: Hide TechTool Pro

cmd-Q: Quit TechTool Pro

cmd-1: Select the Tests category

cmd-2: Select the Tools category

cmd-3: Select the Reports category

Useful Apple Key Combinations

cmd-opt-P-R at startup: zap PRAM

opt at startup: select startup device

cmd-S at startup: boot into single user mode

cmd-V at startup: boot using verbose mode

shift at startup: boot into safe mode

shift at login: bypass user startup items

cmd-opt-O-F at startup: drop into open firmware on PowerPC Macs

cmd-D at startup: start up in Apple Hardware Test if Install DVD 1 is in the drive

cmd-T: start up in FireWire Target Disk mode

Basic Open Firmware Commands (PowerPC Macs)

reset-nvram

set-defaults

reset-all

eject cd

dir hd:\

dir hd:\<pathname>

mac-boot

Handy Terminal Commands (for Geeks only)

`sudo diskutil enableJournal /`: Enables journaling.

`sudo diskutil disableJournal /`: Disables journaling.

`sudo sh /etc/daily`: Runs the daily system cleanup tasks.

`sudo sh /etc/weekly`: Runs the weekly system cleanup tasks.

`sudo sh /etc/monthly`: Runs the monthly system cleanup tasks.

`pwd`: Displays the path name of the current working directory.

`cal`: Displays a calendar for the current month.

`cd`: With no argument changes the working directory to the user's directory. When followed by a directory name it changes the working directory to the specified directory.

`ls`: Lists the current directory's files.

`ls -a`: Lists all files, including invisible files.

`ls -l`: Includes more information in the listing.

`rm`: When followed by a file name deletes the file.

`rm -r`: When followed by a directory name removes the directory and all its subdirectories (be very careful, this is a dangerous command).

`rmdir`: Removes an empty directory.

`top`: Provides a live display of currently running processes (type “q” to quit).

`sudo`: Followed by a command, allows you to execute a single command as root.

`kill`: Followed by a process ID, terminates that process.

Macintosh File Systems

Your Macintosh computer needs fast and easy access a tremendous amount of information in order to function and perform its various tasks. In particular, it must be able to access the system files, application programs, and other data as you work. This data may be stored on a variety of physical devices, including hard drives, floppy drives, CD-ROMs, memory cards, etc. In order to provide a consistent interface to these various physical devices the Macintosh File Systems were developed. To fully understand and appreciate how your Macintosh works and some of the things that may go wrong with it, you need to have some understanding of the Macintosh File Systems. Although this is a complex and somewhat technical subject, a general overview of the file systems will make you a more informed Macintosh user. In particular, the importance of preventative maintenance and backups should become apparent. You will also gain a better understanding of what is going on with your computer and drives when problems do develop.

The two most common Macintosh File Systems are the original Hierarchical File System Standard (HFS Standard or HFS) and the newer Hierarchical File System Extended (HFS Extended, HFS Plus, or HFS+). The original HFS file system was developed in the days of the original 400K floppy disk. At that time a 20 MB hard drive was considered a huge storage device. The HFS Extended format was developed primarily to make more efficient use of storage space on large drives. It is now the format most commonly used on the Macintosh and the format that we will focus

on here. However, before delving into HFS Extended we will need to introduce a few basic concepts.

To allow computers to work in a consistent way with a variety of physical devices, a number of abstractions have been developed. Perhaps the most basic is the bit. A bit is the smallest unit of information that can be accessed by a computer and can be represented as a 0 or a 1. It may be stored in different devices in different ways. For example, a bit on a hard disk drive is stored as a magnetic trace, whereas on a CD-ROM it is stored as a pit on the disk. Within the computer circuitry a bit may be simply a pulse of electricity. Larger chunks of information are the byte and the word. A byte is simply eight bits and a word is two bytes. All information in the computer is encoded in the form of bits, bytes, and words.

The data storage device has been abstracted as a logical device called a volume. The computer recognizes a volume as one “device”. It may actually be a floppy disk, one partition on a hard drive, a CD-ROM drive, etc. Note that one physical device, such as a single hard drive that has been partitioned, can be seen as multiple volumes by the file system. Data is stored on volumes in the form of files. A file is simply a named collection of bits. It may contain representations of user data, system data, programs, or even the structures used to keep track of where other files are stored. Macintosh files are currently split into two parts called forks—the data fork and the resource fork. It is possible for either fork to contain no data.

Both HFS and HFS Extended are specifications for how data and the information necessary to retrieve that data are stored on volumes. Volumes are divided into 512 byte logical blocks called sectors. The sector is an abstraction from the “sector” of a disk platter. The typical hard drive platter is divided into sectors of 512 bytes. Sectors are numbered from 0 and continuing to the last one on the volume. Space on a volume is allocated as a group of consecutive sectors called an allocation block. The size of the allocation block is set at the time the volume is initialized. The most common allocation block size is 4 K (8 sectors). There can be at most 2^{32} allocation blocks on a volume. The file system attempts to provide allocation blocks for a file in a fixed size group called a clump. A larger clump size tends to decrease file fragmentation, but can result in wasted space being left at the end of the file. Finally, a series of contiguous allocation blocks that store a file on a volume is called an extent of the file.

The first block on a physical disk contains the driver descriptor map. This holds information about the number and location of drivers on the disk. The second block begins the disk’s partition map. It specifies the start, length, and type of each partition (volume). The partition type may be HFS+, AU/X, MS-DOS, etc. The partition map is itself a partition and holds an entry for itself. The device driver (if present) is typically located after the partition map. Finally, the partitions themselves typically fill the remainder of the disk space.

A number of data structures work together to keep track of data on HFS Extended volumes. These include the following:

- Volume Header
- Catalog File
- Extents File
- Attributes File
- Allocation File
- Startup File

These structures will be described in more detail below. They each consist of one or more allocation blocks.

Volume Header

The HFS Extended Volume Header contains critical information about the volume as a whole. It corresponds to the Master Directory Block (MDB) of an HFS volume. A partial list of the information stored in the Volume Header includes:

- location and size of the other volume structure components
- total number of folders and files on the drive
- size of the allocation blocks in bytes
- total number of allocation blocks on the volume
- next free allocation block
- default clump size for data and resource forks
- next unused catalog ID number

- date/time of the volume's creation and last modification
- language to use to display file and folder names
- whether the volume is write-protected

The Volume Header is always located at the volume's second sector. Note that this may not be the actual second physical sector on a physical disk. Because the data in the Volume Header is so important, a copy of it is kept at the second to last sector on the volume. This is called the Alternate Volume Header. It is one of the few pieces of data on a volume that may not reside in an allocation block. This could occur if the second to last sector falls outside an allocation block. The Alternate Volume Header may be used by disk utilities such as TechTool Pro in the case of damage to the main Volume Header.

The Volume Header may become corrupt if the computer quits unexpectedly and the Volume Header has not been properly updated. This could also happen if a bad block were to develop in the Volume Header. If both the Volume Header and the Alternate Volume Header are incorrect, this can pose a challenge for repair utilities. Such damage may not be repairable. If the corruption to the Volume Header is severe enough, it may not even be possible to access data on the drive using standard software.

B-Trees

The Catalog file, Extents file, and Attributes file all make use of a data structure called a B-tree (Balanced tree) to store their information. A B-tree is a data structure spe-

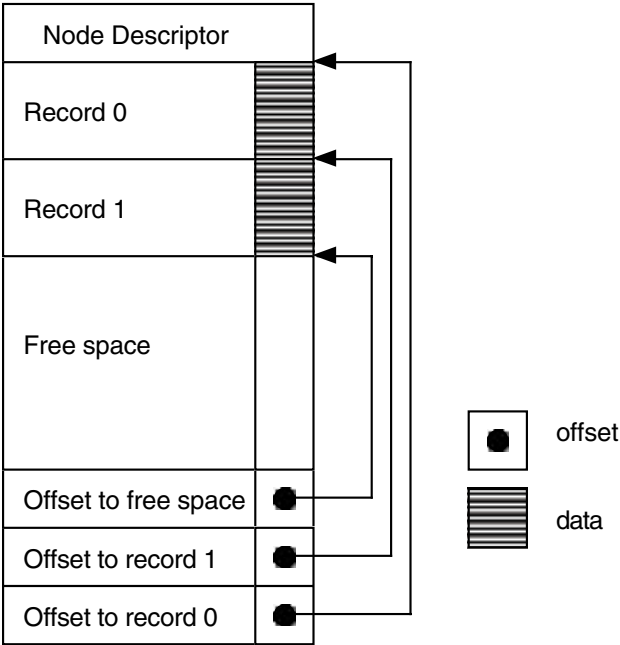
cifically designed for fast retrieval of information. Using B-trees in the volume structures allows the File System to locate data on a volume containing hundreds of thousands of files in a reasonable length of time.

A B-tree file contains a series of nodes. Each node contains records. A record contains a key used to identify the record and also some data. The keys are unique and ordered so that the particular key for an individual record can be located via a search. The data may include pointers (links) to other nodes as well as other data associated with that particular key.

The nodes give the B-tree its structure and come in four types:

- header node (the entry point into the tree)
- map node (holds allocation data if the map record in the header gets full)
- index node (holds pointer records)
- leaf node (holds the data associated with a key)

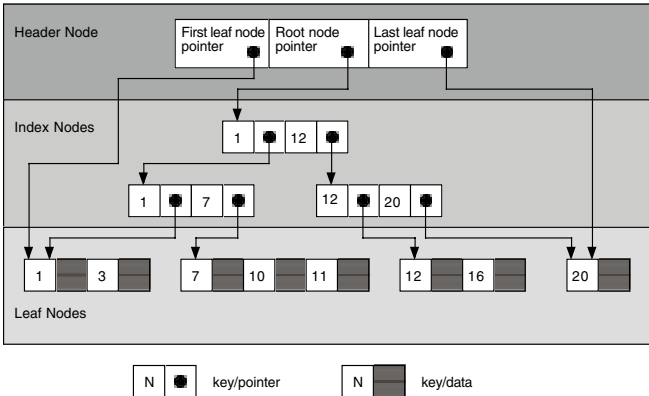
A node has the following structure:



Structure of a Node

The node descriptor indicates the type of node, the number of records it contains, where it belongs in the tree, and contains links to previous or next nodes.

A simple B-tree is illustrated below:



Structure of a B-Tree

In the above example it is clear that it will only be necessary to search at most three nodes to find the record associated with any key.

Damage to a B-tree may occur in the key field, pointer field, or data field. If damage occurs in a key field, then a record or whole sub-tree may not be able to be found. If in the data field of an index node (a pointer), then the sub-tree pointed to could be orphaned. Finally, if damage occurs to the data field of a leaf node, then the actual data itself for that key would be invalid. The type of damage to the file system will depend on whether the B-tree is hold-

ing the Catalog, Extents, or Attributes data and also on which type of node is damaged.

Catalog File

One of the most important files of the volume structures is the Catalog file. The Catalog file keeps track of the hierarchy of files and folders on a volume. The first extent of the Catalog file is stored in the Volume Header. This means that the Catalog header, or entry point into the Catalog, is stored in the Volume Header. If the Volume Header is damaged, then the Catalog Header may not be able to be found and it may not be possible to even locate the Catalog file.

Each file and folder in the Catalog file is assigned a unique identifier called the Catalog Node ID or CNID. For a file this is called the File ID and for a folder the Folder ID. For each file or folder the Parent ID is the CNID of the folder containing that item. Some important reserved CNID's follow:

- 1–parent ID of the root folder
- 2–CNID of the root folder
- 3–CNID of the Extents file
- 4–CNID of the Catalog file itself
- 5–CNID of the bad block file (a special file described below)
- 6–CNID of the Allocation file
- 7–CNID of the Startup file
- 8–CNID of the Attributes file

Every B-tree record must contain a key in order for the file system to be able to traverse the tree and locate that record. In the Catalog B-tree there are two possibilities for the key:

- for a file or folder record the key contains the CNID of the parent and the name of the file and folder
- for a thread record (a link) the key contains the CNID of the file or folder itself and no name

There are four types of Catalog leaf nodes:

- folder record—contains information about a particular folder
- file record—contains information about a particular file
- folder thread record—links a folder to its parent folder
- file thread record—links a file to its parent folder

Some of the more important information stored in the Catalog folder record includes the CNID of the folder, the number of files and folders in the folder, the creation and modification dates, the backup date, and the folder's permissions.

Information stored in the Catalog file record includes the CNID of the file, the creation and modification dates, the backup date, whether the file is locked, the location of the first eight extents of each fork, and the file's permissions.

The CNID and name of a file or folder allows the information for that item to be easily located in the Catalog B-tree. Corruption in the Catalog file can cause loss of the file or folder information contained in the Catalog records

as well as incorrect placement of files and folders in the folder hierarchy. For example, if you were to suddenly find some of your files scattered about at the root level of the hard drive instead of in their correct folders, this could indicate damage to the Catalog file.

Extents File

When a file is saved, the file system assigns space on the volume to hold the file. This space consists of one or more allocation blocks. Each set of contiguous allocation blocks is called an extent. The file record of each file in the Catalog file holds the locations of the first eight extents of each fork in the file. The locations of any additional (or overflow) extents that make up a file's forks are maintained by the Extents file (also called the Extents overflow file).

The Extents file is stored as a simple B-tree. A record key in the Extents B-tree includes the CNID of the file, the type of fork (whether resource or data), and the offset in allocation blocks to the extent. Each extent location is represented as a pair of numbers: the first allocation block of the extent and the number of allocation blocks in the extent. This information is stored in the Extents file data record and allows a file fork's actual data to be located on the volume.

When the Extents B-tree is searched the information in the keys is compared in the following order: CNID, fork type, offset. Thus, the extents for each fork are grouped together and are located next to the extents for the other fork of the file.

Corruption in the Extents file could cause the file system to lose track of the locations of portions of the data in one or both forks of a file. This could cause files to be truncated or result in garbage data to appear in a file. If the Extents file itself cannot be located, then any data beyond the first eight extents of each file's fork, which is stored in the Catalog file, would be lost.

The Extents file holds information about a special file called the bad block file. If a sector is found to be bad, in other words it cannot hold data reliably, then the entire allocation block containing that sector is added to the bad block file. This ensures that the space occupied by the bad block will not be used to store data.

A bad block on a hard disk indicates an actual physical defect in the media surface at that location. Bad blocks are located during an initialization of the drive using the "zero all data" option. They may also be discovered by the drive itself as data is written to and read from the drive.

The bad block file is different than standard files. It does not have a record in the Catalog file and is not referenced in the Header file. The bad block file has a CNID of 5 for use as an identifier in the Extents file. Bad block extents are considered data forks. When a bad block is entered in the Extents file, its allocation block is marked as used in the Allocation file (see below). This prevents it from being used in the future. Keeping track of a bad block's location in the Extents file allows for consistency checks in the Allocation file. Every location marked as used in the Allocation file

should correspond to an extent of some file.

An interesting aside is that when an HFS Extended volume is contained within an HFS wrapper (see HFS Wrapper below), all the extents of the HFS Extended volume are entered into the HFS volume's bad block file. This ensures that if the HFS wrapper volume mounts when using a version of the Mac OS that does not support HFS Extended, then the space occupied by the HFS Extended volume will not be written to.

Allocation File

The Allocation file keeps track of whether or not each allocation block in the volume is being used by the file system. It is a simple list with an entry for each allocation block indicating whether or not it is used. If an allocation block is marked as unused, then the file system may assign it to hold data for a new file. When a file is deleted, the allocation blocks occupied by that file are marked as free and they may be reused to hold other data at any time.

The allocation information for an HFS volume is stored in a special location on the volume called the Volume Bitmap, instead of being stored in an actual file.

Corruption in the Allocation file or the Volume Bitmap can cause the file system to think that areas actually storing data are available for use by another file. In that case the data in the original file may be overwritten and corrupted. If an unused area is marked as already allocated, then the

file system will report that the volume has less free space available than it actually has.

Attributes File

The Attributes file is new to the HFS Extended specification. Like the Catalog and Extents files, the Attributes file is defined to be a B-tree. The Attributes File stores three types of 4 KB records: Inline Data Attribute records, Fork Data Attribute records and Extension Attribute records. Inline Data Attribute records store small attributes that can fit within the record itself. Fork Data Attribute records contain references to a maximum of eight extents that can hold larger attributes. Extension Attributes are used to extend a Fork Data Attribute record when its eight extent records are already used. Extended Attributes enable metadata to be associated with computer files not interpreted by the file system itself, whereas regular attributes have a purpose defined by the file system itself (such as permissions or records of creation and modification times). As an example, Extended Attributes are used by Apple's Safari browser to add security to the Macintosh operating system. When an application is downloaded by Safari, this information is stored as an Extended Attribute. The first time an attempt is made to launch the application, a dialog appears warning the user that they are about to open a downloaded application for the first time and requesting permission to proceed.

Startup File

The Startup file is intended for use by systems that do not have built-in ROM support for booting from HFS Extended volumes. It is similar to the Boot Blocks of an HFS volume. The first eight extents of the Startup File are stored in the Volume Header. This makes them easy to locate and read into memory. This file contains information formerly used by the computer's ROM to determine what program will boot the computer. For newer Macs, this is handled by the HFS Wrapper.

HFS Wrapper

Most HFS Extended volumes are embedded inside a locked HFS volume called the HFS wrapper. However, newer Mac models are beginning to support "pure" HFS Extended (wrapperless HFS Extended) format.

Embedding HFS Extended volumes in an HFS wrapper makes it possible for a computer with HFS (but not HFS Extended) support in ROM to boot from an HFS Extended volume. Additionally, if an HFS Extended volume is attached to a computer with HFS (but not HFS Extended) support, the HFS wrapper can be mounted and provide a message indicating that the computer does not support HFS Extended volumes. This was especially important during the years immediately after the introduction of the HFS Extended format. At that time many people were still using Mac OS 8.0 or earlier, which did not support HFS Ex-

tended volumes. When using a wrapped HFS+ volume under Mac OS 8.1 or above, the HFS Extended volume itself will mount and the HFS wrapper will not be visible.

The HFS wrapper contains an invisible minimal System and Finder file. The root folder of the wrapper is set as a "blessed" folder so that it can be used for startup. When starting up from that volume, the computer will begin the startup sequence from the special System on the wrapper volume, recognize and mount the HFS Extended volume, and then continue starting up from the System on the HFS Extended volume.

The HFS wrapper is locked so that its contents cannot be altered. This protects it from inadvertent corruption. It typically contains a text file named "Where_have_all_my_files_gone?" If a wrapped HFS Extended volume is attached to a computer that does not have support for the HFS Extended format, the HFS wrapper will mount and that text file will show up on the volume. The contents of the text file explain why the HFS Extended volume is not appearing.

Damage to the HFS wrapper can cause the HFS Extended volume to not be accessible or make it unable to startup the computer.

Journaling

Mac OS X 10.2.2 added a new feature to the HFS Extended file system called journaling. Journaling is part of a set of incremental enhancements to the HFS Extended file system and is backward compatible with earlier versions of that file system.

Journaling makes the file system more robust and helps protect against data loss. When journaling is enabled, the file system logs transactions as they occur. If your computer fails in the middle of an operation (which might occur due to a crash or power failure), disk reads and writes may be interrupted. This can cause discrepancies between the file system directory and the actual location and structure of stored files. In an unjournaled file system, volumes may be left in a corrupted state after an unexpected shutdown. If journaling was enabled, the file system can “replay” the information in its log and complete the interrupted operations when the computer restarts. Although there may be minor loss of data that was buffered at the time of the failure, the file system itself will be returned to a consistent state. This allows the computer to restart much faster since the volume structures will not need to be repaired during startup.

Journaling adds a small amount of extra overhead to file reads and writes. In most cases, the impact of journaling upon data access performance will not be noticed. However, for files requiring high transfer speeds, such as large video, graphics, or audio files, the reliability provided by journaling may not justify the performance loss when accessing the data.

Glossary

AirPort: AirPort is Apple’s name for the IEEE 802.11 wireless networking standard. The original AirPort based on the 802.11b standard has a maximum transmission speed of 11 Mbps. The newer AirPort protocols are based on the 802.11g standard with a maximum speed of 54 Mbps and the 802.11n standard with a maximum speed of 248 Mbps.

Allocation Block: The space on a volume is allocated as a group of consecutive sectors called an allocation block.

Allocation File: This file in the volume structures keeps track of the blocks that are used and those that are free.

Altivec: Altivec is a technology built into most PowerPC processors that provides increased performance for certain types of high-bandwidth data processing functions.

Apple Sound Chip: The Apple Sound Chip, or ASC, is a custom manufactured sound chip made for Apple by Sony. Often referred to as a DAC, or Digital to Analog Converter, the ASC provides the Macintosh with advanced sound creation capabilities.

ASC: See Apple Sound Chip.

ASCII: American Standard Code for Information Interchange. A numeric ID assigned to every number, letter, or other symbol that enables different programs and different computers to consistently share information. The standard code consists of an 8-bit coded number.

AT Attachment Packet Interface: This is an interface, commonly known as ATAPI, between the computer and

attached CD-ROM drives and tape backup drives. ATAPI adds additional commands to the IDE interface (see IDE/ATA below) needed for controlling CD-ROM and tape players. ATAPI is part of the Enhanced IDE (EIDE) interface, also known as ATA-2.

AT Attachment Standard: This is a standard electronic interface, commonly called ATA or IDE, between a computer and its mass storage devices that specify how peripherals communicate with the computer.

The following chart shows the maximum data transfer rate for the various ATA versions:

ATA (original)	4 Mb/sec
ATA-2	16.6 Mb/sec
ATA-3	16.6 Mb/sec
ATA-4 (Ultra ATA/33)	33.3 Mb/sec
ATA-5 (Ultra ATA/66)	66.6 Mb/sec
ATA-6 (Ultra ATA/100)	100.0 Mb/sec

ATA: See AT Attachment Standard.

ATAPI: See AT Attachment Packet Interface.

Attributes File: This file in the volume structures, if present, tracks the attributes of a file—such as whether the file is locked or not.

Backup: An exact copy of computer information. In case of data loss or corruption, the original data can be retrieved from the backup.

Benchmark Test: In a given configuration, the test used to evaluate the performance of computer software and hardware.

Bit: A bit is the smallest unit of information that can be stored by a computer. It is represented as a zero or a one.

Bootling: The term bootling originated from bootstrap. It is the process by which the computer starts itself and reads the Operating System. When you boot from a CD you are starting and reading the OS from the CD.

Bundle Bit: A bundle bit is a resource located in most Macintosh applications. If active, it indicates that the file contains icon information.

Bus: A bus is the path that transmits information between a computer and connected devices. An example is the USB bus, which connects the computer to USB devices such as keyboards and mice.

Byte: A byte is a unit of information stored in the computer. A byte consists of eight bits. An ASCII character consists of one byte.

Cache: A high-speed intermediate buffer memory that lies between the processor and main memory in the computer's memory hierarchy. It can reduce memory access time.

Catalog File: The Catalog File is a part of the Volume Structures. It keeps track of the files and folders on a volume.

Central Processor Unit: The Central Processor Unit or Main Processor Unit is a chip that maintains the processing and sequencing facilities for machine-related functions such as initial program booting and instruction execution.

Chip: A "chip," or Integrated Circuit, is a miniature electronic component with specialized functions within the computer.

Circuit: A conductor through which an electric current can flow; the entire course traversed by an electric current. Parts and components assembled to function together in an electric or electronic device or system.

Clump: The file system attempts to provide allocation blocks for a file in a fixed size group called a clump.

Contiguous: Joining or touching in a continual, consecutive, unbroken order to a common edge or boundary.

CPU: See Central Processing Unit.

CRT: CRT is an acronym for cathode Ray tube. It is the element that produces the image on most computer and television screens.

Device: A device is any piece of equipment that can be attached to a computer. These might include a monitor, disk drive, printer, etc. Devices are also known as peripherals.

DIMM: See Dual Inline Memory Module.

Directory: Another term for the volume structures.

Disk: A disk is a flat circular device for storing computer data. The data might be stored magnetically or optically. The most common disks are CD-ROM disks made of stiff, translucent plastic.

Disk Drive: A device for controlling and accessing data stored on a disk or disk stack.

Disk Driver: A driver for a block transfer device (see Driver below) such as a hard disk drive, floppy drive, or CD-ROM drive. It is a software plug-in that implements a hardware abstraction layer for the device.

Drive: A drive is a computer peripheral that stores data. It might use a tape cartridge, a disk, or other medium. A drive may be “read only” or “read/write.”

Driver: A driver (or device driver) is software that lets a computer communicate with a device such as a printer, hard drive, etc. When you purchase a new device, its driver is usually provided as part of the software that comes with it.

Driver Descriptor Map: The Driver Descriptor Map holds information about the number and location of drivers on a disk.

Dual Inline Memory Module: A DIMM, or Dual Inline Memory Module, is a memory unit used by the computer.

It contains RAM chips mounted on a small printed circuit board that plugs into DIMM slots making for easy installation and removal.

EIDE: See Enhanced Integrated Drive Electronics.

Enhanced Integrated Drive Electronics: This is a standard electronic interface, commonly called EIDE, between a computer and its mass storage devices. EIDE is an enhancement to IDE (see below) which makes it possible to address a hard drive larger than 528 MB. It also provides faster access to the hard drive, support for Direct Memory Access (DMA), and support for additional drives, including CD-ROM drives and tape drives.

Ethernet: A popular networking protocol originally developed at Xerox. Standard ethernet communicates at 10Mbps and fast ethernet communicates at 100Mbps or 1 GB.

Extents File: This file in the volume structures contains the extent data for the volume. Extents are the separate components of a fragmented file.

File System: Every volume uses a file system to organize the information it stores. A file system keeps track of where files are located on the volume. The Macintosh typically uses either the HFS or HFS+ filing system.

FireWire: FireWire is Apple’s name for the high speed IEEE 1394 bus standard. It can handle data rates of up to 400Mbps and is commonly used to connect hard drives

and video cameras to the Macintosh. The newer IEEE 1394b specification, which Apple calls FireWire 800, handles data rates of 800Mbps.

Firmware: This is software that has been permanently recorded into ROM (Read Only Memory). It is a cross between hardware and software.

GB: See Gigabyte.

Gigabyte: A Gigabyte consists of 1,024 Megabytes.

Head: A mechanism that reads, writes, or erases data on a storage medium.

Head Crash: A Head Crash refers to contact between a read/write head and a floppy or a hard disk surface. This usually results in damage to the disk surface and loss of data.

HFS: HFS stands for Hierarchical Filing System and is also known as Macintosh OS Standard Format. It is a method of formatting storage devices for Macintosh computers.

HFS+: Macintosh OS Extended Format is a method of formatting storage devices attached to Macintosh computers. Compared to the earlier HFS it supports more files and increases the efficiency of storage on larger drives.

I/O: An acronym for input/output.

IDE: See Integrated Device Electronics.

IEEE: See Institute of Electrical and Electronics Engineers.

Initialize: Initialization is a process of preparing a storage medium to hold data. During initialization, the volume structures for a volume are created specifying locations for storing data. Initialization erases directory information. However; the data in files themselves may be left on the volume.

Institute of Electrical and Electronics Engineers: Often referred to as IEEE (I-triple-E), this is a professional organization that sets many standards used in the computer and electronics industries. For example, AirPort is another name for the IEEE 802.11b networking standard.

Integrated Device Electronics: This is a standard electronic interface, commonly called IDE, between a computer and its mass storage devices. IDE devices (sometimes called ATA devices) conform to the ATA (AT Attachment Standard, see reference earlier in the Glossary) which specifies how peripherals communicate with the computer.

Journaling: Journaling is a feature available for HFS+ volumes under Mac OS X 10.2.2 and above. If journaling is enabled on a volume then the file system maintains a transaction log of reads and writes. This makes the file system more robust and helps protect against data loss in the event of an unexpected shutdown.

Kb: Kilobit or 1024 bits.

KB: Kilobyte or 1024 bytes.

Kbps: Kilobits per second.

KBps: Kilobytes per second.

LAN: See Local Area Network.

Local Area Network: A Local Area Network, or LAN, consists of a group of computers and peripherals in close proximity that have been set up so that they can communicate with one another. Macintosh computers usually connect via Ethernet or LocalTalk.

Logic Board: The logic board is the main component of any computer system. It might even be called the brain of the computer since it contains all the parts necessary to perform the many calculations that computers perform. This is where the CPU, the memory, and the main components of the computer are located.

Logical Unit Number: The SCSI bus identification number.

Low-Level Format: Low-level formatting removes and then recreates the markers that organize the data on a drive. All data on the drive is usually erased. Low-level formatting is usually followed by initializing.

LUN: See Logical Unit Number.

MAC address: see Media Access Control address.

Mb: See Megabit.

Mbps: Megabits per second.

MB: See Megabyte.

MBps: Megabytes per second.

MHz: See Megahertz.

Media Access Control address: The Media Access Control address, or MAC address, of an ethernet interface is a unique 48-bit address that is encoded directly into the ethernet adapter hardware by the manufacturer. It consists of 6 hexadecimal numbers separated by colons. For example: 00:00:c0:34:f1:52.

Megabit: A unit of measure for storage capacity. One megabit is equivalent to 1,048,576 bits.

Megabyte: A unit of measure for storage capacity. One megabyte is equivalent to 1,048,576 bytes.

Megahertz: A measure of frequency—one million cycles per second.

Mount Point: The mount point of a volume is the location in the directory hierarchy that the volume appears. The volume appears as a sub-directory of the mount point. In Mac OS X this is typically /Volumes.

OS: OS stands for Operating System. This is the software that allows you to interact with your computer and that keeps track of files, peripherals, programs, networks, etc.

Parallel: Parallel, the converse of serial, is a method of transmitting simultaneous bits of information over a multi-paired connector. This is much faster than serial communication since multiple bits of data can be transmitted at once. The SCSI port is a parallel port.

Partition: Disks contain sections called partitions. A partition is a block of addresses on a drive that the disk driver assigns to a specific volume.

Partition Map: The partition map holds information about the start, length, and type of each partition on a disk.

Parameter RAM: Also called PRAM. This is a dedicated chip that holds information that is vital to the Macintosh computer. A battery supplies power to the PRAM so that when the Macintosh is shut down it will retain this information. Information contained in this chip includes keyboard settings, mouse settings, and the startup device.

PCI: The standard bus on the newer Macintosh computers. It supersedes NuBus.

PRAM: See Parameter RAM.

PRAM Battery: The PRAM battery is a 3 to 4 1/2 volt battery that supplies the parameter RAM chip with power once the Macintosh has been turned off.

Protocol: A set of rules that dictate the operations of computers to allow them to communicate.

Quartz Extreme: Quartz Extreme is the name for enhanced graphics routines (such as high quality animations) that Apple added in Mac OS X 10.4. It is supported by the video subsystem on faster G4 and later Mac models. The Graphics/Displays area of System Profiler will indicate whether or not the computer supports Quartz Extreme.

RAID: See Redundant Array of Independent Disks

RAM: See Random Access Memory.

Random Access Memory: RAM is an acronym for Random Access Memory. This is memory that stores the data and programs used by your computer. Its contents are lost when the computer is turned off. RAM generally comes in packages called DIMMs and SIMMs.

Read Only Memory: ROM is dedicated chips that permanently store information. In the Macintosh the chips contain operational routines that the computer employs. ROM does not lose its information when the power is turned off. The information is permanent and cannot be changed.

Redundant Array of Independent Disks: Usually referred to as RAID. RAID software allows multiple physical hard drives to be combined so as to appear as one or more volumes. This allows for faster and/or more reliable disk access. The most common RAID standards are RAID0 (or striped) where data is distributed in parallel across multiple drives for increased speed and RAID1 (or mirrored) where the same data is written simultaneously to multiple drives for reliability.

Refresh Rate: This is the rate at which an image is repeated on a display surface such as a monitor.

Resolution: A measurement of the sharpness of an image; either by the number of pixels or the number of lines and columns on the display screen.

RGB: RGB is a video format standing for Red, Green and Blue providing color images on a CRT. By combining different levels of the red, green, and blue signals almost any color can be displayed on a monitor.

ROM: See Read Only Memory.

Root Directory: The top level of a volume's directory. It may contain subdirectories (otherwise known as folders).

SCC: See Serial Communication Controller.

SCSI: See Small Computer System Interface.

SCSI Chip: The SCSI Chip allows the Macintosh to communicate with SCSI devices. Most Macintosh computers equipped with SCSI use the 8530 SCSI chip.

SCSI Conflict: A SCSI Conflict occurs when two or more SCSI devices share the same ID number on the same bus. This can keep the devices from working reliably or from working at all.

Sector: A Sector is a portion of a disk drive's track and typically contains 512 bytes of data.

Self-Monitoring Analysis and Reporting Technology: This is a technology built into most modern hard drives. It is an industry standard that employs predictive diagnostics and analysis to help foresee a drive failure BEFORE it happens.

Serial: Serial is a communication format for sending information in consecutive bits of data, in contrast to parallel in which multiple bits of data are sent simultaneously. The advantage of using this format is that it requires less data lines, usually two, whereas parallel can require up to 50.

Serial Communication Controller: The Serial Communication Controller or SCC is an integrated circuit that supervises all serial processing on the Macintosh.

Small Computer System Interface: Also known as SCSI, this is a parallel interface standard that specifies how peripherals communicate with the computer. There are several varieties of SCSI. The transfer rate for standard SCSI built into SCSI-equipped Macs is 4MBps. The maximum rate for

SCSI is 80MBps.

SIMM: See Single Inline Memory Module.

Single Inline Memory Module: A SIMM, or Single Inline Memory Module, is a memory unit used by the computer. It contains RAM chips mounted on a small printed circuit board that plugs into SIMM slots allowing for easy installation and removal.

S.M.A.R.T: see Self-Monitoring Analysis and Reporting Technology

Startup File: This file in the volume structures, if present, contains information used by the ROM to determine what program will boot the computer.

Termination: A technique of capping the end of a signal bus to prevent resonance from occurring within a signal. A SCSI bus requires a terminator at each end.

USB: USB or Universal Serial Bus is a medium speed protocol for connecting devices to a computer. It has superseded ADB on Macintosh computers. USB is hot-swappable and has a maximum transfer rate of 12Mbps. The new USB 2.0 standard has a raw data rate at 480Mbps.

Versatile Interface Adapter: Versatile Interface Adapter or VIA is an integrated circuit used to control user input on the Macintosh. The VIA is attached to the ADB circuitry, as well as the NuBus, to control signal timing.

Volume: A volume refers to a logical storage unit seen

by the computer as a single item. This may be a floppy disk, an entire hard drive, or one or more partitions on hard drives. Although a partition is typically seen as one volume, a RAID volume may consist of more than one partition on more than one drive.

Volume Header: This portion of the volume structures contains important data about the volume as a whole. Included is the volume name, number of files and folders, and amount of free space.

Volume Structures: A collection of data structures on a volume that is used by the file system to organize the storage of data on the volume. They include the Volume Header and Catalog.

VRAM: VRAM, or Video RAM, is the memory that holds the information that is displayed on your computer's screen.