

TECHTOOL[®] PRO

VERSION 4..



User's Guide and Reference Manual



www.micromat.com

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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.
- Recover data from damaged drives.
- Test critical computer components and sub-systems.
- Perform routine maintenance on your computer.
- Reveal the culprits which 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 the intricate components of your Macintosh with a simple click of your mouse. When TechTool Pro finds a problem with your computer, it will either fix it for you or 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

- A Macintosh capable of running Mac OS X 10.2.
- CD-ROM or DVD Drive.
- 256 MB RAM or higher recommended.

Note that 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. The installer offers several installation options and these are explained in detail on the TechTool Pro installation screen. The TechTool Pro Installer will restart the computer when installation is complete.

If you suspect that your disk is damaged or that there may be other computer problems, do not install TechTool Pro until problems are resolved. We recommend that you run TechTool Pro before installation to verify that your desired installation volume is trouble free. You can startup and run TechTool Pro directly from the CD to do this. Instructions for starting up from the CD are printed on the face of the CD. For instructions on running a computer diagnostics test, see the *Sample Diagnostics Section* under *Using TechTool Pro* later in the manual.

To install:

- Insert the TechTool Pro 4 CD.
- Double-click on the **TechTool® Pro 4 Installer** icon.
- Enter your administrator password when prompted.
- Read the explanatory text on the installer screens and follow the prompts.

The default location for TechTool Pro will be in the *Applications* folder on the startup volume. However, you may choose another location if you wish.

Near the end of the installation you will have the option to place a TechTool Pro 4 icon on the Mac OS X Dock.

The TechTool Pro Installer includes an uninstall option. This option is available via the popup menu in the upper left corner of the main Install screen. Performing an uninstall will completely remove all the TechTool Pro 4 components from the selected volume.



What's Installed

When you install TechTool Pro, the program package is copied to your hard drive. This contains the main program components in one convenient location on your hard drive accessible via the TechTool Pro 4 program icon.



By default, the TechTool Pro 4 package is installed in the *Applications* folder on your startup volume:

- Applications/TechTool Pro 4

In addition, the installer installs the following folders which holds some global program preferences:

- Library/Preferences/TechTool Pro 4/

Some program user preferences are stored in:

- ~/Library/Preferences/com.micromat.TechToolPro4.plist file

Once the program has been launched and personalized, the following folder will be created:

- ~/Library/Preferences/TechTool Pro 4/

This folder holds preference files for each individual TechTool Pro test.

Personalization and Registration

The first time you launch the installed version of Tech Tool Pro you will see the **Personalization** screen.

Simply enter your name, company (if applicable), and serial number in the appropriate fields. Your TechTool Pro serial number is on a bar code sticker on the inside front cover of the program manual.

You must enter a valid TechTool Pro serial number in the Personalization screen to launch the program. If you make a mistake and enter an invalid number, the program will beep and not accept it. You can then re-enter the number. If you enter an invalid number several times in succession the program will quit. In that case, verify the number, re-launch the program, and then enter the correct number.

TechTool Pro needs to be installed on each computer you wish to protect. If the program is not installed, then the automatic diagnostic and protection features are not active. You need a unique valid serial number for each installation of TechTool Pro. When you enter a serial number, the program will check over the network to be sure that number is not in use on another computer. If it is, you will receive a message to that effect. You can then re-enter a different serial number. Additional serial numbers are available for a fee from Micromat Sales.

Each time you launch an installed version of TechTool Pro the program will check over the network to be sure that serial number is not in use on another computer. If it is,

then the program will give you a message to that effect and will not launch. You will then need to uninstall TechTool Pro, re-install it, and enter a unique valid serial number.

When you have completed personalizing the program a dialog will appear prompting you to register the program. Clicking on the **Register** button will launch your default browser and connect you to Micromat's website so that you can register. Please take a moment to register your serial number. It is your proof of ownership of TechTool Pro. Keep the serial number 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 you are registered. In addition, registration is required to receive free technical support for TechTool Pro. This is subject to change without notification.

You may also register online later if you would prefer. Simply click on the link to the Micromat web site located on the bottom of the TechTool Pro 4 program window or go directly to **www.micromat.com**. Then click on the Registration link on the left side of the page. Fill out and submit the online form and you are done.

If you do not have Internet access, cut out and mail the registration form found on the first page of this manual.

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 refer to the back cover of this manual or 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: Apple Macintosh G4/466, 256 MB RAM, 30 GB internal hard drive.)
- Version of Mac OS X installed.

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.

TechTool Pro Overview

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 lets you know and provides straightforward advice on how to proceed. If 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 catastrophe strikes, 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 see the **TechTool Pro 4** application window.



All the features of TechTool Pro are easily accessible from within this window. They are sub-divided into five categories that are displayed as icons in the **Toolbar** at the top of the application window.



The TechTool Pro Categories are:

- Suites—automated test suites to check your computer.
- Tests—individual tests to check components, drives, files, etc.
- Performance—options to enhance the performance of your computer.
- Tools—miscellaneous utilities to work with your computer and data.
- Safety—to configure TechTool Pro's automatic features.

Clicking on a category's icon in the Toolbar displays the options available for that category in the bottom portion of the TechTool Pro 4 window. Some of the categories, such as **Tests**, include sub-categories. These are selected via a "tab" interface in the category's screen.



Clicking on a tab displays that sub-category's screen. From there you can perform the functions available for that sub-category.

The upper area of sub-category screens for **Tests** and **Performance** display a **Master Test Strip** for that sub-category.



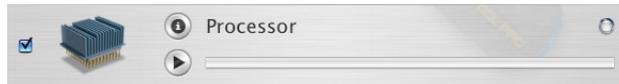
The Master Test Strip allows you to run all the available enabled tests in that sub-category with one button click. The Master Test Strip includes the following controls:

▶ Pressing the **Begin** button starts executing all available enabled tests and changes the button to a **Stop** button. Pressing the button while the tests are running cancels testing. The tests are multi-tasking and will run concurrently. The progress bar below the button shows the overall progress of the tests. If you choose a new category from the Toolbar while tests are in progress, it will be necessary to cancel those tests. Consequently, if you try to do this a warning dialog will appear and you can choose to either proceed to the new category (stopping current tests) or cancel the change.

Pressing the **Disclosure** arrow will display or hide the individual test strips in the area below the Master Test Strip.



An Individual Test Strip will be displayed for each test or function in the sub-category. You use this test strip to enable, disable, or perform a single test or function. The name of the particular test is displayed in the top center of the individual test strip. If it is a disk test, then a drive identifier or volume name will also be displayed beneath the test name.



Each test strip includes the following information and controls:

The **Enable** check box allows you to enable or disable the test. A checkmark in the box indicates that the test is enabled. Unchecking the box disables the test and dims the Test Icon to the right of the check box. Clicking on a check box while holding down the *shift* key toggles all check boxes to the opposite state. This allows you to easily enable or disable all tests with one click.



The **Test Icon** is a graphical identifier for the test. It will be dimmed for disabled tests. For drive or volume tests, the device identifier or mount point is shown below the test icon.

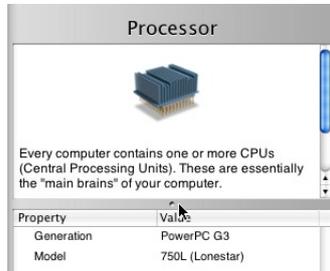


• The **Status Indicator** “LED” is on the upper right of the Test Strip. It provides a visual indication of test status as follows:

- Yellow–Pending; not yet ready to test.
- Clear–Ready to test.
- Green (flashing)–Testing in progress.
- Green–Testing finished and passed.
- Red (flashing)–Test failed, but still in progress.
- Red–Testing finished and failed.

• Pressing the **Begin** button starts the test and changes the button to a **Stop** button. The button will be dimmed if the test is not enabled. Pressing the button while the test is underway cancels the test. To the right of the **Begin** button are either one or two progress bars. Two progress bars will be present if the test actually performs a suite of tests. In that case, the bottom progress bar shows the progress for each individual test as it runs. The top bar shows the overall progress for the test suite. The name of the current test is displayed above the scroll bar(s).

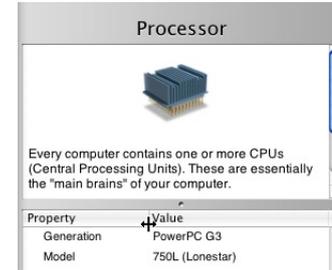
① The **Info** button toggles a drawer open or closed on the side of the application window. When the Info drawer is open the background of the **Info** button will be blue instead of black. The Info drawer contains a Split View providing information appropriate to the particular test. Just drag the view's Split Bar up or down to resize a view.



Use the scrollbars within a view if necessary to reveal any hidden information.

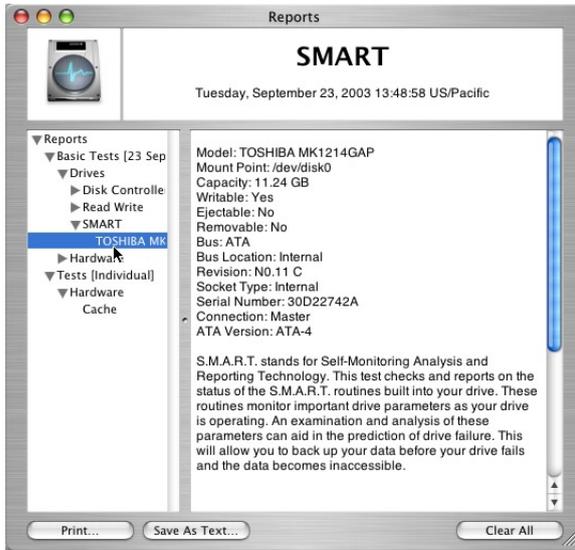
The upper view includes a test description and other general information. Details about your computer's hardware will be displayed in the lower view. Slide the Split Bar up or down as desired to display this information.

Information in the lower view is presented in the form of a table. The table lists a property and its corresponding value. The table's column size may be adjusted by dragging the separator between the column header names.



At the bottom of the TechTool Pro 4 window you will find the program version number listed on the left, a link to the Micromat website in the center, and copyright information on the right.

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 4 **Reports** window. The **Reports** window automatically appears after running a test.



The **Reports** window includes a description of each test that was performed, the results of the test, and advice on how to proceed if any problems were found.

Online help is available for TechTool Pro 4 through the Apple Help Center. Simply choose **TechTool Pro 4 Help** from the **Help** menu while using TechTool Pro. This will bring up the **TechTool Pro 4 Help** screen with indexed and searchable online documentation.

TechTool Pro 4 Manual

The TechTool Pro 4 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 four sections of the manual are introductory. They include installation instructions, an overview of the program, and general troubleshooting information. The following seven sections, from *Suites* 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. It may be of interest if you want more details about the inner working of the file system. An understanding of the file system will provide 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.

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 volumes and backup their directories. These features are configurable from within the Protection area of TechTool Pro.

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 Suites 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 cannot 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 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

Keep your version of TechTool Pro up-to-date. You may use the **Check for Update...** option found under the **TechTool Pro 4** menu to see if a new version of the program is available. Know where the TechTool Pro CD-ROM is in case you need it. Consider using TechTool Pro to set up an emergency eDrive on your hard drive. That way you could 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

Run through the basic tests in TechTool Pro and opt to repair whatever problems might be found. Log out and then log back in as a different user and see if the problems still occur. 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 CD 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, and websites, listserves, 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 outcome 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 are enabled for your volumes. Configure these options within the Safety category of TechTool Pro.

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). CD-ROMs and floppy disks 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* 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 can check the mechanical and electronic aspects of a drive to alert you to such problems, as well as find and repair problems with the volume structures.

To check for disk problems, run the drive hardware tests in the **Drives** sub-category and the volume structures

test from the **Volumes** sub-category under **Tests**. These tests do a thorough check of the drive hardware and should locate any problems within a volume's directories. If TechTool Pro finds problems, it will let you know what they are and ask whether you wish to repair any that may be repairable. It would be wise at this point to stop and make a backup of your important files if necessary. If you cannot backup files by simply dragging them to another volume due to disk corruption, try using TechTool Pro's Data Recovery routines. Then run the tests again and opt to proceed with repairs. TechTool Pro will then attempt to repair the problems. 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 all free space is consolidated into one contiguous area. **Optimization** is available as a sub-category under **Performance**. Before optimizing, check the volume structures of the volume (and repair if necessary). The volume structure tests are found in the **Volumes** sub-category under **Tests**. 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. These tests are available in the **Hardware** sub-category under **Tests**.

Using TechTool Pro

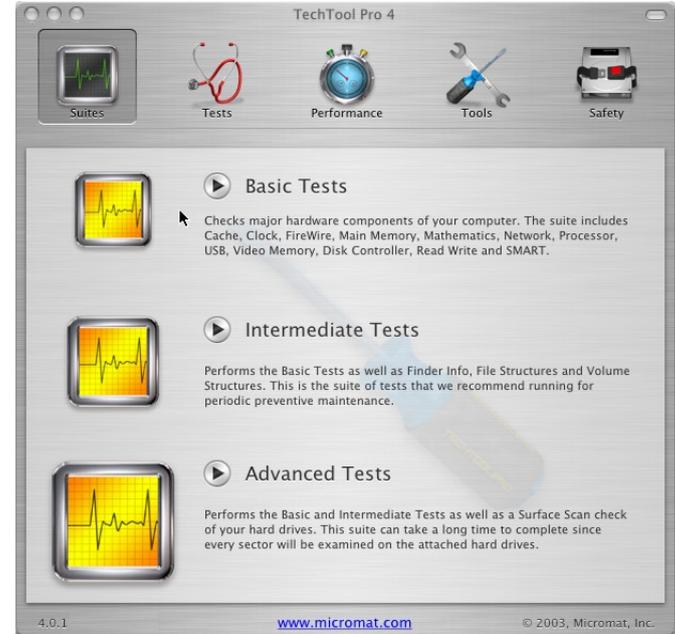
Launching TechTool Pro

TechTool Pro will be installed in the *Applications* folder on your startup volume by default. To launch TechTool Pro simply double-click on the **TechTool Pro 4** program icon.



Sample Diagnostics Section

After launching TechTool Pro you will see the **TechTool Pro 4** Application window.



A comprehensive diagnostic check of the major hardware and software subsystems in your computer is very easy to perform. To run a check simply select the **Suites** category from the top left of the TechTool Pro 4 Toolbar and then click on the **Begin** button  for the **Intermedi-**

ate Tests suite. Testing will begin immediately and all the tests in the suite will be performed. Many tests are done concurrently. If any tests fail, there will be a message to that effect in red above that test's progress bar. If a problem is found that might be repairable by TechTool Pro, you will be offered the option to begin repairs at that time. When all tests are completed the **Reports** window will appear. It provides information about the tests that were performed and advice on how to proceed if problems were detected.

For a quicker check you can select the **Basic Tests** and for a more thorough and time consuming check select the **Advanced Tests**.

This is all that is required to perform a sophisticated set of tests on your computer system. Information about more in depth testing and about additional features of TechTool Pro can be found in the following sections of this manual.

Suites

Suites

From the **Suites** category you can easily run an automated group of tests to check a variety of components and sub-systems within your computer. You can choose among three levels of testing. The **Basic Tests** perform the quickest check while the **Advanced Tests** performs the most thorough and lengthy tests.



Periodically running one of the test Suites is recommended for preventive maintenance. 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 repairable. You might consider running the **Basic Tests** weekly, the **Intermediate Tests** monthly, and the **Advanced Tests** semi-annually. Of course, if your computer is crashing or exhibiting other problems then it would be a good idea to run the tests immediately to try to pinpoint the problem.

To perform the tests in a Suite, simply click on the **Begin** button (▶) for that suite or click on the Suite's icon. The suite of tests will begin running immediately. The tests are multi-tasking. This means that many of the tests will run concurrently for greater efficiency. All the tests for the selected suite will be performed, whether or not they are enabled in their individual Test Strips. As the tests run, you will see the corresponding Test screens with their Test Strips. This allows you to monitor the progress as testing proceeds. When a test finishes you will see either Passed or Failed displayed above the test's progress bar. You may cancel a suite at any time by pressing the **Stop** button (■) in the currently executing Master Test Strip. At the conclusion of testing, the **Reports** window will appear with details about the tests performed, their results, and any advice or recommendations. Simply select any of the tests from the left hand side of the **Reports** window.

The pass/fail status will appear at the top of the screen and detailed information about the test will appear on the right.

The tests available in each Suite are listed below. For detailed information about a specific test refer to the section about that particular test later in the manual.

Basic Tests

- Cache
- Clock
- FireWire
- Main Memory
- Mathematics
- Network
- Processor
- USB
- Video Memory
- Disk Controller
- Read Write
- SMART

Intermediate Tests

The **Intermediate Tests** includes all the tests in the **Basic Tests** as well as:

- Finder Info
- File Structures
- Volume Structures

Advanced Tests

The **Advanced Tests** includes all the tests in the **Basic** and **Intermediate Tests** as well as:

- Surface Scan



The **Advanced Tests** suite may take many hours to complete since it performs a Surface Scan test on all attached drives. The more drives that are present and the larger they are the longer the test will take, since every single sector on the drives must be tested.

If problems are discovered during any of the tests you will be provided with advice on how to proceed and given the option to make repairs at that time if appropriate. When testing is complete you can find details about what was done, what was found, and repair advice in the TechTool Pro Report.



When performing a Suite, tests will be performed on all available volumes and drives. This includes CD-ROM drives. Some of these tests are time consuming, particularly so on CD-ROM drives since they are inherently much slower than hard drives. For this reason it is recommended that you remove any CD-ROMS before testing, unless you specifically wish to test them. Note that when booted from the TechTool Pro CD-ROM you will not be able to remove it since it is the current startup volume.

Tests

Tests



The **Tests** category includes options to test various hardware components, drives, and other aspects of your computer system. The **Tests** window provides a tabbed

interface including the following sub-categories: **Hardware**, **Drives**, **Volumes**, and **Files**. These sub-categories and their tests are described in detail below.

Hardware



Selecting the **Hardware** tab in the **Tests** screen displays the **Hardware Diagnostics** Master Test Strip. Simply press the **Begin** button  to test all the enabled hardware tests. Use the Hardware Tests disclosure arrow if necessary to view the individual hardware test strips. This will allow you to enable, disable, or run specific tests. A detailed description of each of each test follows.

Cache



Cache RAM is fast random-access memory that is used to store data for CPU operations. Macintosh computers that have a PowerPC processor have an instruction cache built into the CPU called Level 1 cache. This cache speeds up processing speed 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.

The next type of cache is Level 2 cache. This may reside on separate chips, generally on an optional card that is attached to the Macintosh logic board, or integrated into the computer's processor itself. Some third party upgrade cards also come with L2 cache. Just as the L1 cache holds frequently used CPU instructions, the L2 cache is a repository for frequently used blocks of memory. Conventional L2 cache is connected to the system bus and its speed is limited by the system bus speed. The newer Level 2 backside cache is located on the same board as the CPU processor board and is connected directly to the CPU through its own high-speed bus. The L2 backside cache allows the system to run significantly faster than conventional L2 cache.

Level 3 cache is the name for extra cache built into motherboard between the microprocessor and the main memory. What was once L2 cache on motherboards now becomes L3 cache when used with microprocessors containing L2 backside cache.

TechTool Pro displays the amount of L1, L2, and L3

cache (if present) in your system and will test it for proper operation. In particular, the following tests are performed:

L1 Performance

This test checks the amount of L1 cache contained in the computer and will verify that it is operational.

L2 Performance

This test checks the amount of L2 cache contained in the computer and will verify that it is operational.

L3 Performance

This test checks the amount of L3 cache contained in the computer and will verify that it is operational.

④ Pressing the **Info** button toggles the Info drawer. The upper view displays general information about cache memory. The lower view displays details about the amount of each type of cache memory installed for each processor present in the your computer. Use the Split Bar if necessary to adjust the views.

Clock



In computer jargon the term “clock speed” is a measure of performance. It refers to the speed at which the computer is able to perform its various operations. It is similar

to “horse power” in the automobile industry. Computer users can improve their computer’s performance by finding ways to increase their clock speed. This can be accomplished by either buying a new machine or upgrading the existing computer with an accelerator or faster clock chip.

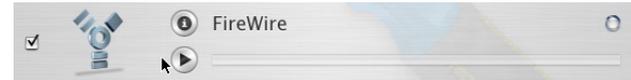
The Macintosh clock provides base timing signals to the Central Processing Unit (CPU). These dictate how many instructions per second the CPU can perform. Sometimes comprised of a crystal unit and clock circuit, the computer’s clock determines the “heart beat” of the computer. The faster the rate, the faster the computer runs. The clock rate is measured in megahertz (MHz) or gigahertz (GHz). One megahertz represents 1,000,000 pulses per second, while a gigahertz is 1,000,000,000 pulses per second. The original 1984 Macintosh ran at a whopping 8MHz or 8,000,000 pulses per second (don’t confuse this with IPS—instructions per second). A Macintosh G4 might run at 1.5 GHz or 1,500,000,000 pulses per second – quite a difference.

While clock speed has become the industry benchmark for comparing computer speeds, it is not an absolute indicator of overall computer performance. For instance, an old Macintosh G3 modified to run at 500Mhz may seem like it would perform better than a Power Macintosh G4 running at 450MHz, but that is not the case. The improved processor, newer bus architecture, and accelerated I/O of the G4 will boost overall performance above what can be achieved from older-generation systems.

TechTool Pro lets you verify your clock speed and test the circuit that comprises your Macintosh clock. While this is helpful in diagnosing an ailing machine, you will also find it useful for testing upgrades to verify that advertised gains in clock speed are being realized.

ⓘ Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the computer’s clock circuitry. The lower view will display details your computer’s CPU and Bus speed. Use the Split Bar if necessary to adjust the views.

FireWire



FireWire is a cross-platform implementation of the high-speed serial data bus defined by IEEE Standard 1394. FireWire was conceived by Apple Computer 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 one of the fastest peripheral standards ever developed. It is integrated into Power Macintoshes, iMacs, eMacs, PowerBooks, iBooks, and the iPod. FireWire ports were also used in many other computer products dating back to the Power Macintosh G3 “Blue

& White” computers. All these machines include FireWire ports that operate at up to 400 Mbps. In addition, FireWire ports may 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 like the latest hard disk drives and printers.

TechTool Pro can check the FireWire bus in your computer to ensure that it is functioning. Note that the program itself can not check the FireWire ports to verify that data is being sent and received properly. This would require special loopback hardware not normally available. The FireWire test performs the following functions:

FireWire Check 1

This test checks the computer for the presence of a loaded and actively running firewire driver. If a computer’s firewire ports have all failed the no driver will be loaded at startup and this test will fail.

FireWireCheck 2

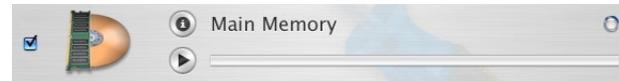
This test checks that the firewire configuration ROM of the computer is functional.

Even though the FireWire tests cannot test the FireWire ports, they may allow you to determine whether a port is faulty. The Info drawer displays all attached FireWire devices recognized by the system. If a FireWire device (device #1) does not show up when plugged into a

port, try moving both it and its cable to a second port (if available) that does display a FireWire device (device #2). Also move device #2 (with its cable) to the possibly faulty port. Then check the Info drawer again. If device #1 does not show up, then the problem is probably with that device or its cable. If device #2 does not show up, then the original port itself is probably faulty.

ⓘ Pressing the **Info** button toggles the Info drawer. The upper view displays general information about FireWire. The lower view displays information about all recognized FireWire devices attached to your computer. Use the Split Bar if necessary to adjust the views.

Main Memory



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 will appear intermittently, leading you to believe you've solved the it only to discover later that the problem still exists.

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 thoroughly check your Macintosh memory. TechTool Pro's pattern tests scan your memory for RAM problems and let you know if problems are found. The following tests are performed by TechTool Pro:

10101010

This test works by writing the binary pattern 10101010 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

01010101

This test works by writing the binary pattern 01010101 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

11110000

This test works by writing the binary pattern 11110000 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

00001111

This test works by writing the binary pattern 00001111 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

11111111

This test works by writing the binary pattern 11111111 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

00000000

This test works by writing the binary pattern 00000000 consecutively throughout the memory matrix, reading and verifying each pattern after it has been written.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about computer memory. The lower view displays details about your computer's actual memory configuration. Use the Split Bar if necessary to adjust the views.

In particular, the following information is displayed for each memory slot:

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

Mathematics



These tests allow you to check for correct operation of your computer's mathematical processing hardware and software routines. Older Macintosh's use a separate chip called a Floating Point Unit (FPU). This is sometimes referred to as a math coprocessor. If available, this chip helps the CPU calculate floating-point and other complex math operations and functions. While many machines

have separate and independent FPU chips, the recent trend has been to super-integrate these circuits into the CPU. This saves the manufacturer money by reducing the number of components and assembly time. The user gains by reduced product costs and a nominal computational speed increase since an integrated FPU does not have to contend with bus arbitration and the other delays of processor-to-processor communications.

AltiVec is a Motorola technology incorporated into most PowerPC processors. It expands the PowerPC architecture via the addition of a 128-bit vector execution unit that operates concurrently with the processor's existing integer and floating-point units. The AltiVec instruction set can perform operations on multiple bits within the 128-bit wide registers. It allows the simultaneous execution of up to 16 operations in a single clock cycle. This combination of additional instructions, parallel operation on multiple bits, and wider registers provides speed enhancements of up to 30x on high-bandwidth data processing routines such as those commonly included in image and video processing programs (among others).

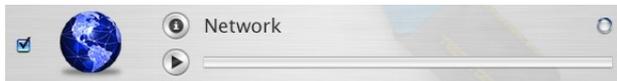
Whatever type of mathematical processing your computer employs, TechTool Pro will test it by requesting both simple and complex floating point calculations from the system. These are thousand-iteration tests that use a cascading scheme that exponentially increase in complexity.

TechTool Pro uses the following computational functions to test the accuracy and timing of the FPU chip or FPU circuit of the CPU:

- Add/Subtract
- Multiply/Divide
- Square Root
- Round Integral
- Truncate Integral
- Remainder
- Binary Log
- Binary Scale
- Binary To Binary
- Binary to Decimal
- Decimal to Binary
- Base-E Logarithm
- Base-2 Logarithm
- Base-E Exponential
- Base-2 Exponential
- Cosine

 Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the Mathematics tests. The lower view displays details about your system, including whether AltiVec is present. Use the Split Bar if necessary to adjust the views.

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. Both AirPort and AirPort Extreme transmit on one of 11 channels in the 2.4 GHz band.

Every ethernet port has a unique hardware address called a Media Access Control (MAC) address. The manufacturer assigns this unique identifier to the ether-

net hardware at the factory.

TechTool Pro will locate all available network interfaces recognized by your system and give you a report on their status. It will also provide you with each port's MAC address.

The Network test performs the following functions:

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.



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.

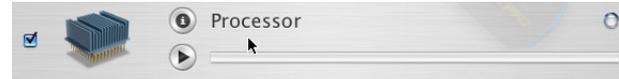
A test failure may be due to an incorrect networking configuration, corruption in the System's networking software, wiring problems, or hardware failure. If the test fails verify that the network configuration is correct and that all cables are securely attached. TechTool Pro cannot test the networking hardware itself. This requires specialized test equipment. If the problem appears to be faulty hardware, you will probably need to contact a qualified technician.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about networking. The lower view displays information about your computer's available network services. Use the Split Bar if necessary to adjust the views.

In particular, the following is displayed for each network interface:

- Vendor.
- Driver.
- Model.
- Link Status.
- Link Speed.
- Base Station (if wireless).
- Channel (if wireless).
- MAC Address.

Processor



Every computer contains one or more Central Processing Units (CPUs). These are essentially the "main brains" of your computer. As you might remember from the Clock section of this manual, the clock provides the timing signals that the CPUs need to operate. While clock speed is a major factor in overall computer performance, 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. In particular, it performs the following tests:

Memory Move

Floating-point move instructions copy data from one floating-point register to another altering the sign bit (bit 0).

Memory Read

Memory load test using little-endian byte ordering.

Memory Write

Memory store test using little-endian byte ordering.

Integer Compare

Compares instructions algebraically with the UIMM operand.

Integer Logic

Compares instructions logically with the UIMM operand.

Integer Rotate

Rotates the contents of a register. The result of the rotation is inserted into the target register using mask bit 1 and mask bit 2 operations.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about computer processors. The lower view displays details about the processor(s) present in your computer. Use the Split Bar if necessary to adjust the views.

In particular, the following information is displayed for each processor:

- Generation—G3, G4, etc.
- Model—processor model (including code name if available).
- Version—the version number of the processor.
- Speed—the clock speed of the processor in megahertz.
- Activec—whether present or not.
- Configuration—single processor, dual processor, etc.



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 new USB 2.0 standard has a raw data rate at 480 Mbps. USB has superseded the Apple Desktop Bus (ADB) on

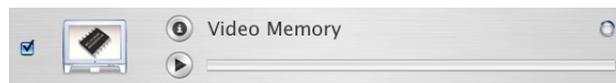
Macintosh computers for attaching low speed peripherals. It is present on all recent Macintosh models. In addition, USB ports may be added via PCI cards or as USB hubs attached to existing ports. Typical USB devices include keyboards, mice, joysticks, game pads, and other low-bandwidth, low-cost devices. 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 can check the USB bus in your computer to ensure that it is functioning. Note that the program can not check the USB ports themselves to verify that data is being sent and received properly. This would require special loopback hardware not normally available. Even though the USB tests cannot test the USB ports, they may allow you to determine whether a port is faulty. The Info drawer displays all attached USB devices recognized by the system. If a USB device (device #1) does not show up when plugged into a port, try moving both it and its cable to a second port (if available) that does display a USB device (device #2). Also move device #2 (with its cable) to the possibly faulty port. Then check the Info drawer again. If device #1 does not show up, then the problem is probably with that device or its cable. If device #2 does not show up, then the original port itself is probably faulty.

① Pressing the **Info** button toggles the Info drawer. The upper view displays general information about USB. The lower view displays information about all recognized USB devices attached to your computer. Use the Split Bar if necessary to adjust the views.

Video Memory



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 Main Memory tests. For test details please refer to the *Main Memory* test section under *Hardware* earlier in the manual.



The computer's screen may display strange patterns or colors while performing the Video Memory tests. This is normal.



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

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about video memory. The lower view displays information about the display configuration of your computer. Use the Split Bar if necessary to adjust the views.

Drives



Selecting the **Drives** tab in the **Tests** screen displays the **Drive Diagnostics** Master Test Strip. The **Drives** tests check various aspects of drive hardware. Many of the tests can be run on CD-ROM drives as well as hard drives. To test a CD-ROM drive a valid Macintosh formatted CD-ROM must be in the drive.

Simply press the **Begin** button to perform the enabled tests on the selected drives. Use the **Drive Tests** disclosure arrow if necessary to view the individual drives' test-

strips. This will allow you to enable, disable, or perform tests on specific drives. A detailed description of each test follows.

Three separate tests may be performed on each physical drive: **Disk Controller**, **Read Write**, and **Surface Scan**. Details about each test follow.

Disk Controller



Although there are utilities available to help recover lost files and repair damaged directory information, few utilities examine the mechanics of the hard drive. The hardware aspects of the drive, including the controller board, heads, spindle motor, and head armature, are just a few items that deserve at least as much attention as the software attributes of the drive. If one of these items fails, no software recovery program alone will be able to save your data.

TechTool Pro tests many critical elements of your hard drive, including the controller I/O, memory and head-positioning mechanism, and drive voltage. These universal tests are applicable to almost any drive types. Some of the tests can even be performed on CD-ROM drives. The Disk Controller suite of tests check the following aspects of the drive:

Diagnostic Check

This test initiates a self-diagnostic on the target drive. These routines are designed by the drive manufacturer and provide excellent insight into the operational condition of the drive.

Format Check

This test establishes whether the drive was properly formatted during initial setup.

Rezero Unit

This test is used to determine the target drive's ability to position the actuator at cylinder zero.

Spare Sector Check

This test checks the service tracks to determine whether there are enough spare blocks left for bad block repairs.

Supply Voltage Check

This test checks that the voltage to the drive is within acceptable limits.

Unit Ready Check

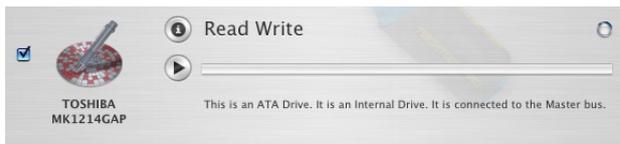
This test determines whether the target drive is able and ready to receive commands.

④ Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the **Disk Controller** tests. The lower view displays the following additional details about the selected drive (as appropriate for the drive type):

- Model (if available).
- Mount Point.
- Total disk capacity.
- Whether it is writable.
- Whether it is ejectable.
- Whether it is removable.
- Bus connection.
- Bus location.
- Revision (if available).
- Socket Type.
- Drive serial number (if available).
- ATA connection type (if applicable).
- ATA Version (if applicable).
- SCSI LUN (if applicable).
- SCSI ID (if applicable).

Use the Split Bar if necessary to adjust the views.

Read Write



It is critical that your computer can reliably write data to and read it from your drives. TechTool Pro performs the following important tests to verify that your drives are able to store and retrieve information correctly:

Read Buffer

This test is used in conjunction with the Write Buffer test as a diagnostic function for testing target memory and the bus integrity.

Write Buffer

This test is used in conjunction with the Read Buffer test as a diagnostic function for testing target memory and the bus integrity.

Linear Read

Reads blocks of data linearly.

Linear Write

Writes blocks of data linearly to a free storage location.

Random Read

Reads data from a random memory location.

Random Write

Writes data to a random free storage location.

Seek Test

The Seek test determines whether the initiator can be positioned properly to access a particular logical block on the drive.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the Read Write tests. The lower view displays the following additional details about the selected drive:

- Model (if available).
- Mount Point.
- Total disk capacity.
- Whether it is writable.
- Whether it is ejectable.
- Whether it is removable.
- Bus connection.
- Bus location.
- Revision (if available).
- Socket Type.
- Drive serial number (if available).
- ATA connection type (if applicable).
- ATA Version (if applicable).
- SCSI LUN (if applicable).
- SCSI ID (if applicable).

Use the Split Bar if necessary to adjust the views.

SMART



S.M.A.R.T. stands for Self-Monitoring Analysis and Reporting Technology. This technology was developed through the efforts of the S.M.A.R.T. Working Group (SWG), a consortium of major hard disk manufacturers, to increase the reliability of hard drives. S.M.A.R.T. routines are now incorporated into most new hard disk drives. Although the S.M.A.R.T. 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 S.M.A.R.T. 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 S.M.A.R.T. monitoring can predict 70% of drive hardware failures before they occur. Even though not all drive failures can be predicted, S.M.A.R.T. provides a high level of insurance against such problems. S.M.A.R.T. 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.



SMART is only available for ATA hard drives. It is not available for SCSI hard drives or CD/DVD-ROM drives. FireWire and USB drive interfaces do not pass the S.M.A.R.T. calls necessary to perform the SMART test routines even though the drive in the housing may be an ATA drive.

Each physical hard drive that supports S.M.A.R.T. appears in its own SMART test strip. To perform a SMART check of the drive simply press the **Begin** button in the drive's test strip. The test results will appear in the **Reports** window. They will include a list of drive Attributes and whether or not each Attribute is within prescribed limits. Each Attribute will have a Normal, Worst, and Threshold value. Normal and Worst values range from 1 to 253. Threshold values range from 0 to 253. The higher the value the better. A Threshold value of 0 indicates that that Attribute always passes. The exact meanings of the numeric values are determined by individual drive manufacturers, and will vary from maker to maker. They do not

relate directly to real-world measurable quantities. Different drive makers may have completely different Threshold and Normal values for the same Attribute. What is important is that a value never falls below the Threshold. If it does, this may signal a failing drive. If an Attribute's value does fall below the Threshold, the SMART test will indicate this with the word **Warning!** above the scrollbar. **Warning!** will also appear beside the corresponding attribute in the **Reports** window. Although Threshold levels may be exceeded occasionally, this could indicate a failing drive and it would be wise to have current backups in this case. You might consider printing the results of the SMART test for reference and then contacting the manufacturer of the drive. With the SMART test results they should be able to provide you with details about the precise meaning of the failure and whether that indicates the drive should be replaced. If the drive is under warranty the SMART test results may be all that are required to verify a problem and to receive a replacement drive.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about S.M.A.R.T. technology. The lower view displays the following additional details and options for the selected drive:

- Model (if available).
- Mount Point.
- Total disk capacity.
- Whether it is writable.
- Whether it is ejectable.
- Whether it is removable.
- Bus connection.

- Bus location.
- Revision (if available).
- Socket Type.
- Drive serial number (if available).
- ATA connection type (if applicable).
- ATA Version (if applicable).
- SCSI LUN (if applicable).
- SCSI ID (if applicable).

Use the Split Bar if necessary to adjust the views.

TechTool Pro can be configured to automatically query the S.M.A.R.T. registry for selected drives at specific pre-configured times and to notify you of problems via email so that you can take appropriate action. The automatic SMART functions are configured via the **Safety** category in the Toolbar.

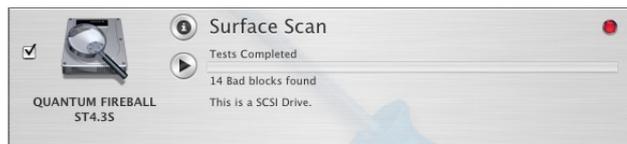
Surface Scan



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. It reads data from every block on the drive to check the integrity of the drive surface. As the test runs the current block being scanned is displayed above the progress bar. The number of bad blocks encountered (if any) are displayed below the scroll bar.



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.

ATA drives are the most common type 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 ATA drives. The drive controller in ATA drives automatically tries to lock out bad blocks as they are encountered. It will do this unless either the bad block is in a critical area that cannot be locked out at the moment or

the bad block table is full. If this occurs, TechTool Pro will report a bad block and you will need to reinitialize the drive.



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

You would typically use Apple's Disk Utility or Drive Setup to reinitialize your drive. Be sure to choose the option to "zero all data." This may take several hours (depending on the size of your drive). It will test for and attempt to lock out any bad blocks that are found anywhere on the disk surface. If the re-initialization is successful then the drive should be fine at that point. If it fails, then the drive is most likely faulty and will need to be replaced.

SCSI drives do not automatically lock out bad blocks. If bad blocks are reported for a SCSI drive, you should backup and reinitialize the drive as described above using the "zero all data" option.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the **Surface Scan** tests. The lower view displays the following additional details about the selected drive:

- Model (if available).
- Mount Point.
- Total disk capacity.
- Whether it is writable.
- Whether it is ejectable.

- Whether it is removable.
- Bus connection.
- Bus location.
- Revision (if available).
- Socket Type.
- Drive serial number (if available).
- ATA connection type (if applicable).
- ATA Version (if applicable).
- SCSI LUN (if applicable).
- SCSI ID (if applicable).

Use the Split Bar if necessary to adjust the views.

Volumes

There are a variety 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. 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.

Mac OS X 10.2.2 has added a new feature to the Mac OS Extended (HFS Plus) file system called journaling. 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 are in a possibly corrupted state after a failure. If journaling was enabled, the file system can “replay” the information in its log and complete the interrupted operations when the computer restarts. This may prevent volume structure problems that could occur after an unexpected shutdown--or improve the chances of a successful repair if they do. TechTool Pro is fully compatible with journaled volumes.

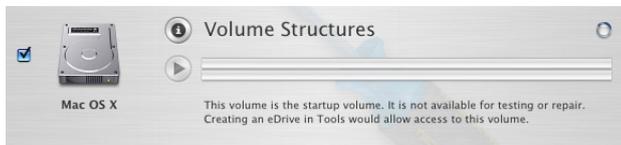
TechTool Pro can scan your volumes for problems related to the numerous structures that are necessary for the volumes to function properly. If TechTool Pro discovers problems with one of your volumes, you will be given the option to attempt repairs.

Selecting the Volumes tab in the Tests screen displays the Volume Diagnostics Master Test Strip.



Simply press the Begin button to test the volume structures of the selected volumes. Use the Volumes disclosure arrow if necessary to view the individual Volumes' Test Strips. This will allow you to enable, disable, or run tests on specific volumes. A detailed description of the volume tests follows.

An individual Volume Structures Test Strip will be displayed below the Master Volume Test Strip for each volume recognized by TechTool Pro.



Be sure the test is enabled for each volume you wish to

check and then press the appropriate **Begin** button to test an individual volume.



TechTool Pro may recognize volumes that are damaged and do not mount normally on the desktop.



If an attached volume is unmounted, TechTool Pro will still display a test strip for the volume. However, instead of a volume icon there will be special “restricted” icon with a **Mount** button below it.



Pressing the **Mount** button mounts the volume so that it can be tested.

If problems are found on a volume during testing, the test strip name will change to **Volume Structure Repair** in RED and a failure message will be displayed below the scroll bars. In that case, pressing the **Begin** button (the same button you pressed to originally run the test) will commence a volume structure repair.



Before repairing volume structure problems, be sure to have any important data saved to another volume if possible. Use TechTool Pro's data recovery routines if necessary.



Volumes with OS X installed on them contain tens to hundreds of thousands of files. The volume structures are extremely complex and consequently a volume structure repair may take some time. Several hours is not uncommon.

In order to repair a volume, TechTool Pro will attempt to rebuild completely new directories for that volume in RAM. If it can do this successfully, it will bring up a Technical Comparison for the volume.

Comparison Data For Verification
Volume: "Mac OS X"

 This comparison data allows you to verify the accuracy of the rebuild process prior to saving these changes to disk. Use the technical comparison data and compare the Original Directory Data to the Rebuilt Directory Data.
Press the 'Replace' button to replace the current directory contents with the rebuilt directory contents.

Original Directory Data	Rebuilt Directory Data
Volume Information Total Folders: 312 Total Files: 2,914 Volume Content Size: 335.2 MB	Volume Information Total Folders: 312 Total Files: 2,914 Volume Content Size: 335.2 MB
Catalog B-Tree Information Depth: 2 Node Size: 8 KB Leaf Record Count: 6,454 Maximum Key Size: 516 Used Nodes: 153 Free Nodes: 359	Catalog B-Tree Information Depth: 2 Node Size: 8 KB Leaf Record Count: 6,454 Maximum Key Size: 516 Used Nodes: 128 Free Nodes: 384
Extents B-Tree Information Depth: 1 Node Size: 4 KB Leaf Record Count: 1 Maximum Key Size: 10 Used Nodes: 2 Free Nodes: 1,022	Extents B-Tree Information Depth: 1 Node Size: 4 KB Leaf Record Count: 1 Maximum Key Size: 10 Used Nodes: 2 Free Nodes: 1,022

Favorable Change Unusual Change

The Technical Comparison displays important technical information about both the original directories and the newly created directories stored in RAM. 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.



If there are RED changes in the Technical Comparison, it would be prudent to press the **Cancel** button and backup any important data before proceeding with the repair. An incorrect repair usually requires a reinitialization of the volume and restoration of your data.

Note that a red change in the Technical Comparison is not necessarily a bad change. However, it is a change that is unusual. Red changes indicate that you should consider the ramifications of the change very carefully before committing to the repair. Particularly important are any changes in volume content size or the total number of files and folders. If the numbers in the Technical Comparison seem reasonable and you decide to go ahead with the repair, press the **Replace** button. This will delete the original directories and replace them with the new ones. Otherwise, press the **Cancel** button and nothing will be changed on the volume.

TechTool Pro can analyze and often repair 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 complete 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.

Startup File

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.



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

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the volume structures and the tests. The lower view displays details about the selected volume:

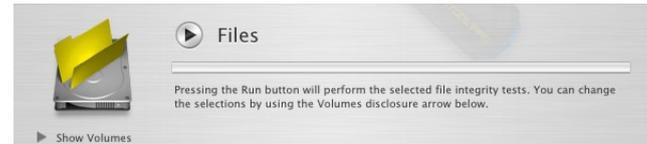
- Volume name.
- Mount point.
- Volume format.
- Whether journaling is enabled.
- Creation date.
- Last modification date.
- Capacity.
- Used space
- Available space.
- Total number of files.
- Total number of folders.
- Whether the volume is writable.
- Whether the volume is ejectable.
- Whether the volume is removable.

Use the Split Bar if necessary to adjust the views.

Files

The tests in the **Files** sub-category will test individual files on a volume for specific types of file corruption. In particular, it will test for file structure problems (damaged file resources) and finder info problems (file dates, bundle bits, and custom icon problems).

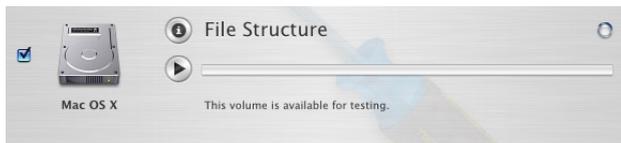
Selecting the **Files** tab in the **Tests** screen displays the **File Diagnostics** Master Test Strip.



Simply press the **Begin** button to perform all enabled file tests for the selected volumes. Use the **Volumes** disclosure arrow if necessary to view the individual test strips for each volume. This will allow you to enable, disable, or run enabled tests on specific volumes.

The Files tests are described below:

File Structure



The File Structure tests of TechTool Pro are used to determine whether the resources of individual files are damaged. If any damaged files are found, TechTool Pro will let you know which files are bad. There is no way for TechTool Pro to repair a corrupt file, since there is no way to know what the data in the file should have been originally. If corrupt files are found, you should delete them and then restore them from a known good source.

Some of the items checked by the File Structure tests are:

Resources

- Verifies that resource length is correct.
- Checks that resource map follows resource data.
- Verifies that type list offset is correct.
- Determines if reference list offset is correct.
- Checks if resource data length is correct.
- Verifies that resource name length is correct.

PPC native code in the data fork

- Determines if valid data fork exists.
- Verifies that fragment location and offset are valid.
- Scans data fork to determine if declared code is actually present.
- Tests for code fragment type matches.
- Verifies that fragment length is correct.

Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the File Structures tests. The lower view displays details about the selected volume:

- Volume name.
- Mount point.
- Volume format.
- Whether journaling is enabled.
- Creation date.
- Last modification date.
- Capacity.
- Used space
- Available space.
- Total number of files.
- Total number of folders.
- Whether the volume is writable.
- Whether the volume is ejectable.
- Whether the volume is removable.

Use the Split Bar if necessary to adjust the views.

Finder Info



The Finder Info Test Strip allows you to check for problems with the Finder information of the files on a volume. The tests will scan the selected volumes, validate, and optionally repair problems that are found. The Finder Info tests check the following:

Bundle Bits

These are resources within applications that determine which documents belong to an application. If this resource is not correctly configured, the result will be generic icons for documents or failure of the application to launch when those documents are double-clicked.

File Dates

Sometimes file and creation dates will be incorrect because the Macintosh clock was incorrect when the file was created or modified. This results in files with improbable file dates such as January 1, 1904. While determining the true dates for a file may not be possible, TechTool Pro will change the file dates to the computer's current date if they are obviously incorrect.

Custom Icons

If you assign a custom icon to a file or application, a custom icon bit is set so that the Finder knows it should display the custom icon instead of the normal icon for that file. Sometimes this custom icon bit will be set incorrectly and the custom icon will not display. TechTool Pro will correct this problem by properly setting the bit.

The Finder Info test strip includes a **Repair On** checkbox below the test name. If this box is checked then Finder Info problems will automatically be repaired as they are encountered.

i Pressing the **Info** button toggles the Info drawer. The upper view displays general information about the Finder Info tests. The lower view displays the following additional details about the selected volume:

- Volume name.
- Mount point.
- Volume format.
- Whether journaling is enabled.
- Creation date.
- Last modification date.
- Capacity.
- Used space
- Available space.
- Total number of files.
- Total number of folders.
- Whether the volume is writable.
- Whether the volume is ejectable.
- Whether the volume is removable.

Performance

Performance

The **Performance** category contains features to enhance the overall speed of your computer system. The **Performance** window provides a “tab” interface with the following sub-categories: **Maintenance** and **Optimization**.



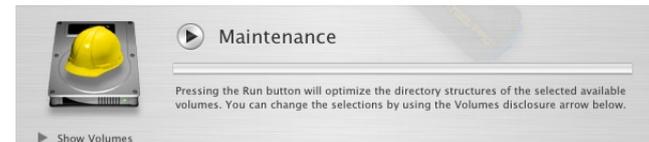
Maintenance

The directory of a volume stores critical information about the files and folders stored on the volume and where they are located. As files and folders are added to and deleted from a volume, the data structures that hold this information may become inefficiently organized. The data that keeps track of file locations may become fragmented and scattered throughout the directories. This lowers the speed at which this vital information can be accessed by the system. Rebuilding the directories completely reconstructs these critical data structures, optimizing them and improving overall system performance.



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

Selecting the **Maintenance** tab in the **Performance** screen displays the **Maintenance** screen with the **Maintenance** Master Test Strip at the top.



Simply press the **Begin** button to rebuild the directories of the selected available volumes. Use the **Show Volumes** disclosure arrow if necessary to view the individual

volumes' Directory Maintenance Test Strips. This will allow you to enable, disable, or perform directory maintenance on specific volumes. A detailed description of Directory Maintenance follows.

An individual Directory Maintenance Test Strip is displayed below the Master Volume Test Strip for each volume recognized by TechTool Pro.



Performing directory maintenance on a volume totally rebuilds the volume structures for that volume, thereby optimizing their data structures.



Volumes with OS X installed on them contain tens to hundreds of thousands of files. The volume structures are extremely complex and consequently a volume structure rebuild may take some time. Several hours is not uncommon.

To rebuild the volume structures, be sure the Test Strip is enabled for each volume you wish to rebuild. Then begin the rebuilds—either individually or concurrently. TechTool Pro will attempt to rebuild new directories for the selected volumes in RAM. If it can do this successfully it will bring up a **Technical Comparison** screen for each volume it completes.

Comparison Data For Verification

Volume: "Mac OS X"

This comparison data allows you to verify the accuracy of the rebuild process prior to saving these changes to disk. Use the technical comparison data and compare the Original Directory Data to the Rebuilt Directory Data.

Press the 'Replace' button to replace the current directory contents with the rebuilt directory contents.

Original Directory Data	Rebuilt Directory Data
Volume Information Total Folders: 312 Total Files: 2,914 Volume Content Size: 335.2 MB	Volume Information Total Folders: 312 Total Files: 2,914 Volume Content Size: 335.2 MB
Catalog B-Tree Information Depth: 2 Node Size: 8 KB Leaf Record Count: 6,454 Maximum Key Size: 516 Used Nodes: 153 Free Nodes: 359	Catalog B-Tree Information Depth: 2 Node Size: 8 KB Leaf Record Count: 6,454 Maximum Key Size: 516 Used Nodes: 128 Free Nodes: 384
Extents B-Tree Information Depth: 1 Node Size: 4 KB Leaf Record Count: 1 Maximum Key Size: 10 Used Nodes: 2 Free Nodes: 1,022	Extents B-Tree Information Depth: 1 Node Size: 4 KB Leaf Record Count: 1 Maximum Key Size: 10 Used Nodes: 2 Free Nodes: 1,022

■ Favorable Change ■ Unusual Change

Cancel **Replace**

The **Technical Comparison** displays important technical information about both the original directories and the newly created directories stored in memory. 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.



If there are RED changes in the **Technical Comparison**, it would be prudent to press the **Cancel** button and backup any important data before proceeding with the rebuild. An incorrect rebuild usually requires a reinitialization of the volume and restoration of the data.

Note that a red change in the **Technical Comparison** is not necessarily a bad change. However, it is a change that is unusual. Red changes indicate that you should consider the ramifications of the change very carefully before committing to the repair. Particularly important to consider are any changes in volume content size or the total number of files and folders. If the numbers in the **Technical Comparison** seem reasonable and you decide to go ahead with the rebuild, press the **Replace** button. This will delete the original directories and replace them with the new optimized ones. Otherwise, press the **Cancel** button and nothing will be changed on the volume.



To rebuild a volume it must be unmounted. This means that nothing can be open or running on the volume. In particular, you must both boot the computer and run TechTool Pro from another volume. To rebuild your normal startup volume you would typically boot the computer and run TechTool Pro directly from the TechTool Pro CD-ROM or from your eDrive. Instructions for booting from the CD-ROM are printed on the face of the CD-ROM. For information about setting up and using

eDrive refer to the section on eDrive later in the manual.

The individual test strips contain the following controls:

 Pressing the **Info** button toggles the Info drawer. The drawer's upper view displays general information about the volume structures and the reasons for rebuilding them. The lower view displays the following additional details about the selected volume:

- Volume name.
- Mount point.
- Volume format.
- Whether journaling is enabled.
- Creation date.
- Last modification date.
- Capacity.
- Used space
- Available space.
- Total number of files.
- Total number of folders.
- Whether the volume is writable.
- Whether the volume is ejectable.
- Whether the volume is removable.

Use the Split Bar if necessary to adjust the views.

 Pressing the **Graph** button creates and displays the **Directory Maintenance** window for the volume. As the graph is created the progress is indicated by the scroll bar at the bottom of the window.

The **Directory Maintenance** window provides a graphical indication of the state of data fragmentation in the

volume's directories. The graph displays the portion of the directory currently holding data in blue. The more fragmented the blue area in the graph, the more inefficiently the data is organized. An optimized directory will show all the blue in one contiguous area. The graph is a visual aid to help you decide whether it is time to rebuild the directories.

Optimization

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.

Optimization has two goals: to defragment the files on a volume and to consolidate the free space on the volume into one large block. This can improve performance when reading to or writing from the volume.

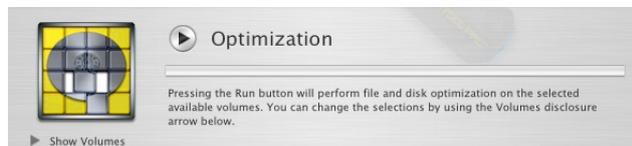
As files are written to and read from a volume, the file system instructs the drive mechanism on where and how to store and find the information. It can place this information anywhere there is available free space on the volume. If there is not a contiguous free area large enough to store a file, then the file system will fragment the file. It will save a piece here and a piece there. 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 can effect the speed of file access on

your volumes. It increases the amount of time needed to read and write files resulting in less than optimal performance. Instead of the drive head being able to scoop up a requested file in one swoop, it must locate the scattered pieces of a file and then reconstruct it. If the free space is fragmented, writing a file may require it to be broken up into many pieces and each individual piece written separately to the disk.

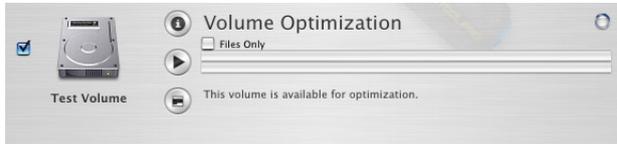
There are two types of fragmentation: file fragmentation and disk fragmentation. File fragmentation occurs when an individual file is broken into multiple segments. Disk fragmentation refers to the free space on the drive being broken into segments. TechTool Pro can eliminate both types of fragmentation to fully optimize your drives. This is done much like the game "Hanoi Towers" is played. Several files may be moved until the target file will have enough free space to be written contiguously. This process is repeated many times until all or most of the files are no longer fragmented.

Selecting the **Optimization** tab in the **Performance** screen displays **Optimization** screen with the **Optimization Master Test Strip** at the top.



Simply press the **Begin** button to begin optimizing all

the selected available volumes. Use the **Show Volumes** disclosure arrow if necessary to view the individual volumes' Optimization Test Strips. This allows you to enable, disable, or run Optimization on specific volumes. An individual Volume Optimization Test Strip is displayed below the Master Volume Test Strip for each volume recognized by TechTool Pro.



Be sure the test is enabled for each volume you wish to optimize. Then just press the appropriate **Begin** button to optimize an individual volume.

You may choose to optimize only the files if you wish. Doing so will defragment all the fragmented files, but will leave the free space fragmented. Optimizing only the files will be faster than performing a full optimization. If you wish to do this simply check the **Optimize Files Only** checkbox above the scroll bars.



You cannot optimize a journaled volume. A message to this effect will be displayed below the progress bars on the test strip for any journaled volumes and the **Begin** button will be disabled. To optimize a journaled volume, simply go to **Volume Journaling** under **Tools** and disable journaling for the volume.

You can turn journaling back on once optimization has completed.



To optimize a volume it must be unmounted. This means that nothing can be open or running on the volume. In particular, you must both boot the computer and run TechTool Pro from another volume. To optimize your normal startup volume you would typically boot the computer and run TechTool Pro directly from the TechTool Pro CD-ROM or from your eDrive. Instructions for booting from the CD-ROM are printed on the face of the CD-ROM. For information about setting up and using eDrive refer to the section on eDrive later in the manual.

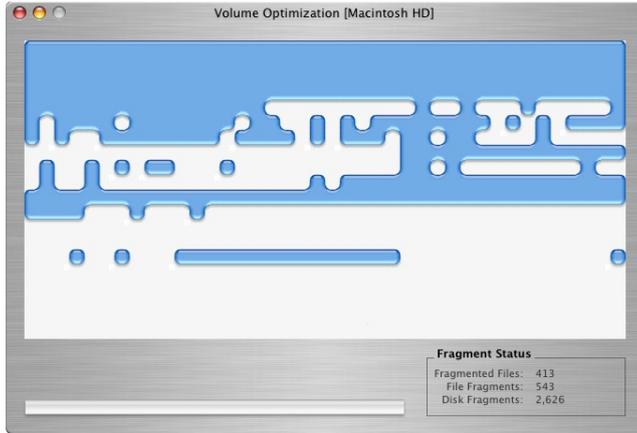
Pressing the **Info** button toggles the Info drawer. The drawer's upper View displays general information about optimization. The lower view displays the following additional details about the selected volume:

- Volume name.
- Mount point.
- Volume format.
- Whether journaling is enabled.
- Creation date.
- Last modification date.
- Capacity.
- Used space
- Available space.
- Total number of files.
- Total number of folders.
- Whether the volume is writable.

- Whether the volume is ejectable.
- Whether the volume is removable.

Use the Split Bar if necessary to adjust the views.

Pressing the **Graph** button creates and displays the **Optimization** window which provides a graphical indication of the state of fragmentation of the volume. This allows for an easy visual check of the state of fragmentation and can help you determine whether optimization is necessary.



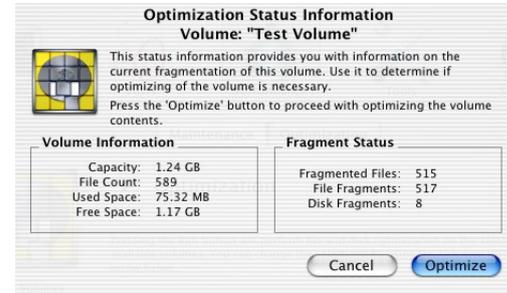
The volume is represented as a grid of equal sized segments. The amount of data represented by a segment depends on the total size of the volume. Segments that contain data are indicated in blue. Those that contain no data are white. The more blue fragments there are, the

greater is the fragmentation. A fully optimized volume will have one white block with blue areas at the beginning and/or end of the graph. This corresponds to one disk fragment (free space is in one block) and zero file fragments (no fragmented files).

The Optimization window also displays the following information:

- Number of fragmented files.
- Number of file fragments.
- Number of disk fragments.

Pressing the **Begin** button on the Optimization Test Strip for a volume brings up the **Optimization Status Information** dialog for the volume.



The **Optimization Status Information** dialog provides information about the current volume and its degree of fragmentation. In particular it displays the following:

Volume Information

- Capacity: total size of the volume.
- File Count: total number of files on the volume.
- Used Space: amount of space used by data on the volume.
- Free Space: amount of space available to store data.

Fragment Status

- Fragmented Files: number of files that are fragmented.
- File Fragments: number of file fragments on the volume.
- Disk Fragments: number of free space fragments on the volume.

This information, together with the graph, can help you determine if optimization is necessary. If you wish to proceed with optimization, just press the **Optimize** button. Otherwise, press the **Cancel** button.



Optimization is very safe when performed on a volume with no pre-existing directory problems and as long as there are no unexpected computer problems during optimization (such as a power failure). For this reason, it is a good idea to have current backups before optimizing. It is extremely important to do a Volume Structure test of the volume before optimizing. If any problems are found they should be resolved before optimizing. Optimizing moves many files around on the drive. If there is corruption in the volume directories, then this corruption could easily get worse as the files are being relocated. It is possible that a minor volume problem could spread and become a serious problem, possibly resulting in data loss.



When optimizing a Macintosh portable computer, be sure it is plugged into a reliable source of power. Do not perform optimization while the computer is running from the battery. Optimization may take a while to complete. If the computer is running from battery and the battery runs out of power while optimizing, then optimization will be forced to terminate abnormally. This could lead to volume corruption and loss of data.

Tools

Tools



TechTool Pro offers a number of tools that you may use to enhance the performance of your computer, work with files, folders, and volumes, and assist in recovery from disasters. These are appropriately accessed via the **Tools**

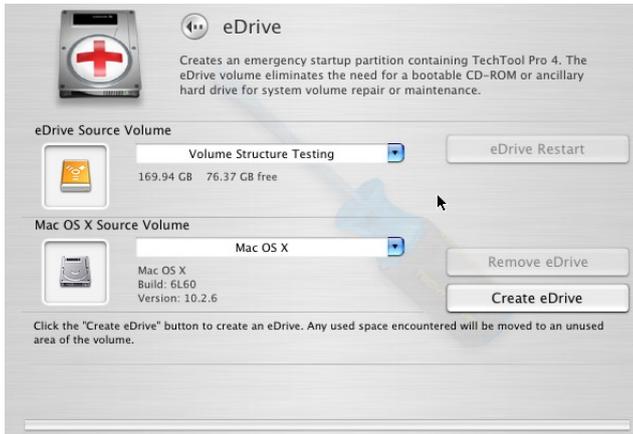
button in the Toolbar. The lower portion of the main **Tools** screen displays each tool in its own Tool Strip.

eDrive

Use TechTool Pro's eDrive tool to create an emergency startup partition on your hard drive containing TechTool Pro. This new partition is created **WITHOUT** the need to reformat the drive on which it is created. The eDrive contains your basic Mac OS X system 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 CD-ROM 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 CD 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 CD-ROM. In that case, simply use the TechTool Pro updater to update your eDrive as well as the copy of TechTool Pro installed on your normal startup volume. You can then startup from the eDrive and run the updated version of TechTool Pro in order to work on your normal startup drive.

Selecting the eDrive **Go** button (⏪) in the **Tools** window brings up **eDrive** screen.



The eDrive screen contains the following displays and controls:

eDrive Source Volume

This area displays information about the attached eDrive if one is present. Otherwise, you can use the popdown menu to select the volume on which you would like to create an eDrive.

If an eDrive is present on your computer when the eDrive screen opens, the eDrive's icon automatically appears in the icon well. The name, size, and free space of the selected volume are displayed to the right of the volume's icon.

Mac OS X Source Volume

Use this area to select the volume containing the OS X system components you wish to copy to an eDrive when it is created. Choose the OS X volume from the popdown menu. The selected OS X volume icon will then be displayed as well as the Mac OS X build and version numbers.

To create an eDrive on a volume, choose the eDrive Source Volume and the Mac OS X Source Volume from the appropriate popdown menus. Then press the **Create eDrive** button. The appropriate OS X components and a copy of the active TechTool Pro application will be copied to the eDrive. Details of the creation process will be displayed in the Message Area at the bottom of the screen and a scroll bar below the Message Area will show the progress.



To create an eDrive on any volume residing on the drive containing the current startup volume, you must startup from a volume on a different drive (such as directly from the TechTool Pro CD-ROM itself). This is necessary because all volumes on the drive holding the selected volume must be unmounted in order to create the eDrive and it is not possible to unmount the startup volume.



Only one eDrive may be used at a time. If an eDrive is attached to your system it will automatically appear in the **eDrive Source Volume** window when the window opens. You will not be able to select another volume if an eDrive is already present. You would need to remove the current eDrive first (using the **Remove eDrive** button).



There must be a minimum of 4 GB available on the source volume to create an eDrive. If there is not enough space available, then a message to that effect will appear in the Message Area.

Message Area

The Message Area resides below the Mac OS X Source Volume area. It provides information and feedback as you work with eDrive's options.

eDrive Restart

Pressing the **eDrive Restart** button restarts the computer from the selected eDrive. Note that 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 is automatically launched. When you quit TechTool Pro the computer will restart, typically from the previously designated startup device.



TechTool Pro will not mount the eDrive on your desktop when booted from your regular startup volume. 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.



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. This could cause problems and possible data loss when using other applications.

Remove eDrive

Pressing the **Remove eDrive** button removes the selected eDrive and returns the space it used back to the original volume. The Message Area will indicate that the eDrive is being removed during this process.

Create eDrive

Press the **Create eDrive** button to create an eDrive on the selected source volume. This will create the new eDrive partition, install a minimal version of Mac OS X from the selected Mac OS X source volume, and also install a copy of TechTool Pro onto the eDrive. The Message Area will display details of what is being done dur-

ing the creation of the eDrive. The progress bar beneath the Message Area will give feedback about how much remains to be done. Note that it takes some time to create an eDrive since a working Mac OS X system must be installed on the new partition.

Pressing the eDrive **Return** button  takes you back to the main **Tools** screen.

Data Recovery

Data Recovery is designed to:

- Recover data from a damaged volume.
- Resurrect a damaged volume.

If one of your volumes develops directory problems, the first thing you should do is backup any important data to another drive if possible. If you are able to access the damaged volume from the desktop and all or some of your data is available, consider simply copying your files to another location. However, if any of the data cannot be copied normally, then you can proceed with Data Recovery to attempt to rescue any remaining important data.

The options in Data Recovery work in unison with the data saved in TechTool Pro's Protection files. These files are backups of a volume's directories. They contain important file location data, allowing TechTool Pro to easily find files and, in many cases, quickly restore a lost volume to its original state. If you have disabled the Protection feature, you should seriously consider re-en-

abling it to help guard against a potential future catastrophe. Protection is configured via **Safety** in the Toolbar. If you have multiple volumes on your system, be sure that Protection is set to protect ALL of your volumes and to save the Protection files to at least two different drives if possible. You should configure the automatic Protection features of the program in a way that is appropriate for the drives and volumes available on your system. Refer to the **Protection Setup** section under **Safety** later in the manual for further information on how to do this.

Pressing the Data Recovery **Go** button  in the Tools screen brings up the **Data Recovery** screen.



The **Data Recovery** screen offers options and features that make recovering your data very easy. These include:

Recovery Method

The first step in data recovery is to choose the method of recovery. The options available are:

- Recover Files using Protection Data—this option uses a selected Protection file to generate a file list so that you can choose the files you wish to recover.
- Recover Files using Directory Data— this option scans (scavenges) the entire volume sector-by-sector looking for directory data. A recovery file list is generated based on the directory data that is found. This takes a while since the entire volume must be examined.
- Resurrect Protected Volume—this option replaces the volume's damaged directories with those saved in a selected Protection file. You would normally use this option as a last resort in hopes of returning a damaged volume to a usable state. Any changes made to a volume after the Protection file is created will be lost when resurrecting the volume.



Before resurrecting a volume it is highly recommended that you first try to recover important files to another volume. Resurrecting a volume cannot be undone.

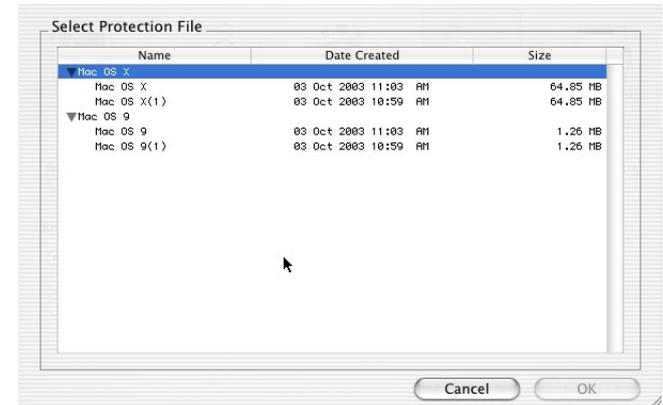
- Scavenge Volumes For Data—select this option if Protection files were saved on a damaged volume and they cannot be chosen normally. A checkmark in the box instructs TechTool Pro to scan the selected volume sector-by-sector looking for valid Protection files.



If you choose the option to **Recover Files Using Directory Data**, the **Scavenge Volumes For Data** option is automatically selected. This is because you would only choose the option to recover using directory data if the directory were damaged and not accessible normally.

Select Protection File...

This button is available when the option to **Recover Files Using Protection Data** or **Resurrect Protected Volume** is chosen and the **Scavenge Volumes For Data** option has not been selected. Pressing this button brings up the **Select Protection File** window.



This window lists all protected volumes and the Protection files available on them. In addition, the date and time

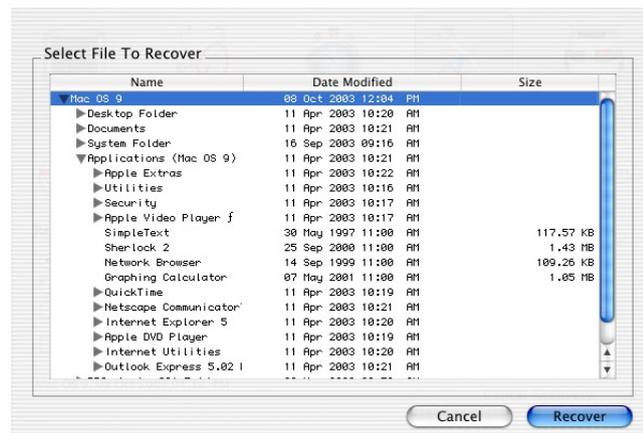
the Protection files were created and their size are also displayed. Simply select the Protection file you wish to use for resurrection or recovery and then press the **Okay** button.

If you had selected the option to **Resurrect a Protected Volume**, a warning dialog will appear confirming whether you wish to proceed with the resurrection or not.



If the option to **Resurrect Protected Volume** was selected then only Protection files that can be used to resurrect will be available. This means Protection files for the startup volume will not be displayed. Also, Protection files for a volume saved on the volume itself will not be appear. This is because you should only resurrect a badly damaged volume. If a volume is damaged, any Protection files on the volume will probably be corrupted and hence should not be available for use.

If you had selected the option to **Recover Files Using Protection Data**, the **Select Files to Recover** window will appear. It will list all the files and folder available using the selected Protection file.



Select the files or folders you wish to recover and then press the **Recover** button. The selected items will be saved in a folder named *Recovered Files* on your desktop. You may then go back and select additional files or folders if you wish. They will be saved in sequentially numbered *Recovered Files* folders: *Recovered Files 1*, *Recovered Files 2*, etc.

Select Volume...

This button is available when scavenging. Use it to choose the volume from which you wish to scavenge either Protection or Directory data. After selecting a volume, a window will appear showing the progress of the scavenge. You may stop the process at any time by pressing the **Cancel** button. Once scavenging is com-

plete you will be presented with either a list of Protection files or a list of Found files. You can then proceed with recovery as detailed above.



You can use Data Recovery to attempt to retrieve accidentally deleted files. As long as a valid Protection file is available that was created before the files were deleted AND as long as none of the data in the deleted files has actually been overwritten, they may still be recoverable. Note that files are often written in the background without your knowledge, so portions of a deleted file may be overwritten without you being aware of it.

Pressing the Data Recovery **Return** button  takes you back to the main **Tools** screen.

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 details 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.

Selecting the Wipe Data **Go** button  in the **Tools** window brings up **Wipe Data** screen.



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

Wipe Type

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

- Binary 00000000—Overwrites the file with all zeros.

- Binary 10101010—Overwrites the file with alternating ones and zeros.
- Binary 11111111—Overwrites the file with all ones.
- ASCII Garbage—Overwrites the file with pseudo-random pattern of zeros and ones. Helpful when trying to hide the fact that a file has been wiped.
- Overwrite Count—Indicates the number of times the pattern will overwrite the file data. Although overwriting the data once is normally sufficient to permanently erase the data, some government agencies specify that data must be overwritten a specific number of times to be considered securely deleted.

Choose Item to Wipe...

Use 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 information box above the progress bar. This allows you to verify what item will be wiped before actually performing that function.

Wipe Free Space

Pressing this button overwrites the free unused space on the selected volume with the selected pattern.

Wipe Volume

Pressing this button completely overwrites the entire volume's contents with the selected pattern. Note that **ALL** data on the volume will be lost.

Wipe Selection

Pressing this button overwrites the selected file or folder with the selected pattern.



Once the data is overwritten by TechTool Pro's Wipe Data routines there is no possibility of recovering the data.

Stop Button

Pressing this button terminates the current wipe operation.

Information Box

This text box located above the Progress Bar displays the item to be wiped.

Progress Bar

The progress bar at the bottom left of the screen displays the progress of the wipe data as it proceeds.

Pressing the Wipe Data **Return** button (⏪) takes you back to the main **Tools** screen.

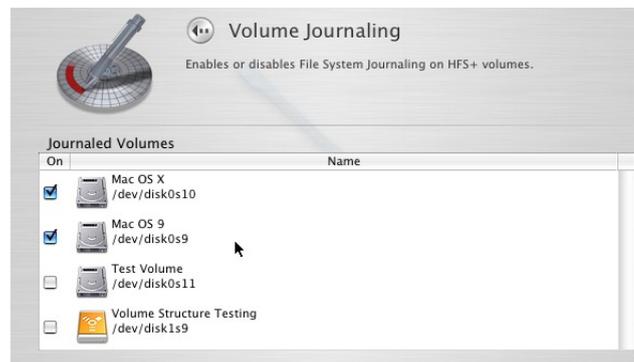
Volume Journaling

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 this manual.

The Volume Journaling tool in TechTool Pro allows you to turn journaling on or off for your HFS+ volumes. Selecting the Volume Journaling **Go** button  in the **Tools** window brings you up **Volume Journaling** screen.



Each available writable HFS+ volume will be listed. To enable journaling for a volume simply put a checkmark in the box to the left of the volume name. To disable journaling uncheck the box. When you change the state of journaling for a volume a dialog will appear indicating that the change is being made.

Pressing the Journaling **Return** button  takes you back to the main **Tools** screen.

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 environment.

TechTool Pro's Audio tool lets you check the audio output of your computer. Like the Video Lab 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 output is acceptable. The audio tests require stereo output to test properly. Without stereo output the tests will be monophonic.

Selecting the Audio **Go** button  in the **Tools** window brings up the **Audio** screen.



Use the **Begin** button  on the **Audio** screen to turn on the audio. The button will switch to a **Stop** button which you press to turn the audio off. The following sliders allow you to adjust the output:

- Volume—levels from 0.0 to 1.0 (0=off, 1.0=maximum)
- Frequency—levels from 30.0 Hz to 3000.0 Hz
- Balance—adjustments from -1.0 to 1.0 (-1.0=left channel only, 0=both channels equal, 1.0=right channel only)

By adjusting the sliders 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.

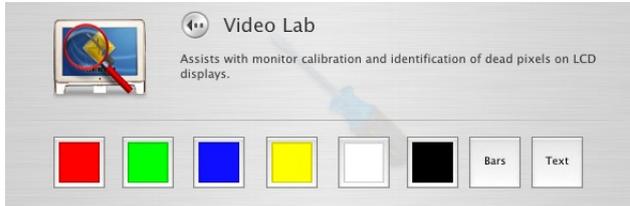
Pressing the Audio **Return** button  takes you back to the main **Tools** screen.

Video Lab

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.

Selecting the Video Lab **Go** button  in the **Tools** window brings up **Video Lab** 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 Lab** panel. You may choose among the following test screens:

- Red Screen—Paints the entire screen red.
- Green Screen—Paints the entire screen green.
- Blue Screen—Paints the entire screen blue.
- Yellow Screen—Paints the entire screen yellow.
- White—Paints the entire screen white.
- Black—Paints the entire screen black.
- Bars—Displays a series of vertical color bars.
- Text—Displays a screen full of black on white text characters.

Pressing the Video Lab **Return** button  takes you back to the main **Tools** screen.

Safety

Safety

TechTool Pro offers a number of features that may be configured to run automatically as your computer operates. They can test and monitor the operation of your computer and provide advance warning of impending problems. If these features are enabled and serious problems do occur, then you will have a better chance of successful recovery or repair.



After installing TechTool Pro the automatic Safety features will not be enabled until you launch TechTool Pro for the first time. Subsequently, they will be activated at login and execute based on your configuration settings. During login each test is delayed by a certain amount so that they will not interfere with each other or otherwise impact your computer's performance. For example, if all Safety features are set to run at login, then 90 seconds after login SMART tests will execute, 30 seconds later Diagnostics will be performed, and then 90 seconds later Protection will occur.

The automatic features are scheduled and configured from the **Safety** category in the Toolbar.



The various Safety options are accessible in the lower portion of the Application window. The options are Protection Setup, Diagnostics Setup, SMART Setup, and Alerts Setup. Each is described in detail below.

Protection Setup

The purpose of Protection is to periodically save **Protection** files. These are invisible backup files of critical volume structure data. Protection files can greatly assist TechTool Pro with recovering lost files or volumes. The Protection Setup screen allows you to select the volumes you wish to protect. In addition, by clicking on a volume's icon in the Protection Setup screen you may select the volume(s) to which you would like to save the Protection files.



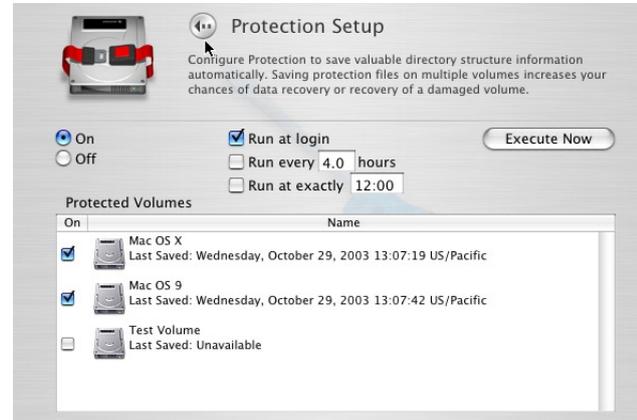
Protection files are not backups of your actual data. Rather, they are backups of the volume structures for the entire volume. It is very important to keep backups of your actual data in another location.

By opting to save Protection files to more than one volume, you increase the chances of having a valid Protection file available should you have a drive/volume failure. If damage occurs to a volume, a Protection file saved to that volume could end up being corrupted. Having a Protection file for a volume saved elsewhere may make the difference between success and failure when doing data recovery or repair.

TechTool Pro ships with Protection off. You may turn it on and configure it to run it at login, at predetermined time intervals, or at a specific time every day. Use the **Feature Enable** radio buttons to turn Protection on or off. If you

disable Protection, then chances of successful volume repair or data recovery are greatly reduced.

Selecting the Protection Setup **Go** button  in the **Safety** screen brings up the **Protection Setup** screen.



The following controls are available to allow you to configure the Protection features to your liking:

Feature Enable

Allows you to enable or disable the Protection function by selecting the **On** or **Off** radio button.

Schedule

Allows you to choose when the Protection files are auto-

matically created. The options are:

- Run at login—the file is created when you login.
- Run every X hours—the file is created at the interval specified.
- Run at exactly XX:XX—the file is created at the exact time specified.



Scheduled Protection will not run while the TechTool Pro program is running. This is to avoid interference with the program during testing or other program functions.

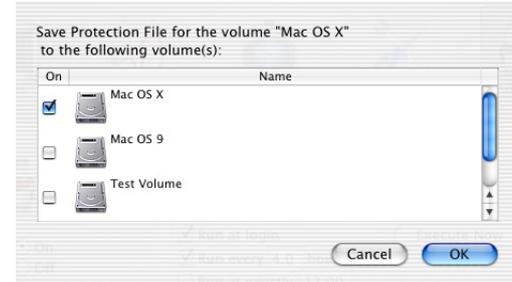
Protected Volumes

This box lists the available volume(s) and indicates by a checkmark the volume(s) for which Protection file(s) will be stored. The date of the last Protection file for that volume is indicated under the volume name (or **Unavailable** if one has not yet been created).



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

When you click in a check box beside one of the volume icons or on the icon itself, the Protection File Location dialog will appear.



This dialog lets you select where the Protection file for a particular volume will be stored. Simply place a check mark in the box beside each volume where you wish to save the Protection file. To turn off Protection for a volume, deselect all the choices in the dialog. Once you have selected the volume(s) (if any) to hold the Protection file(s) choose **OK** to accept the settings (or **Cancel** to return to the Protection screen with the settings unchanged.)



If your system has more than one volume, it is a good idea to store the Protection file on at least one volume other than the one being protected. That way, if there is serious damage to the original volume and its Protection file cannot be read, the Protection file might still be available on another volume. The data recovery and repair routines that rely on Protection data will search all local volumes for Protection files.

Execute Now

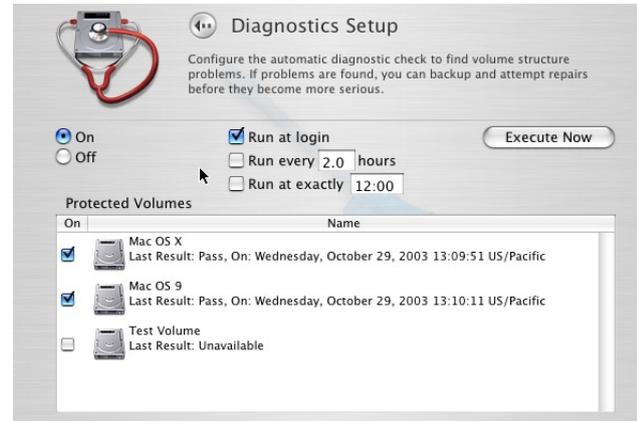
The **Execute Now** button instructs TechTool Protection to immediately write the selected Protection file(s) for the selected volumes. After pressing the button a progress bar will appear below the button and the name of the volume being protected will appear above the bar.

Clicking the Protection Setup **Return** button  takes you back to the **Safety** screen.

Diagnostic Setup

The Diagnostic feature adds some automation to TechTool Pro's volume testing. It runs a quick check of the volume structures on the selected volumes and alerts you if any problems are found. If problems are reported you may have enough advance warning to make backups and repairs before they become so serious that this is impossible. While the Diagnostics check is not as thorough as the full volume structure tests in the TechTool Pro application, it can often alert you to problems before they become catastrophic.

Selecting the Diagnostic Setup **Go** button  in the **Safety** screen brings up the **Diagnostic Setup** screen.



The following controls are available to configure the Diagnostic features to your liking:

Feature Enable

Allows you to enable or disable the Diagnostic function by selecting the **On** or **Off** radio button.

Schedule

Allows you to choose when the diagnostic test is executed. The options are:

- Run at login—if checked, Diagnostic is executed at login.
- Run every X hours—Diagnostic is performed at the interval specified.
- Run at exactly XX:XX—Diagnostic is performed at the exact time specified.

Protected Volumes

This area displays the available local volume(s). A check in the box before the volume icon indicates that Diagnostic will be performed on that volume. Uncheck the box to disable it. The result of the last test performed will be displayed below the volume name, as well as the date and time the test was run. The **Last Result** will indicate **Unavailable** if it has never been run.

Execute Now

Pressing the **Execute Now** button runs the Diagnostic immediately on the selected volumes. After pressing the button a progress bar will appear below the button and the name of the volume being tested will appear above the bar.



Diagnostics will not run while the TechTool Pro program is running. This is to avoid interference with the program during testing or other program functions.

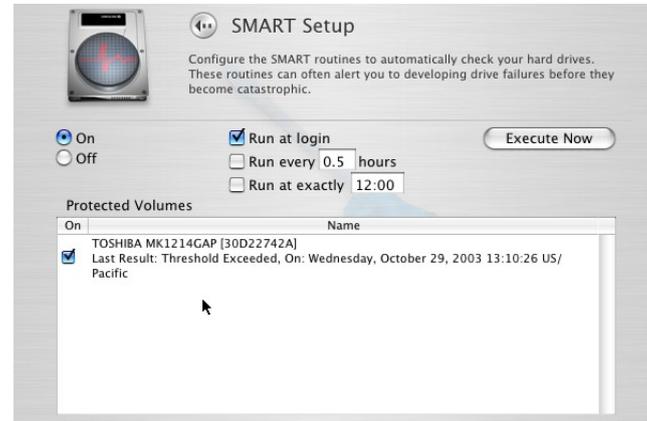
Clicking the Diagnostics Setup **Return** button  takes you back to the **Safety** screen.

SMART Setup

The SMART Setup section of Safety allows you to configure TechTool Pro to automatically query your drive's S.M.A.R.T. 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 S.M.A.R.T. monitoring is available in the *Drives* section of the manual under the *SMART* tests.

Selecting the SMART Setup **Go** button  in the **Safety** screen brings up the **SMART Setup** screen.



The following controls are available to set up Tech Tool Pro's S.M.A.R.T. monitoring:

Feature Enable

Allows you to enable or disable the automatic S.M.A.R.T. tests by selecting the **On** or **Off** radio button.

Schedule

Allows you to choose when the S.M.A.R.T. routines are executed. The options are:

- Run at login—if checked, S.M.A.R.T. routines are executed at login.
- Run every X hours—S.M.A.R.T. routines are performed at the interval specified.
- Run at exactly XX:XX—S.M.A.R.T. routines are performed at the exact time specified.

Protected Volumes

Displays available ATA drive(s). A check in the box before the drive icon indicates that S.M.A.R.T. routines will be performed on that drive. Uncheck the box to disable testing. The result of the last test as well as the date and time of the test will be indicated to the right of the drive icon (or **Unavailable** if it has never been run).



SMART is only available for ATA drives, so only ATA drives will show up in the **Protected Volumes** list. SCSI drives do not support S.M.A.R.T. FireWire and USB drive interfaces do not pass the S.M.A.R.T. calls necessary to perform the SMART test routines even though the drive in the housing may be an ATA drive.

Execute Now

Pressing the **Execute Now** button runs the SMART routines immediately on the selected volumes. After pressing the button a progress bar will appear below the button and the name of the volume being tested will appear above the bar.



SMART tests will not be run while the TechTool Pro program is running. This is to avoid interference with the program during testing or other program functions.

Clicking the SMART Setup **Return** button  takes you back to the Safety screen.

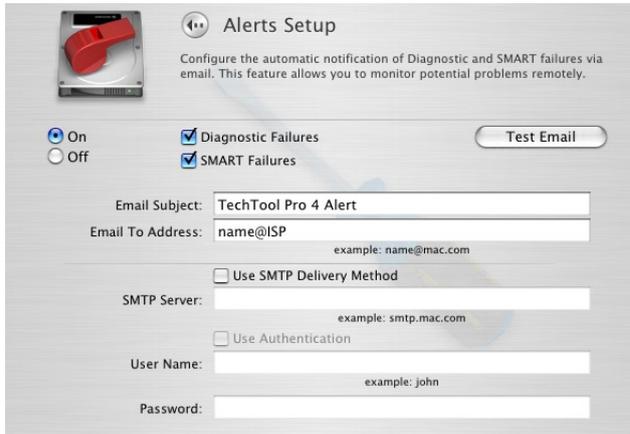
Alerts Setup

TechTool Pro can automatically send an email message alerting you to Diagnostic or S.M.A.R.T. failures. This lets you monitor a computer even though you may not be physically present, providing an early warning of impending problems. An alert may give you enough time to backup your data and address the problems before experiencing a catastrophic failure.

To use this feature, Email must be properly configured on the computer being monitored. This is done via the **Email** tab in the **Internet** setup portion of Mac OS X's **System Preferences**. Be sure the following options are set correctly: Email Address, Account Type, User Account ID,

and Outgoing Mail Server.

Selecting the Alerts Setup **Go** button  in the **Safety** screen brings up the **Alerts Setup** screen.



The image shows the Alerts Setup configuration screen. At the top left is a red emergency stop button icon. The title is "Alerts Setup" with a back arrow icon. Below the title is a descriptive paragraph: "Configure the automatic notification of Diagnostic and SMART failures via email. This feature allows you to monitor potential problems remotely." There are two radio buttons for "On" (selected) and "Off". To the right are two checked checkboxes for "Diagnostic Failures" and "SMART Failures", with a "Test Email" button. Below these are input fields for "Email Subject:" (containing "TechTool Pro 4 Alert"), "Email To Address:" (containing "name@ISP" with a subtext "example: name@mac.com"), "SMTP Server:" (with a subtext "example: smtp.mac.com"), "User Name:" (with a subtext "example: john"), and "Password:". There are also two unchecked checkboxes: "Use SMTP Delivery Method" and "Use Authentication".

The following controls are available to configure the Alerts features to your liking:

Feature Enable

Allows you to enable or disable the Alert function by selecting the **On** or **Off** radio button.

Alerts

A checkmark in the appropriate checkbox will specify that an email alert be sent to the specified address in the

event of a Diagnostic failure and/or a S.M.A.R.T. failure.

Email Subject

This field contains the subject line to be included in the Alert email. The default subject is "TechTool Pro 4 Alert."

Email To Address

Enter the email address where the Alert should be sent into this field.

Use SMTP Delivery Method

If the computer is using an SMTP mail system then put a checkmark in this box.

SMTP Server

If using an SMTP mail server then enter the SMTP server name into this field.

Use Authentication

If using an SMTP mail server and authentication is required then put a checkmark into this box.

User Name

If using an SMTP mail server requiring authentication, then enter the user's name into this field.

Password

If using an SMTP mail server and authentication is required, then enter the user's password into this field.

Test Email

Pressing the **Test Email** button sends a test email message to the specified address. Do this to verify that mail is working properly on the computer and that the Alert feature is properly configured. After pressing the button, a status message will appear to the left of the button indicating whether or not the message was sent successfully.

If Alerts are enabled and an error occurs in a selected option, then an email will be sent to the specified user with the specified email subject. The body of the email will contain the following information:

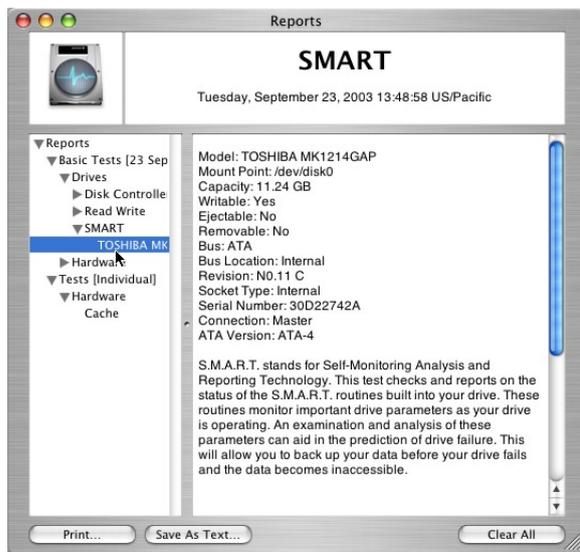
- Date and Time of the Alert.
- Computer's User Name.
- Computer's Rendezvous Name.
- Computer's Mac OS X Version.
- Failure Category, Volume or Device name, and Failure Type.

Clicking the Alerts Setup **Return** button  takes you back to the **Safety** screen.

TechTool Pro 4 Reports

TechTool Pro 4 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 available in the TechTool Pro 4 **Reports** window. The **Reports** window will automatically appear after running a test and may also be selected from the **Window** menu.



The **Reports** window is designed to provide convenient access to details about each test that has been performed. When running TechTool Pro from your hard drive

the results of each test are automatically saved to the Report. This allows you to quickly and easily refer back to earlier tests. 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** window is divided into three main areas: top, left, and right. The individual test name and overall results appear at the top. The main report area is located below this. It consists of two columns. The size of the columns can be adjusted by dragging the Split Bar divider.

The left column contains a nested test selector list. Use the disclosure arrows to expand or collapse items in the list and to navigate to a particular test. To view information about an item in the list simply click on it to select it.

The right column displays details about the currently selected item. The following information is provided depending on the selection:

- Reports—general information about the computer.
- Category—general information about the specific test Category.
- Sub-category—general information about the specific test Sub-category.
- Test—general information about the selected test, test results, and repair advice if appropriate.



When viewing information about a specific test in the right column of the Report, not all the information may fit in the window at once. Use the scroll bar if necessary to view the complete text. Test results and repair advice (if a problem was found) will appear near the end.

The top left side of the **Reports** window displays an icon of the currently selected item. To the right of the icon is the item name. If a test is selected, the date and time the test was performed is displayed below the test name. If any other item is selected, the date and time of the latest saved test will be displayed.

At the bottom of the **Reports** window are the following three buttons:

- Print—prints the report.
- Save As Text...— saves the report to a text file.
- Clear All—clears the report.



Using the **Clear All** button completely erases the contents of the report. You may wish to save the report first using the **Save As Text...** button or print it using the **Print** button. That way you will have a record of previous tests.



If the **Reports** window is closed you can re-open it by choosing **Report Window** from the **Window** menu.

TechTool Pro 4 Menu Options

A number of TechTool Pro options are available from the **TechTool Pro 4** menu. They are:

About TechTool Pro 4

Selecting this option brings up the TechTool Pro 4 Information screen. It displays your personalization information, serial number, the program's version number, the program credits, and other general information.

Registration...

Selecting this option uses your default internet browser to connect to Micromat's Registration page. Once connected, simply enter your TechTool Pro 4 serial number, complete the registration form, and submit it.



You must have an active connection to the Internet in order to connect to the Micromat Registration page

Registering TechTool Pro 4 entitles you to access Micromat technical support for TechTool Pro 4. If you include your email address when you register we will notify you via email about updates, upgrades, or any other important information concerning the program. Also, if you should lose your serial number, we will be able to locate it for you in the registration database.

Check for Update...

Selecting this option checks the Micromat server to see if an update to TechTool Pro is available. If an update is available, then your default internet browser will connect to the Micromat Downloads page so that you can download the latest updater.



You must have an active connection to the Internet in order to connect to Micromat's site and check for updates.

Hide TechTool Pro 4

Selecting this option closes the TechTool Pro windows. Clicking the TechTool Pro 4 icon on the dock will return the windows to their previous state.

Quit TechTool Pro 4

Selecting this option quits the TechTool Pro application.



If you booted from the TechTool Pro 4 CD-ROM, then quitting the TechTool Pro will automatically restart the computer.

Commonly Asked Questions

How do I start up (boot) the computer from the TechTool Pro CD-ROM?

Insert the TechTool Pro CD-ROM into the CD-ROM drive, restart the computer and immediately press and hold down the “C” key. Be patient. It takes longer to boot from a CD-ROM than a hard drive since the CD-ROM drive is so much slower. Note that the instructions for booting from the TechTool Pro CD-ROM are printed on the CD-ROM.

I booted from the TechTool Pro CD-ROM. When I quit TechTool Pro the computer restarts from the TechTool Pro CD-ROM, not the hard drive. How do I restart from the hard drive?

When you quit TechTool Pro, the computer will try to restart from whatever device was the last preferred startup device. Simply ejecting the TechTool Pro CD-ROM at startup will force the computer to look elsewhere for another startup device. Ways of doing this include pressing and holding one of the following buttons during startup: the **eject** button on the CD-ROM drive (if available), the CD-ROM **eject** button on the keyboard (if available), the mouse button or trackpad. In addition, holding down the **option** key at startup will present a choice of startup devices on most Macs. You can then choose your hard drive as the startup device. If you boot from the TechTool Pro CD-ROM by holding down the “C” key during startup (as instructed on the front of the TechTool Pro CD-ROM), the startup disk preferences are not changed

and the computer should restart from its normal location when you quit TechTool Pro.

Why do I get a message that my startup volume is not ready for repair?

In order to repair a volume it must be dismounted. This means that nothing can be open or running on the volume. Hence, you must boot the computer and run TechTool Pro from another volume, such as the TechTool Pro CD-ROM or the eDrive. Once you have done this, the repair options should become available.

Why can't TechTool Pro do a volume structure test on the volume from which the computer is booted?

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. Consequently, 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 CD-ROM or eDrive, in order to test 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.

TechTool Pro 4 does not include some features, such as Desktop Rebuild and Serial Port tests, contained in earlier versions of the program. Why is this?

Mac OS X is a completely new operating system. Some diagnostic and repair features available in TechTool Pro 3 and earlier are no longer appropriate for Mac OS X. Mac OS X does not use volume desktop databases to maintain document/application links and hence there is no reason to have a Desktop Rebuild option. Recent Macintosh models do not include serial ports and OS X does not include support for peripherals connected via serial ports. For this reason TechTool Pro 4 does not include a Serial Port test.

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 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 4 Installer includes an uninstall option. Select it from the popup menu at the top of the installer screen. Doing an uninstall will delete all the TechTool Pro files from the selected volume.

The Read Write tests in the Drives sub-category of Tests are unavailable for my CD-ROM drive. Is there something wrong with the drive?

No. In order for TechTool Pro to be able to run this test a file must be written to the drive to verify the validity of the read. Since CD-ROM is a read-only device, any test that involves writing data will not be available.

Can TechTool Pro mount a drive that has been unmounted?

Yes. Choose the **Volumes** tab in the **Tests** category. Each volume, both mounted and unmounted, will appear in its own test strip. Unmounted volumes will be indicated with an **unavailable** symbol above the volume icon and a **mount** button below the icon. Simply press the **mount** button to mount the volume.

Tips, Short Cuts, and Hidden Features

TechTool Pro 4 Key Commands

cmd-?: TechTool Pro 4 Help

cmd-H: Hide TechTool Pro 4

cmd-Q: Quit TechTool Pro 4

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

Basic Open Firmware Commands

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.

man: Follow by a command to obtain documentation about the command, including what arguments available for it.

man: why did you get a divorce: Try it for chuckles.

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 ready 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 4 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

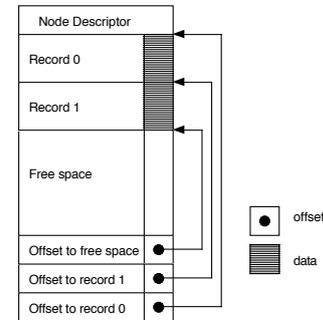
The Catalog file, Extents file, and Attributes file all make use of a data structure called a **B-tree** (Balanced tree) to store their information. A B-tree is a data structure specifically designed for fast retrieval of information. Using B-trees in the volume structures allows the File System to locate 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:

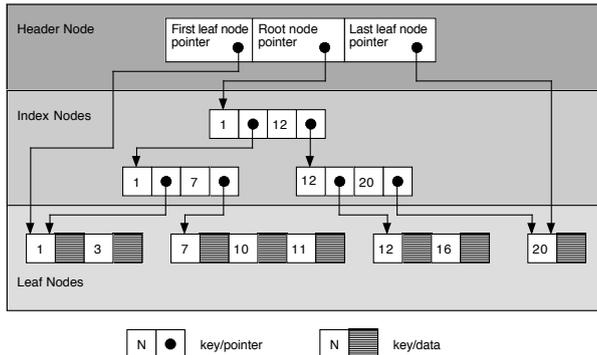


Structure of a Node

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 holding 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 included in the HFS Extended specification to allow additional of file forks to be added in the future. Like the Catalog and Extents files, the Attributes file is defined to be a B-tree. This file tracks attributes of each file and folder on a volume. Some attributes include whether a file is locked or not.

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. 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 used by the computer's ROM to determine what program will boot the computer. In almost every case, this will be configured to point to the preferred System.

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 at-

tached 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 Extended 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 Ex-

tended 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 OS Extended file system called journaling. Journaling is part of a set of incremental enhancements to the Macintosh OS 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 journal-

ing 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 Extreme is based on the 802.11g standard and has a maximum speed of 54 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.

Booting: The term booting 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.

Diskette: Also known as a floppy disk or Zip disk. It is a lower capacity, removable storage medium that holds data on a substrate with a magnetic coating.

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 multipaired 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.

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.

