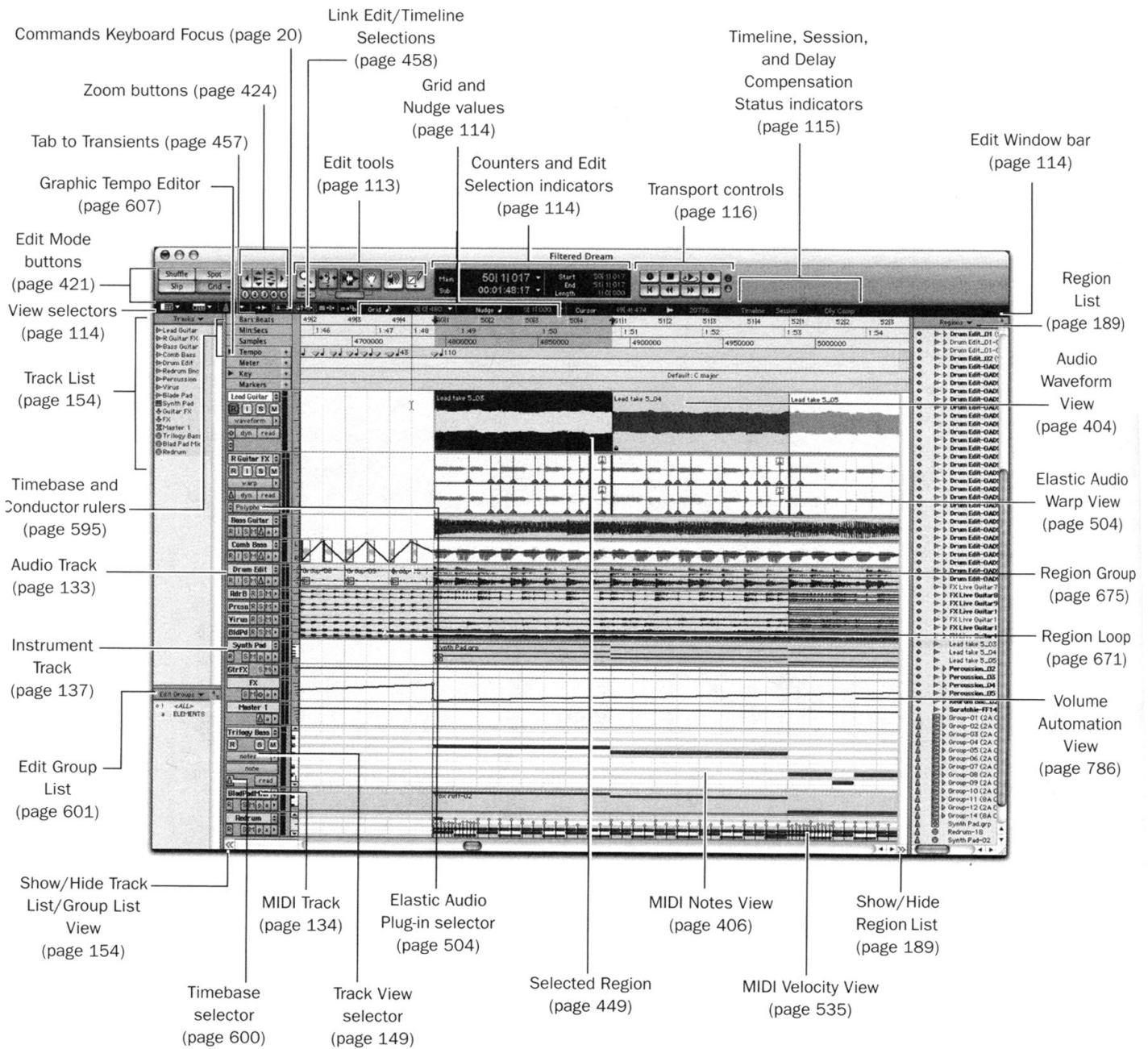


## Digital Audio Workstations

As personal computers evolved, their ability to perform the necessary amount of data storage and transfer to allow real-time data acquisition made them an attractive platform for the recording and mixing of sound and music. The earliest attempts to record, edit and play back sound files were stereo systems. Soon, it became possible to record multiple channels of audio at reasonable sample rates and to store, process, mix and play back more complicated sessions, approaching the capabilities of 4- and 8-track analog studio recorders and mixing consoles. The low cost of small computers and the ability to add hardware to the system allowed the development of recording hardware and software that started the move that eventually created the modern digital audio workstation (DAW).

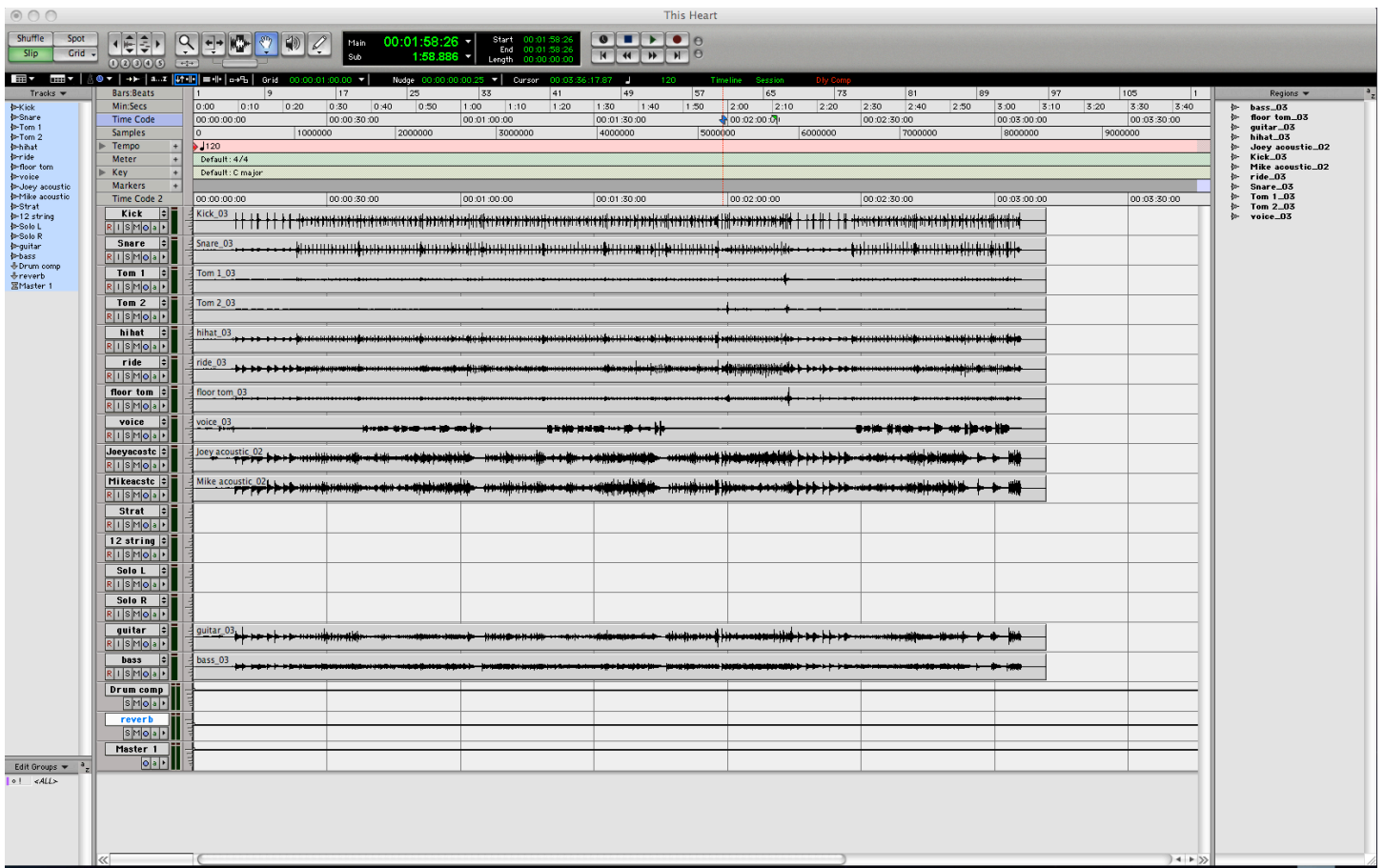
Pro Tools was Digidesign's Macintosh-based DAW. It was one of the first systems on the market to combine digital recording, editing and mixing in an integrated product. (Such systems existed as far back as 1979, when Micro Technology Unlimited created the first digital audio workstation.) In order to allow the rapid processing of audio files, Pro Tools included a hardware processing card that used Motorola 56000 fixed-point DSP chips to augment the power of the CPU. This became possible when Apple released the Mac II computer that accepted third-party cards using the NuBus protocol to be inserted into the computer. Pro Tools has evolved into an industry standard platform on both Macintosh and Windows computers and is now a product of Avid Technology, Inc. It makes use of the computer's CPU, disk and memory resources, adding A/D, D/A and in some systems DSP cards to the system with software to create a complete recording studio "in the box."

Pro Tools is certainly not the only system accomplishing the virtual recording studio, but since it is still the most common and well accepted, it is a good example to investigate. Pro Tools is a complete recording system including multi-track recording and playback, editing, mixing, MIDI and signal processing. The software configures each session with the desired number of tracks for recording and editing and automatically generates a mixer tailored to the number of tracks used in each project. The mixer can be further extended by creating auxiliary channels for effects and complicated routing via internal buses and sends and returns, both software and hardware. The editing window shows a graphic representation of the various sound files and allows cut-and-paste editing with cross-fades between files to smooth transitions. The mixer window controls signal levels, panning, and inserts for plug-in functions available for signal processing like equalization, dynamics processing, and special effects as well as external sends and returns. Automation recalls all programmed events. Each project uses only the functions needed, reconfiguring for each different session. The user can tailor the desired environment. The system is in effect a complete studio in a box.



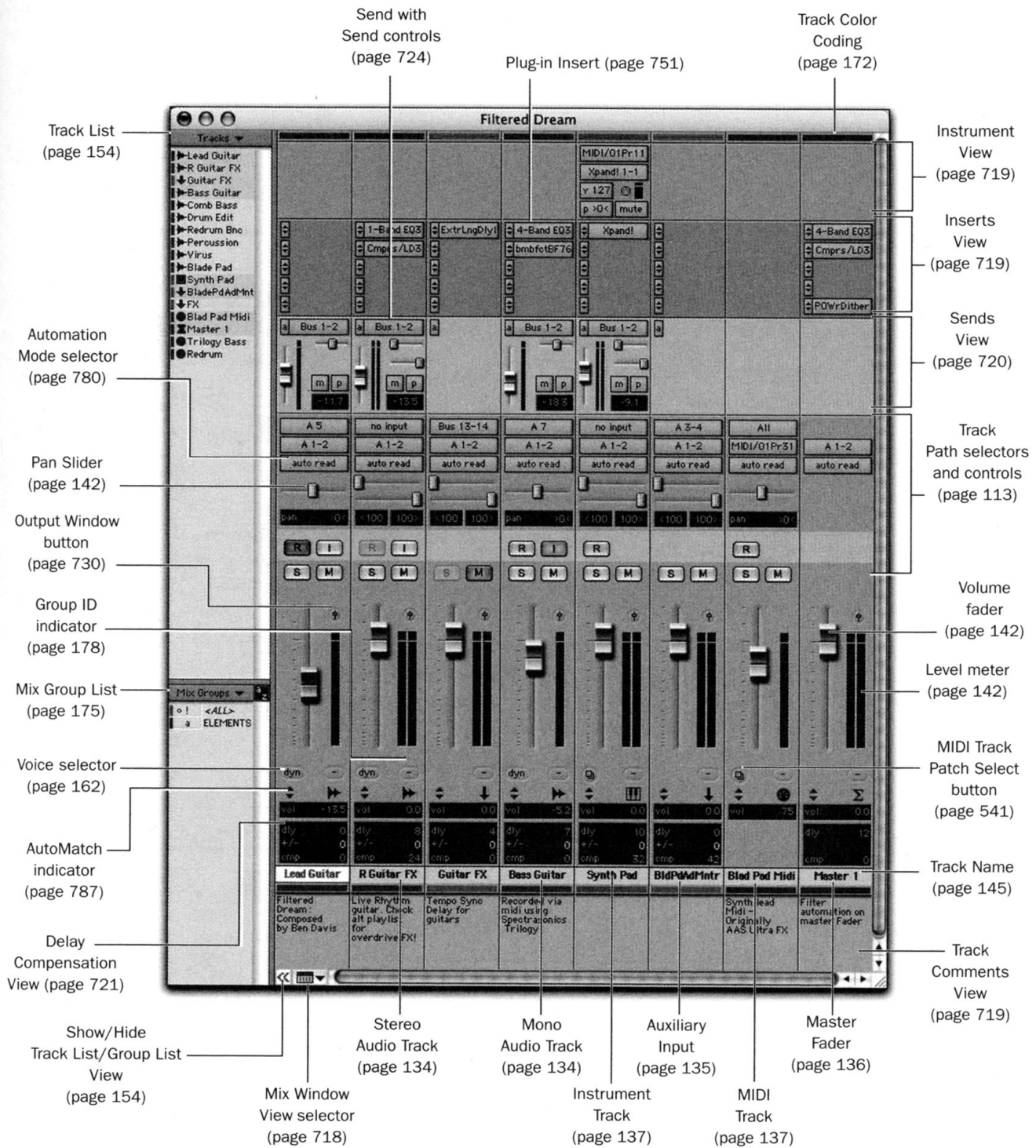
### Pro Tools 7 Edit window

The annotations show the various functions available on the Edit window. (The page numbers refer to the Pro Tools 7 manual.) This gives only a quick summary of the edit display.

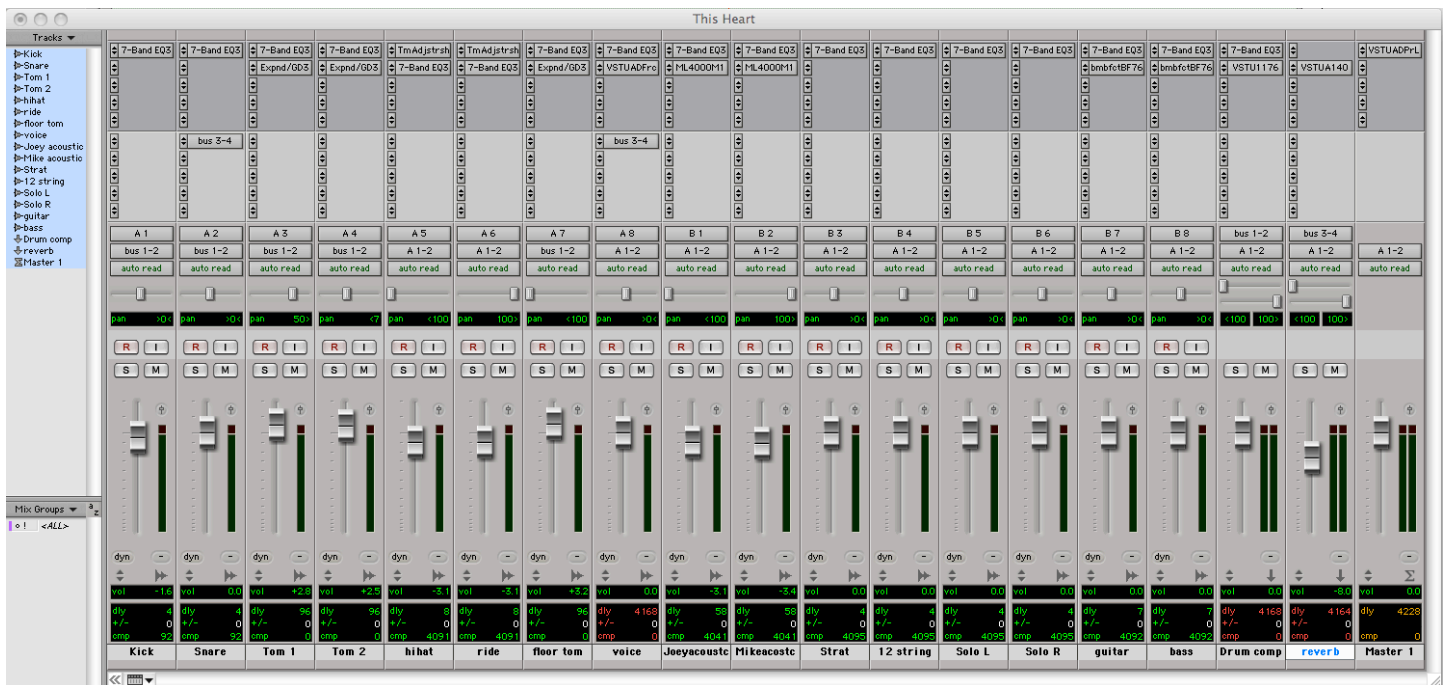


Pro Tools 9 Edit window

Changes in Pro Tools 9 refine the look and some of the functionality of the edit window, but the basic structure is the same. (The function labels in the figure for Pro Tools 7 still apply for Pro Tools 9 for the most part.)



Pro Tools 7 Mix window



Pro Tools 9 Mix window

In order to use Pro Tools, it is necessary to understand the function the two main windows: edit and mix. Although each overlaps in function to some degree, the main function of the edit window is to allow visualization of the sound file envelope, MIDI data and automation data like level and pan for editing. The mix window functions like a mixer, with faders, pans, and inserts. Both windows allow record arming for each track along with mute and solo functions for monitoring and both provide signal level indicators.

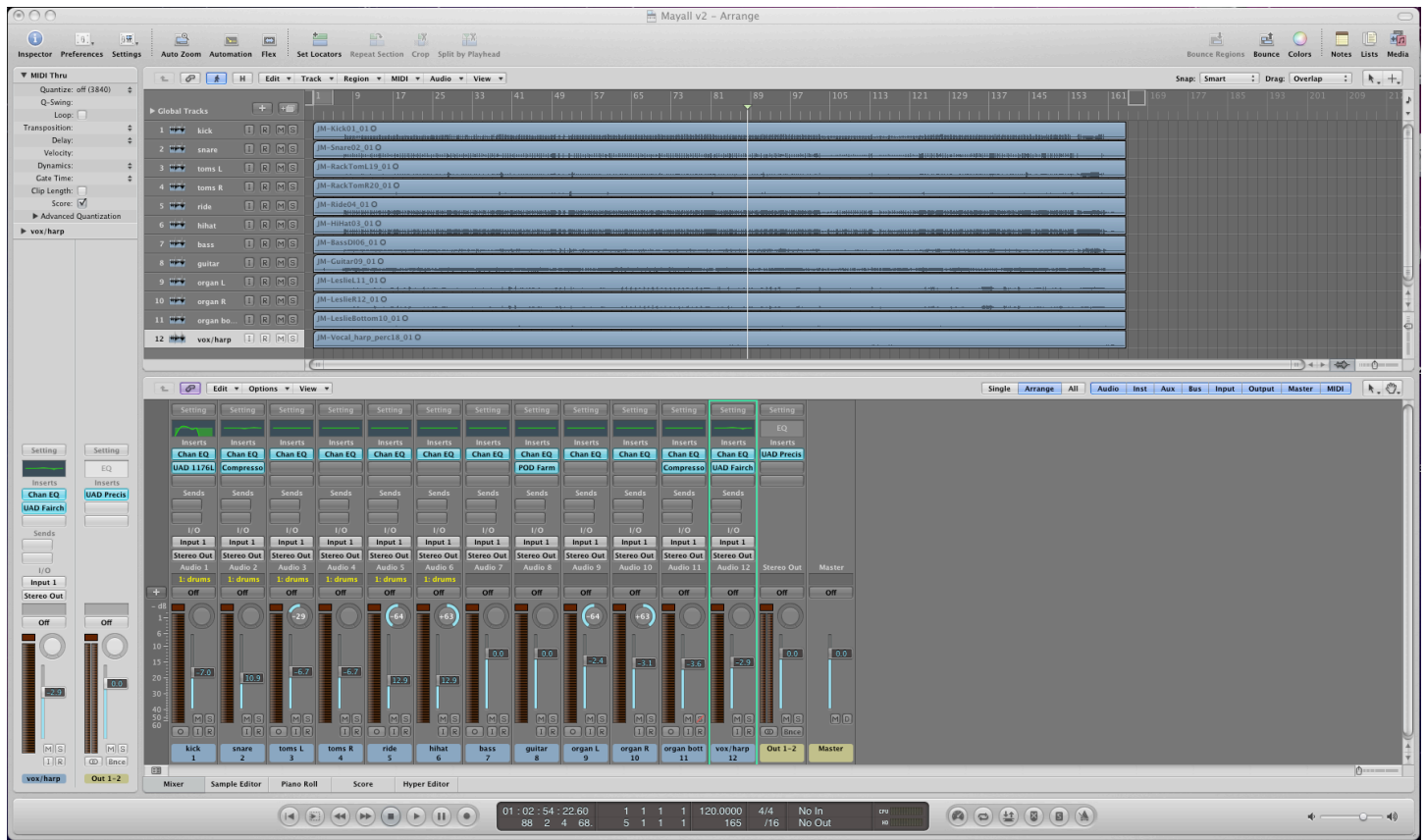
Pro Tools is available in two versions: TDM (time division multiplexing) and LE. The TDM system uses dedicated DSP hardware while LE systems use the computer CPU to run the software. TDM systems are more powerful and expandable, with the TDM bus connecting the DSP cards and allowing audio data transfer independent of the computer system bus. Each DSP card has several processors and several cards may be used in a system. As CPUs have become more powerful, the LE platform has grown in popularity and many of the same plug-ins available for TDM systems can now run on LE host-based systems as RTAS (real-time Audiosuite). (Audiosuite plug-ins are alternatives to TDM plug-ins that do not run in real time on host-based systems.) Earlier Pro Tools systems required some Digidesign hardware in order to run. With Pro Tools 10, specific hardware is not required and the company is now known simply as Avid, no longer as Digidesign.

Since Pro Tools interacts with the host operating system, there are specific requirements with regard to version compatibility. This can be somewhat problematic and Digidesign maintains a large compatibility database for users. As computer hardware changes, Pro Tools hardware also changes. The PCI bus is now common to Macintosh and PC platforms, having changed from PCI to PCI-X and now to PCI-e bus systems. The latest Pro Tools TDM cards are PCI-e and are not compatible with older computers. There is a constant pressure to upgrade to maintain current compatibility, but there are sometimes major upgrades that require new hardware as well as new software. It can be frustrating but once a system is stable and capable of doing what is needed, further upgrades may be unnecessary.

## Logic Pro

Logic Pro began life as E-Magic Logic, a MIDI sequencing program that later added audio recording capabilities. (Pro Tools began as an audio recording program that added MIDI support.) Logic Pro is now an Apple product, having been acquired by Apple in order to provide a high-quality audio and MIDI program

tightly integrated with the Apple operating system. While Logic looks and acts somewhat differently from Pro Tools, both programs handle MIDI sequencing and audio recording and mixing.



Logic Arrange window

The Logic Arrange window contains both the mixer and edit windows. The upper part of the window is equivalent to Pro Tools' Edit window while the lower section is switchable between the mixer (displayed), a sample-accurate editing window, a MIDI piano roll display, a score display and a MIDI "Hyper-editor". Logic comes with several DVD-ROMs full of samples and loops.

Prior to Pro Tools 10, Pro Tools required Digidesign hardware for input/output but Logic uses the Apple Core Audio driver and therefore can use any hardware interface the system can support. FireWire and USB audio/MIDI interfaces allow great flexibility in selecting the interface just right for the application.

## Other DAWs

While Pro Tools and Logic are the most widely used DAWs, they are not the only options. Pro Tools versions are available for both Mac and PC systems, while Logic is now produced by Apple and only runs on their hardware. PC-only DAWs include Cubase and Sonar. A new contender has been developing with both PC and Mac support – REAPER. REAPER is under active development with frequent updates and refinements and is being quickly adopted by many engineers frustrated with corporate decisions that affect many of the other competitors. It is very user-configurable and inexpensive. For those deciding on a first platform to adopt, REAPER is a very attractive option. Many long-time users of Pro Tools are beginning to switch to REAPER, especially those who do not need inter-studio compatibility for their projects, something still a strength for Pro Tools.



## DAW-computer interaction

All DAWs have features in common. Data files acquired by recording MIDI data and audio sound files are stored on the host hard drives. This process can be slowed if the same drive must be used for system software and for data storage, so it is recommended that a separate drive be used for data. As drives get larger and faster the number of tracks that can be recorded to a shared system drive has increased, but for maximum performance a dedicated drive is still recommended. The seek time of the hard drive is also a consideration, but even the slowest current drives are capable of recording many audio tracks at a time.

The operating system (OS) software that runs on the computer interacts with the recording application program. With the popularity of multitasking operating systems come potential problems for time-critical applications like sound recording. The real-time nature of the recording process often demands the full attention of the computer hardware. If several processes are running concurrently, the audio interface may not be able to use the system bus when it needs to ship data from the interface to memory or the hard drive. In order to allow priority scheduling to time-critical processes, the operating system must coordinate all requests for bus and hard drive access including those from the OS itself. Differences in how these requests are handled between different operating systems can influence how reliably the recording applications are able to perform. In some cases it is necessary to disable certain features of the OS in order to guarantee acceptable performance of the recording applications. The best situation is for the computer used for recording and mixing not to be used for other applications, especially concurrently. As OS software matures, some of these problems are less important but may still cause intermittent problems.

Because the recording programs depend on the OS, changes to the OS from upgrading versions frequently breaks something in the recording process. Most recording application revision levels are tied to specific operating system versions and will fail if one or the other version is changed. While manufacturers often provide detailed compatibility information, any desire to upgrade must be tempered with the knowledge that things may not go smoothly.

DAW systems provide a software interface that allows third party developers to add code to the DAW to emulate signal processors and similar functions. These are known as plug-ins. There are several standard plug-in formats and each DAW works with one or more of these. Some plug-in architectures work on only one DAW and some are cross-platform. Developers sometimes produce multiple versions of their plug-ins and sometimes only a single version. With the increasing popularity of host-based DAWs, several companies have developed DSP hardware that can be installed in the host system bus or connected through FireWire interfaces to add computing power for plug-ins that otherwise would overwhelm the host CPU. Plug-in versions are usually tied to application and OS versions and may introduce another level of (in)compatibility issues.