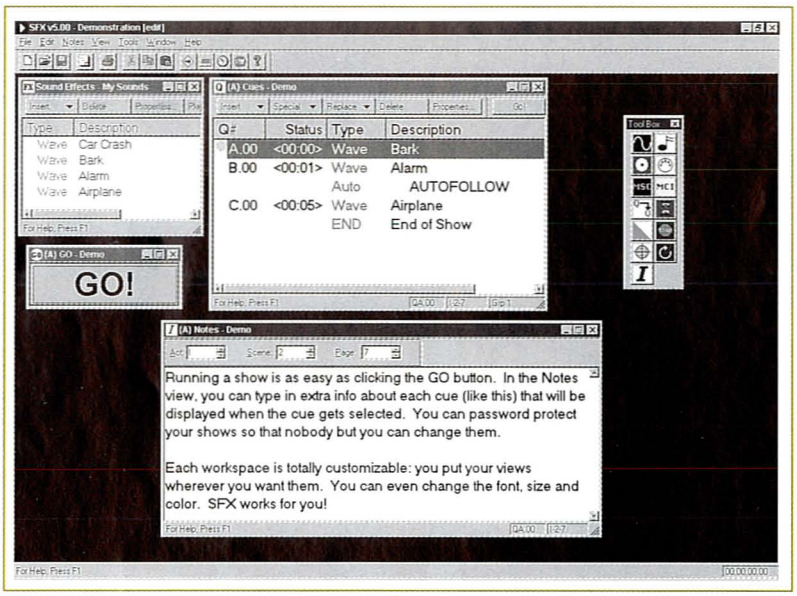
Sound Score Playback Options: part two



clockwise from above:

- *screenshot of SFX 5.0 by Stage Research, Inc. (an asynchronous multi-track hard disk system)*
- *Denon's model DN-990R (a MiniDisc system)*
- *360 System's DigiCart II Plus (a two-track hard disk system)*
- *EMU's Darwin (a multi-track hard disk system)*
- *Level Control Systems' model LD-88 (another asynchronous multi-track hard disk system)*

by
Richard K. Thomas

Part one of this article described several options for sound score playback devices commonly used in live performance environments. Part two of this article compares specific devices from several manufacturers.

Comparing the features of all the different devices that are currently being used in theatres for sound score playback would be impossible.

This article narrows the field to just six categories of playback devices: compact disc, MiniDisc, digital audio tape (DAT), two-track hard disk, multi-track hard disk, and asynchronous multi-track hard disk. Thirty-six playback devices are compared in the Product Comparison Guide on pages 52–53, concentrating on the features that have particular importance to theatre sound playback. This report, which is based on a seminar offered at the 1998 USITT Conference & Stage Expo in Long Beach, California, only includes devices that are commercially available at the time of this writing. Hopefully, the reader will not attempt to draw any indication of an endorsement for any products, or even categories of products based on this discussion. Throughout this report, references are made to remarks by the seminar panelists. These individuals include Dave Tosti-Lane, Richard Zvonar, EC Keller, Jon Gottlieb, and Tom Mardikes. Their generous contribution to that seminar and indirectly to this article are much appreciated.

Readers may wonder about a few types of devices that are not included in this report. An obvious one is the audio sampler. Samplers have become such an important part of theatrical sound score playback that it is almost impossible to find a theatre that does not use one. They are also essential in many other types of audio production—film, music recording, broadcast, video, etc. This widespread use of samplers means that there are too many products available to adequately cover all of them in this article. However, a discussion of how one designer uses samplers and why he feels they are such an essential tool for sound score playback is included here as a sidebar on page 47.

This report also does not include recording systems that utilize software controlled sound cards in computers. Dave Tosti-Lane and Eileen Smitheimer co-chaired a session at the 1998 USITT Conference & Stage Expo in Long Beach devoted to computer sound cards and their application to theatre. David showed a spread sheet that included no less than twenty-five sound cards, and that did not even include the software manufacturers and their products which are required to make the sound cards work. Many theatres have attempted to play back sound scores directly from these types of systems with results that varied from excellent to adequate. Users report that two products work well in live performance situations: SAW Plus from Innovative Quality Software, and TripleDat from Creamware. Both of these products feature RAM start, an important consideration for playback in live theatre that will be discussed later in this report.

Hard disk systems without more than two outputs are also excluded from this report. The main advantage of a hard disk system over one of the other options is the ability to play back more than two channels at once over more than two out-

put channels at once. The notable exceptions to this are the Digicart and Instant Replay products offered by 360 Systems, because, in spite of their limited channels, they offer features and performance comparable to other non-hard disk systems.

REQUIRED FEATURES

With so many dozens of potential playback devices excluded from this report, the reader may wonder what devices actually got included. For starters, we tried to include devices that have achieved some level of acceptance in theatres, or may serve as direct competition for products that are being used for playback in theatres. Two important features—instant start and auto-cue—are essential for theatre sound score playback.

Remember the old Revoxes which had a built in sensor that would stop the tape when the deck encountered a piece of clear leader tape?

INSTANT START: A device must produce sound immediately when the sound board operator pushes the "go" or "start" button. All of the devices considered in this report have near instantaneous start capabilities. Most compact disc players have a start time much less than half-a-second, which is comparable to or better than the analog reel-to-reel machines they replace. However, most DAT players and many hard disk systems have a noticeable delay (i.e., greater than one-half second) between the time the start button is pushed and when the sound occurs. To get around this problem, many devices designed for live playback offer a feature known as RAM playback buffers. As seminar panelist Richard Zvonar explains it, "[RAM buffering] means that the start of your track is put into RAM memory, so that when you trigger it, it's instant start, and after it goes through that initial segment it just streams off the hard drive." All of the MiniDisc, DAT players, and asynchronous playback systems included in this report have RAM start capabilities. Only the Akai hard disk recorders do not use a RAM playback buffer, although users report that with a properly defragmented drive, start times less than .2 second are possible, well within the requirements of many users. Most of the CD players don't have RAM start capability, but the start time of the typical CD player is so short that most users find the delay acceptable. Some high end CD players do include RAM buffering which reduces the already very short start time to instantaneous.

AUTO-CUE: Many people involved in sound score playback for theatres remember the auto-cue device manufactured by Tony Tait. It was a simple device that when connected to an open reel tape deck would stop the deck at the beginning of the next cue. Others may remember the old Revox A-77s, B-77s and PR-99s, which had a built-in sensor that would stop the tape when the deck encountered a piece of clear leader tape. These features seem to have had very little importance to the rest of the audio world except, perhaps, broadcasters. But to the theatre sound board operator trying to keep track of a whole room full of tape decks in a complicated show they were a godsend. When the digital world met the broadcasting world, it became so easy and inexpensive to incorporate auto-cue functions into decks that some manufacturers even incorporated the feature into their lowest-end consumer products.

Today, so many products are available with this feature that it seems silly to include products in a report like this that don't have it. However, there are two notable exceptions: DAT players and hard disk recorders. In both cases, some theatre practitioners have found that features offered by these devices make up for their lack of auto-cue. And many use a relatively simple workaround: they simply put a lot of blank space after each cue, so that the board operator won't accidentally run into the next cue. The board operator will still have to cue the deck up, but this is a relatively simple matter for both types of devices.

PRODUCT COMPARISON GUIDE

The Product Comparison Guide and these accompanying notes are intended for readers to use as a starting point in their investigation. A list of manufacturer's contact information is included and readers are encouraged to obtain full details on any product before making a purchase decision. Following are explanations of some of the comparison categories in the product comparison guide.

RETAIL PRICE: All prices are manufacturer's suggested list for the base model. Optional features, and their prices, are included in the Notes section on pages 54–55. The devices in each category are ordered from lowest to highest price. Note that models costing a lot more than others typically have more features. Also, more expensive units are designed for heavy use applications where they might operate 24 hours a day, 365 days a year.

ANALOG INPUTS AND OUTPUTS: All inputs and outputs are left and right stereo. The multi-track hard disk units of course are designed for more than two, and the number of ins and outs are noted in the table. Sound playback equipment specifiers should determine the need for balanced inputs and outputs in their system. Lengthy cable runs between the playback device and the mixing console, or runs that come in close proximity to strong electromagnetic or electrostatic fields may require balanced inputs and outputs to keep hum, static, etc., to a minimum. Theatres are generally more likely to be able to get away with unbalanced inputs and outputs when the sound equipment is portable, and wiring does not traverse through conduit, raceways, walls, ceilings, etc. In such systems the user often provides the single grounding point for the entire audio system through the third pin of the electrical plug coming from the power strip to which the audio equipment is connected. Also, patch cables between equipment are readily accessible, which simplifies troubleshooting should ground loops or other hum and noise develop.

In fixed installations, however, balanced inputs and outputs become more necessary as the complexity of the system grows. As such systems grow, wiring in equipment racks becomes increasingly unwieldy, and proper grounding and isola-

tion techniques must be employed to prevent difficult to trouble-shoot ground loops and other problems from creeping up as additional equipment is added to the system. The equipment in fixed installations is often more securely mounted, and access to a large number of inputs and outputs may be awkward, especially if the entire system is tied together through patch panels.

DIGITAL INPUTS AND OUTPUTS: All inputs and outputs are left and right stereo, unless otherwise indicated by a number.

Originally, users could identify **AES/EBU** inputs and outputs as "XLR" style connectors on the back of a device, and S/PDIF inputs and outputs as either an "RCA" or optical connector. However, this obvious distinction has become somewhat blurred in modern devices. Although the optical connector still transmits only **S/PDIF**, the RCA connector is now used to transmit the "unbalanced" digital output, and the XLR transmits "balanced" digital output. Some devices only have one set of inputs and outputs, which may be balanced or unbalanced (e.g., RCA or XLR), and the user may select whether the connectors transmit AES/EBU or S/PDIF information. (See the notes section for more information.)

SCMS prevents the user from making a digital copy from a device that has already been digitally copied. It does not affect analog copying. Consumer devices tend to incorporate SCMS protection, and the inability to make a digital copy (e.g., as a backup of a show tape) can rear its ugly head when the user least expects it. An X in this column indicates that the device either does not recognize SCMS, and therefore does not retransmit it, or that the user may select whether to have the device recognize SCMS. Note that SCMS coding is only sent through S/PDIF consumer outputs. AES/EBU does not transmit SCMS.

It is highly desirable for the sound designer or board operator to be able to make an exact duplicate (**clone**) of the show tapes after each technical rehearsal, or set of changes to the show tapes. Some devices allow full cloning, including non-destructive editing, titling, etc. Compact discs and DATs have no editing or titling capability, and are therefore also clonable. However, the user should remember that program ID and start ID numbers are not transmitted through the AES/EBU protocol. Users should plan to create clones using the S/PDIF outputs of these devices to preserve the track indexing information. Users should also determine the cost of additional hardware that may be necessary to create backups when they consider their options. Note that only the high end Sony MDSB5/B6 MiniDisc is capable of actually "cloning" another MiniDisc. If users plan to back up a compressed file using AES/EBU or S/PDIF, consider making a test backup before committing to purchasing, because the backup will have undergone two stages of compression/decompression—first, the original, and subsequently, the backup. Users should listen to determine how much difference they can actually hear between the original and the backup, and determine if they could live with that in their show until they had an opportunity to remaster from their original digital source. They should also re-

member that the backups will not have the titling of the original, and then only the edited versions will be recorded, not the non-destructive edit points themselves (see next section).

EDITING: For purposes of theatrical sound playback, editing refers to the ability of a device to provide simple cuts and changes in a sound cue on a single machine. Some devices, such as the Panasonic SV4100 DAT allow video style insert editing, but require two machines. Generally speaking, the more sophisticated the device, the more editing features included, and some of the hard disk models even allow fade-ins and outs, as well as volume changes, which, once set, allow the cue to be repeated consistently from evening to evening (although some may argue that the volume of cues will need to change with variations in each performance).

For novice board operators, an indication on the deck of the cue number and the name of the cue is very valuable.

In order to perform an edit, the user needs some method of locating the edit points. Two of the more advanced methods for accomplishing this involve the use of a **scrubbing wheel** or a **jog wheel**. Scrubbing is very similar to the analog reel-to-reel ATR practice of "rocking the reels" to locate edit points. Typically, a scrubbing wheel holds a certain amount of audio in the device's RAM buffer both before and after the currently selected edit point. This allows the user to turn a knob in one direction to play the sound from the device's RAM buffer forward, and to turn the knob in an opposite direction to literally play the sound backwards from the spot. The less the knob is turned, the slower the playback of the sound, and the further the knob is turned, the faster the playback. Jog wheels do not use edit buffers, so the sound played when the reels are rocked back and forth comes directly from the storage medium, and often is limited in the speed of shuttling and in the sound quality of the shuttle. Although scrubbing is preferable to jogging, either method is preferable to no method at all, or very limited jogging accomplished by single speed fast forward and rewind buttons.

There are two types of editing available, **destructive editing**, in which the actual data on the storage medium is changed, and **non-destructive editing**, in which only the "pointers" to the edit points are changed. For most theatre purposes, non-destructive editing provides ample on-the-spot editing, with the capability to redo the edits at a later time. Compact discs and DAT players offer no editing capabilities, MiniDisc offers simple cut, copy, paste, and move editing, and hard disk systems offer the greatest flexibility in editing.

CUEING: Cueing is an extremely important feature in the playback of sound scores in live theatre. The most important attributes of cueing are cue titling, instant start capabilities, auto-cue, auto pause, and direct access to cues.

Cue titling is a feature that allows a device to display the cue name and number on its front panel, which is similar to the old practice of labeling the white paper leader tape on a reel-to-reel with the cue number and title at the beginning of the cue. It is a desirable feature, but some users may feel that it is not mandatory compared to other tradeoffs between similarly priced devices. Others may feel that in an environment with novice board operators, an indication on the deck of the cue number AND the name of the sound cue is a very valuable feature. Compact discs and DATs don't have this feature. The Akai hard disk decks, allow individual naming of files. However, many users of this product for theatre place their cues at appropriately spaced auto-locate points, which allow them to quickly call up individual cues on the deck. However, the auto-locate points are not titleable.

Another important feature for decks that do allow titling is the method used for entering characters. Some devices have inputs for standard PC keyboards, which makes entering of cue names and titles a relatively simple matter. Other devices use more complicated input systems, and the user may need to decide that if it's not easy to title cues, will anyone bother?

RAM Start or the ability to play a sound almost instantaneously when the sound board operator presses the "go" button (e.g., less than ½ second, or the typical start up time for an analog reel-to-reel ATR) is critical for sound score playback devices. Most devices accomplish this by using a RAM buffer, which loads the initial segment of the cue into the device's RAM memory, immediately plays it when the board operator presses the "go" button, and then continues playing back from the normal storage medium when the device reaches its normal start playback time and has synchronized itself to the RAM buffer. CD's tend to have a delay of about .3 seconds, which may be quick enough for most theatre sound score playback applications. Some units offer optional RAM starts to decrease this to near instantaneous. Many devices also have so-called "Hot Keys" that allow users to assign sounds to buttons on the front panel of the device or the remote control. These sounds can then be repeatedly fired, sampler-style, since they reside in the RAM of the device.

Auto-cue refers to the ability of a device to play through a cue, and then cue up to the next cue, and either enter stop or pause mode. Auto-pause refers to the ability of a device to automatically enter the pause mode when a cue has finished playing. Readers should be aware that not all companies refer to these functions by this name, and should make sure that the devices they intend to purchase actually have the desired features. This feature is highly desirable, although some users will be willing to trade auto-cueing for increased number of outputs in devices such as the multi-track hard disks. All of the devices included in this survey have this feature except DAT players and the multi-track hard disks. This survey only considered MiniDisc and Compact Disc players that included Auto Pause/Auto Cueing features, since so many devices that have these capabilities exist in each category.

Direct search, or access to cues (track numbers) eliminates the need for the sound board operator to press an incremental up button 72 times to get the deck cued up to cue 72. Almost all of the devices included in this survey have this capability, or have the capability as an option.

MEDIA COSTS PER MINUTE STEREO AUDIO: The rapid decline in the cost of storage media has almost made

this category a moot point. However, different media do have different costs associated with them, and the sound equipment specifier may want to consider the implications of the cost of the media on the sound operating budget. The Product Comparison Guide attempts to provide a "ballpark" estimate for the cost per stereo (i.e., two tracks) minute of audio storage. Compressed files offer a lower cost per minute, but specifiers must weigh the cost advantages against their own perceptions of the tradeoffs in sound quality. The basic formula for hard disk systems is based on the standard approximation of 10 Megabytes of hard disk space for every minute of 44.1 kHz, 16 bit uncompressed digital audio (your mileage may vary).

Media cost per minute is based on the following:

- CD Recordable: 2¢ per minute ($1.50/disc)
- MiniDisc: 5¢ per minute ($4.00/disc)
- DAT: 5¢ per minute ($6.00/tape)
- Hard Drives:
  - 8 G drive: $1 per minute ($800/drive)
  - Jaz: 1G cartridge: $1 per minute ($100/cart.)
  - Zip: 100M cartridge: $1.50 per min. ($15.00/cart.)
  - Hard Drive w/Dolby AC2 Compression: 20¢ per minute (based on 5:1 compression)
  - (hard drives typically store 10MB per minute stereo, 44.1 kHz, 16-bit audio)

Note that the LCS system stores data in a true 32-bit format, which doubles the cost of the typical storage media.

The cheapest storage media tend to be compact discs, MiniDiscs and DATs. Hard disk recording, although more expensive, can be wrestled under control by careful selection of an appropriate backup/archive medium such as CD-R, DAT, etc. In any case, one may wonder whether the rapidly plummeting cost of storage media renders the effects of media cost on operating budgets inconsequential.

STORAGE CAPACITY: The storage capacity of typical media for the format is given in minutes using the same formulas developed in "Media Cost" category. Hard drives and removable hard drives are available in so many sizes that a "typical" storage size is hard to establish. For reference purposes, a 4 gigabyte hard drive will typically store approximately 400 minutes of stereo 44.1 kHz 16 bit audio. Such large capacities for hard drives make them ideal storage devices for multi-track playback devices.

SAMPLING RATE: Most units will playback standard 44.1 kHz audio files. CD players playback at 44.1 kHz, although the Denon DN-C680 offers an optional converter to 32 kHz or 48 kHz. Some of the MiniDisc players have the ability to convert incoming 32 kHz and 48 kHz sample rates to the MiniDisc standard 44.1 kHz, or to convert the outgoing sample rate to 32 kHz or 48 kHz. All of the DATs, 2 track hard disk and multi-track hard disk units record and playback both 44.1 kHz and 48 kHz, and some models will also work at 32 kHz, with the exception of the Richmond and LCS systems, which operate at 48 kHz.

SIDEBAR

SAMPLERS

Many people feel that samplers are an essential piece of gear in the theatre sound playback environment. David Smith spoke to the attendees of a sessions at the 1998 USITT Conference & Stage Expo in Long Beach about the advantages of using samplers in the theatre.

I've been using samplers since their onset, and at the time, when I needed to play something more than stereo, samplers were the only way to go in the theatre environment. I own my own sampling system because I've found that as a sound designer, I would get to design sound in some theatres, and their playback equipment wasn't really suited for the way I designed sound, so when people employed me as a sound designer they would get the use of the equipment for the run of the show, and that was the only way I could guarantee that I could do multichannel, multi-triggerable sound. None of these systems do multi-triggerable sound—they play one sound, when you trigger another sound they stop that first sound, and play that second sound. The nice thing about samplers is that you can layer many things and have them come out of many speakers. [With samplers you can become] part of the performance—that's what it's all about. Directors like this, so suddenly the sound man becomes a friend of the director again.

Smith demonstrated for the USITT audience how he accomplished "layering" and "multi-triggering" using close and distant thunders, and creating rain sequences and wind sequences. Another useful technique he demonstrated was how to use a loop to sustain a sound under actor business until activating a new cue which required the sound to stop, not just fade out. In one example, he showed how he could create the sound of a movie projector playing, and then when the film broke, he could trigger another sound that had the projector grinding to a halt. Similarly, he showed how he could make a phone ring and then end on cue.

As sound equipment matures, look for the line between samplers and hard disk players to grow increasingly blurred. Many products in this article include so-called "Hot Start" buttons which hold a sound in RAM and therefore allow the user to do some of the multi-triggering and layering that Smith creates using samplers. Hard disk playback systems currently can't do all the things that full-blown samplers can, such as pitch shifting, looping, and the ability to trigger sounds from a MIDI keyboard, but the day may not be too far off when users will have the best of both worlds—the multi-triggerability, layering, looping, and keyboard (or other) controller performance capabilities of a sampler, combined with the scrubbing, jogging, editing, auto-locating, etc. features of a hard disk system.

Sampling rates become an important issue when transferring audio digitally between devices. Ideally, users would prefer no sample rate conversion to take place, as the conversion process may potentially alter the sound. Most conversion processes are relatively benign, however, and users tend to prefer digital transfers using conversion to analog dubbing. The most important issue for sound equipment specifiers is determining how they will resolve issues related to copying sounds from one unit to another before committing to purchasing a specific system. Moving sounds back and forth between devices which use different sample rates can cause additional headaches and surprises for users if the user has not resolved methods for accomplishing such transfers before purchasing equipment.

There are three reasons why many people consider computers to be unreliable for theatre sound score playback.

QUANTIZATION: Most of the devices in this report record and play back audio using 16 bits. MiniDiscs use 8 bits, however, and the Level Control System's Analog to Digital Converters are 20 bit, while it stores sounds as 32 bit files on hard drives.

COMPRESSION: The 8 bit MiniDisc format uses a compression scheme called Adaptive Transform Acoustic Coding (ATRAC). The 360 Systems products allow users to select between linear recording and Dolby AC-2 compression, which provides approximately five times as much recording time per megabyte of storage space as linear recording. All other devices record and playback linearly.

RACK MOUNTABLE: Rack mounting becomes an issue where security for expensive audio equipment is concerned. Rack mounting does not eliminate the possibility for theft, but may serve as a deterrent, especially if the sound system installer uses "tamper proof" screws. Rack-mounting may also create a more professional visual appearance for the sound booth, and may help to keep dirt and contaminants—a major problem in live theatre environments—out of the inside of racks. On the other hand, rack mounting may also make servicing equipment more difficult, and some theatres prefer to operate their playback equipment in a more "portable" environment.

Most of the devices included in this report are rack-mountable. Two notable exceptions are some consumer devices, and professional devices that are in "half rack form." Sound system installers often rack mount half-rack devices by purchasing rack shelving, removing the rubber feet from the device, drilling holes in the shelf at the appropriate location, attaching the device to the shelf, and then rack mounting the entire assembly. Sound playback equipment specifiers should consider the ergonomics and security issues of the playback environment before committing to specific purchase strategies.

SYNCHRONIZATION: As the requirements for technical complexity and sophistication increase in the performing arts, the demand for audio playback devices that can synchronize other devices, or synchronize to other devices increases. For example, lighting designers may want to automate lighting changes to pre-recorded music cues to allow greater complexity and less opportunity for operator error. Sound designers may want to have special effects such as pyro trigger sound effects. Synchronization capabilities generally require more sophisticated sound playback devices, but offer the advantage of eliminating the need for stage management to call cues that need to occur in exactly the same place (e.g., at a certain part of the music) every performance, or exactly at the same time.

Four types of synchronization are typically encountered in theatre sound playback devices: SMPTE, MIDI, Word Clock, and Video.

Perhaps the most standard method of interlocking audio, video, and film transports is SMPTE time code, an eight digit address that provides a unique location in hours, minutes, seconds and frames for synchronization. Two types of SMPTE time code exist: Longitudinal time code (LTC), an audio signal that carries the SMPTE time code, and Vertical Interval Time Code (VITC), a video signal that carries the SMPTE time code. Several devices included in this report support direct SMPTE synchronization.

Many devices in this report synchronize to MIDI Time Code (MTC), a system developed to translate SMPTE into MIDI messages. MTC has emerged as a very viable method for synchronizing computers to SMPTE. Sound system specifiers should remember, however, that MTC often requires a separate MIDI interface for the computer system. Another variation of MIDI that has been specifically developed for live theatre applications is MIDI Show Control, and is typically implemented in more sophisticated systems which are specifically designed to accommodate large complex technical requirements.

A few of the compact disc players, MiniDiscs and DAT players synchronize to word clock, a synchronizing signal based on the sampling frequency or rate of sampled audio data sent over a digital audio interface. Others will synchronize to Video black burst signals, a synchronization system derived from video that is commonly used to synchronize multiple video and audio decks together in audio for video post production.

COMPUTER INTERFACE: Many sound playback devices are remotely controllable from an external computer or controller. Typically these devices will use either RS-232 and RS-422 protocols. RS-232 is the standard serial interface used on most personal computers. It is a format widely supported for bi-directional data transfer at low to moderate rates, and is commonly used to connect personal computers with peripheral hardware and instruments. RS-422 is essentially a balanced signal version of RS-232 utilized by Apple Macintosh computers. The major differences between the two formats are that RS-232 is intended for short distances and a single interface, whereas RS-422 can work at much greater distances, and multiple devices can be daisy chained together.

Sound Playback devices may also incorporate a Small Computer Serial Interface (SCSI), a standard 8-bit parallel in-

terface used to connect up to seven peripherals, such as an additional external hard drive or removable drive which allows quick backup of show tapes, etc.

SOFTWARE: Some devices include computer software that can be used to program and control the device from an external computer.

SUBJECTIVE ISSUES

Three subjective issues related to theatre sound playback—audio quality, product reliability, and the potential of the media formats to survive in a rapidly changing technological world—are impossible to quantify or compare in a table. They are, however, important issues for anyone making a purchasing decision. This section provides some comments, mostly gleaned from the 1998 USITT conference session in Long Beach.

AUDIO QUALITY: The only area where controversy has appeared related to audio quality seems to be the MiniDisc, and the reader may want to carefully consider Dave Tosti-Lane's comments in the section on MiniDisc players. However, beauty, as they say, is in the ear of the beholder, and anyone contemplating purchasing new sound playback equipment for their theatres owe it to themselves to give the MiniDisc a serious listen. Potential users should not just rely on what others tell them about the quality of audio on the MiniDisc, buts should critically listen to them. Although the MiniDisc has not yet caught on in the American consumer market, it has made important strides in the broadcasting community, and the fact that important manufacturers of professional audio equipment such as Denon, Sony, and Tascam have made commitments to the medium should suggest that the product might be appropriate for some theatre applications.

WHAT ABOUT RELIABILITY? Towards the end of the Long Beach session, an audience member stood up and asked the $64,000 question: "what about reliability?" It was difficult for the panelists to provide a definitive answer to such a question. Perhaps the reason is that for every horror story one hears about a particular format, one also hears a testimonial from another person who has used the format in their theatres for years without encountering a single problem. As a general rule, consumer products are not designed with the reliability concerns that manufacturers need to address for the professional world. In professional products, there are also key differences between products that are designed for normal use, and products that are designed to work 24 hours a day, 365 days a year, in critical environments. Although some theatre sound specifiers might want to invest in that level of designed reliability, others may want to consider targeting their budgets more towards redundancy: even the best products can fail, and if you don't have another one to swap in for the broken one, the show will have a hard time going on.

Computer systems tend to elicit the most amount of fear from potential users. As one attendee put it, "I think we're worried more about the computers crashing than the MiniDisc." Yet, when one examines the reasons why users may

perceive computers as unreliable, one may come to the conclusion that there is no reason to believe that a computer system is any more unreliable than a dedicated hardware product. It is a curious situation that the most expensive and sophisticated productions in the world, including Broadway, Las Vegas, and major theme parks, have embraced computer sound score playback. Some productions perform for years without a single computer crash or hardware failure. It is hard to imagine, with so much money at stake, that theatre producers would be willing to risk even a single production, and the box office revenues that come with it, on a device whose reliability is suspect.

There are perhaps three important reasons why theatre sound specifiers might perceive computers as unreliable. The first has to do with a fear of "putting all of your eggs in one basket," so to speak. In a five deck show, if one deck fails, you can hobble along using the remaining four. But if all of your cues are on one computer, and that computer fails, the whole show goes down. Many professional performing arts organizations resolve this problem by providing full or partial redundancy. In really critical cases, the redundant devices run concurrently with the show, so if one item fails, the backup system takes over. Although this might seem like an expensive option, the continued low cost of key hardware components such as CPUs, hard drives, etc., may make this a viable option for those desiring all of the amazing features that computer systems have to offer.

The second reason has to do with how the end user sets up the computer system. As EC Keller suggested: "It's also how you set up your computer. If you set up Doom and other games, it's going to crash more, but if you just run what you need to do, it's going to be clean, it's going to be lean, and it's going to run what you want."

Computer systems run best when not bogged down with a lot of non essential software. Those considering using a computer in a critical playback environment may want to also consider purchasing a second computer that could not only serve as a backup CPU, but could also be used with a separate external drive, software, etc., for all of the other applications such as word processing, drawing, database management, etc., needed to make the sound area run smoothly.

The third reason computers fail has to do with operator error. Jon Gottlieb suggested: "As you get into the computer system and stuff, the more buttons you have to push, the more you got to have people who know what they're doing." The old expression, "garbage in/garbage out (GIGO) applies to sound score playback also. It is amazing at how many problems students attribute to computer failure are actually caused by operator error, or the uncanny ability of the inexperienced user to find strange ways to put the computer into illegal states, etc. The more experience one has with a computer system, the less likely they will be to operate the system in such a way as to create a system failure.

In the final analysis, one wonders whether there is any reason at all to avoid buying into a computer system for fear of lack of reliability.

There may be one product that most users tend to agree has some long term reliability issues. The general reliability of DAT has been suspect for some time. As a close engineering friend in the broadcasting business once confided, "if you own a DAT player, you will eventually have problems." Those problems seem to occur after about a year of 12 hour a day (or more) usage. Tom Mardikes echoed this sentiment: "DATs works fine if you are a one machine operation. We use about 8 machines in 6 studios and just have too many problems moving from one machine to another. The head and guide adjustments are too critical and fine. We have tried to minimize differences by using all Panasonics; 3700's and 3800's. Still doesn't eliminate the error reading problems. It is also a dangerous adventure to try reusing a DAT. You can't erase the things. You record over something and move to another machine in another studio and the second machine is trying to read data from two recordings. We just have too many problems using DATs."

Since the reliability problems of DAT seem to increase as the machine ages, sound equipment specifiers may still want to consider including these devices in systems where the number of actual hours the DAT will be used remain relatively low. The reason for this is that DAT remains a low cost media, with full digital fidelity, that works very well not only as a backup medium, but also as a portable location recording device.

WILL THE FORMAT SURVIVE? Until science invents a better crystal ball, no one will be able to accurately predict which of the formats considered in this report will last the longest. The compact disc seems firmly entrenched in the marketplace, but manufactur-

ers have been busy for several years trying to replace the medium with new products such as DVD. The MiniDisc still hasn't caught on with the consumer, at least not in this country. As Jon Gottlieb suggested: "MiniDisc is great, and there are a lot of companies out there trying to get MiniDisc into the consumer market, but I'm still not convinced that it's going to have the same footprint in the marketplace that's now done by CD and cassette."

Tom Mardikes also speculated on the demise of DAT given the rapidly decreasing cost of recordable CD's: "I think that what we're going to see die and die pretty quickly is the DAT format. Right now and everywhere you can buy CD recordables for 99 cents a disc. At UMKC we have a large concert recording operation and we're looking at paying $1 for media to record a concert instead of eight to twelve dollars for a DAT tape. Do 350 events a year and you save a lot of money! CD-Rs also last longer from the archiving perspective. CD-Rs don't jam and tangle!"

However, until a replacement format comes along that different industries embrace for ENG (electronic news gathering), and location sound effects recording, the DAT may continue to find a niche in the professional audio market.

Computers remain the most volatile products on the market, not because of the audio manufacturers, but because the computers themselves have such a short life span (five years, if you believe the Internal Revenue Service). Some of the audio manufacturers included in this report, such as Richmond Sound Design Ltd., have been supplying products to the theatre sound market for over twenty years. Nevertheless, the evolution of products that are primarily software based continues at a speed that appears to be much quicker than that of the hardware formats. The good news is that the products keep getting better and better; the bad news is that you'll probably be lusting after something different next year than what you purchased this year.

The sound playback equipment specifier may take solace in the fact that most of the formats discussed in this report have found a niche in a world that is much larger than live performance sound score playback. Those niches provide something of a guarantee that the formats will survive for at least a few more years, as those who have already invested in the equipment are not likely to haul all of their equipment out to the city dump, just because the next big thing has arrived. There are perhaps better reasons to invest in one particular type of device over another, than speculation on which format will survive.

CONCLUSION

This report began with a discussion about the current controversial nature of choosing sound score playback options for the theatre. It speculated that there were two important reasons for the controversy: first, different performing arts venues had differing sound score playback needs, and second, no single piece of theatre sound equipment addresses all of the needs of every user. There can be little doubt that the controversy will wage on. However, those who have invested heavily in theatre sound playback devices need not worry that they haven't chosen the perfect product, because that product doesn't exist. The purpose of this report was to help illuminate the many and often confusing issues that sound equipment specifiers must consider in order to make purchasing decisions that are appropriate for theatres. If it accomplishes its purpose, perhaps those making the decisions will have found some help in organizing their thoughts so that they might be better able to focus not on choosing the best product, but on choosing the best product for their specific application and situation.

The discussion did not end at Long Beach, and this article will certainly not end it here. Quite the contrary, the comments made in this article may generate a great deal more discussion, and that discussion will certainly help to advance the goal of a better world for theatre sound, and for live theatres in general. One very good place to join the discussion, which has been raging for some time, is the Theatre-Sound Mailing List. To subscribe, visit the Theatre-Sound Web site at: www.brooklyn.com/theatre-sound/. ❖

The author wishes to thank Sara Bader, Cory Kent, and theatre sound students at Purdue University for their help in gathering data for this article.

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[The following pages include a feature-by-feature comparison of thirty-five playback products.]

PRODUCT COMPARISON GUIDE

Format	Manufacturer	Model	Retail Cost	Analog				Digital					Editing			Cueing					Media Cost per Minute Stereo	Storage Capacity
				Balanced In	Unbalanced In	Balanced Out	Unbalanced Out	S/PDIF Optical	S/PDIF Co-ax	SCMS Defeat	AES/EBU	Cloning	Scrubbing/Jog Wheel	Destructive	Non-Destructive	Cue Titling	RAM Start	Auto-Cue	Auto-Pause	Direct Search		
Compact Disc	Technics	SL-PG480A	149				X	X				X						X		X		
	Technics	SL-PS770D	399				X	X				X						X		X		
	Tascam	CD201	529				X		X			X						X	X	0		
	Marantz	PMD321	529			X			X			X						X		X		
	Sony	CDP-L3	600			X		X				X						X	X	X		
	Tascam	CD301	739			X	X		X			X						X	X	0		
	Denon	DN-C680	900			X	X		X		X	X	X					X	X	X	$0.02	74 min.
	Tascam	CD401	1,049			X	X		X			X						X	X	X		
	Sony	CDP-D500	1,595			X	X		X		X	X	X					X	X	X		
	Tascam	CD601	1,799			X	X		X		0	X	X				0	X	X	X		
	Tascam	CD701	2,499			X	X		X			X	X				0	X	X	X		
	Sony	CDP-3100	3,650			X	X				X		X				0	X	X	0		
MiniDisc	Sony	MDSJE500	360		X		X	X							X	X	X	X		X		
	Tascam	MD301	899		X		X	X	X	X					X	X	X	X	X	X		
	Denon	DN-M2000R	1,250		X		X		X	X			X		X	X	X	X	X	X		
	Tascam	MD501	1,299	X	X	X	X	X	X	X			X		X	X	X	X	X	X		
	Denon	DN-M1050R	1,999	X	X	X	X		X	X	X		X		X	X	X	X	X	X		
	Denon	DN-981F	2,300			X											X	X	X	X	$0.05	74 min.
	Sony	MDS-B6	2,300			X			X		X			X	X	X	X	X	X			
	Tascam	MD801R	2,499	X	X	X	X		X	X	X		X		X	X	X	X	X			
	Denon	DN-990R	2,800	X		X				X	X				X	X	X	X	X	X		
	Sony	MDS-B5	3,295	X		X			X		X	X		X	X	X	X	X	X			
DAT	Panasonic	SV4100	2,950	X		X		X	X	X	X	X	X				X			X		
	Fostex	D-15	3,295	X	X	X	X	X		X	X	X	X				X			X	$0.05	120 min.
	Fostex	D-25	7,995	X	X	X	X	X		X	X	X	X				X			X		
Two-Track Hard Disk	360 Systems	Digicart II Plus	3,995	X		X			X	X	X	X			X	X	X	X	X	0	$0.20	Varies
	360 Systems	Instant Replay 2.0	2,995	X		X			X	X	X	X				X	X	X	X	X	$0.20	
Multi-Track Hard Disk	Akai	DR8	1,995	8		8		0	X	X	X	X	X	X	X					X		
	EMU	Darwin	1,995	4		8			X	X	X	X	X		X	X	X			X		
	Fostex	D-90	2,595		8		8	8	0	X		X	X	X	X		X		X	X	$1.00	Varies
	Akai	DR16	2,995	8		16		0	X	X	X	X	X	X	X					X		
	Fostex	D-160	3,995		8		16	8	0	X		X	X	X	X	X	X		X	X		
Asynchronous Multi-Track Hard Disk	Stage Research	SFX 5.0	495									X				X	X	X	X	X	$1.00	Varies
	Richmond	Audio Box DM1616HD	8,990	8		16				X		X			X	X	X	X	X	X	$1.00	Varies
	LCS	LD-88LD-16S	20,400	8		8				X		X			X	X	X	X	X	X	$2.00	Varies

Sampling Rate				Quantization	Compression	Rack Mountable	MIDI	Synchronization	Computer Interface	Software
32	44.1	48	Variable Speed							
	X			16						
	X			16						
	X			16		X				
	X		X	16		X			AMX/Crestron	
	X			16		X			RS232	
	X			16		X				
0	X	0	X	16		X		0	RS232C/RS422A D-sub 9-pin	
	X		X	16		X				
	X		X	16		X				
	X		X	16				X		
	X		X	16						
	X			16		X		X	RS232	
	X			8	X	0				
X	X	X		8	X	X				
	X		X	8	X	X				
X	X	X		8	X	X				
0	X	0	X	8	X	X		0	RS232/422A D-sub 9-pin	
	X		X	8	X				RS232/422A D-sub 9-pin	ACD19A
	X			8	X	X			RS232/Par	
	X			8	X	X			RS232/Par	
	X			8	X				RS232 D-sub 9-pin	ACD19A
	X			8	X				RS232	
X	X	X		16				X		
	X	X		16		X		0	RS-422A option	
	X	X	X	16		X		X	RS-422A	
X	X	X		16	X				SCSI/RS422	
	X	X		16	X				SCSI/Printer	
X	X	X	X	16		X	0	0	SCSI/RS422 option	
	X	X	0	16		X	X	0	SCSI	
	X	X	X	16		X	X	X	SCSI option	
X	X	X	X	16		X	0	0	SCSI/RS422 option	
	X	X	X	16		X	X	X	SCSI	
								X		SFX
		X		20		X	X	X	SCSI	AB Edit, AB Control (option), Show Man (option)
		X	X	20		X	X	X	RS232/422	Cue Satation, WiLdtracks (BeOS)

Akai Electronics
4710 Mercantile Drive, Fort Worth, TX 76137
817-831-9203 (voice)
www.akai.com (web)

CreamWare US Inc.
446 Harrsion St., Sumas, WA 98295, USA
800-899-1939 (voice), 604-527-9934 (fax)
www.creamware.com (web)

Denon Electronics
222 New Road, Parsippany, NJ 07054
973-575-7810 (voice)
www.denon.com (web)

EMU Corporation
1600 Green Hills Road, P.O. Box 660015
Scotts Valley, CA 95067-0015
408-438-1921 (voice), 408-438-8612 (fax)
www.emu.com (web)

Fostex
15431 Blackburn Ave., Norwalk, CA 90650
562-921-1112 (voice), 562-802-1964 (fax)
www.fostex.com (web)

Innovative Quality Software
4680 S. Eastern Ave., Suite D, Las Vegas, NV 89119-6192
800-844-1554 (US), 702-435-9077 (International)
702-435-9106 (fax)
www.iqsoft.com/HomePage/contact.htm (web)

Level Control Systems (LCS)
130 E. Montecito Ave #236, Sierra Madre, CA 91024
626-836-0446 (voice), 626-836-4883 (fax)
www.lcsaudio.com (web)

Marantz
Superscope Technologies, Inc.
1000 Corporate Blvd. Suite D, Aurora, IL 60504
630-820-4800 (voice), 630-820-8103 (fax)

Panasonic
Broadcast & Television Systems Company
One Panasonic Way, Secaucus NJ 07094
714-373-7277 (voice)
800-211-PANA (tech support)
www.panasonic.com (web)

Richmond Sound Design
1234 West Sixth Ave, Vancouver, CANADA VGH 1A5
604-664-5860 (voice), 604-732-1234 (fax)
www.theatre-sound.com (web)

Sony Service Center
1 Sony Drive, Park Ridge NJ 17656
800-282-2848 (cust. service), 800-788-SONY (fax)
bpgprod.sel.sony.com (web)

Stage Research
1929 E. Royalton Rd., Cleveland, OH 44147
440-717-7510 (voice), 800-929-1708 (toll free)
(440) 717-7601 (fax)
www.stageresearch.com (web)

TASCAM
c/o TEAC America, Inc.
7733 Telegraph Road, Montebello, CA 90640
213-726-0303 (voice), 213-727-7632 (fax)
www.tascam.com (web)

360 Systems
5321 Sterling Center Drive, Westlake Village, CA 91361
818-991-0360 (voice), 818-991-1360 (fax)
www.360systems.com (web)

COMPACT DISC NOTES

Technics SI-PG480A

- Direct search available through included remote control

Tascam CD201

- Direct search available through optional remote control

Tascam CD301

- Direct search available through optional remote control

Denon DN-C680

- Optional ACD27CS synch card for LTC, video or word clock, includes RS422 VTR control, compatible with Sony protocol equivalent to BVW 75 ($550.00)
- Optional ACD25FSC digital converter option converts 44.1 kHz to either 48 kHz or 32 kHz ($250.00)
- Optional RC680 hard wired remote ($130.00)
- Direct search accomplished by turning select knob; pushing in on knob increments track ID number by 10, otherwise by 1

Tascam CD601

- Optional IF-601 interface card provides AES-EBU output (XLR connector prewired for SPDIF) ($225.00)
- Optional BU-2 RAM buffer for instantaneous starts ($350.00)
- Half rack form unit

Tascam CD701

- Optional BU-2 RAM buffer for instantaneous starts ($350.00)
- Half rack form unit

Sony DCP3100

- Optional DABK-3101 RAM buffer for instantaneous starts ($610.00)
- Optional DABK-3102 Interface Board provides sync from video or word sync ($1400.00)
- Optional CDS-3100 Remote Control provides direct access to specific tracks ($1875.00)
- Half rack form unit

MINI DISC NOTES

Sony MDSJE500

- Optional RK500 rack mount kit ($40.00)
- Automatically converts 48 kHz incoming sample rates to 44.1 kHz
- Direct access to cues is available through remote control
- Auto-cue is available through remote control

Tascam MD-301

- Optical and coaxial digital inputs, optical output only
- Incoming sample rate converter converts 32 kHz and 48 kHz to 44.1 kHz
- Direct access to individual cues available through included remote control

Denon DNM-2000R

- SPDIF coax digital input only
- Direct search accomplished by turning select knob; pushing in knob increments track ID number by 10, otherwise by 1
- Cues to music
- Five built-in hot start buttons
- Seamless looping

Tascam MD-501

- Optical and coaxial digital inputs, optical output only
- Incoming sample rate converter converts 32 kHz and 48 kHz to 44.1 kHz
- Front panel optical digital input
- PS-2 keyboard input on front panel

Denon DN-M1050R

- Optional ACD26HM provides 20 hot start buttons ($250.00)
- Optional ACD27MS synch card for LTC, video, or word clock includes RS422 VTR control, compatible with Sony protocol equivalent to BVW 75($550.00)
- Optional ACD25FSM digital converter converts 44.1 kHz to either 48 kHz or 32 kHz output ($250.00)
- Optional RC650 hard wired remote via included dB 25 cable ($135.00)
- Direct search accomplished by incrementing +/- 10 or +/- 1 buttons
- Automatically converts incoming 32 kHz and 48 kHz sample rates to 44.1

Denon DN-981F

- Optional ACD19A software for Windows 95, Windows 3.1 ($125.00)
- Optional RC650 hard wired remote via included dB 25 cable ($135.00)
- Player unit only
- Cart style unit designed so that three units can fit side by side into a single rack shelf
- Digital output conforms to IEC958 standard
- Includes 10 hot start buttons

Tascam MD-801

- Optional RAM buffer (BU-801) available ($249.00)

Denon DN-990R

- Optional ACD19 Software for Windows 95, Windows 3.1 ($125.00)
- Optional RC650 hard wired remote via included dB 25 cable ($135.00)
- Digital input will work with either AES/EBU or IEC958
- Digital output conforms to IEC958 standard
- Cart style unit designed so that three units can fit side by side into a single rack shelf

DAT NOTES

Panasonic SV4100

- Can sync to Video reference sync, 25 Hz (PAL), 29.97 Hz, 30 Hz (NTSC), Word sync, or Digital Audio Data sync (48 kHz, 44.1 kHz, or 32 kHz)
- 32 kHz recording only available from digital inputs

Fostex D-15

- (D-15TC) includes SMPTE, video and word clock synchronizatinon ($3,890.00)
- (D-15TCR) includes D-15TC features and RS-422 control ($4,085.00)
- 8 MB RAM allows instant start
- RAM scrub mode allows analog "reel rocking" simulation

Fostex D-25

- XLR digital inputs and outputs switchable between AES/EBU and S/PDIE; however S/PDIF does not include subcode information
- 9-pin connector included for interfacing with video editors and workstations
- Parallel port included for interfacing with synchronizers
- Four-head design for off-tape confidence monitoring
- RAM scrub mode allows analog "reel rocking" simulation
- 16 MB RAM allows instant start and preview
- XLR time code input and output, BNC VITC input, BNC word input/output

HARD DISK NOTES

Digicart II Plus @ 44.1 kHz

- D2720: 3.3 hours (linear recording); 16 hours (Dolby AC2); ($3995.00)
- D2730: 5 hours (linear recording); 24 hours (Dolby AC2); ($4395.00)
- Zip Disk: 9.4 minutes (linear recording); 46 minutes (Dolby AC2); (included in all models)
- Optional RC220 remote allows direct search ($745.00)
- S/PDIF outputs available on BNC connectors.
- Digicart II Plus allows users to choose between linear 32 kHz, 44.1 kHz, 48 kHz, and Dolby AC-2 compression (which provides approximately five times the storage capacity over linear 44.1 kHz recording)
- Cloning—including cut names and running times—to other 360 System products is available via 360 Systems proprietary D-NET file transfer network through the AES/EBU ports. The unit also has space for two internal hard drives, so data may be cloned and backed up internally.

360 Systems Instant Replay 2.0

- DR552-16: 3.3 hours (linear recording); 16 hours (Dolby AC2); ($2995.00)
- DR552-24: 5 hours (linear recording); 24 hours (Dolby AC2); ($3495.00)
- Instant Replay allows users to choose between linear 32 kHz, 44.1 kHz, 48 kHz, and Dolby AC-2 compression (which provides approximately five times the storage capacity over linear 44.1 kHz recording).
- Cloning—including cut names and running times—to other 360 System products is available via 360 Systems proprietary D-NET file transfer network through the AES/EBU ports.
- Instant Replay will convert any incoming sampling rate between 24 kHz and 56 kHz to 48 kHz
- Print output of cues is available via parallel output on 25-pin D connector; printer port works with Epson LQ mode type printers, or HP LaserJet printers, can print overlay for hot key buttons with cue numbers or names.

HARD DISK MULTI-TRACK NOTES

Akai DR 8

- DR8HD includes internal 2 GB hard drive ($2395.00)
- Optional IB807V "Superview" VGA output board allows visual editing and titling of cues ($699.00)
- Optional MT8 Mix interface ($799.00)
- Optional IB801S SCSI interface ($299.00)
- Optional IB802T SMPTE interface ($299.00)
- Optional IB803M MIDI interface ($379.00)
- Optional D1B-06 8 in/8 out ADAT interface ($249.00)
- Optional DBN-06EX adds 8 in/16 out to D1B-06 ($299.00)
- Optional IB805R RS422 interface ($299.00)
- Optional IB806B Biphase interface ($299.00)
- Optional IB-D8TIF TDIF digital I/O board ($245.00)
- Optional IB-D8MA 8 channel AES/EBU digital I/O ($495.00)
- Inputs and outputs are ¼" Tip/Ring/Sleeve (TRS) balanced, switchable between +4 and –10 dBu.
- Also records and plays back 44.056 sample rate

Emu Darwin

- Basic model (4001) with 2 G drive ($1995.00)
- 4010 four-input expander to allow 8 track simultaneous recording ($149.00)
- 4011 ADAT digital I/O card (8 channels digital input/output) ($119.00)
- 4012 ADAT 9 pin sync card allows connecting up to 16 Darwins together and synching to ADATs, BRCs, etc. ($299.00)
- 4013 SMPTE and word clock sync card ($349.00)
- 4014 32 bit floating point DSP card for fades, gain changes normalization, time compression/expansion, polyphonic pitch transposition ($399.00)
- 4020 JAZ drive option kit ($599.00)
- 4021 cable kit for second SCSI drive in front panel ($39.95)
- Basic model generates MIDI Time Code (MTC)
- Inputs and outputs are ¼" TRS and are switchable between +4 and –10 dBu
- S/PDIF and AES/EBU available through RCA connectors
- Cloning available through SCSI bus to QIC/Travan tape, SCSI DAT, Jaz, Zip, etc.
- Direct locate available through 10 autolocate buttons which can access locate points in each of four banks for a total of 40 autolocate points per version.
- Inputs and 24-bit internal digital mixer may be patched to any outputs through internal digital patch bay.
- Speed variable through external word clock control
- Disc formatting compatible with Windows 95

Fostex D-90

- RCA unbalanced I/O w/2.55 G internal hard drive ($2,595.00)
- (D-90B) D-sub 25 balanced 25 pin ($2,960.00)
- (D-90S) SCSI port ($2,960.00)
- (D-90BS) balanced I/O and SCSI port ($3,325.00)
- Optional COP-1 optical S/PDIF to coax S/PDIF converter ($96.00)
- Digital input and output switchable between S/PDIF and ADAT Lightpipe
- Cloning available through S/PDIF, ADAT and optional SCSI port for backup only
- Synchronization available through MIDI Time Code (MTC)
- Direct locate available for up to seven user defined locate points

Akai DR16

- Akai DR16HD includes internal 2 GB hard drive ($3395.00)
- Optional IB807V "Superview" VGA output board allows visual editing and titling of cues ($699.00)
- Optional MT8 Mix interface ($799.00)
- Optional IB801S SCSI interface ($299.00)
- Optional IB802T SMPTE interface ($299.00)
- Optional IB803M MIDI interface ($379.00)
- Optional D1B-06 8 in/8 out ADAT interface ($249.00)
- Optional DBN-06EX adds 8 in/16 out to D1B-06 ($299.00)
- Optional IB805R RS422 interface ($299.00)
- Optional IB806B Biphase Interface ($299.00)
- Optional IB-D8TIF TDIF digital I/O board ($245.00)
- Optional IB-D8MA 8 channel AES/EBU digital I/O ($495.00)
- Inputs and outputs are ¼" TRS and are switchable between +4 and –10 dBu
- Also records and plays back 44.056 Sample Rate

Fostex D-160

- RCA Unbalanced I/O ($3995.00)
- (D-160B) D-Sub 25 balanced 25 pin ($4540.00)
- (D-160TC) Synchronization with SMPTE, video, word clock ($4890.00)
- (D-160TCB) Balanced I/O and synchronization ($5435.00)
- Optional COP-1 optical S/PDIF to coax S/PDIF converter ($96.00)
- Digital input and output switchable between S/PDIF and ADAT Lightpipe
- Cloning available through S/PDIF, ADAT and included SCSI port for backup only
- 16 channel simultaneous record capability through optical inputs
- Direct locate available for up to seven user defined locate points
- Synchronization via MIDI Time Code (MTC)

ASYNCHRONOUS HARD DISK MULTI-TRACK NOTES

SFX System

- Basic version allows two cue lists, two effect lists and outputs two stereo outputs per cue list (a total of four), and a limit of two playing cue files at one time per playlist ($300.00)
- Standard version allows unlimited cue lists, unlimited effects list, and outputs to 4 stereo outputs per list (total of 8 outputs per list), and 4 Wave files playing per cue list; adds MIDI and internal CD support ($495.00)
- Pro Audio includes features of standard version and allows 16 channels of output per cue list, no limits to number of play-in files (limited to speed of computer, etc.), includes looping capabilities in each Wave file ($845.00)
- Show Control includes features of standard version, adds MIDI Show Control, MIDI Time Code and Media Control Effects (MCE) which allows manufacturers to communicate to AV devices such as laserdisks, VCRs, DVD players, etc. ($845.00)
- SFX Pro Audio/Show Control combines Pro Audio and Show Control Software ($1195.00)
- Since SFX is a software only product, many features that will be discussed in the Product Comparison Guide are dependent on the sound card's hardware and specific computer system used. (The Product Comparison Guide leaves these categories blank for purposes of simplicity.)
- System requires Pentium 133 MHz processor, 32 MB RAM, CD-ROM, mouse, display with at least 800X600 resolution, Win95 or Win NT, SCSI hard drive, a parallel port, and one or more sound cards that support direct X.
- Synchronous or asynchronous tracks directly triggered from external SCSI 2 hard drive; number of simultaneous tracks depends on computer/peripherals, etc., but is reported to be 6 to 9 tracks at once on a Pentium 133 with 32 Megs of RAM.
- Plug-ins for effects, etc. are included with various versions of SFX
- Supports both MIDI Time Code (MTC) and MIDI Show Control (MSC)
- Hardware analog and digital inputs and outputs, sample rates, quantization, etc., are determined by sound card used.
- Since SFX is designed only for theatrical playback, separate software must be purchased for recording, editing, etc.
- Note that SFX supports playback from removable JAZ drives.

Richmond AudioBox

- AB Control software for Macintosh ($1,800.00)
- Show Man-AB/1 software for Windows NT ($2,750.00)
- Show Man-AB/8 software for Windows NT ($4,600.00)
- Optional SMPTE synchronization available ($300.00)
- Synchronization available through MIDI Time Code (MTC)

LCS CD-88 Digital Mixer with LD-16S SCSI expander installed

- LCS CD-88 digital mixer ($17,500.00)
- Optional LD-16S Wildtracks sound playback ($2,900.00)
- 16 synchronous or asynchronous tracks directly triggered from external SCSI 2 hard drive.
- RAM start includes 31 RAM buffers which can be reallocated as needed.
- System synchronizes to MIDI Time Control (MTC)
- Supports hard disk mirroring, which allows a second hard disk to play back sounds in the event that the primary disk fails.
- Sampling rate is 48 kHz, analog audio is sampled at 20 bits and stored as 32 bit floating point quantization.
- Cue Station software uses BeOS which runs on Power Macs and Pentium Processors.