Creative Recording Techniques in Music Education:

Performance Artistry with MIDI Sequencing

and/or Digital Audio Recording Technology

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By now, many music educators are realizing that of all the computer music technology applications, performance-oriented applications are probably the most popular. There's immediate gratification with music notation applications from viewing, hearing and printing the music. While in the commercial realm, MIDI sequencing and digital audio recording are king, they are lagging in the education world. Why is this so? It is easier to show paper evidence of achievement to a parent or administrator. This tangible "hardcopy" is easier to comprehend than a recording handed to someone on a disk. It also takes a concerted effort to come up with quality recordings worthy of sharing with others.

To be honest, sequencing and digital recording techniques do take a little more effort, but there are definite advantages. You can make your school CD's without middle man cost and heighten student interest and support when you use computer technology like this. And to top it off, your digital recordings can be posted on the school web site. What a great way to promote your school music program.

Sequencing is the process where digital representations of notes, dynamics, rhythms, etc. are stored digitally. The Internet has also become an important medium to promoting school music programs with the use of both audio and video streaming capabilities. Please check out the

SBO articles by me on MP3 (October, 2000) and video streaming (December, 2000) for further insight at: <http://www.sbomagazine.com/technology/technology_frame.htm>.

Where to Begin First: MIDI Sequencing!

Today, MIDI (Musical Instrument Digital Interface) is almost synonymous with personal computers. When we speak of MIDI, computers, other computer-related applications immediately come to mind like software, sequencers, and audio. MIDI has expanded computer music technology into digital audio recording and sequencing applications that record MIDI data from MIDI capable instruments.

MIDI sequencers allow more control of the musical material than CD recordings. Using an audio file, you can make small adjustments in tempo, tuning, and transposition. Teachers can use MIDI sequencers to record their own rehearsal files especially for their students and play back song files to "fill in" missing parts in rehearsal. Students can rehearse with accompaniments generated by a sequencer. For the best 25 "how to" tips on MIDI sequencing in class and rehearsal, read Dr. Thomas E. Rudolph's on-line article at: <http://www.lentine.com/articles/25_walys.htm>. And for more ideas, view his video entitled: *The MIDI Sequencer in the Music Classroom* published by GIA Publications <http://www.giamusic.com/cgi-bin/cart/SoftCart.exe/scstore/P-midiclassroom.html?E+scstore>.

Sequencing has been around for a long time. Multi-track tape recording is a form of sequencing. Where we use to cut and splice. today's digital sequencer whips past this disruptive process.

Sequencers are at the heart of MIDI recording. Sequencing software can change or to edit almost any aspect of the performance information. Long before MIDI was created in 1983,

sequencers that could record about eight seconds of material were built into analog synthesizers manufactured by Moog, ARP, Roland and Buchla. The original sequencer could control eight to sixteen events (notes) at a time and was primarily used for ostinatos. With the advent of microprocessor-controlled digital instruments in the 1980's and the growth of the computer, sequencers could record thousands of events.

Today, there are three types of sequencers available for composing/arranging music. Each of the three types has advantages and disadvantages: 1) software sequencer, 2) dedicated hardware and 3) integrated sequencers.

The software sequencer format is the least expensive way to go if you already own a computer, a MIDI, Serial or USB keyboard and a MIDI interface. The advent of Serial, USB and Firewire port connections to your computer can speed MIDI transfer between a keyboard and a computer. Many keyboards come with Serial and USB connections but there are far more in use that support only MIDI connections. Most sequencing software products will print musical scores from your recordings. Others will also allow you to digitally record vocals and acoustic instruments with your MIDI data. If speed, power and capacity are necessary requirements, software sequencers are far and away the most economical long-term investment.

Dedicated hardware sequencers offer portability and price when compared to the price of a computer, MIDI interface, and software. If the hardware sequencer doesn't contain an internal sound generator, you will have to purchase and carry a MIDI keyboard or an expander module. Disadvantages of hardware sequencers is the small screen size when compared to a typical computer monitor, storage capacity, editing restrictions and expandability.

Integrated sequencers are sequencers built into electronic music instruments such as synthesizers, digital pianos, and drum machines. A main advantage over hardware sequencers and software sequencers is in their portability. Everything you need to record, play back, and play along with your music is in one piece. In the past, these sequencers had limited capabilities and were very expensive. This is no longer the case. Integrated sequencers can now do things that software and computers don't do. For example on the Clavinova, you can insert and edit META events, edit to a resolution of better than 1900 PPQ, (pulses per quarter note) and do the same editing as the software sequencers. META events are those special command codes that actually allow the person to control the hardware as if you were playing it. They allow you to "press" controls as the sequence is going. They give you the control of the inner workings of the device to a degree that SYS-EX just doesn't do. They are extremely useful.

When you factor in the computer system, the larger hard drive that is needed, and the "time" that the computer takes, you may find that a dedicated sequencer is faster and easier to get your music down. I have tested a computer sequencers vs a hardware sequencers and have found the computer just takes longer to do a task. It's difficult to do two things at once with a single cursor. For example, if you are editing a file and changing volumes in the mix, it's very difficult to control more than one slider at a time. With a hardware sequencer, I can work more than one slider at a time and do everything by knobs. Interesting item to note, computer sequencers have plug-ins to work with the mixers that are on the market due to this issue. *Cakewalk*, *Digital Performer*, 0and others have plug-ins for the Yamaha Pro-Mix 01 for example.

As for pricing, integrated sequencers are now very attractive and in some cases extremely portable and easy to use. For example, Yamaha has a 24 track sequencer with drum machine, accompaniment generator, XG, voice editing, mixer, and more for $695.00 retail. It's about the size of a VCR tape so it's part of the new "PDA's" for music. Go to http://www.yamaha.com and look up the QY100. This things a gas to use on a plane as it's battery operated. While there, check out the QY700, a 48 track sequencer with all the trimmings at $1495.00 retail.

Analog and Digital Recording Basics

In analog recording, instruments or voices are captured by a microphone or electrical device that functions as a transducer. Sound waves are converted into electric voltage which can be stored on a tape recorder. In digital recording, the instruments or voices are also captured by a microphone or similar transducer. But this time, the voltages are fed into an analog-to-digital (A/D) converter which converts the voltages directly into digital data which can be recognized and processed by a computer or digital recording device for playback and/or editing.

Let's look at a few comparisons. Most digital recording devices record at 16-bit resolution. This resolution provides a signal to noise (S/N) ratio of more than 90 dB, which is far beyond most tape recorders. Higher S/N Ratio equals less noise. Most tape recorders have a good signal to noise ratio but the type and specifications of the tape can negate even the best equipment.

Tape recorders make it necessary to rewind and to fast forward to find specific parts of a composition. Most digital recording software and hardware use random access that allows you to cue to any location in recorded material instantly. Material recorded digitally can be edited and extended with great accuracy and ease.

Non-destructive editing, without actually modifying the original data, is possible digitally because you can recall the original audio data at any time. Time compression/expansion is also available on most digital recording devices. Compression/expansion allows you to slow down or speed up the tempo without changing the original pitch. If you speed up a tape recorder the pitch rises and vice versa. Digital signal processors can also add extra musical effects (called ambient effects) such as reverberation and echo, equalization, and other special effects to enhance or modify the original recorded sound.

Digital recording with MIDI allows a vast amount of editing capability, and you can you cam manipulate the original performance in ways not possible with any other type of recording. Here are some basic editing techniques available in most MIDI sequencers.

Snip -- Snip a section out and automatically adjust the ends so they meet smoothly,

Copy/paste,

Layering -- copy the same material to different tracks and instruments so the same material can start on a different beat,

Quantizing -- clean up the recorded midi signals and align them with a grid that represents a minimum allowable duration,

Transposing.

Which is better, MIDI sequencing or audio recording? It is impossible to say because they are both really different applications.

1. Digital Audio recording captures the actual sound of a live instrument. You can record any instrument including vocals.

2. MIDI only records the mechanics of performance. MIDI requires a MIDI controller and a synthesizer module to playback the performance.

Just as a photographer can save time land improve a shot by airbrushing so also can MIDI editing be very creative and useful to arrangers and composers. You can easily fix those bad takes, change faulty pitches instead of do the recording over again, and change key or mode with simple editing.

.WAV audio files which are currently the most common audio file format can be quite large while MIDI data files are extremely small. It is easy to send attached MIDI files over the Internet because they are so small but large .WAV files must be converted to MP3 or written onto a CD and sent via mail. It is better to convert .WAV files to MP3 because they can be compressed 10 to 20 times smaller than the original .WAV files and retain much of the original audio quality.

Here is an example of file size differences between audio and MIDI files. The entire Tchaikovsky Piano Concerto can fit on one 3.5" high density double sided floppy disk (1.4MB) in MIDI file format. Audio files, for the same orchestra work can take up to10 MB of data per minute of playback time. That's why you can only get up to 74 minutes worth of music on a CD at CD quality. And then there is DVD which takes a whole lot storage space for video files. Sometimes it is easier to think 3.5 disks for MIDI, CD's for audio recordings, and DVD's for video recordings.

Common MIDI Sequencing Features

The following is a list of features found on most MIDI sequencers whether they are software or hardware based. Check any product you are going to purchase against this list and

see how well it stacks up. You may see a very low price for a MIDI sequencer but find out that the amount of data it can handle is limited, requires extra hardware to work, has limited track or editing capability or is just too slow. Also, make sure that the sequencer you buy has product support available. There may be news groups or user's groups managed by the company where you can ask a variety of questions. This list is not exhaustive but gives a general overview of many sequencers.

1. Installs easily or operates easily. If you need to read a 300 page manual before you start, avoid it like the plague.

2. Somewhat intuitive. The screen is laid out in a way that makes sense. Functions are clearly labeled or descriptive ICONs leave little doubt as to function. For example, a metronome

ICON pretty well says: "Tempo"

1. Help files that actually help you.

As you are playing a file, you should easily be able to:

1. Adjust tempo during performance
2. Adjust tempo and dynamics while a piece is playing
3. Re-orchestrate or move tracks, change instruments or add instrument sounds
4. Link and play song files continuously, one after the other
5. Define rehearsal points and set playback settings so the same section will repeat the number of times you specify for practice
6. Adjust tuning of performance to match other acoustic instruments (piano, organ, etc).

7. Adjust your playback using SMPTE time code so that performances can be “locked” to video for media projects

For recording, you should have the ability to:

1. Mix tracks to combine various tracks of the same instrument or voice to one track.

2. Record all events including System Exclusive and Meta events. Sys-Ex and Meta events are crucial to achieving a professional sound from a MIDI file recording as these codes allow for unparalleled control of a MIDI file

3. Edit tracks using a text based event list editor. Notation and piano roll editing are not as precise as a text based editor and precision in editing is necessary to get the best recording possible

2. Must save as a Standard MIDI file so that a song can be exported to other sequencers

3. Step entry mode so that those with limited keyboard skills can input music note by note

There are some other recording features that may be part of the sequencer. These are not crucial because you can duplicate them using features of the sequencer. However, they may make your job a good deal easier.

1. Sound to MIDI entry so a student could play or sing into a microphone and have the sequencer convert the audio to MIDI notes. This allows more access to recording for those with limited keyboard skills.

2. Auto Accompaniment program to create accompaniments quickly for exercises and rehearsals.

3. Voice editor so you one can “customize” voices to be more realistic to their ears

Three Types of Digital Recording Systems

The most common consumer and professional portable digital tape recorder format is known as DAT (Digital Audio Tape). It is priced in the $600 - $1,900 range and comes in many different sizes even as small as a cell phone. DATs are amazingly powerful for portable recordings with a stereo microphone. You can then transfer the output to your computer and edit the sound file or to create a CD in your home/school recording studio.

Hard disk recorders can be classified as either modular hard-disk recorders or digital audio workstations. The former is a dedicated machine that records digital audio. It is self-contained with either a built-in hard disk or a small removable disk. Some of the larger models contain a built-in mixer and optional effects processors. They are very portable and use cassette deck-type controls for recording and playback.

Digital audio workstations consist of a PC or Macintosh computer, a software package and hardware interface to get audio into and out of the computer. Digital audio workstations give you tremendous flexibility when editing digital audio. The large computer display makes editing a manageable task.. Optical digital recorders consist of MiniDisc records using a 2.5 inch optical disc for doing digital audio. They use Sony's ATRAC (Adaptive Transform Acoustic Coding) data compression in order to maximize the storage capacity of the disc. The sound quality is good but not equal to the sound quality generated by compact discs. I use this format to make audition CD's for college auditions since it is so inexpensive, flexible to use and easy to duplicate. Major manufacturers are Sony and Sharp. For under $300, you can have a quality MiniDisk player/recorder with a quality external stereo microphone. You can purchase the mini CD's inexpensively as well. Note: the CD-R format is not used to record live audio, but to create a compact disc. Someday, the DVD-R (Recordable Digital Video Disc) technology

will be available with more recording enhancements. Presently, there are several DVD formats available: DVD-RAM, DVD+RW, DVD-Audio.

Yes, there are many choices in digital audio recording. For making digital recordings of your performance groups to eventually burn CD's, I recommend DAT or MiniDisk recorders on location but you can also use a digital recorder. To create multi-track recordings, I recommend any of the multi-track sequencing products mentioned in this article. To copy and edit old analog tape recordings, I recommend you use a multi-track digital audio product..

Where to Start Recording?

Probably the most economical and logical place to start is with MIDI sequencing software on a computer. Chances are your school has a computer that can offer you and your students the opportunity to get involved with digital recording. Using a MIDI sequencer, you have two ways to view the music or performance data: Numerically and graphically. Sequencing programs can also produce notation. However, these programs allow minimal notation control when compared to dedicated notation programs.

Using numerical or event editing, your can edit 480 ticks per beat. Ever hear of a 480th note? This partitioning of the beat allows for very fine timing details of the note's pitch, its velocity value, and duration. With a resolution of 480 ticks, you can have a note sound at any one of the 480 ticks. A quarter note would occur on tick 000 and end on tick 480. Two 8th notes would occur on 000 and end on 240 with the second beginning on 240 and ending on 480. Dividing further, 16th notes would begin on 000, 120, 240, and 360. The division of a beat into 480 ticks gives you a lot of control. If you know that 16th notes occur at 000, 120, 240, 360 and you want to humanize, or create slight imperfections in each note duration, you can add 1 or 2 to each value. For example, 120 may become 121 and 360 may become 363.

In the graphic view, the data is presented in a kind of "piano-roll" format where pitch is shown on the vertical axis from low to high and time is shown on the horizontal axis, divided into measures, beats, and fractions. You can grab any element with your mouse and move it around in the grid.

The notation view allows you to check the pitch and duration of your music in standard music notation. Most sequencers do not provide a whole palette of tools for creating professional music notation output, but provide this view simply for editing pitches in a familiar format.

It is easy to move between sequencers and music notation packages using the Standard MIDI File format. Today's sequencers have the ability to record audio directly into a track and then you can add MIDI data to other tracks. This allows you to combine the best of both acoustic and electronic worlds letting you combine MIDI and audio data in the same file. Many sequencers also provide on-screen mixing consoles and allow you to use digital signal processing in real-time. Now you have complete control over both MIDI synthesizers and digitally recorded audio tracks for mixing, panning, equalizing and processing sounds all in a convenient graphic environment.

Once you have created a number of sound files and stored them to disk, you can proceed to create a file to master an audio CD. You can even go further with your original sequenced composition with some seamless software packages of digital audio and video that can be incorporated with the MIDI sequencing environment. The web has become a great place to post files for mass viewing by the public. Editing sound files has become a by-word for sequencing. Multimedia is the combination of music, sound, graphics, text and video into an interactive environment. This field offers many opportunities for musicians to use the computer for adding music to these interactive projects.

Digital Audio for Professional Sounding Recordings

The capabilities of digital audio recording with 16/24 bit/44.1 - 48kHz operations that generate compact disc quality recordings go far beyond analog recording. It requires a massive amounts of memory to do digital audio, and the higher resolution, 96 kHz and up uses a lot of hard disk space.

Creating CD's via digital audio recording has their own CDE player and uses it everyday anyway. Almost every student owns a computer and every computer can play CDs and WAV/MP3 files.

Digital audio recording software can record over 72 audio channels simultaneously which allows a sophisticated recording for a large ensemble such as an orchestra, concert band or jazz ensemble. The more audio channels available, the more individual instruments can be recorded. For example, a woodwind quartet could be recorded with each instrument on a separate channel. This allows the recording engineer to re-mix the end product with the ability to control each instrument's wave (WAV) data independently. Balancing, panning, fading, and all other performance parameters can be done on individual instruments rather than on the ensemble. However, you can set filters so that an individual action can effect any number of instruments.

In addition, applying a number of processing special sound effects you can actually make the finished recording sound superior to the originally recording. These are especially useful when a performance is recorded "live" and the acoustics of a facility are sub par. With built-in or added digital audio effects, you can enhance the sound for a more professional end product.

Wave (WAV) files are directly accessible for CD burning which makes it possible for you to produce school ensemble recordings at a fraction of what it would cost to produce a

compact disc recording using a commercial studio. As mention earlier, rehearsal CD's and archives of student achievement are a valuable function of digital audio and MIDI recordings. It may be desirable to have a CD duplicator so that concerts can be recorded then distributed to students or their parents.

Digital audio uses a multi-track piano roll view which allows one to edit and mix the recording into a finished product. This view gives a global representation of what note and how long it was held. I say global in that it is not as specific as an event list where not only do you get the exact numbers of what note and how long it was played, in the event list editor, you also get the volume of the note.

DirectX8

What is DirectX8? Microsoft DirectX® is an advanced suite of multimedia application programming interfaces (APIs) built into Microsoft Windows® operating systems. DirectX provides a standard development platform for Windows-based PCs by enabling software developers to access specialized hardware features without having to write hardware-specific code. This technology was first introduced in 1995 and is a recognized standard for multimedia application development on the Windows platform.

Support for DirectX 8 automatable plug-ins which can further enhance the original recording. As Direct X becomes more available in devices other than computer systems, it may become a way to move data effectively. At this point, it still has a ways to go to beat the use of standard MIDI files and CD audio recording. For the average band /orchestra /string teacher, there just aren't a lot of advantages of this over the other formats available today. But after exploring their web site at http://www.microsoft.com/windows/directx/default.asp, there is a

tremendous library of sounds that can be augmented into your MIDI Sequencing and Digital Audio recordings that go far beyond General MIDI capabilities in music software applications.

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Part II: The Sequencing Market

MIDI sequencing and digital audio music technology applications was the subject of part I of this article in Sept. 2002 issue. These software applications can be a very creative tool for the music educator. You'll probably want to jump right in and purchase what looks good for your needs. But before you do this may I suggest that you try downloading some demo software versions of the products you're interested in or try them on consignment from your local music technology dealer. Also, try some dedicated or integrated hardware so that you can get a better idea of how they work. If you need a reference book to get you going faster, try *Sequencing Basics* or *The Art of Sequencing* both by Don Muro, published by Warner Bros. The first book even has a companion video that thoroughly explains the contents. Once you discover that sequencing can play a role in your curriculum, the following information will guide you to recommended software and dedicated hardware and integrated hardware. The products can be very powerful and will be priced variously from free shareware to professional levels..

Software Recommendations

If you already have a computer, then software is a logical place to begin. There are many sequencing software products today that offer both MIDI and digital audio recording capabilities. Sequencing recording software packages have become very sophisticated. If you went out and evaluated just the mixing/editing hardware equivalents of these software products, you'd be amazed at how much money in hardware equipment (mixers, editors, etc.) can be replicated with software modules at a fraction of the cost. And in some cases, you can also update the software at a more modest cost compared to purchasing and upgrading all new hardware.

Entry Level:

Lower-priced, entry-level software sequencers run between $40 to $80 like Cakewalk *Home Studio 2002* (http://www.cakewalk.com) or Cubase's *AV* (http://www.steinberg.net/) will let you do much of what their grown-up cousins can do, but as you'd expect, draw the line at more exotic functions. Cakewalk's *Home Studio 2002* is Cakewalk's entry level version which offers everything you need to turn your PC into a powerful multitrack studio. Its intuitive tools make it easy to quickly edit, arrange, and mix quality recordings of music.

Looking for a particularly good buy for an entry-level software sequencers at the lowest possible price? *PowerTracks Pro Audio* by PG Music (http://www.pgmusic.com/powertracks.htm) is now in version 8.0 and is a pretty powerful, seamlessly integrated digital audio/MIDI recording sequencing program with built in music notation for the PC platform at a list price of only $49.95. It harnesses the power of the popular DirectX audio plugin format with DirectX support, 48K sample rate support, improved resolution in the audio edit window and a new CD-R burning feature that easily edits and overdubs of any audio track. Its mixer has a new master volume control that allows you to

change overall levels without affecting individual tracks, keeping your mix intact. I like the tutorials built into the manual making it a winner for the novice and entry-level sequencing person. I use this software in my entry-level sequencing clinics because of these user-friendly tutorials.

Unfortunately for the MAC platform, there are no sequencing products that I can recommend for entry-level sequencing priced under $150.00 except for a free shareware program, *MIDIGraphy* that can be found at <http:/./www.harmony-central.com>. This is a full functioning shareware program. I believe the author asks $25 for the program. When you download it, everything works. It's a sequencer that probably has one of the best event list editors you will find. The piano roll view allows for multiple track display in different colors so that you can work on multiple tracks simultaneously. While it has no notation or audio recording, it's one heck of a MIDI sequencer.

For PC's, *Anvil Studio* at www.anvilstudio.com has a freeware sequencer, and if you are going to be doing MIDI recording it's a great way to start. Since it's a free download, students have easy access to a nifty sequencer. Also, for a small price, Anvil has plug-ins available for a nominal fee that expand it's basic structure to include notation printing, audio recording, and others. The budget minded person should check it out.

Looking for another powerful, multifunctional sequencing software for less than $100? Consider Yamaha's *XG Works* for the PC platform which is a suite of program modules that work together. This one program has a sequencer, a TWE audio editor, a XG Voice editor, a Voice to MIDI converter, notation, an auto arranger, a chord entry program with styles, and a lot more. The TWE Audio even allows wave forms to be broken down for analysis and editing. This program also converts a monophonic audio track source like a woodwind, brass, or string

instrument to MIDI data, a valuable addition to this package. It lets instrumentalists record a melodic idea into the program and then see it in notation or use it for the next step in song creation. After converting a melodic line into MIDI (or just recording a melody with a MIDI keyboard or step entry), *XG Works* has a program called Auto Arranger that will take that melodic line and based on your choices of musical style, create an entire backup band to go with the melody. This Auto Arrange function chooses the chord progression, gives alternatives, adds intros and endings, and uses the choices the user makes to create a full arrangement. This is an excellent tool for not only encouraging composition by students, but it also spurs discussion as to why the computer makes its choices. This is great for analysis.

Another part of this package is the XG Editor. This editor allows the user to edit any part of the sound. As mentioned in the section on XG, you can could change the timbre of the voice to get subtleties in the sound that recreate the acoustic instrument on playback. Having a graphic editor within the program structure means easier access. The event list editor in this program is outstanding. It will show all data in the order it was recorded. Unlike other programs that do not list Meta events and reorder sys-ex commands, XG Works shows it all and leaves it the way you intended. Built-in notation and karaoke lyric editor features editing in standard music, printing of basic music sheets and adding lyrics to a song file. The lyrics feature can also be used for placing directions into a file for the performer.

Another excellent entry level sequencer that I still use in my primer-level MIDI sequencing clinics is: *Master Tracks Pro* formerly by Passport Designs and G-Vox. It is a very good intuitive, perfect for entry level MIDI sequencing applications for both Mac and PC Windows platforms. Note: you can still sometimes purchase this product on E-Bay for much less than its former retail price of $75.00. There nothing under $150 except for *MIDIGraphy*

With *MasterTracks Pro*, you can record, edit, and play musical compositions on your computer with exceptional ease and accuracy. You can play back up to 64 tracks of music with independent track looping. The program's wealth of powerful features, combined with its easy-to-use interface, helps to make it a great choice for entry level students and educators.

Music Master by Datasonics is an unusual sequencing/notation software application manufactured in Australia where it is in over 1,000 schools. The American distributor is Electronic Courseware Systems, <http://www.ecsmedia.com/>. This product is published in three versions: *Professional*, *Performa* and *Publisher* at: <http://www.datasonics.com.au>. The best source of information for your perusal is their website. The information on Mastering Music is <http://www.datasonics.com.au/mmlessons.html>. This gives an explanation of the products in the Mastering Music range, and also shows some screen shots that show how it looks and works. The prices for these products in US dollars can be obtained from <http://www.datasonics.com.au/distrib.html> clicking on the US flag.

Music Master has a number of unique features that set it apart from all other sequencers in the market. The MIDI sequencing is tightly coupled to the notation, making it a very convenient tool for music educators. It also plays all the structure markings such as repeats, codas, fines, dynamic markings, crescendos and diminuendos, note accents, ornaments (trills, mordents, turns, etc.), tempo changes, pauses, ritards and accelerations
just to name a few! It also has complete auto chord analysis including full jazz embellishments, and automatic instrument transposition for transposing instruments. You must see their website to more fully understand this creative sequencer/notation software application.

Specifications for the use of Music Master are shown on their website. Needless to say, *Professional* and *Performa* need more power than *Publisher* because they do audio as well. All

the MIDI functions work quite well on Pentium 266Mhz with 32Mb RAM on a test computer in my studio running Windows 95, but the audio functions "struggle." So a Pentium II 300 MHz CPU or higher is recommended.

Intermediate/Professional Levels:

There are professional level programs between $200 and $500 like *Sonar* by Cakewalk, Steinberg's *Cubase VST*, *Digital Performer* by Motu and *Logic Audio Platinum* by E-magic. These have just about every bell and whistle you can imagine including unlimited number of tracks, effects processing, automated mix-downs and the ability to interface with many popular hardware devices.

Cakewalk makes two excellent sequencers for the PC platform: *Sonar* (advanced level) and *Home Studio* (entry-level). The *Sonar* digital multitrack recording system is a new generation of professional audio technology from Cakewalk, a leading developer of music and sound software for the Windows platform. *Sonar* is often the musician's choice for recording, editing, mixing, and delivering music and sound projects for CDs, film and video scores, the Internet, or any multimedia project. What I like about it, is that you can do all of your audio and MIDI recording, editing, arranging, mixing and delivery, audio loop construction, editing, and integrated DXi soft synths in just one place via its streamlined Track view which is the heart of the program. It can also convert a MIDI file into a digital audio file so you can create practice CD's for your students which can streamline your instruction more than you can imagine. See the sidebar for step-by-step instructions.

Steinberg's *Cubase VST/32* (http://www.steinberg.net/) is the complete professional music recording system for extremely high resolution MIDI recording as well as audio recording

in 16, 24 or 32 bit studio quality. With its VST interface, *Cubase VST/32* offers the world's most comprehensive, seamless integration of real-time audio effects. Because it also incorporates the latest low-latency ASIO soundcards, *Cubase VST* is the ideal environment for using sample accurate VST instruments and virtual effect processors. The new 5.1 version distinguishes itself through optimized program codes for AMD Athlon, Pentium III, IV and AltiVec as well as a large range of integrated VST instruments and virtual effect processors. *Cubase VST* is a not just an audio recorder, it is a complete audio studio with the first 32 bit audio recording capacity. The audio channels are connected to the outputs of a virtual multi-track recorder. Each of the channels has a level fader, a pan control, solo and mute switches, effects, equalization controls and 5-stage dynamics section. Featured highlights include: integrated synthesizers with advanced analog modeling, studio quality virtual effect processors, superior MIDI timing with Steinberg's Midex and LTB, interactive real-time graphic editing, and real mixing desk feel with the VST Mixer and Score printing.

Digital Performer by Moto is an integrated digital audio and MIDI sequencing production system. It provides a comprehensive environment for editing, arranging, mixing, processing and mastering multitrack audio projects for a wide variety of applications. It allows you to simultaneously record and playback multiple tracks of digital audio and midi data in a totally integrated, creative environment. Unlimited audio and midi tracks lets you record as many tracks as your hardware will allow. You can view your MIDI and audio tracks in a single, unified mixer with up to twenty effects inserted per audio channel and 32 stereo busses. *Digital Performer* includes dozens of real-time DSP effects with easy to use graphic controls and complete automation.

Logic Audio Platinum is E-magic's flagship sequencer/digital audio software that supports 24 bit recording and up to 192kHz sample rate. *Logic Audio Platinum,* http://www.emagic.de, has just about every bell and whistle you can imagine, including an unlimited number of MIDI tracks, up to 128 audio tracks, effects processing, automated mix-downs and the ability to interface with multiple popular hardware devices. Note: E-magic has just been purchased by Apple and will be producing exclusively for the Macintosh platform. Starting from September 30th, E-magic will discontinue its development for the Windows platform, but will continue to service and support all Logic Windows owners according to the standard product warranty policies beyond this date.

Dedicated Sequencing Hardware Considerations

Sequencing has had a back and forth evolution. Most professionals began a decade ago using hardware sequencers and then went to computer sequencers when the CPU's, RAM and hard disk drives became faster and more powerful. Now more and more professional people are going back to using dedicated and integrated hardware. When you factor in the computer system, the larger hard drive that is needed, and the "time" that the computer takes, you may find that a dedicated sequencer is faster and easier to get your music down. I have tested computer sequencers and hardware sequencers and have found the computer takes longer to do a task. It's difficult to do two things at once with a single cursor. For example, if you are editing a file and changing volumes in the mix, it's very difficult to control more than one slider at a time. With a hardware sequencer, I can work more than one slider at a time and do everything by knobs. Interestingly, some computer sequencers have plugins to work with the mixers that address this issue. Cakewalk, Digital Performer, and others have plugins for the Yamaha Pro-Mix 01 for example. In tests done where a person was to record a line, edit, and playback a

sequence, the hardware sequencer won out in time saved. Just think what must be done on a computer to record just one track.

* Look at the screen
* Find the cursor
* Grab the mouse
* Move the cursor to File
* Select New
* Select the track
* Select the channel
* Select the voice
* Click on the record box for the track to activate it
* Click on the REC button
* Record your track
* Click on stop

With many many hardware sequencers, you just…

* Select the sound
* Press Record
* Select the track
* Play
* Hit stop.

As for price, dedicated hardware can be attractive. For example, Yamaha has a 24 track sequencer with drum machine, accompaniment generator, XG, voice editing, mixer, and more for $695.00 retail. It's about the size of a VCR cassette so it's part of the new "PDA's" for music.

Go to http://www.yamaha.com and look up the QY100. This thing is great to use on a plane as it's battery operated. While there, check out the QY700, a 48 track sequencer with all the trimmings that retails at $1,495.00. Want to do audio? The AW2816 is a 28 input pro workstation with hard drive and CDRW. The advantage of this box is that it works just like a mixing console. It is also a lot easier to move from site to site for recording and list is at $2,399.00 By the time you add all the inputs to the computer, and get the programs to work together you could be done with a project using this. If you want 44 inputs, the AW4416 retails at $3,799.00.

Roland's digital studio, BR-532, is an ultra-affordable, simple 4-track digital recording studio with 32 virtual tracks. It has an onboard rhythm guide with realistic drum sounds and patterns plus easy "Boss-style" operation. Just plug in and record with guitar, microphone (XLR and 1/4") and stereo line inputs. And it is battery powered with built-in mic for recording any time, any place.

My favorite Roland entry/intermediate level digital studio piece of recording equipment is their BR-1180CD which is a digital recording studio The BR-1180 Digital Recording Studio takes BOSS' "manual shmanual" concept to the next level. This powerful digital studio gives you eight playback tracks, a stereo Master Track and 80 Virtual Tracks for recording. There's also a 20GB hard drive and an available internal CD-RW drive to burn your music to a CD. And with slick BOSS effects and a separate Rhythm Track with sampled drum sounds, there's not much you can't do. It is simple to use and for the $1,200+ list price represents a lot of recording technology for your school musicians.

Superscope Technologies is a company that has focused attention on dedicated hardware for making remote “live” digital audio recordings easier and more affordable. They have two particularly exciting technologies: the portable direct-to-CD recorder and the portable solid state recorder. The Marantz CDR300, from Superscope, is the first truly stand-alone system for recording directly to blank CD-R (write-once) and CD-RW (rewritable) discs. It includes a built-in microphone as well as stereo XLR and 1/4" mic inputs. It can set record levels automatically and filter out unwanted background noises. The dual-well Superscope PSD300 version includes a CD recorder drive and a CD player drive that includes the powerful performing arts controls of the PSD230 portable CD player from Superscope. It's ideal for changing the tempo or key of any CD, playing along, and recording the mix of the manipulated CD with live accompaniment direct to CD. Afterwards, you can turn around and duplicate audio CDs on the machine at 2X speed. No questions about it, this dedicated CD Recording System is the hottest portable digital recording hardware on the market for recording your music groups and students directly on a CD and then posting it to the Internet via MP3 file conversion. If you are not really into technology but want to start recording your music groups with minimum errors, try this piece of hardware and in a short time, you will have amassed a wealth of digital recordings for processing a CD of your music program and still have these recordings available for Internet posting. The downside is that you can’t edit the audio files created by the PSD 300 but you can record your school music groups in the easiest user-friendly manner that can be later edited in a digital audio recording software application.

Marantz Professional's solid state recorders, the PMD680 (mono) and PMD690 (stereo), record to PC cards, compact flash, or IBM Micro Drives. Recordings can be easily transferred to

computers for immediate editing, mixing and post production without having to wait for a real-time audio download. Just insert the card into your notebook computer's PCMCIA slot or desktop computer PC card reader peripheral, and drag the file to your hard drive. From there, you can playback the file using standard audio software, edit it using common editing programs, burn it to CD, or post stream audio on a website. The PMD680 and PMD690 record audio as uncompressed WAV files or MP3 files utilizing various compression settings to fit more minutes of recording on smaller capacity cards. You can record many hours without changing media. The option to use either XLR or 1/4 inch microphones provides high quality digital audio recordings. These versatile pieces of equipment are highly portable, and also very practical for use in a home or school music studio.

Integrated Sequencers

Integrated sequencers are built into electronic musical instruments such as synthesizers, digital pianos and drum machines. Many of today's electronic instruments contain powerful integrated sequencers. The Korg Trinity is a digital keyboard containing a powerful integrated sequencer which can store up to 800,000 notes. Other popular instruments with integrated sequencers are manufactured by Ensoniq, Kuzweil, Roland and Yamaha. A very best buy for the money for school and home use is the Yamaha PSR–550 keyboard which has a street of under $500. It comes ;with a 3.5" floppy disk drive that can both save and read Standard MIDI file format which makes this integrated sequencer completely compatible with all other MIDI sequencers. This model also boasts some very effective digital effects that can enhance your performances with reverb (rich, spacial ambiance of various performance halls), chorus (enriches the voices by making them sound warmer and thicker), DSP (such distortion or tremolo) and Harmony/Echo (alters your right-hand melodies with a variety of special effects). An integrated

sequencer's main advantage over hardware sequencers and software sequencers is portability. Everything you need to record, play back and play along with your music is in one piece.

It also has the best sounds in the industry for the price with Yamaha XG sounds with 215 panel voices, 12 drum kits and 480 XG sounds plus 106 musical styles with rhythm and accompaniment patterns. Important note: XG is not an extension of Roland sounds. XG is a standard that was proposed based on the industry standard General MIDI sound set. It's interesting to look at the "standards". You will find that both General MIDI and GS read more like guidelines whereas XG really defines every single part of the standard in great detail. This is one reason why so many developers are jumping on XG. Today, Direct X programmers, Sony (there's a XG chip in the Playstation), and many computer manufacturers are installing it on their systems even though Microsoft and Apple have licensed the GS set.

Recent developments point to XG as being a very big deal as many manufacturers including Korg, Roland, and others are installing XG sound chips in their products. The new Roland I series of digital pianos has "XG Lite" which is a version that contains the voice map of XG but without the effects processor support of full XG. Korg is using fully implemented XG chips. It looks like XG is really catching on so it should be a consideration when looking at voice devices.

If you want an all-in-one instrument with all the stuff, you really need to look at the "MOTIF" by Yamaha. .This is one phenomenal integrated hardware instrument. It comes in 3 sizes, 61 keys with Aftertouch, 76 keys with Aftertouch, and an 88 key Balanced Hammer Action with Aftertouch. It has a 16 track audio/MIDI sequencer built in and does what only computers did before. It has a plugin for Cubase, Logic, Cakewalk, and Pro Tools. You really need to see this thing. The retails are 61 = $2,250.00, 76 = $2,750.00, and 88 = $3,250.00. If you

were to get all the equipment that is built in to this instrument, you could easily spend much more.

Alternative Sequencing Option: Notation Software Technology

Even though notation software applications are not designed to compete with sequencing software applications, all of them have sequencing capabilities. To better facilitate both recording and writing opportunities, I would suggest you have both sequencing and notation applications available for your students to use. If you can only afford one sequencing/notation application, you might consider using one of the following notation programs for your sequencing needs. Notation programs like *Finale 2003* (http://www.codamusic.com), *Sibelius* (http://www.sibelius.com), *Musicator 4.0 (http://www.musicator.com), Igor Engraver* (http://www.noteheads.com), Play It (http://www.musichttp://www.musictechnologies.com) and others can excel in creating and modifying printed music. If your main focus is creating performances, I recommend that you use sequencing rather than notation applications. Although most sequencers have the ability to show and edit music in traditional staff format, notation programs usually are the choice of musicians to work with large ensembles. There is one notation program that offers an unusually powerful sequencing component for a notation application by including both MIDI and audio sequencers. It is *Musicator* (http://www.musicator.com) and can handle 255 tracks and 32 audio tracks in stereo or mono plus an unlimited number of plug-ins per mixer track. It even has a multitrack arranger window, a piano roll, and an event list.

Musitek's *SmartScore Pro Edition*, version 2.03 (http://www.musiteck.com) is a unique program with fully integrated music scanning, scoring and MIDI sequencing. This product allows you to scan sheet music with up to 32 staffs per system in minutes and convert it into

standard MIDI files, complete with all the written articulations, music symbols, lyrics and notation. The file can then be modified using a sequencer and played back on a computer or musical keyboard. It is compatible with all MIDI-based software programs plus can export SmartScore files directly to Finale 2000c or newer versions.

One important point that should be brought up is that notation software is not a sequencer software. No package can do both well. By definition, a sequencer is concerned with what the music "sounds" like while notation programs are concerned with what the music "looks" like. This is an important distinction. Sequencer programs have ways of manipulating the performance to such a degree as to have the music sound exactly the way you want it to sound. Notation programs lack these sound editing capabilities. Just look at the number of notation programs that have very poor sys-ex editors (or none at all) and no event list editing. On the other side, note the number of sequencers that do not give you the total control over the graphic elements of a score. If you want both, use a sequencer to get the song the way you want it to sound, then import it into a notation program to edit for notation.

If you ever need to use both sequencing and notation applications interchangeably, note that *Finale 2003* can retain all the original sequencing parameters in tact, including: volume, instrument patch-plays back correct instrument, pitch bend, duration, velocity, and many more. This is not the case with most notation applications which automatically strip down sequencing files of their original performance parameters. Consequently, you don't want to open up sequencing files in a music notation program and then save and use them again in a sequencing program because the original parameters will be missing. Thus, this is a strong case for Finale 2003 as a multipurpose sequencing/notation product.

V.I.P. Sequencing Teaching Resources:

Books on Recording Technology:

* *Sequencing Basics* by Don Muro, Warner Bros; Miami, Florida, 1998, 40 pp. I use this text is my basic instruction book for my primer-level students.
* *The Art of Sequencing* by Don Muro, Miami, Florida: Warner Bros., 1993. A step-by-step approach in 157 pages. I use this text as my basic instruction book.
* *Tech Terms* by George Petersen and Steve Oppenheimer, Hal Leonard: Milwaukee, Wisconsin, 1993, 50 pp. All the technology vocabulary you will ever need to know.
* *Teaching Music Technology* by Thomas E. Rudolph, Chicago, Illinois: GIA Publishing, 1996. 316 pp. Great overview of music technology for the educator.
* *Practical Recording Techniques* by Bruce and Jenny Bartlett: Focal Press.
* *Yamaha's Sound Reinforcement Handbook* by Gary Davis and Ralph Jones: Good encyclopedia of sound. Very detailed.
* *The Art of Mixing* by David Gibson, Mix Books. It is a great intro to mixing theory and has an accompanying video.

Videos on Recording Technology:

* *The MIDI Sequencer in the Classroom* by Thomas E. Rudolph and Ken Peters, Chicago, Illinois: GIA Publications, 1997. 45 minutes. Good video for educator applications in the classroom.
* *The Art of Sequencing* by Don Muro, Miami, Florida: Warner Bros., 1993. This step-by-step approach to sequencing with a companion 157 page book and accompanying video is very clear and organized sequencing fundamentals.
* *The Basics of Home Recording*, volumes I, II, III and IV, Canoga Park, California: MVP Home Entertainment, 1997. Provides explanations of how to set up and use a home multitrack recorder, a MIDI studio and how to use different types of outboard gear and how to mix recordings to sound their best. URL: <http://www.mvphomevideo.com>.
* *The Basics of Digital Home Recording*, volumes I, II and III. Canoga Park, California; MVP Home Entertainment, 1999. Learn PC based and hard disk recording. Learn about choosing software, PC requirements, MIDI, virtual vs. audio track from beginning, intermediate to advanced recording techniques. URL: <http:/www.mvphomevideo.com>.

Recommended Web Site featuring Recording Techniques/Technology:

* ArtistPro: http://www.artistpro.com. Great recording education website, including MixBooks, EM Books, and others.
* Electronic Musician: http://www.emusician.com. This website has back issues with 2001 issues on-line at no charge and is a fantastic resource for students and teachers alike. *Electronic Musician* is the #1 magazine for musicians interested in recording and producing music in a home or personal studio.

* Mix Magazine: http://www.mixonline.com. This fine website has all back issues on-line on a purchase basis; a very good resource.

Closing Comments:

No question about it; MIDI sequencing is still the mainstay of the current music education recording scene, especially for teaching the fundamentals of recording technology and for entry level applications. The learning curve is easier than with digital audio recordings. If computers are your primary interest, then MIDI technology is very appropriate especially with the various playback options. Any data conforming to Standard MIDI will be played accurately on any General MIDI compatible tone generator, soundcard or synthesizer from any manufacture on any software. Yamaha's XG and Roland's GS technology are significant improvements over the 128 General MIDI sounds and they are is non-proprietary and fully backward-compatible to General MIDI software applications which works well with all computer software applications..

But also note that audio recording with digital audio is rapidly become an exciting norm to mix with MIDI recording technology. Computer processors are becoming exceptionally fast and inexpensive and hard disk drives are getting cheaper and larger. It is no longer required that hard disk drive recording (digital audio) have the expensive SCSI hard disk drive since IDE hard disk drive technology is becoming so fast, efficient and inexpensive. If you get into dedicated hardware and integrated systems for digital audio recording, the learning curve can be even easier to master.

Never before has recording technology become so attractive for music educators and their students with MIDI sequencing, dedicated hardware and integrated sequencers. In future columns, we will focus on how to put together a home and/or school music studio that can burn

CD's for your music groups, make college audition CD's, post audio and video streaming on your school web sites, record compositions with MIDI and digital audio components and much more. Check out some of the examples of digital audio recordings posted on my web site at: http://www.kuzmich.com/unt/unt.html, http://www.kuzmich.com/BYU2002/07_Track07.html and http://www.kuzmich.com/BYUrecording_2001.html.

Side Bar

Sequencers Can Be Valuable for Music Educators:

Converting MIDI files to Audio Files for Instructional CD Burning!

Ever wish you could make practice CD's for your students to use at home? Sequencers are a fast way to create MIDI files of essential practice exercises from notation, sequencing and performance accompaniments via Band-In-A-Box, for example. The trick is in converting the MIDI files to audio files which can be a complicated procedure. Fortunately, *Sonar* and *Home Studio 2002* by Cakewalk offer some direct and powerful ways to do it from your MIDI files from either a notation program, sequencing applications or automatic accompaniment generators. Here are some standardized instructions for creating audio files from SONAR projects containing either audio, MIDI, or both. I recommend using *SONAR's* or *Home Studio 2002's* with DXi synthesizers to render the MIDI Tracks, details of which I've included below.

Creating an Audio File from a SONAR Project Containing MIDI

MIDI is simply an instruction set, like words on a page, with no inherent 'sound' other than that created by a synthesizer. Depending on the synthesizer, the quality and other particulars of this sound can change. To allow easy distribution such as .MP3's, CD, etc you will need to capture this sound as a waveform. There are many ways this can be done, however, the easiest way is to use a DXi (DirectX Instrument) in SONAR. This is a 'virtual synthesizer'. When you export your file, all of the MIDI tracks playing through the DXi will automatically be converted to audio.

How to Insert, Setup, and Assign DXi in SONAR

1. Create a new audio track. (Insert > Audio Track)
2. Expand the Track Vertically/Horizontally, or click on the FX tab so that you can see the FX parameter for the track.
3. Right-click on the FX parameter and select DXi Synth > Edirol/Roland VSC. The Virtual Sound Canvas should appear.
4. For each MIDI track, you should now be able to select the VSC as an Output. Select all tracks, then Track > Properties > Outputs to change them all simultaneously.
5. Make sure each MIDI track is set to a different channel, 10 is normally drums.
6. If you want to process the VSC with effects such as Reverb, Chorus, etc, simply right click on the FX parameter on the VSC track. Make sure the effect is to the right of VSC.
7. You can add multiple instances of VSC in order to use different effects or to handle more than 16 tracks of MIDI.

8. When you choose File > Export Audio from SONAR, all MIDI tracks feeding a DXi will automatically be included. If you wish to mix down a previous MIDI track to export, select the MIDI Track and the Audio track containing the DXi and select Edit > Bounce to Track.

Creating an Audio File from a Audio-only SONAR Project

You can create an audio CD from any wave file (extension .wav) of up either 74 or 80 minutes depending on the recordable CD media you have. If your projects are audio only, you can simply mix down to a stereo wave file. Once you have all the stereo wave files you want to include on your CD, you are ready to burn a CD. Most CD burners come with CD burning software, if yours does not, you will need to buy CD burning software, like Cakewalk's Pyro. To download a free demo of Pyro, visit the Cakewalk website at <http://www.cakewalk.com>.

To Export Audio to Wave File Format

1. Set all volume, pan, effects, and automation settings just the way you want them.
2. Choose File-Export Audio to open the Export Audio dialog box.
3. Select a destination folder using the Look In field.
4. Enter a file name.
5. Choose Wave from the Files of type drop down list.
6. Click Export.

The audio is then exported to the Wave file.