

## Software Techniques for MIDI Sequencing



### DVD-ROM

Projects 11–12 on the accompanying DVD are designed to give you hands-on experience with the tasks in Table 15.1.

**W**ith the basic understanding of MIDI supplied in the last module, we now turn to software for MIDI sequencing. Actually, you are unlikely to find a popular, music sequencer featuring MIDI that does not also support tracks for digital audio. As we noted in Viewport IV, many multitrack recorder programs like ProTools and Audition include MIDI. However, in this module we will stress MIDI recording and editing in software that is primarily known for MIDI support; we use the term “sequencer” to characterize these titles.

We begin with some concepts that will help you understand MIDI-based sequencing, including some important terminology. Basic-level sequencers are then featured, including sections on preparing for and doing the recording. Next, we move to editing techniques, including the use of built-in effects and MIDI effects plug-ins. We include an introduction to virtual-instrument plug-ins, present a section on adding digital audio to MIDI, and end the module with information on saving MIDI data files. As with tables in other modules, Table 15.1 provides a set of tasks that will guide your study.

**TABLE 15.1** Tasks for Music Sequencing and MIDI Basics

Setting	Task	Typical Software
Studio or Live Concert Setting	<ul style="list-style-type: none"> <li>Record multiple tracks of MIDI data from a MIDI device, edit MIDI files</li> </ul>	PowerTracks Pro Audio, Home Studio, Metro SE, Logic Express, Tracktion, Cubase SE
Studio	<ul style="list-style-type: none"> <li>Apply virtual instruments and MIDI effects</li> </ul>	Home Studio, VSC, VeloMaster Lite
Studio with and without Live Performers	<ul style="list-style-type: none"> <li>Add digital-audio tracks to basic-level MIDI sequencers</li> </ul>	PowerTracks Pro Audio, Home Studio, Metro SE, Logic Express, Tracktion, Cubase SE
Studio	<ul style="list-style-type: none"> <li>Mix and save MIDI data, as well as convert it to digital audio</li> </ul>	PowerTracks Pro Audio, Home Studio, Metro SE, Logic Express, Tracktion, Cubase SE

## Basic Design of Sequencing Software

Have you ever watched an old-time player piano work? If so, you probably noticed a paper piano roll with holes that moved across a metal cylinder. The holes are triggers that control which notes are played and how loudly they're played. Even the keys and the pedals of the piano move appropriately, controlled by the paper roll. The player piano and the principle that makes it work date back some 150 years and provide an example of an early music sequencer.

### What Does Sequencing Software Do?

One answer is “record and process music data.” A more precise answer is “record and process MIDI and digital audio data.” As you learned in the last module, MIDI is a kind of digital language that describes music performance. It uses numerical codes to tell some *other device* to turn on a sound, play it at a certain loudness level and with certain effects, and then turn it off.

Sequencing software acts as a tool for capturing and working with MIDI and digital audio data, usually for the purposes of composing or arranging. This soft-

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## SIDE BAR ON SEQUENCING

### Historical Perspective

Music-sequencing machines are actually quite old. One clear beginning would be the eighteenth century, early music boxes and music composed by Mozart for barrel organ. The paper piano rolls that followed were created by artists who understood patterns in music and their complexity in time. In 1804, an instrument called the Panharmonium was designed by Maelzel. It was driven by air pressure and was intended to reproduce the timbres of traditional instruments. Beethoven wrote the *Battle of Vittoria* for this device, but it was never performed because of technical problems. The calliope was developed by Boch and Wachter in 1895 using a metal disk with punched holes to represent music.

The beginning of the twentieth century saw the creation of a number of early electronic instruments played by sequences of some kind. In the 1920s, Givelet and Coupleux's Pipeless Organ was one of the first programmable analog music synthesizers. At the same time, Seeburg, Wurlitzer, and others were building the first electronic jukeboxes.

The 1950s saw experiments with some of the first computer systems, like the ILLIAC and the RCA Mark 11 Synthesizer. Music was created on these devices with the help of codes punched on cards or paper tape.

In the next decade, the invention of the transistor helped Buchla create a transistor-based analog synthesizer with the first built-in electronic sequencer. Moog created a synthesizer that became a popular hit. This growth in small keyboard systems continued into the 1970s with the classic



Courtesy of the Smithsonian Institution

Music-box sequencing mechanism (1890s) using pins on a cylinder

Prophet analog synthesizer and the Fairlight and Synclavier devices, which featured real-time sequencing. The first drum machine was created by the Linn company, and Roland produced the first digital sequencing device controlled by a microprocessor.

Of course, the real boon for sequencing came in the 1980s with implementation of the MIDI protocol together with the growth of personal computers. Keyboards like the

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**LINK**

Look ahead to Module 16 regarding hardware setups that involve MIDI.

ware lets you record multiple layers of information, much as you might record multiple layers of digital audio sound as described in Viewport IV.

Imagine you are working with a computer that has sequencing software installed and a MIDI keyboard coupled with your MIDI interface. You also have a microphone connected, similar to the setup you had in Viewport IV. You tell the software to “record” and then move to the keyboard to play a passage using the bassoon timbre. You begin the passage softly in the low register and then end in a long crescendo with several notes played in a higher register. You play a ritard at the end for a special effect. Returning to your computer, you stop the recording process, “rewind,” and listen to what you played. The MIDI software plays back the passage exactly the way you played it, with all the subtleties of phrasing and dynamics.

Next, you ask your software to record on a different track. You return to your keyboard and add another track of percussion sounds while listening to your first passage played back to you by the same MIDI workstation. When finished, you “rewind” again and listen to the whole piece. You also ask your software to add a touch of rubato in the middle of the passage, together with some dynamic changes. You don’t like the percussion sounds that your MIDI keyboard is producing, so you ask your software to use an instrument plug-in that simulates percussion sounds.

Now you rewind and add a third track by singing into the microphone. You

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**sidebar on sequencing (continued)**


Courtesy of the David Sarnoff Research Center

Paper-tape sequencing (1950s) with the RCA Electronic Music Synthesizer

Roland Jupiter 6 and the Yamaha DX7 were among the first instruments to include MIDI. Hundreds of keyboard models have since followed suit, many with sequencers built into the hardware much like the Buchla.

On the computer side, the 1980s saw a growth in both PC and Macintosh music-related products. IBM produced its Music Feature Card, which allowed some software control of sound. Mark of the Unicorn’s Performer software for the Macintosh became the first professional software-based sequencing package on a computer. Today, such software, the focus of this module, is plentiful.

The MIDI protocol began as the basic data structure for sequencing; however, the combination of digital audio with MIDI is now quite common. In fact, multitrack recording software that uses only digital audio or uses MIDI just as a triggering or control mechanism rather than for sound generation is emerging as a standard. Such technology is pervasive in all phases of the music enterprise, particularly in the popular music recording and concert scene. Sound tracks for movies and for many multimedia products rely heavily on sequencing. Composers and conductors such as Pierre Boulez are experimenting with interesting combinations in live performance using analog instruments with MIDI sequencers driving digital equipment. Sequencing will continue to play a role in music development in the future, just as it has in the past.

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sing a passage that goes along with your percussion and bassoon sounds. After listening to your voice, you decide to add a little reverb effect and maybe a plug-in effect, much as you did in Module 9 in Viewport III with digital audio editors.

When you're finished, you have two tracks of MIDI data and one track of digital audio. In a nutshell, this is what sequencing software accomplishes.

### Better Than a Tape Deck!

Sequencing programs resemble the function of analog tape decks, but with powerful differences. The MIDI instructions and audio data can be flexibly altered in an instant. You edited both the MIDI and audio data for musical ends. You might ask the software to play back the data in a different key and in a different tempo. You can edit errors by simply changing values in a list, with piano-roll or traditional notation. All this flexibility is possible because the MIDI and audio data are just a set of numbers that describe a performance.

### Timing

Software sequencers constantly run a clock in the background during recording and playback of data. This clock keeps track of measures, beats, and fractions of beats, often referred to as *ticks*. The number of ticks per defined beat varies depending on the software, ranging from 96 to a resolution as high as 1,024. As data arrive at the software sequencer, rhythm is coded against an invisible time grid represented by the tick resolution. This allows the sequencer to be extremely sensitive to nuances in performance tempo. Generally, the higher the resolution, the more accurate the sequencer is in coding rhythmic performance.

The concept of “quantization” is also critical for understanding how sequencers work. Sequencers can be asked to adjust time values to make notes conform to standard grid alignments, such as an eighth- or sixteenth-note. This can be useful if you intend to export the file to a notation package for printing, or to fine-tune a section to make it sound rhythmically tighter.

### Other Important Terminology

You need to understand three additional concepts specific to sequencing software: track, patch (sometimes called program or instrument), and channel.

Figure 15.1 displays an overview of a typical basic-level software sequencer. Notice the windows to the right that contain notation and lists of MIDI data. There is also a mixer window and an audio edit window, much like the software reviewed in Module 12. More on these later, but right now, study the Tracks window to the upper left.

Here you see three tracks, much as described above: two MIDI tracks (1 and 2) and one audio track (3). The concept of “track” in a sequencing program is really quite similar to how we defined a track in multiple-track recording: a convenient way for the software to visually and internally represent a location for an entered line of music. Software tracks can contain a large amount of information. Polyphonic textures created by a pianist, for example, can all be recorded on one track if desired. Sequencing software provides windows that let you edit these tracks. Portions of a single track can be moved around and defined in different ways by sequencing programs.

The notion of a “channel” in terms of MIDI is somewhat different from that in the hardware context that we described in the last viewport, although both are related to routing. In MIDI terms, a channel is like an address to which a stream of data is sent. The MIDI language codes every note with a channel number, a kind



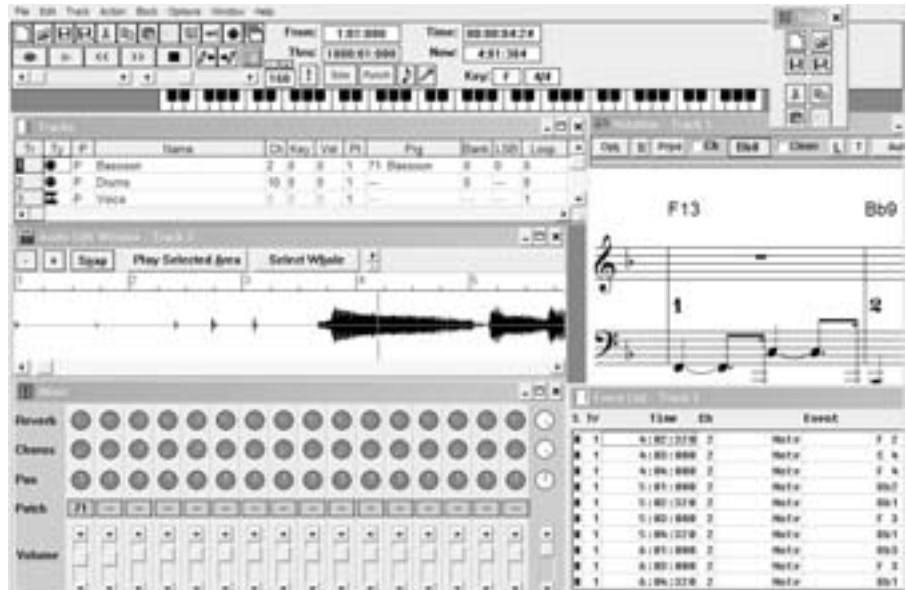
#### LINK

MIDI and sequencer timing is covered in more depth in Module 18.



#### LINK

Be sure to reread the basic description of MIDI in Module 14 and the discussion of Channel messages.



**FIGURE 15.1**  
PowerTracks Pro Audio (PG Music, Inc. [Win])



**LINK**

Expanding MIDI channels is discussed in Module 18.



**ASIDE**

Additional patches can be accessed from various *banks* of sounds, 128 sounds per bank. This is particularly true with the expanded choices in the GM2 specification described in the previous module. See the listing of GM2 banks in Table 14.4.



**DVD-ROM**

Project 11 Editing MIDI Tracks with Basic Sequencing software

of destination label like a TV channel. MIDI devices can be “tuned” to listen for notes on a specified channel. In this way, the sequencing software can send streams of notes to particular synthesizers or sound modules. In Figure 15.1, we have assigned the bassoon line to channel 2 and the drums to channel 10. It is quite common, in fact often required, that each separate timbre have its own channel number. You’re allowed up to 16 channels on one MIDI cable. If you require more than 16 discrete timbres to sound at once, you’ll need MIDI hardware and software that allow this.

Most often, you’ll want to place a single channel on a single track with its own respective timbre; however, in some sequencing programs, multiple channels and their respective timbres can be included on a *single* track. For example, you might want to add a flute part to the bassoon melody by doubling an octave higher. Rather than create another track for the flute, it might be more sensible to add the flute line to the first track because it is playing the same music.

A “patch” or “program” is the sequencing term for an individual timbre. Most MIDI devices have a wide assortment of preset patches or timbres that can be addressed by MIDI. We used the bassoon and drum patches in your example above. MIDI software sends the MIDI patch code to the hardware device and the correct timbre is played for the music. The first General MIDI specification identified up to 128 different programs or patches and the newer GM2 specification adds more, as we described in the previous module. Many MIDI sound devices have hundreds of other patch sounds not standardized under General MIDI; they also can be accessed directly in sequencing software.

**Basics of Using Sequencers with MIDI Data**

First, a few words about the practical aspects of setting up your computer for MIDI work. In Module 12, Viewport IV, we described how to check your operating-system settings to be sure the computer knows about the digital audio and MIDI

hardware you are using and how to route the digital audio and MIDI data. We recommend that you review that information now so that you are clear about how MIDI is handled by PC and Macintosh computers. Module 16 will describe many of the options for adding MIDI hardware to your computer. You will find useful information there about virtual routing, including the use of helpful utilities like MIDI-OX for PCs and MIDI Patchbay for Macintosh computers to support more extensive MIDI setups.

### Entering MIDI Data

We will cover the basics of using sequencers by first entering data with a MIDI device such as a keyboard controller and then editing that data with typical techniques (see Table 15.1). Figure 15.2 reveals another basic layout of a sequencing program in Metro that is concerned primarily with MIDI. The upper window lists the tracks and gives a small graphic overview of the contents of each track. Clicking on any of the track overviews brings up a graphic editor with “piano-roll” notation.

As the project develops, the mixer is very useful and serves many of the same functions that a mixer did in the multiple-track digital-audio software reviewed in Module 12. Finally, the Transport panel at the top left of the graphic contains the buttons necessary to play the project, rewind, stop, and so forth. Number displays show where the music is in terms of beats and measures and SMPTE time code, a system useful when working with video.

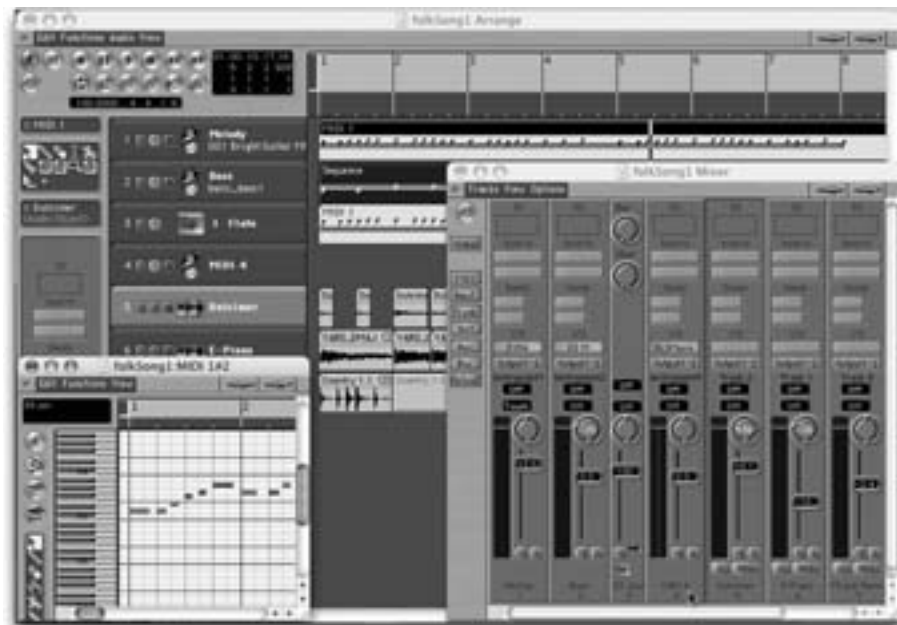
### Setting Up Recording

Of course, Figure 15.2 is of an already-completed composition. Figure 15.3a shows a project in its very beginning stages. Here, we have selected channel 1 in the Instruments column by choosing X5D-1. The program number is 73 for piccolo (the patch number used in the General MIDI bank for this instrument) and we have named the track accordingly. Notice we have “armed” the track for recording by clicking in the “R” column on the extreme left. The little dot indicates this. The recording process will start when you click on the larger dot in the Transport



#### LINK

SMPTE and other time codes are covered in Module 18.

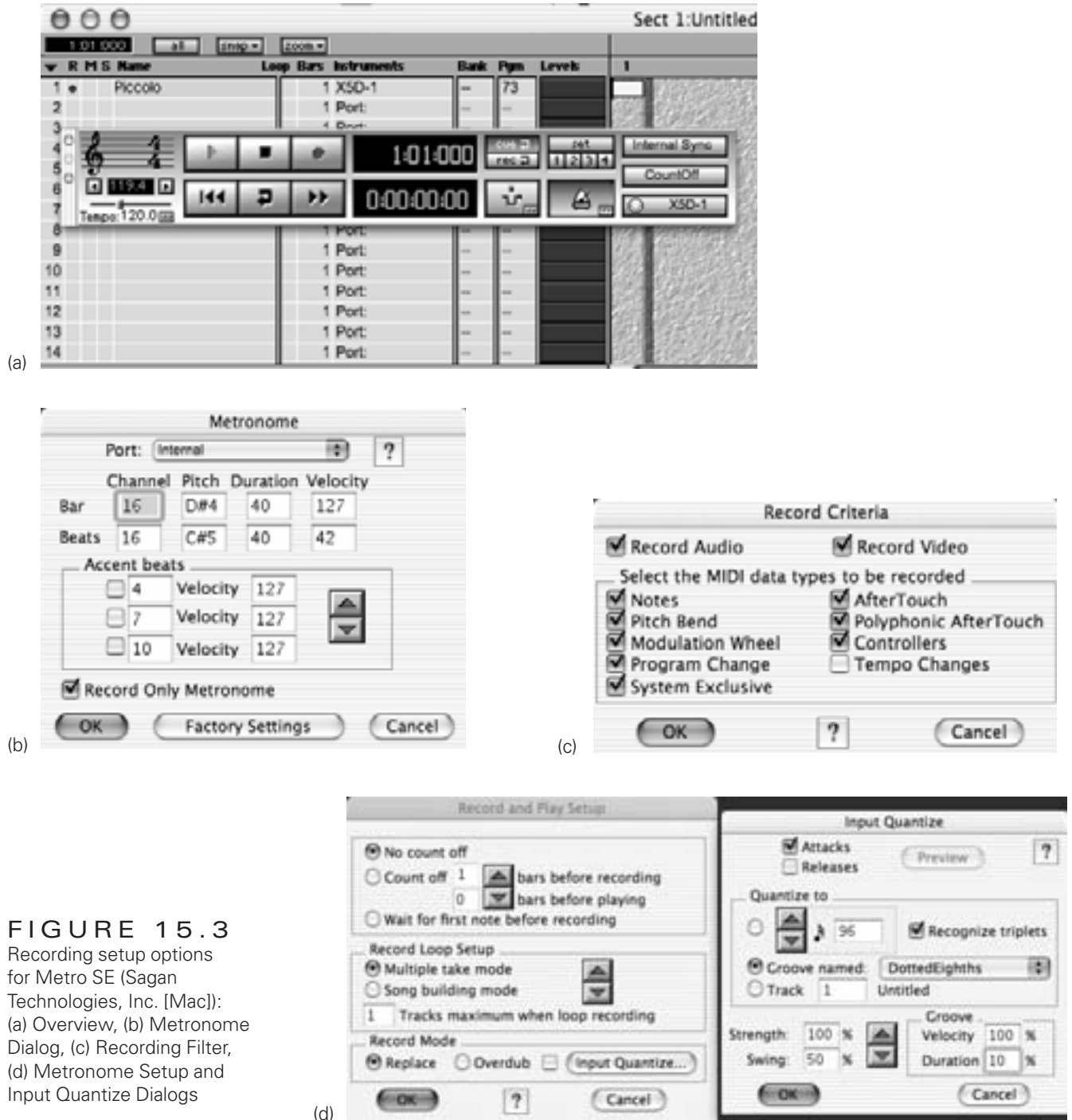


**FIGURE 15.2**  
Overview of windows in  
Logic Express (Apple  
Computer, Inc. [Mac])

bar below. The “M” column is used to mute the track if needed, and the “S” solos the track and turns all the other tracks off.

You are just about ready to record. Next comes a series of options to control the recording. Nearly all sequencing software offers these options as standard features, although they are implemented in different ways. Refer to Figures 15.3a–d as we work through the setup.

**Tempo, Meter, and Key** You’ll want to think of a comfortable tempo for recording your music. You can choose a slower tempo than you plan to use for the final performance, because the tempo can be changed instantly without altering other



**FIGURE 15.3** Recording setup options for Metro SE (Sagan Technologies, Inc. [Mac]): (a) Overview, (b) Metronome Dialog, (c) Recording Filter, (d) Metronome Setup and Input Quantize Dialogs

variables. Tempo is initially set on the left of the Transport panel in Figure 15.3a. We have chosen a quarter-note equal to 119.4 beats per minute in this example.

Initial decisions about meter and key are set with menu items on this software. These settings may seem unnecessary if you just want to use a sequencer to produce a sound mix, but they are vital for proper metronome function and when the files are exported to notation programs or synchronized with audio data.

**Metronome** A metronome click is useful when recording, especially with the first few tracks so that you come close rhythmically to accurate performance. The closer you come to playing accurately, the more freedom you have in choosing options for quantizing (see below). The metronome is turned off and on in the same Transport panel. By clicking on the small graphic in the lower right of the metronome button in Figure 15.3a, the dialog box in Figure 15.3b appears. Here you can set where the sound of the click comes from (internal speaker of the computer or your MIDI device); the pitch, duration, and velocity (loudness) of the beat; and accents. If you choose Channel 10, you are likely to get a percussion sound set and if you choose to only hear the clicking in record mode, you can set this as well.

**Filtering MIDI during recording** Next, you might consider filtering certain MIDI data during recording. Figure 15.3c shows a dialog box that allows you to check off what you want. You can decide to filter out any MIDI data that are not desired, such as controller data of after-touch (special effect by a keyboard player after the key is struck). Here you can decide not to record audio and video as well.

**Count-off, loop recording, overdub** The dialog box to the left in Figure 15.3d provides a number of important options. Count-off controls the time clicked off before recording actually begins. You can set a “measure for nothing” to prepare yourself to begin accurately. You can also start recording anytime with the first note’s performance.

Creating loops in sequencing software is always possible using features in this same dialog box. The loops created, however, are not specially “marked” for time and pitch change in the same way as those created in looping sequencers described in Module 12. The Record Mode in Metro is a nice way either to replace the material in a track completely or to place multiple lines of music in a single track.

**Input quantization** “Quantization” is a process that adjusts the onset of a MIDI note event so that it starts exactly on a beat division point, such as a quarter-, eighth-, or sixteenth-note. It is a powerful option for tightening up your rhythmic performance as you are recording, but it also can destroy the human feeling of the music if not used with care. Remember that no musician plays perfectly in time with the underlying “beat.” To do so would be completely unmusical! The give-and-take of expression is a beautiful part of the musical experience. However, on many occasions real-time note entry will require some adjusting, and quantization is necessary for this. Nearly all packages offer some form of quantizing.

The dialog to the right in Figure 15.3d is shown by clicking on the Input Quantize button. Here, we set quantization for input. Sequencers offer post-production options for quantization as well (see below). The options presented include quantizing attacks and releases (ends of notes), resolution level of quantization (we chose the sixteenth-note), and special groove quantization that allows a performance style to be recognized and supported with different levels of strength.



#### LINK

The notion of quantizing was mentioned in Module 12 in reviewing multitrack audio sequencers.



#### LINK

Much more on MIDI timing in Module 18.



### ASIDE

The notion of THRU described here is not the same as the function of a MIDI THRU port on a MIDI interface or sound device described in Modules 14 and 16 of this Viewport.



### LINK

We will cover real-time and step-time entry with notation software as well in Module 20.



### TIP

Percussion usually goes in Channel 10 with most sequencers using General MIDI as the bank for instrument sounds.

**Sync clock** You can set your sequencer to listen to its inside clock to manage all event timing. If you choose external synchronization, the program will listen for a clock outside the computer. Set in the Transport panel in Figure 15.3a, this might be useful if at some point you want to sync to a video device or other hardware.

**THRU** Most MIDI keyboards have an option in their hardware to set labeled Local Control on or off. Local Control Off prevents the keys from sounding notes; you may discover that your software and hardware work better together with this setting in the off position. This lets the computer take complete charge of the MIDI device during playback. The only problem is that you can't hear the sounds of the workstation while playing it! To remove this problem, most software includes a *THRU* option. You may want to have this selected so you can hear the workstation "thru" the computer. The software will simply send the MIDI data back to the keyboard so it can be heard. In Figure 15.5a, this is set in the Transport panel on the lower right.

## Creating the Sequences

Now comes one of the most exciting parts of using sequencing software: recording the data. You have two approaches to consider: real-time and step-time. Real-time is by far the most common approach because sequencing software is optimized to work best using this approach. However, step-time can be helpful at times.

### Real-Time Input

As we work through the following steps, refer to actual software, if you can, and practice some of this as you read.

*Step 1.* Begin by thinking through your music. What line has the greatest continuity and would therefore be a good place to start? It might be good to put the drum line in first because that would set the proper feel for the rest of the work. However, if your music doesn't use a continuous drum line, you may want to choose something else. Remember: You can also record portions of a piece and add measures later.

*Step 2.* Practice before recording. Sequencers are quite flexible, but they can't be expected to solve every performance problem. You need to practice until you feel quite comfortable with the music, knowing that you can fix some problems in the editing phase. Remember that sequencing software records all the nuances you perform, including rubatos, phrasing, articulations, and dynamics. Try to include as much of this as possible in your playing early in the recording; you can always "edit out" unwanted aspects of your performance but it's more difficult to "put in" missing elements! This is the major difference in approach between real-time entry in a sequencer versus a notation program. The emphasis here is on capturing as much of the performance data as possible.

*Step 3.* Double-check all the settings. Decide if you are comfortable with how the metronome is set. Practice a little with the metronome to be sure.

*Step 4.* Now, record your first track. Make sure that the track is "armed" by clicking into the column of the track that indicates recording.

*Step 5.* Rewind and listen to the track, and perform it again if necessary. A wise safety procedure is to "deselect" the Record button to turn it off while listening.

*Step 6.* Add a new track. If you want, you can now turn off the metronome while adding the second track. Make sure that the new track is in the record mode with the dot in its column for recording. Change the channel to a new number if

**TIP**

If you don't hear your MIDI device playing back different patches (timbres), your device may not be in "multi" or "poly" mode. You can change it to this mode either physically on the device itself or by a message from your sequencer software (see Module 14 for help with modes).

**TIP**

Step-time is great for musicians who don't play the piano well.

you're using a new timbre and be sure to choose the timbre you want ahead of time. You should hear the first track played back as you record the second.

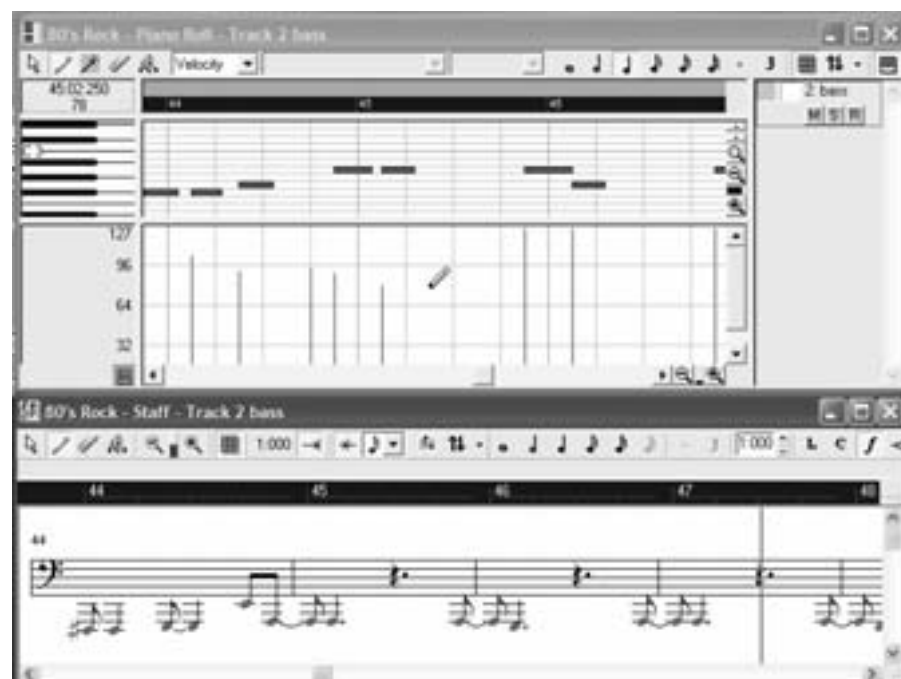
**Step-Time Entry**

Sequencers accomplish step-time entry in different ways, but the basic concept is the same. You can draw in pitches and durations with a pencil tool or some other pointer device, or you can use the MIDI keyboard to determine a pitch level while you use your mouse or keyboard keys to choose a duration value. The latter approach is often called MIDI step entry.

Look at the two displays in Figure 15.4. The top view shows a track line with its data displayed in piano-roll fashion. The bottom view uses traditional notation. The tools at the top of each view allow you to pencil in a change and erase an event if you make a mistake. The vertical lines at the bottom of the top view are designed to control velocity (loudness) of each note—the higher the line, the louder. In the bottom view in traditional notation, dynamics are handled with dynamic markings.

Step-time entry in sequencing packages is often used to notate particularly difficult rhythmic sequences for which real-time performance is a problem. For instance, you might consider step entry for passages that require "tuplets." Tuplets are needed when a certain number of notes (usually an odd number) must be played in the space of a specified rhythmic division (usually even): for instance, three notes in the space of two eighth-notes. This would be a 3:2 designation or *three against two*. Another possibility might be 5:4 (five sixteenth-notes in the space of four).

There is actually a third way to enter music into a sequencer: by importing a standard MIDI file (SMF). Someone could send you an SMF on a CD or via the Internet. You may decide to import the file into a sequencer to build on to it or perhaps alter it for some purpose. Most sequencing programs offer this as a simple import option or allow you to open the SMF directly in the program.

**FIGURE 15.4**

Piano-roll and traditional notation views from Cakewalk HomeStudio (Twelve Tone Systems, Inc., [Win])

## Editing and Saving Sequences

Careful performances will go a long way in creating your MIDI-based masterpieces, but editing is always necessary after the raw material is in. Here are a few of the most-often-used techniques.

### Correcting Errors

Sequencing software offers a number of ways to correct errors. One approach is to use the tools shown in Figure 15.4. Here you can alter the pitch and duration of individual notes and also adjust the volume using the vertical lines. You can also drag the pencil tool across the vertical lines to help define a gradual crescendo and decrescendo.

Groups of notes can be highlighted for change. Cutting, copying, and pasting are all supported by sequencing software. Keep in mind that most packages treat cutting and deletion as two different concepts. If you want to eliminate the first two measures of a composition and have the sequence automatically shift to the left, for example, you probably need to use the delete option. Cutting may only remove the notes and leave the measures. Also, some sequencing software expects you to indicate whether to shift music backwards in time following a deleted section. Many programs support Clear or Erase options. These differ from cutting because the material is not placed in clipboard memory for later retrieval but is simply eliminated from the score. Finally, if you copy and paste, be sure that the target track setup is similar to the one you are copying from; otherwise, the software may refuse to paste the material.

The Punch option is a great way to record a single measure or other small section in real time. Begin by identifying the spot you would like to change. Then start playing a few measures before it. When the section arrives, play the correct version in real time; the computer automatically knows to “punch in” the new material or insert it in the proper spot while overriding the offending data. The punch in-and-out button can be seen in Figure 15.3a in the Transport panel right next to the number displays under the Cue and Rec buttons.

Sometimes it’s hard to pick out the offending errors in a complicated texture while listening. Most sequencing software provides an impressive *scrub* feature. For Home Studio, you can see the scrubbing feature in Figure 15.4 represented by the little speaker in the tools bar. Pulling this icon forward (or backward!) plays the notes underneath. This is an elegant option for “proofhearing” your music.

### Editing with Event Lists

You’ve seen a number of ways in which sequencers provide views of the music. In addition to the track window, you’ve seen “piano roll” and traditional notation. These are, by far, the most common in sequencing programs, but at least one other view is worth your time—the event list.

Figure 15.5 displays an event list, which can be a very effective way to edit. An event list is just what it sounds like, a listing of each MIDI event as numbers in the order of their input to the computer in the MIDI data stream. Here, the list is open for a piano part in a composition using Cubase SE. Reading from left to right in the Event List window, you’ll see values that define the position, length, and note name (if the event is a pitch).

Event lists offer an important window to the basic level of MIDI data, which is often necessary for precise control of performance data. You can look for the presence of controller data like pitch wheel or modulation information and use the editor to enter precise placement of program (patch or timbre) changes just where



#### LINK

Punching in and out in MIDI is similar to the same processes in recording digital audio in Module 12.



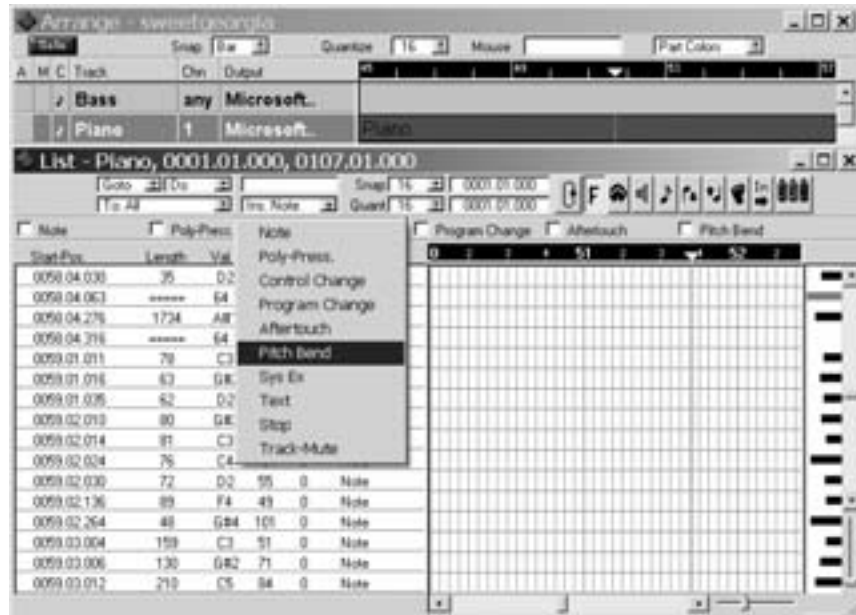
#### LINK

MIDI codes used in event lists are explained in Module 14.



#### LINK

See Module 19 in the next Viewport for information about controller data.



**FIGURE 15.5**  
Event list in Cubase SE  
(Steinberg/Yamaha,  
[Mac/Win])

you want them in the bit stream. The event list can also filter out certain kinds of MIDI events and only show others. Such detail can be very helpful in studying real-time music performance.

### Menu-Driven Editing

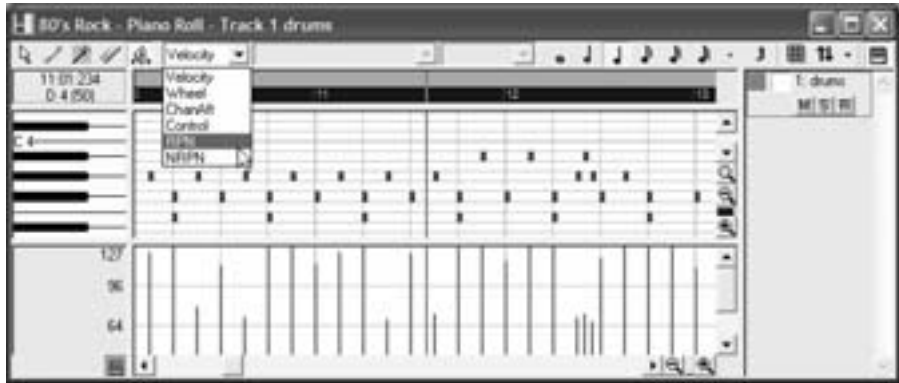
Most sequencing software provides menus that allow for MIDI editing. Figure 15.6 displays this option in Home Studio. The graphic shows how controller data and velocity information can be changed in the piano-roll view with a pull-down menu right in the display.

**Adjusting tempo and scaling time** Dialog boxes control tempo changes and scaling of MIDI data in this software. Gradual or less-gradual tempo changes can be accomplished with simply drawing changes over time. It is even possible to scale time much as you saw in Modules 9 and 12 with digital-audio software. These edits can be performed quickly on a large chunk of MIDI data to offer a number of musical changes after the basic data has been captured.

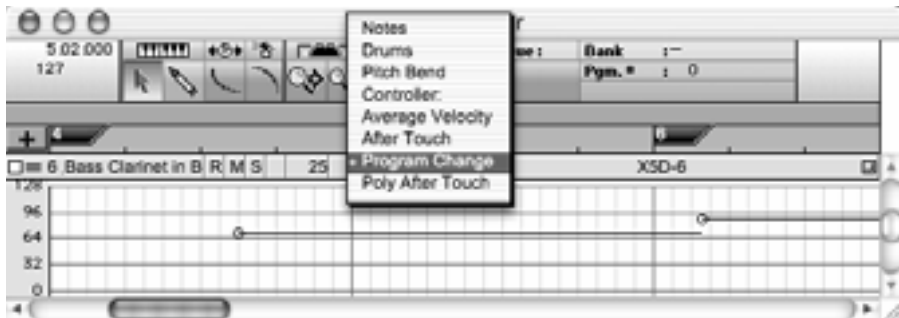
**Changing patches** Another example is the pop-up menu in Metro's Graphic Editor that allows you to change patches or programs much as you can with the event list. Figure 15.7 shows the menu, with options for seeing note values, controller data, and the like. We have chosen to show program change; you can see the little circles and horizontal lines that show the onset of a timbre. Clicking on the circle displays a Program Event Edit window that lets you specify exactly what you wish the program to change to.

**Quantization (post-recording)** A final example is the ability to quantize a section of MIDI data after it has been entered, rather than as data are recorded. Figures 15.8a and b demonstrate how this is done and its effect. First choose the quantization resolution level, what is to be quantized, and any options for humanizing the changes. Figure 15.8a represents the timing of the pitches before and (b) shows how they have snapped into place in the grid after quantization.

**FIGURE 15.6**  
Menus for changing MIDI data in (a) HomeStudio



**FIGURE 15.7**  
Menu to control views in Metro's Graphic Editor



**FIGURE 15.8A**  
MIDI data before quantization

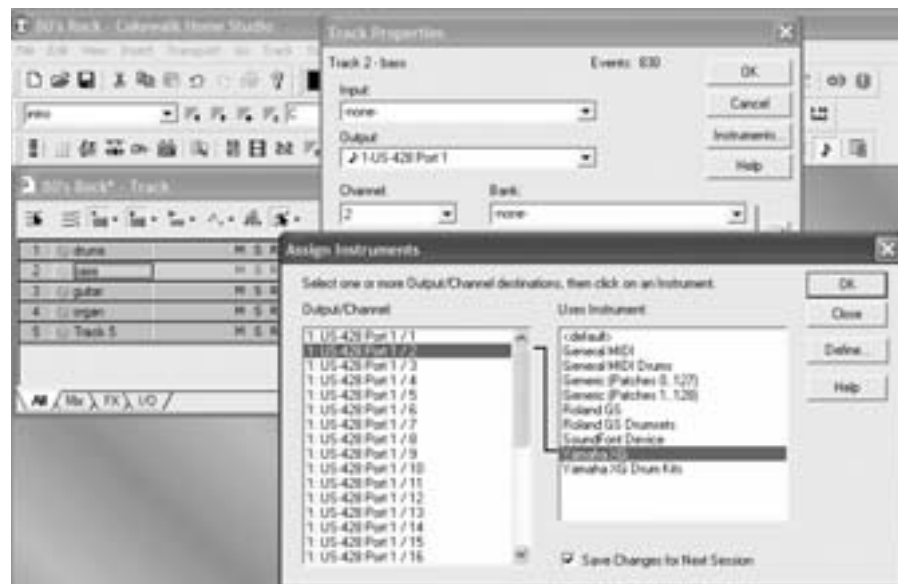


**FIGURE 15.8B**  
MIDI data after quantization.

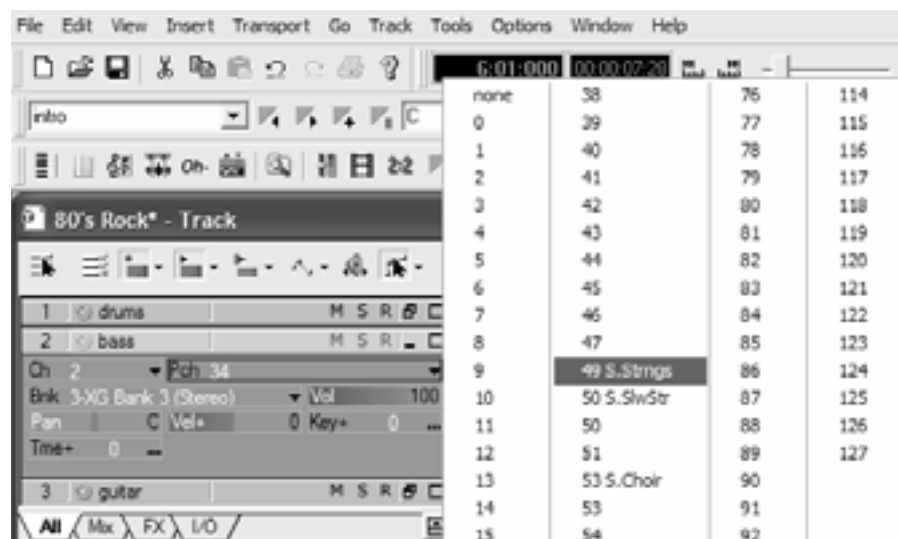


### Special Bank Selection

In the last module, you learned about the newer GM2 extensions for General MIDI and the possibilities for more than just the GM1 bank of sounds. Many software manufacturers include ways to change the bank of instruments that can be played by common MIDI devices. Figure 15.9a shows one way this is accomplished in Home Studio. We have right-clicked on the bass track (Track 2) in the example, which created the appearance of the Track Properties window. In Track Properties, we clicked on the “Instruments” button, which led to the Assign Instruments dialog. We chose the Yamaha XG instrument definition supported by this version of Home Studio, with the assumption that a Yamaha XG hardware instrument is connected to the computer. We then returned to the Track Properties window and chose the Bank 3 (Stereo) bank. Figure 15.9b shows how we then returned to Track 2’s header information, which now shows the desired bank. By clicking on the “Pch” button in the header information, you can choose whatever instrument you want in the Yamaha XG’s bank.



**FIGURE 15.9A**  
Track properties and assigning a different instrument bank in HomeStudio



**FIGURE 15.9B**  
Changing a Specific Instrument in Home Studio

## Plug-Ins: Applying MIDI Effects and Software-Based Instruments

In addition to the editing techniques we have just described, there are additional ways to alter and expand the sonic experience using MIDI data. As with digital audio, effects processing is possible with MIDI in the form of built-in effects and MIDI plug-ins. It is also possible to replace the hardware MIDI device with software instruments as either VST or DX plug-in extensions. We will revisit these ideas with the more advanced digital audio workstation (DAW) software in the next viewport, but here are some examples of these enhancements with basic-level titles.

### MIDI Effects

Figures 15.10a and b show the initial use of built-in MIDI effects in Home Studio and the actual dialog box for one of these effects: the Echo Delay. In this example, we applied the effect to a bass timbre. The effect list is displayed by right-clicking on the “Fx” area just below the track’s name. Such effects only work for MIDI data tracks. A similar technique for audio tracks returns a list of all of the audio built-in effects that Home Studio has programmed, similar to the software in Module 12.

Notice in the Echo Delay dialog box the options for the units to be either Notes, MIDI Ticks, or Milliseconds. In order to hear the effect, you simply start the sequence going and manipulate the parameters. Another useful effect is the Arpeggiator.

Notice, too, in Figure 15.10a that another option was the MusicLab VeloMaster Lite plug-in. This particular plug-in, displayed in Figure 15.10c, is an example of a third-party MIDI plug-in that features sound compression, expansion, and other effects. We will explore more of these in the next Viewport.

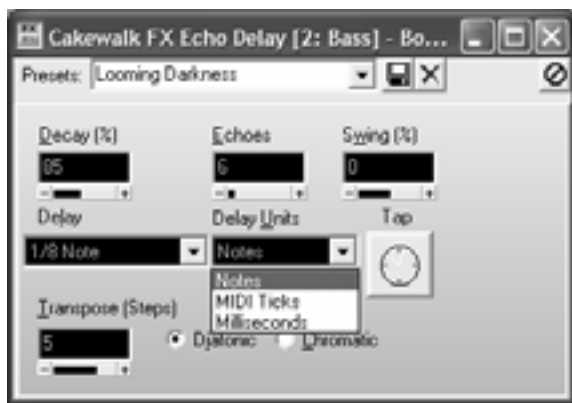
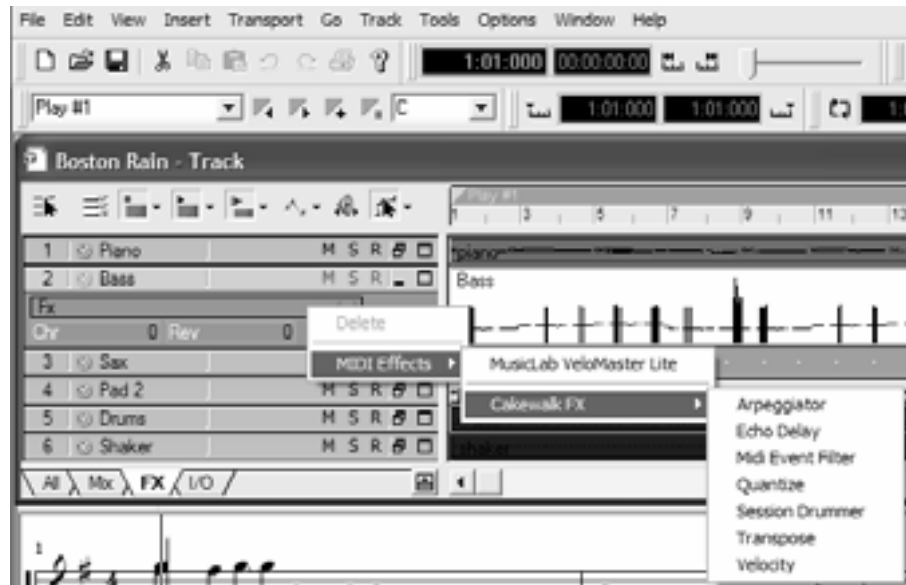
### Virtual Instruments

A recent development in MIDI sequencer technology is the use of virtual instruments. Rather than use the sounds from a MIDI device to play back the MIDI data, you can route the sounds internally to a software program designed to emulate a device or to create an instrument of its own. These are often referred to as “soft synths.” Just as effects plug-ins must be written to a particular format, so too must these collections of virtual instruments. Both the VST and DirectX formats are common; these are often called VSTi (Mac/Win) and DXi (Win) plug-ins. Figure 15.11 provides a view of how these instruments work for Home Studio.

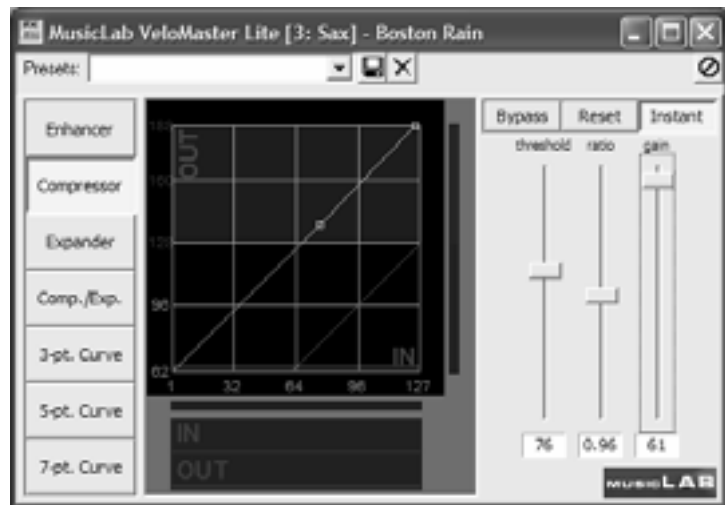
The first step is to create a spare audio track in a project. In that track, you right-click on the “Fx” area and choose the DX Instruments item in the pop-up box. This allows the instrument grouping to be made available in all the other MIDI tracks—in this case, five other tracks. In Figure 15.11, the VSC (Virtual Sound Canvas) from Edirol (Roland) has been accessed. We have chosen the “15488-GM2” bank in four of the five tracks and have used the “Pch” area to choose a particular timbre from that set of GM2 instruments. Notice the dialog box to the right, which contains a listing of the 16 tracks available and the options for effects such as volume, expression, reverb, chorus, and delay.

Once these sounds are chosen, pushing the play button routes the MIDI data through the virtual software so that you no longer need your outboard MIDI

**FIGURE 15.10A**  
Activating build-in effects in HomeStudio



**FIGURE 15.10B** Echo delay effect in HomeStudio



**FIGURE 15.10C** MIDI plug-in MusicLab Velomaster Lite (MusicLab, Inc. [Win])

device. The VSC can also be played directly from the MIDI keyboard if you want. Software options such as these offer still more variety for your music.

## Adding Digital Audio



**DVD-ROM**  
Project 12 Working with Audio and MIDI Tracks

Up to this point, we have been concentrating on the MIDI side of sequencers. In this section, we will review some of the features that exist for entering and treating digital audio information, focusing on the entry, mixing and editing, and effects processing of sound in sequencing programs. Keep in mind that the entry and manipulation of digital sound has much in common with the multiple-track work in Module 12.

**FIGURE 15.11**  
Using a virtual instrument in Home Studio, VSC (Edirol, Roland, Inc. [Win])



**LINK**  
It would be useful to review Viewports III and IV.

### Basic Entry and Data Representation

You can enter digital audio information into your sequencer by simply importing an already-created audio file or by recording sounds in real-time, much like real time entry with MIDI data. By far the most common, this second approach is accomplished by using the microphone and sound-capturing hardware that is part of both Macintosh and PC machines. The microphones that come with computers work satisfactorily for low-stakes real-time recording, but you may want better-quality microphones as your needs become more demanding. For this reason, we recommend the digital audio interfaces reviewed in Module 13 and the multipurpose MIDI/digital-audio interfaces highlighted in Module 16.

As you learned in Module 12, digital-audio information is recorded directly to your hard disk. The number of tracks you can record for a project depends on the computer you're using and the limitations often imposed on cheaper versions of major software titles. Large amounts of hard-disk space are a must, especially if you're recording works that last longer than a few minutes.

Representation of digital audio by most sequencers is integrated right into the track window displays. Return to Figure 15.1, the Power Tracks Pro Audio program that opened this module. Notice there is an audio edit window that represents the audio in Track 3. In the Tracks window, the small icon in the "Ty" column represents MIDI and digital-audio tracks. You also saw this mix of digital audio and MIDI in GarageBand in Module 12.



**LINK**  
Reread the various options for microphones in Module 10.

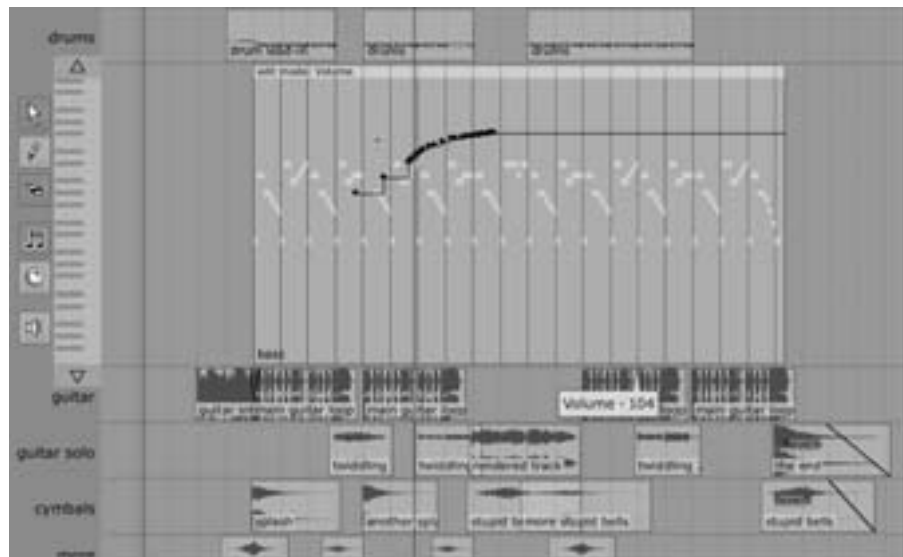
Figure 15.12a displays another example of MIDI and digital audio together in the software Tracktion. The top two tracks (drums and bass) are MIDI and the majority of the remaining tracks are digital audio. In this figure, we've highlighted the first guitar loop in the third track; its detailed information is displayed at the bottom of the graphic. Clicking on a MIDI track replaces the digital information with data about the MIDI track. In Figure 15.12b, we've done this to the bass line in track 2. Notice the display of MIDI notes in an expanded view. We've chosen the pencil tool to draw in volume changes, much as we did in Figure 15.4 in Home Studio.

### Effects Processing

All of the digital audio built-in and plug-in effects presented in past modules are possible with the audio in sequencing software. In Figure 15.13, we've selected a short segment of audio and have called up several options in Home Studio for effects



(a)



(b)

## FIGURE 15.12

MIDI and digital audio together in Traktion (Raw Material Software, Ltd. [Mac/Win])

processing. Many effects are built into the software, but others are plug-ins purchased especially for this purpose or found on the computer's hard drive, where other programs were installed. Notice the full set available in the Sonic Foundry folder.

Another example can be seen with Traktion in Figure 15.14. In the upper right-hand corner, the “new filter” graphic is dragged over the areas that require a new effect in the track lines below. The pop-up window appears with the catalog of effects available for Traktion. Once chosen, the various effects controls are displayed in the bottom area of the main window. In Traktion, effects can be chained, one after the other, depending on where they are dragged.

## Mixing and Mastering

Can you mix and master in sequencing software as we described in Module 12 for multiple-track recorders? Yes, but perhaps not as effectively. Basic-level sequencing software that stresses MIDI tracks and companion digital-audio tracks have



FIGURE 15.13 Effects-processing options in HomeStudio



FIGURE 15.14 Effects-processing options in Tracktion

some mixing capabilities, but you will need to experiment with your software to see how easily the MIDI tracks can be controlled by the mixer. Direct control of the MIDI sound levels and properties may not be supported and you may need to consider a more advanced program.

Figures 15.15a and b show how you might be able to use virtual-instrument assignments to help mix with basic-level sequencers. Here, we've added the DXi instrument we used in Figure 15.11. In Figure 15.15a, we've assigned MIDI tracks 7 and 8 (Banjo and Shaker) to the Roland VSC instrument. Figure 15.15b shows the mixer that now controls not only all of the audio tracks but also the MIDI tracks.



**FIGURE 15.15A** Tracks ready for mixing in HomeStudio



**FIGURE 15.15B** Mixer window and plug-in effects in HomeStudio

You can also include some plug-in effects to help with mastering. Notice in the Drums Left and Bass tracks in Figure 15.15b that we've added these effects in the upper portion of the fader block. Adding these effects also prompts the dialogs on the right, which can be adjusted during playback.

Software-based automation of the built-in mixer settings is also possible. Home Studio allows you to “arm” a track fader for animation and then records your changes while the music is being played. Special bus routing is also a possibility in this software, much like what we described in Module 12. These capabilities are fine for most work. Should you need professional-level results for mastering, multiple-track recorders or DAW software are probably a better bet.

## Saving Sequencing Files

After fine-tuning your music with or without digital audio, you'll want to save your work. You can save for live performance, production of a CD or DVD, or the Internet or other multimedia purposes. Sequencing files for performance can remain with mixed-data structures (MIDI and digital audio). This kind of mixed-data structure can be played directly from a sequencing software program to accompany

instruments or voices in live performance. You can save these files in the file format of the particular sequencer. The computer keeps track of the digital audio segments and MIDI files in directories that you specify. Of course, this means that you need to have your computer with you for the performance venue.

If you want to use a mixed-media file for CD/DVD production or for creating files for Internet distribution, you'll need to convert the MIDI tracks to digital audio so that the entire work can be one data structure. Below, we will describe how to save sequencing files for all nonperformance purposes when you're dealing with only MIDI data or with both MIDI and digital audio.

### MIDI Content Only

Most software sequencers allow you to save at least two kinds of standard MIDI Files (SMF). Type "0" puts all the data into one track and Type "1" saves data into multiple tracks. You will probably want to save your SMFs as Type-1 files so that individual tracks appear correctly in notation software and the files can be switched effectively between sequencing programs for track editing.

If you're planning to save files to be rendered on the Internet or in other multimedia programs, you'll want to assign instrument timbres (patches/programs) to the General MIDI bank set. This will ensure that the built-in instrument timbres within PCs and Macs play back the right sounds.

If you want to store sequencing files that have just MIDI data on CD- or DVD-ROM discs, simply save the information as data. If you have sequencing files that have only MIDI data and you want to distribute the files on CDs-or DVD-audio discs so you can play them back on CD or DVD players, you'll need to save your MIDI files as digital audio (see next section).



#### LINK

Study Module 17 for technical details on CD and DVD formats for data and for audio recording.

### Mixed Data (MIDI/Digital Audio)

Saving mixed data for playback requires you to convert sequencing files into digital audio. You can't just ask your computer to convert MIDI files to audio, because MIDI files contain no direct information about the complex waveforms of digital audio. Another solution is necessary.

In the case of files whose MIDI codes rely on external MIDI hardware devices, you'll need to record the MIDI instrument's audio output back into the audio tracks of your sequencing software. This is actually quite easy to do. Connect the audio outputs of your device to the inputs of your digital audio interface (card or outboard box). Once the connections are made, you "arm" a new audio track on which you want to record and then record. The older MIDI track plays the device and the analog sound from the instrument is recorded digitally. You'll need to follow this procedure for each track of MIDI data.

When all this is done, your sequencing software will have tracks that have both the MIDI codes and the digital information representing the same sounds. You can then "mix down" all of the digital audio to a stereo or surround-sound mix and proceed to master and distribute on CD- or DVD-audio discs.

Of course, if the sequencer files use software-based virtual instruments as described previously, it's a simple matter of mixing down to a stereo or surround-sound mix and proceeding as usual. This is another reason why virtual instruments appeal to musicians.