Opcode Patch Editor:
Yamaha DX/TX Synthesizers

Manual for the *Opcode DX/TX Editor/Librarian* version
(Editor v. 1.20el+)

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Introduction

Overview

If you own a Yamaha programmable digital FM synthesizer, you are undoubtedly well aware that it is capable of producing sounds which are superior to just about any other synthesizer available. However, programming these sounds is not nearly as easy as enjoying them. Opcode Patch Editor is a program that uses the power of the Macintosh to ease the complexity of creating FM sounds, or patches. "Patch" is a misnomer for digital machines such as the DX7, since no hardware elements are being hooked up with patch cords. What you are really doing is playing with numbers (called *parameters*) in a recipe (called an *algorithm*). The Patch Editor can show you all the parameters on the Macintosh screen at once, unlike the DX7, which only displays one at a time.

If you own a TX816 or TX7 synthesizer, a system such as Opcode Patch Editor is required to do any kind of programming, unless you also own a DX7. You edit the sounds in real time and can even "play" your synthesizer by hitting keys on the Macintosh keyboard, or record an example sequence on your MIDI synthesizer keyboard and play it back at the touch of a key, or if you desire, every time you make a change to the patch. Values are displayed graphically, and you can "draw" envelopes and keyboard scaling curves in a manner similar to drawing pictures in MacPaint.

Acknowledgement

The Opcode Patch Editor and this manual were written by David Zicarelli. The author is a doctoral student in the program in Hearing and Speech Sciences at Stanford University, and is studying at the Center for Computer Research in Music and Acoustics (CCRMA), whose director, John Chowning, holds the patent on digital FM synthesis.

The patches supplied in the Tutorial Examples file were created by David Zicarelli and Brian Donovan. And yes, we'll admit it...they were done *before* the Patch Editor was written.

The author wishes to thank Dave Oppenheim of Opcode Systems for his technical and aesthetic advice and assistance during the development of the program, as well as all of the Patch Editor customers who have suggested improvements since its release.

This manual is designed to be of use to people with differing backgrounds and levels of experience in FM synthesis programming and the use of a DX7. The screen might be rather intimidating if you're not familiar with programming the DX7; however you should be able to play around with it immediately without hurting anything (perhaps the neighbors' ears). However, if you have DX7 experience; it should be quite apparent how the program works, and you may never need to refer to this document more than a couple of times.

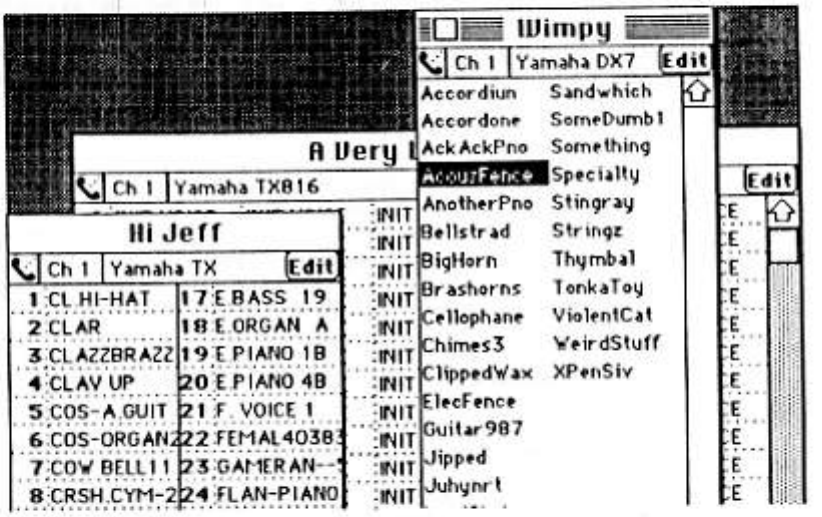
If you already feel that you're a DX7 expert and have a lot of Macintosh experience, the essential thing is getting the computer, software, interface, and synthesizer set up in the right way. This information can be found in the Patch Librarian manual. You might want to then review the Patch Editor Menus section to learn some of the advanced features of the program, such as Copying and Pasting operations.

If you own a TX but not a DX7 and need to know what "programming" is all about, you should definitely go through all the tutorials. I've tried to include just about all of the information in the DX7 manual to get you started. The other thing to do is look at the voices that came with your machine, and also at the Tutorial Examples file included on the Patch Editor disk.

If you've done a little DX7 programming but were frustrated and have never really spent a lot of time with the process, you should also go through the tutorials, although you may be able to skip the first one. You'll also find the reference section helpful, especially the explanations of the Voice Parameters and Performance Parameters.

Starting from the Librarian

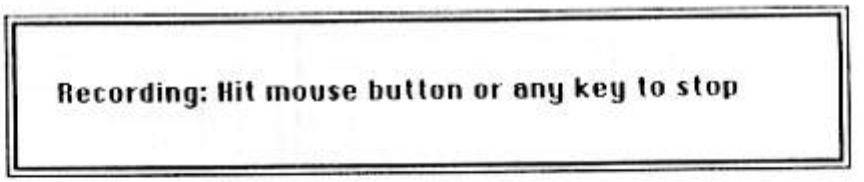
To start the Patch Editor, you select a patch you want to Edit and then click on the Edit button (shown below) in a Patch Librarian DX7, TX, or TX816 Bank or Library window.



The first time the Editor is called, the screen will initialize and the cursor will turn into a coffee cup (telling you to go get a cup of coffee instead of just staring at your watch). After a few seconds, the windows of the Editor will appear with all the information about the patch you selected. In addition, the patch should have been sent to your synthesizer. If this doesn't appear to be the case check to see that the proper steps have been taken to set up the synthesizer. These appear on the screen the first time you open a window for a particular kind of synthesizer and are also found in the Librarian manual.

Now that you have a sound loaded into the Editor, let's listen to it. If you have a piano-like keyboard (such as the one on a DX7), you should now be able to play the sound in the Editor by hitting the keys. You can also use the Macintosh *typewriter keyboard* as a MIDI keyboard. Hit a few of the letter keys toward the left side of the keyboard. The note is held as long as you hold the key down, and stops when you lift your finger. The keyboard is arranged to play the C scale in six octaves. To get the lower three octaves, press the Caps Lock key (*not* the Shift key—notes tend to get "stuck" if you lift up the shift key at the wrong time). The lowest row of keys (ZXCV etc.) is pretty low!

There is also the **Play/Record** menu (also available in the Librarian), within which lurks a tiny MIDI sequencer. If you have a MIDI keyboard connected to the Macintosh (the one on the DX7 does nicely), select **Record Example** from this menu. You will see a dialog box that looks like this:



Start playing an avant-garde melody on your keyboard. There's no hurry to do so because hitting the first note starts the "tape" rolling. The melody can only consist of about 200 MIDI events (that's about 100 notes) but you'll see that's plenty for the purposes of this program.

When you're done, hit the mouse button. Now let's listen to it. Select **Play Example** from the **Play/Record** menu. You should be hearing exactly what you played.

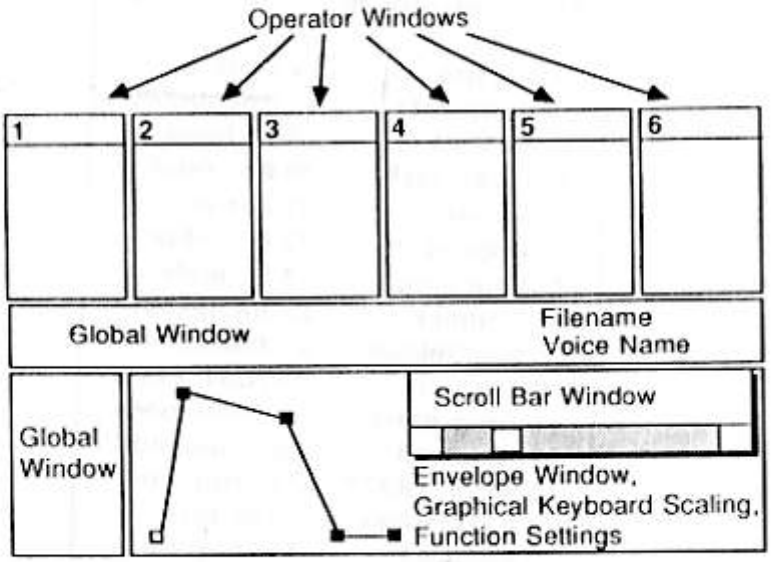
Important tip: Hit the mouse button or any key while the sequence is playing and it will stop immedately. You'll soon find out that you don't want to hear this sequence over and over again in its entirety when you're editing a voice.

Pull down the **Voice** menu. You will see the names of all the voices in the Bank or Library window you're working with. To listen to another voice, just select its name from the menu. The new voice's data are displayed on the screen and sent to the synthesizer. So select a new voice and try your classic Example Sequence on it by selecting **Play Example.**

Returning to the Librarian

To return to the Librarian, select **Exit** from the **File** menu. You'll need to do this to Quit the Editor/Librarian and return to the Finder. You can switch back and forth between the two programs with the Edit button and the Exit command as much as you like. After the Editor has been initialized, switching is quite rapid.

In this tutorial, we'll take a quick look at how the editor screen is arranged and point out some key locations. Then you'll learn the basic techniques needed to create and edit your own DX/TX voices with the MIDIMAC Patch Editor. First though, my apologies for the screen. Certainly it is one of the most complicated and overwhelming Macintosh screens around. However, once you've become accustomed to where everything is, you'll appreciate being able to scan so much information at once. I think that having a complete picture of the sound available to you at all times will be a big help in coming up with ideas about *what to try next* while you're working. Below is a rough sketch of how the screen is organized:



Menu Overview

File Edit Voice Function Record/Play

Apple This menu contains the About box with the Copyright notice and any Desk Accesories you might have in your system.

File This menu allows you to:
- Get the settings of the INIT VOICE
- Load a voice from your synthesizer into the Editor
- Save the current Bank or Library in a file
- Print out the settings of the currently edited voice or an entire Bank or Library

Edit This menu allows you to make certain kinds of changes to the currently edited voice similar to those you might do in a word processor.

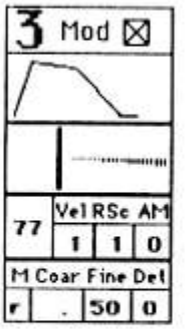
Voice This menu displays the names of all voices in the current Bank or Library file and allows you to select a new one for editing, or make a copy of what you're working with to a new location in a Bank.

Function This menu is allows you edit the TX Performance parameters. If you have a DX7, you can simulate the TX's management of your DX7's Tan Function settings here.

Record/Play This menu, similar to the one in the Librarian, allows you to record and play back a short example sequence to test out your editing.

Operator Windows

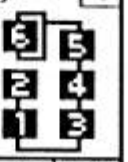
Below the menus are six Operator Windows. These correspond to the six glorified digital sine wave oscillators, or Operators, in your synthesizer. All parameters of the sound which are specific to an Operator are located here. For example, it's clear that each Operator has an envelope, drawn near the top of the window. You'll select a number (or picture, in the case of an Envelope or Keyboard Scaling curve) in this window when you want to change its value.



Below the Operator Windows are parameters which apply to the entire patch, not just to an individual Operator. We'll refer to these as Global parameters, and they include the configuration of Operators; what Yamaha calls an *Algorithm*. A diagram of the current algorithm is provided for you on the left side of the screen. Other examples of global parameters are the Pitch Envelope and the Low Frequency Oscillator (LFO).

PEGRat	99	99	99	99	LFOWave	Spd	Del	PMD	AMD	PMS	Sync
PEGLev	50	50	50	50	Triangl	35	0	0	0	3	On

Algorithm	1



KeyTP	C3
Feedback	0
KeySync	On

Scroll Bar Window

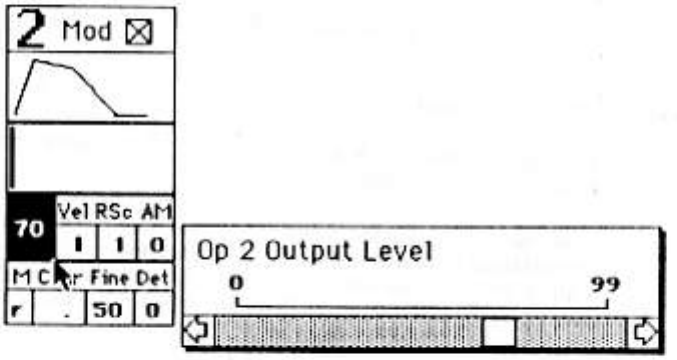
The Scroll Bar Window is one place where you'll be spending a lot of time. It functions as a replacement for the Data Entry slider knob on a DX7. However, I think it is superior in many respects to the DX7's slider. Not only does it show you the name of the parameter you're changing, but it automatically puts the "thumb" (the little white box) at the current setting of the parameter. It also shows you the possible maximum and minimum values for any parameter. We'll discuss this window in more detail a little bit later, but if you're familiar with Macintosh scroll bars, by all means try it out now.

How to Edit: Select with the Mouse, then Change

If you want to change anything in the patch, there are two steps to follow:

Step 1: Select

Select the parameter by Clicking on its current value. What do I mean by that? Here's an example. Suppose you want to change the Operator 2 Output Level, (highlighted below). When you Click on the number 70 (called a *control*), the number is highlighted (turns white against black). In addition, the name of the parameter ("Op 2 Output Level") appears in the Scroll Bar Window and it current value is displayed against its possible maximum and minimum (in this case 0 and 99).



Step 2: Change

Typing

Change by typing the new value. If you want to change the Operator 2 Output Level to a value of 99, just type "99" on the Macintosh keyboard. When you type the first "9", the level is set to 9. Then when you type the second "9" the level jumps to 99. Notice that both the scroll bar and the highlighed number change when you type a number. Now you might think that if you type another "9" the level will go to 999 and smoke will begin to rise out of your synthesizer. Not so; at this point the number keys have no effect. However, if you hit either the **Return** key the or **Enter** key, you can type in a new number. The keyboard is also "reset" when you select (highlight) a different parameter to change.

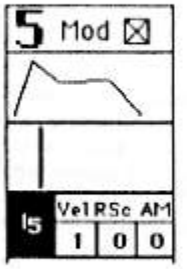
Scroll Bar

Change by using the Scroll Bar. For large changes when you don't have a specific number in mind, the Scroll Bar is the preferred method of changing parameters. In addition, by using the Scroll Bar, you won't have to take your hand off the mouse. Finally, there are some controls on the screen which contain values other than numbers. Since the letter keys are usually reserved for musical performance, these parameters can *only* be changed with the Scroll Bar or the Up-Down Arrow Cursor.

Up-Down Arrow Cursor

Change by using the Up-Down Cursor. The fastest and most convenient way to make small changes to any value is by holding the mouse button down on the number itself. After you select a parameter for editing (like Operator Output Level) you will notice that the cursor changes to a *thin arrow* pointing either up or down. In the top half of the highlighted box, the cursor points up, and in the lower half, the cursor points down. If you press the mouse button while the cursor is a thin up

arrow, the value of the parameter will begin to scroll up by 1, and as you would expect, pressing the mouse button while the cursor is a downward arrow will begin to scroll the value down by 1.

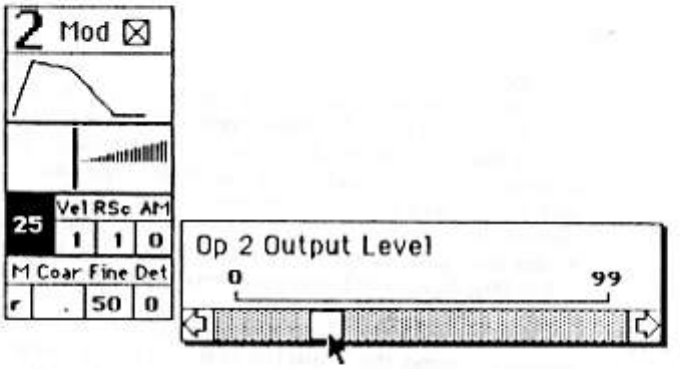


Use of the Up and Down Arrow Cursors

Three Ways to Use the Scroll Bar

Let's take a closer look at the Scroll Bar. There are three different ways to use it to make parameter changes.

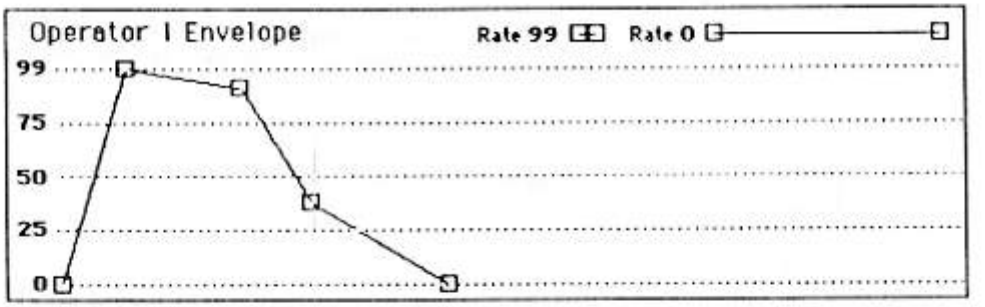
Method 1: You can click inside the polka-dot shaded area and the parameter is changed to reflect approximately that proportion of the maximum value. For example, if the current output level of Operator 2 is at 99, click about a fourth of the way from 0. You should have set the level to 25 or 30. *Notice that the Scroll Bar works differently in this way than it does in most other Macintosh programs.*



Method 2: The little arrows on each side function as the +1 and -1 buttons. If you hold the mouse button down on one of them, they continue to change the current value at a rate of about 4 steps per second, until you reach the parameter's maximum or minimum value.

Method 3: You can also "drag" the thumb around inside its little polka dot cage. When you lift up the mouse button, it's as though you clicked at this spot, so this is exactly like the first method described above.

Perhaps the window that first caught your eye when the program started was the diagram of the Operator 1 envelope. The envelope can be changed by dragging the "corners" of the diagram around on the screen with the mouse. The mouse cursor changes to a "bombsight" when you move it into the Envelope Window. In order to move a corner of the envelope, you have to get the middle of the bombsight inside one of the boxes located at each corner, *then* press the mouse button and drag. As you do this, notice the Rate and Level numbers (corresponding to the corner you're moving) change in the Operator 1 Window.

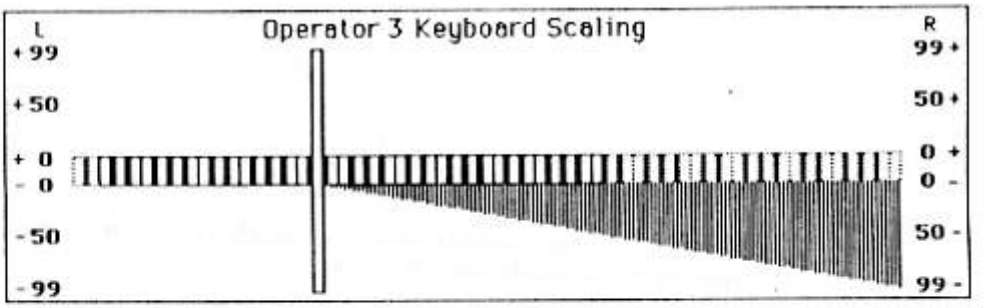


The Envelope Window

To select the other envelopes for editing, just click on one of the reduced Envelope representations in an Operator Window.

The Envelope Window changes into a large representation of the current settings of the Keyboard Scaling when you click on the picture in the box below the Envelope. There are five different parameters you can set using this window. To set the Depth, click the mouse and drag in the columns of numbers on the left and right sides of the window. To set the Break Point, simply click on the key you want and it will "expand." Note that the black part of the keyboard represents the current location of the physical DX7 keyboard (based on the value of Key Transpose). Curve types (linear or exponential) can only be set in the Operator Window using the Up-Down Arrow Cursor.

Note: The miniature representations of the scaling curves in the Operator Windows do not indicate whether the curves are linear or exponential, but they do show sign and depth.



Graphical Keyboard Scaling window

Conclusion So now you know how to change the values of *all* the parameters on the screen. The most important thing I haven't mentioned yet is that each time you make a change, you can listen to it. So hit a few letters on the Mac keyboard while you're playing around, I'll go get *my* coffee and then we'll start the next session.

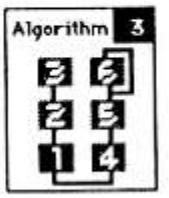
Introduction This tutorial will go through the same material as the "Let's Actually Create a Voice" chapter of the original DX7 manual. Many of you have probably never seen this manual, but Yamaha never sent me the promised "real" manual and training cassette, so it's what I used to learn the machine. (It contains a number of wonderful examples of Japanese-English translation.) Don't expect this to be a killer sound; even if I thought it was one (which I don't) I wouldn't want to incriminate myself by admitting it.

To start "from scratch" select the **Initialize** command from the **File** menu. This will initialize the currently edited voice. Another way you can get the INIT VOICE is to select a **New Bank** (of DX or TX type) from the Librarian's **File** Menu. Then click on the Edit button in that window.

Once you have the INIT VOICE on the screen of the Editor, we're ready to create our clarinet which will make Pete Fountain green with envy. So, now, let's actually create a voice...

Decide on an Algorithm

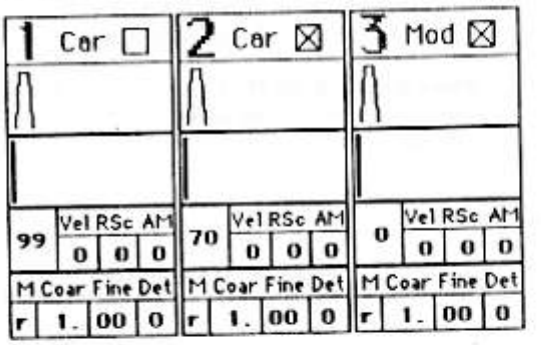
Locate the number of the algorithm above its icon. Click on the number and then set the value to 3 in whatever way you choose. The icon should look like this...



We're only going to use Operators 1 and 2 in this example Voice. Operator 1 will be the carrier (you can tell this because it's on the bottom of the algorithm diagram and also because it says "Car" next to the big number 1 at the top of the Operator Window). Operator 2 will be the modulator. Which leads us to...

Disable all Operators that are not immediately necessary

There are two ways to do this. First, you can click in the Check Boxes at the top of each Operator window. Or, you can click directly on the elements in the picture of the Algorithm. Since all Operators except 1 are currently dimmed, there's no real need to turn them off, but, just for good measure, let's turn off Operators 3-6. When the box is not checked or the Algorithm picture element is gray, it means no sound will come from the Operator. You can also tell the Operator is disabled because the big number at the top of the window is either gray or dark gray (the difference will be explained later). The INIT VOICE has Operators 2-6 dimmed because their Output Level is set to 0 (which is the same as being turned off, right?). Use the Check Box or Algorithm picture when you want to *temporarily* turn off an Operator—this setting is not saved with the Voice.



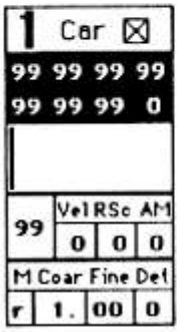
Temporarily Disabled | Enabled with non-zero level | Enabled with zero level

Set the Output Level of Operator 2 to a value of 70. Notice that the number "2" turns black when you do this.

Determine the Carrier Frequency

For a clarinet, they want the Carrier at 2:1. Use the Coarse Frequency control to do this, located at the bottom of the Operator 1 window. You *can't type the number of the frequency* you want. The best way to change Frequency parameters is to scroll the value with the Up-Down Arrow Cursor.

If you click on any of the numbers where the *little* picture of the Operator 1 Envelope should be, the Scroll Bar window disappears and all the numbers become highlighted. You can also just Click on one of the envelope's "corners" in the Envelope Window to select the envelope.

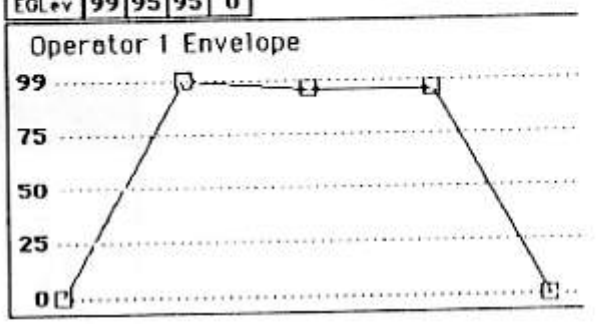


Operator Window showing a selected Envelope

Anything about an envelope can be changed by dragging its corners around. We'll want our carrier envelope to look like the picture below. The numbers are shown above if you want to match them exactly by using the keyboard. With practice, it's possible to this with the mouse; it's sort of like tuning in a radio station. Drag with the mouse and watch the numbers in the Operator Window go up and down. Notice that if you want to change an envelope *level*, you move the cursor vertically, and when you want to change a *rate*, you move it horizontally. If you want to change only a rate or level, hold the Shift Key down before you start to drag a corner, and you'll only be able to move in the direction you initially started in. This is similar to the Constrain use of the Shift Key in MacPaint.

Most of the time you won't know exactly what numbers you want until you're fine tuning the sound, so don't worry about it if you're a frustrated envelope artist at this point. If you feel that you need more practice in hand-eye-mouse coordination, try some exact geometic drawing in MacPaint. As Susan Kare, graphic designer of the Macintosh, is quoted as saying, "FatBits is for sissies."

EGRate	51	50	51	55
EGLev	99	95	95	0



Set the Carrier Envelope to look like this

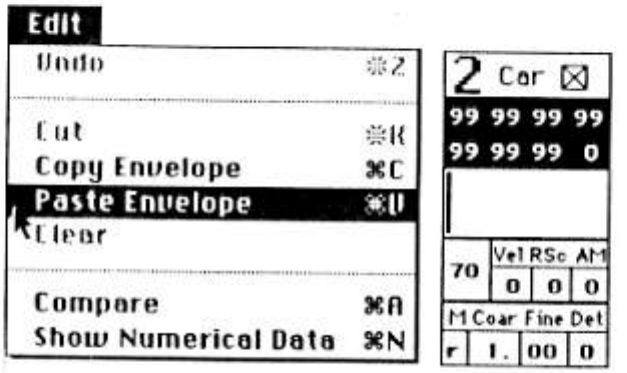
Frequency

The Modulator in our example is Operator 2. You can immediately start working with Operator 2 by clicking on what you want to change in its window. We've already set the Output Level, so now we want to set the Frequency to 2.00, using the Coarse Frequency control. Test the sound to see how clarinet-like it's becoming.

Just for fun, Click on the Fine frequency control. With Fine frequency, you can create an *inharmonic* (i.e. not an integer) ratio. Note that as you move the Scroll Bar to the right to increase the Fine Frequency, the number on the Coarse frequency starts to change as well. The minimum and maximum values that appear above the Scroll Bar are those which apply if the current parameter (either Coarse or Fine) were set to its minimum or maximum, *not* the absolute maximum possible frequency. Having these *two* controls is convenient so that you make harmonic adjustments with the Coarse and inharmonic ratios with the Fine. While you learn how these controls operate, make sure to try out the effects of different frequency settings by typing on the Mac's keyboard. Don't forget to set the frequency back to 2.00 when you're through exploring. Otherwise it won't sound like a clarinet, and we wouldn't want that.

Envelope

In its tutorial, Yamaha wants you to use the DX7 EG Copy function to set the Modulator Envelope, but as this is a Macintosh, we use the Clipboard to *Copy and Paste* envelopes. If you pull down the **Edit** menu when you have an envelope selected, the **Copy Envelope** command is highlighted. Click on the little picture of the Operator 1 envelope you so painstakingly created, and select **Copy Envelope**. The envelope has now been copied to the Clipboard. Now select the little picture of the Operator 2 Envelope. Now select **Paste Envelope** as shown in the figure below.



Pasting Operator 1's Envelope into Operator 2

Voila! Operator 2's envelope is now an exact duplicate of Operator 1's. This feature doesn't really come into much use when you are modifying other people's patches (the preferred way to start programming) but it's very useful for taking data from one voice and putting it into another.

Try out the sound. Perhaps vibrato will help. For this, we will change parameters in the Global Window. First, look at the LFO settings. Yamaha would like you to set the parameters as shown in the example Global Window below but feel free to try your own settings. For the LFO Wave, click on the word "Triangl", and then choose from among six different waveforms by changing the Scroll Bar. You cannot type a number to change this parameter. The other LFO controls all work the same way as, for example, the Operator Output Level parameter.

PEGRat	99	99	99	99	LFOWave	Spd	Del	PMD	AMD	PMS	Sync
PEGLev	50	50	50	50	Triangl	28	36	0	0	1	On

Global Controls: Pitch Envelope and LFO Modulation

To hear the effect of the modulation, you must have one of the controls like the Modulation Wheel on your DX7 set to allow the LFO to control the pitch of the sound. If you don't have a DX7, you can simulate the effect by changing the Pitch Modulation Depth (PMD) to some non-zero value. If you do have a DX7, you can turn the Wheel (or whatever) to hear the vibrato. If your DX7 doesn't seem to be adding vibrato as you turn the wheel, you'll need to change its Modulation Wheel Range (Function 17) to some non-zero value, and also make sure that Modulation Wheel Pitch (Function 18) is turned on. If you're using a TX, the Init "Performance" that was sent to your synthesizer with the INIT VOICE will allow any modulation wheel to add vibrato to the sound.

Right now, INIT VOICE is currently the name of our clarinet. Let's call it something a bit warmer and more descriptive. Click on the words INIT VOICE in the Global Window. The whole name is selected, allowing you type a new name in with the Macintosh keyboard. How about "MacLarinet"... One of the cool things about using a computer with the DX7 is that the DX7 (and TX7) LCD will actually display *lower case*! This, to the aesthetically minded among us, is a wonderful improvement. There's quite a high-tech trend, which I believe may have been started here in Palo Alto, to capitalize letters in the middle of words. You only have 10 characters to name your voice with, so be laconic. When you select something else (i.e. another parameter), the new name is placed in the current Edit Buffer (and is also displayed on your synthesizer's LCD—if it has one). Ah, but if you pull down the **Voice** menu, you will not see the new name replacing INIT VOICE yet (if only things were so simple...). Remember that you are editing a *copy* of the INIT VOICE, and the original is still safely tucked away somewhere else inside your Macintosh.

Store the voice in the Macintosh memory

Select Store Current Edit from the **Voice** menu. Now when you save your Bank or Library file, the new voice will be included. Actually, if you decide to save the file before doing a **Store Current Edit**, the program does the **Store Current Edit** for you.

Save the file to a Macintosh disk

Select Save (if the file already exists) or **Save As...** from the **File** menu. You will be given a standard Macintosh save box. Type a name for your file, and hit Return. The MacLarinet is now saved for future generations on a 3.5 inch floppy disk.

Making a Voice with two sounds and a split keyboard

In this tutorial, we'll take two existing sounds on the supplied Tutorial Examples file of patches, and combine them into one Voice, placing one on the lower half of the keyboard and the other on the upper half. We'll demonstrate Copying and Pasting of Operators and an copying an entire Voice within the Editor to reduce the amount of work it takes to do this sort of task.

Open the Tutorial Examples file

In the Librarian, choose the **Open...** command from the **File** menu. Select either DX7 or TX (there are Tutorial Examples files of both kinds on the disk). Then open the Tutorial Examples file on the Editor/Librarian master disk (you're free to copy this file—unlike the program itself, it's not copy-protected!). After the file has been opened, select voice #20 "StringFlex" and click the Edit button to start the Editor.

Set up an Example Sequence

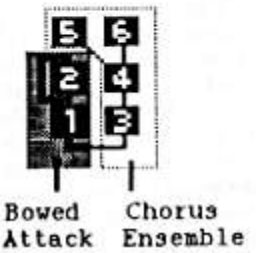
Before we delve into the workings of this voice, why don't you record an Example Sequence using **Record Example** from the **Record/Play** menu. Because we'll be testing the split keyboard technique, you should probably record something which uses a wide range of notes. You might also want to include a variety of staccato and legato events as well. But remember, you've only got a limited number of notes available. Have I put enough pressure on you? The important thing is just to record something, so we can use the automatic playback feature. After you're happy with your Example, enable **Play on Parameter Change** by selecting it from the **Record/Play** menu. Of course at any time during the tutorial, feel free to record something else if you get tired of your Example, or to turn the feature off entirely (select **Play on Parameter Change** again and the Check Mark disappears).

Examine "StringFlex"

Try out the sound if you haven't yet, playing both staccato and long sustained notes. The "Flex" part comes from an attempt to "be flexible" and give the sound a bowed attack portion you hear when playing staccato, and a smooth ensemble color which becomes more prominent as you hold the notes down. So it can sort of sound like one cello or a whole section of 'em depending on how you play.

Let's quickly get an overall understanding of what's going on. The first thing you want to do when trying to understand a patch is look at the Algorithm icon. Notice that there are two independent carriers (1 and 3). You can think of these carriers and the modulators that feed into them as separate "systems." Mixed together they give us the total timbre, but in isolation, each carrier-modulator system may do very different things. Now we want to know which system is making what portion of the sound. Do this by turning off one of the systems—all you need do is disable *one* of the carriers by clicking in its Check Box. The Operator's number should dim when you do this.

Listen to just Operators 1 and 2 by disabling Operator 3. Note that this is definitely the bowed attack portion of the sound. Now re-enable Operator 3 and disable Operator 1. Now you should hear a much mellower, dreamy sound. Thus we have now separated StringFlex into its two components. What we'll eventually be doing is only using the bowed attack portion of the sound (replacing the chorus with a part of another Voice), so let's look a little more closely at the system consisting of Operators 1 and 2. For the following exercises, make sure Operator 3 is disabled.



The two components of StringFlex

Simulating Bowing with Feedback

Probably the most dramatic thing you can do to see how StringFlex achieves the bowed attack sound is to select the Feedback parameter and reduce it to 0. The "life" of the sound has pretty much gone away, no? Now, use Undo (or Command-Z) from the Edit menu to restore the value to 7. If you Undo again, you'll get the 0 back. Undoing *again* gets the 7 back. You might want to try experimenting with other feedback settings besides 0 and 7, but in my opinion, the best results are to be found at 7. Digital Feedback is a rather simple thing for the computer inside your DX/TX to do (although Yamaha has a patent on this particular Feedback implementation) but it has the ability to produce spectra that could only be achieved with an infinite number of carrier-modulator pairs. Generally, you'll find that increasing the feedback tends to produce a rapidly increasing number of harmonics. The increase is so rapid (sort of analogous to what happens when a microphone starts feeding back) that the sound turns into noise. Having an envelope on the modulator which is doing feedback so that you can control what happens over the course of a note (as Jimi Hendrix might do) is the useful thing, and this is basically what is responsible for the bowing sound.

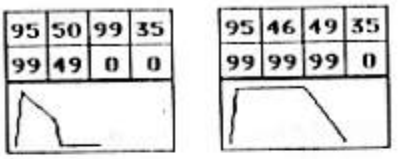
Make a Copy of StringFlex

We'll want to keep the original of StringFlex around in addition to our new combined sound, so we should make a copy of StringFlex to play with. Location number 32 in the Tutorial Examples bank file has been left "blank" for this very purpose. You could make a copy of StringFlex in the Librarian but there's a quick shortcut in the Editor. While holding down the **Command** (cloverleaf) key, select Voice #32 from the **Voice** menu. You've now put the current Edit in location number 32.

Note that this technique will only work in Banks, since Libraries sort of give you the third degree about having duplicate names and parameter settings.

Now let's turn our attention to the sound we'll be combining with the bowed part of StringFlex, sound #10 which is called Dry Harp. Select it from the Voice menu (well be editing the copy of StringFlex we made in location 32).

In Dry Harp, only 3 Operators (1-3) are used. The rest of the Operators (4-6) are dimmed, because their Output Levels are 0, and are thus not contributing one iota to the patch. If you examine the Algorithm, you'll see that the sound is being produced by a modulator feeding another modulator which feeds the carrier. This is known in the FM biz as "cascade modulation." Operator 3 is perhaps the most interesting thing to look at. If you disable it, the loose twang of the pluck disappears. Generally the "higher" modulators in a cascade modulation system can most effectively contribute *transients* (short high-frequency events) which are often a subtle but important cue for our ears to perceive a more "natural" result. You'll notice that Operator 3's envelope is signifigantly sharper than that of either Operator 1 or Operator 2. If you make the envelope look like the one on the right below, you'll notice that the "transient" has become much less convincing.

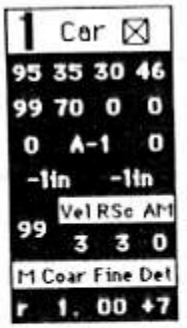


"Transient" **"Irritation"**

Two possible Operator 3 Envelopes

Keyboard division for the Strng&Harp voice

Now we want to use the Clipboard to transfer the Dry Harp's Operators 1, 2, and 3 to Voice 32. We can copy these to the Clipboard all at once by using the standard Macintosh "shift-select" technique. Click on the "1" in the Operator 1 window. All the numbers in the Operator become highlighed and the message in the Scroll Bar Window informs you that you've selected an Operator for Copying. Your Operator 1 should look like the picture below.

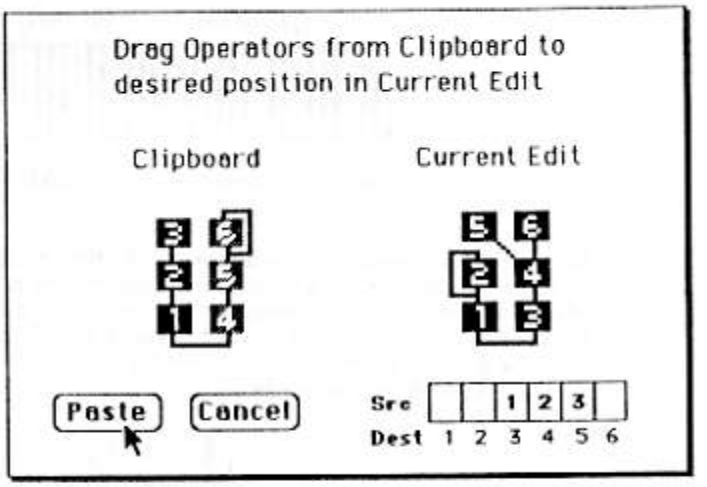


Operator 1 Selected

Now, while holding down the Shift key, select Operators 2 and 3. Once you've got all three selected, choose **Copy Operators** from the **Edit** menu. The essence of Dry Harp is now on the Clipboard.

Return to the StringFlex in location 32 by selecting it from the **Voice** menu. Since our bowed sound is located in Operators 1 and 2, we don't want to move the Dry Harp there. Examine the algorithm used in StringFlex. It looks like we have a cascade modulation system available in Operators 3,4,5, and 6 (even though we don't need 6). Things work out so nicely in software tutorials, don't they?

If you look at the **Edit** menu now, you'll see that the **Paste Operators...** command is highlighted. Select it, and you will see the following dialog box appear on the screen:



Multiple-Operator Paste Dialog

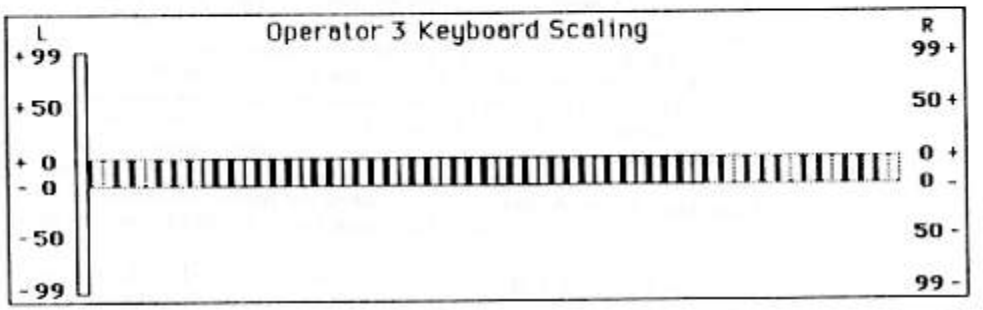
Your task is now to drag the highlighted operators from the Clipboard algorithm picture (note that it's the algorithm used in Dry Harp!) to their new homes in the Current Edit algorithm picture. In our case, we want to move Clipboard 1 to Current Edit 3, Clipboard 2 to Current Edit 4, and Clipboard 5 to Current Edit 5. Dragging the Operators works in exactly the same way as does dragging a file to the trash can in the Finder (and you've all had experience with that, right?). When you're finished dragging, the Dialog should look like the one above.

Our final step is to change the Keyboard Level Scaling of the Operators to allow only the string sound to be heard on the lower half of the keyboard, and the harp sound to be heard only in the upper half. I'm just going to suggest settings I found to be the most effective in doing this, although with a bit more patience you might be able to come up with something better.

First, let's bump off Operator 6 permanently by turning its Output Level to 0. Operator 6's number will turn gray (if it isn't already) at this point. If you've been listening to the sound as you've progressed this far, you should now hear a slightly thin bowed string sound dominating a harp sound playing an octave lower. We won't be able to do anything about the thinness of the bowed string, but this is only an *example*.

In order to produce the effect of splitting the keyboard, we have to set the Level Scaling of the two carrier Operators in the voice to drop off sharply on opposite sides of the middle of the keyboard. The "middle of the keyboard" shifts depending on the setting of the Key Transpose parameter.

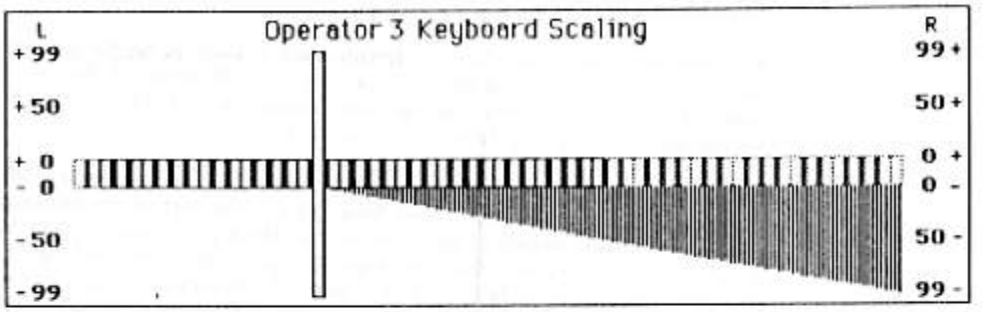
Select the small Scaling picture for Operator 1. You'll now see the Graphical Keyboard Scaling window. Note how the middle part of the keyboard is Black while the outside region is gray. Well, the Black part represents a *physical* DX7 keyboard, where as the gray areas represent possible settings of the scaling Break Point that *aren't on the keyboard*. For those of you lucky enough to own a keyboard with more keys than a DX7, I apologize for not allowing a variable length physical keyboard, but on the other hand, I don't really feel sorry for you. Your keyboard extends one octave on either side of the 61-note DX7 keyboard.



In the picture above, the setting of the Key Transpose is at C3. Try changing this parameter, and watch the Black part of the keyboard move up and down. This should help you locate Break Points on the physical keyboard rather easily. For our example, the Key Tranpose has been set at C2. This means that when we click on a key for the "middle of the keyboard" in the Graphical Keyboard Scaling diagram, it will be an octave lower than what might otherwise have been expected.

So anyway, it turns out that you want to set the Break Point for Operator 1 (the string sound carrier) a little bit below where you want the sound to die out, since the scaling curve is not a sharp drop off. Set the Break Point for Operator 1 to about D2 by clicking on the proper D key on the scaling keyboard.

Now, to get the strings to disappear quickly, we'll use the most "powerful" curve, the negative linear (-lin). This is, of course, the Right Curve, since we are scaling the level *above* the keyboard Break Point. Click in the lower right corner of the scaling display, on the number -99. A striped triangle should appear beneath the keyboard and the numerial display in the Operator window should read "-lin" and 99 as shown below.



Scale the Harp For the Harp's carrier, Operator 3, we want the sound to disappear over the bottom half of the keyboard. Thus you will want to set the Break Point a little bit above the String sound, though this is certainly within the realm of "seasoning to taste." I decided that G2 was an appropriate spot. After you've set the Break Point, set the Left Curve to -lin, and the Left Depth to, of course 99. The scaling is basically complete, but if you now play the lower regions of the harp, it seems to have lost a bit of it definition. The trick here is to increase the level of the first modulator as the carrier is disappearing. This won't make the overall sound of the Harp any louder in the regions where we don't want it to show up, since the carrier is "shutting off" anything the modulators produce when we reduce its output level (notice that we haven't had to scale the modulators to achieve the split keyboard effect).

Set the Operator 4 Break Point to about G3, the Left Curve to +lin or +exp (I thought the latter sounded slightly better), and the Left Depth to 65. That's about how I left it, although if you think the Strings are too loud in comparison with the Harp, you might want to reduce the Output Level of Operator 1, or, more cleverly, give Operator 1 some Key Velocity Sensitivity (about 3), which will reduce its Output Level relative to the Harp for the same keyboard pressure, but allows for some flexibility in performing the Voice.

Further work on this voice might lead you to devise a use for Operator 6 in the Harp sound, perhaps to come in with a second transient slightly after Operator 5's to give the impression of having plucked two strings.

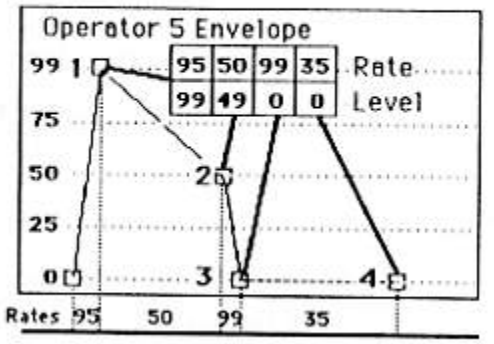
Envelopes

Envelopes are graphically represented in a format which does *not* accurately represent their real shape, time or amplitude. However, that doesn't mean they're not displayed in a helpful manner. The representation used in Patch Editor is designed to make it easy to *manipulate* the Envelope, rather than to display accurately the real representation of time and level.

Note:

Information on Envelope timing is presented in the Tables and "Inside DX/TX Envelopes" section of this manual.

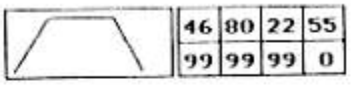
Each line represents a connection between a Rate-Level Breakpoint. I decided simply to graph Rate vs. Level and allow you to move one breakpoint around in this two dimensional space. The movement of the other parts of the Rate vs. Level graph when you "pick up" a Breakpoint and move it around on the screen maintains the represenation of all the other breakpoints in the envelope. You will also notice that further mouse movement beyond a certain point does nothing. This happens when you have moved one (or both) of the values in the Breakpoint to 99 or 0. One pixel on the Macintosh screen represents a value of 1 in both rate and level. There is also a 8x8 pixel gap to leave spaces for the Breakpoint rectangles that you pick up and drag around.



Envelope Diagram showing relation to numerical controls

Notice that the rate (reperesented by the horizontal axis) is actually graphed *backwards* from the number Yamaha uses to represent the setting. A rate of 99 places the Breakpoint rectangle right next to the previous one, and a rate of 0 moves it a maximum distance away (100 pixels).

Envelopes can be displayed in two ways depending on the setting of the **Show Numerical Data** menu item in the **Edit** menu. The editor will initially display a 25 percent reduction of the larger diagram described above. If you've selected Show Numerical Data, this small picture will be replaced with the eight numbers of Rate and Level breakpoints. When you select an envelope for editing, both of these are replaced a highlighted display of the current numerical settings. The rates are displayed along the top row, and the levels are on the bottom.



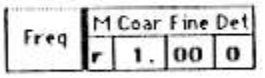
Miniature Envelope and its Numerical values

The Pitch Envelope (in the Global Window) maintains the numerical representation all the time, since for the vast majority of pitch envelopes a 25% representation is totally useless. When you drag any of the rate-level Breakpoint rectangles, the corresponding numbers change in the operator window in relation to your mouse movement. When you lift up the mouse button, the new setting of the envelope is sent as a parameter change to the synthesizer.

There are a couple of important points to make about all of this. First, you should notice that the graph is of rate versus level, *not* time versus level, the traditional way electronic music teachers have drawn envelopes for centuries. But don't worry; you'll begin to associate these graphs with the sounds they make just as readily as if you dealt with the actual time-level graphs.

Operator Frequency

Besides the envelopes, the Operator Frequency control in the Patch Editor is the only other aspect of the editing mechanism that may not be obvious at first glance. The four Frequency controls (located on the bottom row of each Operator Window) work exactly in the same manner as those on the DX7. One important thing to note is that none of the frequency controls respond to numeric keyboard input. You have to use the Scroll Bar or the Up-Down Arrow Cursor to change all settings.



Oscillator Mode (M)

This determines whether the Operator's frequency will be a Fixed ("f") frequency no matter what key you hit, or whether it will be a Ratio ("r") of the note you play. Just about every sound supplied with your DX or TX uses the oscillators in the Ratio ("r") mode, since it represents the usual structure of tonal instruments. A good example of a sound with both Fixed and Ratio frequencies is the "Triangle" sound on the "Tutorial Examples" Bank file which comes with your Patch Editor.

When the Mode is set to "f" the Coarse and Fine frequency controls work differently than they do in Ratio mode. Read below for details.

Coarse Frequency (Coar) and Fine Frequency (Fine)

These two controls are located right next to each other and together they always show the current representation of an Operator's frequency. You can make either a major or minor change in the frequency by clicking on the Coar or Fine number respectively.

Ratio Mode: Major (usually harmonic) changes are made with the Coarse Frequency parameter. In Ratio mode, you can change the frequency from a minimum of .50:1 to a maximum of about 49.00:1. Exactly what the values are also depends on the setting of the Fine Frequency parameter. Most of the time (in a completely harmonic case) there is no additional Fine frequency component, and the Coarse Frequency range above the Scroll Bar shows .50 to 31.00. When you add any amount of Fine Frequency, the values selected by settings of Coarse Frequency spread out and become inharmonic. The formula for the effective frequency ratio is as follows:

Real Frequency Ratio = Coarse frequency step (0=.50, 1=1.00, 2=2.00 ...31=31.00)

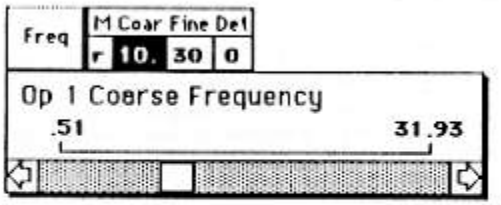
+

Fine Frequency step (0 to 99) * (Coarse frequency value * .01)

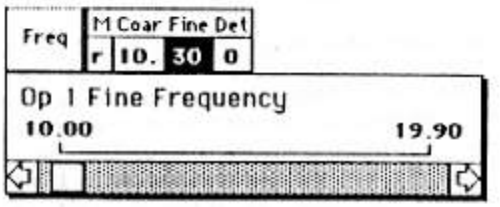
Ratio Mode: An illustrative example

If you have moved the Scroll Bar over 10 steps in the Coarse Frequency parameter and 3 steps in the Fine Frequency parameter, the resulting frequency ratio is:

10.00 + (3 * (10.00 * .01)) = 10.30 : 1



Appearance of the Scroll Bar on Coarse Frequency for a ratio of 10.30



Appearance of the Scroll Bar on Fine Frequency for a ratio of 10.30

The whole thing will be cleared up intuitively when you actually try adjusting the Coar and Fine controls in the program. The musical implication is that small amounts of Fine Frequency steps produce beating, chorusing, or slightly out-of-tune effects, and large changes produce inharmonic ratios (found in bells and drums).

Fixed Mode Things are little simpler in this mode. If you select Coarse Frequency, you can multiply the Fine Frequency by a factor of 1, 10, 100, or 1000. The Fine Frequency values go in 100 steps from 1.000Hz to 9.772Hz. The steps are not evenly spaced apart, in fact, the step differences don't even *increase* steadily. There are some rather strange gaps between a couple of the steps, but this is only a curiosity that amuses engineers—musicians don't need to be concerned with it. A table of the Fine Frequency values for each step is provided in the Tables section of the manual and is also outlined in the MIDI documentation for the TX7 and TX816 synthesizers.

Oscillator Detune (Det)

A value of 0 for the Detune parameter is in the middle of the possible range. Values on either side of 0 have a plus (+) or minus(-) sign in front of them, indicating whether the frequency is being slightly increased or decreased. The perceptual effect of the detune is more noticable at higher frequencies. You can also use slight differences in Frequency as detuning. Usually you think about detuning carriers for a "chorus" effect. However, an example of slightly mistuned modulators is found in the MerryGoRnd voice in the "Tutorial Examples" Bank file. Another good technique to employ with Detune is to have three or four slightly detuned copies of the same voice playing the same note at the same time. This is possible with the TX816 or a multitrack tape recorder.

Operator Output Level

Output Level is one of the most important parameters to look at when you are trying to figure out an existing patch, so it is larger than any other single control. It is a standard numerical control ranging from 0-99. When you set the Output Level of an Operator to zero, you make it completely irrelevant to the sound you're hearing. The Patch Editor indicates this fact for you by *dimming the number of the Operator* in the Operator Window (and in the Algorithm picture) for all Operators whose Output Level is zero. If you change the output level to a non-zero value, the number turns black again.

Note: See Operator On/Off (below) for more information about number dimming.

One rather subtle thing to realize is that any modulators which are feeding into an Operator whose Output Level is zero are also not contributing to the sound. The implications of Output Level for a carrier are quite obvious: an increase in loudness. For a modulator, a larger Output Level setting tends to increase the number and amplitude of the partials of a note. Therefore, you could draw an analogy between decreasing the Output Level and decreasing the cutoff frequency of a low-pass filter in an analog synthesizer. Both tend to make a sound more closely resemble a sine wave, although in different ways.

Operator On/Off

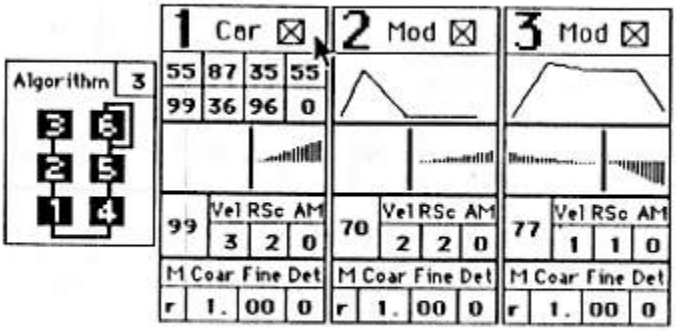
There are two ways to temporarily turn the output of an Operator On or Off. This act tended to be more important when using the front panel of a DX7 than it is when using the Editor, but it can still be helpful in identifying components of Voices with multiple Carrier-Modulator systems.

Note: The On/Off setting is *not* stored permanently with the Voice.

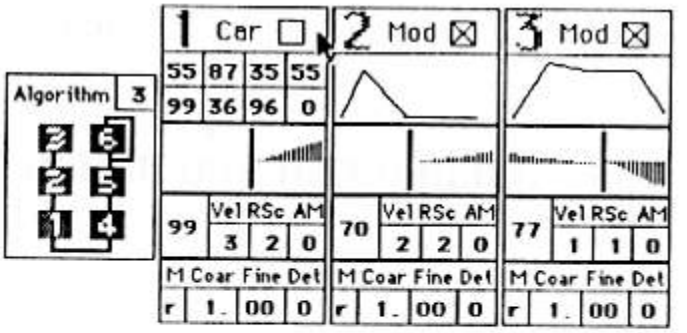
The *Check Box* next to the number of each Operator can be used to turn the Operator on or off. When checked (as it is when a new voice is edited), the box indicates the Operator is on. However, as discussed above, being On does not necessarily mean that it's doing anything. You can also, if you wish, click on the number of the Operator you want to disable/enable in the *Algorithm picture*.

Gray Shading: Both the algorithm picture and the number of the Operator will turn gray for any Operators that are disabled, or for Operators whose output is being fed into disabled Operators. In the latter case, the Operator number turns *dark gray* if its Output Level is non-zero.

The subtle shading of all of this is illustrated in the following example. Note that in the Before picture, Operators 2 and 3 are modulating Operator 1, which has a non-zero output level. In the after picture, Operator 1 has been turned off (there's no check in the check box). The number for Operator 1 has dimmed to gray (indicating no output) and the numbers for Operators 2 and 3 have turned to dark gray, since they are having no effect even though they do have output. Note also that the Algorithm Icon now reflects whether Operators are on or off (see the After picture below).



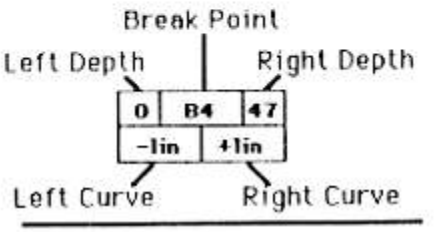
Before Turning Operator 1 off



After Turning Operator 1 off—Note Algorithm Icon

Keyboard Level Scaling Parameters

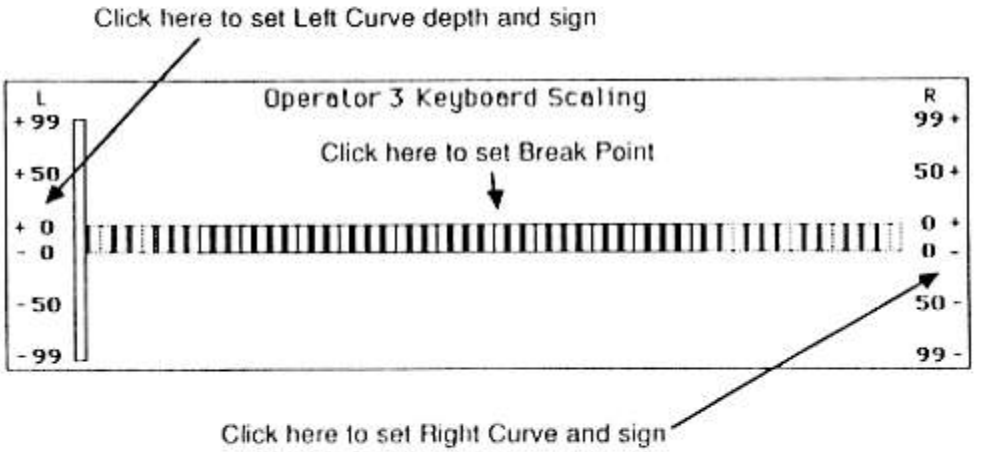
"Keyboard Level Scaling" refers to your synthesizer's ability to add or subtract to the Output Level of an Operator depending on what key is played. There are five parameters that determine the level scaling of an Operator, and in the Patch Editor, they are grouped together in the middle of each Operator window. There are two independent scalings possible, called Left and Right, which occur on either side of the Break Point key. A diagram on the top of a DX7 illustrates the Scaling features.



Level Scaling Controls

Usually, you won't see any of these controls until you select the Scaling picture in the Operator window. This picture is below the Envelope and will look similar to one of the following:

When you select an Operator's Scaling to change, a larger representation of the scaling parameters appears in the Envelope Window, and the five controls become highlighted. The most intuitive method of changing the parameters is to use the larger representation shown below.



Break Point The Break Point determines the boundary between the two scaling curves. This control is located in the middle of the five Scaling controls (wonder why?) and displays the current note on the keyboard where the Break Point is located. 99 notes are possible (obviously more than are on most keyboards!), ranging from A-1 (27.5 Hz—below what we can hear) to C8 (approx. 8300Hz—above where we can accurately determine the pitch of one note from another). If you pick a Break Point at one of these two extremes, you are in effect saying that you only want the scaling to occur in one direction. A Break Point at A-1 means that only the Right Curve will have any effect, and a Break Point at C8 means only the Left Curve is relevant.

To change the Break Point, click on any of the keys in the rather perverse keyboard that spans the length of the lower window, even the ones that are dimmed out. That key will then "expand" to the full height of the window and the scaling diagram will be redrawn to reflect the new Break Point. Alternatively, you can use the Up and Down arrows to change the settings and a key will happily bounce up and down the keyboard until you lift up the mouse button.

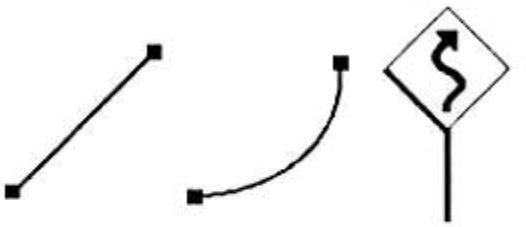
Left and Right Depth

The Depth determines the amount of scaling that takes place. These are standard numerical controls that range from 0 to 99. If you have a depth of 0, no scaling is taking place, and as such, changing the corresponding Curve type has no effect.

To set the Depth and the sign of the Curve (positve or negative Scaling), click in the areas on each end of the Scaling window where the numbers are located. You'll then see a striped area filling in the area between the Break Point and the edge of the window. Clicking in the numbers above the keyboard will result in a Positive (+lin or +exp) curve, while clicking below the keyboard produces a negative (-line or -exp) curve. You can also use the Up and Down arrows or the Keyboard to set these values, though you won't be changing the sign of the Scaling.

Left and Right Curve

For each side of the Break Point, these parameters determine whether the scaling adds to or subtracts from the Output Level, and in what progression as you go up or down the keyboard. Possible curves are "-lin" (negative linear), "-exp" (negative exponential), "+exp" (positive exponential), and "+lin" (positive linear). Most people find the linear curves have a more noticeable effect with the same amount of Depth.



Linear Curve Exponential Curve Dangerous Curve

Use the Up and Down arrows to select a Linear or Exponential curve. You can set the sign of the curve using the technique in the large scaling display described above in the discussion of Depth.

Key Velocity Sensitivity (KV)

One of the more wonderful ideas embodied in the DX7 implementation of FM synthesis is that of changing the Output Level of an Operator (which changes the timbre and/or loudness) in response to increased key velocity. With this parameter you control *how much effect* the velocity information has on the Output Level.

The parameter ranges from 0 (no effect) to 7 (maximum effect). The result of increasing the Key Velocity Sensitivity is first to subtract from the Output Level, and then add an amount back depending on the key velocity information. So you may find you have to hit the keys pretty hard to get a loud sound with the Velocity Sensitivity set at 7.

How to adjust the Velocity Information of the Macintosh keyboard

In the Global Window to the right of the name of the voice you're currently editing is a lonely control labeled TstKV (for Test Key Velocity). Initially it is set at 64 (the standard MIDI velocity number for non-velocity sensitive keyboards). TstKV changes the key velocity number that is sent when you perform a sound on the *Macintosh keyboard*. You can change it by selecting it just like any other control, or, while you are performing, by hitting the < and > keys, which increases (>) or decreases (<) the transmitted key velocity by a value of 8. Note that the Test Key Velocity is not stored as part of a voice, and remains where you last set it until you quit the Editor/Librarian. Note also that while you're using the Librarian and "Testing Sounds" mode, the value of TstKV remains where you set it in the Editor.

Keyboard Rate Scaling (RSc)

With this parameter, you can set the amount of *increase* in the Envelope rates which occurs as you go from the bottom to the top of the keyboard. Scaling can be calculated with the use of the graph in the Tables section of the manual.

Note that as with scaling of the Output Level, if your Envelope Rates are all 99 (you like clicks, no?) not much is going to happen as you play higher notes for two reasons: First of all, a rate of 99 is the synthesizer's "top speed" and secondly, even if it did have faster rates, our ears cannot perceive *differences* in rise and decay times any faster than about 5-10 milliseconds (rates of 99 generally correspond to 3 milliseconds).

Amplitude Modulation Sensitivity (AM)

Certainly the most unused parameter on the synthesizer, AM sensitivity has some interesting applications in conjunction with the Amplitude and EG Bias Function controller assignments. When set to a non-zero value, it decreases the Output Level of an Operator so that you can gain control it by manipulating a wheel or pedal and/or setting the Amplitude Modulation Depth (AMD) of the LFO to a non-zero value.

One use of the AM parameter is tremolo. Note that tremolo can be applied to either carriers or modulators. With carriers, tremolo results the traditional periodic variation in amplitude, but with modulators, you get a periodic variation in timbre because the Output Level of the modulator is increasing and decreasing with the LFO Wave. To achieve tremolo effects, set AM to a non-zero value. Then you have a choice of setting the LFO AMD (Amplitude Modulation Depth) to some non-zero value or turning on the Amplitude for some Function controller (such as the Modulation Wheel) and manipulating the controller, or both. AMD will produce a certain amount of tremolo independent of what you do with the controller, whereas using a controller will allow real-time changes in the effect. Note that if the AM is set at zero for any Operator, no tremolo effect can be applied to that Operator.

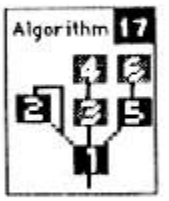
AM can also be used to enable EG Bias, a Function control no one seems to have bothered to figure out (including me, until I had to write this manual). Try setting AM to 3 for all the carriers in a voice and the EG Bias to On for some controller. With the controller's range set at a maximum and the contoller all the way down (such as not blowing into the Breath Controller), no sound will be heard when you play a note on the keyboard. But as you manipulate the controller and play the keyboard, you'll see that you have a sort of "volume pedal" on the sound. More information can be found in the Performance Parameters section of this manual.

Global Parameters are not tied to any one of the six Operators; their effects are applied to the sound as a whole. The Global Parameters include the name of the Voice, LFO for vibrato and tremolo, the Algorithm used to configure the Operators, the Pitch Envelope, Key Transpose to place your sound on the keyboard, and a rather subtle parameter called Oscillator Key Sync.

Algorithm

When you select the algorithm control, you can change how the Operators are connected together. Every time you make a change to the Algorithm, a diagram of the configuration is displayed below the number of the parameter. There are 32 Algorithms, displayed on the top of a DX7 and in Table 5 of Appendix B. In switching Algorithms, you may also be changing whether an Operator is a carrier or a modulator, so this information is redrawn at the top of the Operator Windows. Choosing an algorithm is on one level quite important and on another rather arbitrary. There are several classifications of FM synthesis, distinguished by the connections between two or more Operators, but all are based around the principles of the basic carrier-modulator pair.

Note that the algorithm picture displays which Operators are contributing to the sound (black) and which are not (gray). You can also enable and disable Operators by clicking on the numbers in the algorithm picture.

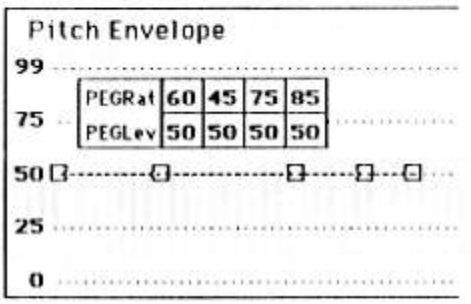


Pitch Envelope (PEGRat, PEGLev)

The Pitch Envelope allows you to add what is known in the computer music biz as Frequency Skew to your patch. Every acoustic instrument (and certainly the human voice) has some kind of change (skew) in pitch over the duration of a note, so many DX/TX voices that try to emulate real instruments have a subtle envelope applied to their frequency. And if you're into emulating internal combustion engines, the Pitch Envelope at its less-than-subtle worst can help you simulate increases in RPM.

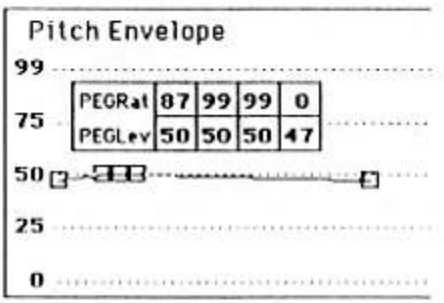
When you select a Pitch Envelope control, a representation of the current envelope is displayed in the Envelope Window and can be manipulated graphically with the same techniques as Operator Envelopes. Refer to the discussion on Operator Envelopes for more information. The only difference between Pitch and Operator Envelopes is that when you are not editing a Pitch Envelope, a 25% reduction of the envelope is not shown since most of the changes in the Levels are too fine to show up in a such a diagram.

All four Levels set at 50 represent no change in the pitch of the sound, as in the example below:



Ineffectual Pitch Envelope

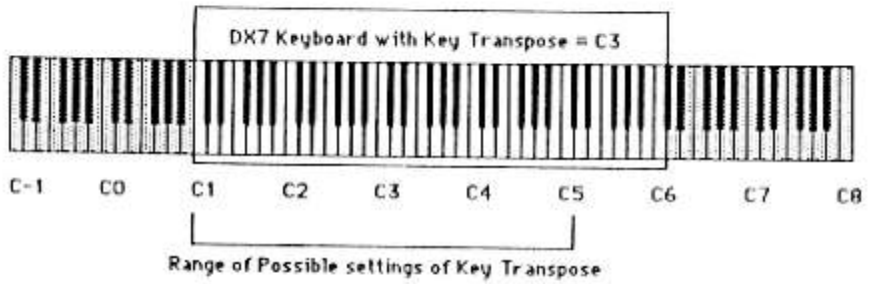
One rather non-intuitive thing to realize is that if you want the envelope to either drop or rise in pitch at the onset of a note, you have to change *Level 4* at the termination point of the envelope. The pitch rises from and decays to Level 4 when a note isn't playing. If you don't want to hear the pitch falling back down at the end of a note, change Rate 4 to 0 and it will change in pitch more slowly than the decay of the Operator Envelopes (unless *their* Rate 4s are set at 0, which is usually a big mistake). An example of this technique is shown below.



Clever Pitch Envelope

Key Transpose (KeyTP)

This parameter allows you to select the best range for your patch on a keyboard, or, if you want to play in a different key without learning how to hit black notes, you can select a value other than C1, C2, C3, C4, or C5 to transpose your performance. The value is is the "absolute pitch" sounded when you hit the third C from the bottom of the DX7 keyboard (although depending on the Operator Frequency settings, you may not actually hear this pitch).



Note that the Key Transpose affects where the keyboard level scaling Break Point of an Operator lands on the *physical keyboard*. You can see this visually when you change the Key Transpose while an Operator's Scaling is selected. The black part of the keyboard represents the physical keyboard amongst all the possible Break Point values (which extend from A-1 to C8).

Key Transpose has rather interesting implications in terms of MIDI. On the TX816, for example, you could have all eight TF1s playing in different keys even though you are sending only one MIDI note at a time. (You can also get similar results, what a friend of mine calls the Dave Rose Effect, by using the the Transpose Keyboard mode in the MIDIMAC Sequencer).

Note that this control operates in the same manner as Break Point in the Operator Window. You cannot type numbers on the keyboard to change the setting.

Feedback

Digital feedback is a way to create timbres which would otherwise require an infinite number of Carrier-Modulator pairs. The DX/TX Feedback parameter is responsible for making many otherwise ho-hum Voices interesting. It can simulate the sound of bowing, the splatter of a brass attack, or create an infinite spectrum (white noise) for explosions, cymbals, and seascapes. Only one Carrier-Modulator system is affected by Feedback in each Algorithm, denoted by the line that wraps around (or feeds back into) the Modulator of that system.

Thus to hear the result of feedback, you need to have the Output Level of the Operator which will be feeding back set to some non-zero level. The Output Level of this modulator Operator will contribute enormously to how much feedback you hear, along with the setting (0-7) of Feedback itself, and the Output Level of any modulators or carriers "below" the feedback Operator.

Note One algorithm, number 32, has a Carrier which contains feedback. It's not what you would call an earth-shattering sound, however, reminding me of the wimpiest thing you get out of a Farfisa organ.

Oscillator Key Sync (KeySync)

This parameter can be either On or Off. It determines whether the phase angle of an Oscillator is synchronized with the onset of a note (On) or by an internal clock (Off).

For a demonstration of the difference, set your synthesizer to a sound like the DX7's E. PIANO 1 (the staple of MOR Pop these days) and play lots of notes holding the sustain pedal down. With Key Sync *On* you'll hear little clicks every time you play a new note if all 16 are sounding. With Key Sync Off (the way the parameter is set in E. PIANO 1) the clicks go away.

The LFO

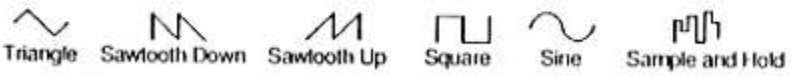
The LFO (Low Frequency Oscillator) applies periodic varitions in pitch and/or amplitude (called *modulation*) to the Voice as whole. With the exception of the LFO Wave, all of the LFO controls accept either keyboard or Scroll Bar input.

LFOWave	Spd	Del	PMD	AMD	PMS	Sync
Triangl	35	36	67	26	3	On

LFO Controls in the Global Window

LFO Wave

Determines the shape of the periodic modulation. As you change the setting of the Scoll Bar, different wave names are displayed in the control. From left to right, you have a choice of:



LFO Speed (Spd)

Vary this control from 0 to 99 to set the speed of the LFO. Generally a setting between 25 and 40 approximates the vibrato speed of most acoustic instruments.

LFO Delay (Del)

This parameter controls the initial period after a note starts before the LFO begins operating. A similar effect is generally found in the more enlightened brands of home organs. 99 is the maximum delay, about four seconds. If you listen closely, you can hear that the synthesizer ramps up the modulation after the intial delay, rather than turning it on full strength at once. They've thought of everything...

Another point that might not be obvious is that if you are controlling the modulation with a device such as the Modulation Wheel, manipulating the controller overrides the Delay and immediately activates the LFO.

LFO Pitch Modulation Depth (PMD)

Vibrato seekers, look no further! Well, almost. This parameter determines the depth of the vibrato, however, you can have PMD set to its maximum value (99) and still not hear any. This is because the Pitch Modulation Sensitivity (PMS) parameter functions as a "gate" on the vibrato—if the PMS is 0 (i.e. "nobody gets through"), no vibrato will be heard.

The PMD can be thought of as a "source" of vibrato, in the same way that turning up the Modulation Wheel causes vibrato. The difference between turning the Modulation Wheel and setting the PMD to a high value is that the PMD will always produce the same amount of vibrato regardless of the setting of any controller, whereas with the Wheel you can control the amount as you perform.

LFO Amplitude Modulation Depth (AMD)

Amplitude modulation varies the Output Level of each Operator. When the Operator is a carrier, this results in periodic changes in volume, similar to those you hear late at night on an AM radio. When the Operator is a modulator, periodic variations in timbre result. Refer to the discussion on the AM Sensitivity parameter in the section on Operator-Specific Parameters. The AMD functions analogously to the PMD in that is a constant source of Amplitude Modulation which is gated by the AM Sensitivity for each Operator. You also have a variable source of AM available if you turn a controller's Amplitude assignment to On and manipulate the controller.

Pitch Modulation Sensitivity (PMS)

This parameter varies from 0 to 7 and acts as the final "volume control" on how much vibrato is heard. If the PMS is set to 0, it doesn't matter what you do with the Modulation Wheel or any other controller, or the setting of Pitch Modulation Depth. You won't hear any vibrato. If, on the other hand, you set PMS to 7, the slightest amount of PMD or movement of a controller will cause prominent vibrato. Generally for traditional instrumental effects, you can leave the PMS at 1 and concentrate on the resulting amount of vibrato by playing with a controller and/or PMD.

LFO Key Sync (Sync)

If the Key Sync to On, the LFO will start the beginning of its cycle with each new note you play. This means that if there are notes already playing, their LFO cycle is interrupted and restarted to match that of the new note. If you have some massive LFO effect, such as the TackyNess Voice in the Tutorial Examples file, you'll want to make sure that you start the LFO over again each time you hear the effect, so set the Key Sync to On.

If, on the other hand, you want vibrato for an acoustic-sounding instrument, you probably will want the vibrato to begin in random places in the LFO cycle, so set the Key Sync to Off.

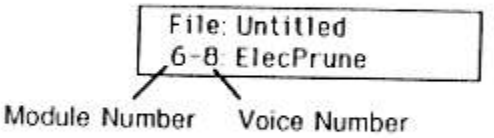
Fun With Science Part 97

Speaking of LFO Sync, psychoacoustic research has shown if the vibratos are completely out of sync with other, there is a stronger perception of multiple instruments playing. Unfortunately, on the DX and TF1 you always have one synchronized vibrato wave for all notes playing. If you have a multitrack tape recorder, compare the sound of two independent tracks of a String Ensemble type of sound playing one note with that of the same two notes being played on the synthesizer at once. If you have a TXN16, you can set all your modules to the same Voice but different MIDI channels. Then using a sequencer program, send each module one note of a chord (by setting each track to a different MIDI channel), and you should hear what an unsynchronized vibrato sounds like.

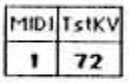
Voice Name You can name the Voice in the Editor by selecting the name displayed on the screen (as shown below). The voice name can be 10 alphanumeric characters, and as pointed out in the tutorial section, lower case is displayed by the DX7 and TX7 front panel displays. The voice name shown in the Voice menu will not change to what you've typed in until you do a **Store Current Edit** from the Voice menu.

Note: For wholesale renaming of your voices, the Librarian is far more convenient than the Editor, and includes an Undo Typing facility.

The number next to the voice name will be different (or non-existent) depending on whether you're editing from a Bank or Library. If you have a traditional flavor DX7 or TX Bank, the numbering is what you'd expect, 1 to 32. Libraries, however, have no synthesizer memory locations associated with them, so none is displayed. And TX816 Banks have a number which consists of a module number and then a voice number, as illustrated below.



Editor Controls are not stored with any Voice or Bank File. Instead they change things about the current editing environment.



Editor Controls in the Global Window

MIDI Channel Select (MIDI)

If you own a TX7 or TX816, you can select any MIDI channel to use when editing, loading, or sending voices. This can be useful in two circumstances...

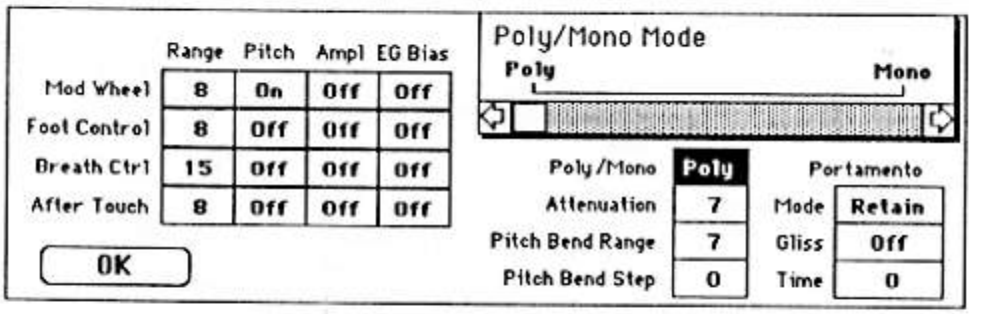
First, if you have a TX7 and a DX7 hooked up to the Editor (using the MIDI Thru connection on one of the synthesizers), you can select a different MIDI Channel for each and then change the MIDI control to switch between the TX and DX. The MIDI Channel for the DX7 must be 1 (hence if you are editing a DX7 Bank or Library, this control does nothing), but the TX7's can be anything—in this case make it anything other than 1.

With TX816 Banks, the Editor/Librarian automatically assigns unique MIDI Channels to each of the modules, assigned in ascending order. The MIDI Channel control sets the number of the *first* module. As an example, if the MIDI Channel control says 3 and you're editing something in Module 6, the real MIDI Channel is 8.

Test Key Velocity (TstKV)

The Macintosh keyboard, in addition to its lack of musical character, also is not velocity sensitive. Thus if you want to see the effect of hitting a note "harder" from the Macintosh keyboard, you need to change the velocity information that is sent when you type. TstKV works just like any other numerical control on the screen, but it also accepts positive and negative increments of 8 with the use of the > (pos) and < (neg) keys. The initial value of the control is 64, the velocity information sent out by non-velocity sensitive keyboards such as the DX9 or DX21.

You edit Performance Parameters by selecting the **Edit Settings...** item from the **Function** menu. The Envelope Window is then replaced with a quasi-dialog showing the current settings of all the TX Performance controls. The **Edit Settings...** menu item is not enabled for DX7 files, however, you can without penalty create a TX file and put DX sounds in it. The TX file will then reserve space for 32 Performances for each voice. These can be sent to your DX7 every time you select a new voice by selecting the **Send Functions to DX7** item in the **Function** menu.



The Function Settings Window

The window operates in much the same way as the rest of the program, although you don't have use of any of the menus for Undoing, Copying, or Pasting. Just select which parameter you want to change by Clicking on it, and the use the Scroll Bar to change it. If you have a DX7, you can test the changes by performing on your keyboard and manipulating the other controllers such as the Modulation Wheel and Pitch Bend Lever.

When you're done editing the Performance Parameters, you can return to editing the current Voice by clicking on the OK button in the lower left-hand corner of the window.

Poly/Mono Mode

Determines whether the synthesizer will play more than one note at a time. I've not met anyone who regularly puts their DX7 in Mono mode, but if the thought of accidentally playing two simultaneous notes worries you, by all means use Mono mode. Portamento works slightly differently in Mono mode, so you may want to try that out some day.

Attenuation

This parameter is available on the TX synthesizers *only*, and reduces the overall Output Level of the entire voice (as opposed to Operator Output Level, which just reduces the output of a single Operator). It is useful for balancing the loudness of multiple voices coming from your synthesizer(s) at the same time. You can also use a "primitive" analog mixer to do the same thing. By the way, for those of you who don't know, to *attenuate* something means to decrease its output. Now it would seem to me that the *highest* Attenuation would be the softest volume, but in fact it works the other way. The "maximum" value of this parameter (7—the default) is actually the *least* Attenuation. Oh well.

Portamento Mode

The choices you have for this parameter depend on whether you're in Poly or Mono mode. They switch automatically when you change from Poly to Mono mode, or vice versa.

Portamento Modes in Poly Mode:

In SUS-KEY P RETAIN mode (indicated by Retain on the Portmento Mode control), the keys you already have down, or are holding with the Sustain Pedal *retain* their pitch, when new notes are played. In other words, new notes are played while old notes are still sounding. If there are no notes sounding, then the new note you hit behaves in the usual portamentic fashion.

In SUS-KEY P FOLLOW mode (indicated by Follow), the new notes you hit *replace* the old notes, *if* two conditions exist: First, the Portamento Time must be non-zero (setting it to zero is like turning off Portamento), and second, you must be holding down the Sustain Pedal but not holding down the notes you're sustaining. Try playing a chord in Follow mode (with some amount of Portamento Time), hold it with the sustain pedal, and then hit a single key. The chord should be replaced with the single note.

Portamento Modes in Mono Mode:

In FINGERED PORTA (indicated by "Fingered" on the Patch Editor Portamento Mode control), portamento occurs only when the new note that you hit is pressed before you lift up your finger from the old note. You might think that the Sustain Pedal would play a part in this, but in fact it doesn't—portamento doesn't occur if you're just holding a note with the Sustain Pedal, you have to be holding the key down with your finger.

In FULL TIME PORTA mode, Portamento happens, as advertised, all the time.

Portamento Glissando

When Glissando is Off, the pitch changes smoothly from one note to the next. When it's On, the pitch changes by what appear to be chromatic steps up or down. For frustrated horror movie soundtrack writers, generate your cues automatically by playing chords with a string ensemble patch and the following Portamento settings:

- Portamento Time between 80 and 99
- Portamento Glissando On
- Portamento Mode = Retain

Then, for all you Cheap Science Fiction Movie fans, turn the Glissando Off and enjoy the show.

Portamento Time

As you might expect, this sets the length of time the synthesizer takes to get from one note to the next. A time of zero (the default) shuts off the entire Portamento business. A time of 99 is the sort of thing that gives electronic music a bad name.

Pitch Bend Range

Indicates in half steps how far you can increase of decrease the pitch from the center point with the DX7's Pitch Bend lever. The maximum is 12, which is an octave up and down for a total of two octaves. Obviously, you can turn the pitch bend off if you set the range to zero.

Pitch Bend Step

Similar to the Pitch Bend Range, the Step indicates the size of the steps (in half steps) the Pitch Bend lever uses to get from the center point to the maximum or minimum. A value of zero gives you the traditional continuous Pitch Bend, and a value of 1 gives you half step increments. When the Step value is non-zero, the Pitch Bend Range is automatically set to 12.

In the upper left hand corner of the Function window there is a matrix of parameters which determines what the various DX7 controllers do. Each controller can affect three aspects of the sound: Pitch, Amplitude, and EG Bias. In addition, each controller has a Range, from 0 to 15, which determines the amount of the effect. The four controllers available are the traditional Modulation Wheel, the Foot Control, the optional Breath Controller, and the keyboard After Touch.

Pitch Works in conjunction with Pitch Modulation Sensitivity (PMS) parameter in a Voice to increase the amount of vibrato as you manipulate the controller. If the PMS parameter is zero, no amount of manipulation of the controller assigned to Pitch will increase the vibrato. Other LFO parameters such as Pitch Modulation Depth and LFO Speed also affect the vibrato.

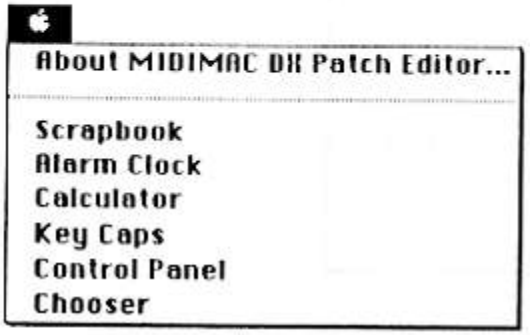
Amplitude Changes the amount of tremolo effect (variations in amplitude) as you manipulate a controller. The Amplitude Modulation Sensitivity (AM) parameter in *each operator* also affects the amount of tremolo that you hear. If all operators' AM sensitivity are set to zero, no maniuplation of the controller assigned to Amplitude will increase the tremolo effect. Tremolo is also affected by the LFO parameter Amplitude Modulation Depth (AMD) which, if set to 99, results in the maximum amount of Tremolo independent of any controller assignment or manipulation.

EG Bias The EG Bias control allows you to turn your favorite controller into a kind of volume pedal on the voice you're performing. In other words, manipulating the controller directly affects the Output Level of an Operator. The Amplitude Modulation Sensitivity (AM) parameter in each operator, as with the Amplitude factor, also affects the extent to which the EG Bias effect is heard. With all carriers' AM sensitivity set to 3 and the full range on your favorite controller, you can turn a sound completely from zero to full volume by manipulating the controller.

Menus

This section documents the features of the Menu items in the MIDIMAC Patch Editor.

The Apple Menu

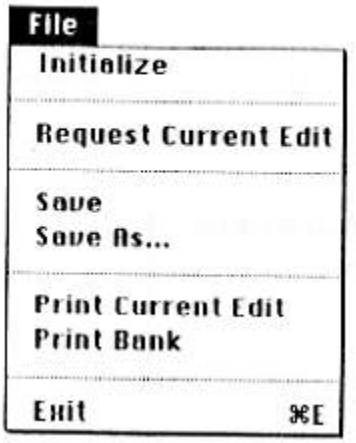


About MIDIMAC Patch Editor...

This command opens a window which contains the copyright notice, version number and date of the program. If you report a bug to Opcode Systems we'd appreciate it if you'd identify the date and version number on the program you were shipped. The Editor/Librarian contains three version numbers: the Librarian version number, the DX/TX Librarian module version number, and the Editor version number, which will be something like 1.20e1. Clicking the mouse button erases the window.

Desk Accessories

You may use any desk accessory while running the Editor, but you won't be able to use the Editor until you close any desk accessories. Instructions for the standard desk accessories supplied with the program may be found in Macintosh, the user's manual.



Initialize Changes the current edit to an INIT VOICE (and Init Performances in the case of a TX). This is the same as using the Voice Init function (Tan #10) on a DX7. You'll be asked to confirm the selection, since your current edit (and its stored version) are erased. Don't expect to create a terribly profound sound "from scratch" with an INIT VOICE.

Load One Voice... (DX7)
Request Current Edit (TX)

Loading from a DX7

Load One Voice... opens a window prompting you to select a program to be loaded. The program will be loaded into both the Edit Buffer *and* its corresponding location in the bank file. This allows you full use of the **Compare** function in the **Edit** menu.

To load the patch on the DX7, hit MEMORY SELECT (INTERNAL or CARTRIDGE), and a program number (i.e. one of the numbered green keys).

To cancel the command, Click the mouse once. Note that there is no corresponding Send One Voice command, because each time you select a voice from the **Voice** menu, it is sent to the synthesizer.

Loading from a TX

Request Current Edit will automatically load the both the Voice and Performance data associated with the current Edit Buffer. Therefore you should select the program you want to load *before* issuing this command. The Voice and Performance data will be loaded into both the Edit Buffer and the "permanent" location in the current Bank or Library that you're currently editing.

Save Used to write any changes to the currently active Bank or Library file out to the disk. This command works only if the bank file already has a name: for files whose name appears as "Untitled" on the screen, you must use the **Save As...** command. If the disk associated with the file is not currently in a drive, you will be asked to insert it so the file can be saved.

Note Use **Save** often if you're concerned about protecting your work. However, if your computer does malfunction, your current edit should be recoverable in the edit buffer of your synthesizer.

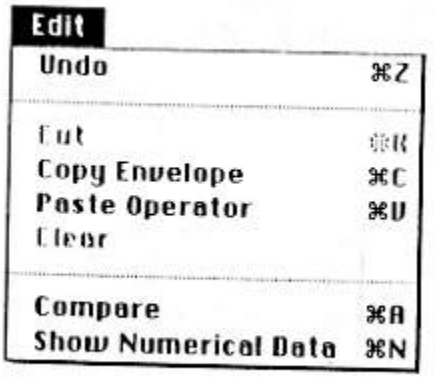
Save As... This command is used to write the contents of the currently active editing session to a disk file for the first time, or for saving the current version of an existing file under a different name. The standard Macintosh "Save As" box will appear, and prompt for a filename. Depending on what type of Bank or Library window you started from, the file will be saved in TX, DX, or TX816 format.

Print Current Edit

Allows you to print out the current state of the current Voice on a printer connected to the Printer Port. It's not a "real" Printing routine; rather it "prepares" the Patch Editor screen by replacing all the envelopes with their numerical controls, and adding the Function Settings editing window over the current envelope or scaling diagram. Then **Print Current Edit** runs the "screen dump" routine available to you as Command-Shift-4. When the printing has finished, the screen is restored to its original state. Note that the printing routine won't run if you have a MIDI interface connected to the Printer Port of your Macintosh. Command-Shift-4 is pretty stupid when it comes to making adjustments for which port your printer is connected to.

Print Bank This prints the stored versions of the Voices in the entire Bank as described in Print Current Edit above.

Exit This command returns you to the Librarian with the Voice you were editing as the selected one and the Window you were editing from as the active window. If you haven't made any changes to your Voice since you last stored it, Exit returns immediately. If you have done anything since the last Store Current Edit, you are asked if you want to store any changes you've made.



The **Edit** menu commands are used for the "word-processing" functions of the Patch Editor. Some of the commands, like **Cut** and **Clear**, are never enabled, but exist in case you you use any desk accesories that perform functions with the Clipboard common to Macintosh programs. Nothing in the Patch Editor can be transferred to or from the standard Clipboard, although there are functions that operate with the Clipboard "concept."

Undo

You can use **Undo** to cancel any change(s) you've made to a selected parameter since it was selected. If you issue an **Undo,** make some more adjustments to the same parameter, and then do another **Undo**, you get back the value you had *just before you did the first* **Undo**. When you select a new parameter to edit, Undo forgets about anything you may have done before and is disabled until you make a change. Note that since none of the menu items work while you're changing TX Performance Parameters, you can't **Undo** changes you make while working on them.

The best thing **Undo** is good for is a sort of "localized" version of the DX7's Edit/Compare feature. You can look at the setting of a parameter before you messed around with it by issuing an **Undo**, then go back to your messed-up version by selecting **Undo** again.

Undo works differently for envelopes, since when you are modifying them in the Envelope Window you are changing two parameters at once. Issuing an **Undo** changes both parameters back to what they were when you picked up the corner of the envelope.

Copy Operator(s)
Copy Envelope

Copying commands will be enabled if you have an Operator Envelope, an entire Operator selected, or multiple Operators selected. You can **Copy** the data in an Envelope or Operator to a Clipboard for Pasting into other Operators or even other Voices. A detailed description of the procedure for Copying and Pasting follows the brief description of Paste below.

Paste Operator
Paste Operators...
Paste Envelope

Paste will be enabled if you have copied an Operator Envelope or an entire Operator to the Clipboard. Copying Operators and Operator Envelopes is a good way to build up a sound quickly. You might want to go back later and try to make slight changes to the modulator's envelope in carrier-modulator pair where the envelopes are identical. For example, if you wanted to produce a brighter spectrum at the very beginning of a note, you might want to give the modulator a sharper attack (move the first Breakpoint to the left) and initial decay (second Breakpoint to the left).

Note: The Patch Editor Clipboard is an "internal" clipboard only, and cannot be used to transfer information to other programs. Besides, what you'd want to do with Envelope data in MacWrite is beyond me.

Copying an Envelope from one Operator to another

Step 1: Select the Envelope you want to copy by Clicking on it. Eight numbers in inverse should appear.

Step 2: Select **Copy Envelope** from the **Edit** menu. The Envelope will remain selected.

Step 3: Click on any control in the destination Operator Window.

Step 4: Select **Paste Envelope** from the **Edit** menu. The Pasted envelope will appear in the Operator Window you selected in Step 3. If you decide you don't want to put the envelope where you just did (or were merely testing it out), you can Undo the Paste by selecting **Undo** from the **Edit** menu. However, the moment you select another control, your chance to **Undo** is gone.

Copying an Envelope from one Voice to another

Step 1: Select the Envelope you want to copy by Clicking on it.

Step 2: Select **Copy Envelope** from the **Edit** menu.

Step 3: Select the Voice where you want to Paste the envelope from the **Voice** menu. If you've made any changes to the voice you're currently editing, you will be asked if you want to store them; if you don't, they'll be lost when you select the new voice.

Step 4: Click on any control in the Operator Window of the new voice where you want to paste the Envelope.

Step 5: Select **Paste Envelope** from the **Edit** menu. As with the situation for Pasting within a voice, you'll only be able to **Undo** as long as you don't select another control. You can also Paste the Envelopes to any number of other Operators until you Copy something else.

Copying and Pasting One Operator within a Voice

Step 1: Click on the number of the Operator you want to Copy. Yes, the *number* located in the upper left-hand corner of the Window. All of the Operator's controls will become highlighted, the Scroll Bar disappear, and the text above the Scroll Bar will read "Operator(s) Selected." . At this point you'll also find that some of the menu items are disabled.

Step 2: Select **Copy Operator** from the **Edit** menu.

Step 3: Click on any control in the Window of the Operator you want to become the same as the one you just copied.

Step 4: Select **Paste Operator** from the **Edit** menu. The destination Operator will become highlighted, containing all the data of the Operator you copied, allowing you to Undo the Paste. As with Envelopes, you won't be able to Undo after you select something else. You can, however, continue to Paste to other Operators until you Copy something else, just like the normal Macintosh Clipboard.

Copying One Operator between Voices

Step 1: Click on the number of the Operator you want to copy. All the controls in the Operator's window will become highlighted.

Step 2: Select **Copy Operator** from the **Edit** menu.

Step 3: Select the Voice where you want to Paste the envelope from the **Voice** menu. If you've modified the voice you're currently editing, you will be asked if you want to store the changes; otherwise they'll be lost when you select the new voice. If you want to Paste it in the same location, the Operator number you just copied from is already selected after the new voice appears.

Step 4: Select any control in the Operator of the new voice where you want to Paste the information.

Step 5: Select **Paste Operator** from the **Edit** menu. You can Paste this information to any other Operators you wish by repeating steps 5 and 6. Also remember that you can't Undo the Paste after you select something else.

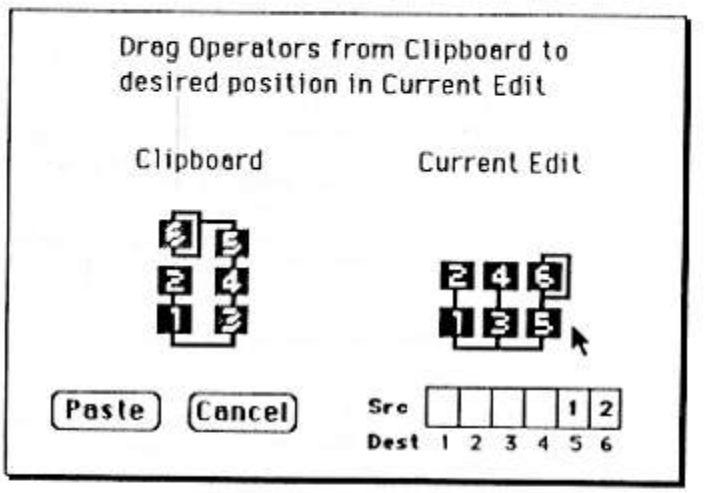
Copying Multiple Operators within a Voice or between Voices

Step 1: Select the Operators you want to copy by clicking on their numbers while holding down the Shift key.

Step 2: Select **Copy Operators** from the **Edit** menu.

Step 3: If you want to copy the Operators to another voice, select it from the Voice menu. If you modified the voice you were editing, you'll be asked if you want to store the changes.

Step 4: Select **Paste Operators** from the **Edit** menu. A box will appear such as the one below that will allow you to direct the transfer of Operators from the clipboard. Select any of the highlighted Operators in the algorithm picture on the left (representing the Operators on the clipboard), and drag its outline over to the algorithm picture on the right (representing the Current Edit). When the mouse is dragged over any of the destination Operator's numbers, they'll turn white. "Drop" the Operator's outline onto the number where you want it to go.



Multiple-Operator Paste Dialog Box

Repeat this process as many times as you want for the Operators you want to Paste. If you make a mistake, there are two things you can do:

• Click on the Cancel button, in which case no Paste is performed.

• It's possible to Paste over an Operator that you've already Pasted into. So, if you've dragged the Clipboard's Operator 2 to the Current Edit's Operator 5, but you really wanted to drag the Clipboard's Operator 1 there, just go ahead and do it, and Clipboard's Operator 2 will disappear from the Current Edit.

Step 5: If you're satisfied with the Paste, click the Paste button in the window. The Operators you pasted into will be selected. Listen to what happened and Undo at this point, before you select something else.

Caveats regarding Multiple Operator Paste

Keep in mind is that depending on the context of your Copy and Paste, you may not actually be duplicating a sound completely. For example, in the window shown above, if Feedback were turned on in the Current Edit, the Operator 5 and 6 system might sound very different than it did as Operators 1 and 2 (which have no feedback). The values of the LFO, Pitch Envelope and Key Transpose can also affect multiple-operator Copy and Paste, so don't automatically blame the Editor when things don't immediately work out.

Compare
UnCompare

These functions allow you to switch between viewing the parameters of a new and old (stored) version of the same voice. In addition, the compared voice is sent to the synthesizer so you can evaluate whether you're improving it or not. It seems that at least 50 percent of the time you make things worse, not better.

Selecting **Compare** transfers the stored voice (and performance) located in the current Bank or Library to the Edit Buffers of both the Editor and synthesizer. The previous contents of the Edit Buffer are placed in a temporary buffer awaiting to be summoned again when you select **UnCompare**. Unlike the Edit/Compare feature on the DX7, you're not under any obligation to go back to the changes you made. After selecting a **Compare**, the menu item changes to **UnCompare** and the number of the Voice (if there is one—Libraries don't have numbers) is **outlined**. It will remain that way until you actually do return to the "changed" version (by selected **UnCompare**) or start editing a new voice.

Restoring Operators or Envelopes from the stored version

One useful feature of Compare/UnCompare is using it in conjunction with Copy and Paste. If you find that you've completely messed up either an Operator or an Envelope, but you don't want to lose the changes to the rest of the Voice, try the following steps:

Step 1: Select **Compare** from the **Edit** menu

Step 2: Select the Operator or Envelope you want to restore from the stored version.

Step 3: Select **Copy** (Operator or Envelope) from the **Edit** menu

Step 4: Select **UnCompare** from the **Edit** menu to get back to your messed-up version.

Step 5: If you're going to Paste the data to a different Operator, select an Envelope in that Operator.

Step 6: Select **Paste** (Operator or Envelope) from the **Edit** menu. The old data should now be restored.

Comparatively important hints

Don't use **Compare** to get rid of all the changes you made to a patch so you can start over. If you ever want to do a **Compare** again, you'll actually be doing an **UnCompare** with a sound that you presumably weren't too impressed with. If you do want to start from scratch again, you should reselect the name of the voice you're currently editing from the Voice menu. Then when you make your new improvements, you can use **Compare/UnCompare** properly.

Command-A You'll want to learn the Command-A keyboard equivalent for Compare, which becomes quite convenient for rapid sound comparisons. Notice that Compare is disabled when you have an entire Operator selected for Copying.

Show Numerical Data
Show Graphical Data

These commands allow you switch back and forth between the miniature graphical representations of Envelopes and Keyboard scaling, and the Numerical displays you see when an Envelope or set of Scaling curves is displayed in the Envelope Window.

The Numerical Data setting might be important to you if you were entering a sound from a sheet of paper with numbers on it, and wanted to insure you got the whole thing right. You also might be a real DX7 hacker and just feel more comfortable surrounded by hundreds of numbers.

The Graphical Data setting (which I prefer, so I made it the one the Editor starts up in) gives you an intuitive summary of how what kind of Scaling or Envelope you're dealing with in each Operator. This is important in getting an undertanding of what's going on FM-wise in a Voice.

Note: Suppose you select Numerical Data and then Exit to the Librarian. If you come back to the Editor again, it will remember that you wanted Numerical Data. Also note the Command-N keyboard equivalent.

You use the **Voice** menu to transfer voices into the Edit Buffer of the Patch Editor and your synthesizer. There are three varieties of voice menus:

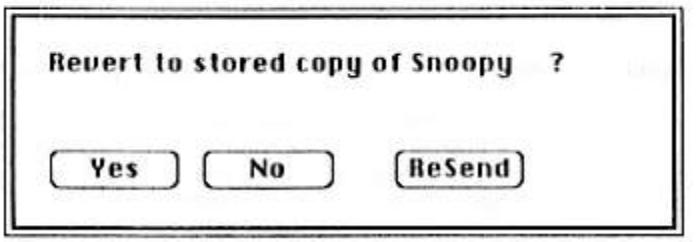
- DX7 and TX Bank voice menu
- Library voice menu
- TX816 Bank voice menu

First we'll talk about the features common to all of the kinds of menus, then discuss the special features of each.

When you pull down the **Voice** menu, the voice you currently have in the Edit Buffer has a check mark next to it (in the example DX/TX Bank menu below, it's #17: Pepsi 1).

Selecting the Currently Checked Voice

Suppose you want to return to the original copy of the voice you are editing, having mangled, for example, a Steel Drum sound into a close replica of a car door slam. You can do this easily by *selecting the checked voice* in the **Voice** menu. If you have made any changes to the Voice you are given three choices:



"Yes" will overwrite your edited version of the voice with the Stored version. "No" cancels the action. "ReSend" is handy if you were messing around with the MIDI connections to your synthesizer and lost the voice, or somehow lost the synthesizer's copy of the Edit Buffer. ReSend does *not* load the stored voice but it does send whatever's in the Edit Buffer to the synthesizer; it is thus equivalent to saying "No."

If you *haven't* made any changes to the Voice, selecting the checked voice won't load the stored version (since there's no point in doing so) but it *will* resend the Edit Buffer to the synthesizer.

Store Current Edit

Store Current Edit is sort of the opposite of selecting the checked voice, it copies the contents of the Edit buffer over the original in the current bank file so that you could, for example, use the current state of your patch as the reference for **Compare/UnCompare**. Please note that Store Current Edit offers absolutely no protection against hardware failure, so use **Save** from the **File** menu to store your changes often if you're making good progress.

Command-S Note the handy keyboard equivalent for **Store Current Edit**. This happened to be a lot harder to program than the other keyboard equivalents, so appreciate and use it.

Copying Voices and Performances in Banks with Command-Option Select

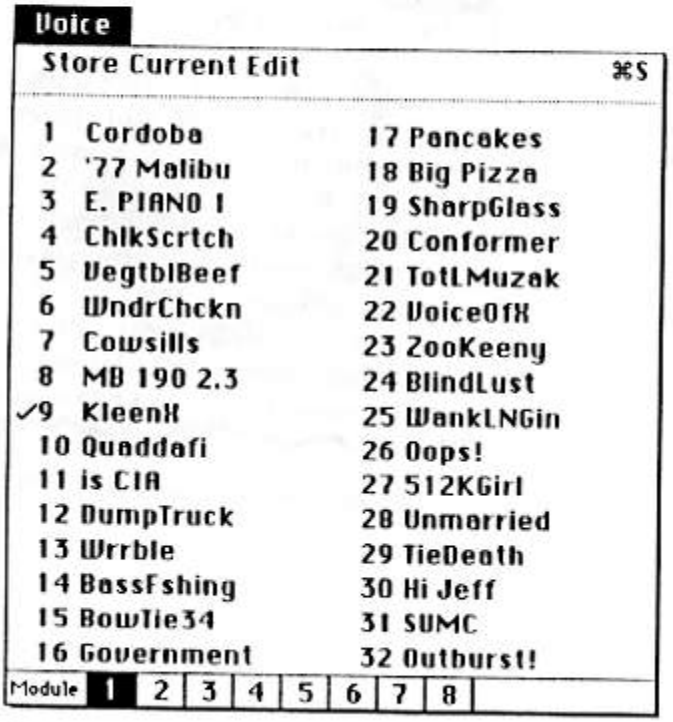
To make a copy of the Current Edit somewhere besides the number of the voic you're editing, hold down the **Command** and/or **Option** keys and select a voic from the Voice menu where you want the copy to go. If you hold down th **Command** key, the Voice parameters are copied, and if you hold down the **Optio** key, the Performance parameters are copied. Holding down *both* keys copies al parameters. If you can't remember which key copies which parameters, just try t remember to hold both down. If you have a bank of DX7 voices, holding dow *either* key will copy the Voice parameters. Note that this feature does not work wit Libraries.

Scrolling Library Voice Menus (that's right, *Scrolling*)

The Library Voice menu has a "two-speed bidirectional scrolling feature" whic allows you to choose from as many voices as you have in the Library. On the righ side are some arrows that look vaguely militaristic. Selecting them and holding th mouse button down will cause the alphabetized list of menu choices to scroll up o down through the list of names in the Library. If you have 16 or fewer Voices i your Library, these arrows are disabled, since you can choose from all of the Voice without scrolling.

The double-arrows are the "fast-forward" and "fast-rewind" speeds, for use wit giant libraries. The single-arrows are for slower scrolling, in smaller Libraries when you near your destination in a large Library.

At the bottom of the TX816 Bank Voice menu, you'll see a bunch of boxes numbered from 1 to 8. These allow to see the 32 voices of a different TF1 Module than the one you're currently working with. When you select one of these numbers, the entire contents of the menu changes to reflect the voices in that module. The module in which the Current Edit resides is the one which will appear first when you pull down the Voice menu.

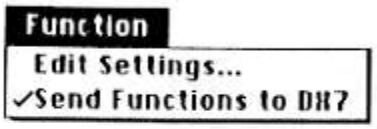


Note: If you've reduced the number of Modules in the Bank using the Librarian's **Number of Modules** command, the extra module numbers will be dimmed.

Do you find it difficult to choose Voice 17?

You may find it takes a certain amount of Mouse Finesse at first to select some of the voices in the second column (e.g. Voices 17-32). Use a circular mouse trajectory by moving vertically down the first column and then back up the second column until you reach the voice you want as shown in the figure below.

Choosing Voices in the second column



Note: These menu items are disabled for DX7 Banks and Libraries.

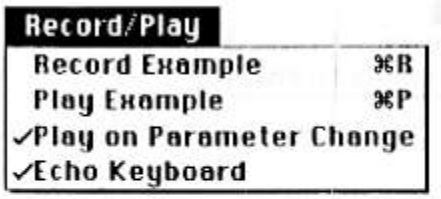
Edit Settings...

With this command, you edit the Performance data associated with each voice. Note that if Send Functions to DX7 (described below) is checked, whenever you select a new voice to edit, the Patch Editor sends the associated Performance to the DX7. How to edit Performances is described fully in the *Performance Parameters* section of this manual, along with the nature of each of the parameters.

Send Functions to DX7

This item shows a Check Mark next to it if the program is to send associated Performances to the DX7 when you select a new Voice to edit. This emulates the behavior of a TX7. To change the setting of this item, just select it. If it's checked and you select it, it will become unchecked and the values of the Functions will not be sent to the DX7.

Unlike the TX7, note that Functions settings are also sent to DX7s with old ROMs (those with serial numbers below 24000 or so). For the curious, the Patch Editor does this by sending a stream of DX7 Function Parameter changes corresponding to the settings of the applicable Performance data. You'll also want to note that in the **Edit Settings...** window, the Range parameters for the Modulation Wheel, Foot Control, Breath Control, and After Touch only range from 0 to 15 while on the DX7 they go from 0 to 99. It turns out that there *are* only 16 settings, and that whole ranges of numbers on the DX7 actually produce the same result. The Patch Editor does an internal translation of these numbers, based on the table supplied in the TX7 Performance Notes manual, reproduced for you in Appendix B.



The **Record/Play** menu gives you access to a limited one-track MIDI sequencer that will play short example passages of the patch you're working on so that your hands aren't constantly moving from the Macintosh to the DX7 (or other MIDI) keyboard. If you don't have a keyboard, you won't be able to record sequences, but you're not completely out of luck: you can always perform on the letter keys on your Macintosh to hear the results of your editing. There is also a **Play On Parameter Change** option (initally off) which plays the recorded sequence every time you change a parameter in your patch.

The advantage of using **Record/Play** over hitting the Macintosh keyboard is that you can more easily determine the current effect of playing on the velocity sensitive keyboard. On the other hand, you'll probably get quite tired of your little example sequence after a while...That's one of the reasons why you can't store the sequence on disk. Buy a *real* sequencer, like the MIDIMAC Sequencer, if you want to do that.

Record Example

When you select this item, a dialog window appears informing you how you are to stop the sequence—basically by doing anything on the Macintosh (except of course turning the computer off, which stops a lot more than just the sequence recorder). When you start to play on the piano keyboard, recording begins. The recorder records a total of 200 MIDI Note-On, Note-Off, pitch bend, and other various MIDI events. If you use up all of your 100 notes, the dialog window disappears and the recording session is terminated. You still made a valid recording, it's just a bit shorter than you intended. You can record over previous examples as many times as you desire; but there's no way to recover an old sequence once you start a new recording.

Note: You'll soon find that sequences of 25 notes or less are most helpful in testing the sound in a somewhat efficient manner.

Play Example

Initially dimmed until you use **Record Example** (or you use Record Example in the Librarian) this command plays your recorded example sequence once. You can bag it prematurely by hitting any key or Clicking the mouse. I'd suggest you learn to use the Command-P keyboard shortcut for **Play Example**, it will save you an immense amount of time if you use this feature a lot, although Play On Parameter Change (below) might save you more.

Play on Parameter Change

If you like the idea of not having to do anything but concentrate on your patch editing work, or like to hear how a Voice will sound "in context," try selecting the **Play on Parameter Change** option. When enabled it shows a Check Mark. This option sends your Example Sequence to your synthesizer immediately after it transmits every parameter change (i.e. when you change the Output Level of Operator 1). As with Play Example above, any keystroke or mouse Click will terminate the playing of a sequence Note that whatever you do to stop the sequence is ignored by the program. You may find this feature rather annoying, so to disable it, merely select the checked **Play on Parameter Change** again. You'll still be able to use **Play Example**.

Echo Keyboard

Users of the TX7 and TX816 synthesizers may wish to play their synthesizers from a remote keyboard such as a Yamaha KX88 (or a DX7 for that matter). **Echo Keyboard**, when checked, sends all MIDI notes and other events (such as pitch bend) which are received by the Patch Editor through the Bank or Library's specified MIDI Out port. They will also be sent on the MIDI channel specified by the MIDI control next to the current filename and Voice name.

Note: The TX7 and TX816 can receive notes and programming information on any MIDI Channel, even though no mention of this is made in the TX7 manual.

This information is supplied for those of you who want to write Macintosh programs which use the files produced by Opcode Patch Editor/Librarian.

There are several kinds of Opcode DX/TX files. They all consist of a two-byte number which contains the number of patches in the file. This number is always 32 for DX and TX Bank files, and is variable for TX816 Banks (Number of Modules * 32), and Libraries (could be anything). Next are that number of blocks of data.

- 1 data block for DX7 Banks and Libraries (128 bytes) =
  128-byte DX/TX Voice data

- 1 data block for TX and TX816 Banks and Libraries (196 bytes) =
  128-byte DX/TX Voice data
  64-byte TX Performance data

Voice data The 128-byte Voice format is an individual patch among the 32 sent when you use the DX7 MIDI TRANSMIT function or request 32 Voices from a TX.

Performance data

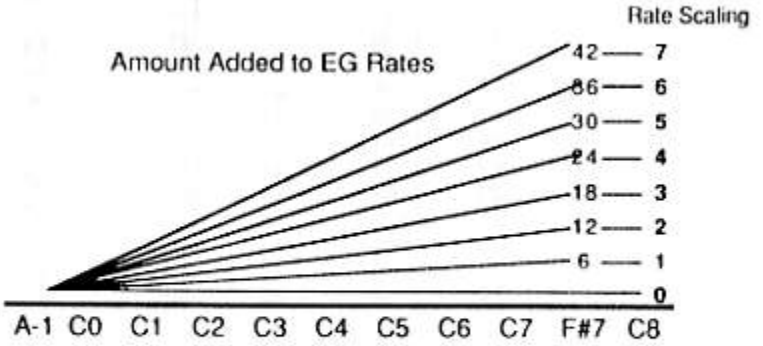
The 64-byte Performance is an individual patch among the 64 sent when you request 64 Performances from the TX. The TX7 and TX816 ignore the last 32 performances, as well as the middle 30 bytes of each performance. Note that when you request or load an individual Voice or Performance, the data formats are completely different. More information about the MIDI data format for Yamaha products can be found in the TX7 or TX816 manuals. The information on Performance data in the TX manuals is definitely not complete. We have figured out a few things ourselves, and owners of this program are free to call Opcode with technical questions about the unused bytes in the Performance data.

Old Editor Files Previous versions of the Opcode Patch Editor (1.16 or less) used the TX Bank format to store *all* files.

1. **Conversion between DX7 Function controller ranges (0-99) and Opcode Patch Editor/TX Function controller ranges (0-15).** When you send a change to a Function parameter to a DX7, the Patch Editor automatically performs the conversion for you. *Source: Yamaha TX7 Owner's Manual*

TX	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DX	0	6	13	19	26	33	39	46	53	59	66	72	79	86	92	99

2. **Diagram of Keyboard Rate Scaling functions.** The graph shows you the number *added* to all of an Operator's EG Rates depending on what note is played. The notes are in the "absolute" pitch system, so transposing the Voice on the keyboard will affect what the Rate Scaling does. *Source: Yamaha DX7 Operation Manual*



3. Fixed Fine Frequency values

This table lists the four digits of the Fine Frequency when the Oscillator Mode is set to Fixed ("f"). Changing the Coarse Frequency in this case multiplies the value by a power of 10.

Step	Freq	Step	Freq	Step	Freq	Step	Freq
0	1000	25	1778	50	3162	75	5623
1	1023	26	1820	51	3236	76	5754
2	1047	27	1862	52	3311	77	5888
3	1072	28	1905	53	3388	78	6026
4	1096	29	1950	54	3467	79	6166
5	1122	30	1995	55	3548	80	6310
6	1148	31	2042	56	3631	81	6457
7	1175	32	2089	57	3715	82	6607
8	1202	33	2138	58	3802	83	6761
9	1230	34	2188	59	3890	84	6918
10	1259	35	2239	60	3981	85	7079
11	1288	36	2291	61	4074	86	7244
12	1318	37	2344	62	4169	87	7413
13	1349	38	2399	63	4266	88	7586
14	1380	39	2455	64	4365	89	7762
15	1413	40	2512	65	4467	90	7943
16	1445	41	2570	66	4571	91	8128
17	1479	42	2630	67	4677	92	8318
18	1514	43	2692	68	4786	93	8511
19	1549	44	2716	69	4898	94	8718
20	1585	45	2818	70	5012	95	8913
21	1622	46	2884	71	5129	96	9120
22	1660	47	2951	72	5248	97	9333
23	1690	48	3020	73	5370	98	9550
24	1738	49	3090	74	5495	99	9772

4. Envelope Time Calculation Tables

4A. Times for Envelopes to go up from 0 to 99. Interpolate for values in between the rates listed.

Rate	Time (seconds)	Rate	Time
99	.003	55	.321
96	.003	52	.409
93	.005	49	.505
90	.007	46	.615
87	.008	43	.737
84	.008	35	1.3
81	.011	30	1.8
78	.014	25	2.7
75	.018	20	4.8
72	.024	15	7.5
69	.032	10	12
67	.055	5	22.8
61	.080	1	38.0

4B. Times for Envelopes to go down from 99 to 0.

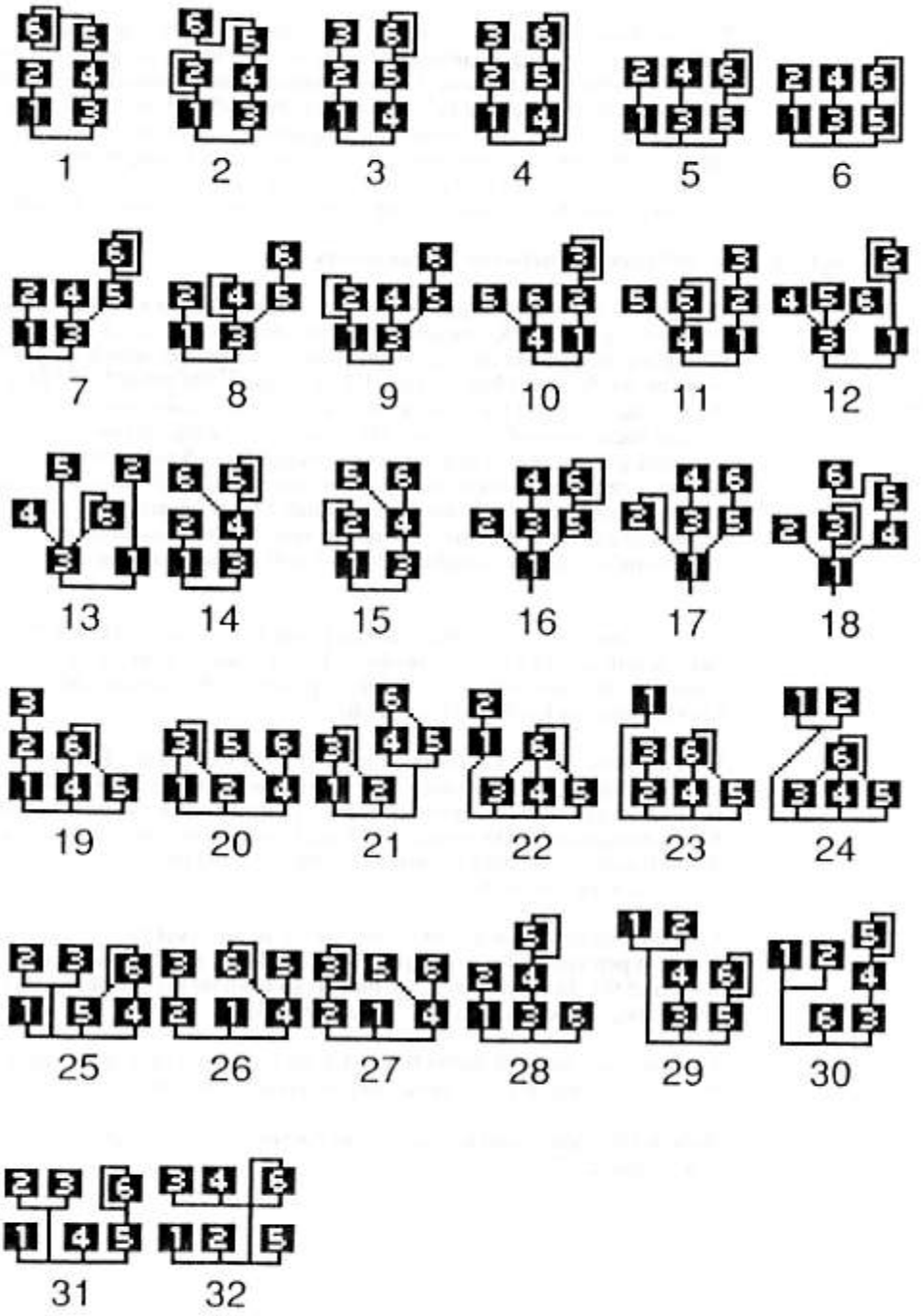
Rate	Time(seconds)	Rate	Time(seconds)
99	.008	58	.99
96	.008	55	1.34
93	.008	52	1.99
90	.013	46	3.98
87	.020	43	5.66
84	.025	35	7.0
81	.037	30	11.2
78	.047	25	20
75	.068	20	39.7
72	.081	15	63
69	.15	10	115
66	.41	5	181
61	.71	1	318 (over five minutes!)

4C. **Percentage of 0-99 up times for EG Levels.** Interpolate for values in between those listed. Note: Astoundingly, any EG level below 31 is equivalent to a level of 0, and the rise time between 0 and such a level is effectively instantaneous.

Level	Percentage of 0-99 time to go from 0 to Level
>=31	0%
35	2
40	6
50	14
60	24
70	35
80	50
90	70
95	86
99	100

4D. **Percentage of 99-0 down times for EG Levels.**

Level	Percentage of 99-0 time to from Level to 0
99	100%
90	92
80	84
70	77
60	70
50	59
40	52
30	43
20	35
10	25
0	0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The envelopes used in an Yamaha FM synthesis chip are programmed with eight numbers representing quantities from 0 to 99. Many people may be under the impression that these numerical scales represent linear scales in the sense of time or amplitude. Nothing could be further from the truth! Apparently, the engineers at Yamaha decided to give musicians/programmers a model which would allow a variety of envelopes to be created with a minimum of complications. The outward "simplification" was to take choice settings for rates and amplitudes that vary over a huge range and then let each setting be represented by a number from 0 to 99.

Calculating time differences between breakpoints

This past year I used a digital sound editing program at CCRMA called EdSnd to examine digitized DX7 envelopes at the millisecond level. At the time I was attempting to simulate the DX7 with another synthesizer which only costs about 50 times as much... and had no idea I'd be writing *this* program. There is a certain irony in the fact that I had to make recordings of the analog output of a DX7 and then digitize them when of course the DX is internally a digital machine. The fact that I also used a stopwatch to time longer envelopes (over 5 *minutes*!) should tell you that the times between breakpoints are quite varied. Though don't have access to the internal design of the DX7 hardware, I think I have figured out a formula which can be used to calculate the time differences based on the eight rate and level numbers. The formula is rather complicated, but I will outline how the calculation might be done.

Let's say we have an envelope with a Level 1 of 90, a Level 2 of 40, and a Rate 2 (which will affect the time between Level 1 and Level 2) of 35. Assume, for simplicity, that the output level of the Operator is 99, and that there is no Keyboard Level Scaling or Keyboard Rate Scaling.

Step 1: Find the time it takes to go from a level of 99 *down* to 0 at a Rate of 35. Notice that the word "down" is italicized. This is because the times for envelopes going down is much longer than the times for going up for the same rate and distance numbers. In my emulation of DX envelopes, I used the data in found in Appendix C (tables 4A-4D) and interpolated linearly between indicated points. So, for a rate of 35, we have a time of 7 seconds.

Step 2: Find the percentage of the 99-0 time for the initial level (90). This turns out to be a constant percentage for *every* possible rate. From table 4D, we have 92 percent for a level of 90. In other words, the time to go from 90 to 0 would be 92 percent of the 99-0 time, or about 6.4 seconds for a rate of 35.

Step 3: Find the percentage of the 99-0 time for the final level (40). From table 4D, we have 52 percent. Thus it takes 3.6 seconds to go from 40 to 0.

Step 4: Subtract the time found in Step 3 from the time in Step 2. Thus we have 6.4 - 3.6 or 2.8 seconds.

Time Factors You should note that the Output Level and Scaling factors affect what the real Initial and Final Levels are *before* the Envelopes are calculated. Thus there are six factors which appear to determine the time it takes for an Envelope to get from one point to another:

- Operator Output Level (determines the actual level)
- Keyboard Level Scaling (determines the actual level)
- Operator EG Levels (determines difference in rise or decay and actual level)
- Operator EG Rate (time difference from maximum to minimum value or vice versa)
- Keyboard Rate Scaling (how much the Rates are increased)
- The pitch of the note (for Keyboard Rate Scaling and Keyboard Level Scaling)

Exponential Envelopes

The shape of the DX Envelopes is consistently exponential (an example is shown below). Even the rapid Rates of 99 have an exponential curve to them!

Linear Envelope Exponential Envelope

In psychoacoustical tests, subjects report that slow Exponential rises and decays in amplitude rise "constantly" (or linearly) whereas linear rises and decays sound exponential. Another experiment that shows this phenomenon is an experiment where a subject is told to "turn down" the volume of a sound source with a knob at a "constant" rate. The actual decrease in amplitude will be exponential.

It also seems to be the case that most natural instruments have exponential attacks and decays. A prime example is the piano.

Summary If you were hoping that the Opcode Patch Editor would display real time representations of Envelopes, I hope that the preceding information has at least made you realize how complex it is to do the job right. First of all, any representation would involve some kind of distortion, since there's no way to display a time difference of .003 seconds against one of 5 minutes on a 512x342 pixel screen with any sort of signifant resolution. Secondly, there are so many factors which determine the actual envelope, some of which are beyond the control of the program (like what note you play!), that the speed of using the Patch Editor would decrease considerably if it had to recalculate and/or redraw the envelopes every time you changed something.

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