by Alex Case

Nuts & Bolts

A New Beginner's series on the Nuts and Bolts of Recording

Part 1: Consoles and Connections

Ladies and gentlemen: By now most of you know Alex Case's writing very well (for instance, he wrote that famous 'The Snare—mastering the art of noise' article in the January'issue). What you may not know is that Alex is a busy engineer in the Boston area, that he teaches music production and engineering at Berklee College of Music, and that he's just the right person to be starting our new beginner's series.

Before turning the mighty pen over to Alex for this extended-mix opening column, let me just reassure fellow fans of Mike Rivers' 'Oops Wrong Button' that the series will continue in its more advanced state. It's simply time to start over from Square 1 so recording novices can be brought up to speed.

And now without further ado I give you...Alex.—NB

The roads of Boston are famous for their random wandering. Few streets intersect at right angles. Individual streets change names, become one way, or dead end without warning. The natives, not just the rent-a-car equipped tourists, admit that it's easy to get lost. A running joke says that somewhere in this city you'll reach an intersection while driving down a one way street and innocently encounter all three signs of doom at once: no left turn, no right turn, and do not enter.

Maybe there is a flashing red light to warn you are approaching this dreaded intersection. And there is probably also a sign admonishing you to yield to pedestrians, as if your ability to make progress weren't already limited enough. Naturally there are no signs telling you what street you are on or what street you have reached.

The cars, most of them taxis, just line up. Your blood pressure rises. Your appointments expire. You scream to yourself, "Why am I driving in this town anyway?"

Without some fundamental understanding of how a studio is connected, you'll eventually find yourself at the audio equivalent of this intersection: feedback loops scream through the monitors, no fader seems capable of turning down the vocal, drums rattle away in the headphones but aren't getting to tape... I could go on. Believe me. I could go on.

At the center of this mess is the mixing console (a.k.a. mixer, board, or desk). In the hands of a qualified engineer, it manages the flow of all audio signals, getting them to their appropriate destination safely and smoothly. The untrained user can expect to get lost, encounter fender benders, and eventually be paralyzed by gridlock.

The role of the mixer

The ultimate function of the console is to control, manipulate, and route all the various audio signals racing in and out of the different pieces of equipment in the studio or synth rack—it provides the appropriate signal path for the recording task at hand.

Consider mixdown. The signal flow goal of mixing is to combine several tracks of music that have been oh-so-carefully recorded on a multitrack into two tracks of music that our friends, the radio stations, and the record buying public can enjoy. They all have stereos, so we 'convert' the multitrack recording into stereo: 24 tracks in, two tracks out. The mixer is the device that does this.

Naturally, there's a lot more to mixing than just combining the 24 tracks into a nice sounding 2-track mix. For example, we might also add reverb. And equalization. And compression. And a little turbo-auto-panning-flange-wah-distortion™ (patent pending. It's just a little patch I'm working on in the ol' digital multi-effects box).

It is the mixing console's job to provide the signal flow structure that enables all these devices to be hooked up correctly. It ensures that all the appropriate signals get to their destinations without running into anything. A primary function of the console is revealed: the mixer must be able to hook up any audio output to any audio input. See Figure 1 for an example of the many possible hookups you might expect your mixer to provide.

In connecting any of these outputs to any of these inputs, the console is asked to make a nearly infinite number of options possible. We mentioned mixdown as an example above, but we do more than mix. Our signal routing device has to be able to configure the gear for recording a bunch of signals to the multitrack recorder simultaneously, like when we record a big band. It should also be able to make the necessary signal flow adjustments required to permit an overdub on the multitrack.Additionally, we might need to record or broadcast live in stereo.

Fortunately, all sessions fall into one of the following categories.

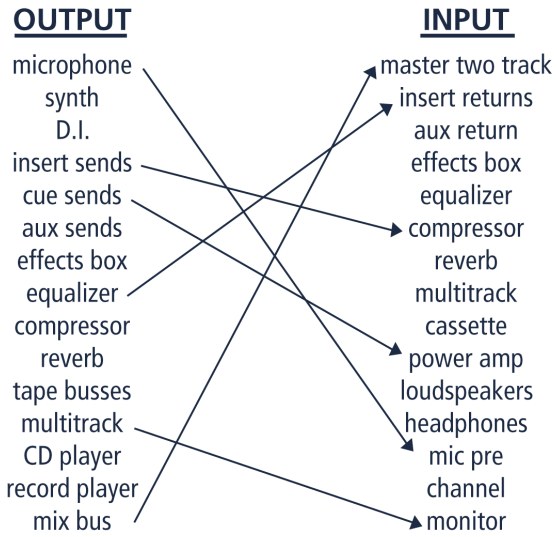
1. Basics

A multitrack recording project begins with the basics session. When doing the basics session, nothing is on tape yet, lots of musicians are in the room playing, and the engineer is charged with the task of getting the first tracks onto tape.

You know how it goes. The band all plays together, and you record them onto separate tracks. Of course the

singer will want to redo her part as an overdub later. Ditto for the guitarist. You still record everything, as sometimes the keeper take is the one that happens during basics. No pressure, just sing/play along so the band can keep track of which verse they are on, and we'll record a more careful track in a few weeks.

FIGURE 1: MAKING THE RIGHT CONNECTION



Such freedom often leads to creativity and chance-taking, key components of a great take. So you may one day be glad you recorded the singer that day. Ditto for the guitarist.

With the intent to do so many tracks as overdubs later anyway, the audio mission of the basics session is reduced to getting the killer drum and bass performance onto the multitrack. And sometimes even the bass part gets deferred into an overdub.

So for basics we record the entire band playing all at once to get the drummer's part on tape. Check out the set-up sheet for a very simple basics session. It's just a trio—drums, bass, guitar, and vocals—and yet we've got at least 15 microphones going to at least ten tracks.

I say "at least" because it is easy to throw more mics on these same instruments (e.g. create a more interesting guitar tone through the combination of several different kinds of mics in different locations around the guitar amp). And if you have enough tracks, it is tempting to use even more tracks (e.g. record the bass DI direct to the mixer as a separate track from the miked bass cabinet).

The console is in the center of all this, as shown in Figure 3. It routes all those mic signals to the multitrack so you can record them. It routes them to the monitors so you can hear them. It routes those same signals to the headphones so the band members can hear each other, the producer, and the engineer. And it sends and receives audio to and from any number of signal processors (more is better): compressors, equalizers, reverbs, etc.

2. Overdubbing

For the overdubs there are often fewer musicians playing, fewer microphones in action, and possibly fewer band members around. It is often a much calmer experience.

During basics there is the unspoken but strongly implied pressure that no one can mess up or the whole take will have to be stopped. The crowd in the studio is overwhelming. The crowd in the control room is watching. The lights, meters, mics and cables all over the place complete that "in the lab, under a microscope" feeling. Performance anxiety fills the studio of a basics session.

Overdubs, on the other hand, are as uncomplicated as a singer, a microphone, a producer, and an engineer. Dim the lights. Relax. Do a few practice runs. Any musical mistakes tonight are just between us. No one else will hear them. We'll erase them. If you don't like it, just stop and we'll try again.

Meantime, the console routes the mics to the multitrack tape. The console creates the rough mix of the mics and the tracks already on tape and sends them to the monitors. Simultaneously, it creates a separate mix for the headphones. And we never miss an opportunity to patch in a compressor and some effects. Figure 4 lays out the console in overdub mode.

3. Mixdown

For mixdown, the engineer and producer use their musical and technical abilities to the max, coaxing the most satisfying loudspeaker performance out of everything the band recorded. There is no limit to what might be attempted. There is no limit to the amount of gear that might be needed.

In case you've never seen what goes on in a big budget pop mix, let me reveal an important fact: nearly every track (and there are at least 24, probably many more) gets equalized and compressed and probably gets a dose of reverb and/or some additional effects as well. A few hundred patch cables are used. Perhaps several tens, probably hundreds of thousands of dollars worth of outboard signal processing is used.

Automation is required. And an enormous console is desired. During earlier recording and overdubbing sessions you might have thought, "This is sounding like a hit." It's not until mixdown when you'll really feel it. It's not until the gear-intense, track by track assembly of the tune that you'll think, "This sounds like a record!"

As Figure 5 illustrates, the signal flow associated with mixdown is actually quite straightforward. Gone is the need to handle microphone signals. Gone is the need to create a headphone mix. Nothing needs to be sent to the multitrack. The mission is to route multitrack music plus effects to the monitors. The only addition is the master 2-track machine. The point, after all, is to create a DAT, cassette, or CD master of the mix.

4. Live to 2

For many gigs we bypass the multitrack entirely, recording a live performance of any number of musicians straight to the 2-track master machine or sending it live to a stereo broadcast or the house monitors.

A Live to 2 session is the rather intimidating combination of all elements of a Basics and a Mixdown session. Performance anxiety fills the performers, the producer, and the engineer.

FIGURE 2: SET UP SHEET

SET UP SHEET

artist: Angist
producer: ATC
engineer: AUG
assistant: ACH
title: Mixed Signature

date: 17 Sep. 94
studio: A
tape:
machine: # 1, 2, 3
sample rate: 44.1 khz
reel: 3

mic	instrument	input	track	notes
D-12	kick	1	2	pad ✓
km 84	Snare	2	3	
441	Snare	3	3	Ω
451	Hi hat	4	1	
421	Tom 1	5	4/5	
421	Tom 2	6	4/5	
421	Tom 3	7	4/5	
421	Floor Tom	8	4/5	
414	Overhead L	9	6	Ω no pad no roll off
414	Overhead R	10	7	Ω no pad no roll off
		11		
1147	Bass CAB	12	8	
Jensen	DI	13	8	
		14		
57	EGT close	15	9	
4050	amb	16	9	Ω no pad no roll off
		17		
		18		
		19		
		20		
		21		
		22		
		23		
VMI	L Vocal	24	10	

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But for the console itself, the gig is actually quite straightforward: microphones in, stereo mix out. Of course we want to patch in any number of signal processors. Then the resulting stereo feed goes to the studio monitors, the house monitors, the headphones, the 2-track master recorder, and/or the transmitter.

Board of confusion

These four types of sessions define the full range of signal flow requirements of the most capable mixer. Yet despite having distilled the possibilities into these key categories, the console demands to be approached with some organization. Broadly, we can expect to be frustrated by two inherent features of the device: complexity of flow (where is the signal supposed to be going?) and quantity of controls (look at all these pots!).

Complexity is built into the console because it can provide the signal flow structure for any kind of recording session one might encounter. The push of any button on the console might radically change the signal flow configuration of the device.

In this studio full of equipment, that little button changes what's hooked up to what. A fader that used to control the snare microphone going to track 16 might instantly be switched into controlling the baritone sax level in the mix. It gets messy fast.

The sheer quantity of controls on the work surface of the mixer is an inevitable headache because the console is capable of routing so many different kinds of outputs to so many different kinds of inputs. 24 tracks is the norm for multitrack projects. Most of us exceed this. Number of microphones and signal processors? Well, let's just say that more is better.

The result is consoles that fill the room—or a pair of 17" computer monitors—with knobs, faders, and switches. The control room starts to look like the cockpit of the space shuttle, with a mind-numbing collection of controls, lights, and meters.

These two factors, complexity and quantity, conspire to make the console a confusing and intimidating device to use. It needn't be.

Flexibility: friend or foe?

In the end, a mixer is not doing anything especially tricky. The mixer just creates the signal flow necessary to get the outputs associated with today's session to the appropriate inputs.

The console becomes confusing and intimidating when the signal routing flexibility of the console takes over and the engineer loses control over what the console is doing. It's frustrating to do an overdub when the console is in a Live to 2 configuration. The thing won't permit you to monitor what's on the multitrack tape.

Or if the console is expecting a mixdown, but the session wants to record basic tracks, you experience that helpless feeling of not being able to hear a single microphone that's been set up. The band keeps playing, but the control room remains silent.

It doesn't take too many of these experiences before console-phobia sets in. A loss of confidence maturing into an outright fear of using certain consoles is a natural reaction. Through total knowledge of signal flow, this can be overcome.

The key to understanding the signal flow of all consoles is to break the multitrack recording process—whether mixing, overdubbing, or anything else—into two distinct signal flow stages.

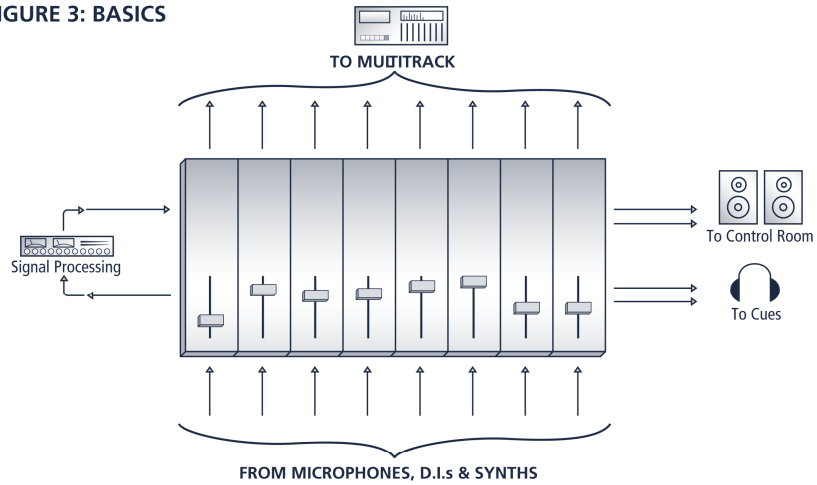
First is the Channel path. Also called the Record path, it is the part of the console used to get a microphone signal (or synth output)

to the multitrack tape machine and, you know, record it.It usually has a microphone preamp at its input, and some numbered tape busses at its output. In between you find a fader and maybe some equalization, compression, effects sends, cue sends, and other handy features associated with getting a great sound to tape.

The second distinct audio path is the Monitor path. It is the part of the console you use to actually hear the sounds you are recording. It typically begins with the multitrack tape returns and ends at the mix bus. Along the way, the Monitor Path has a fader and possibly another collection of signal processing circuitry like equalization, compression, and more.

Keeping these two signal flow paths separate in your mind will enable you to make sense of the plethora of controls sitting in front of you on the console. Try to hang on to these two distinct signal paths conceptually, as this will help you understand how the signal flow structure changes when going from basics to mixdown. Try to break up the console real estate into channel sections and monitor sections so that you know which fader is a channel fader and which is a monitor fader.

FIGURE 3: BASICS



Split consoles

Console manufacturers offer us two channel/monitor layouts. One way to arrange the Channel paths and Monitor paths is to separate them physically from each other. Put all the Channel paths on, say, the left side of the mixer and the Monitor

paths on the right as in Figure 8A. This is a split configuration.

Working on this type of console is fairly straightforward. See the snare overload on the multitrack? This is a recording problem. Head to the left side of the board and grab the Channel fader governing the snare mic. Levels to tape look good, but the guitar is drowning out the vocal? This is a monitoring problem. Reach over to the right side of the console and fix it with the Monitor faders.

Sitting in front of 48 faders is less confusing if you know the 24 on the left are controlling microphone levels to tape (channel faders) and the 24 on the right are controlling mix levels to the loudspeakers (monitor faders). So it's not too confusing that there are two faders labeled,"Lead vocal." The one on the left is the mic you're recording; the one on the right is the track you're listening to.

In-line consoles

A clever but often confusing enhancement to the console is the in-line configuration. Here the channel and monitor paths are no longer separated into separate modules on separate sides of the mixer. In fact, they are combinedinto a single module set; see Figure 8B.

Experience tells us that our focus, and therefore our signal processing, tends to be oriented toward either the channel path or the monitor path, but not both. During tracking the engineer is dedicating ears, brains, heart, and equipment to the record path, trying to get the best sounds on tape as possible.

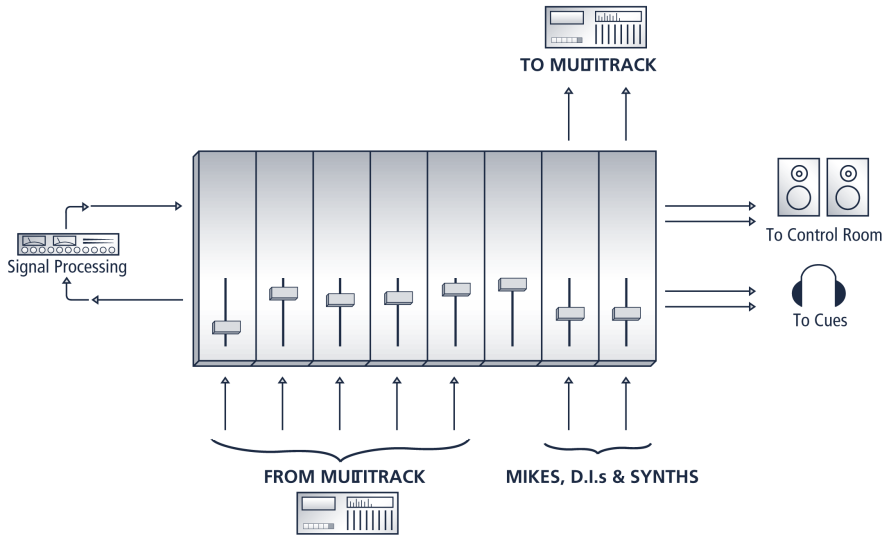
Sure the monitoring part of the console is being used. The music being recorded couldn't be heard otherwise. But the monitor section is just creating a 'rough mix,' giving the engineer, producer and musicians an honest aural image of what is being recorded.

The real work is happening on the channel side of things, and the monitor path should only report the results of that work accurately. Adding elaborate signal processing on the monitor path only adds confusion at best, and misleading lies at worst. For example adding a "smiley face" equalization curve—boosting the lows and the highs so that a graphic eq would seem to smile—on the monitor path of the vocal could hide the fact that a boxy, thin,and muffled signal is what's actually being recorded onto the multitrack.

It turns out that for tracking, overdubbing, mixing, and live to 2 sessions, we only really need signal processing once, in the channel or the monitor path. We've just seen the channel path focus of tracking. Mixing and Live to 2 sessions are almost entirely focused on the final stereo mix that we hear, so the engineer and the equipment become more monitor path oriented.

Herein lies an opportunity to improve the console. If the normal course of a session rarely requires signal processing on both the monitor path and the channel path, then why not cut out half the signal processors? If half the equalizers, filters, compressors, aux sends, etc. are removed, the manufacturer can offer the console at a lower price,

FIGURE 4: OVERDUBBING



or spend the freed resources on a higher quality version of the signal processors that remain, or little bit of both.

And as an added bonus the console gets a little smaller and a lot of those knobs and switches disappear, reducing costs and confusion further still. This motivates the creation of the in-line console.

On an in-line console, the channel path and the monitor path are combined into a single module so they can share some equipment. Switches lie next to most pieces of the console, letting the engineer decide, piece by piece, whether a given feature is needed in the channel path or the monitor path. The equalizer, for example, can be switched into the record path during an overdub and then into the monitor path during mixdown. Ditto for any other signal processing.

Of course, some equipment is required for both the channel path and the monitor path—like faders. So there is always a channel fader and a separate monitor fader (less expensive mixers often use monitor pots). The in-line console is a clever collection of only the equipment needed, when it's needed, where it's needed.

Channel surfing

An unavoidable result of streamlining the console into an in-line configuration is the following kind of confusion. A single module, which now consists of two distinct signal paths, might have two very different audio sounds within it.

Consider a simple vocal overdub. A given module might easily have a vocal microphone on its channel fader but some other signal, like a previously recorded guitar track, on its monitor fader. The live vocal track is actually being monitored on some other module and there is no channel for the guitar, as it was overdubbed yesterday.

Levels to tape look good, but the guitar is drowning out the vocal? This is a monitoring problem. The solution is to turn down the monitor fader for the guitar. But where is it?

Unlike the split design, an in-line console presents us with the ability to both record and monitor signals on every module across the entire console. Each module has a monitor path. Therefore each module might have a previously recorded track under the control of one of its faders. Each module also has a channel path. Therefore, each module might have a live microphone signal running through it.

To use an in-line console, you must be able to answer the following question in a split second: "Which of the perhaps 100 faders in front of me controls the guitar track?" Know where the guitar's monitor path is at all times, and don't be bothered if the channel fader sharing that module has nothing to do with the guitar track. The monitor strip may say, "Guitar."

But you know that the channel contains the vocal being recorded. It is essential to know how to turn down the guitar's monitor fader without fear of accidentally pulling down the level of the vocal going to the multitrack tape.

FIGURE 5: MIXDOWN

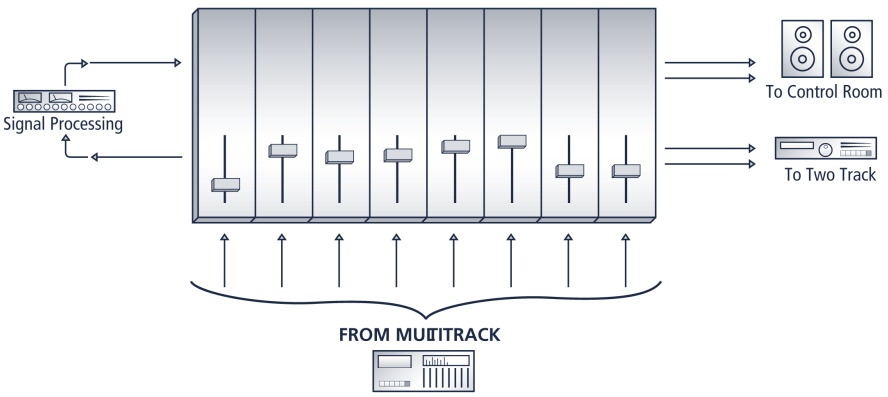
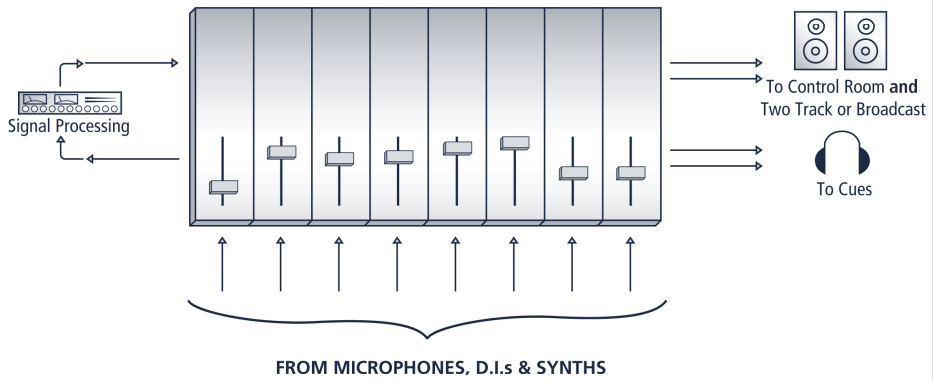


FIGURE 6: LIVE TO TWO



One must maintain track sheets, set-up sheets, and other session documentation. These pieces of paper can be as important as the tape/hard disk that stores the music. However, rather than just relying on these notes, it helps to maintain a mental inventory of where every microphone, track, and effects unit is patched into the mixer.

Much to the frustration of the assistant engineer who needs to watch and document what's going on and the producer who would like to figure out what's going on, many engineers don't even bother labeling the strip or any equipment for an overdub session or even a mix session. The entire session set-up and track sheet is in their heads.

If you have enough mental RAM for this, try to do it. It helps you get into the project. You are forced to be as focused on the song as the musicians are. They've got lines and changes and solos and lyrics to keep track of.

The engineer can be expected to keep up with the microphones and reverbs and tracks on tape. This comes with practice. And when you know the layout of the console this intimately, the overlapping of microphones and tracks that appears on an in-line console is not so confusing.

Sure the split console offers some geographic separation of mic signals from tape signals, which makes it a little easier to remember what's where. But through practice you are going to keep up with all the details in a session anyway. The in-line console becomes a perfectly comfortable place to work.

Getting your ducks in a row

If you've dialed in the perfect equalization and compression for the snare drum during a basics session, but fail to notice that you are processing its monitor path instead of its channel path, you are in for a surprise. When you play back the track next week for overdubs, you'll find that that powerful snare was a monitoring creation only and didn't go to tape. It evaporated on the last playback last week.

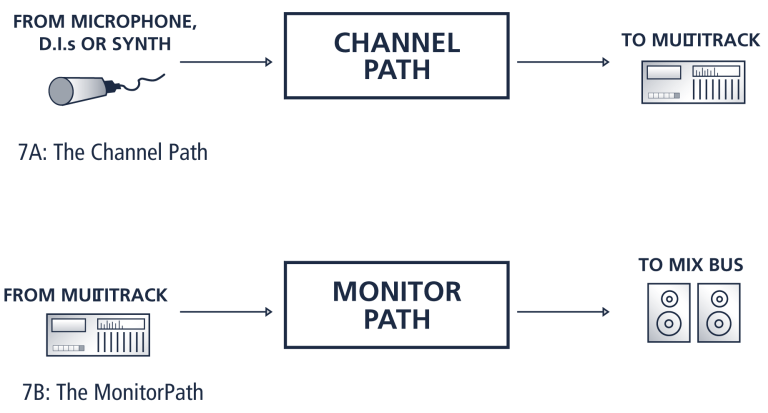
Hopefully you remember and/or document the settings of all signal processing equipment anyway, but more helpful would be to have had the signal processing chain in front of the multitrack tape machine, not after. No worries.

Through experience, you'll learn the best place for signal processing for any given session. Equalization, compression, reverb, the headphones—each has a logical choice for its source: the channel path or monitor path. And it varies by type of session. Once you've lived through a variety of sessions it becomes instinctive.

Your mission is to know how to piece together channel paths, monitor paths, and any desired signal processing for any type of session. Then the signal flow flexibility of any mixer, split or in-line, is no longer intimidating.

By staying oriented to the channel portion of the signal and the monitor portion of the signal, you can use either console to accomplish the work of any session. You can focus instead on music making.

FIGURE 7: TWO DISTINCT SIGNAL PATHS



7A: The Channel Path

7B: The MonitorPath

Nuts & Bolts

What's that switch do?

I will admit that there is such a thing as too much. You may be an excellent engineer capable of recording sweet tracks, but when Peter Gabriel invites you to his studio and you sit in front of his 72 channel G-Series SSL, you will have trouble doing what you know how to do (recording the sweet tracks) while dealing with what you don't know how to do (use this enormous mixer with, gulp, more than 8,000 knobs and switches).

Good news: that vast control surface is primarily just one smaller control group (the module) repeated over, and over, and over again. Know how to use a single module and you know how to use the whole collection of 72 modules.

Impress your clients. Impress your friends. Heck, impress yourself. Master the many subtle aspects of juggling monitor and channel paths through different types of sessions, and learn to sit calmly in front of consoles that have grown well beyond 100 modules, and you'll have developed 90% of the ability to use any console anywhere.

Alex Case always has a convincingly innocent look on his face when he sees a traffic cop or a console. You can write to Alex with questions or suggestions on what you'd like to see in 'Nuts & Bolts' at case@recordingmag.com.

Glossary

We'll include a list of terms introduced in each installment of the column, and collect them on our Web site as an ongoing reference. Here's a starting list of terms mentioned in this article.

basics (or tracking): The early stages of a recording project—recording the individual tracks on the multitrack recorder. This is done before adding overdubs, mixing to stereo, or mastering for final duplication/distribution.

bus (sometimes spelled buss): A signal path that can accept and mix signals from various sources.

channel, channel path (or input path or record path): The signal coming from your source (mic, instrument, or returning from an already-recorded track on your multitracker) into one of the mixer's channels, passing through that channel's electronics, then usually getting split to go to several destinations (monitor section for listening, multitracker to be recorded, effect sends for delay/reverb etc, master section for stereo mix).

compression: Dynamic treatment of a signal so that the difference between the loudest and softest moments is reduced.

Delay: Electronically created repetitions of a sound (echoes). Shorter delays are perceived as flanging, chorusing or doubling. We'll study these effects another time.

DI: Direct Inject or Direct Input—bypassing an instrument amp by taking the signal (usually from guitars and bass guitars) straight to a channel input of the board. Usually this is done via a small device called a direct box, which matches levels so the instrument's weak signal is matched to the board's input.

equalization or eq: Tonal treatment of a signal by attenuating (reducing) or boosting selected ranges of the total spectrum (bass and treble controls are the simplest examples). There are many types of eq, which we'll learn about later.

filter: An electronic device that reduces certain ranges of the total spectrum. For example, a low-pass filter attenuates (reduces) high frequencies, passes (leaves alone) low frequencies. Equalization is generally done with arrays of filters.

live to 2: Bypassing a multitrack recorder, mixing any number of input sources all at once into stereo.

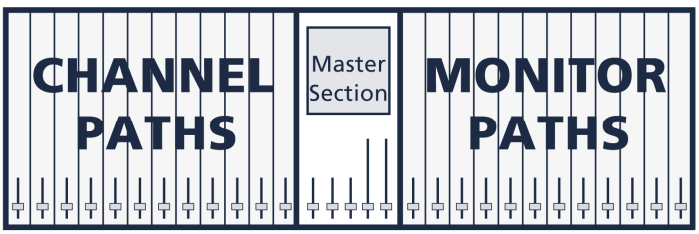
microphone preamp: An electronic device that increases the typically very weak signals produced by microphones so that these signals can join others at "line" level in a mixer.

mix bus: See bus.

mixdown: Usually stage three in a recording project after basics and overdubs, this is when all previously recorded tracks on the multitracker are routed through (returned to) the board, their levels and panning and effects adjusted, resulting in a final stereo mix.

mixer (or console, board, desk): An apparatus with many electronic

FIGURE 8: CHANNEL / MONITOR LAYOUT



8A: The Split Console

8B: The In-Line Console

circuits, all designed to accept audio signals, split (duplicate) them, re-route them, combine them, adjust their levels, tonal characteristics, and placement in the final stereo mix.

module: A group of electronic circuits that combine to achieve a specific task, as in a mixer's channel module

monitor path: A mixer signal path that accepts and mixes signals to be monitored (listened to).

outboard signal processing: Treatment (reverb, delays, others) of signals outside of the board (reached via effects or auxiliary send busses and send outputs, returned to the board via return inputs and return busses)

overdub: Adding one track or several tracks to previously recorded tracks (e.g. a singer adds vocals after the instrumental tracks have been recorded).

patch cable: A cord connecting two points to carry a signal from A to B.

pot: Short for potentiometer, a device that increases or decreases the signal strength (a kind of volume control) or tweaks eq settings, etc. Basically a techie term for a knob.

return (tape or aux or effects): A type of input into the board bringing back signals other than the original sources (mics or instruments), either previously recorded multitracks, or signals returning from outboard processors. See send.

reverb: An electronically created illusion of room acoustics.

send (aux or cue): Circuits (busses) that lead to an output connector from where signals can be sent to outboard processors or to monitoring (listening) setups. See return.

stereo bus: The final two circuits in a board that accept and mix signals to become the Left and Right channels of a stereo mix.

tape bus: A circuit that accepts and mixes signals to or from tape recorders.

two mix: See stereo bus.

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