NUTS and BOLTS

PART 9

COMPRESSORS

What happens when you ignore what they were originally designed to do?

BY ALEX CASE

Music signals are rarely consistent in level. Every crack of the snare, syllable of the vocal, and strum of the guitar causes the signal to surge up and recede down in amplitude.

The top of Figure 1 (on Page 52) shows the amplitude of about a bar of music. Signals like this one must fit through our entire audio chain without distortion: the microphone, the microphone preamp, the console, the outboard gear, the multitrack recorder, the 2-track master recorder, the power amp, and the loudspeakers.

The highest peak must get through these devices without clipping, while the detail of the lowest, nearly silent bits of music must pass through without being swamped by noise. When we aim for 0VU on the meters, all we're doing is trying to avoid distortion at the high end of things and noise down on the bottom.

To help us fit extremely dynamic signals within the amplitude limits imposed by our studio, we reach for a compressor. Its task? Quite simply, when a signal gets too loud, the compressor turns it down.

What counts as too loud? The Threshold setting on the compressor sets the level at which compression is to begin. When the amplitude of the signal is below this threshold the device passes the audio through unchanged. When the signal exceeds the threshold the compressor begins to turn the signal down.

Taking control

How does it turn it down? This question breaks in two. How much? And how fast?

The amount of compression is determined by the Ratio setting. Mathematically, the ratio compares the amount of the input signal above threshold to the amount of the attenuated output above threshold.

For example, a 4:1 (four to one) ratio describes a situation in which the input was four times higher than the output above the threshold—4 dB above threshold in becomes 1 dB above threshold out, 8 dB above threshold in becomes 2 dB above threshold out. A ratio of X:1 sets the compressor so that the input must exceed the threshold by X dB for the output to go just one dB above threshold.

How fast the signal is attenuated is controlled by the Attack setting.Attack describes how quickly the compressor can fully kick in after the threshold has been exceeded.

Fast attack times will enable the compressor to react very quickly, while slow attack times are more lethargic. Sometimes compressors change the gain so quickly that it becomes audible—and unmusical (although the effect can be useful as an effect). It becomes desirable to slow the attack time down and let the compression sneak into action. It's a trade-off, though, because if the purpose of compression is to control the dynamic range of a signal to prevent distortion, then it must act quickly.

Threshold, ratio, attack…then what? When the amplitude of the music returns to a level below threshold, the compressor must stop compressing. The amount of time it takes the compressor to return to zero gain change after the signal falls below threshold is set by adjusting the compressor's ReleaseSetting this control properly helps avoid introducing artifacts to your sound.

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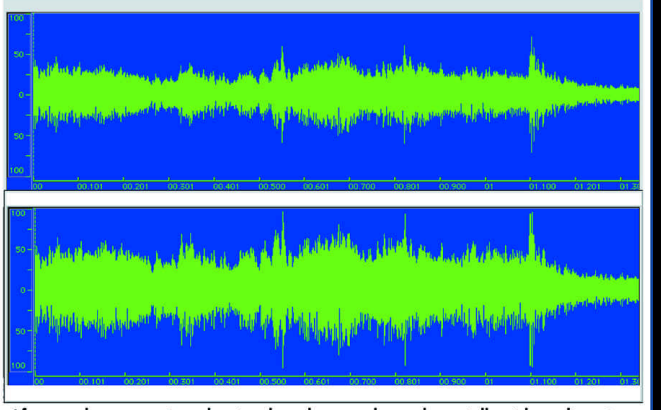
Welcome to the world of compression. Sometimes it's too fast; other times it's too slow. Sometimes we know when it's just right. Other times we seek to set it so that we can't even hear it working. Tweaking a device until it sounds so good that you can't even hear it isn't easy.

This brings us to an important issue with compression: it is often hard to hear. We discuss many applications for compression here in this month's episode of 'Nuts&Bolts.' Each application sounds different. And most of them, until you've had some experience and audio ear training, are frustrating to hear accurately. Compression, like so much of what we do as engineers, leads to:

- A few mistakes. Overcompressing is a common problem. Sometimes you can't tell that it's overcompressed until the next day. The affect of compression is at times quite subtle and at other times quite obvious. Spending all day mixing one song with your ears wide open can make it hard to remain objective.

Figure 2: Gentle Compression - Louder



After gentle compression, the signal can be turned up substantially without distortion.

If it were invented today, it would have some hyped-up, one word with two capital letters sort of name like PowerFader—and it would have a Website. The humble compressor offers a handy way to control precisely and manipulate the dynamics of the signals we record.

While these four parameters are always at work, they are not always on the faceplate of the device. That is, they are not always user-adjustable. There are compressors at all price points that leave off some of these controls; it's part of their sound. Other compressors offer full control over all the parameters yet also offer presets.

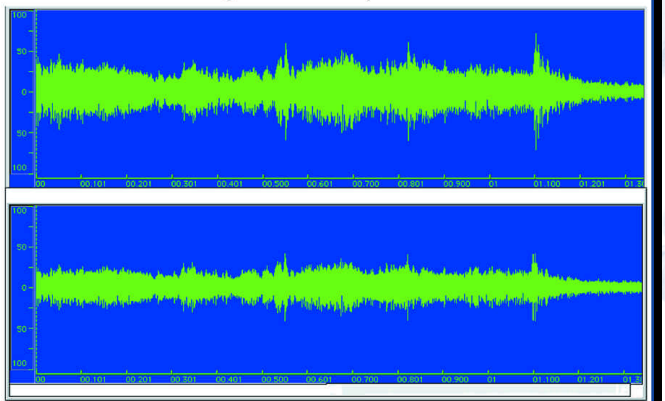
Without amplitude protection a killer take could be lost. Be ready with some gentle compression for the vocal.

- Audio hype and attitude. People might rave about how great the compression sounds—and you don't hear what on earth they're talking about.Again, some compression is hard to hear and requires experience. Perhaps they've had the chance to hear this kind of compression before. All you need is time between the speakers immersed in compression of all kinds and you'll pick it up. On the other hand, sometimes people are just full of bull pucky.

Beyond the controls

These four parameters—threshold, ratio, attack and release—enable the compressor to carefully monitor and make fine adjustments to the amplitude of a signal automatically. The engineer is then freed to concentrate more on other things (Is the guitar in tune? Is the coffee strong enough?)

Figure 1: Gentle Compression



A comparison of the original signal and the same signal after some gentle compression

The presets reflect someone else's careful tweaking to get the sound in the right place. Sometimes the presets simulate the attack and release characteristics of other, vintage, collectible, famous sorts of compressors.

It's a good idea for beginners to spend some time with the fully adjustable type for exploration and ear training. But I don't hesitate to reach for those compressors with only a few knobs on the box during a session. They can often get the job done more quickly and with better sonic results.

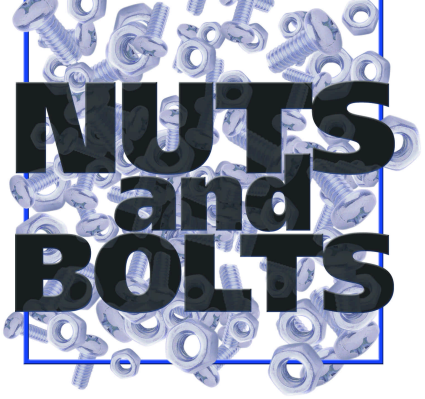
Easily compressed

When the singer really gets confident and excited he or she sings the choruses really loud—louder than during all the other takes in rehearsal. Great performance. Unusable track.

Without some amplitude protection a killer take is lost to distortion. Be ready for this with some gentle (around 4:1 or less) compression across the vocal. Then your audio path can withstand the adrenaline-induced increase in amplitude that comes from musicians when they are 'in the zone.'

When the guitarist gets nervous he or she starts moving around on the stool, leaving you to mike a moving target. Compelling performer. Nervous in the studio. Without the constant gain-riding of a compressor, you can hear the guitarist moving on- and off-mic. Again, a little gentle compression might just coax a usable recording out of an inexperienced studio performer.

When the bass player pulls out that wonderful old, collectible, valuable, sweet sounding, could sure use a little cleaning up, aren't those the original strings, couldn't stay in tune for eight bars if you paid it…gorgeous beast of an instrument, you can be sure that—even in the



hands of a master—the A string is consistently a little quieter than the E string.

Of course the solution is compression. Without the careful, precision adjustments made to the amplitude of the signal, the very foundation of the song (according to the bass player, anyway) becomes shaky. All too often you need the careful level adjustments of gentle compression (as shown in Figure 1).

There's more to it than fixing a problematic track. We also patch gentle compression across perfectly fine tracks to make them, er, better. Well, louder anyway.

A handy side effect of compressing—reducing the overall dynamic range of the signal—is that now it can be turned up. While this may seem counterintuitive,there's room to make the track louder as a whole when the points of highest amplitude have been lowered by the compressor. Figure 2 demonstrates this sort of gentle compression.

Fitting a signal on tape without overloading, or broadcasting a signal without overmodulating (getting too loud,simply put) requires that the signal never exceed a certain amplitude. Limiters are inserted to ensure these amplitude limits are honored.

In live sound applications, exceeding the amplitude capability of the sound reinforcement system can lead to feedback, damage loudspeakers, and turn happy crowds into hostile ones. Limiters offer the solution again. They guard the equipment and listeners downstream by stopping the signal from getting too loud.

Ulterior motives

When the answering machine was invented, its intended purpose was to answer the phone and take messages when you were away. But the day after the first one was sold, the answering machine took on a new, more important role: call screening. The most common message on these devices is something like,"It's me. Pick up. Pick up!"

The use of a device in ways not originally intended occurs all too often, and the compressor offers a case in point. While dynamic range reduction and peak limiting are effective, intended use for the device, we use them for other, less obvious, more creative reasons as well.

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This is often taken to radical extremes where mixes are absolutely crushed (i.e. really compressed, see also squashed, smushed, et al.) by compression so that the apparent loudness of the song exceeds the loudness of all the other songs on the radio dial. Selling records is a competitive business. Loudness does seem to help sell records.

And so it goes. Often the music suffers in this commitment to loudness and hope for sales. Artist, producer, and engineer must make this trade-off carefully. But even in small measures, a little bit of gentle compression buys you a little bit of loudness if you want it.

Take it to the limit

Another use of the compressor is to attenuate the sharp amplitude spikes within the audio that would overload a device and cause (unwanted) distortion.

During the course of a song, some snare hits are harder than others. The slamming that goes on during the chorus might be substantially louder than the delicate, ghost-note-filled snare work of the bridge.

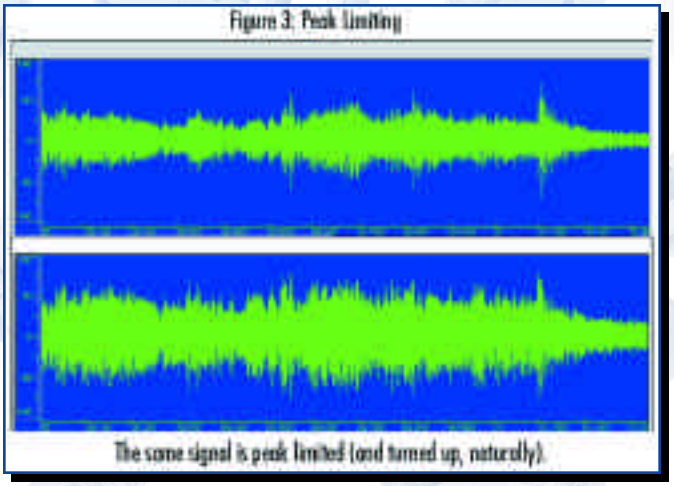
A limiter will attenuate the extreme peaks and prevent nasty distortion. And a limiter is nothing more than a compressor taken out to rather extreme settings. Threshold is high so that it only affects the peaks, leaving the rest of the music untouched. Ratio is high, greater than 10:1, so that any signal that breaks above threshold is severely attenuated.Attack is very fast so that nothing gets through without limiting.

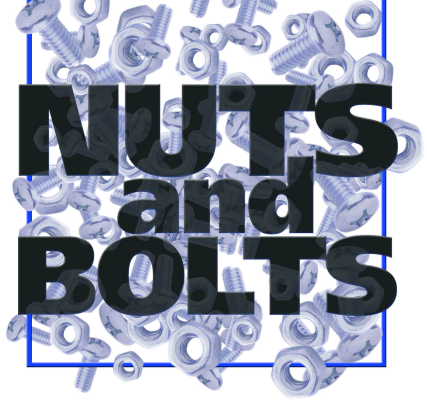
Called peak limiting,this sort of processing is used to prevent distortion and protect equipment. Figure 3 gives an example.

The envelope please

The envelope describes the 'shape' of the sound, how gradually or abruptly the sound begins and ends, and what happens in between.Drums, for example, have a sharp attack and nearly instant decay. That is, the envelope resembles a spike or impulse. Synth pads might ooze in and out of the mix, a gentle envelope on both the attack and decay side. Piano offers a combination of the two. Its unique envelope begins with a distinct, sharp attack and rings through a gently changing,slowly decaying sustain.

All instruments offer their own unique envelope. Consider the sonic differences among several instruments playing the same pitch: piano, trumpet, voice, guitar, violin, and didgeridoo. There are obvious differences





in the spectral content of these instruments; they have a different tone. But at least as important, each of these instruments begins and ends the note with its own characteristic envelope—its signature.

The compressor is the tool we use to modify the envelope of a sound. A low threshold, medium attack, high ratio setting can be used to sharpen the attack. The sound begins, at an amplitude above threshold (set low). An instant later (medium attack), the compressor leaps into action and yanks the amplitude of the signal down (high ratio). Such compression audibly alters the shape of the beginning of the sound, giving it more a more pronounced attack.

This approach can of course be applied to most any track. A good starting point for this sort of work is a snare drum sound. It's demonstrated in Figure 4, seen on Page 58.

Find a track or sample to process. Patch in a compressor and sharpen the attack. Be sure your attack isn't too fast or you might remove the sharpness of the snare entirely. Set the ratio to at least 4:1, and gradually pull the threshold down.

This type of compression has the effect of morphing a spike onto the front of the snare sound. Musical judgement is required to make sure the click of the sharper attack fits with the remaining ring of the snare. Trading off a low threshold with a high ratio offers the engineer precise control over the shape of the more aggressive attack.

Pop music pushes us to have bright, airy, in your face, exciting vocal tracks...

And this isn't just for snares. Anything goes, but do try similar processing on piano and acoustic guitar. Done well, you'll create a more exciting sound that finds it place in a crowded mix more easily.

Another unusual effect can be created using the release of a compressor. A fast release pulls up the amplitude of the sound even as it decays.

This is also shown in the snare example of Figure 4. Notice the raised amplitude and increased length in the decay portion of the waveform. Dial in a fast enough release time, and the compressor can raise the volume of the sound almost as quickly as it decays—it's almost "uncompressing" it.

Applied to piano, guitar, and cymbals, this setting develops a nearly infinite sustain, making these instruments bell or chime-like in character, while still retaining the unmistakable sound of the original instrument. File this under 'Special Effects,' but don't forget about it. An unnatural effect like this can be just what a pop tune needs to get noticed.

Another interesting thing happens when you apply some extreme compression with a fast release time. If the compressor has pulled down the peaks of the waveform and then quickly releases the signal after it

has fallen below threshold, you start to hear parts of the sound that were previously inaudible.

Fast release compression enables you to turn up the sound and hear more of the decay of a snare, the expressive breaths between the words of a vocal, the ambience of the room in between drum hits, the delicate detail at the end of a sax note, and so on. Once again, here is a use of compression to make certain parts of the signal louder.

The flip side is that you might not want, say, the pick noise to become overly accentuated.

...above a wall of guitars, tortured cymbals, reverb, and sizzling synth patches.

That hurtSSS

Pop music standards push us to have bright,airy, in your face, exciting vocal tracks. And this convincing vocal sound must rise above a wall of distorted guitars,tortured cymbals,shimmering reverb, and sizzling synth patches.

Needless to say, we push vocals with a high dose of high frequency hype (available on your trusty equalizer).Add some fast release compression to this bright equalization contour, and you really start to hear the breathing, rasping, sweating, and drooling of the singer; that's where a good deal of the emotion lives.

We can get away with this aggressive equalization move everywhere except where the vocal was already bright to begin with: hard consonants like S and F (and even Z, X, T, D, K). These sounds are naturally rich in high frequency content.

Run them through the equalizer that adds still more high end, and you've got the sort of vocal that zings the ears with pain on every S. You can't miss it: everyone in the room blinks every time the singer hits an S.

Clever compression will solve this problem. In our discussion of compression so far we have been applying our settings of threshold, ratio, attack and release to the signal being compressed. But what if we compressed one signal while 'looking at' another?

Specifically, let's compress the lead vocal. But instead of compressing it based on the vocal track itself, let's use a different signal to govern the compression.

We feed a modified vocal signal into this alternative input (called a sidechain). The vocal itself is what gets compressed, but the behavior of the compressor—when, how much, how fast and how long to compress—is governed by the sidechain signal.

To get rid of esses, we feed a signal into the sidechain that has enhanced esses. That is, the side chain input is the vocal track equalized so as to bring out the esses, and de-emphasize the rest.

We never hear this track—only the compressor does. But when the singer sings an S, it goes into the compressor loud and clear, breaking threshold and sending the compressor into action.

The sidechain signal is the vocal with a high frequency boost (maybe 12 dB somewhere around 4 kHz to 8 kHz, wherever the particularly painful consonant lives for that singer); you can filter out the rest of the side chain vocal. The compressor is set with a mid to high ratio, fast attack, and fast release.

The threshold is adjusted so that the compressor operates during the loud esses only. In between esses the

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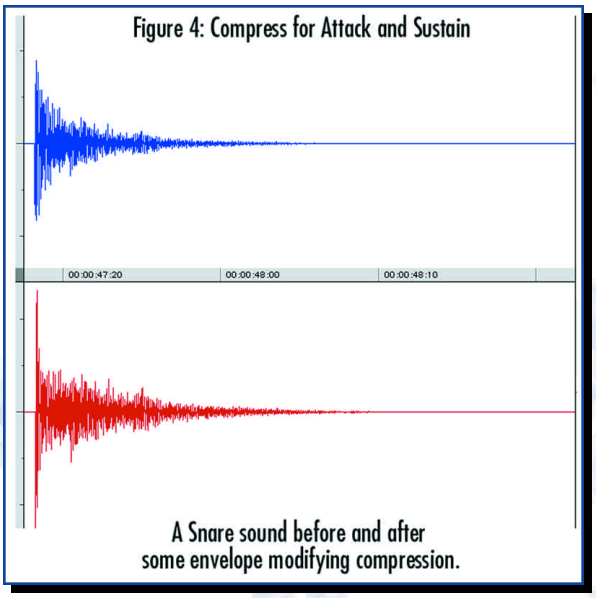
compressor doesn't touch the vocal. This vocal can be made edgy and bright without fear.

More is better

Sometimes a strong dose of compression is applied—to an individual track or the entire mix—just for the effect of, well,compression. That is, there is something about the sound of extreme compression that makes the music more exciting.

The distortion typically dialed in on most electric guitar amps adds an unmistakable, instinctively stimulating effect. By modifying the amplitude of the waveform, compression is also a kind of distortion. And it seems to communicate an intense, on the edge, pushing the limits sort of feeling.



A profoundly effective example of this is Tom Lord-Alge's mix of "One Headlight" by the Wallflowers.At each chorus there is a compelling amount of energy. It feels right.

But if you listen analytically, not emotionally, you hear that there is no big change in the arrangement: the drummer doesn't just start banging every cymbal in sight, a wall of extra distorted guitars doesn't come flying in. Jakob Dylan's voice is certainly raised, but it's well short of a scream.

Mostly the whole mix just gets squashed big time. I almost think, analytically, that the song gets a little quieter at each chorus, with the 2-mix compression pushing hard. But musically, the chorus soars.

That's the sort of compression that sells records.

Mercedes makes a car with the word Kompressor on it. Alex Case wants one. Request Nuts & Bolts topics via case@recordingmag.com.