Principles of Dynamics

by Dr. Andrea Pejrolo

Dynamics: overview

Dynamic effects play a crucial role in modern mixing. Their name comes from the fact that they are designed to alter the dynamic range of an audio signal. They are important because they allow you to control the ratios between high and low peaks in dynamic of an audio track over time. These types of effects are more often used on live acoustic instruments than on synthesizers and therefore their applications in a sequencer/MIDI environment is somewhat limited. There are four main dynamic effects: compressor, limiter, expander and gate. In Table 1, I have listed their main features and applications.

Effect	Description	Comments
Compressor	Allows you to reduce the dynamic range (difference in amplitude between high and low peaks) of an audio signal	Useful in situations where the audio signal has a very large dynamic range
Limiter	Represents a drastic version of a compressor where the ratio is set extremely high	Used mainly during tracking in order to avoid distortion and during mastering to maximize the overall volume of the mix
Expander	The exact opposite of a compressor. It allows you to increase the dynamic range of an audio signal	Sometimes useful to “re-generate” a track that was over compressed
Gate	An extreme application of an expander where the ratio is set extremely high	Very useful to reduce unwanted noises during “silent” passages of an audio track

Table 1: The Dynamic effects and their use

Compressors and Limiters

Among the dynamic effects listed in Table 1 the compressor is the one that is most commonly used on acoustic live tracks. Usually its effectiveness is somehow reduced when inserted on audio tracks that contained material recorded from a synthesizer since their audio material is for the most part well balanced in term of amplitude variations. I recommend using a compressor on synthesized tracks sparsely and only if really needed. In fact synthesized tracks in general can benefit from a larger dynamic range instead of a reduced one. Reducing the dynamic range can sometimes flatten the sonority and compromise realism. A compressor can help an acoustic track to sit better in a complex mix.

As mentioned in Table 1, a limiter is very similar to a compressor. The difference is that a limiter operates a more drastic reduction of the highest peak in dynamics, setting a ceiling over which the signal can not go. It can be effectively used to increase the overall volume of a signal without getting distortion. The parameters of compressor and limiter are listed in Table 2.

Parameter	Description	Comments
Threshold	Sets the level in dB above which the effect starts reducing the gain of the signal	If the signal is below the threshold the effect doesn't affect the signal. As soon as the level goes over the threshold the effect starts reducing the gain of the signal
Ratio	Sets how much the gain of the signal is reduced after the level goes over the threshold	- It is usually set as a *x:y* value. With a setting of 1:1 the level is not altered, with a setting of 30:1 the level is highly compressed. With a setting of 100:1 the effect is considered a soft limiter. - In certain limiters the Ratio parameter is omitted implying a ratio set to infinite. In this case the effect can be referred as a hard-limiter
Attack	Sets how quickly the effect reacts after the signal goes over the threshold	
Release	Sets how quickly the effect reacts after the signal returns below the threshold	
Knee	It controls the curvature during the transitional moment below and above the threshold point. A "Soft-knee" allows for a more gentle transition, while a "Hard-knee" generates a more drastic transition	This parameter is not found on every dynamics processor
Gain	It allows you to control the overall gain of the signal after compression/limiting.	- Since the clear effect that compression and limiting have on the signal is a reduction of amplitude the Gain parameter allows you to boost back the compressed signal by the amount specified.
		- Some dynamic plug-ins featured an "Auto Gain" option that automatically sets the level of amplification so that the output, after compression, matches the input before compression

Table 2: The parameters of compressor and limiter

In Fig. 1 you can see a diagram showing the effect that a compressor has on a generic waveform. Notice how the gain parameter is set to boost the overall level of the signal in order to bring back its highest peak to its original value.

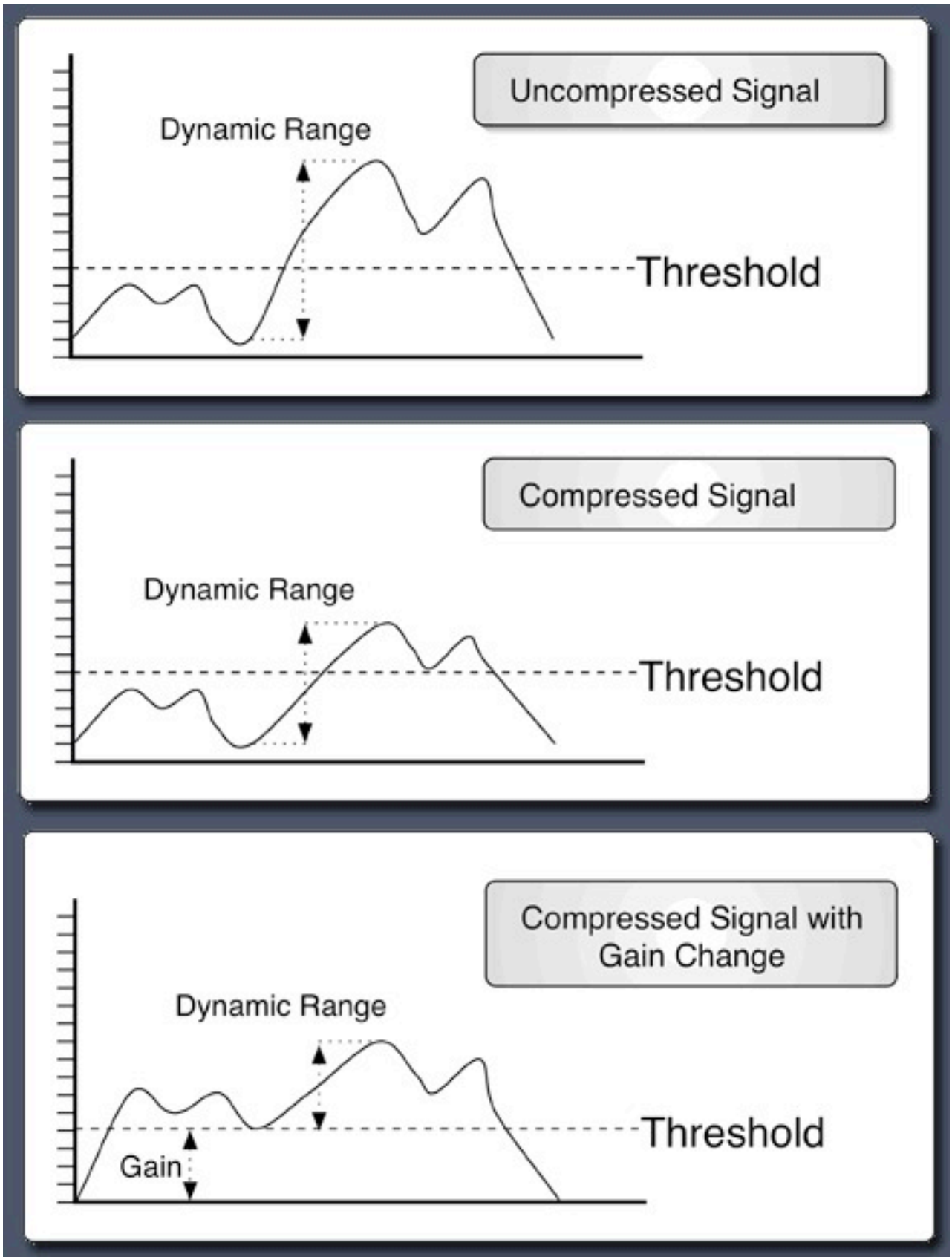

Fig. 1: Example of a compressor

Expanders and Noise Gates

Expanders and noise gates work like compressors and limiters in reverse. An expander increases the dynamic range of a signal by lowering the level of audio material that is below a set threshold. The amount of reduction is set by the ratio. If an extreme ratio setting is chosen (such as negative infinite) then the effect is a noise gate. This means that when the signal goes below the threshold is amplitude is turned to negative infinite, meaning the signal is basically muted. While expanders are usually not very common in a MIDI studio, noise gates can be effectively used to reduce the noise in between "silent" passages. Look at Fig. 2 to see how a noise gate would alter a generic waveform.

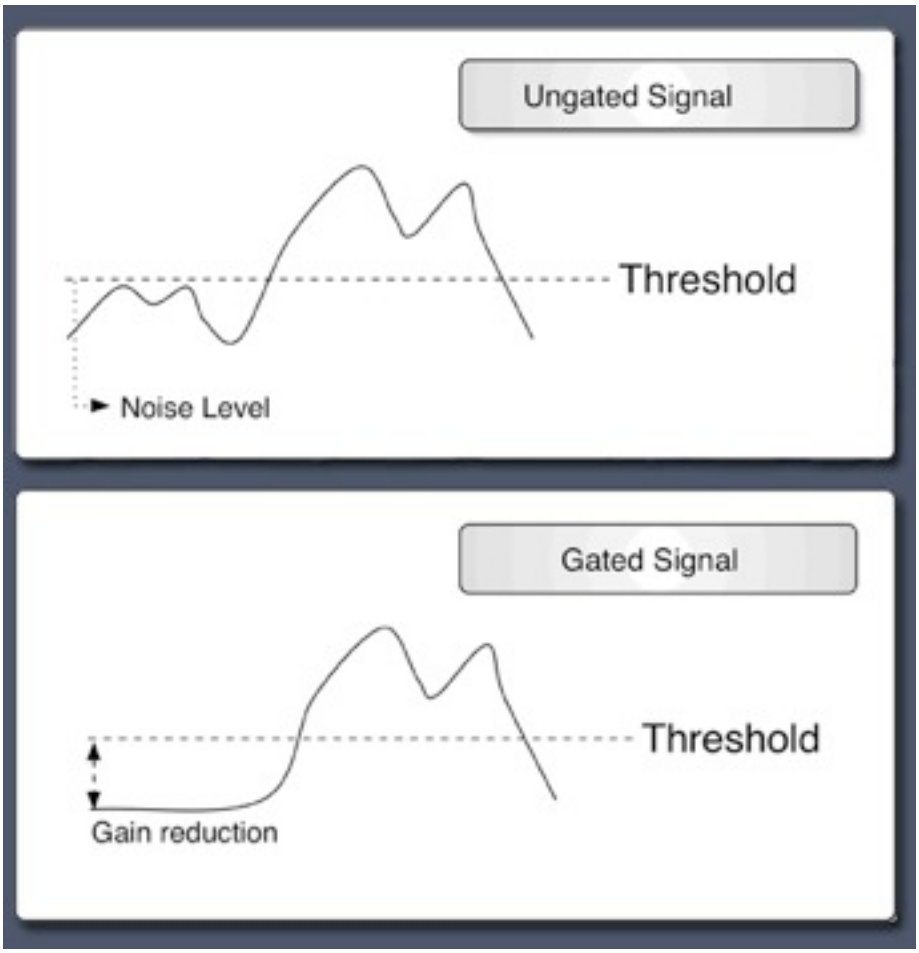

Fig. 2: Example of a noise gate

Rules of Thumb

In the case of dynamic effects it is almost impossible to come up with generic presets that would work in every situation. Every audio material is different and therefore calls for specifically targeted parameters and settings. Compressors and expanders seem the hardest to set since their effect is very often subtle and hard to identify.

In general, when working with such effects, I always recommend starting with very mild settings and then work your way towards more drastic and aggressive changes. In the case of a compressor I suggest to start with a low ratio and a fairly high threshold. This allows the compressor to "kick in" sporadically and to reduce the volume very gently. Then start lowering the threshold and raising the ratio until you start hearing undesired audio artifacts such as "pumping" effects. At that point back up a little bit by raising back the threshold and lowering back again the ratio just a notch.Make sure not to over-use dynamic effects, they can be very useful if utilized with parsimony but they can be disastrous if unnecessarily handled.

To learn more about Andrea Pejrolo visit www.geocities.com/pejobass