

# How To Manipulate Dynamic Range for Fun and Profit

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PART ONE:  
MACRODYNAMICS

**Dynamic Range** is defined as the *ratio* between the loudest and softest passages of the body of the music; hence it should not be confused with loudness or *absolute* level; the term **dynamic range** is only concerned with **differences**. For popular music, this is typically only 6 to 10 dB, but for some musical forms it can be as little as a single dB or as great as 15 (very rare). In typical pop music, soft passages 8 to 15 dB below the highest level are effective only for brief periods, but in classical, jazz and many other acoustic forms, soft passages can last several minutes.

### Microdynamics and Macrodynamics

The art of manipulating dynamics may be divided into **Macrodynamics** and **Microdynamics**. I call music's rhythmic expression, integrity or bounce, the *microdynamics* of the music. I call *macrodynamics* the loudness differences between sections of a song or song-cycle. Usually dynamics processors (such as compressors, expanders) are best for *microdynamic manipulation*, and manual gain riding is best for *macrodynamic manipulation*. The micro- and macro- work hand in hand, and many good compositions incorporate both microdynamic changes (e.g. percussive hits or instantaneous changes) as well as macrodynamic (e.g., crescendos and decrescendos). If you think of a music album as a full-course meal, then the progression from soup to appetizer to main course and dessert is the macrodynamics. The spicy impact

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\* A common misconception. Thanks to Gordon Reid of Cedar for contributing this audio myth.



**MYTH:**

"Of course I've got dynamic range. I'm playing as loudly as I can!"\*

of each morsel, is the microdynamics. In this chapter we concentrate on macrodynamics.

### Dynamics in Musical History

Dynamic changes became very important to western music sometime between the medieval Gregorian chants and the classical period, when composer Franz Josef Haydn surprised us with perhaps the first example of simultaneous micro- and macrodynamics.<sup>1</sup> Since ancient times, many “non-western” styles, such as African, Afro-Caribbean, Eastern, Indian, Balinese and other Oriental music forms, have stressed rhythm (microdynamics, especially in the form of percussion) as much as melody, and in the twentieth century of integration, heavy percussive rhythm became extremely important to western musical forms as well.<sup>2</sup>

Any genre that does not grow in musicality will quickly die, and dynamic contrast plays a big musical role. Today’s Rap and Hip-hop music has taken a 250-year-old lesson from classical

*The soundtrack for the movie **The Fugitive** is mixed like a relentless, fatiguing music single. **Titanic** was mixed like a beautiful record album.*

composition, by beginning to incorporate a melodic and harmonic structure. The genre can further

grow and avoid sounding tiresome by expanding its dynamic range, adding surprises. Silence and low level material creates suspense that makes the loud parts sound even more exciting. Five big firecrackers in a row just don’t sound as exciting as four little cherry bombs followed by an M80. Radio,

TV and Internet distribution are currently too compressed to transmit the joy of wide dynamic range, but it sure turns people on at home, and also in the motion picture theater.

Films provide an ideal framework to study the creative use of dynamic range. The public is usually not consciously aware of the effect of sound, but it can play a role in a film’s success. I think the movie *The Fugitive* succeeded because of its drama, but despite an aggressive, compressed, fatiguing sound mix. From the beginning bus ride, with its super-hot dialog and effects, all the crashes were constantly loud and overstated, completely destroying the impact of the big train crash. I can hear the director shouting, “more more more” to the mix engineers. Haven’t they heard of the term *suspense*? Because when everything is loud, then really, *nothing* is loud. In contrast, the sound mix of ‘97’s biggest movie, *Titanic*, is a masterpiece of natural dynamic range. The dialog and effects at the beginning of the movie are played at natural levels, truly enhancing the beauty, drama and suspense for the big thrills at the end. Kudos to director James Cameron and the Skywalker Sound mix team for their restraint and incredible use of dynamic range. That’s where the excitement lies for me.

### Life Imitates Art?

Clearly, modern recording techniques and equipment have aided in the creation of whole new musical styles, for example, hip hop, which uses digital editing and processing to create the beats of the music in a highly compressed, often low-dynamic-range style.<sup>3</sup> This is basically an extension of a trend in popular music that began many years

ago with the invention of electric instruments and amplifiers, and has accelerated exponentially with modern recording techniques and powerful digital processors. Successive styles have incorporated less and less dynamic range, both macrodynamics and microdynamics. Going hand in hand with this trend is an exponential increase in distortion from style to style and year to year. This may very well be due to a vicious circle that is centered in the mastering engineer's hands, for inevitably, most masters tend to be more compressed than the sources<sup>4</sup>—and what sources do recording engineers listen to for inspiration? Mastered records! We may have bred the very disease which we seek to eliminate!

While I find the current high-distortion trend very fatiguing and unlistenable after short periods of time, we must remember that one man's meat is another man's poison—never more true in the case of popular music. Musical and sound styles have been created out of the very results of pushing digital compressors beyond their usual settings, for example, sound qualities such as *squashing* and *shred*. Which is why the successful mastering engineer must be familiar with and enjoy listening to many musical styles and sounds, including perhaps those sound qualities that would not normally be considered *clean* by practicing engineers. I simply hope that the cycle has reached its peak, since there's nowhere to go but back down, when music has dynamic range of 3 dB and distortion that tears the hair out of one's ears. In due time, these new styles will become assimilated into the larger musical vocabulary, and we can hope that decent and exciting dynamics will return as a rule rather than the exception.

### The Art of Decreasing Dynamic Range

The dynamics of a song or song cycle are critical to creative musicians and composers. As engineers, our internal sound quality reference should be the sound quality of a live performance; we should be able to tell by listening if a recording will be helped or hurt by modifying its dynamics. Many recordings have already gone through several stages of transient-destroying degradation, and indiscriminate or further dynamic reduction can easily take the clarity and the quality downhill. However, usually the recording medium and intended listening environment simply cannot keep up with the full dynamic range of real life, so the mastering engineer is often called upon to raise the level of soft passages, and/or to reduce loud passages, which is a form of **manual compression**.<sup>5</sup> We may reduce dynamic range (compress) when the original range is too large for the typical home environment, or to help make the mix sound more exciting, *fatter*, more coherent, to bring out inner details, or to even out dynamic changes within a song if they sound excessive.<sup>6</sup>

Experience tells us when a passage is too soft. The context of the soft passage also determines whether it has to be raised. For example, a soft introduction immediately after a loud song may have to be raised, but a similar soft passage in the middle of a piece may be just fine. This is because the ears self-adjust their sensitivity over a medium time period, and may not be prepared for an instantaneous soft level after a very loud one. Thus, meter readings are fairly useless in this regard. How soft is too soft? The engineers at Lucasfilm discovered that



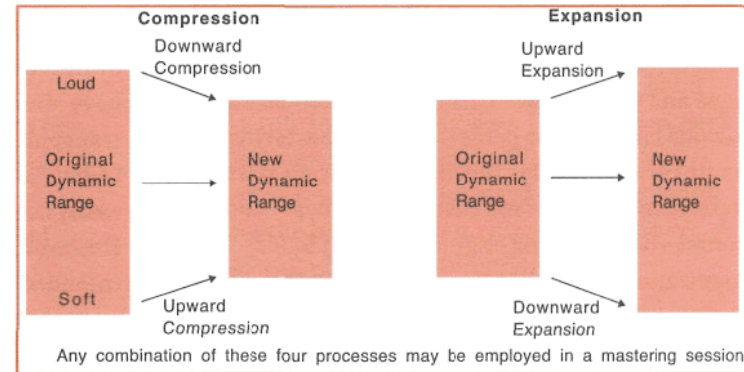
having a calibrated monitor gain and a dubbing stage with NC-30\* noise floor do not guarantee that a film mix will translate to the theatre. During theatre test screenings, some very delicate dialogue scenes were “eaten up” by the air conditioning rumble and audience noise in a real theatre. So they created a specially-calibrated noise generator, added to the mixing studio’s monitor system, labeled “popcorn noise,” which could be switched on whenever they wanted to check a particularly soft passage. For similar purposes, the “typical” (alternate) listening room we have at Digital Domain has a ceiling fan and other noisemakers. Whenever I have a concern, I start the DAW playing a loud passage just before the soft one, and take a walk to the noisy listening room. If the soft passage seems a bit too soft in comparison to the loud one, it will be obvious in there.

### The Art of Increasing Dynamic Range...

...can also make a song sound more exciting, by using the art of contrast or by increasing the intensity of a peak, for much of the impact of a song comes from its internal dynamics and transients. The trick is to recognize when an enhancement has become a defect—musical interest can be enhanced by variety, but too much variety is just as bad as too much similarity. Musical taste, experience and a great monitor system are required to make these judgments. Increasing dynamic range is known as **expansion**. Another reason to expand is to restore, or attempt to restore the excitement of dynamics

which had been lost due to multiple generations of compression or tape saturation; in this case we are increasing the recorded range.

### The Four Varieties of Dynamic Range Modification



We always use the term **Compression** for the reduction of dynamic range and **Expansion** for its increase. There are two varieties of each: **upward compression, downward compression, upward expansion, and downward expansion**, as illustrated in the above figure.

**Downward compression** is the most popular form of dynamic modification, taking high level passages and bringing them down. Limiting is a special case—downward compression with a very high ratio (to be explained in Chapter 10). Examples include just about every compressor or limiter you have ever used. For clarity in this book, we will always use the short term **compressor** to mean **downward compressor** unless we need to distinguish it from **upward compressor**.

Upward compression takes low level passages and brings them up. Examples include the encode

\* A room with an NC-30 rating is very quiet.

side of a Dolby® or other noise reduction system, the AGC<sup>7</sup> which radio stations use to make soft things louder, and the type of compressor frequently used in inexpensive video cameras and consumer VCRs. In Chapter 11 we will introduce you to a powerful upward compression technique that is extremely transparent to the ear.

**Upward expansion** takes high level passages and brings them up even further. Upward expanders are very rare and very precious, for in skilled hands they can be used to enhance dynamics, increase musical excitement, or restore lost dynamics. Examples include the peak restoration process in the playback side of a Dolby SR, the DBX Quantum Processor, the various Waves brand dynamics processors, and the Weiss DS1-MK2 when used with ratios less than 1:1 (to be explained).

**Downward expansion** is the most common type of expansion: it takes low level passages and brings them down further. Most downward expanders are used to reduce noise, hiss, or leakage. A dedicated noise gate is a special case—downward expansion with a very high ratio (to be explained). Examples of downward expanders include the classic Kepex and Drawmer gates, Dolby and similar noise reduction systems in playback mode, expander functions in multi-function boxes (e.g., Finalizer), and the gates on recording consoles. For clarity in this book, we will use the simple term **expander** to mean the downward type unless we need to distinguish it from the upward type.

## II. The Art of Manual Gain-Riding: Macrodynamic Manipulation

### In General

Level changes need to be made in the most musical way. To this end, internal level changes are least intrusive when performed manually (by raising or lowering the fader), as little as a 1/4 dB at a time, as opposed to using processors such as compressors or expanders, which tend to be more aggressive.

When gain riding, rock the boat the right way; try to go with the waves, don't fight them. If the musicians are trying for upward impact, pulling the fader back during a crescendo can be devastating since taking the fader down during a peak diminishes the intended impact. If you're doing a live recording and you sense the musicians are going to overload the recorder, you're already too late. The best case scenario is to use your sixth sense as early as possible, and lower the fader as slowly as possible, and only enough to fix the anticipated problem. An experienced live recording engineer will log where she made such changes, so that the original dynamic range may be restored by reversing the moves in post-production. Another trick is to measure peak levels during rehearsal, and assume the concert will have a peak at least 3 dB hotter! Having calibrated faders makes that adjustment easier. The art of manual leveling can really improve a production. We can enhance a great rock or pop mix during mastering, first by discovering any inappropriate level changes that the mix engineer may have missed, and by reversing them we can restore or enhance where the music is

trying to go. I've heard many a rock piece where the climax was emasculated because the mix engineer kept on dropping the master fader to keep from overloading. In mastering we can correct for this unintentional error with delicate changes; it's amazing what a dB here or there can accomplish. It's also our responsibility to check with the client in case their level change was intentional! A great rock and roll mix is extremely rare; during mixing it's really hard to simultaneously pay attention to the internal balances as well as the dynamic movement of the music between, for example, verse and chorus. A sensitive mastering engineer will take a well-balanced mix the rest of the way; you may not even realize what was missing or how much it can be enhanced until you hear the mastered version. We try to enhance those moments where it should have swelled or dipped, for this is where some of the excitement of the song can be generated.

#### **How and When to Move the Fader**

Extra-soft beginnings, endings or even middle spots require special attention. If the highest point in the song sounds "just right" after processing, but the intro sounds too soft, it's best to simply raise the intro, finding just the right editing method to restore the gain to normal after the intro using one or more of these approaches:

- Sometimes a long, gradual decrescendo is the solution, which might occur at the end of the intro, or slowly during the first verse of the body.
- Sometimes a series of 1/4 or 1/2 dB edits, taking the sound down step by step at critical moments. This is useful when you don't want the listener to note that you're cheating the gain back down and

you may be forced to work against the natural dynamics.

- Sometimes a quick edit and level change at the transition between the raised-level intro and the normal-level body creates a nice effect and is the least intrusive.

The reverse approach, that is, purposely creating a softer intro so that the body of the song seems louder and has impact on the entrance can also work. In this case, the quick edit (gain change) between intro and body provides dramatic impact.

#### **The Art of Changing Internal Levels of a Song**

Some soft passages must be raised. But if the musicians are trying to play something delicately, pushing the fader too far can ruin the effect of the soft passage. The art is to know how far to raise it without losing the feeling of being soft, and the ideal speed to move the fader without being noticed. In a DAW, physical fader moves are replaced by commands, crossfades, or by drawing on a volume/time line. The true magic of the mastering engineer is to be so invisible that no one knows you have anything up your sleeve; if they think the sound is being manipulated, you haven't done your job.<sup>8</sup> Here's a technique for decreasing the dynamic range in the least damaging and most helpful way. I learned this over 30 years ago from Alec Nesbitt's book **The Technique of the Sound Studio** (see Appendix 10). When doing it live, you must know the score, to anticipate the moves of the musicians. But after the fact, on a digital audio workstation it's real easy, for the waveform is the score. Supposing that you must take a loud passage down. The best place to take the level down is at the end of the

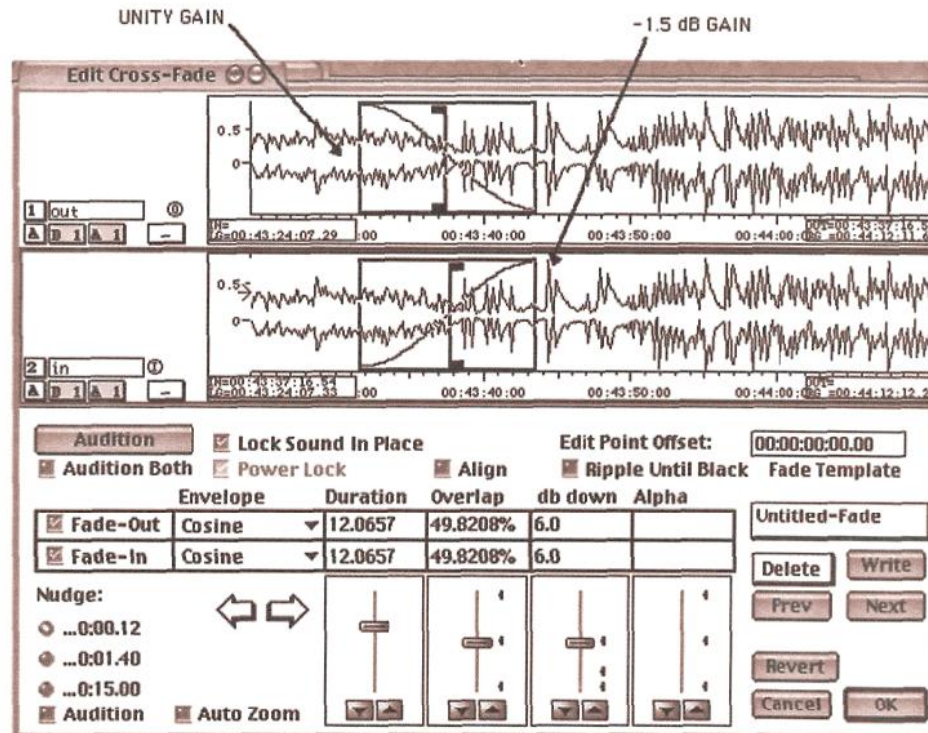


preceding soft passage before the loud part begins. Look for a natural dip or decrease in energy prior to the beginning of the crescendo, and apply the gain drop during the end of the soft passage before the crescendo begins. That way, the loud passage will not lose its comparative impact, for the ear judges loud passages in the context of the soft ones.

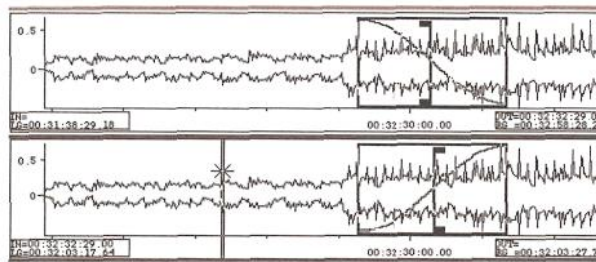
The figure at right from a Sonic Solutions workstation illustrates the technique. The gain change is accomplished through a crossfade from one gain to another.

The producer and I decided that the *shout chorus* of this jazz piece was a bit overplayed and had to be brought down from triple to double forte (which amounted to a dB or so).<sup>9</sup> To retain the contrast, the trick is to drop the level during the soft passage just before the drum hit announcing the shout chorus. You'll see this in the 12 second crossfade from unity gain (top panel) to -1.5 dB gain (bottom panel); the drum hit is just to the right of the crossfade box. If done right, you'll still feel goose bumps as the musicians make a delicate soft move (now enhanced with a further decrescendo by the mastering engineer), and then hit you with the chorus.

Some songs start with a very soft introduction, and this may have to be raised. Other songs start softly and build to a big climax. I like to start mastering by going directly to the climax. After I get a great sound with the necessary processing, I return to the beginning and if there's room, I may lower the gentle introduction, which will enhance the body that follows by contrast. This also reduces the temptation to raise the loud part so much that it



might be squashed by excessive processing. In the following figure, I've reduced the level of a song's introduction, and slowly introduce a crescendo (20 seconds long) that enhances the natural build of the song as it goes into the first chorus. The top panel is at -1 dB gain, bottom panel is at unity (0 dB) gain, achieved at the end of the crossfade.



The modern version of fader-riding. Note that the gain drop is performed in the soft passage preceding the loud downbeat, thus preserving the apparent impact of the downbeat.

A soft introduction has been reduced even further, and the impact of the body of the song is enhanced by gradually increasing the gain during the beginning of the main part of the song.

Another trick is to increase the space before a song, which increases its dynamic impact by extending the tension caused by silence. Give the ear a chance to adjust to silence and then hit them with all you've got! The best musicians know how to use space within their music; they consider the rests to be as important as the notes.

### In Conclusion

Macrodynamic manipulation is a sometimes overlooked but powerful tool in the mastering engineer's arsenal. In the next chapter we move on to the use of compressors, expanders and limiters to manipulate **microdynamics**.

- 1 Surprise Symphony, No. 94 in G, 1791, incorporated a mischievous drumbeat in the middle of a slow passage. This type of microdynamic instantaneous impact is often termed a *sforzando* in western music. To 20<sup>th</sup> century ears, Haydn's piece seems rather tame. Especially after you've been exposed to John Williams' quasi-classical **Suite from Close Encounters** reproduced on a decent Hi-Fi.
- 2 Especially with the influence of Afro-Caribbean musical forms on jazz (and eventually R&B, fusion, and rock) when in the 1940's Dizzy Gillespie brought percussionist Chano Pozo into his band.
- 3 Naturally with many exceptions. For example, I think The Geto Boys *Da Good Da Bad and Da Ugly*, one of the honor roll CDs (listed at [www.digido.com](http://www.digido.com)), is a masterpiece of inventive musicality, dynamic range, depth, and tone on the same order as a good classical work.
- 4 It's hard for a mastering engineer to return a master to a producer that isn't louder than what was sent, even if the original recording was already too loud and compressed. But I find that producers like to receive recordings which are clearer and more impacting than what they sent in, even if the master is not quite as loud. Dare to try it!
- 5 Please do not confuse the term *dynamic range reduction* (compression) with *data rate reduction*. Digital Coding systems employ data rate reduction, so that the bit rate (measured in kilobits per second) is less. Examples include the MPEG (MP3) or Dolby AC-3 (now called *Dolby Digital*) systems. Since it's not good to refer to two different concepts with the same word, we should encourage people to use the term **Data Reduction System** or **Coding system** when referring to data and **Compression** only when referring to the reduction of dynamic range.
- 6 Excessive is definitely in the ear of the behearer! It's very important to develop an esthetic which appreciates the benefits of dynamic range, and which also knows when there is too much—or too little. This is clearly a matter of taste, as well as objective knowledge of the requirements of the medium and listening environment.
- 7 AGC (automatic gain control) has been given a bad name by its ubiquitous use in consumer and professional camcorders. Listen to the news reports on TV where a portable camera was used with AGC to see what I mean. You will hear severe hiss modulation in between syllables, and the transient syllabic impact is reduced.
- 8 This is true for most of the "natural" music genres, with some exceptions being hip-hop, psychedelic rock, performance art, etc., where the artists invite the engineer to contribute surprising or rococo dynamic effects.
- 9 Producers don't always use classical Italian dynamic terms to describe their needs. The mastering engineer should chose the bonding language which is best for the client—"Make it louder, man!"