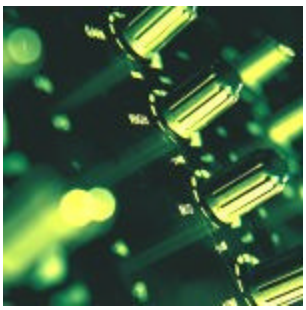
EQ masterclass



EQ can be the difference between a quality recording and a disaster...

There are many urban myths surrounding the use and abuse of equalisation in the studio, and sorting out myth from madness can be a tricky business. Often, when questioned, famous record producers and engineers will state: 'I don't really use EQ'. However, if you get the chance to work with these people, you'll discover that the EQ is frequently switched in. What they are really saying is that whenever possible, they try to avoid using equalisation as their primary sound-shaping mechanism. In fact, in most cases, they still use EQ as much as anyone else in order to make quality recordings without changing the fundamental character of the sound - this is just good recording practice.

Unfortunately, many sound professionals don't like discussing exactly what they get up to with EQ, fearing they might give away their personal secrets. And that's why we've decided to bring you the facts about EQ - no nonsense, no hype, just plain and simple truths to make you more confident about when to (and when not to) reach for those knobs.

Why use EQ?
The name 'equalisation' comes from the original intent of the invention - to make the final recorded sound equal to the original source, making up for inadequacies of both the equipment and the recording environment itself. This is an art that is, unfortunately, being lost. In the first part of this article, then, we will explore several different equalisation techniques that are used during the first part of the recording process: tracklaying. Some of these are old, and some are new - but all are techniques that you should be aware of. All are quite unrelated to the kind of creative sound-shaping that many people resort to all-too-quickly when recording and mixing a track - we'll be looking at those in next month's article.

Noise reduction
A fundamental part of recording is to get the best signal down to 'tape', and extraneous noise can be a nuisance. This can be EQ'd out, but when it comes to getting rid of unwanted noise from a signal, it's better to get the sound right at source, solving the problem once and for all. If you persistently get, for example, a hum on your electric guitar, it's much better to track down and remove the source of interference for good, instead of remembering to roll off the bass every time you record. If you don't take this kind of action whenever possible, it can substantially limit your ability to make more extreme, creative adjustments later on.
Unfortunately, there are many sources of unwanted background noise when recording, such as rumbles, bumps and bangs, popping, hums, hiss and instrument spill. Let's take a look at what we can do about them...

Rumbles
Background rumbles can come from a number of sources. In a purpose-built studio, air conditioning systems are a prime suspect. Nearby traffic (and in locations such as central London, tube trains) can generate very low frequency rumbles that aren't noticeable when standing in the room, but on a high-quality microphone at a high gain setting, can be unacceptable.

Because these sources of interference are so very low frequency in nature, they are often unnoticeable when monitoring on nearfields, such as the Yamaha NS10s found in most studios. So it's a wise move to listen to the microphone signal at a decent level on large, main monitors to begin with. Once you're sure there are no bumps or rumbles taking place, then you can relax back into using the (much less tiring) nearfields to continue the session.

To deal with ultra-low frequency noise using an equaliser, it is almost always a good idea to switch in the low frequency roll-off filter that most modern mixing desks provide. If your desk doesn't have adequate filters, then make sure you get a quality microphone with one built-in. This will not detrimentally affect your recording, as most ultra-low frequency noise is well outside of any frequency range that is musically useful for the instrument or person being recorded. The exception is obviously when you are using a microphone to record a very low-frequency sound, such as a bass guitar, cello, or other low-frequency instrument, where keeping ultra-low frequencies is paramount.

Interference
Don't forget, however, that the top end needs attention, too - there's been many a good take spoiled by subtle radio interference from nearby sources. When recording electric piano, for example, try filtering off the top end until the sound gets quite muffled, and then slowly open it out again until the basic sound remains unaffected by the filtering. Of course, it is possible to fix it in the mix, but that means putting up with unsatisfactory monitor mixes until the main mixdown takes place.

Finally, if you're the very cautious type and you have a mixer with high and low pass filters, it can be a good idea to crop off the unwanted parts of the sound that are theoretically outside that instrument's frequency range. Like we said, if you're really cautious...

Mains hum
Mains hum should be removed using a physical solution rather than resorting to EQ. This is rarely just the nice, clean 50Hz hum that you can hear clearly at the low end of the spectrum. More often than not, the hum will include many harmonics reaching right up into the audio spectrum. This is especially the case when recording electric guitars.

The usual candidates for introducing mains hum are: having mains cables too close to instrument or mic cables, fluorescent lights and dimmers, computer monitors, and wall-warts. Keeping unbalanced cables as short as possible goes a long way to removing hum, as does the use of guitar DI boxes using balanced mic leads, in preference to using long, standard guitar cables.

Removing hiss
With multitrack recordings, hiss can build up over the individual tracks, but these can easily be cleaned up to a satisfactory level. Obvious places to start are with the bass drum, bass guitar, electric piano and noisy guitar pick-ups. These instruments have a lot of energy in the high frequency range that you don't want to lose, but in practice most of the energy is well below 8kHz, the frequency above which noise becomes particularly offensive. So under these circumstances use a low-pass filter to damp as much of the top end as possible. With other instruments, it's usually best to leave well enough alone. A little bit of hiss isn't too objectionable - as long as the worst culprits are taken care of, the rest can be tackled with noise gates.

Noise spill
The ability to physically remove offending noise spill from live band recordings is an art in itself, and usually only comes with many years experience of all the different microphones that you use and, in particular, a good knowledge of the characteristics of the room you are recording in. That experience teaches you when to physically shift things in the room about, and when to resort to some careful EQ.

So don't work too hard at removing spill physically from sound sources - it's a case of diminishing returns. If you over-damp everything in the room, your recording will be dull and lifeless. If you put up too many acoustic screens, the musicians will feel disconnected from each other and a poor performance could be the result.

There is also a much more serious problem: if you move the band members too far apart, you will introduce a time delay between all of the microphones, and the spill from each instrument will create slapback echoes. This will result in a very echoey sound, with the drum kit sounding as if it is very far away, and no amount of equalisation will save you.

Damping unwanted harmonics
In most cases during tracklaying, you want the sound you record to feel smooth across the entire sound spectrum. However, when recording live instrument sources, one of the most common problems encountered is the sound of an unnatural ringing in the instrument, produced by unwanted harmonics. In some cases, the ringing is so loud that it can send the level meter shooting way into the red when it happens.

While drums (and snares, in particular) are notorious for producing these unwanted harmonics, they are not the only instruments that can suffer. Some guitars have particular notes that seem to leap out of the mix at you, and certain bass notes can shake the room. Additionally, harmonics can originate not just from the instrument itself, but also from the room you record in, and - in the case of electric guitars, or Hammond organs with Leslie cabinets - from natural resonances in the speaker cabinets themselves.

How well you can deal with these problems depends to a large degree on what kind of equaliser you have available. What you are looking for is a sweep or parametric equaliser with a very, very narrow bandwidth. The EQ sections in budget mixing desks often do not have the ability to get a bandwidth tight enough to do the job, and you might have to resort to an outboard equaliser that gives you full control over the bandwidth.

The technique for finding and isolating harmonics using an equaliser is relatively simple. First, turn down the monitor level so it's quite quiet. What you are about to do can not only hurt your ears, it can also damage speakers if they are turned up too loud. Set the EQ on a very narrow bandwidth, and turn the gain up so you have a boost of about 6-12dB. Then, using the frequency control on the EQ, sweep the equaliser through the frequency range around where you suspect the troublesome harmonics are. You'll know when you've hit the right spot - the offending harmonic will leap out at you at full blast and be immediately recognisable as the source of the problem (that's why you need to turn the monitor speakers down).

Now that you've isolated the offending frequency, turn down the gain control to give you a cut of about 6dB. Now you can safely return the monitor speakers to a sensible listening level. Once you're at this stage, you can listen at a good monitoring level and decide how much cut is actually required. Finally, play with the bandwidth control until you get the most natural, smooth sound. By a careful balance of frequency, tight bandwidth and gain, you should be able to get the offending harmonic ringing down to a level where it is either acceptable, or gone completely.

And don't assume that you will only ever encounter just one harmonic problem on a particular instrument at any one time. You might well have two separate problems to contend with - and that's why it's always worthwhile having at least one powerful equaliser around that has more capabilities than the one built into your console.
As well as removing unwanted harmonics, a very narrow-bandwidth EQ can be used to generate harmonics that weren't there in the first place - what you will actually hear is the sound of the equaliser itself ringing. This technique can be used to good effect when, for example, recording a bass drum. A narrow bandwidth boost at 3-4kHz can work wonders in bringing a powerful kick into an otherwise dull-sounding drum.

Flattening frequency response
When close-miking sound sources such as drums, the microphones are usually set to a cardioid response pattern, either to hone in on the sound source, or because the dynamic mics used to record drums are usually non-adjustable. The problem that results is that cardioid microphones used at close range exhibit a phenomena known as 'proximity effect.' What happens is that the bass response goes sky-high and the sound becomes very stodgy - no matter what instrument you are recording. The only way to prevent it at source is to either move the microphone further away or to change the microphone pickup pattern to omni-directional.

In the case of recording drums, usually neither one of these solutions is desirable...
So when recording and mixing real drums it's a good idea to roll off a fair bit of the bass, in this case to correct the sound of the microphone, with the effect of getting the recorded sound back to what it actually sounds like in the first place. Take the time to go out into the room, listen to how the drums really sound, and try and duplicate that sound in the control room.
A careful combination of low frequency roll-off and low frequency shelving EQ is required to flatten the frequency response.

If you don't have an equaliser with a shelf response, then use a sweep or parametric EQ on the low end, provided the bandwidth is very wide (the opposite of the setting used to remove harmonics). Once you've got to that stage, you can perhaps extend the operation by a few tweaks to polish the basic sound. If, on the other hand, you try creating a drum sound from scratch - without even going into the room to listen to what the kit actually sounds like - then you may be working on that drum sound for a long, painful time.

Sweetening the sound
Okay - so you've followed the techniques above in order to get a basically clean recording. At this point, you may be tempted to go crazy with the EQ trying to create a sound. This type of creative EQ'ing is really best avoided when tracklaying. Until you've finished recording the entire track, it isn't possible to hear how the set of instrumentation you're working on will fit into the complete recording.

For this reason, you should be as conservative as possible when sweetening the sound during recording, and make only minor enhancements. Use a broad bandwidth and restrict yourself to subtle raising and lowering of the top, bottom, or mid-range. There are some basic rules to observe when doing this (unless the part is sequenced and easily reconstructed using readily-available equipment - in which case you have the flexibility to do as you choose as you record)...

Don't do anything that rolls off the frequency response at either end of the spectrum if you're not 100% sure you'll want to do this in the final mix. Once you've rolled off the ends of the frequency response using low-pass or high-pass filters, it is usually impossible to get it back later on. Instead, approximate the desired effect using monitoring EQ (if you have it), and leave the final, destructive roll-off equalisation until the mixing stage.
Likewise, avoid filtering off too much top end. On an analogue recorder - even a pro-quality 2" machine with noise reduction - you can introduce a lot of noise during mixdown by trying to put back top end that was rolled off too much when recording.

Analogue tapes tend to lose top end naturally during the wear and tear of music production anyway, so you need to protect the top end as much as possible. If you are recording instruments such as sharp-picked or rhythm guitars, it can be worthwhile to add just a little extra brightness at about 4-8kHz, to compensate for the loss in top end that the analogue tape will have by the time you come to mix it.

On a digital machine, you have much more
flexibility. Even so, it's still not a good idea to roll off too much top on anything during the recording stage, because many project studio digital recording systems have relatively noisy D-A converters on them, and the hiss will be noticeable when boosting the top end during mixdown. So, as a general rule, don't overdo the 'sweetening EQ' during recording. In the rushed environment of tracklaying, it's very easy to get it wrong, with the result that the monitor mixes will suffer until you get a chance to do a proper mix. And even when you get to the final mix stage, it can be hard to undo the mistake while still keeping a natural sound.

Naturally, you want to get the sound a good way towards how you expect things to be in the final mix, but it is a difficult balance between getting a workable result and boxing yourself into a corner. Doing anything too severe when recording restricts your options for doing different kinds of remixing and experimentation later on.

Finally
All of the above techniques can, and should, be used to good effect while tracklaying, for two reasons: firstly, to ensure the cleanest possible signal is being recorded, and, secondly, to free up as many resources for the all-important mixdown session, where EQ can be put to much better use as a creative, rather than a correctional, tool. While this attention to detail can be time-consuming, the process of filtering out unwanted sound, damping harmonics and flattening an unnatural frequency response is a fact of recording life, but one that can reap huge rewards in terms of the quality of your final mixes.

When to apply EQ: recording or playback?
One of the main considerations when applying equalisation - or any other kind of signal processing - is whether to apply it during recording or playback. It can be agonising trying to decide which. There are three basic considerations: first, is the EQ in any way destructive to the sound? None of the techniques described in Part One of this article can be considered destructive to sound - quite the opposite, in fact. All of the techniques are designed to create a pure, clean sound.

Second, will it take time to set it up in future? In the case of hardware mixers, the answer is obviously 'yes' - and it seems pointless to waste time at the beginning of each subsequent session redoing all those clean-up tasks that can be done just once, at the start.

And finally, will you want to use the EQ module for something else later on? The answer, again, is almost certainly 'yes'. When it comes to mixing - a subject we will deal with in detail in the next issue - you will want to use the equaliser to do more creative things to the sound, so there is little point tying it up doing basic clean-up tasks that you can do while recording.

On a desktop computer system, you might be forgiven for thinking that you can leave all EQ'ing until mixdown. After all, the EQ settings will be automatically recalled next time you reload the project file. But there are three reasons why this is not a good idea: first, a bass-heavy, close-miked sound, or a sound that contains loud unwanted harmonics, eats into the valuable headroom of your soundcard. By the time you've filtered these undesirables out, the signal level may have dropped substantially and the signal quality will suffer. This is less of an issue with the new generation of 24-bit soundcards, but it's a serious consideration with 16-bit cards.

It's far better to get a good signal out of a quality mic amp with an excellent analogue equaliser, and capture that sound on your soundcard, than to pump any old lo-fi sound in and try fixing it later in software.
Second, having lots of equalisers running at once on your desktop system eats into valuable CPU resources. It is much better to record a great sound going into your computer and use CPU resources for more important things, such as effects or more tracks.

Finally - as is also the case with hardware mixing consoles, when it comes to mixdown, you will want to use the EQ on the channel for new, creative tasks, not for correcting something you could have recorded properly in the first place.

Need more EQ?
You might have more sources of specialised equalisation available to you than you think - even if you don't have dedicated outboard equalisers. Most modern digital outboard equipment is exceptionally flexible. For example, a Yamaha A-series sampler can be used as a sophisticated EQ when recording live sound sources - even at the same time as you are using it for sequenced sample playback. Similarly, some outboard processors can be

pressed into service - for example, TC Electronic's M•One has a fully-parametric EQ and Drawmer's DS 201 comes with hi and lo-pass filters.

EQ: the downside
EQ can damage sound, as well as enhance it - remember that EQ affects more than just frequencies. An unfortunate side-effect of EQ is that it also affects the subtle timing relationships between the different frequencies, meaning the sound is no longer 'phase-coherent' across the audio spectrum after adjustment. When people complained about the harsh sound of early CD players, scientists soon realised that the human ear is far more sensitive to this timing information than was originally thought.

Certain types of EQ also introduce subtle ringing artefacts into the sound. If you over-rely on EQ to achieve the sound that you want - especially the EQ that's built into your desk - these factors can conspire to create a mix that sounds cheap and unnatural and, worse still, gives people a headache. If, on long mixing sessions, you find that you're getting frequent, painful headaches and you are not otherwise ill, there's a good chance that you have been over-EQ'ing the mid and top frequencies of important elements of the mix.

Despite these considerations, if you attend a recording or mixing session, even with people who claim they don't use EQ, you will still probably find that the EQ is switched on within almost every channel of the desk.

Types of EQ

1. Filters
Simple filters come in two styles: either a single button for rolling off the bottom end or two rotary controls marked LF and HF. These control how the sound is 'trimmed away' at either end of the audio spectrum, although usually the roll-off is preset and varies with each manufacturer.

2. Shelf
These are capable of both boosting and cutting the sound starting at a given frequency. There's usually one each for top and bottom, with the low frequency shelf EQ working at around 80 to 150Hz, while the high frequency shelf EQ will cover around 8 to 12kHz. Unlike roll-off filters, the amount of boost or cut remains uniform to the ends of the spectrum, giving a level gain change to the affected frequencies.

3. Sweep
Using a sweep EQ allows for frequency selection, with the cut or boost affecting only the area surrounding the specified frequency. On simpler systems it isn't usually possible to control the width of the sonic 'area' affected, and this width varies depending on the manufacturer. Some manufacturers like to keep the area fairly broad, as this is more musical, but others prefer to keep it narrow, as this is more useful for correcting harmonic problems.

4. Semi-parametric
A sweep EQ on its own is of limited use, so these sometimes come fitted with a switch or button that can change the bandwidth covered, giving a choice of narrow or wide response. The whole assembly is often named a semi-parametric EQ.

5. Fully parametric
Top-of-the-range mixing desks are fitted with fully parametric equalisation, whereby you control the frequency, the gain and the bandwidth of the EQ. Often, four of these units are packed together, and a switch on both the first and last unit allows them to be optionally used as shelf high and low frequency EQs, respectively.

6. Graphic
Graphic equalisers allow you to adjust fixed frequencies
over the entire spectrum. These are best employed where a large number of subtle adjustments to the signal are needed - for equalisation of a control room's main monitors, for instance, or for final equalisation of a finished mix while mastering.

7. Passive and Valve
With many equalisers, audible 'ringing' is introduced into the signal, due to the electronic feedback techniques employed. Alternatively, passive EQ cuts the sound across the whole spectrum. In this way, when you boost a signal, you're not really boosting it - the signal is just passing through the passive circuitry unhindered. Valve EQs often work in the same way. Their smoothness often has little to do with the valves; it's usually down to the fact that the circuitry is passive, not active.

8. Software

The beauty of recording on computer-based systems is that all the above-mentioned EQs can be relatively easily modelled or simulated in software. The benefit of having quality EQ plug-ins is that these can be used on as many tracks as you wish, an obvious benefit over a hardware EQ that can only be used over one sound source at a time.

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