



# Australian Technical Production Services

## Acoustic space and 'Wall of noise' syndrome

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Any future updates and other notes may be found at : [www.atps.net](http://www.atps.net)

While you are under no obligation to send me any updates/improvements or corrections I would appreciate them (contact via the website).

### Credits

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# Acoustic Space

or how to deal with 'wall of noise Syndrome'

This concept\* of Acoustic space is an attempt to explain and understand how the Acoustic environment affects live Music.

My original thinking was to express this along the lines of different environments having more or less acoustic space so for example outdoors would have lots of space whereas an echoey room would have very little space. However while this approach does have some merit in getting the basic idea across, it would be both inaccurate and looking at this issue from the wrong direction.

Instead, I have decided to take the (more accurate) approach that while the amount of space you have is fixed, the Acoustic environment will contribute to the amount of space being used. Having said that, when mixing or playing it can be easier to think in terms of different venues having differing amounts of acoustic space.

Let's look at two Scenarios <sup>\*1</sup> where an understanding of acoustic space would have come in useful:

- 1) A Christian outreach event near where I live, 3 different bands from different churches on different nights. The hall was a slightly better than normal run down school hall with a characteristic lower mid peak around 300Hz, however not too bad as these halls go from a reverberant point of view.

Sound check on the first night and the first set of musicians started arriving... and arriving... and, well they seemed to keep on coming. We ended up with: 2 Electric Guitars, 3 Acoustic Guitars, a Sax, 2 Trumpets, 6 Backing Vocals, a Flute, Bass guitar, 2 Keyboards, a Drum kit and.... a Partridge in a pear tree.

I can only surmise that the music director had heard some marvellous Recordings<sup>\*2</sup> and decided to set up as Spectacular a show as possible (I probably do him a disservice in implying that other MDs would have done any differently, had I not chased them all up after the first night and given them a strongly worded and perhaps not diplomatically correct warning).

I have to also point out that I was less experienced at that time (although this event was largely responsible for me starting to ponder the concept of Acoustic space) and I would probably deal with things slightly differently today (the confidence to give a strongly worded warning up front perhaps) I have to say it sounded pretty woeful. The effect of all the Instruments trying to play at the same time added to the (admittedly rather small amounts of) reverberation from the Hall (and don't forget the 300Hz peak) produced what was effectively a wall of noise.

- 2) A bush band playing for some benefit or other in Balmain Town hall (Sydney, Australia).

Now the nature of a bush band is that it consists of a number of musicians and this one as things go was actually pretty good (and also I did have a lot more experience – particularly with bush bands by then) consisting of: Violin, Banjo, Tin whistle (only playing from time to time), Acoustic guitar, Flute and Caller (Vocals).

The hall on the other hand was a large concrete dome with an RT60<sup>\*3</sup> of maybe an hour and a half (OK, perhaps I exaggerate). That night my Mix took a lot of work and I could only 'Feature'<sup>\*4</sup> one instrument at a time, even so it was more a line of last resort mix and the Caller was only just understandable despite some pretty Serious EQ <sup>\*5</sup> work on my part.

To contrast this though, in the breaks between dances they had a female vocalist with a great voice, playing a 12 string Guitar and the natural reverberation which was causing so many nightmares with the bush band made her performance sound absolutely superb with virtually no effort on my part.

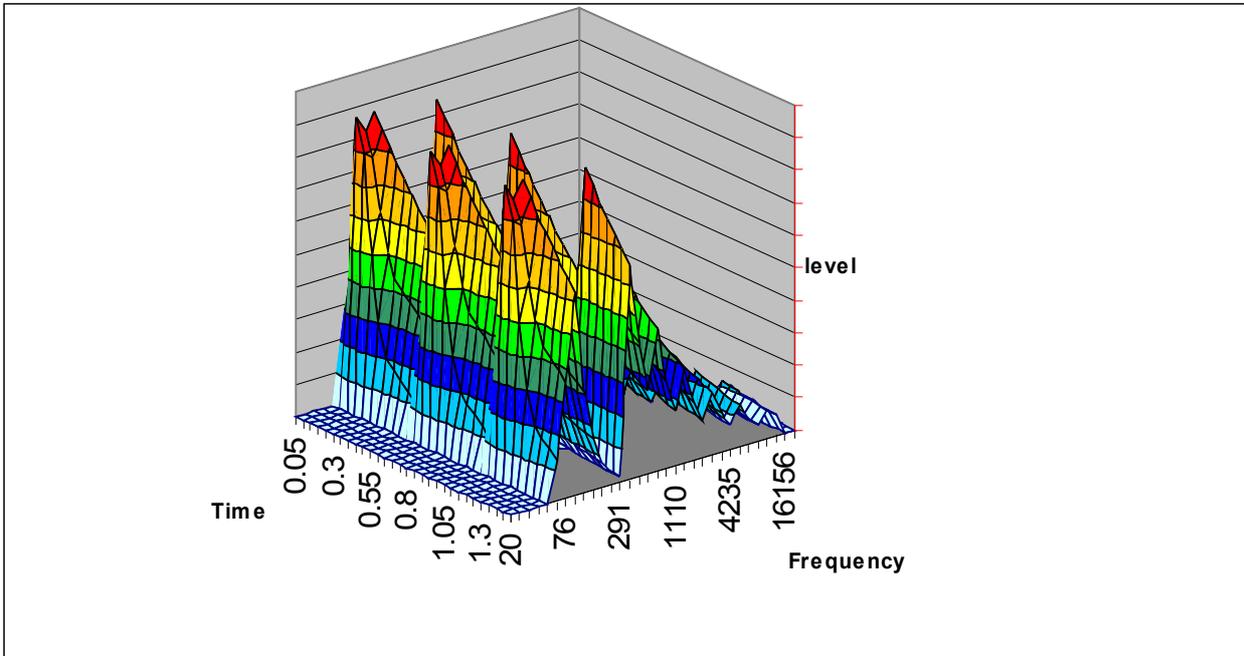
For the sake of this idea\* think of Sound or Music as occupying three dimensions (or domains):

Time

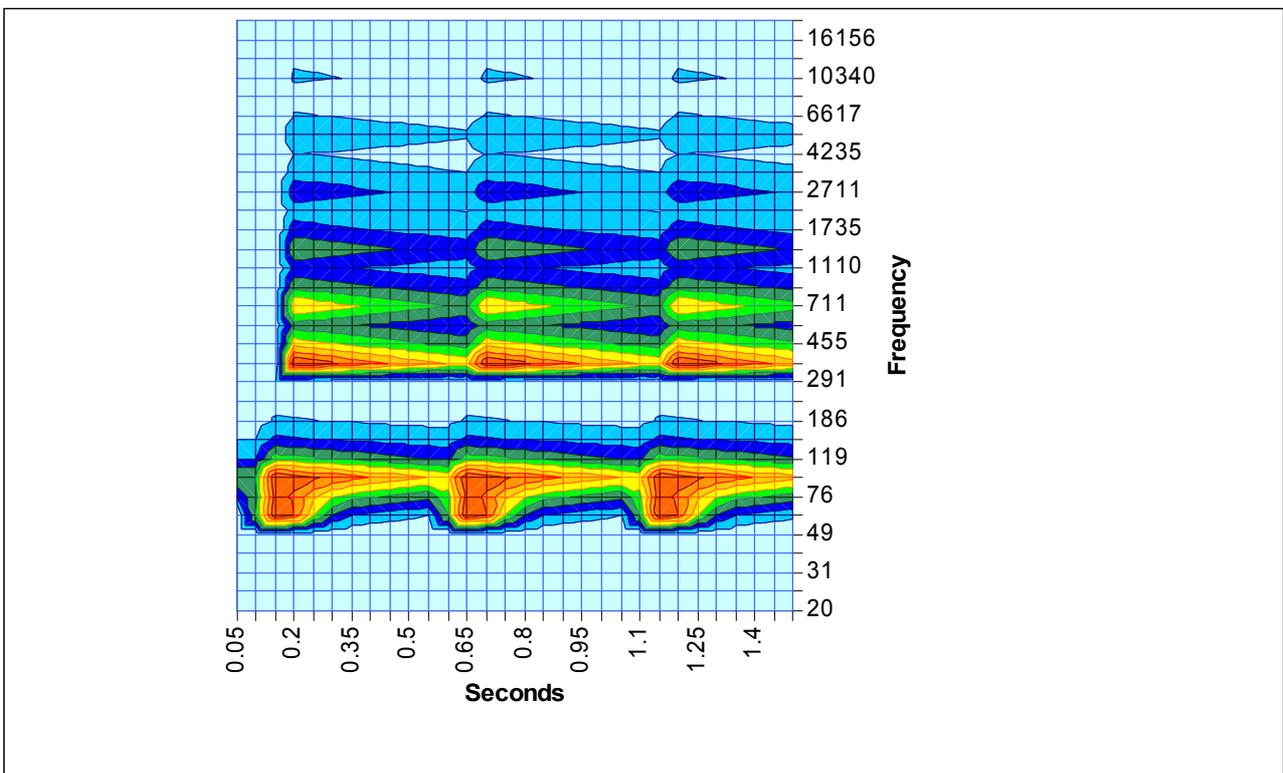
Frequency

Level (SPL)

for the purpose of these notes (and since the written word lacks a certain sound) we can visualise this using pictures, something like this:



That looks pretty cluttered and messy already, so maybe a 2 dimensional image might make things clearer:



This is actually more how I picture it – as starting with a blank canvas, waiting for the Soundscape to be painted on it by the musicians and the mix engineer.

Since Acoustic space tries to take psycho-acoustic effects into account (such as Masking etc) the pictures may not show an exact Physical graph of what is happening.

In fact the Graphs are only there to help you picture the concept of acoustic space in your head, so please try not to get too hung up on them or their accuracy.

To understand what happens when we fill the space available and what 'wall of noise syndrome' is, We need to start by understanding what constitutes noise.

Noise (in this context) can be defined as being when we become incapable of making any sense of what we are hearing.

There are two main ways this can happen:

- 1) When the sound pressure level is so high that the ear becomes overloaded.
- 2) When the Soundscape becomes so busy with multiple instruments trying to provide different 'information' at the same frequency.

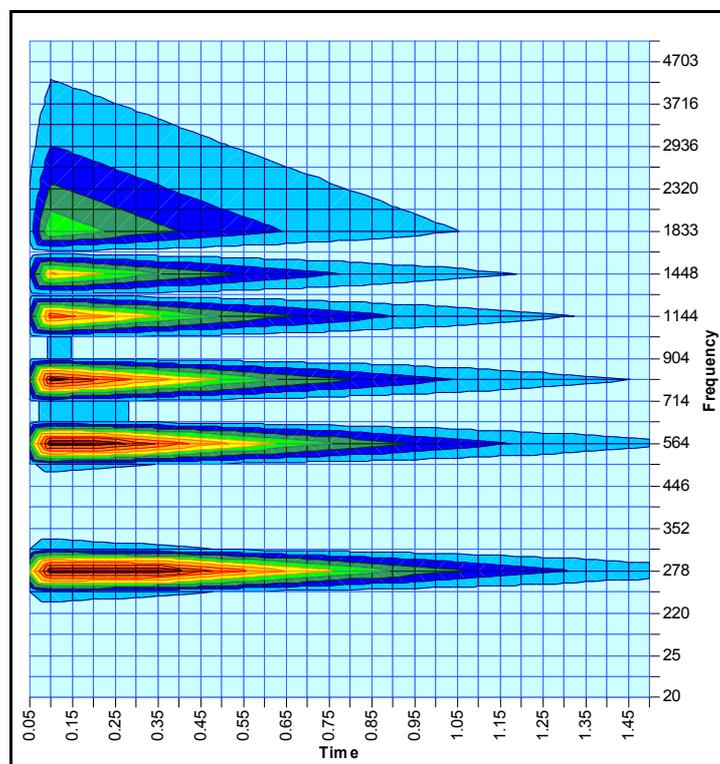
Note that this is different from an orchestra where large numbers of instruments are playing tightly together and so are providing the same 'information' and instead reinforce each other.

## Space fillers

In order to analyse sound, music etc. with respect to acoustic space, there are several common effects to be understood and taken into consideration:

### Distortion

This space filler is much loved of guitarists everywhere, but can also be caused (intentionally or otherwise) elsewhere in a SR system. Distortion increases the acoustic space a signal occupies by adding harmonics - frequencies that are a multiple of the original or 'fundamental' signal.



While the harmonics are not as loud as the fundamental, a distorted signal can still take up a significant amount of space covering several octaves.

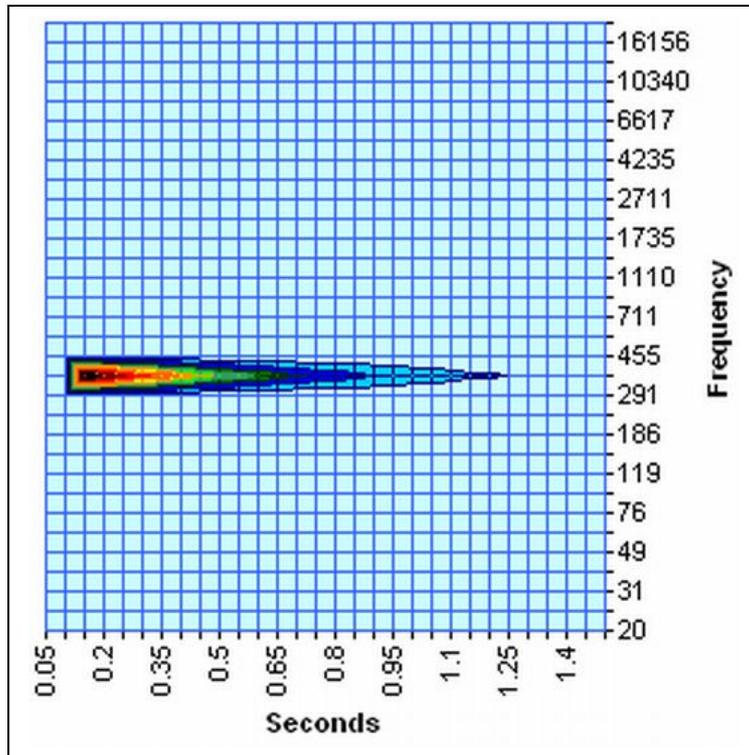
In keeping with the idea of trying to picture this, distortion is shown conceptually above with a fundamental at 278Hz (ish) and significant overtones (harmonics) up to 3 octaves higher.

## Masking

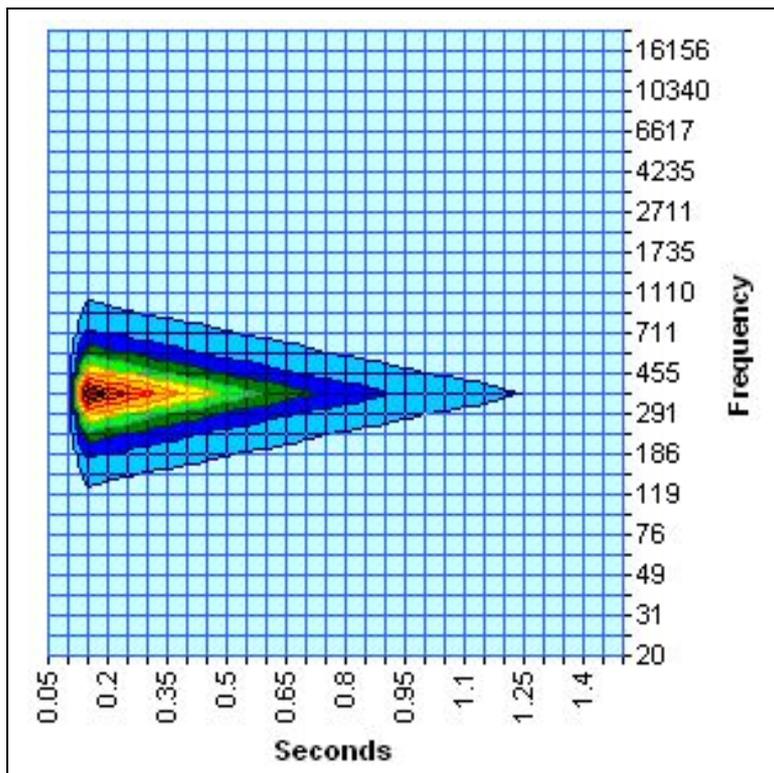
Masking is an effect, where the human ear becomes incapable of discerning quieter sounds in the presence of a louder sound of similar Frequency.

This means that when several instruments start playing similar notes the louder instrument will drown out the others. Unfortunately it does not stop there as what also happens (especially if notes are being played fairly rapidly) is that as the note from one instrument starts to fade out other instruments become dominant and the ear starts to get confused.

So while a pure note might appear in a physical sense to occupy very little acoustic space, something like this:



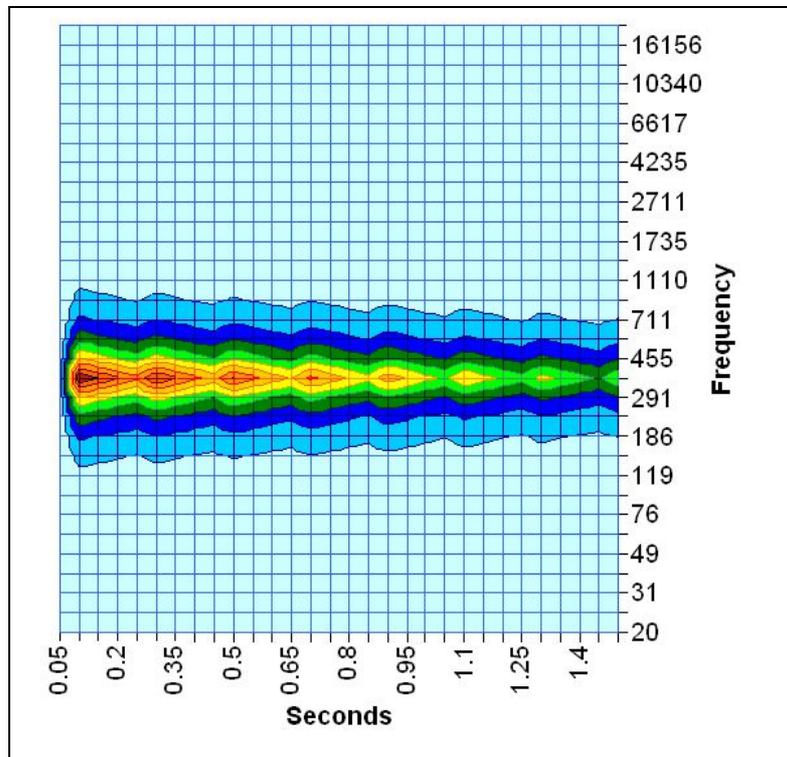
When we take masking into account, it will actually occupy somewhat more space like this:



So even a simple sound occupies more room in the Frequency domain than you might normally expect and a complex Sound (for example an over-driven, distorted guitar – as described earlier) will occupy a lot more space again.

## Reverberation.

Reverberation is caused by the original sound being reflected off hard surfaces (Windows, Concrete, glass etc.) this increases the amount of time the note/instrument occupies.



Note that this is a very simplified graph of reverberation with only one reflection occurring neatly after 0.2 Seconds in reality this would be much worse and also I am not taking into account filtering or destructive interference. Also note that this is a pure tone and most Instruments generate Harmonics (and therefore occupy more space) as well.

A problematic reverberant Venue will usually have a number of Reflections, filling up a lot more acoustic space than this over-simplified graph shows.

A brief word in passing while on the subject of Reverberant Venues. There are a lot of misunderstandings about audio equipment that can deal with and solve audio problems in reverberant rooms and many folk often assume that if you throw more fancy equipment at this problem it can be solved.

Unfortunately the reality is that there is no ‘silver bullet’ and I am afraid that if you have the misfortune to own or be playing/mixing in a reverberant room, the only equipment that can help you deal effectively with it is a D9 Bulldozer - no amount of Electronics, or smart-alec gadgetry is going to help.

An EQ may help to a limited extent, by cutting frequencies that are doing nothing to improve intelligibility, since in a highly reverberant environment anything that is not helping is hindering.

This leads folk to presume that if some EQ work can help a little, it logically follows that more EQ can help a lot. Unfortunately though once you have made that small improvement no amount of further EQ work, or even a fancier EQ, is going to improve matters from there.

If you look at the graph above, EQ only has an effect on the Frequency domain (Y axis) but the main problem with the reverberation is in the time domain (X axis) and a time domain device like a delay, will only make the problem worse (or later).

The best bet in making the most of these situations is an understanding of the concept of acoustic space (but then I would say that), careful composition and if you have the Time and Resources Acoustic damping for the room (think soft and Heavy things, I cannot recommend nice heavy curtains enough, although at a pinch a bunch of people filling the venue can go some way to damping the room out).

## **Making the most of what you have**

So how do you work within the constraints of a venue with limited acoustic space?

Unfortunately the mix engineer ultimately has very little control over what is played and it is really up to the musicians primarily to deal with this issue.

First and foremost the Musicians need to be aware of the venues' limitations and play accordingly.

I have had this discussion with other folk who have told me that they could not possibly presume to tell the musicians how to play their instruments. I disagree with this view, since as the mix engineer it is your job to look after and make the most of the Acoustic space available to the band, if this space is limited then you are the person who will have to take steps to deal with it and if that means (perish the thought) talking to the band then so be it.

Now if you do talk to the band, one of two things could happen: either they take your advice on board (and hopefully most bands would have planned for this, given how many truly awful venues there are out there) and work with you to produce as good a result as possible, or they ignore your advice and you do your best with what you are given....

If you do not communicate potential problems to the band but rather let them go ahead and make a complete mess of things, they are going to blame you for the debacle and if you have not at least warned them of the potential issues, I would suggest that they may have a point.

The core point to keep in mind is that a reverberant venue effectively increases the complexity of your sound, so they want to keep the music as simple as possible, so think minimalist with as few instruments playing at a time as possible and keep the number of instruments occupying the same acoustic space down to an absolute minimum.

Keep space fillers – such as distortion and cymbals to a minimum if possible.

Try to play instruments off against each other (that is one after another) rather than playing them at the same time – the musicians need to try and keep a clearly defined lead, so the mix engineer can keep up and be clued in to what is happening when and where, as there is no point having keyboards lead if the electric guitar is still being featured in the FOH mix.

Keep foldback down as far as possible, make sure instrument amplifiers are pointing at the musicians (see also 'how to smash a sound system').

Use featuring (see also 'mixing part 2') this is a mix technique where you establish a baseline mix slightly lower than your desired front of house level and then 'feature' instruments (including vocals) by pushing the lead instrument above the baseline mix as, and when required. Generally the baseline mix is considered as 'fill', however in a highly reverberant venue you will want to reduce the level of your baseline mix considerably more than normal, as it will otherwise quickly turn into noise. Sure this is not optimal, but if you are working in a severely compromised venue this is not going to be about achieving perfection, but more about doing the best you can, with what you have.

Make the most of what you can get away with. Bass instruments, such as bass guitar and kick drum often cause less problems in a reverberant venue than other instruments so you can keep them up in the mix, which will (hopefully) drive the music and give it plenty of energy. Higher frequency and wider bandwidth instruments will need to be featured more sparingly.

## Acoustic space and the importance of EQing in context

So most of this article has been about poor acoustics in a venue and dealing with them but an understanding of acoustic space is also important, when dealing with a regular mix.

Picture this:

Start with a fairly simple line-up, acoustic guitar, male vocals, and Bass guitar.

During line check\*<sup>6</sup> you EQ each channel individually so you have nice rich warm vocals, the acoustic guitar sounds nice full and rich and the Bass guitar has plenty of body.

Now you start trying to establish the baseline mix, but no matter what you try, you keep ending up with a muffled, muddy, boomy mess. On their own everything sounds great, but when you put them together they just don't work.

What is happening here is that while these three instruments mostly occupy their own space (Bass low, Vocals in the midrange and Guitar starting in the mid range but mostly occupying upper mid).

So conceptually they should all mesh together without too much work (maybe a bit of balancing between vocals and acoustic). But the problem is that they all overlap in what would normally be called lower mid (200-350 Hz) this is the frequency range that adds warmth to the vocals and richness to the acoustic guitar and depth to the bass guitar. So this means that on their own they sound much better with plenty of lower mid, but when you put them together they are all competing in this range and as we have just been discussing when you have too much happening in the same space you end up with a mess.

By all means rough in an EQ while you run through Line check, but let that be a rough EQ only (and also try and allow for the final mix when you do the EQ) Because the trick is to do most of your EQ work until you can hear the instrument in context with the rest of the mix.

One problem you may find (usually) with vocals is that you may want a warmer EQ during solo's introduction or even some verses than the rest of the time. One approach is to tweak the EQ on your desk but another trick is to split the Microphone line and feed it into two adjacent channels on your desk, then EQ one to fit in with the fuller band mix and EQ the other channel so that vocals sound fuller on their own this will let you readily swap between the two (or even just bring up the fatter channel) as required. Note that many Digital consoles let you soft patch an input into multiple channel strips for this kind of thing.

\* This is my attempt to bring together various effects, which influence how we perceive a mix. As far as I am aware the concept of Acoustic space is not an officially recognised concept. Acoustic Space is a term that can also be used to describe Sound-scapes etc.

\*1 These are based on genuine experiences, however names and some details have been changed to protect the guilty....

\*2 Recordings are created in a completely artificial environment so they have no environmental acoustic constraints, So I tend to think of recordings in terms of a blank canvas with the only constraints imposed by the Recording media, which nowadays pretty well exceeds the limits of human hearing.

Having said this though, the mix itself is still subject to the rules of acoustic space and even on a recording if you try and fit too much in the same space it will still sound like crap.

\*3 RT60 is a measurement of the Reverberation decay time. it is basically how long it takes for the Reverberation after the original sound to die down to 60dbA below the level of the original sound.

\*4 Featuring is a term I use to describe running a mix where most instruments are kept back in the mix (and depending on the acoustic space this can mean well back) or at least to a pre-established 'Base line' mix and only one or two instruments are given the lead (or featured) at a time.

This takes a lot of work to do properly, requires a familiarity with the music being played and the mix engineer needs to focus on what the music is doing and where it is going as much as the musicians do.

Having said this, why do people often come up to the mix engineer and ask about Toilets, the urn, what is the Lighting guy doing? where the bar is etc. but not the musicians on stage? It really destroys my concentration when people do this.

Anyway back to featuring, this is pretty well the only option a sound person has when running a mix in a limited acoustic space.

\*5 Contrary to popular belief EQ cannot fix time domain problems such as excessively reverberant rooms. Judicious EQ work however, can sometimes (but not always), make an unintelligible signal more (but not necessarily completely) intelligible.

\*6 see my notes from [www.atps.net](http://www.atps.net) on Soundcheck.