

ON VINYL

By Paul Matthews 2021

I was never big on vinyl growing up, simply.. because I could never afford it! Records were those things that everyone else had. I would beg and borrow them at every opportunity, drag them back to my suburban cave and transcribe them onto cassette. This was back in the 1980's, when vinyl otherwise exclusively ruled.

When digital CD finally began to take over in the '90s I was a keen adopter, moving to it as quickly as possible. The advent of MP3, Napster and hard drives in the early '00s, which could hold more than a few dozen tracks at a time, were a godsend. With digital, I became determined to replace my huge collection of cassettes and hifi VCR tapes with something infinitely more searchable, portable and in every perceivable way, better.

CDs now ripped and permanently retired, my digital collection began to grow. Meanwhile, my feeble collection of mostly second hand records sat discarded in a few crates and boxes out the back room at my local community radio station. A few tracks that I couldn't find anywhere else, were eventually transcribed from vinyl to digital. But wherever possible, I always took the digital substitute. I believed vinyl to be an inferior medium.

All my friends took similar action, their vinyl collections sitting discarded in the same room for a while. Eventually the whole collection both mine and theirs, was booted out and found its way back home to my place to be stored in a cool, dry corner.

It came out a few times in the mid '10's for an occasional special run on SWR999 FM in Sydney, in a segment that became known as "Vinyl Shop Valves." However it wasn't until the covid crisis locked us all in our homes that I decided to seriously get it all out, go through it one record at a time and create two hours per week on SWRFM, sourced *exclusively from vinyl* and entirely produced "the old fashioned way." What I didn't know, is that this show would still be on the air *four months later*.. without repeat playing one record!

"*Vinyl Shop Valves*" has opened my eyes to the incredible difference that has been allowed to propagate into our world through digital music today. After hearing them from digital means for so long, listening to so many of these vinyl tracks from their original source has allowed me to finally quantify and bottle what "that warm and fuzzy vinyl sound" is all about.

So what is "That Vinyl sound"?

Top End Sibilance

The process of dragging a needle across a rough groove to make music in itself is quite a violent process. That's why most needles are created from industrial diamond sapphires. A needle is a physical entity with mass that can only move in one direction at a time. Sometimes the inertia of it moving in one direction means it often misses otherwise important information present in the other direction – particularly at higher frequencies.

This "tug of war" is forever going on in the groove whenever vinyl is played. The ultimate outcome is that high frequency response becomes dependent on what's happening in the lower frequency spectrum. It's a bit like trying to listen to high frequency sounds through a woofer or low frequency speaker. The more "energy" there is in the recording, the more the needle tends to "bounce about" instead of faithfully following the groove in the record. Too much energy and it just jumps out... which is why audio mastering for vinyl has always been so important.



What does all this warfare do to the sound? Firstly it tends to increase “distortion” at high frequencies. However it’s not the “clipping” distortion that we’re used to hearing from an overdriven amplifier. The kind of distortion vinyl playback creates, adds more of a high frequency “fuzziness” or “energy” to the sound which then *follows* the music, instead of just mixing with it. This “delayed” distortion often manifests itself similar to “sibilance” however that’s not a true definition of it.

The distortion evident in high frequencies in vinyl playback actually generates its own harmonics. The response is never linear, because like every other physical thing in this universe, the needle and even the cartridge have their own **resonant frequency**. This means some frequencies are multiplied, whilst others end up cancelled out. All this is going on in a very analog fashion, with everything affecting everything else. The result depends entirely on the frequencies and energy in the music, not just at a frozen point in time but also in the microseconds following. These frequencies resonate in the groove and needle to create a sound all of their own. In analog playback we generally call these sounds “*artefacts*,” as they are sound that were not a part of the original recording but don’t necessarily detract from it like traditional *distortion* does.

It’s this vibration and resonance of the materials in use which create much of “*that vinyl sound*”. This is also the reason why different styli and cartridges can sound different with different material. Stylus wear and shape also has an important part to play, as does wearing of the record itself—as vinyl is not a particularly hard substance. To some extent, every time we even *play* a record, we actually *alter* it.

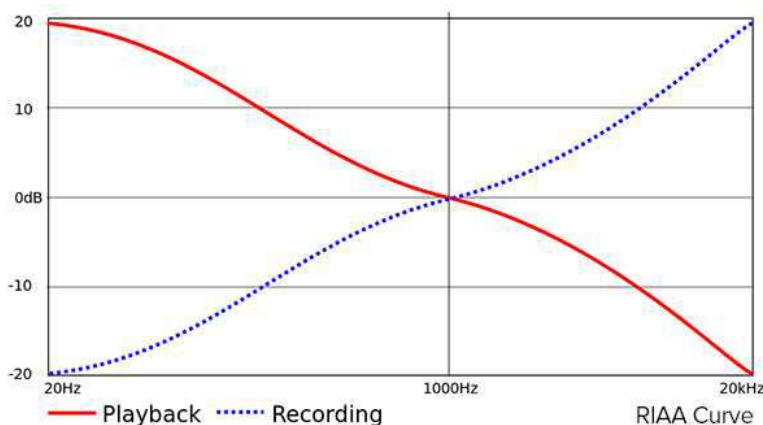
As the technology behind vinyl, styli and cartridges has been refined throughout the sixties and early seventies and even through to today, engineers have always endeavoured to reduce the *distortion* evident with vinyl playback. They’ve done a great job, squeezing incredible performance out of a recording medium which most would agree should never have been asked to perform that well.

With everything we’ve just said about Vinyl and high frequency distortion in your mind, let’s read on and see how things can get worse....

Bass Response and the “RIAA Curve”.

Out there in crazy land, there are “audio purists” who bypass the tone controls on their stereo system, in an ever futile attempt to reach a “more pure and unaltered” sound from their vinyl. It might perhaps come as a shock to them then, to find that the sound on every record they play has already gone through a radical tonal transformation when the master disc was cut!

This transformation is known as the “RIAA Curve,” named after its “inventors,” the *Recording Industry Association of America*.



Just what is the “RIAA Curve?” It’s basically an old, simple 1950’s version of the well known Dolby noise reduction system that came to be used on most analogue tape formats in the 1970’s such as compact cassette. Before the sound gets anywhere near the cutting head of a record master, all of the audio that is recorded to vinyl is passed through a quite radical set of “shelf filters.” **In effect these filters do the same thing to the sound recording as you might do yourself if you were to turn the bass control on your stereo right down and the treble control right up.**

The sound actually cut onto a record is very “treble heavy.” When you play back the record, the sound is put through a **pre amplifier**. However this is no ordinary, linear pre amplifier. It’s known as an “**RIAA**” **pre amplifier**. It’s effectively just like another set of tone controls... only this time with the *bass turned right up and the treble turned right down*.

Every scrap of sound you hear off ANY vinyl record made since the early 1950s, has been put through not just one radical “tone control”... but TWO.

The purpose of this tonal jiggery pokery is to drastically **reduce the noise** that is otherwise very evident on vinyl playback. The recorded curve of sound is compensated for by the encoding filters – but the noise off the record itself isn’t. The playback noise therefore remains “attenuated” by the filter in your pre amplifier just as effectively as if you had grabbed the treble control on your hifi and turned it down yourself.

The unfortunate side effect of this, is that high frequencies are generally cut onto the record much “louder” than the low frequencies. This potentially makes that “sibilance distortion” we spoke about earlier even more pronounced, particularly with high energy levels in the sound. It also does things to the low frequency response.

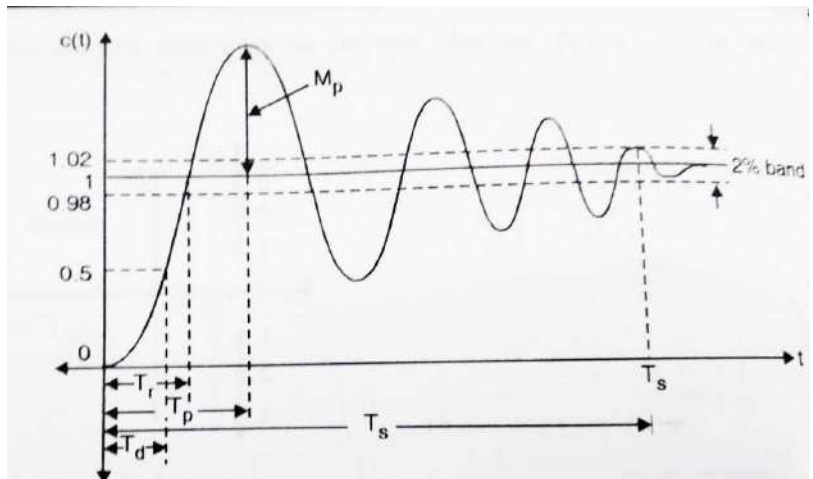
To find out what a vinyl record REALLY sounds like direct from your record player, try this little experiment: (Note this only works if your turntable that does NOT have a built in pre amplifier..). Using an RCA to 6.5mm plug adapter, plug the output of your turntable directly into a high sensitivity linear microphone preamp such as the “MIC” input of a tape recorder or your mixing desk.

Now play your record. You’ll immediately notice how incredibly “tinny” the sound is and how it almost completely lacks any kind of bass response. Now play around with the bass and treble controls on your equipment to see how far you have to twiddle them to get your record to sound anything like it should. You’ll be amazed at just how much cut and boost is involved. Most typical tone controls on hifi equipment cannot add or subtract enough, even if turned full on or off!

Let’s read on..

Transient Response

Taking into account what we’ve already learned above, lets now turned to “transient response”. This is not just the ability for a recording medium to deliver “dynamic range” (i.e. the difference between the loudest and softest sound in a recording), it’s the ability to do that *very quickly*. In electronics we use the term “Slew Rate” to describe this. In the case of an amplifier, it’s basically a measure of how quickly a voltage can rise from 10% to 90% of maximum output relative to any artefacts or oscillations that are added as a result.



Mostly because of that RIAA filter jiggery pokery, the *slew rate* of vinyl as a transcription medium is *very non linear between the low and high frequencies*. The crack of a snare drum will appear very sharp and sudden. Meanwhile the thud of a kick drum will appear far more delayed and distant. This is because the distance the needle has to move for the high frequencies is much further than for the low ones – because of our RIAA curve.

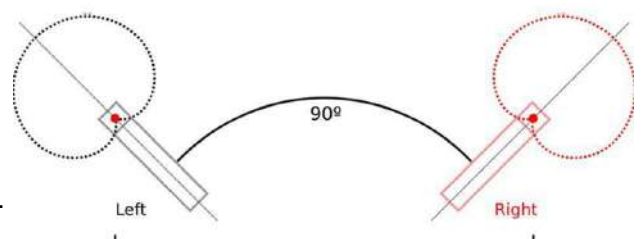
The filters we use to encode and decode the RIAA curve also introduce another problem called *phase angle difference* to the sound. Because there’s an imperfect record and needle in between our two filters, phase errors created in the encoding process are not always cancelled out during the decoding process. Once again, this creates harmonics and artefacts that simply aren’t there in our original recording.

When you get a chance, pick out a nice 7” 45rpm pop single and put it on under a bright light. Watch it and listen as it plays. You’ll notice how different the high frequency “noisy” parts of the record look as the needle hits them, compared to the quieter or lower frequency sounds. Quite often in a vinyl rock track you’ll clearly recognise the snare drum or guitar riff almost instantly as a distinct, swirling pattern in the record.

So to summarise, vinyl as a recording medium reacts differently not to just higher and lower frequencies, but also the speed at which these appear and disappear. These, along with phase differences create *artefacts* that were not there in the original recording. These artefacts are time and frequency dependent and exist in the audio spectrum independent of our original sound and can combine with the effect of resonance to create distortion which is unique to the energy of the material playing at that particular moment.

Stereo Separation

It might come as another surprise to many purists today to know that records weren’t always recorded in “stereo”. Originally all records were mono. It was only through experimentation that engineers discovered it might be feasible to record one track of audio on one side of the record groove while recording a different track on the other side of the groove. A needle coupled to a cartridge with two coils, each arranged 45 degrees from the vertical could then reproduce something that at least in some capacity, approximated the original “stereo” signal.



So now, not only is our poor needle being violently wrenched from side to side but also up and down as well. The intelligibility of each channel depends entirely on where the needle is in relation to the opposite side of the groove.

At very best, the **stereo separation** available using this method, is around 30dB. On a typical vinyl pressing which has already been played a number of times on a typical turntable with stereo cartridge, separation between left and right channels hovers as low as 10~16dB. In electronic engineering terms this is *truly awful* and in some cases not much better than mono. What does it mean?

It means that a guitar riff placed **exclusively on the left channel** in the original studio recording, is going to be noticeably **heard in the right channel** as well when played off vinyl. Therefore engineers of the day mixing audio for vinyl who wanted a sound to appear “a bit on the left” or “a bit on the right,” would fade these hard to left or right in the 1/4 inch master tape. There was no middle ground!

These recording engineers knew about the shortcomings of vinyl all too well. So to compensate they often deliberately did just that – panned instruments hard left and right in their recordings, knowing full well that it would be heard quite differently on the soundscape when pressed to vinyl.

Different Versions of the same recording

Knowing all that we now know about the gross imperfections of vinyl as a recording medium, perhaps you'll hopefully begin to understand how engineers back in the day used to record, mix and master their recordings very differently. They were trying to do get the best, most faithful reproduction to the listener possible using limited equipment and technology which they had at their disposal.

However in doing so, these engineers generally allowed the recording medium to shape their artistic decisions around the production of the music itself. These producers knew what worked on vinyl and what didn't They simply avoided doing things they knew vinyl couldn't do, instead letting the music “form itself around” what it could do. This approach went on to form the foundation of what today, has become known as “**That Vinyl sound**” of 1970's and 1980's popular music.



A 1/4 inch master tape recording for mastering to vinyl often sounds very different to the vinyl result after pressing. This was especially true when it came to hard hitting, high energy pop / rock music running at 45rpm. The engineers always knew this. That's why when it came time to re release music on digital formats, it became necessary for them to completely re master most popular music specifically for the new digital medium.

For digital re release, they had to go back and actually re position sounds where they thought they really should be in the soundscape, instead of where they thought it would have ended up after going through the vinyl washing machine.

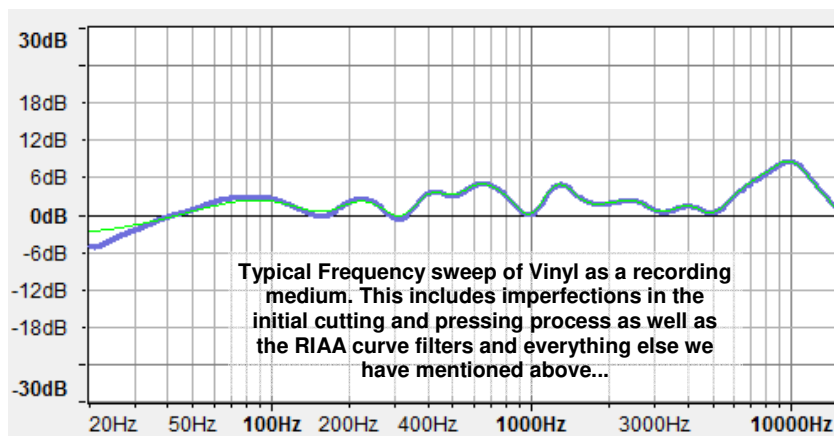
Instruments previously panned hard left or hard right, often (incorrectly) found themselves almost centred in a digital mix. Incidental “background” sounds such as synthesizers, backing vocals and rhythm guitar (which were often placed in the foreground on vinyl mixes in order to compensate for distortion) found themselves right at the back in most digital re releases in the '90s. That *amazing snare drum and hi hat sound...* that you swore could cut through stainless steel off vinyl.... now doesn't even cut mustard in the digital one. These were decisions made by engineers in good faith, trying to produce a result as close as possible to what they thought the original vinyl recording sounded like. However they usually fall well short of the real thing.

We now live in a world where popular music is not just awash with songs and recordings, but a world where most recordings may have up to *three or four different versions associated with them*. These may range from the original vinyl release, through early CD masters (which could well have been nothing more than a direct digitisation of the original 1/4 inch master originally intended for vinyl), thence through various “remastered” versions released by the same artists of the same recorded material, remixed again and again using various analog or digital technology available at the time of re release. We won't even mention those letters “MP3” here.

All these versions are trying to do, somewhat in vain for most, is to get back to that original sound that we all know, and remember when the track first hit our turntables.

Signal to Noise Ratio

We've left this one until last, because it's the one most keenly quoted by audio purists and engineers who aptly agree that any analog medium such as vinyl can never reach the lofty heights of digital when it comes to S/N ratio and frequency response. It is widely accepted that a typical CD, played back on a typical player, will easily manage greater than 90dB of S/N ratio, whereas the very best audiophile records and players still struggle to reach 60dB.



However what most engineers still don't realise is that *"noise ain't necessarily noise."* Our brain registers and ignores noise differently depending on what surrounds that noise and what our brain is able to make sense of in that moment. Ultimately all sound is just "noise" when it enters your ear, however it's up to your brain to work out what it thinks is legible and what isn't. In many ways, this makes it virtually impossible to reduce recording quality down to a single figure like "S/N Ratio".

So while we won't argue here that digital does and always will blow vinyl off the table for S/N ratio, it can be argued that the audio industry as a whole perhaps places far more weight on this figure than it should. While good S/N ratio might be important for classical or other music which features wide dynamic range, it is perhaps almost irrelevant when considering typical '70s or '80s pop music, where the energy of the material remains well above the noise floor from the first beat to the last fade out.

Why do we love *That Vinyl Sound?*

Its at this point we have to leave the engineering aspects of vinyl and look at the psychological way that the human mind listens to and remembers the sound of music.

Due to all of the aspects we have discussed above, it's clear that a pop song played back off its original vinyl pressing is going to sound quite different to one played off any digital format. The discussion then becomes one of which one is "better", not which one is "most original".

There's no question that a digital transcript of an original 1/4 inch master tape is going to be the best recording of "the original". Likewise many of the "remasters" of the original multi track tapes will always bring to our ears the best example of "original," in as much that the original sound has been transported through time in the most faithful way.



However as we all know, a digital master (or re master) of material originally released on vinyl and which became very popular at that time, rarely brings back an emotional response like we get when we drop a needle on that original record and just listen to it. *Why is this so?*

The primary reason for this, at least for the older generations, is because whatever digital version we play, it won't sound exactly the same as the versions we listened to when we first heard the track *off vinyl*. It's this version our brain has memorised in it's entirety. The human mind is particularly good at recording, memorising and storing sound and then linking our emotional responses to this initial memory.

But it gets better than that.

The same people who spent decades listening to that vinyl, also listened to that same vinyl **played on the radio**. Radio does strange things to music—it has to—because radio broadcast has an even worse signal to noise ratio than does vinyl. To compensate for this, all sound broadcast on the radio is *compressed*. The compression algorithms and equipment used in AM and FM broadcast tend to be on the side of extreme, in an ever competitive process of stations *trying to be the loudest on the dial*.

Basically what *compression* does to music, is to make **loud sounds softer and soft sounds louder**. It "squishes" the sound into a smaller space. And guess what?

We've just read about how vinyl playback creates **artefacts** that weren't there in the original recording. Most of these artefacts are subtle in nature and tend to be small when compared with the music being played back.

So guess what our radio station compressors do with these *vinyl artefacts*? That's right.. It makes them LOUDER and more pronounced! That means vinyl played back on the radio sounds even more different than that same song played on the same station via digital means!

So all that vinyl.. played back on the radio back in the day that vinyl was king... has well and truly burnt its mark on every mind that existed and listened to it in that era. That's the primary reason why today our minds respond so favourably to "that vinyl sound" when compared to digital equivalents.

And that's why "Vinyl Shop Valves" sounds so different to anything else on the air today.

Paul Matthews
2021

