# A SOUND INVESTMENT

If you want the best possible sound in your cinema room, acoustic treatments will help. **Mark Craven** chats to custom install experts **Owen Maddock** and **Nic Black** about first reflections, bass traps and parallel walls

**OUR HOME CINEMAS** are never 'finished'. We're always looking – admittedly somewhat idly – at what improvements can be made to perfect our picture, streamline our sources or advance our audio.

When it comes to the latter, obvious avenues to pursue are bigger, better loudspeakers or beefier amplification. But what about the room itself?

The effect your movie den's size, shape and construction can have on the sound of your system shouldn't be underestimated. Highly reflective surfaces will muddy up your soundstage, while unwanted room modes will suck the life out of your subwoofer.

Of course, it's unlikely you're in a position to rebuild a room from scratch. This is where acoustic treatments play their part, be they absorbers, diffusers or bass traps. Positioned correctly, they can address issues with your room's acoustics that are much harder to counter through the calibration system on an AV receiver/processor. A little improvement here can go a long way.

Such treatments are a common feature of professional studios, mastering suites and high-end home cinemas. To find out more about them we chatted to two award-winning UK installers: Nic Black, Managing Director of Pyramid AV, and Owen Maddock, owner of Cinemaworks. **>**

## In a nutshell, what are room treatments used for?

**Owen:** Room treatments help to reduce the sound influence of the room itself – echoes, reverberation and resonance. That allows the sound system to more effectively create a feeling of other spaces, which helps you to disappear inside the film.

## How do you calculate what type of treatment to use where?

**Nic:** Typically we undertake a pre-treatment assessment of each given space in order to gain a clear picture of the room characteristics. This is done in one of two ways.

If we can assess the room in person we'll measure the broadband impulse response using a trigger sound, which will provide a clear indication of the way in which the base structure reverberates across the frequency range. This is outputted as a base RT60 measurement [the time it takes for sound to reduce by 60dB], which allows us to identify the way in which the room will naturally perform to high SPL broadband sounds. From here we can decide, in tandem with an understanding of the type of design we are looking to implement, how we will approach the overall acoustic treatment. We will calculate the necessary absorption and reflection treatments in order to reach our target RT60 outcome.

If, however, access to the room is not possible – in a new-build, for example – then we input the

*Not all treatments need to be visible – this media room from Cinemaworks hides front-wall absorption panels behind acoustically transparent fabric*

*This CEDIA Award-winning system from Pyramid AV uses a non-parallel surface design to improve audio performance*

expected room construction details into our 3D software (EASE), which will give a very accurate prediction of the room's behaviour. Allowing for this prediction we can then continue with the calculations as if we were not in the room, and in both instances we check our calculations using EASE to be sure our assumptions are accurate.

**Owen:** There are a number of methods. Dr. Floyd Toole is the godfather of home cinema acoustics – his seminal work *Sound Reproduction: The*

*Acoustics and Psychoacoustics of Loudspeakers and Rooms* is the go-to reference book for any serious home cinema designer. Toole's extensive research into domestic-sized spaces has also influenced the design guidelines of various standards bodies, such as HAA (Home Acoustics Alliance) and CEDIA (Custom Electronics Design and Install Association), which we all use, certainly as a starting point.

As well as the theory, Dr. Toole conducted very many listening tests and studies with real people, and the results show, very clearly, that we all really do prefer better quality sound, which closely resembles the real sound of instruments and voices. These tests were all conducted blind, without any knowledge of what equipment was being used.

On a Cinemaworks project, we'll design using mathematical models of the room to give the broad brush strokes, then we can refine that using real measurements taken during the installation process.

The more upscale the project is, the more budget we can allocate into the design, measurement and treatment phases, but even on an entry-level project, a small amount of treatment goes a long way.

## Can you explain what 'first reflections' are?

**Nic:** In simple terms, first reflections are the net effect of mid-to-high frequency content from the LCR speakers interacting with adjacent surfaces. This typically creates a secondary reflection or reverberation effect that leads to a slightly delayed and confused signal arriving at the key listening point in tandem with the direct sound emanating from the speakers. Usually side walls and low ceilings are the culprits, but any hard surface around the screen will create reflections so avoiding hard floors is desired. It is always best to plan the dispersion characteristics of the chosen speaker type so as to understand where the higher frequencies will interact with immediate surfaces, and then try and angle speakers to maximise the delivery of the energy to where it is needed.

**Owen:** The first reflection from a speaker to a listener is the main one where sound bounces directly from a side wall and into your ears. Although sound waves will bounce around more from there, each 'bounce' loses energy, so the first reflection has the biggest effect on the performance. Where you have multiple rows of seats, you'll therefore have several first reflection points for each speaker.

To work out where they are, you could use the mirror technique [placing a mirror flat along a side wall and moving it until your speaker is visible from the seating position], or, if calculating it on paper, it's the place where the angle it hits the wall at is the same as the angle it hits the listener – therefore there is only one place per seat (and per speaker) where there is a first reflection.

Historically, recording studios put lots of absorption at the first reflection points, but Dr. Toole's recommendation is to use a mix of absorption and diffusion panels. The latter scatter the sound energy away in several directions, instead
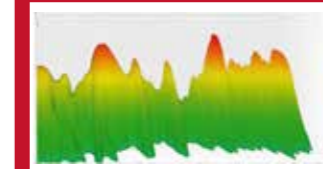
*HCC reader Stefan uses on-wall panels in his cinema to counter first reflections*

of it bouncing directly towards the listener, but without taking so much energy or 'life' out of the room.
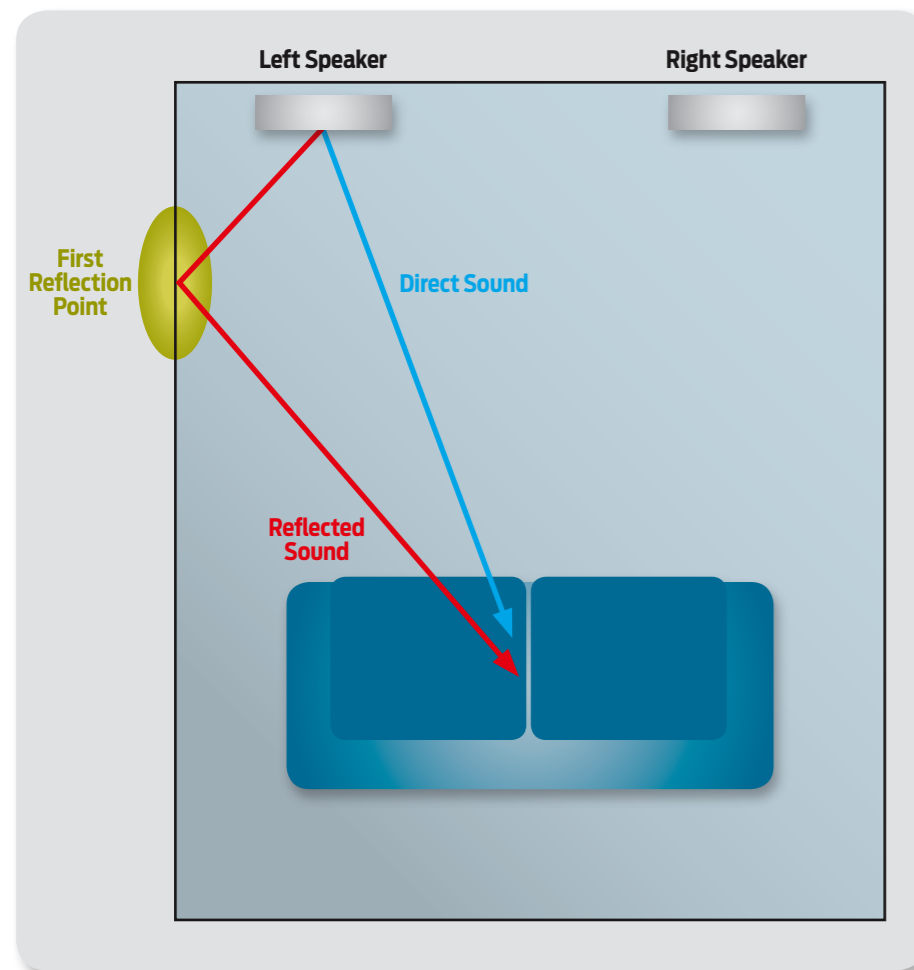
## Is bass the most difficult sound element to control?

**Nic:** Often bass is the most problematic of the frequencies present in a cinema, but not always. High-frequency reflections can create some pretty nasty effects too! In the case of bass the low-frequency nature of the audio wave can create very undesirable effects as a result of nulls or standing waves created by the position of the subs themselves interacting with the room. There are a number of ways to mitigate this effect, from preferred techniques such as the use of bass traps in specific places, to using multiple subs in order to 'smooth out' some of the nulls, by virtue of the differing positions and therefore wave interactions. The latter is the least preferred, and if we have the opportunity we will always calculate the null positions and mitigate these with treatments. At Pyramid we have developed our own method of bass trap construction that has proven very effective over the years.

**Owen:** In 'domestic size' rooms bass is the biggest issue, because the dimensions of our rooms correspond to the wavelength of bass notes. Smaller spaces like cars are quite easy – the bass notes fall straight out of the car and annoy people as you drive past – and concert halls or nightclubs are straightforward too – in those bigger spaces, the bass notes sit quite comfortably.

In regular domestic rooms, between 3m and 10m long, some bass notes bounce back on themselves and create a standing wave or a resonance, just like if you hit a pool ball dead square against the cushion and it bounces back and forth for ages. In practical terms, that means some bass notes disappear, while other notes resonate and 'boom', depending on where you're sitting. When watching films we want even bass, with all notes equal.

The only two effective remedies are a) multiple subwoofers deployed in pairs e.g twos, fours and

Left Speaker

Right Speaker

First Reflection Point

Direct Sound

Reflected Sound

Side walls (and floors and ceilings) will create sound reflections, exacerbated by hard surfaces

a product of parallel walls, ceilings and floors so thought should be given to how these surfaces can be broken up so as to reduce these impacts.

**Owen:** A few competing theories were developed throughout the last century, which some designers will still aim for, however these were created in the 'stereo' era – multichannel surround already overcomes the limits of stereo in many ways, so will be less appropriate.

In practice, we're very rarely given a 'blank slate' where we can draw up those ideal dimensions. Usually there's an existing room, and a desired number of seats to hit. But it's best to avoid square or cube shapes if at all possible, and make sure the dimensions aren't in multiples. For example, if your ceiling height is 2.5m, try to make sure it isn't also 5m long, or you'll get a really big resonance at 70Hz. If we have quite a nice project, and if there's scope to change the dimensions, we might choose to shorten or lengthen the room a bit to avoid these kinds of issues.

It's something of a sliding scale – if your budget is over £100,000 for the cinema system, then you might certainly consider an 'ideal' dimension, but more usually we're dealing with making existing rooms perform as well as possible.

### For someone on a tight budget, what room treatment will have the most impact on sound performance?

**Nic:** Bass traps will help enormously assuming there is a high SPL LFE being delivered, which in turn will reduce possible nulls. If feasible and when using a LCR setup behind an acoustically transparent screen, then whenever you can ensure the construction of the screen wall is as solid as possible. The denser this is, the less loss from rear-of-speaker rejection will take place, and as a result help the LCRs appear more planted and immediate to the listener. Finally, and most obvious, try to reduce or remove hard surfaces that will contribute to the kind of effects mentioned earlier.

so on, and b) acoustic treatment such as bass traps or resonant panels, to prevent standing waves from building up.

### Are there ideal dimensions for a home cinema?

**Nic:** In acoustic terms, it is always best to avoid parallel walls as they will tend to accentuate unwelcome reverberation effects and standing waves. That said, in the majority of cases rooms are



Many custom cinemas, such as this project by Dawsons AV, use removable fabric panels to disguise sonic treatments and make cable and speaker upgrades easier

**Owen:** It depends. Find out if you've got a bass and resonance problem, or a more general reverberation problem, which you can do with affordable tools like RoomEQ Wizard and a decent measurement microphone.

If the sub bass is 'okay' then a few well placed absorption panels can have a good effect, but if the bass is lumpy and bumpy I'd start with bass traps instead. Either way there are some very affordable options, usually finished in a smart cloth.

### What small things can be done in a room to improve sound without fitting absorption/traps, etc?

**Nic:** There are a few ways that people can manage most of the effects of poor acoustics due to high SPLs in a room. Thick carpet and underlay, the use of thick curtains and soft furnishings, and good speaker placement. This will always help in most cases. Direct the sound where it needs to go!

**Owen:** Placement of speakers, seats and subwoofers is absolutely critical. Don't just put things where you think they fit!

If you have an existing system in place, you can do a combination of room modelling and actual in-room measurements, and applying this should make a big difference. Software like RoomEQ Wizard – written by John Mulcahy, one of the pioneers of DSP-based room correction – is powerful and low cost. A good quality measurement microphone is also pretty affordable, such as the MiniDSP UMIK-1 that we use. Audio Tools software for iPad is also very useful.

If you own a single subwoofer, strongly consider adding a second identical one – a single sub can only really give you good bass for one seating position, but with two or more you can do much better, which Dr. Floyd Toole proves very elegantly in his book. Of course, if the room really is just for one, then that's fine!

Try not to place seats too near the walls if at all possible. Or accept that those seats are a bit secondary!

### Has the development of more immersive 3D audio setups made room acoustics more complicated?

**Nic:** In our experience immersive audio systems have reduced the impacts to a point as by definition we are using more points of resolution, which in turn means that the sound is being delivered in a more balanced and better dispersed manner. That does not mean that we have to use less treatment, but it does mean that in a well-designed room with good characteristics, the delivered sound doesn't have to work so hard.

**Owen:** Not hugely! The main sources of energy in a film soundtrack are the subs, the centre and the front left/right speakers. So adding height channels doesn't really change that.

For the very best results with three-dimensional audio, the manufacturer Trinnov suggests a room

On-ceiling treatments can also be used to finesse room acoustics

height of 3m or more. That is to avoid problems of 'localisation' for the height channels. If you are sitting too close to a speaker, you can tell where it is in the room. However, for most of us, or in systems with fewer than 16 audio channels, a ceiling height of 2.2m or higher works pretty well.

I'm not a big fan of those 'Atmos modules' for main speakers unless you absolutely have no chance of doing it another way – the odds of bouncing the sound off the ceiling and hitting the listener at the desired angle are not great.

### Do all your projects include some form of room treatment?

**Nic:** Yes, whenever it needs it as a result of pre-planning and calculations.

**Owen:** If at all possible, we do it. You get enormous benefits even from a small amount of extra cost, and a bigger amount does more.

Any objections we face are usually around how it looks, rather than the effect. So more often these days we're using some sort of fabric walls, which let us hide the treatment panels, and even the side speakers, away completely. Fabric walling also saves cost in other ways. It's much more efficient and vastly more futureproof to hide cable routes away behind removable panels, and we often save a lot of time and cost by not needing a plasterer or electrician on the project. We can even change the look of the room really quite easily if the clients fancy a switch a few years later.

Compared to chasing cables into plastered walls this is a much more appropriate approach for a modern home cinema. The fabric wall needs to be of the right sort, of course. Good fabric manufacturers will publish the sound profile of a given range – a very open weave is ideal. Camira Fabrics' Blazer Lite is our go-to as it looks really classy, it's relatively easy to fit and it has almost no effect on the sound ∎