Rycote

Surround and About

Surround sound is seen as the natural partner to High-Definition pictures but collecting real surround sound, as opposed to making it up in post, poses a number of difficulties. In this article Chris Woolf, Rycote's technical consultant, reveals some of the design principles used for surround microphone arrays.

For many people, stereo – two microphones to produce a limited frontal stage – is a struggle and the idea of adding to this to provide full surround is terrifying. Yet the principles remain unchanged – the creation of phantom sound images between two loudspeakers. The layout of five loudspeakers using the ITU arrangement is not ideal and the degree of accuracy with which sources can be pinpointed is a bit variable, but some envelopment can be produced and if allied to pictures (which have the effect of anchoring poorly positioned aural images) surround sound can enhance a programme. How realistic the results are depends to a large extent on the source material. Genuine location sound often has that mark of veracity that is impossible to fake in post, and it may even be quicker and cheaper to produce – but how to capture it?

Five microphones

Mono programme needs a minimum of a single microphone, stereo needs at least two, so does surround need five? (Please, let's forget the 0.1). Using five discrete, spaced microphones can work and, as with stereo, tends to give a pleasantly wide stage, albeit with slightly fuzzy positioning of sounds. The technique is feasible on location (Florian Camerer has used it to good effect) but the physical problems of handling and moving widely spaced arrays makes it an unattractive route to follow on most occasions. Grouping the microphones nearer together to give close, but *not exact*, coincidence is another technique which is being used [see Fig 1] and can fit into a single windshield while still giving a slightly enhanced stereo effect.

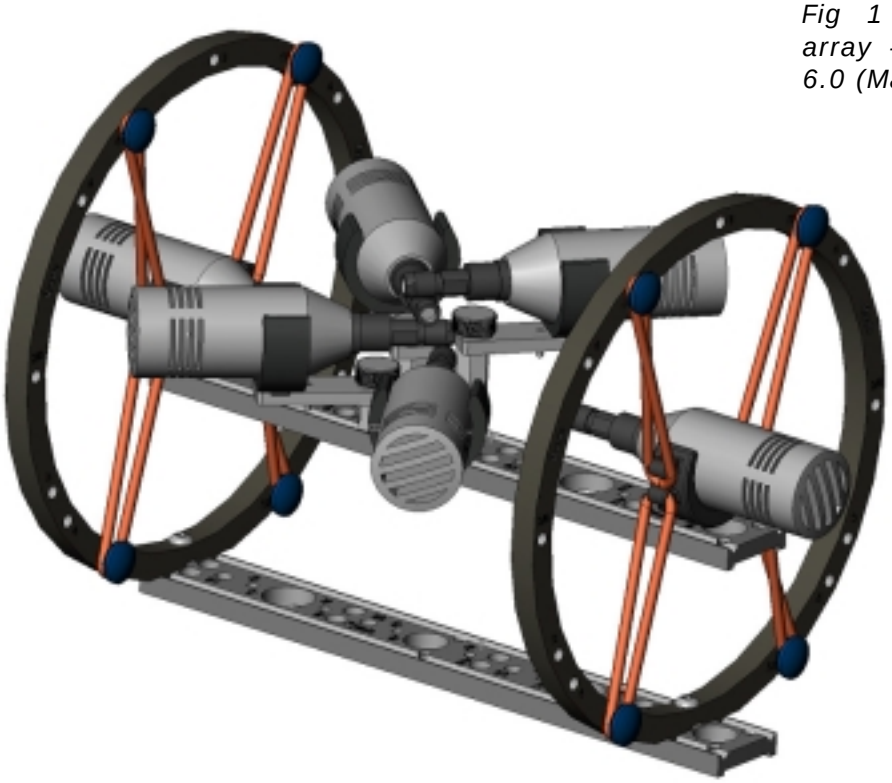


Fig 1 – Near-coincident array – optionally 5.0 or 6.0 (Mangini)

Single windshields are obviously compact and convenient but they have another, less apparent advantage – they keep any unsuppressed windnoise central and static. With multiple windshields the odd rumble of wind will be positioned in first one loudspeaker and then another. It cannot form a phantom image between them and jumps around, making it very obvious.

Fully coincident systems are also used and examples such as the multi-capsule Soundfield microphone are popular for sports ambience where its excellent positional accuracy is a benefit. One of the oldest true coincident stereo techniques, mid/side (MS), has also been modified for surround - Double MS or MSM – and is proving equally popular amongst the film and TV fraternities.

Intriguingly both the Soundfield and DMS make use of the same clever ploy that enables real, coincident capsules to be summed to produce alternative virtual ones pointing in different directions. Stereo MS has a forward pointing cardioid of some description and a sideways figure-of-eight to provide $Left_{front}$, $Right_{front}$ feeds. Obviously a hard, mono Centre is also available if needed. DMS mimics this in reverse by adding a rearward facing cardioid but there is no need for a second figure-of-eight – it can use the existing one by taking a second, polarity-reversed feed during matricing. This provides the ITU $Left_{surround}$, $Right_{surround}$ signals – that's your five microphones from three capsules [see Fig 2]. And you can make more if you have the mind to run to 6 or 7 loudspeakers.

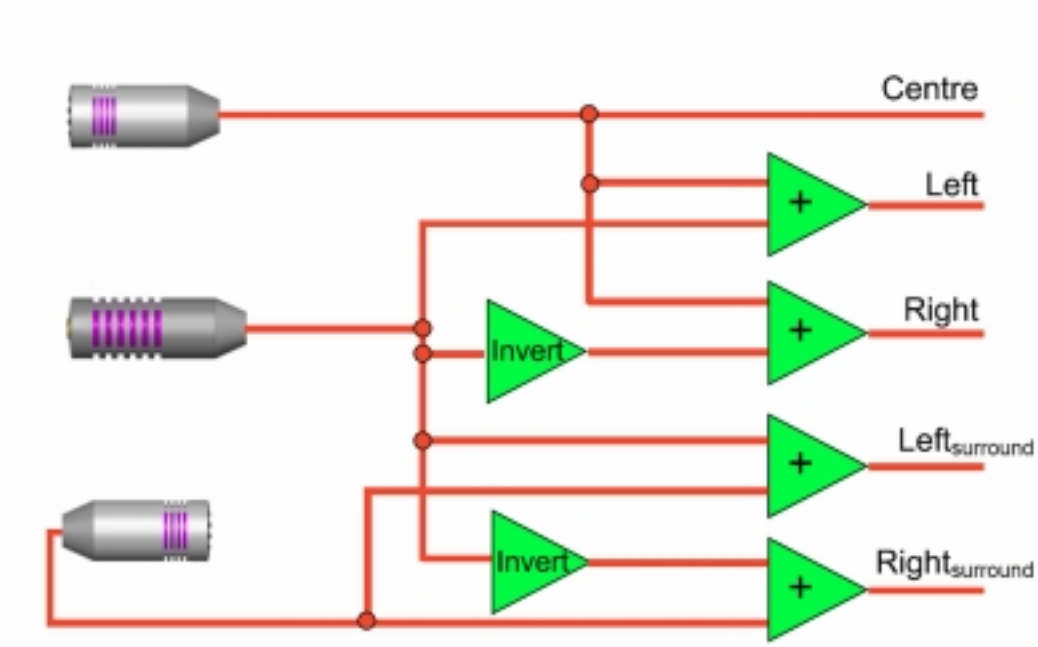


Fig 2 – DMS matrix

Practical aspects

One of the practical benefits of the coincident DMS technique is that all the capsules are necessarily very close together and can be fitted into a single suspension and windshield. One of the practical disadvantages is that that ideally all the capsules should be in exactly the *same* place, which is impossible. For two-capsule MS it is feasible to provide perfect coincidence in one plane and an error of only about 25mm in the other, even with conventional-shaped microphones. Vertical coincidence is preferred since this gives an even horizontal field – the 2D one we usually listen in. For single shank MS microphones the figure-of-eight can be fitted on the same axis as the cardioid but just behind it, with a coincidence error of perhaps 20mm. But with three capsules it all gets much harder.

Obviously what is needed is to have all the capsules as closely coincident as possible, and to minimise positional errors that move a capsule far from the central vertical plane. Less obvious is the need to keep their relative positions constant so that there is no modulation of the apparent source position caused by capsules shuffling around. The array also has to be isolated from handling noise like any other microphone system, and kept neat enough that it can be enclosed in a windshield that is manageable on location.

With long-bodied microphones it is very difficult to do all this. It *has* been done but it is hard to avoid shadowing from microphone bodies or else suffer large alignment errors. There is also the problem of holding a good ½ a kilo of gubbins out on a pole if you do manage to squeeze everything in. For these reasons the most common microphones used for DMS arrays are the compact style ones epitomised by the Schoeps CCM series.

Fig 3 – Schoeps DMS array (picture courtesy of Schoeps)

Schoeps themselves sell a Double MS array in which they use vertically orientated CCMV capsules to get near-perfect coincidence horizontally for both front and rear cardioids [see Figs 3, 3a]. In the vertical plane the spacing is about 60mm. The array sits in a purpose-made rig suspended in a Rycote Modular System framework. This capsule arrangement does mean working with an unusual side-addressed "lantern-style" windshield. However the weight of the array is only around 200g, which is easy on the arms, and the product sells widely.

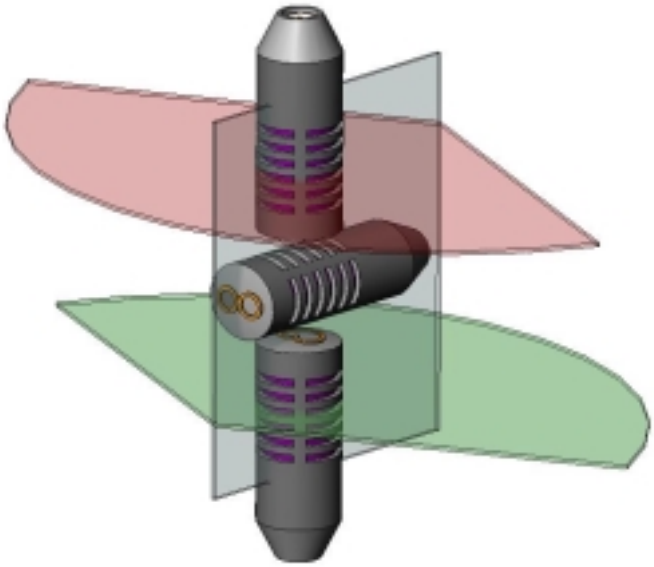


Fig 3a – Horizontal error planes – coincidence is perfect on the vertical plane

Axial capsules

The more usual form of "compact" microphone is the axial version and many recordists would like to make use of capsules they already own. There are a number of geometries that can be used but the illustrated one [see Figs 4, 4a] has proved relatively simple to build. I should make it clear, though, that this is *not* a commercial Rycote product – merely a research "special".

As soon as any capsules are pointed in opposite directions the cables and connectors become a nuisance: capsules cannot be on axis *and* close. In this instance a slight misalignment has been introduced to allow the connectors to “nest” and the vertical plane error between front and rear microphones is only about 14mm. Horizontal plane errors are also small which allows moderate freedom to tilt the rig without introducing obvious HF phasing. The front / rear plane misalignment is about 65mm. In practical terms MS errors of that magnitude are unlikely to be detectable for rear sound sources.

The front / rear positioning is fixed by a spacing rod so that the capsules never shift in relation to each other. If this were not done the heavier front pair would hang significantly further forward when the suspension was tilted downwards than it would when pointing up – the rear MS image would then shift around. The entire array has then to be suspended elastically to isolate it from the pole or stand. The Rycote Modular System was designed to allow many alternative arrangements so this not too difficult in practice. The banding configuration in the photographs is a novel variant that is being tested in the field – we’ll find out if it works well.

Fig 4 – Axial CCMs in DMS array

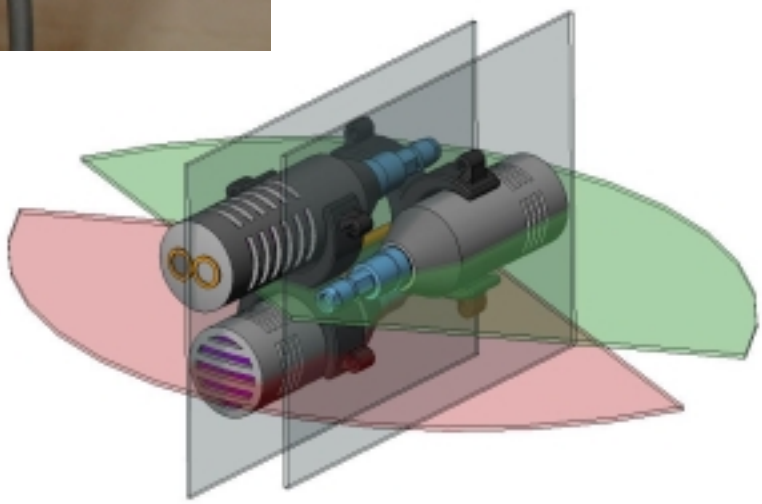


Fig 4a – Vertical and horizontal error planes

The sharp-witted will have worked out that a triple stack of axial capsules could also work and would fit everything into one plane without front / rear misalignments [see Fig 5]. The disadvantages are that it is quite difficult to hold a stack of this form stably without introducing a lot more ironmongery, and it puts the outer capsules considerably nearer to the periphery of a windshield, which greatly decreases its efficiency in suppressing windnoise.

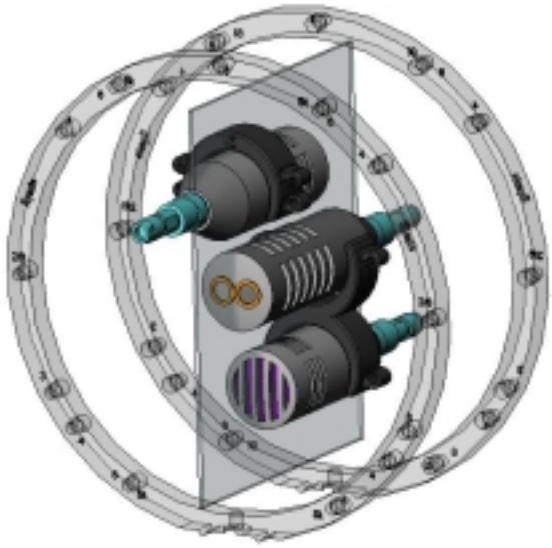


Fig 5 – Triple stack CCM array

Forgotten cables

Those forgotten elements, the cables, also need attention. They must not mechanically short-circuit the elastic suspension so they have to have significantly more compliance – be thin and flexible - than the suspension elements. They also have to be positioned to avoid hitting any of the capsules or the basket or other metalwork. At some point thin cables have to be combined into a thicker one which is robust enough to be let out on the street alone. In the example a captive-cable Connbox similar to the one supplied for the Schoeps DMS mount is used. In the Schoeps case the box has to be poked out to one side on a bracket to avoid blocking the rear–facing capsule but in this array it can sit more conventionally.

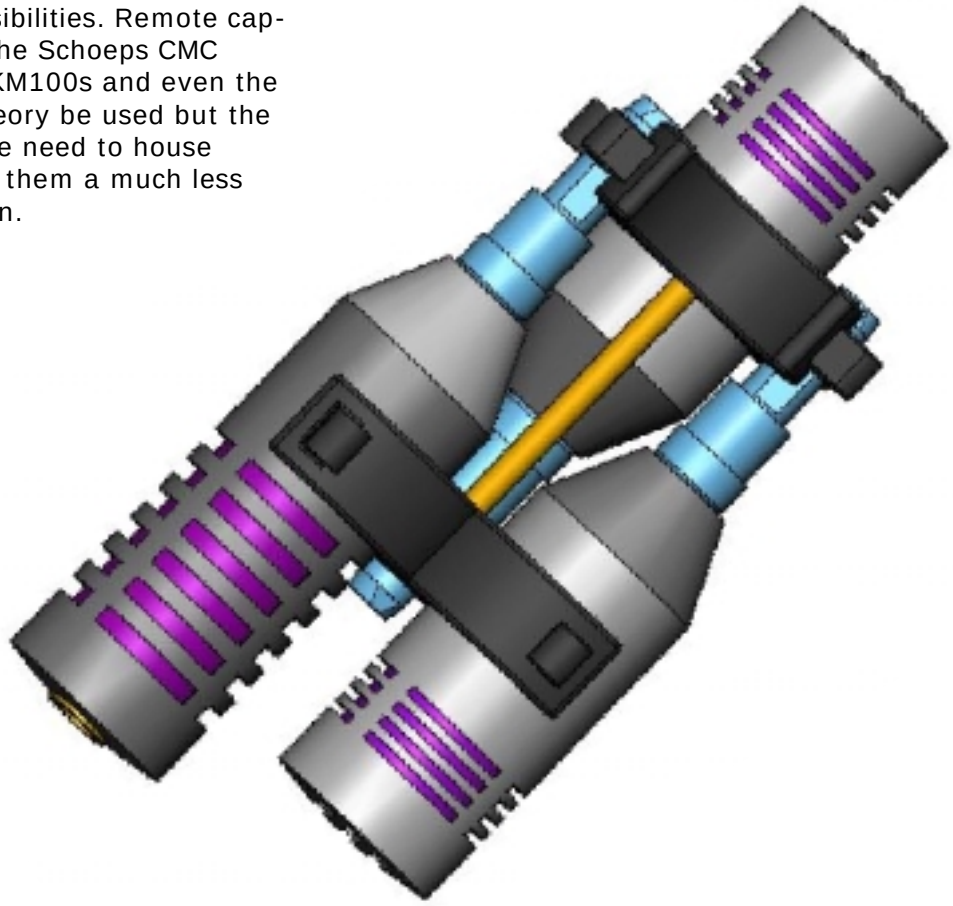
Happily DMS wiring can fit into an XLR7, which avoids the need for more exotic (and thus even more expensive) connectors. But suitable pole cables are harder to find – the Canford MSJ is one of the few. At the mixer end the problem of splitting one cable back into three also has to be faced. Conventional Y-splits are pretty horrible affairs at the best of times, needing lots of heatshrink to reinforce them and provide the cable sheath. For the MSJ it would be a very poor solution and a lightweight splitter-box is a much better option [see fig 6].

Fig 6 – Connbox and breakout

And the rest?

Although Schoeps CCMs are by far the most popular compact capsules other manufacturers have their eye on DMS. DPA have shown a layout using their 4020 series compacts. Since DPA does not make a figure-of-eight they recommend using a pair of opposed cardioids to create one. This does have an advantage in that all the capsules used in the array can be identical. The corresponding drawback is that you need four microphone channels to record the system rather than just three.

Compact capsules are still only made by a handful of manufacturers and this does limit the range of possibilities. Remote capsule designs such as the Schoeps CMC range, the Neumann KM100s and even the Røde NT6 could, in theory be used but the stiff link cables and the need to house bulky preamps makes them a much less attractive configuration.



This article first appeared in LineUp (journal of the Institute of Broadcast Sound), Nov 2006