



SURROUND SOUND EVOLUTION

Surround sound had its origins in the cinema industry.

Although benefits of multi-channel sound delivery systems had been identified as early as 1881, it was not until after the development of the electrical amplifying valve (1914) that single and so multi-channel recording, storage and playback became fully feasible. In 1931 the English inventor Blumlein described improvements to the sound accompanying pictures including binaural (stereo) microphones, capture techniques and recording and playback apparatus so that “the voices in the cinema could follow the actors on the screen”. These developments were to ultimately establish the stereo recording and playback formats we know today.

Perhaps because of competition from television, the cinema industry actively fostered developments in sound systems that could better engage the audience. Key to this were the surround sound extensions that put loudspeakers with dedicated sound channels “all around the audience” and enabled sometimes startling effects.

There were many proprietary configurations developed with varying numbers of channels but the concept of surround sound – loudspeakers surrounding the audience, was common to all. By the 1970’s, loudspeaker configurations were generally standardised to provide three front loudspeakers supporting the picture (left, centre, right) and left and right surround loudspeakers flanking the audience, possibly with an additional rear centre loudspeaker. The surround and rear loudspeakers were arranged to enable so-called fly-past of sounds and so were set back as far as possible.

The general limitation of these systems was that they provided only very limited listening locations where the sound was “as the director intended”. This was the so-called sweet spot located at the centre of the surround loudspeakers. Everywhere else the sound reproduction was at best delivering novel effects.

The ITU 775 surround sound standard

In 1975, American sound engineer Tomlinson Holman coined the term 5.1 to describe the internationally standardised surround format for “sound with accompanying pictures”. This specification formed the basis of the home cinema market for loudspeaker placement and hence channel allocation.

A key and separate aspect of this was the recognition that low frequency sounds should be handled by a dedicated recording and playback channel and a separate loudspeaker.

In the cinema, an emerging problem was overloading of the then analogue optical tracks on the film by low frequency effects - explosions and the like. By providing a separate channel the recording level could be reduced 10 dB and then boosted 10 dB at playback to give the same result without overloading the recording medium – the film.

In the cinema, the surround channel loudspeakers were then made capable enough to handle the required levels of the lowest frequencies encountered in available (i.e. non-effects) program material. This meant that they provided frequency responses covering the woofer range and so were in reality full range loudspeakers with woofers. The separate Low Frequency Effects (LFE) channel was then reproduced separately with what was logically dubbed a sub-woofer loudspeaker.

In the home, the cinema term ‘sub-woofer’ was also used, but unlike the cinema, the home system surround channel loudspeakers evolved to become smaller and rely more on the sub-woofer for normal program channels as well as effects. This trend has more recently found its way back into the cinema.



For the cinema, whilst the loudspeaker layouts were largely standardised on 5.1, the recording formats were still competing. Today there are three main proprietary recording and decoding formats, (SDDS, DTS and Dolby) used in cinemas. For the home, both DTS and Dolby have encoder/decoder formats available. The more recent HD-DVD and Blu-ray formats will support Dolby digital, DTS and linear PCM formats of at least 8 discrete channels¹.

Cinema movies and their DVD home system counterparts still have a separate LFE channel (as distinct from the sub-woofer loudspeaker) even though the need for it has been largely removed by the far better dynamic range of digital sound-tracks. As a result, home system sub-woofers need an extra 10 dB of headroom when playing a movie with LFE over that needed for stereo or five channel surround without the LFE channel.

The way forward

Today the domestic market is faced with multiple choices for sound reproduction. There is stereo format both with and without separate woofers, 5.1 surround sound with and without inbuilt low frequency capability for the surround loudspeakers and with or without sub-woofers.

Additionally there is channel creep. Whilst most program material is recorded and distributed in either stereo or 5.1, manufacturers offer receivers with six, seven, eight or more channels. These systems use inbuilt effects processing to derive signals for the additional channels.

For the professional cinema market, channel creep is still active but here it can involve additional separate recording and playback channels with accompanying true discrete channel loudspeakers, as there is a closer liaison between content producers and the market place and equipment upgrades can be both trialled and introduced progressively.

There have been efforts to improve surround formats, usually involving channel creep, but there was one significant development. Previous stereo and 5.1 systems rendered 'sound in the round' without height information. Height channels and loudspeakers were first introduced with the cinema trials of the 10.2 format in 2000. 10.2 also addressed identified weaknesses in 5.1 including panning gaps (forward left and right surround loudspeakers) and vague rear placement (rear centre loudspeaker). The format started with 5.1 then added the two extra height channels, a "hard" rear centre and two forward surround channels. The bass also used twin channels and loudspeakers, hence the 0.2 (stereo bass). Figure 1 shows the first 10.2 demonstration setup. The forward surrounds, height channels and the top of one of the two woofers Lower right) can be seen.



*Figure 1 - 10.2 demonstration, Las Vegas 2000
(Holman/Huon)*

The Japanese NHK organisation demonstrated 22.2 in 2003. This system also offered height elevation) and depth (declination) information channels and loudspeakers.

¹ For more information on digital formats, see the article "File sizes, data rates and all that", elsewhere on this website (Warning - technical content!).



The key issues for the future of surround sound formats are commercial viability, consumer acceptance and that future additional channels will only provide an incremental improvement.

There is also no generally available source of program material beyond 5.1, though the digital formats of today could support this.

Virtually surrounded

There have been developments in digital signal processing that enable virtual surround loudspeakers to be placed around the listener from a limited number of loudspeakers in the room. These virtual channels could be fed from either actual separate or from derived channels. These systems are the first step in breaking the nexus between channel count and loudspeaker count and could enable commercial viability of high channel count systems by reducing the insatiable loudspeaker appetite of surround evolution. The Australian company Lake DSP developed an instance of this that was licensed to Dolby in 1999.

In 2003, Dr Paul Troughton (formerly of UK, now in Melbourne) developed a patented audio projection system that was licensed to Pioneer (used with their PDSP-1 system) and Yamaha (first in their YSP-1, and subsequently in seven products including the YSP-4000 sound projector). This system also creates virtual loudspeakers.

No matter how surround sound evolution progresses it pays to remember that the fundamental surround format problem of the sweet spot remains no matter how many surround channels and loudspeakers are used or how they are created. It would be useful to be able to eliminate this restriction.

Future format round-up

Are there any other emerging options?

These technologies are further explained elsewhere on this website (warning – technical content!).

The Fraunhofer institute in Germany has developed Wave Field Synthesis (WFS) systems that also overcome the sweet spot limitation of surround systems. Their technologies presently require large numbers of channels, powerful computer signal processing and large numbers of loudspeakers (Typically over 150 channels) to reproduce 2 dimensional “sound in the round” fields for cinema applications. Extension to 3D is possible but will require considerably more channels, more rendering computer power and many more loudspeakers.

HulonLabs has developed a series of technologies that overcome many of the problems of the surround sound systems including being able to eliminate the sweet spot restriction. These technologies:

- Are compatible with the existing surround formats
- Need 4 channels - less than the present 5.1 systems
- Support scalable loudspeaker numbers and flexible placement without performance degradation.

There may be other format developments waiting in the wings. I will believe it when I hear it.

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