

Linear Cinema Sound:

A foundation for Emerging Sound formats

In recent issues *Cinema Technology* magazine has covered the many new emerging 'immersive sound' formats in some detail. We are fortunate to be able to carry a specially written piece from well-respected sound guru John Meyer, who provides a timely reminder that the basics of high-quality sound haven't changed with the introduction of all the new systems, and that truly linear sound remains a vital ingredient of all top class cinema sound systems.



John Meyer,
CEO, Meyer Sound Laboratories, Inc.

Recently, the cinema industry has witnessed the highly publicised debuts of multi-channel surround sound formats that are promising fully immersive experiences beyond 7.1. On one level, this is a potentially significant development for movie fans. A greater sense of emotional involvement via sound could stimulate audience interest and, by extension, make cinema exhibition more competitive with other forms of entertainment.

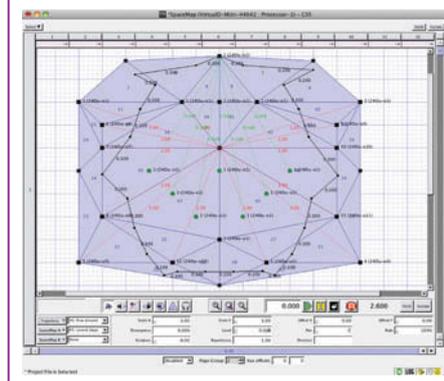
However, adopting new formats without paying attention to loudspeaker quality and linearity could risk audience disappointment and shatter a unique opportunity to extend the boundaries of cinema sound.

In live theatrical and multimedia entertainment, highly sophisticated, multichannel surround sound systems have been successfully deployed all over the world. Meyer Sound has been supporting these experiences for more than 20 years so we fully understand the potential. Our SpaceMap multichannel surround panning provides a tool for sound designers to place sounds accurately wherever you want in a room. Applications of this technology - including nearly all Cirque du

Soleil productions - showcase what can be achieved when you pay meticulous attention to the complete surround experience, starting with sound design and following through by making sure that audio reproduction remains linear, right through the loudspeakers. There's no question that full immersion adds to the sonic impact of these performances. But if you compromised on sound quality, you'd have to wonder what the reaction might be.

In cinemas, just putting up more loudspeakers on the front sides and overhead is not going to be a magic pill.

The Meyer Sound Spacemap system provides extensive audio control, with physical loudspeakers represented by speaker nodes and virtual nodes ensuring smooth panning. Trajectories are defined entirely separately from the physical loudspeaker system.



One nagging problem is that many in the industry only think of loudspeakers as boxes that make sounds louder, without considering the effect of their performance changes at full power. The reality is that a given loudspeaker may sound clean at low levels, but when you start to push it hard to higher volumes, this clarity may fall apart - and the illusion of reality along with it. This happens more often than the industry will admit.

The need for high-quality, linear reproduction becomes even more critical with the new surround formats. Technology now allows for a single surround loudspeaker - among dozens around the room - to localize sounds. These so-called "audio objects" - anything from a bird chirping to a cannon shot or a helicopter - can be dynamically panned around the room. Rendering these effects sonically often proves to be more than typical surround loudspeakers can handle.

Nevertheless, some exhibitors might be misled to think that the quality of loudspeakers doesn't matter in these new formats: "Just add loudspeakers to your existing 5.1 system." But if you read the white papers from the format providers, you'll find a different story. *One white paper specifically notes that the quality and power handling of the loudspeakers is critical to the faithful rendering of the desired effect. We heartily agree.*

The Key: Linearity

Since the future success of these formats may hinge on implementation with linear systems, it might help to define the term "linear." Linearity is a simple concept. In a perfectly linear audio amplification system, the sound coming out is exactly the same as the sound going in, only louder. In other words, linearity defines the system's capacity to maintain uniform performance across the full range of intended operating levels. If the input power goes from 100 watts to 1000 watts, you expect a 10 dB increase in level, but with no change in frequency response or phase response, and no added distortion, all of which would be non-linear characteristics.

An analogy from the visual realm might be helpful. Projectors are usually tested at full brightness to make sure performance is uniformly up to spec. If you turned a 4K projector to full brightness and all of a sudden the flesh tones became lobster red, everybody would notice immediately. But when loudspeakers are pushed to their peak levels and become non-linear, people may not be consciously aware that the sound isn't right, because they don't have a similar frame of reference. But nevertheless, the full effect intended by the film's director and sound team is lost.

What's Linear, What's Not

Audio systems took great strides toward linearity back in the 1950s when the first generations of linear amplifiers launched the hi-fi boom. The sound recording and playback systems of the time - vinyl, tape and film optical tracks - were far less linear, but now these have been replaced by digital technologies, which are inherently highly linear.

Today, all parts of the cinema sound chain are remarkably linear - until the final step: amplification.

Loudspeakers are mechanical devices that must move air, and therefore they are inherently more difficult to design and build to behave in a linear fashion. In a sense, they've lagged behind in the linearity revolution. Making linear loudspeaker systems with a high level of consistency is hard work, and involves more costly components. For example, achieving longer cone excursions requires bigger and stronger magnets and better cone materials, both of which add costs. Also, making a linear two- or three-way system requires that all the components - amplifiers, processing and cabinet acoustics - must be designed to precisely address the inherent non-linearities of those specific moving cones or domes. Long loudspeaker cables also introduce non-linearities, which



Meyer Sound Laboratories cinema meter option for the NTi XL2 handheld audio and acoustics analyser uses a test script that allows cinema sound technicians to calibrate loudspeaker systems efficiently and to an extremely high degree of precision.

is one reason why we build all of our EXP cinema systems to be self-powered.

But the extra costs and effort are worth it. We prefer linear systems because once in operation they are easy to measure and easy to calibrate in a given space. Non-linear systems, on the other hand, are easy to build but nearly impossible to measure and calibrate correctly.

System Tuning and Calibration

Having a full line of linear loudspeaker systems, scalable to any size room, is essential to achieving a linear response in any given cinema. But the system as a whole also must be designed and calibrated for a linear response across the full operating range.

At Meyer Sound, we have developed a new series of test signals and routines to assure that system linearity is maintained up to peak operating levels. Typical cinema sound systems are set up at 85 dB SPL, supposedly 10% of maximum level or -20 dB. We don't believe this is adequate as a true test for today's digital soundtracks. Accordingly, we have developed a more rigorous test routine, which includes four- and six-tone tests and a "-12 dB pink noise" test which is actually only -12.3 dB from full scale digital, the ultimate fixed limit of today's cinema sound systems. These routines are now integrated in the Meyer Sound Cinema Meter, a new option for the XL2 handheld meter from European test equipment maker NTi Audio.

Linearity Benefits "Brave"

The first major release for Dolby's Atmos was Disney Pixar's "Brave", which revealed the potentials of immersive multi-channel sound. Meyer Sound provided Skywalker Sound with loudspeaker systems used for mixing "Brave," including the Atmos

overhead loudspeakers and more. This project brought out many of the challenges of reproducing full-range, high-level sound from single surround loudspeakers. Initially, sound designers were thinking of just a few arrows overhead, but as more powerful sounds were brought in, the demands on the speakers increased. They used bass management to move sounds below 70 Hz into the subwoofers, but some sounds could still stress a single non-linear speaker.

One of the 14 screens to show "Brave" with Dolby Atmos was at Cinetopia in Vancouver, Washington, equipped with an EXP system. In this case, every one of the surrounds was "pre-certified" to carry the sound exactly as it was mixed at Skywalker, and according to Cinetopia's management, the audience response has been very positive.

A Commitment Required

There's no great secret to making a linear cinema sound system. True, at Meyer Sound we have a number of patents that cover specific ways we go about it. But the same could be said of the 4K projector manufacturers, all of whom use different patented approaches to arrive at the same goal. Yet 4K performance was the common goal for all of them.

In this respect, we welcome competition since we believe it's good for the industry in the long run. We hope our competitors also will offer greater linearity in their new products, and we certainly encourage them to apply our more rigorous test routines. We have an opportunity with the new multichannel cinema sound formats, the kind that doesn't come along very often, where we can apply the technology we've developed in EXP. We're not the only ones on the planet with access to that technology, but we did get a step ahead in large part because of our experience with spectacles like Cirque du Soleil.

Our role as partners in cinema sound is to support the filmmakers' work in making the content more interesting and more involving, and to reproduce the desired impact where appropriate. So we invite all cinema audio manufacturers to step forward and, more importantly, we urge cinema exhibitors to insist on highly linear audio systems - whether for the new surround formats or for the majority of screens with 5.1 and 7.1. We certainly don't have to ask post-production facilities to insist on linearity; they've been demanding it for years. We believe that if audiences experience truly extraordinary sound quality, and not just another passing novelty, they will respond, and they will keep coming back.