Surround Broadcasting in Japan

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Surround sound has penetrated the Japanese consumer electronics market more fully than any other. Nearly 45% of all TV sets sold in Japan in 1989 incorporated built-in surround decoders, over and above many elaborate surround systems and components. Japanese television and radio broadcasters have rapidly increased the number of surround broadcasts to keep pace with consumer demand for surround products. This paper describes how they have learned to best utilize surround for sports events, concerts, and both TV and radio dramas. Various microphone and other techniques are described, as well as caveats derived from experience. The elaborate surround mix created for an hour-long NHK radio drama broadcast in May of this year, "The Ears of the Earth", is described in particular detail.

1. Conditions favoring market acceptance

Bonsai is a unique, traditional Japanese hobby which miniaturizes living trees and plants for appreciating nature inside the home. It requires devotion and involvement that go far beyond simply arranging flowers in a vase. Similarly, there is in Japan today a strong demand for recreating within the home the natural sonic atmosphere of concert halls, jazz clubs, movie theaters, and other locations. This demand is augmented by the very existence of the new technology, for which Japanese consumers have an extraordinary appetite.

As a result, home systems combining relatively large-screen TV sets (30 inches or more) with "AV-amps" that feature built-in surround processors have become very popular for enjoying high-quality playback of prerecorded video cassettes and LaserDiscs. In addition, in the past two years integrated "surround TV sets" have become popular, and some of these are now even equipped with sophisticated Dolby Pro Logic decoders.

Going out to a movie or concert is expensive in Japan, and consumers therefore depend heavily on broadcasts and readily-available rental software for entertainment. For the same reason, they also tend to invest in high-quality hardware, and find a sound field that goes beyond conventional stereo particularly appealing. So do broadcasters, including those involved in direct broadcast satellite transmissions, EDTV ("Clear Vision") and HDTV ("Hi-Vision").

2. Market penetration of surround hardware

The increasing popularity of surround is exemplified by worldwide sales of more than 3 million consumer products incorporating Dolby Surround decoders as of December 1989. Although Dolby Surround was introduced initially in the U.S., it was first marketed on a large scale in Japan. As a result, worldwide sales of Dolby Surround products for the moment are divided between Japan, the U.S., and Europe in a ratio of about 6:3:1.

Surround was first adopted by video enthusiasts, then gradually established a position as a more broad-based home entertainment system. In 1989, 46% of all Dolby Surround decoders sold worldwide, and 65% of those sold in Japan, were built into complete TV sets, indicating increased acceptance by less technology-oriented consumers. Today nearly all large-screen TV sets popular in Japan incorporate some sort of surround circuitry, if not always Dolby Surround in particular. This rapid market penetration is shown in Chart 1.

3. Sports programming in surround

Chart 2 is an overall view of surround programming in Japan as of November 1990. Live sports coverage is an obvious use for surround, making it possible for listeners at home to experience stadium "waves", cheers, and crowd noises like those in such Dolby Stereo films as "Major League" and the various "Rocky" episodes.

Where in the U.S. the first broadcast uses of surround was for NBC and CBS coverage of SuperBowl football games, the very first application in Japan was an Osaka baseball game broadcast by MBS (Mainichi Broadcast Station) under the supervision of Hiroshi Hamada in April 1987. They used a simple resistive matrix to create a L-R reverse-phase surround component, and a consumer Dolby Surround decoder

for monitoring. Figure 1 shows the mic arrangements and system set-up for this first broadcast.

In April 1988, Fuji TV made the first Dolby Surround TV broadcast, the special soccer event "Kick Aids '88" (Figure 2). The next Dolby Surround broadcast was of an All-star baseball game in July by NTV, another Tokyo station. However, it was not until August 1988 that surround was given national exposure, when NHK-Osaka broadcast the National High School Baseball Tournament in Dolby Surround. This annual 56-team tournament is followed closely by the Japanese public, and an average of eight hours a day coverage over a two-week period provided a unique opportunity to experiment with various microphone types and placements, and with mixing techniques ensuring compatibility with conventional mono and stereo reception (Figure 3). This extended coverage also had the benefit of familiarizing announcers with the surround concept. In previous broadcasts, they had changed the word "surround" to "sound"!

1989 saw greatly increased surround activity, including coverage by NHK-Tokyo of *Sumo* wrestling that continues for 15 days every other month. Capturing the ambience of a large gymnasium has proved to be one of the most effective uses for surround (Figure 4). In November 1989, another large-scale surround program was undertaken by a network affiliated with Fuji TV: the nearly month-long series of World Cup volley ball matches played in Tokyo, Osaka, Nagoya and Hiroshima.

4. Surround techniques for sports coverage

The best use of surround for broadcasting sports events is for continuous, atmospheric information, such as natural stadium sounds, and not for sudden, unexpected special effects as happens occasionally on movie soundtracks. While the ear naturally becomes less sensitive to continuous subtle surround during long-term listening, the temptation to raise the surround level to offset the insensitivity should be resisted, as too high a level is very tiring.

The key to a good surround mix for sports coverage is the use of just a few elements, beginning with a firm, consistent three-dimensional sound-field. This is best established by the combination of a stereo mic and an omnidirectional mic for the surround channel. "Spice" can be added to the surround channel by spot mics placed to pick up some close-in crowd sounds, but these too should be used subtly, except when the crowd gets really loud. Although not practical all that often, switching the audio mix when the scene changes, as in movies, is well worth the effort. A different mic set-up in a post-game interview room, for example, refreshes listeners' ears with a distinctly different sound field.

Another consideration is the compatibility of the signal with the generic surround decoders offered in many TV sets. Unlike Dolby Surround decoders, generic surround decoders are usually optimized for single-ended use with conventional stereo sources. They derive an artificial "surround channel" from the out-of-phase elements of a stereo signal, without further processing. The result on some sources, particularly those encoded with Dolby Surround, can be excessively high crowd noise in the rear masking the commentary at the front.

A further concern is crowd-noise "pumping". Excessively high peak levels in the commentary can audibly modulate the level of otherwise continuous background crowd noise in the surround channel. This occurs when the excessive peaks actuate a limiter in the transmission channel after the surround encoding. Although not very perceptible with front-only stereo, the problem can be occasionally aggravated by the steering logic in surround decoders. It can be virtually eliminated by applying correlated limiting to the four discrete channels coming into the surround encoder, rather than limiting its encoded output

For surround broadcasts that sometimes continue for hours, we usually link a Dolby SEU-4 encoder/SDU-4 decoder pair with a regular 2-channel stereo mixing console. We have found it very helpful to have 4-channel decode monitor level meters, an X/Y scope displaying Lt/Rt signals, and a remote controller box for selecting the monitor mode (Surround/Stereo/Mono) and adjusting levels. We also look forward to testing a special 4-channel limiter for surround encoding recently developed by Dolby Labs. With this equipment, we can conveniently and economically achieve a mix to satisfy those who listen in either conventional stereo or surround.

5. Concerts

For music broadcasts, surround sound can effectively recreate the ambience of concert halls, and the audience excitement at rock concerts. One of the first applications was an open-air performance of Isao Tomita's "Soundcrowd", broadcast in surround by NHK-Nagoya over high-quality DBS mode-B in October 1988. The broadcast utilized a post-production surround mix derived from the original multitrack recording. The first use of surround to recreate concert hall acoustics was NTV's broadcast of a performance of Beethoven's "Symphony No. 9", which was mixed directly down to two encoded channels at Suntory Hall, Tokyo in December 1988.

Since September 1989, TV Asahi has been

regularly broadcasting "Junior Original Concert" in surround, with more than 20 programs in 6 months. At midnight on 31 December 1989, the leading Japanese rock band "Southern All Stars" performed a "New Year Countdown" concert that was broadcast live by TBS. NHK-Sendai also made an experimental surround recording of their local Sendai Symphony Orchestra in January 1990.

Live concerts are usually recorded on 24-channel multitrack for broadcasting later, and some producers are reluctant to give up even a few of those tracks for surround or effects information. As more mobile units equip with recorders of more than 24 channels, that reluctance is likely to decrease, so the chances for surround broadcasts should therefore increase.

6. Radio dramas

Broadcasting dramas in surround is a logical extension of NHK's more than 20 years' experience in producing stereo FM dramas. The added excitement and reality is similar to that of Dolby Stereo films, as are the mixing techniques.

Since May 1987, eleven dramatic productions have been produced and broadcast in Dolby Surround by NHK. One of these, "Marginal", a space drama produced in October 1989, was later released on CD. To help maintain the accurate phase relationships required for accurate matrix decoding, we use digital for all recording and mixing, beginning with the two-track Sony PCM-3102/3402 for dialogue, music and EFX. The originals are dubbed onto the PCM-3324 in the final mix, then the PCM-3402 is used for the final master.

7. Examples of surround mixing for radio dramas

In our experience, developing surround-sound designs for audio-only media stimulates the imagination and creativity of mixing engineers. This process is well represented by a 60-minute NHK drama, "The Ears of the Earth", mixed by co-author Sawaguchi and broadcast on May 27, 1990. The story — a boy called Ino tries to save the earth from sound pollution — was ideal for the creative use of surround.

At one point in the story, Ino enters Earth's ear, and encounters a doctor who is caring for the eardrum, which has been damaged by exposure to too much sound. This scene illustrates how with the Dolby Surround matrix it is possible to control the size of the image by means of phase relationships. When a sharp localization is required, we record dialogue in mono or by using an X/Y stereo mic pair; to make a broad image we combine a close A/B pair with offset ambience mics.

To achieve the effect of being inside the ear, we recorded the dialogue as shown in Figure 5. The actor playing the doctor placed his head inside a large bass drum, causing the drum to resonate, and varied the tone color of his voice by continuously moving his head back and forth. An omnidirectional mic was placed inside the drum to pick up the voice directly, while an A/B cardioid pair outside the drum picked up the sympathetic vibrations of the drumhead. In contrast, a sharp perspective was required for the voice of the actor playing the boy Ino, so he was recorded in mono separately, in a booth (the actors heard each other over headsets). The final mixing plan of this scene is shown in Figure 6. Additional low-frequency background sounds were "Foleyed" by striking a suspended 6'x 9' steel plate, picked up by a C-ducer and MKH-40P configured as shown in Figure 7.

This scene further required the sound of the two characters bouncing on the eardrum, as on a trampoline. The bouncing sounds were created from the sound of air escaping from a balloon, to which was applied an FB-delay of 240mS and a pitch factor of 0.921 with an AMS harmonizer. In addition, a Lexicon 480 was used to apply 2.24 second reverb to just the left channel of Ino's dialogue. By manipulating the levels of the modified left dialogue track and the unaltered right dialogue track, we created an image of the character bouncing as he spoke.

Another scene features a Sound Monster, which embodies all the kinds of noise ever created on the Earth. As a basis for the sound of the monster's breathing, we recorded the breathing sounds of our directors, Hidenori Sugimori and Toshihiko Ezawa, with a TLM-170i close mike, and with contact mics taped to their throats. These two mics were recorded individually onto two channels. With an AMS harmonizer we added a 200 mS FB-delay to the left and right channels with a ratio of 0.5 and 0.6 respectively (Material 1), and further processed them through the Lexicon 480's Vocal Whisper program (Material 2). The solid core of sound picked up by the direct mic was used separately, processed through the Wild Sweep program of an Eventide 3000. The latter's L/R outputs were assigned to the C/S inputs of the Dolby SEU4 surround encoder, resulting in the effect of the Monster's breath blowing right through the listening room from front to back (Materials 3 and 4). The total effect of the Sound Monster was created by combining all these materials as shown in Figure 8.

Finally, in yet another scene, Ino "captures" all the sounds ever created, in essence playing back a sonic history of Earth. To create this effect, we wanted more

than 30 types of sound to pass in sequence rapidly from front to back, and disappear into a spiral "hole". The sequence was a veritable sonic museum, starting with contemporary sounds, then going back in time to a printing press, a spinning wheel, a water clock, a storm, thunder, a volcano, jungle noises, and so on. Kinnosuke Nishinomiya, in charge of sound effects, selected these materials from his large sound library, and successively assigned them L-to-S, C-to-S, or R-to-S for storage as a pre-mix on four track-pairs of an Audio File DAW. We then played back the Audio File to fine-tune the offset timing, and programmed the fade-in/fade-out curve and final timing of each item. The finished master was then mixed down to two surround-encoded channels. This effect would have been far too costly and time-consuming with conventional tape recorders, but the DAW enabled us to realize our concept within a practical period of time and without sound degradation.

8. Monitoring levels

Dolby Laboratories specifies 85 dB SPL for the monitoring level in Dolby Stereo film dubbing stages, and as the playback level in Dolby Stereo cinemas. Although we started with the same monitor level at NHK, it is still being evaluated. Home listening levels are typically lower (75 to 80 dB), and a standard practice for surround productions is not yet established. We have tried various approaches, including an offset with 85dB for the front channels and 83dB for the surround channel, and reducing the overall monitor level for the final mixdown to 80dB, but we have yet to reach a firm conclusion.

9. TV dramas

The use of surround for stereo TV drama is for the most part exactly the same as for theatrical films. In November 1988, TBS produced a drama on motorcycle racing, "Blow Wind to Suzuka", which used surround for particularly appealing effects. NHK's first TV drama with surround was "Megalopolis Eden", a mixture of fantasy and musical broadcast in April 1990.

Unfortunately, TV dramas are usually under time and budget restraints by video producers or broadcasters who do not have the same experience with surround as film makers. Although the audience demand for surround is there, dramatic series in Japan are still being produced mostly in mono. However, we believe this will ultimately prove to be an important application for surround.

10. Future prospects

A further indication of the demand for advanced audio and video technology in Japan comes from the housing industry, which is becoming increasingly feature-oriented ("amenity" is the latest industry catchword). Builders now offer the option of various A/V systems installed in prefabricated homes, a tendency which would be given further impetus by the development of practical, high-quality wall displays of 50-100 inches.

Given the strong trend among Japanese consumers to turn living rooms both large and small into home theatres, it is important that engineers develop the mixing know-how to deliver high-quality surround programs to the home TV audience. Whether using the discrete surround capabilities of HDTV or the Dolby Surround matrix, on-going efforts to create effective techniques appropriate to a variety of program material, as well as efforts to improve hardware installations, are vital.

In the US film industry, sound designers and mixers have developed unique skills over the years working with surround in both matrixed (35mm Dolby Stereo optical) and discrete (70 mm Dolby Stereo magnetic) formats. We believe that the rest of the world can learn much from these pioneers, and it is our hope that we in Japan will have increased opporutunities to exchange ideas across the Pacific.

Bibliography

H.Hamada, "A TV Surround System in High School Baseball,"
Hoso-Gijutsu (Broadcast Engineering), July 1987

K.Suzuki, "Report on Making FM Surround Drama, 'Travel of Shuna,'"
Hoso-Gijutsu, September 1987

M.Fushiki, "Dolby Surround and Television Broadcasting,"
Hoso-Gijutsu, November 1987

S.Imashiro, "Approach of NHK-Osaka in Broadcasting the 70th National High School Baseball Tournament,"
Prosound, October 1988

J.Koizumi, "Dolby Prologic Surround Decoder,"
Chroma, December 1988

T.Mishima, "Surround Productions in Broadcast,"
JAS Journal, February 1989

Y.Shirahama, "Surround Mixing of Sumo Broadcast,"
Chroma, April 1989

M.Fushiki, "Dolby Surround and Pro Logic,"
JAS Journal, May 1989

T.Mishima, "Surround Productions in Broadcast,"
Presented at AES Tokyo Conference, June 1989

N.Yamada, "Surround Production in Broadcast: 'Blow Wind to Suzuka,'"
Presented at AES Tokyo Conference, June 1989

K.Ohmi, "Hi-Vision Audio: Its Progress in Hardware and Software,"
Chroma, August 1989

T.Shimada, "Progress in Motion Picture Sound,"
Prosound, August and October 1989

M.Sawaguchi, "Approach to Surround Audio in Broadcast Media,"
Video Alpha, December 1989