SCHOEPS Mikrofone

Microphone Usage for Sports Broadcasting

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1. Introduction: The goals of audio for sports broadcasting

Audio for sports broadcasting is a specialty that places extremely high demands on the equipment—the microphones in particular. They have to sound good while reproducing the sound of a complex, often irregular space; one must be able to set them up within a few hours; they must be easy to handle, yet robust enough to withstand wind and weather, and they must be reliable under rough, everyday conditions. And they must be nearly invisible, since they can't be allowed to block the view of the event nor of the advertising banners. All this makes life very interesting for the sound engineers, planners, equipment operators and manufacturers who support this special field.

Given the great popularity of televised sports broadcasts, the number of people hearing the results can be very large. And the qualitative expectations for sports broadcasting are also very high. This comes partly from the enormous competition among service providers, but also from the sound engineers, who realize how much untapped potential there is for television sound to involve the audience in the powerful atmosphere of an event. When creative minds are involved in originating the sound, and when the necessary expenditures are not skimped upon, the total experience of the audience can be improved significantly.

The arrangement chosen for the microphones is an important part of the overall sound concept for a sports broadcast. The main goals of a microphone arrangement in sports broadcasting are:

1. Envelopment: Bringing the audience into the atmosphere of the event
2. Providing information about occurrences, not all of which are visible in the picture
3. Supporting the picture (maintaining "image/sound congruency")
4. Quasi-cinematic dramatization of events

These four main points are not mere details. The sound design and the arrangement of microphones influence the essential characteristics of a sports production significantly, even though the cost in money and personnel represents only a relatively small part of the total technical expenditure for a production. In addition, the TV viewer increasingly expects the kind of first-class, "hyper-real" sound track that Hollywood film productions offer, even if live sports productions may not seem to offer a comparable range of possibilities.

2. Which microphone arrangements offer the greatest potential for sports broadcasting?

Audio producers for the most ambitious sports productions, such as the World Cup soccer championships and the Olympics, face many difficult demands. Their way of using microphones is aimed at supporting the four main goals mentioned above. This does not necessarily cause great expense; a careful review of issues and problem areas can often bring about improvements without any increase in expense at all. The following topics in microphone usage will be given special consideration in this article:

- Main microphones and ambience microphones (Surround/Stereo), see paragraph 3
- Ambience spot microphones (Stereo/Mono), see paragraph 4
- Spot and effects microphones (Mono), see paragraph 5
- Commentator pickup (Mono), see paragraph 6

Each aspect can be optimized. Together they must produce an audio mix that the listener will find striking and informative, and that places him or her in the midst of the event.

Direct sound:

- Loud, discrete sounds in the stadium such as drums, grunting, yelling, ball hits, stadium announcements, etc.

Diffuse sound and ambience:

- Reverberation
- Basic ambience, audience noise
- Stadium music (if applicable)
- Motor noise (if applicable)

3. Main microphones and ambience microphones

Main microphone arrangements or ambience microphone arrangements are each usually placed in a centralized location, though sometimes they may consist of several distributed single microphones. Their purpose is to pick up both the essential occurrences of a sports event as well as the atmosphere and spatial character of the venue. Often, each microphone is directly routed to a single loudspeaker, i.e. in 5.1 surround there are 4-5 microphones for the speakers L, (C), R, LS, RS.

One determining characteristic of the main microphone arrangement should naturally be sonic transparency. In every study, the fidelity of sound color and the avoidance of sound coloration has been found to be the most relevant attribute. We highly recommend small-diaphragm condenser microphones of studio quality for this reason.

The main microphone arrangement has the following functions:

a) Capturing the space and the atmosphere

b) Enveloping the listener and bringing him into the environment of the event

c) Formation of an underlying sonic structure that allows for the fitting in of signals from spot microphones.

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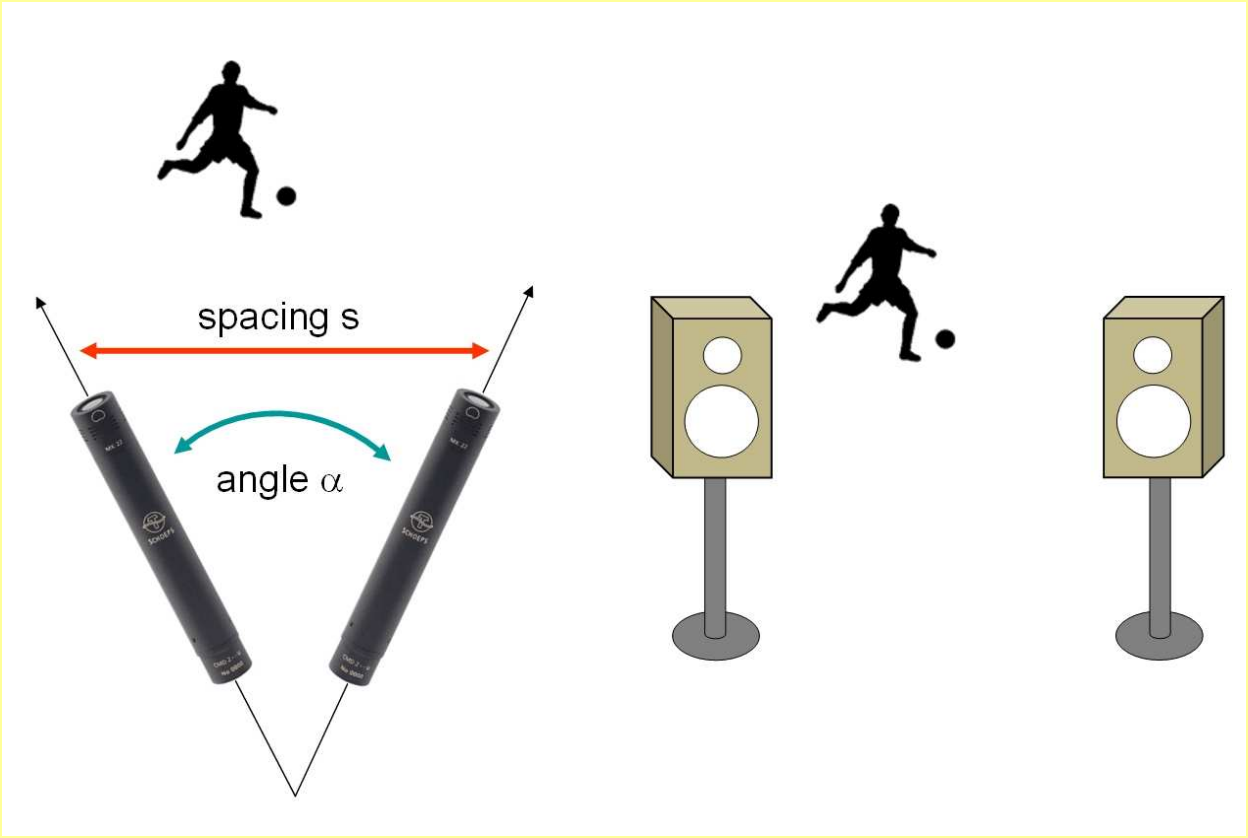
Microphone setup geometry for ideal 360° representation

To achieve an even distribution of sound sources between two loudspeakers, two microphones must be set up with a particular distance and angle between them, thus obtaining level and arrival time differences. The distance and angle depend on the directional pattern of the microphones. These parameters can be calculated by using the *"Image Assistant"* at www.hauptmikrofon.de. One well-known example is the ORTF arrangement, in which two cardioid microphones are set with 17 cm and 110° between them. The ORTF arrangement creates an evenly spread image between the loudspeakers for sound sources with arrival angles between -50° and +50° of center; in other words, the stereophonic recording angle is 100°.



For a 5.1 surround arrangement, the same rules apply as for two-channel stereo, with each adjacent pair of microphones or loudspeakers being considered: L/R (or L/C + C/R), R/RS, LS/L and LS/RS.

These functions can be achieved by choosing the main microphone geometry so that two essential factors are obtained: a good 360° representation of **direct** sound and a decorrelated pickup of the **diffuse** ambient components of the sound field (→ see block above).

360° Imaging

360° imaging is achieved by positioning the microphones so that suitable level and/or arrival time differences occur between each adjacent pair of loudspeakers in the surround environment. The decisive factors are the directional patterns of the microphones as well as their relative distances and angles. The relationship between microphone setup geometry and the resulting directional image is well known; the relevant principles are explained in the following block.

A rough image can also be achieved by using separate microphones that are positioned distinctly far apart from

one another. The signal separation of such microphones will naturally be good, but no kind of stereophonic image will occur between loudspeakers; the loudspeakers themselves will be the only points from which any sound sources will seem to originate. This increases the risk that the ambience will seem to be tied directly to the loudspeakers.

Diffuse-field correlation

Diffuse-field correlation, along with 360° imaging, is the essential criterion for the configuration of ambience microphone setups for surround. Low diffuse-field correlation is required for optimal spaciousness, envelopment and inclusion of the listener. This is especially the case at low frequencies, which are important for the perception of envelopment.
Low diffuse-field correlation can be achieved in several ways: by means of a sufficient angle between two directional microphones, by means of sufficient distance between them, or by a combination of both.

The following "rules of thumb" can be helpful:

- If a coincident setup (microphone distance = 0) is used, an ideally small diffuse-field correlation can be obtained only with supercardioids or figure-8 microphones. The supercardioids should be arranged at an angle of 120°, two figure-8 microphones at an angle of 90°.
- A coincident microphone arrangement cannot produce four sufficiently decorrelated signals, let alone five. This is because the greatest possible angle will be 90° (4 * 90° = 360° or 5 * 72 = 360°). If a coincident arrangement is used, a 4-channel mix (L/R/LS/RS) will sound better than 5 channels since the added center channel will raise the degree of diffuse-field correlation.
- If omnidirectional microphones are used, they should be spaced at least 100 cm apart, while for directional microphones 10—20 cm is sufficient.

Diffuse sound recording

An ambience microphone picks up mainly diffuse sound. In a sports arena the predominant sound components will be diffuse ambience, audience sounds, reverberation, and where applicable, stadium music and motor/engine noise. Optimal pickup of diffuse sound, producing spaciousness and envelopment as well as inclusion of the listener, requires adequate separation among the signals of all the loudspeaker channels. Hence, they must present diffuse sound components that differ from one another. Should this not be so, the virtual space will collapse because the reverberance will seem to emanate only from the specific loudspeaker positions, and the room will sound narrow and unnatural. Each mono component in the main microphone arrangement increases the perceived, unwanted distance between the listener and the recording site. Non-diffuse (in the extreme case, mono) reproduction of diffuse sound has an effect that resembles listening through a small window into the space where the events are occurring. The following block explains the necessary microphone geometry for sufficient decorrelation of diffuse sound.

Does the ambience microphone setup need the center channel?

In ambience pickup for sports events the center channel is mostly used at a low level or not at all. This is partly because other important content already occupies the center channel (commentary, spot mike signals tied to the picture), and partly because the reproduction of ambience actually tends to decrease in quality when the center channel is included; this is due to the less optimal diffuse-field correlation and the energy balance between the front and rear. The ambience microphone arrangement will need to be significantly larger if a center-channel microphone is part of it, since signals of sufficient difference are required for the L/C and C/R speaker pairs.
The main requirement is for a steady, low level of ambience in the center channel so that the commentary microphone can be turned off inaudibly. To meet this requirement it is sufficient to create a center ambience

signal from the sum of the L and R ambience microphones.
If the center-channel signal is derived by matrixing (*e.g.* from a Double M/S or Soundfield microphone arrangement), the same idea still holds: The matrixing should be carried out in 4-channel mode, since that will give a better sonic result.

Checklist for main microphone configurations for sports events:

Sonic characteristics of the main microphone system:

- Tone color
- Spaciousness, envelopment, sense of depth
- Precision and stability of imaging
- Downmix compatibility
- etc.

Practical characteristics of the main microphone system:

- Expense
- Size
- Complexity
- Reliability
- Flexibility
- Usability
- etc.

Signal Separation

The general problem in configuring a main microphone system for surround recording is that the degree of signal separation needed both for imaging and for good pickup of diffuse sound cannot be achieved among four or five microphones placed at a single point. As a logical result, coincident microphone arrangements are at a disadvantage relative to arrangements with some space among the microphones. The spatial impression obtained with coincident main microphone arrangements is demonstrably narrower and less natural sounding, but they can be used if they are merely intended to provide a framework for the signals of other microphones, as in item (c) above. Of course coincident arrangements offer the great advantage of being more compact and simple to set up. But great care must be taken to maximize the signal separation. For matrixed systems this can be achieved through optimal dematrixing. One example of an optimal coincident system is the Schoeps "Double M/S" microphone arrangement with either the passive, fixed-parameter MDMS U matrix or the "Double M/S Tool" software plug-in.

Spaced main microphones

If it is allowed to space the microphones some distance apart, the result will be a significant improvement in 360° imaging particularly in the representation of diffuse sound. Unfortunately there are practical disadvantages to this approach, since spaced microphone arrangements are larger and tend to be more difficult to set up. Another alleged disadvantage, however, is untrue; as long as the microphones are picking up signals that are sufficiently different from one another, spaced microphones bring no disadvantage whatsoever to the two-channel downmix.

There are quite a few theoretically optimal arrangements that follow the above rules. For 5-channel pickup there are the Decca Tree, OCT Surround, Williams MMA and INA5. For 4-channel pickup there are the IRT Cross, "ORTF Surround" and the Hamasaki Square. These have been used successfully for music recording for years now. But some of these setups are too large and complicated for practical use in sports broadcasting, or the kinds of accessories needed for typical sporting events (*e.g.* basket-type windscreens or hanging mounts) do not exist. One exception is the Schoeps "ORTF Surround" system; accessories exist which allow it to be handled quite simply like a "single-point" microphone.

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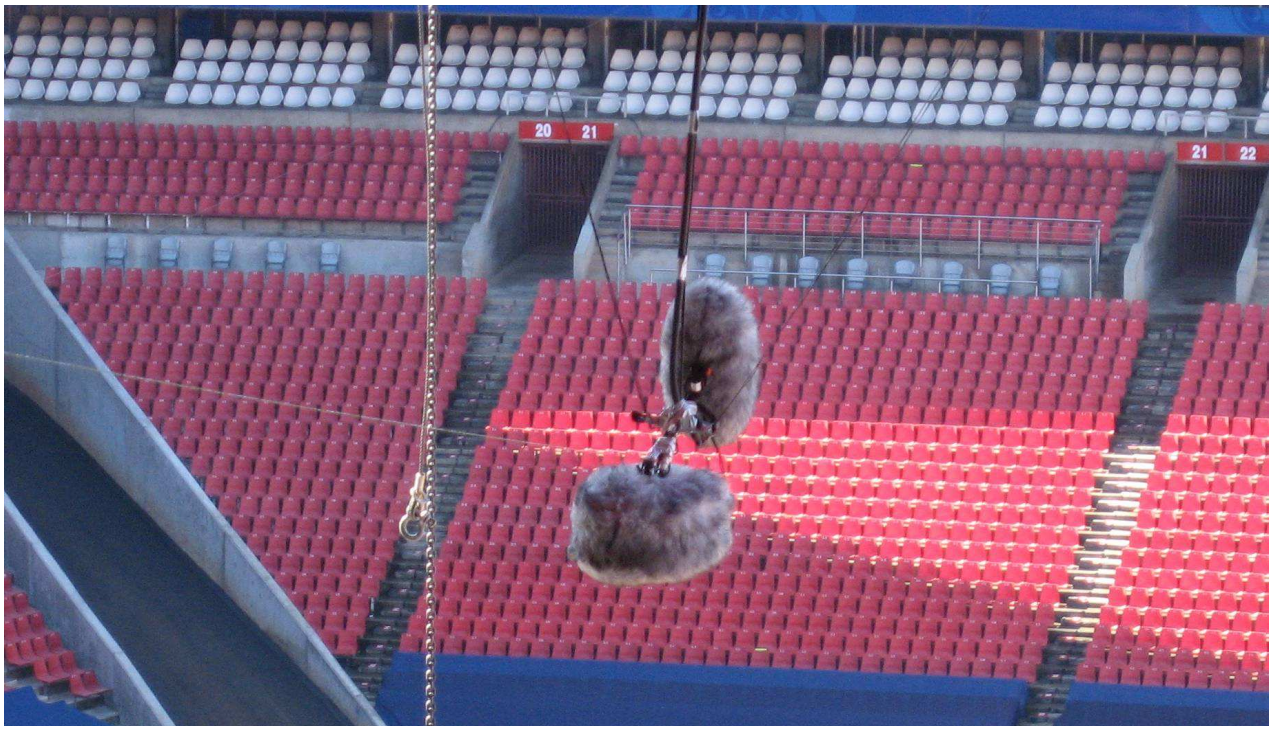


Picture of two ambience microphone arrangements in a stadium (hung next to each other for test purposes). Shown here: SCHOEPS "ORTF Surround" and "Double M/S"

Positioning the main microphone system

The main microphone setup plays a decisive role in the sonic result which is obtained. The main problem is to find a place where an optimally balanced, symmetrical sound image occurs—one which coincides with the visual picture while being neither too far from the sound sources nor too close to any of them. This place must be reachable without undue difficulty, and there also needs to be some way to run cables from it.

This is often difficult in practice. One example is in a soccer arena, where the microphone position that would be ideal from a practical standpoint—along the side of the pitch—is terrible from an acoustical standpoint. This is no surprise, since the VIP and press areas are usually there alongside the primary camera, and nothing that is acoustically very exciting happens there. (See the illustration of the soccer arena on page 10.)

A well-balanced overall sound image is generally available only at a certain elevation, as with room microphones at a music concert. But this is scarcely possible at a sporting event because of the many cameras which would each see the microphones. For this reason the main microphones are often suspended from the roof, which eases this set of problems.

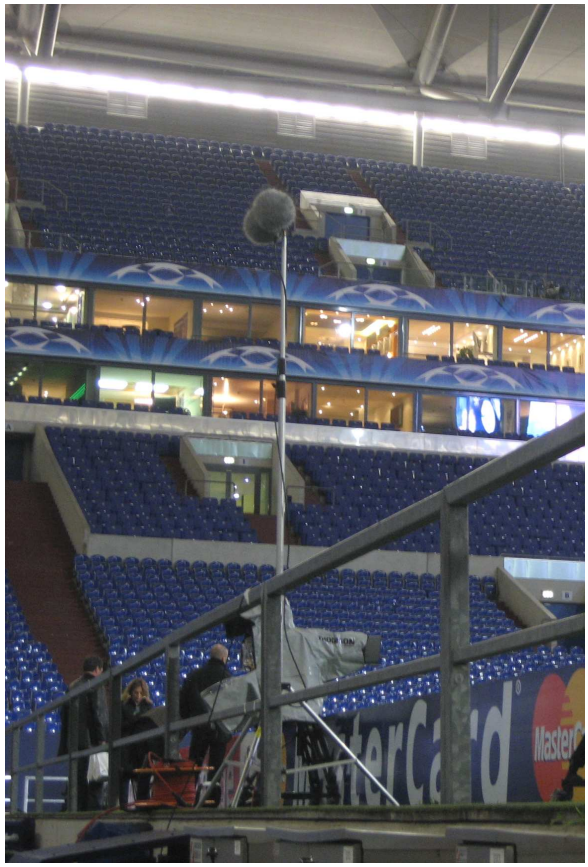
At many types of sports events, such as car races, it is necessary to have several distributed main microphone systems which are dynamically mixed together. If certain rules are followed, it is allowable for the acoustical perspective to shift just as the visual perspective shifts with a cut. This is possible when matching "Audio follows Video" techniques applied between picture and sound.

4. Ambience spot miking

Spot microphones can be placed apart from the central array to pick up ambient sounds which the main microphones or main ambience microphones do not adequately cover, or that the main arrays are picking up from an unsuitable direction. A typical example would be stereo spot microphones placed in front of the spectator sections of a soccer arena (see the illustration of the soccer arena on page 10).

These microphones are intended to create a spatial image; thus the sound must be reproduced not as point sources, but across a stereophonic zone, as explained in the above-mentioned rules. Stereo ambience spot mikes really do work better than mono spot mikes, since they stabilize the spatial impression and localization rather than detracting from it. Thus they can also improve the "sweet spot" of the mix. In general it is to the advantage of the sound quality when the signals routed to the various loudspeakers are as discrete as possible; for example the stereo spot mikes at the right corner of the arena could be routed discretely to R and RS. The basic stereo pairs L-R, L-C, C-R and LS-RS can also be provided with directionally stable signals from ambience spot microphones.

Small-diaphragm microphones arranged according to the usual stereophonic techniques are suitable for stereo ambience spot miking. The main requirement is good separation of the signals from other channel groups; thus X/Y or ORTF setups are often chosen. Here, too, a compact, practical microphone set with the needed accessories is called for. Optimal solutions for this are the Schoeps MSTC 64 ORTF microphone or the Schoeps "ORTF Outdoor Set."



Typical setup of an ORTF stereo pair in the corner of the arena. Shown here: Schoeps MSTC 64U with two Schoeps BBG windscreens.

5. Spot and effects miking

Crosstalk among the spot microphones

The four goals outlined at the beginning of this article require the use of decentralized, spatially separated spot microphones whose signals are dynamically mixed into the overall sound image. They may be used for brief time intervals; for example, the signal from a particular microphone might be used only in the moment when the player jumps into the pit.

This approach works not only because it excludes unwanted noises; what is far more important is that no two microphones should be active if they are picking up the same signal. To do so would cause comb filter effects ("Phasing"), coloration of the sound, and covering of the main microphone pickup

due to the unwanted space and ambience components in the spot microphones.

To get any kind of grasp on this problem, sometimes a submix is made by a second sound engineer, e.g. for the so-called "Close-ball" mix at a soccer game, only the single best-positioned shotgun microphone at the edge of the field is used.

One significant precondition both for avoiding crosstalk between open microphones as well as for unproblematic mixing with the main microphone signals is to have a high ratio of useful to non-useful signal in the spot microphones. The useful signal is the localizable sound source of the moment; the non-useful signal could be ambient sound and/or other nearby localizable sound sources.

Typical setup of shotgun microphones on small stands at the edge of the playing field, in basket-type windscreens (see soccer arena graphic below)

To achieve a high ratio of useful to non-useful signals requires:

- the shortest possible distance from the sound sources
- optimal spacing between the directional microphones
- as narrow as possible a pickup pattern for the directional microphones

It rarely is possible to get the microphones very close to the sound sources, or if so, only with very crafty microphone positioning. Optimal microphone placement is often impossible for "political" reasons, or simply because it is impermissible for the microphones to be seen. In this respect there are advantages to those sports which permit special sensors and microphones to be mounted on and among the players and the sports apparatus.

Optimal spacing among the shotgun microphones will minimize the overlap of their pickup regions, as with spot microphones in an orchestra. This allows the transition between microphones to occur inaudibly.

Sharp directionality

The sharpest possible directionality—a narrow lobe pattern—is generally achieved by using "shotgun" microphones such as the Schoeps CMIT 5U. An interference tube gives these microphones a greater directivity at high frequencies than normal supercardioid microphones, but this comes at the cost of a slight lessening of sound quality due to angle-dependent frequency response. The interference tube principle works only at wavelengths smaller than the length of the tube. This means that a normal shotgun microphone is a supercardioid up to about 2 kHz, and the pattern becomes narrower only above that point. Longer shotgun microphones may start to increase directivity at ca. 500 Hz, but with greater reduction of sound quality. One alternative to this is to use parabolic reflectors, which have a supremely narrow pattern at high frequencies. But at low frequencies they have almost no directional effect, which limits their use to special effects such as ski noise or the sounds of American football.

Very sharp directionality in a microphone is both a blessing and a curse. It is a blessing in that the above-

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Use of the Schoeps SuperCMIT shotgun microphone in a basket-type windscreen at the edge of a soccer field, and on the camera at a boxing match

mentioned problems can be avoided by decreasing the pickup of unwanted sound. But it is a curse because a narrow pickup pattern causes more microphones to be needed within any given region to avoid gaps in the coverage. The ideal would be a microphone that has both a narrow front pickup pattern and also good suppression of diffuse sound pickup. This combination of characteristics has recently become available in the Schoeps digital SuperCMIT microphone, which was introduced in 2010 and immediately passed its first major assignment at a large-scale sporting event with flying colors: the World Cup Soccer championship. This microphone has higher directivity than a long shotgun but also greater sonic neutrality, because both its directionality and the additional suppression of diffuse sound are evenly maintained across most of its frequency range. This is made possible by adaptive signal processing on the basis of two separate microphone capsules. In the meantime the SuperCMIT has been used successfully for many other sporting events of different types—soccer, tennis and rugby among others.

If the intent is to create a cinema-like exaggeration of live sounds, this places even greater demands on the spot microphones. Compression of their signals increases harmful crosstalk among them. A hyper-real, exaggerated loudness and clarity of sound is demanded that can scarcely be obtained from naturally-occurring noises.

The illustration below shows an optimal 5.1 microphone arrangement for soccer. Microphones with this positioning were used by the host broadcaster HBS at the World Cup soccer championship in South Africa. Included are the main "ORTF Surround" microphone setup, the two stereo "ORTF Outdoor Set" spot microphone setups for the two curves and the mono shotguns that were used for picking up the sound of the ball.

This illustration shows a relatively ambitious example of miking a soccer game.
Additional hanging mono spot microphones can be used to cover the sound of the spectator groups.

6. Commentator miking

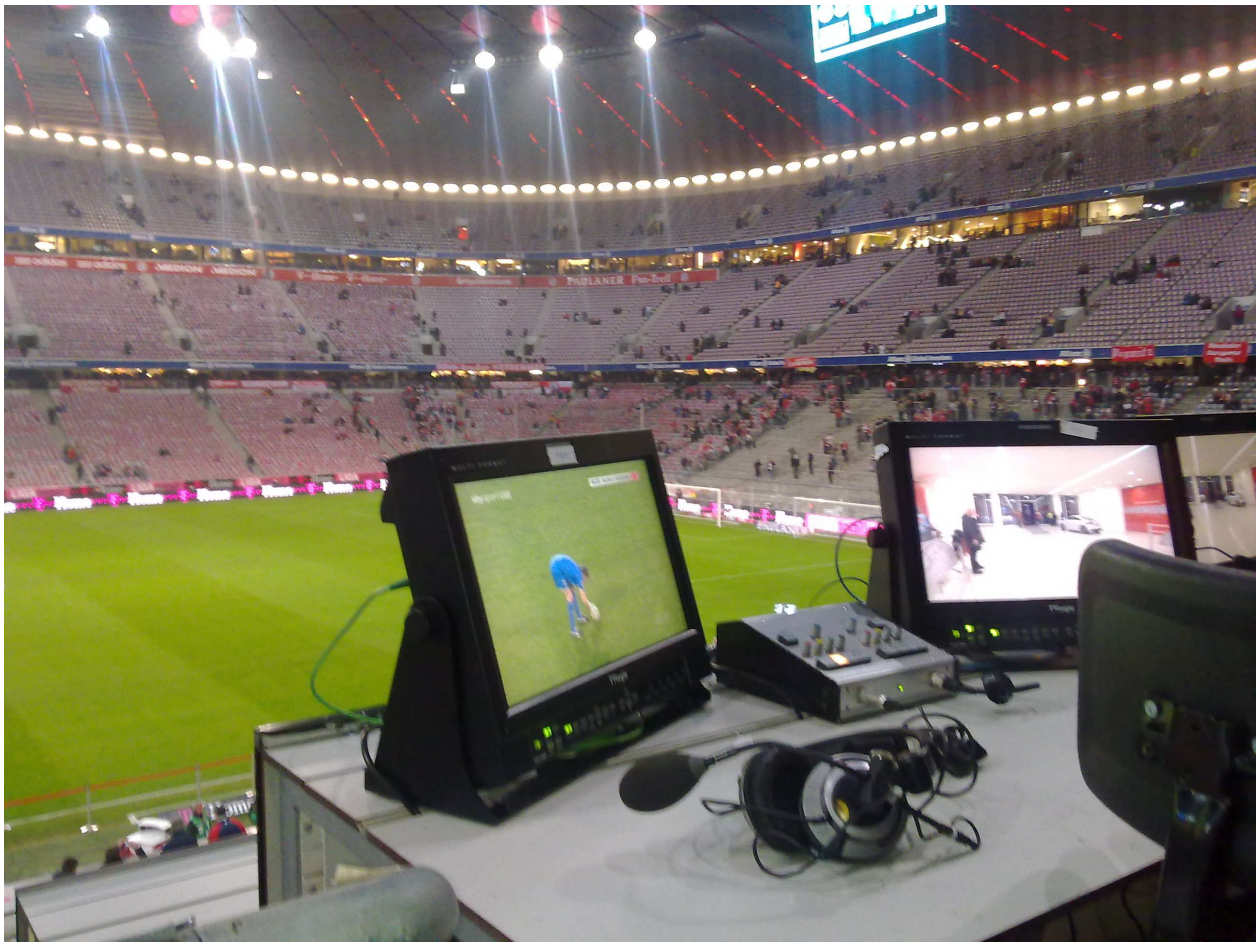
The commentary is an essential component of the sound mix and should be mentioned in this connection because it is often produced within the same space, causing the commentator microphone to pick up ambient sound components. This can sometimes lead to considerable difficulties, since overly strong monophonic ambient signals in the center channel harm the perception of a natural spaciousness. Furthermore, gaps can be heard if the commentator's microphone is muted (*e.g.* when speaking with the director), which are no longer covered by the level of ambient sound pickup in the center channel of the main microphone arrangement.

It is not easy to find a high-quality miking arrangement that also lives up to the practical requirements for the commentator. The microphone, together with the headphones, must form a robust headset that keeps the microphone positioned very close to the mouth. Some people resort to communications headsets, but a solution also exists which uses a small-diaphragm studio condenser microphone: the Schoeps HS 4VXS headset.

7. Sound for sports events – a complex production

As this article shows, miking for sports events is a highly complex matter, and thus, as with music recording, there are true artists among the recording engineers. It quickly becomes clear that the aspects addressed here cover only some of the problem areas (although the most important ones) that occur in an actual assignment. All these problems are entirely real rather than theoretical. On the contrary, all the solutions described and recommended in this article came about without exception at the initiative of experienced practitioners, and are now being used by them.

The quality of sound in a live sports broadcast has become the quality criterion for the broadcast as a whole. No one can afford to produce a substandard result, and the standard is constantly rising as the technology, technical knowledge and overall awareness all increase. Of course there are always financial and political constraints which may frustrate a more ambitious solution. But due to the top quality results at the major events, the awareness of the viewing audience is apparently becoming educated such that soon, inadequate sound will no longer be accepted as part of any sports broadcast. The tools for optimal 5.1 surround sound are ready for action.



Using the Schoeps HS 4VXS Headset in a soccer arena