THE BROADCAST ENGINEERS' APPROACH TO LIVE MUSIC PICKUP

*by Robert W. Carr** — Discussion of the important considerations in planning for live pickup of musical performances for broadcasting and recording.

C. E., the chief engineer, settled into a chair between the program manager and the sales manager and looked expectantly across the desk at the general manager.

"As you know, C. E., we have been looking for additional programming which can help us expand our market. One possibility that looks very good so far is to give your turntables an occasional rest by scheduling a live music series."

As the general manager paused, C. E.'s mind drifted briefly over his all too recent problems with the new stereo operation—and the fact that his only recent experience with live music was the rather incidental pickup of the football band during half-time.

"P. M. has done some serious exploring and is certain we can have a schedule of pickups with the Civic Orchestra and the University Symphonic Band, the two probably alternating on a weekly schedule. Before going any further though, I think we'd better get an idea of what you will need."

C. E. thought for a moment and his eyes wandered over the display of record jackets decorating one wall of G. M.'s office. "I wish I could give you a pat answer, G. M., but there are just too many things that affect what I'll need. I'm sure we can get the pickup you want—and it seems to me that right there is our first step. I suggest that the four of us get together with a group of records this afternoon to get a feel of what you really want to hear. Then I can do some looking and listening at the pickup locations and give you a pretty good picture of what's involved. G. M. agreed, the group disbanded, and C. E. headed for the record library to select some examples for the meeting.

In this mythical setting, our chief engineer is facing a problem now confronting more and more broadcast engineers. His lack of a definite answer is not a display of indecision. It is evidence of the experienced engineer's ability to recognize the complexity of a problem which may appear very innocent to the more casual. He is also indicating his understanding by recognizing that the problem of live music pickup is not entirely technical, but that the very first consideration might best be described as philosophical.

What, then, are the factors that make live music pickup a complex problem, and which must be considered by those who find themselves confronted with such an assignment? It would be ideal if a single article could provide a simple universal answer to all the problems which are inherent in live music broadcasting. Unfortunately, such a promise would be misleading. We can, however, analyze the contributing factors—not only to demonstrate the complexity of the problem, but also to hopefully suggest some specific avenues which may be followed to reach a workable solution.

The Philosophical Factor

The philosophical factor might be expressed most simply by asking, "What does the production staff expect to hear?" This question does not primarily relate to the nature of program material, or to a mere consideration of frequency response—although both are unquestionably significant—but rather to the overall character of the presentation.

To establish our perspective, let us follow C. E. to the record library. Here is the music the public is used to hearing. Whether reproduced on the home phono system or through the medium of radio, the products of the recording engineer have set the pace for what is expected in music reproduction. This is certainly no criticism of the record industry, but is simple recognition of the fact that many more

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Fig. 1. Typical remote-pickup location for broadcast of symphonic band program.

records than concert tickets are sold each year. The character of reproduction carefully engineered into recordings is that which experience indicates the home music listener wants to hear.

Consider, for example, the disc he is playing now. If this character of presentation were expected, C. E. could well submit an estimate of approximately $30,000 for additional equipment—and a requsition for a specially trained mixer to manipulate the new 16-channel console, and mix down the resultant eight-track recording into two appropriate "on the air" channels.

Are we saying that a broadcaster with only a reasonably normal equipment complement cannot hope to produce saleable stereophonic—or even monophonic—reproduction of live music? Certainly not! Consider the next disc, a product of a major record company, recorded at a concert location. This time, however, only a pair of carefully placed matched microphones were used to provide believable stereo reproduction of the entire orchestra, plus one or two additional microphones to properly balance the featured soloists. Despite the contrast with the first disc, the second is also a saleable and convincing presentation of music—and much more in keeping with facilities practical for the broadcaster.

The philosophical factor may be summarized by cautioning that the production requirements must be consistent with practical broadcast facilities and techniques. It is necessary that the production and engineering departments reach an understanding on the character of presentation desired before the technical factors can be properly considered.

Technical Factors

The technical factors are varied, frequently complex, and often stem from causes outside the engineer's control. Any of the factors, which will be briefly discussed here, could well be the subject of a separate article—or, in some cases, an entire volume.

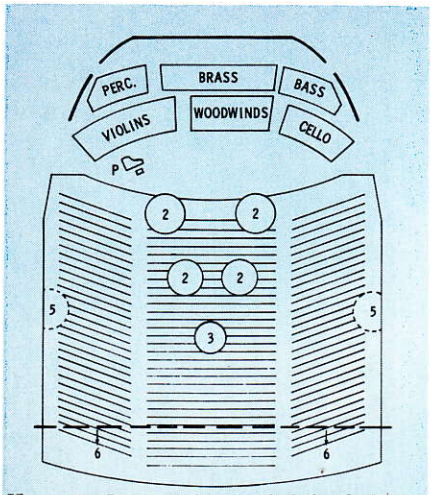
The Physical Location

The physical surrounding is potentially a source of the most difficult and frustrating problems, largely because it is the least understood and almost completely beyond the direct control of the engineer; yet it determines the very nature of the sound available.

The principal elements of room characteristic are implied in the terms "reverberation" and "frequency response." Reverberation relates to the echo or liveness of the room, and is usually described in terms of "reverberation time" (the time during which an echo is audibly sustained). Since high frequency sound is more readily absorbed by draperies, seats, audience, and air, reverberation tends to be more of a low frequency effect (Fig. 1).

Frequency response refers to the coloration of sound as it travels through the room. Specific reflections from hard surfaces, reinforcement of tones by reverberation, and the amount of high frequency absorption in the room all contribute to this coloration. A particularly troublesome aspect is that frequency response usually varies throughout the room.

An outdoor location, with no structure surrounding the listening area, tends to minimize some of these effects. There is still sound coloration, however, because of the reflecting structure normally used to help direct sound into the audience area. Extraneous noise and the loss of overall sound energy due to the lack of reflecting surfaces enclosing the listening area must also be considered.



Notes: 1. Piano mike needed for balance and separation. **2.** Good separation; tonal balance bad, loss of high reeds and 2nd violins; bad reflection on right side. **3.** Very good tonal and directional balance just left of center; bad mixing and reflections above about 10' (check curved balcony). **4.** Color not bad; right reflection better than (2), directional mic. should kill further; stay below 10'; reverb a little high, but check with audience in place. **6.** Behind about row 25, coloration bad, spotty; heavy mixing.

Fig. 2. Six conditions at typical location.

While some of the location peculiarities are characteristic, and usually are desirable to lend authenticity and "presence" to the reproduced program, too much peculiarity can produce serious problems. The effect of over-colored frequency response requires little imagination. Echos and reverberation also play a major part, not only by running notes and phrases together unnaturally, but often by masking the stereo effect through indiscriminate acoustic mixing of what should be locatable sounds.

Except for such measures as carpeting a bare stage, selecting back drop materials, and arranging audience distribution, there is little the broadcaster can do to affect the physical properties of the room. However, he can control the final effect of the room characteristic (Fig. 2) by judicious selection of his pickup tools—a selection which he can make only after becoming familiar with the properties of the room.

To properly explore room properties, it is necessary to recognize a subtle factor in the hearing process. As we sit in a concert hall, the elements which we have outlined are present in varying degrees, but do not destroy our enjoyment of the music. Instead, our ears and brain combine in remarkable fashion to discriminate selectively against some of these elements and allow us to concentrate mainly on those characteristics we wish to hear. If we plug one ear most of this ability is lost, and the undesirable characteristics become very distracting.

The microphone, unfortunately, functions as a single ear. Even if we use two microphones feeding a stereo system, we regain only a small portion of our selective listening ability. In many cases we may expect our pickup tool, the microphone, to seemingly exaggerate the room characteristics; and it becomes important, in exploring the properties of a location, to do at least part of our listening as the microphone does—with only one ear.

The Microphone

Just as room characteristics are basic to the available sound, the

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Live Music Pick-Up

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microphone is basic to achieving the desired reproduction. It is proper selection and use of the microphone which offers the only real control we have over the effects of room characteristics.

For such a vital control element, knowing that a microphone "sounds pretty good back in the studio" is just not enough. It is necessary to understand what elements of control different types of microphones can offer, and to become familiar enough with the characteristics of the location so that we may know what control is needed. Microphone frequency response is important; but the combined effect of microphone response and room characteristics, as altered by all the microphone properties, is the key to final on-the-air reproduction.

For example, a good unidirectional, or often a good bidirectional, microphone can do much toward controlling response coloration caused by sounds reflected from surfaces at various angles around the microphone. The directional microphone can also be of significant help in reclaiming the stereo effect in a very live or reverberant hall. When "tight-micing" is the only solution, it provides a means for separating between different sections of the band or orchestra so that balance may be maintained at the board.

On the other hand, the omnidirectional microphone can be a great help in either stereo or mono by preserving some room color in a very dead location.

While microphone placement is well recognized as important to producing a stereo effect, it has other significance. Proper placement with respect to the music source, or the reflecting surfaces behind it, can have much to do with the musical balance. Since the frequency response of the room varies with location, the microphone placement can contribute significantly to the overall reproduced frequency response. The distance between the microphone and the music can offer added control over the amount of room characteristic which is reproduced. With tight-micing, for example, room characteristics may be almost completely eliminated.

We can see that with even the

most basic microphone arrangements—two matched microphones for stereo, or a single microphone for monaural—a judicious choice of the microphone type and placement makes possible a high degree of control over the reproduced effect. Except in very trying locations, incidentally, these basic approaches probably assure the most consistent program quality.

To help visualize what various microphone types can do for us, Table 1 lists key directional properties for the more common pickup patterns shown in Fig. 3. Two points should be considered in using this table: The directional properties are three dimensional (the patterns shown in Fig. 3 are one cross section through a sphere), and the numbers are based on an ideal microphone which exhibits the same directional properties at all frequencies and in all planes through its axis.

To best predict the performance of a microphone, therefore, it is necessary to make sure that its properties are reasonably uniform. To augment the manufacturer's data, a basic "feel" may be obtained as someone walks around a microphone in a dead studio, while talking at a constant level and maintaining a constant distance. Key factors are the amount of reduction at the null (s), the angle of the null (s), and the change in sound quality as the angle changes.

The Music Source

Physical arrangement of the source is another factor over which the engineer may have only limited control; but it is again important, particularly in producing a believable stereo effect. Physical arrangement of the orchestra or band may also have a significant bearing on the ability to achieve a reasonable musical balance with simple microphone techniques.

The Console

There is no intention to connote an order of importance by considering the console, or board, last. In fact, the board is the very important point at which all of our considerations are put together in one package for presentation.

In the sequence of developing a live music pickup, the ideal approach would be to select the board last—to assure that the board properly complements the desired microphone approach. A board for the basic one- or two-microphone technique could be rather simple. If there were a number of isolated soloists or ensembles, the board could provide for proper microphone coverage of each. If a multiple microphone approach was necessary, the board would allow ample provision for mixing to achieve the proper balance.

Unfortunately, the ideal is often not consistent with economy. When cost limits the choice of the board, ingenuity becomes quite important. A possible approach might be to reconsider the other control elements—such as microphone placement or the number and type of the microphones. Another solution might involve taking soldering iron

Table 1. Pickup Properties of Four Directional Microphone Types.

Property	Omni-Directional	Cardioid	Super-Cardioid	Cosine
Unidirectional effect[1]	0	17 db	23 db	0
Front to back reduction (on axis)[2]	0	infinite (theoretical)	12 db	0
Null angle[3]	.....	180°	126°	90°
Random energy reduction[4]	0	9.6 db	11.4 db	9.6 db
Effective pickup angle[5]				
3 db down	360°	132°	114°	90°
6 db down	360°	180°	156°	120°

Notes:

1. *Pickup reduction in back hemisphere compared to front.*
2. *Pickup reduction at 180° compared to 0°. (See No. 3).*
3. *Angle at which minimum pick up (null) occurs. As with cardioid (see No. 2) reduction at null is theoretically infinite.*
4. *Reduction in pickup of surrounding sound waves — compared to omni-directional.*
5. *Included angle at microphone front for 3 or 6 db down at extremes.*

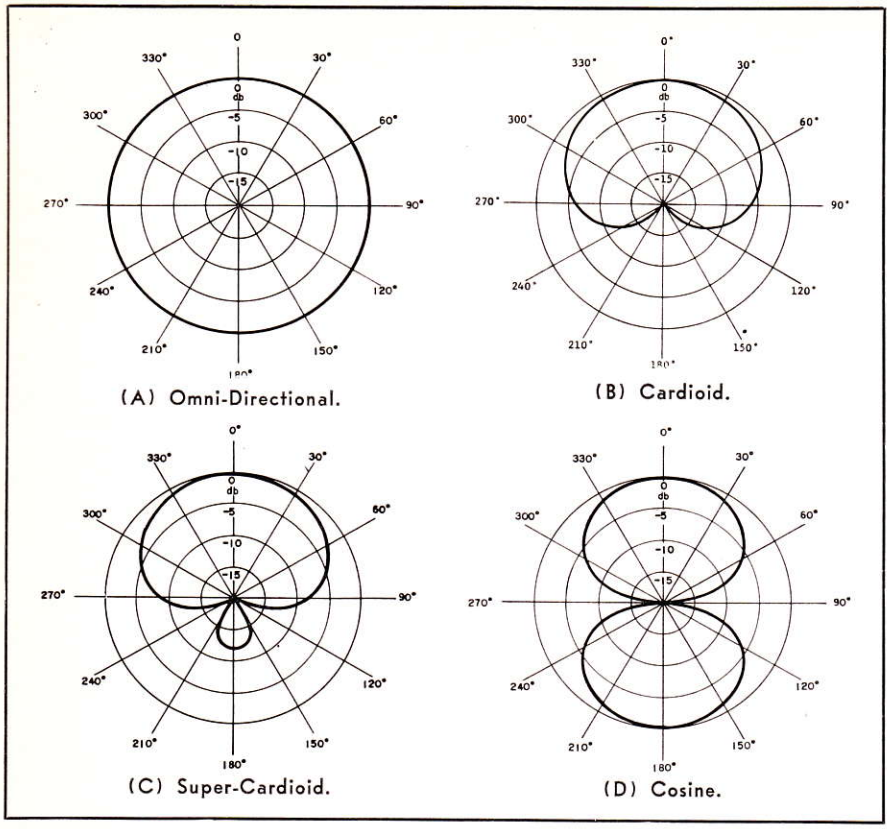

Fig. 3. Directional pickup patterns of four popular types of microphones.

in hand and modifying existing equipment, perhaps by adding one or two subchannels to the existing board.

Summary

Having looked at some of the important considerations in approaching a live music pickup, let's rejoin C. E. to see what progress he has made.

Our chief engineer has agreed with the production staff that the objective is a conservative, believable stereo presentation, with frequency response sufficient to lend authenticity to the music and with enough room coloration to suggest the location (but not so much as to conflict with the other objectives). They have selected a simply presented, but well accepted, live concert recording to define the goal.

C. E. has also determined that the pickups will be made with an audience present, and that the average audiences in one hall occupy about two-thirds of the seating, while approximately one-half occupancy is usual in the other.

He has attended a rehearsal of each group and, while he has no good provision for measuring the room characteristics objectively, he devoted himself to extensive listening (partly, we hope, with one ear) at various possible microphone locations. He has also made simple sketches of the hall and the normal physical arrangement of the musical groups. On the sketches he has jotted his notes regarding the characteristics of different microphone locations which he has studied.

Armed with these observations, his own experience with different microphone types (plus more detailed information which he has requested from microphone manufacturers), and comments of acquaintances who are also in the throes of this problem, C. E. is ready to develop tentative plans for approaching his assignment. These plans will be evaluated by listening again at the tentatively selected microphone locations during public concerts of each group.

When the program plans have crystallized and the schedule is at least tentatively established, there is one more step which C. E. should not overlook. We hope that he will go to the trouble of practicing—of recorded dry runs—not only to check out the equipment, but to perfect the setup and operating techniques which will assure the success of his, and your, live music pickup. ▲