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DISC RECORDING

Production and the Studio

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BESIDES the familiar and long-established home-entertainment field, there exists, today, another commercial application of disc recording which is rapidly becoming very important. This is the relatively new field of electrical transcription. During the few years since its introduction in its present form, experience has made it obvious that electrical transcription is an invaluable element of the broadcasting business, chiefly because of the many important advantages that accrue from the ability to broadcast programs from records.

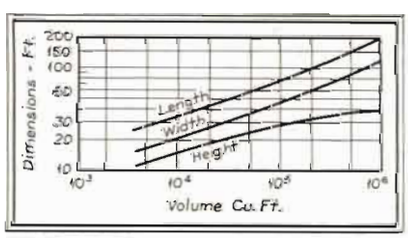
Of those two outstanding applications of the disc recording at the present time, the home-entertainment field is, of course, pre-eminent as regards the number of copies run off from each recording; however, it is in transcription work that the majority of the most interesting recording-engineering developments of recent years have had their first practical application, particularly those having to do with the refinement of quality. This is largely because of certain special conditions associated with transcription work, such as the necessity for maintaining high-quality standards, the desirability of having copies ready very soon after recording, and the availability of skilled engineering personnel to operate the reproducing equipment. The present discussion will, therefore, deal with disc recording primarily from the electrical-transcription standpoint.

FIELD OF ELECTRICAL TRANSCRIPTION

While the majority of communication engineers have become familiar with the significance of the term "electrical transcription" and are aware that the practice plays an important part in present-day broadcasting, the subject is such a special one that few people outside the industry appreciate the considerations that have led to the prevailing extensive use of electrical transcriptions.

The most important factor that has influenced this situation is the fact that better results can practically always be secured by the use of electrical transcription than would be possible with direct pickup, provided that the program is one which permits of repetition or rehearsal. The reason is, of course, that, no matter how many previous rehearsals have taken place, mistakes made after a direct broadcast has begun can never be corrected, while with a transcription the program can be repeated, if this seems desirable, in order to obtain the best results possible from an artistic or technical standpoint. The making of corrections is, we may remark, greatly facilitated by the high development of disc-recording technique, which permits of inserting, rearranging or removing parts when re-recording, much as a cutter edits a sound-picture film.

FIG. 1
In determining the shape of the studio the following ratio have been found to yield the best results.



A secondary consideration which is worth mentioning is that it is frequently desirable for a number of reasons—commercial, legal, technical, or artistic—to have a permanent record of many programs which are put on the air. In this case a high-quality recording of the program as it passes through the studio bus bars furnishes exactly the type of document required.

HOW TRANSCRIPTION WORK IS ORGANIZED

In the operation of the electrical-transcription industry, there are recognized the same two types of program which are familiar in direct broadcasting; namely, the sponsored program which is paid for by the advertising agency and which is put on the air by buying the necessary station time, and the sustaining program which the transcription organization maintains as a service to those stations desiring it, by means of its record library. The first step in the origination of a sponsored program occurs, of course, when an advertising agency approaches the sales department of the transcription organization with a statement of its needs. It is the function of this department to analyze the problem presented by the customer, and after a satisfactory agreement has been reached as to the nature of the program, a broadcast date is set. This is forthwith communicated to the shipping department which, from its knowledge of the time which will be required for distribution of the records to the stations through which the broadcast will be made, is able to work back and set a dead-line date by which the

production department must make its record pressings available.

It may also be noted that sometimes a departure is made from the system described above for establishing dates, in that the broadcast date may not be finally set until the pressings have been approved. The decision to proceed in this manner might be made, for example, if the program were of a novel kind which might require revision, or if there was a possibility that the client's plans might change.

After these essential preliminaries, the details relating to the actual requirements of the program are determined and are transmitted to the recording department in terms which establish the type of orchestra being employed, the musical requirements, the length of the program, etc. A date is also set on which the recording is to take place; this naturally is determined with reference to the distribution dead-line date previously mentioned.

As soon as the length and type of program have been decided upon, it becomes the function of the recording department to select a suitable stage and schedule it for the assigned date. It is also, of course, necessary to make sure that the required number of recording machines will be available. Whenever a program is to last longer than a single disc, for example, longer than fifteen minutes, it becomes necessary to use at least two machines. This constitutes what is termed "overlap" recording, which, by alternating machines, may be continued to carry a program of any desired length. When such a program is reproduced, it becomes necessary to establish a cue at the end of each record, to indicate the instant at which the reproducing turntable with the oncoming record must be started in order to produce the necessary continuity of effect. Depending very largely on the extent to which the program is capable of rehearsal or repetition and the expense which would be involved by this, it may also be decided to make parallel takes, with the object of guarding against the possibility of loss through accident or error during the recording or processing. Sometimes it is considered justifiable to use all available machines for this purpose. It may also become necessary to resort to parallel takes if a large number of copies of the recording will be required in a short time, as this means that several masters will be available and several record presses may be producing simultaneously without waiting for duplication of the master to stampers.

There are several necessary details which must also be attended to with an eye on the date set for the recording, such as, the provision of the required recording wax blanks, the operation of the air-conditioning system, the provision of personnel in the required numbers and assurance that sufficient processing capacity will be available. Studio routines should be such as to automatically take care of these factors.

After the recording is made, it immediately becomes important to have a test pressing available as soon as possible. This test pressing is first checked by the production department's test man, and sometimes by the monitor man. For a sustaining program, these are usually all the approvals that are required; but in the case of a sponsored program, the test pressing is rushed to the sponsor for his approval before any production pressings are made.

The number of production copies required may vary from one to several hundred, depending on the distribution which it is intended to give the program. Air express may be resorted to when the time available for distribution is limited.

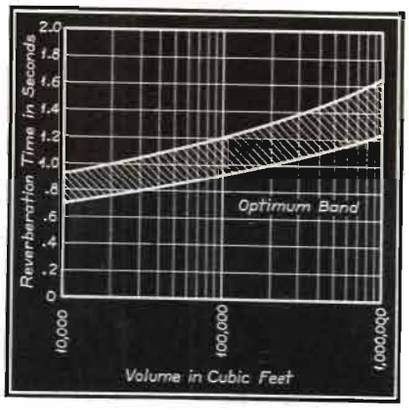


FIG. 2
Showing a relation between optimum reverberation time and volume.

STUDIO ACOUSTICS

Since one of the objectives of electrical transcriptions is to produce a program indistinguishable from a direct broadcast, the studio-acoustic and pickup technique is in many ways the same as for broadcasting. However, since there are usually more possibilities of repetition and correction than with a broadcast program, the transcription studio has also many points in common with a scoring studio for motion-picture work, and in fact is more closely related to the latter than to a typical broadcast studio.

While it is sometimes said that it is the function of broadcasting to take the artist or entertainment into the home, at other times the idea is expressed that the listener should be transported to the studio or to the imagined scene of the action. As a matter of fact, both statements are true if qualified with reference to the type of program; where it is of the intimate "fireside talk" variety, it is desirable to have pickup acoustics of the type that are said to bring the program "into the home"; where the program employs a large orchestra or is supposed, for example, to come from a battle-field, the aim should be at the opposite effect. In either case, however, the studio acoustics should simulate the effects and conditions natural to the type of entertainment.

It is well recognized today that the acoustics of a room are a definite part of the sound, particularly music, produced in it. It has been shown that a larger part of the acoustic energy affecting the ear reaches it by reflection from the various surfaces, than by direct transmission from the instruments, and the need for sound-reflecting surfaces in the vicinity of an orchestra has long been known. The proper control of reverberation is therefore a factor of paramount importance in the acoustics of studios for making electrical transcriptions. Furthermore, since this sound is to be reproduced in a second room, the reverberation at this second point also enters the picture. However, contrary to a common opinion held in the earlier days of reproduction, it has been found, in all recent experience using improved pickup and reproducing equipment, that the effect of combining the reverberation of two rooms is not additive and consequently the reduction of reverberation at the source is not required. In practice, it has been determined that the most natural and pleasing conditions obtain where the apparent reverberation to the listener is largely that of the source room, sufficient liveness being present in the receiving room to blend naturally and heighten the imaginative impression of being present at the source. Insufficient reverberation in the source room causes the reproduction, in a room of moderate or greater liveness, to sound cramped and as if issuing from a small point rather than an extension of the listening room. Consideration must also be given to the apparent added liveness of monaural pickup. One explanation of this condition is the existence of an interference pattern which is reduced in effectiveness by the cancelling effect of two ears. In the present state of the art, the most feasible means of compensating for the added liveness of monaural pickup is the creation of a zone acoustically more dead than the average reverberation period of the total enclosure. Fortunately, this coincides with accepted theories of the best arrangement for listening to music; namely, live surroundings for the mu-

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or absorption. It is planned to cover the desired area or audience under the least favorable circumstances; under other conditions it will be found to possess fifty or seventy-five percent more power than is actually needed at the moment. However, the use of unnecessarily high volume must always be avoided as it provokes unfavorable public reaction which has already led, in a number of communities, to drastic police regulation.

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sicians and relatively dead surroundings for the listener.

Summarizing the above factors, we find that the studio must have an amount of reverberation suitable to simulate conditions expected to surround the entertainment produced and to permit proper creation of music, and it must contain a zone sufficiently dead to compensate for the added liveness of monaural pickup. The accomplishment of these requirements is related to studio design by a determination of the size, shape, reverberation, and distribution of absorbing materials.

Ideally, the size of a studio should be determined by the character of program which will customarily be produced. For music there is a relationship between the number of musicians and the size of the enclosure which, within limits, should be adhered to for best results.

The feeling that a certain size of room should be associated with a certain type of music may be partly due to our being accustomed to hearing orchestras in halls whose size bears a certain relationship to the number of instruments, but it seems that a more important cause may lie in what is termed "space effect," which may represent audible perspective to the ear as "depth" in a picture represents perspective to the eye. Thus, direct sound from the source reaches the ear surrounded by general reflections or reverberation of a character influenced by the nature of the surrounding room. Lack of this effect largely destroys the apparent ability to visualize an orchestra, the component parts of which are separated in space, and thus the size of the orchestra is materially under-estimated, since only individual parts of the music may be heard, with diminished sense of a number of instruments playing each part. The space effect may be destroyed by lack of sufficient reverberation, by improper frequency characteristic, by the wrong mode of decay and even in proper surroundings by improper pickup. Even if the pickup is flawless, the tone mixture from several instruments playing the same note may convey only a partial impression of the number of instruments.

As the number of instruments tends to exceed the expressed limiting numbers for a given size of studio, the impression of added orchestral size is not proportional. Where the number of instruments is less than the specified limit for the studio, it is possible with proper pickup to give the effects of numbers in excess of those actually employed.[1] In considering the economics of building a large studio, consideration should be given to this factor.

The shape of a studio is important in obtaining best results. References to ideal shapes have been made with such frequency as to preclude references to many sources. However, certain ratios of length, width and height with respect to volume have been found to yield most desirable results (see Fig. 1, which is reproduced from Messrs. Stanton and Schmid's paper referred to previously). Increases in length beyond these ratios complicate the arrangement of performers and the securing of a satisfactory pickup. Widths in excess of these ratios may somewhat complicate pickup and generally result in a reduced space effect of the room. The heights shown with respect to length and width represent reasonable minimums for each condition, since as a practical matter it is desirable to reduce the required height. Certain unusual shapes of studios have been proposed in which directional effects of inclined or curved walls are employed or in which irregular wall surfaces are used. The desirability of the former appears questionable except for very unusual conditions. The desirability of the latter is unquestioned and has for some time been a feature of the best studio practice.

With the size and shape of the studio fixed, the degree and amount of reverberation is the next consideration.[2] Fig. 2, which is reproduced from the paper by D. P. Loye, just cited, shows a relation between optimum-reverberation time and volume, based on a large amount of experience. These values were determined under conditions approximating those most desirable; that is, relatively live surfaces surrounding the music with the microphone located in a relatively dead region. All of these values refer to time of reverberation in seconds at 512 cycles.

It is of equal if not greater importance that the relative amounts of reverberation for the different frequencies

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be properly balanced. If this reverberation be such that sounds of equal loudness at the different frequencies decay to the threshold in equal times,[3] a condition satisfying a theoretical requirement for ideal balance is reached. In small studios, consideration must also be given to the phenomenon of air resonance. In the small studio, the frequencies of maximum resonant response are in the register of the bass instruments. It is not improbable, and some experience seems to indicate, that in addition to the actual prolongation of reverberation time at these resonant frequencies, there is sufficient reaction at the source to cause an increased energy radiation at this frequency. In determining the absorption characteristic of materials to be employed in a small studio, careful consideration should be given to compensating so far as practicable for the resonance effect. Also, a tendency to over-bass may make desirable a further reduction in the actual reverberation time at low frequencies. It is, of course, assumed that the construction of the floors, walls, and ceilings is such as to avoid sharp resonance in these structures.

With the amount of absorption at the various frequencies pre-determined by the selected reverberation time and characteristic, it is necessary to consider the distribution to be made of the absorption. The shape and size of the studio, together with the necessity for correct liveness for the production of music and the minimum interference at the point of pickup, will determine this distribution. Allowance should be made for the acoustic absorption presented by the musicians or performers in the location which they occupy. The remainder of the absorption is customarily located upon walls, ceilings and to some extent on the floors. Obviously, the absorbing areas must be of sufficient size to accommodate the requisite amount of absorption to give the desired reverberation period, and be distributed about the studio so as to provide an unbalance of liveness between the performance and pickup ends of the studio.

The desired absorption coefficient is best determined after the location of treatment is decided. With the areas to be made absorbent and the total amounts of absorption known, the necessary coefficient for each frequency is determined. The departure from the exact areas considered desirable for treatment is determined by the degree of agreement obtainable between the coefficient of a suitable material, and the ideal coefficient. The departure of the actual from the desired coefficients will require further re-balance between desired reverberation time and desired areas to be treated.

As the foregoing summary indicates, the successful acoustic treatment of studios involves the coordination of many factors and the application of a large amount of experience, and is therefore a highly-specialized function which should be referred to a responsible group of acoustic consultants familiar with this class of work.

In recording orchestral music it is desirable, wherever possible, to use one microphone at a time rather than two or more connected through a mixer to the recording channel. By suitable placement of the microphone a desirable balance can be attained between the various instruments of the orchestra. Those instruments that should be most prominent should, of course, usually be the closest to the microphone. This applies also when a soloist and chorus are present as well as an orchestra. When the orchestra is used for accompaniment, the soloist is usually placed nearest the microphone, the chorus next, and the orchestra somewhat farther back. Acoustic-perspective control can be achieved to some extent by adjusting the relative distances from the microphone of the soloist, chorus, and orchestra. The use of a single microphone probably represents the most natural arrangement, the microphone taking the place of the listener. When sufficient time is not permitted for rehearsals and adjustments, auxiliary control methods may be used, which involve the use of more than one microphone. However, although the use of more than one microphone introduces many complications, the necessary conditions which must be fulfilled in order to obtain satisfactory results with two microphones, have been elucidated by D. P. Loye.[4] Among the outstanding features established by Mr. Loye's work, is the very marked interference effect produced when the two microphones are rather close together and near the source of sound. This leads to the conclusion that the difference in distance between each microphone and the sound source should be at least ten feet, that they should not be too close to the source, and that the sound volumes picked up by them should be adjusted to differ as widely as practicable.

[3] "Acoustics of Broadcasting and Recording Studios" by G. T. Stanton and F. C. Schmid, *Journal of the Acoustical Society of America*, July, 1932.

[4] "Acoustic Considerations in the Construction and use of Sound Stages" by D. P. Loye, *Journal of the Society of Motion Picture Engineers*, September, 1936.

[5] "Optimum Reverberation Time for Auditoriums" by W. A. MacNair, *Journal of the Acoustical Society of America*, January, 1930. (Part 1.)

[6] "Acoustic Considerations in the Construction and Use of Sound Stages" by D. P. Loye, *Journal of the Society of Motion Picture Engineers*, Vol. XXVII, No. 3, 1936.