ACOUSTICAL CONSULTING SERVICES AT RCA

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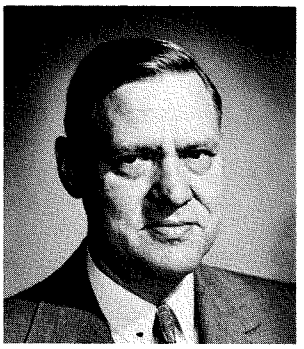


JOHN E. VOLKMANN attended the University of Illinois, where he received his BS in Engineering Physics in 1927, his MS in Engineering Physics in 1928, and Professional Degree as Engineer-Physicist in 1940. Mr. Volkmann has over 31 years' experience with RCA, starting with RCA Research in New York in 1928 as Assistant Physicist in Acoustic Research. In the interim to the present he has worked as an engineer, supervisor, or manager in Acoustic Development for RCA Photophone (New York), RCA Victor Co. (Camden), RCA Manufacturing Co. (Camden), RCA Victor Division (Indianapolis), RCA Victor Division (Camden), and Engineering Products Division. Mr. Volkmann is at present in the Industrial and Automation Division as Staff Engineer. He is a Fellow of the Acoustical Society of America, a Fellow of the SMPTE, a Member of the Sigma Tau and an Associate Member of the Sigma Xi.

EVER SINCE the early days of sound motion pictures, RCA has found it expedient and necessary to offer its sound-equipment customers an acoustical consulting service—sometimes on a chargeable basis, but most frequently as a form of insurance against the use of RCA products in undesirable acoustical environments. At one time, during the peak of sales by RCA Photophone, Inc. (then a separate RCA subsidiary set up for the sale and servicing of sound motion-picture recording and reproducing equipments), when most of the silent-movie theaters had to be redesigned acoustically for "talking movies," between 50 and 100 theater acoustic surveys and analyses were handled per month by several representatives from the Service Department in the Eastern, Central, and Western Divisions under the supervision of the RCA Photophone Engineering Department.

Since many special requests for acoustical advice (about 100 per year and now mostly on new-building projects) still originate in IEP in connection with sound-system sales, an acoustical-analysis and sound-survey service is maintained as a staff engineering function in the Industrial and Automation Division, Camden, N. J. Surveys, however, are also handled locally by IEP Engineering in Hollywood, Calif., in connection with the sound stages and studios of RCA's film recording Licencees. While the bulk of the surveys made relate to the application of specific RCA products (mainly loudspeakers and/or microphones) to a given acoustical environment, occasionally we are called upon to make analyses relating purely to noise problems or to the design of a room without the association of a sound system. Where a sound system is involved, the acoustics of *both the room and the sound system* must be analyzed and carefully coordinated or integrated *in the overall design for good hearing.* It is the following of this philosophy of integrating the overall acoustic design that has led to the successful performance of the more-outstanding RCA sound system installations made over the years. A general description of the nature of these surveys and of some of the more interesting ones follows.

NATURE OF ACOUSTIC SURVEYS

A room acoustic and/or sound-system survey involves either a study of the architectural drawings, particularly in the case of new structures during the planning stage, or a survey of the actual site in the case of existing structures. This study generally includes an analysis of the reverberation time of the room based on the total sound-absorbing power of the walls, ceiling, floor, chairs, and other surfaces and objects in the enclosure. It also includes an analysis of the individual echo reflections from the geometry of the space, particularly with respect to loudspeaker and microphone placement. Lastly, but of first importance, it includes a study of the optimum placement of loudspeakers and microphones with respect to direct sound coverage of the audience area. Stated another way, to properly analyze the acoustics of the space we must include all of the acoustic energy heard at any particular point in the space. This may be expressed simply as follows:

$$E_T = E_D + E_L + E_E + E_R + E_N$$

Where E_T = total sound energy at the listening point

E_D = energy direct from the original sound source

E_L = energy direct from the reinforcing loudspeaker

E_E = the energy of echo reflections (these are considered beneficial if delayed less than 0.05 seconds)

E_R = energy from reverberant reflections

E_N = energy from extraneous noise and distortion.

The foregoing room acoustic energy relation obviously applies to *any* acoustical analysis of rooms—whether sound-reinforcing loudspeakers are used or not.

SCOPE OF CURRENT SURVEYS

To show the general scope of the room acoustic consulting activity practiced at RCA, a number of photographs are presented on these pages. Brief descriptions of some of these activities follow.

Radio City Music Hall

One of the most valuable aspects of any continuing consulting service is that it quite often results in repeat business and frequently leads to new developments. This has been true in the case of Radio City Music Hall, where RCA not only had representation in the early planning stage on the auditorium acoustics and on the sound movie system and sound reinforcing system specifications (in 1930-32), but also has continued to act in a consulting capacity on every major change and improvement in the sound equipment and auditorium acoustics since then. As a result, RCA developed the first multiple-channel stereophonic sound reinforcing system for a theater auditorium, which was installed in Radio City Music Hall in 1935. The circles in Fig. 1 indicate the location of the stereo reinforcing speakers in the present system, installed in 1955.

Fantasia and *Eternal Road*

Of early historical interest in the stereophonic recording field were the special large projects in which RCA participated on a grand scale, including the acoustical consulting for the Walt Disney's *Fantasia.* For this, RCA provided all of the sound equipment and services for the nine-channel film-recording system used by Leopold Stokowski and the three-channel reproducing system used for road showing—the forerunner of stereophonic sound in the theater. Fig. 2 shows the polycylindrical bandshell designed for recordings by Leopold Stokowski at about this same time.

Another special multi-channel film-recording-and-reproducing-equipment project that required acoustical consulting services from RCA was *The Eternal*

Road production by Kurt Weil in the Manhattan Opera House, New York, N. Y. Here, the orchestra was completely absent from the auditorium because of elaborate scenic requirements on stage and in the orchestra pit. Hence, the musical score was rendered entirely by means of high-fidelity optical film recordings. This multiple-channel sound system included special switching facilities for controlling the direction of sound from various different locations on and around the stage.

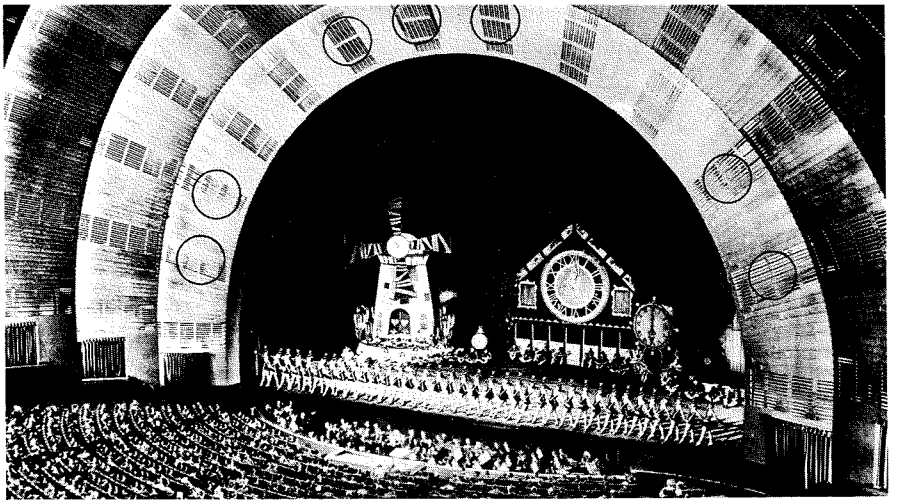


Fig. 1—Radio City Music Hall Theater Auditorium. Circles indicate location of stereo reinforcing speakers.

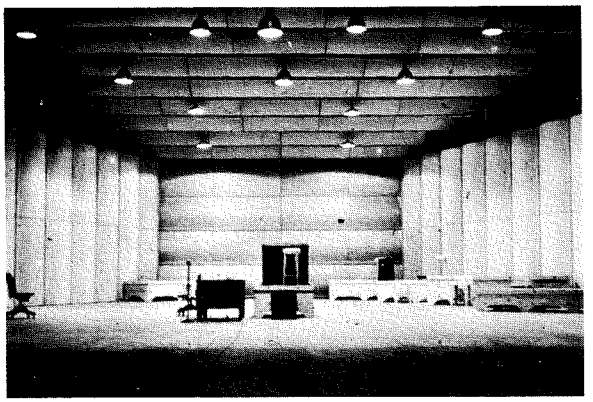


Fig. 2—Polycylindrical bandshell designed for recordings by Leopold Stokowski.

Hollywood Bowl and Other Outdoor Stereophonic Installations

The more recent adaptation of stereophonic sound to *Cinemascope* and other wide-screen forms of motion-picture presentation has led to more and more consideration of the benefits of spatial and directional sound effects in the field of sound reinforcement and for general sound-system applications. Fig. 3 shows the location of the loudspeakers recommended to our West Coast sound distributor for the multiple-channel sound system in the Hollywood Bowl, while Fig. 4 shows the suspension of the special 180° radial loudspeakers designed for Commercial Radio Sound Corporation for the multiple-channel sound system in the Marine Theater at Jones Beach, Long Island. The latter is used for such outdoor extravaganza productions as *Showboat* and *Song of Norway*.

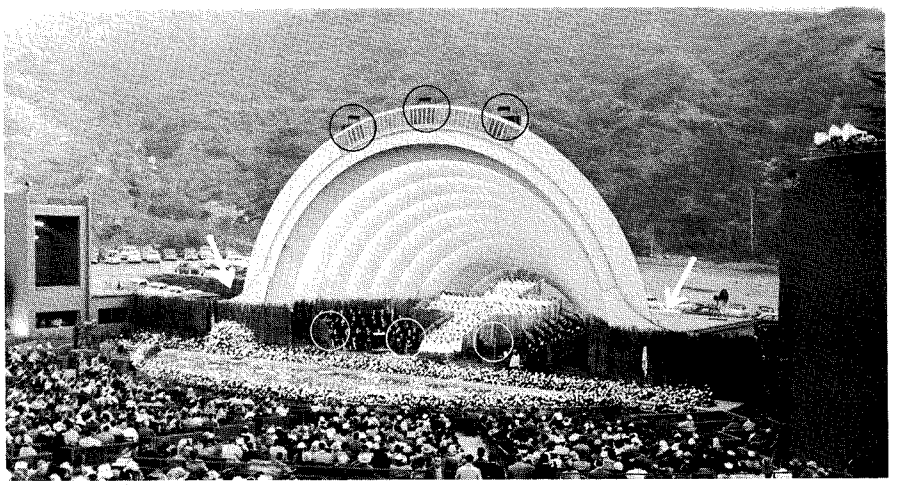
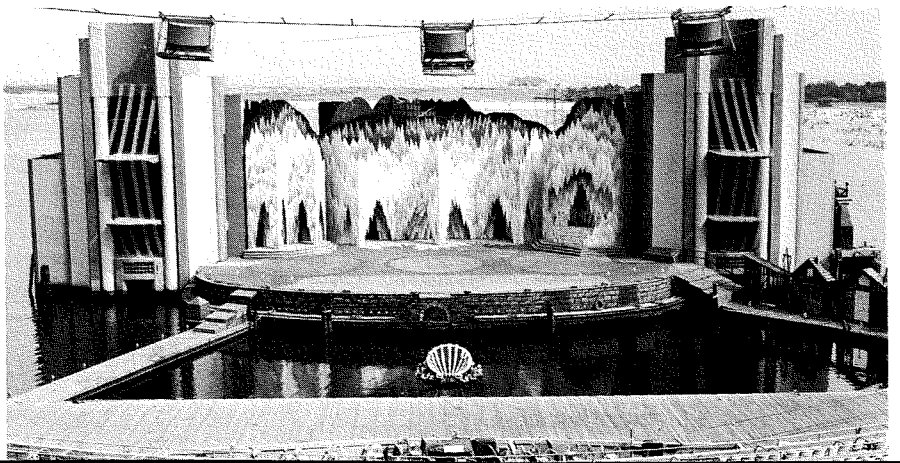


Fig. 3—Hollywood Bowl. Encircled is the basic microphone and loudspeaker system. Arrows indicate supplementary loudspeaker locations for use either with the shell speakers or for large-scale pageants when the shell is moved off the stage. These auxiliary speakers are mounted in movable pylons.

Fig. 4—Marine Theater, Jones Beach, Long Island, showing suspension of special 180° radial loud speakers.



Distributed Stereophonic Sound In the Home

Often, the study of an acoustic problem in one application leads to the application of sound systems in other areas, as in the case of the acoustic design of the 35-mm projection room for the home of a distinguished Washingtonian. Here, the opportunity was offered to present the idea of supplementing the regular sound-movie projection system with a separate high-fidelity and stereophonic record system in which four speakers were fitted into the corners of the ceiling of the projection room, or the Pavillion Room, as it is called. The stereophonic sound system also extends to other areas such as the drawing room, and library. Probably representing the first application of distributed stereophonic sound in a home, this system permits the piping and recording of live stereophonic sound picked up in the Pavillion Room as well as the reproduction of regular stereo records. Other areas covered by the high-fidelity sys-

Fig. 5—Design of a new stereo-sound recording studio in the NBC Bldg. Hollywood, California.

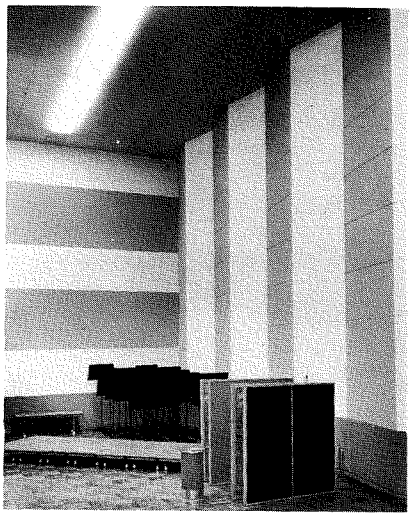


Fig. 6—Acoustical details of the studio shown in Fig. 5.

tem include the stair hall, dining room, porch ceiling, outdoor gardens, and control room.

New RCA Recording Studios in Hollywood

The recording of stereophonic sound in small studios has led to the need for designs in which it is possible to get greater separation between various musical instrument groups without making the studio feel too dead for the musicians. Fig. 5 shows the design of one of the new studios opened by the Record Division in the NBC Building in Hollywood this past year. The horizontal reflector vanes and vertical serrations, which are an important part of the shape and acoustic design, are shown in the close-up view, Fig. 6.

Screening Room for TV Advertising

The growth of TV advertising has led to more and more agencies setting up their own viewing or screening studios with the attendant requirements for good listening-room acoustics. The recent design of a room for a prominent agency in New York City is shown in Fig. 7. Here, good sound diffusion, an important element in the control of small-room acoustics, was obtained by the angular or diamond pattern of the walls and ceiling.

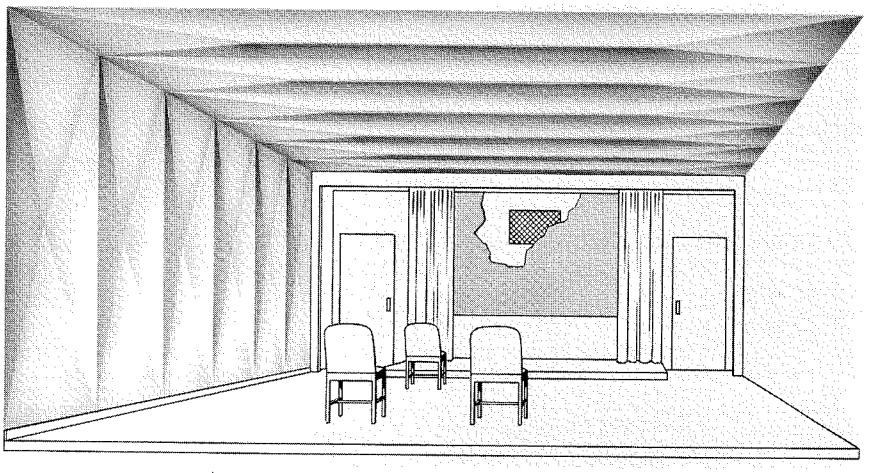


Fig. 7—A design of angular or diamond-shaped sound-diffusing panels for good listening-room acoustics.

Basilique Notre Dame Du Cap

Acoustic survey work on large new projects often extends over a period of several years insofar as the elapsed time is concerned. Fig. 8 shows the wood mockup model for a new basilica in Canada during the earliest planning stage. This is the time when acoustical consulting is the most fruitful both for the architect and his client, and for RCA. Early consultation permits establishing basic acoustic requirements and resolving the many problems relating to physical location and appearance of loudspeakers, and acoustic treatment. When this project is completed, it will consist of a multiple-channel sound system with directional sound reinforcement from the chancel and choir areas as well as a distributed stereo system for the reproduction of music. Fig. 9 shows a plan view of the multiple loudspeaker locations required to meet the basic acoustic coverage requirements.

LOUDSPEAKER DESIGNS FROM ACOUSTIC SURVEYS

As mentioned earlier, acoustic analysis on a specific project often results in new product developments or special designs. Fig. 10 shows two special loudspeaker designs resulting from acoustic survey activities, namely: the two-way cubical loudspeaker for the New York and San Francisco World's Fairs, and the two-way corner horn for Walt Disney's *Fantasia*. As an interesting sidelight, mention should be made of the world's largest two-way high-quality loudspeaker system, designed for the New York World's Fair *Perisphere*. This loudspeaker, built in the ground directly under the *Perisphere*, radiated over an angle of 360° and consisted of 24 low-frequency units and 24 high-frequency units. The low-frequency section of the speaker was poured in concrete and was 22 feet in diameter.

RCA PLANT PROJECTS

RCA's acoustical consulting activity naturally has included analyses and recommendations for projects within

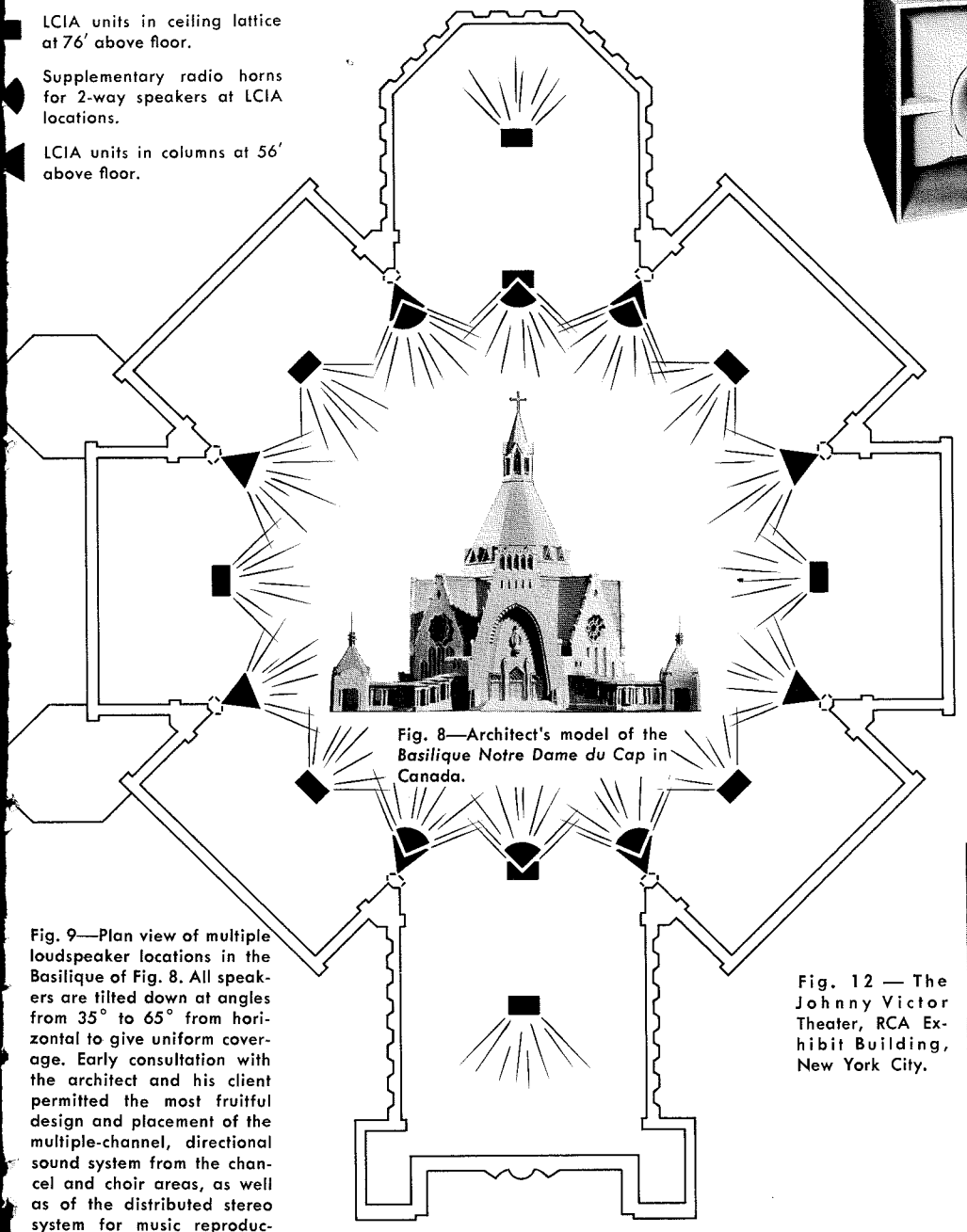


Fig. 8—Architect's model of the *Basilique Notre Dame du Cap* in Canada.

Fig. 9—Plan view of multiple loudspeaker locations in the Basilique of Fig. 8. All speakers are tilted down at angles from 35° to 65° from horizontal to give uniform coverage. Early consultation with the architect and his client permitted the most fruitful design and placement of the multiple-channel, directional sound system from the chancel and choir areas, as well as of the distributed stereo system for music reproduction.

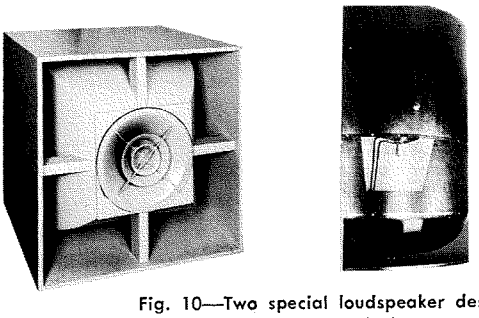


Fig. 10—Two special loudspeaker designs that resulted from acoustical surveys. Left, two-way cubicle loudspeaker for the New York and San Francisco World's Fair; right, two-way corner horn for Walt Disney's *Fantasia*.

Fig. 11—The RCA Little Theater, Building 2-1, Camden, N. J.

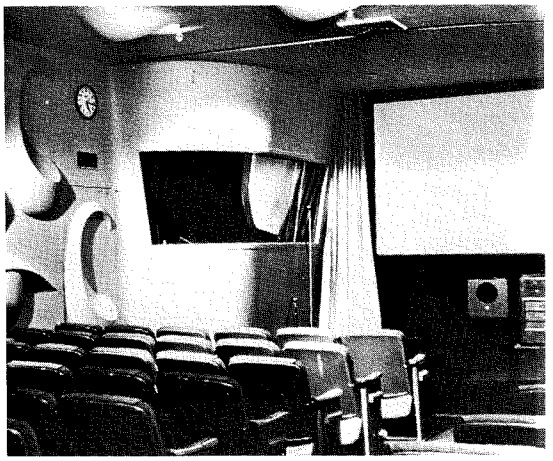


Fig. 12 — The Johnny Victor Theater, RCA Exhibit Building, New York City.

the company such as the Little Theater (Fig. 11) in Building 2-1, Camden, N. J., the Johnny Victor Theater (Fig. 12) in the RCA Exhibit Building in New York City, record test booths for the Record Dept., RCA Victor Recording Studios in New York, Chicago, Hollywood, Argentina, and Spain. A view of the Little Theater in Fig. 11 shows how the acoustical diffusion and architectural-decor requirements were met in a unique and unusually attractive design.

NEW SURVEYS AND SUBJECTIVE TESTS

In almost any engineering survey work, one of the problems is getting accurate and sufficient information to make a proper analysis. In the case of room acoustic analysis, it is essential that the consulting engineer be furnished with up-to-date architectural drawings showing the floor plan, longitudinal and transverse sections as well as the specifications on the finish and construction of all interior surfaces and furnishings of the room. In addition, in the case of structures already completed, it is always helpful to have photographs, preferably stereoscopic slides, taken from different vantage points such as the last row of seats in the balcony, the front row at the sides, and from the stage at the center line of the auditorium.

Room acoustic design is as much an art as it is a science and, therefore, usually depends more on subjective listening tests than on quantitative physical tests. This situation, the acoustic engineer will tell you, arises not from any complexity of the theory but from the general problem of making objective measurements. Particular difficulty is experienced indoors, where a multiplicity of reflective wave patterns arise. These vary in length from the very large to the very small relative to the dimensions of the objects and surfaces in the room.

As long as RCA continues in the sound and picture business, and people have ears to hear and eyes to see, there will be a need for the company to provide auxiliary engineering consulting services such as described herein.