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An Institute of Musical Science—A Suggestion

HARVEY FLETCHER
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IN the past, applied physics has been largely concerned with the development of things to meet the fundamental needs of human beings, such as food, clothing, shelter, transportation, and communication. As we grow in our cultural level as a nation, more and more of the time of scientists will be devoted to increasing our esthetic enjoyment. The termination of the war will permit us once more to think of the beautiful things of life and to cultivate those which give us joy and happiness. Music we know is one of these fundamental things which stirs our emotions and makes for a fuller life. Why this should be is a philosophical question which I shall not try to answer but will merely say is true. Consequently, if we can by scientific means increase the possibilities of music and also increase the number of those who are enjoying it, then such an effort is praiseworthy and should be supported by the public. Having this aim in view I am suggesting that an Institute of Musical Science be created in one or more of our large universities.

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The Institute should be located in a metropolitan center like New York, Philadelphia, or Chicago, or in a center for musical talent like Hollywood or Rochester, and it should preferably be connected with one of the large universities having a good school of music.

For housing, the Institute would require a relatively large building with research laboratories and facilities for a number of physicists, engineers, musicians, and psychologists. Its most essential facility would be a large auditorium and stage, adaptable to many experimental conditions. This space would provide for concerts, operas, and other musical performances, with or without the addition of acoustical effects electro-mechanically produced. It would permit a wide range of experimentation on reproduced or synthetic sound with variations in the character and location of the sound sources, and at the same time with variations in the color and intensity pattern displayed on the stage screen. Provision would also be made for the introduction of low frequency effects such as vibration transmitted through floor or walls.

The building in which the Institute might be housed can be envisaged as approximately equivalent in size to Carnegie Hall in New York City or the Academy of Music in Philadelphia. Its auditorium, seating 1500 or 2000 persons, and a second hall sufficient to accommodate in practice session a full-sized orchestra, can be run on a commercial basis for a limited number of nights a week for sound pictures, concerts, operas, and broadcasts. On certain nights the halls would be reserved for selected experimental audiences.

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This would also be a service group to be used by all the staff. Tools and other facilities should be provided not only for this group but also for some of the engineers who wish to make simple experimental apparatus. Its personnel would include one engineer and seven mechanics.

Besides these three general groups there would be seven others concerned with specific aspects of the research work as follows.

IV. METHODS FOR THE ENHANCEMENT OF THE PERFORMANCE OF EXISTING INSTRUMENTS

The aim of this department would be to find the best method of amplifying the sounds from orchestras and operas. An attempt should be made to answer such questions as:

Do people prefer a stereophonic system rather than a single-channel system?

Do people prefer a multi-channel reproducing system rather than a single-channel system?

What loudness is appropriate for listeners to give the best emotional effects for various types of music?

It is well known that it is difficult to bring the various sections of the orchestra into a desired balance for different kinds of selections, and methods of selective amplification should be developed so that the various sections of the orchestra—for example, bass, flute, harp, etc.—can be brought to any desired balance.

Also it would be interesting to find the effect of completely modifying the usual spacial distribution. For example, can new and desirable effects be produced by letting the low frequencies be transmitted through the floor and have certain sections of the orchestra transmitted from above and others from the sides and front, etc.?

Particular attention should be given to the best method of amplifying voices and solo instruments in an ensemble. A good method is needed for amplifying the voices in opera so that they will be in a better balance with the orchestra and will more easily reach large audiences.

Its personnel would include one physicist, one engineer, and one assistant.

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In this department, such questions as the following would receive attention:

Do people prefer to listen to music while viewing a beautiful scene, a dark stage, or the players producing the music?

In producing opera, would people prefer to have the singers and players off-stage and out of sight and to see competent mimes act out the story? That method would permit a much better balance between vocal and instrumental music than is now possible.

Means of making quick changes either mechanically or electrically in the reverberation time should be provided. Then studies could be made of the dramatic effect of such changes. Means should be provided so that the sound produced by a singer or a player on the stage is picked up and modified in various ways and then sent back to the performer. Also it should be arranged so that very little of this sound reaches the audience. Under such circumstances it may be found that considerable help may be given to the performer in producing better singing or playing. Its personnel would include one physicist, one psychologist, one musician, one engineer, and one assistant.

VI. NEW MUSICAL INSTRUMENTS

With the new electronic techniques which are now available, a large number of new musical instruments might be developed which will have great entertainment value. The present types of instruments should be studied to see if desired improvements can be made either by mechanical or electrical means. Then a new line of instruments might be developed having organ-type keyboards but using electronic methods for generating and controlling the tones. Also, with these new methods there are possibilities of producing melodic or single-line instruments having controls which give a wide range of tone color, attack and release characteristics, vibrato, etc. Different methods of playing such instruments should be studied. For example, should one use the usual organ keyboard, or the position of the fingers on strings, or the control of the amount of blowing pressure for creating the succession of tones that is desired?

Instruments should also be provided which are capable of playing in intonation systems different from those in common use.

The development of very simple instruments for instruction in the school and home would fill a great need.

Finally, this department would be concerned with the research and development of an instrument which might be called a Synthetic Orchestra. Devices might be developed for imitating the well-known instruments in an orchestra and for producing other beautiful tones not yet known to the musical profession. Keyboards or other means would be provided so that the artist playing an instrument can satisfy every musical

mood. With a combination of six keyboards it is believed that the effect of a full orchestra can be produced. Out of this development would grow instruments similar to the piano and organ but with a much wider variety of tone quality, attack and release, and dynamic range. It is expected that an instrument can be developed which is more flexible, more varied, and with just as good tone quality as the present pipe organ, and at a lower cost. Along with the development of these new instruments must go the development of techniques for playing them. One development will react upon the other so they must be carried on together.

To fulfill the ultimate objective of this work the cooperation of some interested commercial institutions would be necessary to manufacture and distribute such instruments. The work of the Institute would be concerned primarily with the investigation of the fundamental possibilities of these new facilities. Its personnel would include two physicists, two musicians, two mechanical engineers, and two electrical engineers.

VII. NEW TECHNIQUES OF ORCHESTRATION AND COMPOSITION

In the present arrangements of symphonic orchestras many things are desired that science could provide. For example, most conductors desire more intensity in the bass instruments. Even after filling the stage with bass viols, the intensity is still far from that desired. Also a background of noise is created in connection with playing of orchestral instruments, which is a great nuisance. By scientific studies, changes could be made to reduce this background of noise.

If amplifying devices can be used, then, one would ask, how many instruments in each section would be necessary in order to produce the mass effect of a large orchestra? Also, can new electronic instruments supply certain of the deficiencies? If so, what kind of keyboard is best suited for control?

These are illustrations of the type of problems concerned with orchestration. With the new instruments and facilities available which are described above in departments III–VI, it is evident that to make the best use of them would require creative artists who can use the tones in making new compositions. Such a composer must make ventures in entirely new fields and then try out the results with the new facilities. Its personnel would include one orchestra leader, one composer, one physicist, and two electrical engineers.

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This department would be concerned with the development of radically new sound systems for sound pictures. There are a number of things which could be tried rather easily once the experimental auditorium was available. For example, such sound systems as were used in *Fantasia*, and other systems even more elaborate, could be tried. When showing a football or baseball picture the sound of the crowd could be made to surround the audience, rather than come from the stage. This would have the effect of placing the listener in the midst of the scene. It would give greater intimacy and probably greater emotional effect. This same feature could be used in any picture of a crowd where its noise is important. A consideration should be given to what modification in phonograph and radio sets is necessary to give better musical quality. Its personnel would include one physicist, one engineer, and two mechanics.

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It is important to develop further methods of selecting from a group of young persons, before they have started their musical education, those who have musical talent. The work of Seashore provides an excellent base from which to start.

There is need for a more scientific approach to the problem of voice training, particularly for singing. Apparatus aids for this training should be developed in cooperation with a teacher of voice of unquestioned reputation. Typical of some of the equipment needed are a simple apparatus for recording and reproducing so that a singer can hear his own voice immediately after singing, a device for showing a singer the pitch and intensity of his voice in comparison with what he is striving to produce, and a means for seeing quickly the quality of voice being produced. Also, devices for measuring the volume of air used in singing under various conditions and for studying the vocal cord action by stereo-

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Devices for aiding choral work would be tried. One such device is a recording-reproducing machine which will make it possible to learn to sing a chorus in four parts in a very short time. This would be possible even though the singers cannot read music. It would be a five-channel recording and reproducing device. On one channel the instrumental accompaniment would be recorded. While listening to this being reproduced, the conductor would have the organist play, or have one of his best singers sing, the melody for the soprano, and have it recorded on the second channel. Similarly, the alto, tenor, and bass could be recorded on the third, fourth, and fifth channels. Then all five channels may be reproduced simultaneously, the sound coming from a group of telephone receivers. The men singing the bass, for example, would have telephone receivers in which they will hear only the bass part and, consequently, need only to sing in unison with its reproduction; similarly, for the other parts. An attempt should be made to develop a machine of this sort which would be simple enough in construction and operation so that choirs and choruses, like those of churches and schools, could easily use it. In this way it is expected that school children could be taught to sing even difficult choral selections, and through participation receive early a stimulus toward the enjoyment of good music.

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This department would also be concerned with ways and means of getting greater participation in the creation and production of good music. In cooperation with department VI, some simple solo instruments would be developed which can easily be mastered by children or adults and which could be played with the piano or organ. These instruments should have good musical quality. The Solovox is typical of this class but has not enough versatility in tone quality. For example, it may be possible to encourage group participation as follows: Let the radio or phonograph play the accompaniment, which is usually the hard part of the music, and then let the group join by playing simple solo instruments.

For school work the aid to choral work described in department IX should be tried. Apparatus should be developed so that the good operas could be recorded stereophonically on equipment suitable for school usage, so that the music of the opera could be produced on a stage and could have the proper spacial relationships. Students could learn the parts of the various actors and then act as mimes while the music is being reproduced. In this way some very fine entertainment could be produced, and the students would gain considerably in musical appreciation in learning the operas by this direct participation.

Its personnel would include one psychologist, one educator, one statistician, and one electrical engineer.

Obviously the financing of this entire venture would call for substantial amounts of money, but any discussion of this phase of the subject is beyond the scope of this paper.

Although it is a future plan of work, its outline has been evolving during the past ten years from discussions of the author with many persons, both scientists and musicians, who are interested in this field. It is hoped that its presentation now will bring an Institute of Musical Science nearer to reality.

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