

1919.
NEW ZEALAND.

FURNISHING ADVISORY COMMITTEE

(FINAL REPORT OF)

(MR. MALCOLM, CHAIRMAN.)

Presented to the House of Representatives, and ordered to be printed.

ORDER OF REFERENCE.

Extract from the Journals of the House of Representatives.

WEDNESDAY, THE 3RD DAY OF SEPTEMBER, 1919.

Ordered, "That Standing Order No. 219 be suspended, and that a Select Committee be appointed, consisting of twelve members, to take evidence on the best method of improving the acoustic properties of this chamber, and, with the approval of Cabinet, to take such steps as may be deemed necessary to effect this purpose; this Committee also to make to Cabinet such recommendations as it may deem desirable in regard to furnishing this chamber; the Committee to have leave to sit during the recess, and when dealing with the furnishing of all parts of Parliament Buildings beyond the two chambers to sit as a Joint Committee with a similar Committee appointed by the Legislative Council; all members of this Joint Committee residing outside the boundaries of the City of Wellington to be entitled to receive reasonable travelling-expenses in connection with attending each sitting during the recess; the Committee to consist of Mr. Anderson, Mr. Ell, the Hon. Mr. Herries, Mr. Isitt, the Hon. Mr. MacDonald, Mr. Malcolm, the Hon. Mr. Ngata, Mr. Parr, the Hon. the Speaker, Mr. Wilkinson, Mr. Witty, and the mover."—(Hon. Sir W. FRASER.)

REPORT.

The Furnishing Advisory Committee has directed me to report:—

The Committee held eight meetings during the recess. It devoted its chief attention to improving the acoustics of the chamber, and everything that experience and science could suggest was tried.

The Committee called in the services of Professor Clark, lately Professor of Physics at Victoria College. After a long series of experiments on definite lines he discovered the causes of the bad acoustics of the chamber, and he recommended that the floor of the chamber and the panels of the walls in the galleries should be covered with absorbent material. His recommendations, which are hereto appended, were adopted, with the most satisfactory results—results that will, the Committee feels sure, be gratifying to members.

Numerous recommendations in regard to furniture, &c., have been made by the Committee and have been adopted.

In response to requests from your Committee, the Speakers or Prime Ministers of various Parliaments of the Empire have sent most interesting photographs of exteriors and interiors of many of the Parliament Buildings throughout our Empire. These have now been mounted, bound, and placed in the library. The Committee is particularly indebted to the Government of India for the splendid collection of views it sent.

The Committee has received every possible assistance from the Government Architect.

The Committee wishes to acknowledge the hearty co-operation of the Minister of Public Works, who practically adopted every recommendation made by the Committee.

The Committee recommends that the Furnishing Advisory Committee should be continued.

2nd September, 1919.

A. S. MALCOLM, Chairman.

APPENDIX.

Victoria University College, Wellington, 28th May, 1919.

SIR.—In accordance with your Committee's request of the 26th March, I have made a careful study of the acoustic properties of the chamber of the House of Representatives in the new Parliament Buildings, and I take pleasure in submitting the report which you will find enclosed.

I have made only general suggestions for altering the room, because materials of proper acoustic quality at present available in the Dominion are not entirely suitable from an artistic standpoint. Information about proper materials manufactured elsewhere is expected within a few days, and when this comes to hand it will be possible for me without further experimental work to make more definite suggestions if the Committee so desires.

The Committee may think it desirable to make temporary changes in the room, or to make permanent changes at once with materials at present available. In view of this possibility it seems to me best to submit the report in its present form and to supplement it later if desirable.

The very brief description of the general problem of acoustics is embodied in the report to enable your Committee better to understand the difficulties sometimes encountered, the impossibility of effecting a complete correction in some cases, and the fact that a room acoustically corrected for one purpose is not suitable for other purposes.

The report contains a frank criticism of the design of the chamber. It must be remembered that the science of architectural acoustics is of very recent origin. For the best work, perhaps the only really scientific work, on the subject we are indebted to the late Wallace C. Sabine, who died recently without publishing his collected works. Although so little of real value in this line is found in architectural literature, there is to be found plenty of work of doubtful value done by men untrained in science.

In justice, then, I have to say that in my opinion it is unreasonable to expect an architect to be able in every case to design a room free from acoustic defects unless he has made a very special study of the subject, which, as explained above, is not easy. Furthermore, rooms are not designed solely for perfect acoustic purposes. Artistic excellence, and a form, traditional for certain purposes, must weigh heavily when the various properties come into conflict.

In conclusion I wish to thank the Committee for its kindness in accepting unfortunate delays in the work and for its good spirit in co-operation.

I am, &c.,

HARRY CLARK.

Mr. A. S. Malcolm, Chairman of the Furnishing Advisory Committee of the
House of Representatives, Wellington.

REPORT TO THE FURNISHING ADVISORY COMMITTEE ON THE ACOUSTIC PROPERTIES OF THE CHAMBER
OF THE HOUSE OF REPRESENTATIVES OF NEW ZEALAND.

The General Problem of Acoustics.

The simplest auditorium, the open air, has the one great defect that sound rapidly becomes faint as the distance from the speaker increases. The walls of a room reflect the sound-waves, thereby increasing the loudness, but reflection produces other effects which are undesirable.

The several distinct echoes produced by highly reflecting walls in a very large room are easily recognized. In a small room they occur in such rapid succession as to appear continuous, in which case the effect is called "reverberation."

Reflection also produces "interference" resulting in a peculiar distribution of sound such that while in a certain place the sound is intense, another place a few inches away (in some cases a fraction of an inch) will be in silence. Because of "interference" the sound from an organ-pipe, instead of dying away after the pipe has ceased to play, may become very much louder for a short time. "Interference" cannot be discussed briefly with profit: suffice it to say that my tests have shown that it can be reduced to a minimum in the chamber.

In a room of moderate size with highly reflecting walls and floor the audible reverberation may persist for six or seven seconds. Since in this time a speaker may pronounce perhaps thirty syllables, great confusion results. The reverberation-time depends only slightly upon the loudness, consequently in such a room little advantage is gained by speaking in a loud voice. A room of this kind may be said to be easy to speak in because a speaker can without effort fill the room with sound.

Reverberation-time depends upon the reflecting-power of the walls. Stone, cement, plaster, and wood are almost perfect reflectors. Soft material, such as curtains, carpets, cushions, and felt, together with certain tiles especially made for the purpose, being good absorbers of sound, reflect but slightly. The clothing of the people in the audience is a large factor in the absorption. It would be a comparatively simple matter to reduce the reverberation in a room of proper shape to any desired value by the use of such materials were it not for the fact that the relation of absorption to pitch is sometimes complex. Some materials used in certain ways absorb sounds of low pitch well, but reflect the high pitches. Others have the opposite effect. Still others absorb the middle register and reflect the high and low pitches.

The relations of the various pitches contained in the human voice constitute its peculiar quality, and the reverberation-times must bear a proper relation to one another.

Reverberation-time depends also upon the size of the room, the walls being of constant quality. It will be greater in a large room because of the greater distances which sounds must traverse between successive reflections.

The proper amount of reverberation in a room is to a certain extent a matter of taste. If it exceeds about 2.5 seconds the room is not suitable for any purpose. About 2 seconds is proper to piano and chamber music. Orchestral music demands a somewhat shorter time. Speaking is distinct only for times below 1 second. Further deadening increases distinctness, but always at a sacrifice of loudness. A much-deadened room impairs the musical quality of the voice or of the musical instrument, because a quickly damped note, considered scientifically, consists necessarily of an unpleasant combination of pitches. A highly damped room is said to be a difficult room to speak in; a great effort is required to fill the room with sound. Yet speech is quite distinct if an ordinary tone of voice is used.

In general, any acoustic correction consists in effecting a compromise among loudness, musical quality, and the confusion caused by reverberation.

To give the best results a room should be so designed that the speaker's voice may go to each person in the audience in a straight line. Sound travels around obstructions to a certain extent, but loudness is very much impaired if the sound is required to turn through large angles. In general, a listener understands with difficulty a speaker whose mouth he is unable to see. The application of this principle to the chamber will be discussed elsewhere.

The Committee has asked my opinion of the effect on the acoustic properties of a room of wires stretched across it. Although I know that they are used extensively, I have never observed any uniformity in the method of wiring. Inquiries about the effect, beneficial or otherwise, are answered quite inconsistently by speakers and listeners. No accurate measurements of their effects have been made, to my knowledge. I can see no reason for expecting wires to alter the sound, and it is my definite opinion that they have no effect whatever. If it please the Committee I shall be pleased to make an experiment with wires.

Criticism of the Acoustics of the Chamber.

1. Considered from the standpoint of acoustics the design of the galleries is not the best. The height of the galleries above the floor of the House, the way in which they project over the body of the space below, and the height of the woodwork in front of them contribute to make it impossible for people in the galleries to see all of the members. From certain positions the voices of the members can reach the gallery directly only by turning through nearly a right angle. The Speaker's Chair and the Press Gallery are in this relation. It follows, therefore, that in such cases distinct hearing is possible only with the assistance of the echo. Persons sitting in the corners adjacent to the Press Galleries are at a great disadvantage.

2. Although it is not difficult to design a large auditorium with good hearing-qualities, it should be remembered that the qualities will not be good if one speaks from parts of the room other than the stage. In the chamber members speak from all positions. It may safely be said that the size of the chamber is sufficiently great, considering the method of use, to present a difficult acoustic problem to the architect.

3. The mean reverberation-time of the chamber as used during the last session, but without a curtain in the gallery, is 1.96 seconds. It is greater for high pitches than for low ones, the average difference over five octaves being 0.10 seconds. Both of these times are excessive. Interference gives considerable trouble.

Suggestions for Improving the Acoustics.

As a result of experiments in the chamber, including over five thousand determinations of the time of reverberation under various conditions, I am able to make suggestions for improving the acoustic properties of the chamber as follows:—

Absorbing-materials equivalent to 300 square yards of hair-felt $\frac{1}{2}$ in. thick should be introduced. This may be done in various ways:—

- (1.) Very much better seats in the gallery, provided with hair cushions, and well upholstered on back and arms with thick, well-padded material, are desirable. Absorption provided in this way will be about the same whether a large or small audience is present. Each seat of this kind may be considered equivalent to one-fourth of the square yard of $\frac{1}{2}$ in. felt.
- (2.) Heavy carpets may be used, carpet being considered equivalent to its weight of $\frac{1}{2}$ in. felt.
- (3.) Felt may be used on the walls and ceilings of the galleries. It may be covered with tightly stretched cloth, which need not touch the felt, presenting a pleasing appearance, and the cloth may be filled with calamine or a similar substance if desired. Asbestos paper, or a combination of paper and cloth, may be used as a covering. If very thick felt is used its equivalent in $\frac{1}{2}$ in. felt may be estimated by reference to the following table:—

Thickness.						Relative Absorption Co-efficient.
$\frac{1}{2}$ in.	...	...	...	...	...	1
1 in.	...	...	...	...	...	1.8
$1\frac{1}{2}$ in.	...	...	...	...	...	2.4
2 in.	...	...	...	...	...	2.8

No one of these suggested methods should be considered sufficient. The correctness should be distributed. Carpets should be placed on the floor of the chamber, on the gallery passages, and over the entire floor of the Press Gallery. At least one-third of the correction should be made on the walls and ceiling of the galleries. It can be put conveniently into the panels of these places, which have an area of about 130 square yards.

In addition to these general suggestions the following specific ones are submitted:—

1. In order to exclude noise from the corridors very heavy curtains should be placed around entrance-doors, and the spaces thus enclosed should be covered at the top with heavy material. The short passage leading to the Public Gallery should be deadened with felt.

2. No great benefit would result, in my opinion, from costly alterations necessary to exclude the gallery-corners near the Press Gallery. The seats in them will probably continue to be undesirable, but if special attention is given to deadening the walls, ceiling, and floor in these corners they will have no undesirable effect upon the rest of the room.

It may be well to mention in this connection that curtains such as were used during the last session in the galleries do not acoustically cut off the space behind them; that they have no more effect upon sound than they would have if placed against the walls; and that about 8 square yards

of this material are equivalent to only 1 square yard of $\frac{1}{2}$ in. felt. The drappings of art serge which it is proposed to hang between the columns are of value as sound-absorbers, but only to the extent mentioned above.

3. I would suggest that the Speaker's chair be moved forward about 2 feet.

4. If trouble is experienced from noise coming from the passages outside the chamber, these passages should be well carpeted.

Information about special materials is expected to come to hand within a few days. With this it will be possible, perhaps, for me to make further suggestions if the Committee so desires.

If the above recommendations are carried out, the reverberation-time will be reduced to 0.9 second for all pitches, which will, I think, give as good hearing-qualities as can be obtained without making very extensive and costly alterations in the design of the chamber.

The Committee should not forget that the chamber, if altered as I suggest, though suitable for speaking, will be unsuitable for music. The deadening effect upon sound may be considered unpleasant by some, but this is to a certain extent a question of psychology. One expects a large room to have a considerable reverberation-time. The deadness of the chamber will be not nearly so great as that of the old Legislative Council chamber. The latter is, however, a small room; one expects to find it dead for sound, and is not therefore disagreeably surprised.

If the Committee so desires, correction may be obtained temporarily by placing strips of felt on the walls and ceiling, and under the carpets of the gallery; and on the floor of the Press Gallery; also under the carpets and in unused spaces of the main floor. Considerable quantities can be placed effectively behind the large curtain at the end of the chamber.

I am, &c.,

HARRY CLARK.

Wellington, 28th May, 1919.

SUPPLEMENTARY REPORT TO THE FURNISHING ADVISORY COMMITTEE ON THE ACOUSTIC PROPERTIES OF THE CHAMBER OF THE HOUSE OF REPRESENTATIVES OF NEW ZEALAND.

Experiments on the Acoustic Effects of Stretched Wires.

All of the felt and other sound-absorbing materials which had been placed temporarily in the chamber were removed. Measurements of the reverberation-time to the number of 450, together with speaking tests, were made in various parts of the floor and gallery. Wires were then strung under the direction of Mr. Campbell, and the measurements and other tests were repeated. The position of the organ and the various places of observation were the same during both experiments.

The wires, which were copper, No. 20 gauge, were attached to battens which were secured at the top of the woodwork in front of the galleries. They were strung both lengthwise and crosswise, at 6 in. intervals, over the entire area of the chamber enclosed by the woodwork, and were tightly stretched.

The mean reverberation-time *with wires* exceeded that *without wires* by one-half of 1 per cent. This difference is not greater than the expected error of measurement. The wires had no perceptible effect upon *interference* of sound. Speaking tests, which are always of questionable value, showed no differences.

There is therefore good reason to believe that the wiring of the chamber has had no effect of any kind on the acoustic properties.

Expected Information about Materials.

It was stated in the report of 28th May that information about suitable materials for use on the walls of the chamber was expected shortly. This information has not yet come to hand.

Yours, &c.,

Wellington, 7th June, 1919.

HARRY CLARK.

SPECIAL REPORT.

I HAVE the honour to report that at a meeting of the Furnishing Advisory Committee held on Tuesday, the 2nd March, the following resolution was unanimously agreed to: "That the members of the Furnishing Advisory Committee express their high appreciation of the care and energy with which Mr. Malcolm has discharged the duties of Chairman of the Committee, and that this resolution be recorded on the Journals of the House.

2nd September, 1919.

A MEMBER OF THE COMMITTEE.

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