THE CHRISTIAN SCIENCE BRANCH CHURCH
an architectural type study

a thesis submitted in partial fulfillment of
the requirements for the degree of Master in Architecture
Massachusetts Institute of Technology
April 18, 1950

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Dear Dean Wurster:

In partial fulfillment of the requirements for the degree of Master in Architecture, I hereby submit this thesis, The Christian Science Branch Church, an architectural type study.

Sincerely yours,

Dorothy West Pelzer

April 18, 1950
To the coming realization of truth in church building this beginning study is dedicated.
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Introduction

"Behold, I bring you good tidings of great joy, which shall be to all people." Luke 2: 10

Much that has appeared in recent architectural magazines on the subject of religious architecture seems to me lacking in clarity and conviction because the writer failed to distinguish the concept of church behind the building. The Gothic cathedral and the New England meetinghouse are expressions of widely different concepts. The long and narrow nave, to dramatize processional and ritual, the height and shadowiness of a mystic atmosphere, speak a totally different concept from the plain auditorium, devoid of material stimulation.

The Christian Science concept of church would produce a simple atmosphere. In this church, the material building of itself is nothing; it is not the "house of God" in any literal sense. "Behold the heaven and heaven of heavens cannot contain thee; how much less this house..." 1. Its beams and columns have no magic power to instruct or inspire. To
endow them with symbolic meaning would be to lay
unnecessary importance on the building - which is
temporal means, not end.

The inspiration to the congregation is the message
spoken there. The inspiration to its members is
participation in the work - serving on committees,
ushering, teaching in the Sunday school, reading -
quite as much as listening to the service. Such
activity forwards individual growth.

The message of Church is not aesthetics, and
architecture can best speak by becoming so far as
possible transparent to this message.

Before proceeding to specifically architectural
requirements, some general facts about church
organization are essential.
Organization

The Church of Christ, Scientist, is comprised of The Mother Church, (The First Church of Christ, Scientist, in Boston, Massachusetts), and its branches throughout the world. It was founded as "a church designed to commemorate the word and works of our Master, which should reinstate primitive Christianity and its lost element of healing." 2.

Its ordained Pastor is the Bible, (Authorized King James Version), together with the textbook, Science and Health with Key to the Scriptures, by Mary Baker Eddy, the Discoverer and Founder of Christian Science. A weekly Lesson-Sermon, consisting of correlative passages from these books, which has been the subject of individual study during the week previous, is read on Sunday in branch churches everywhere. Readers are elected by the local churches from their memberships for a term of three years and are not eligible for re-election. Wednesday evening meetings, which include testimonies of Christian Science healing, are held in every branch church. After readings from the desk, these meetings are opened for remarks from the floor. At least once a year, and usually 2, 3, or 4 times a
year, each church sponsors a free public lecture by a member of the Board of Lectureship of The Mother Church. There are no special services in addition to the regular Sunday and Wednesday meetings and occasional lectures, (except on Thanksgiving, a sort of combination Sunday and Wednesday service), no baptismals, marriages, or funerals, no vespers or special music programs. When there is a Sunday afternoon or evening service, it is a repetition of the morning service.

Sunday school, for pupils up to the age of 20 years, is an important part of branch church activity.

Likewise the Reading Room, for the study, sale, and lending of the Bible and authorized Christian Science literature. (The Reading Room is usually found to be of greatest service when in a down-town location, in a business center rather than as part of the church edifice, which is apt to be in a residential neighborhood. For this reason, although an important part of the plant holdings of a church, the Reading Room has not been considered as a part of this study. It is a rather simple problem of interior layout and design, which, although it could benefit considerably from qualified professional attention, needs little theoreti-
cal study to be accomplished in practice. )

Government of The Mother Church and its branches is by the Church Manual. This is the unchangeable, constituted authority. Under the Manual each branch church is "distinctly democratic in its government," enacting its own By-laws to govern its local action. The order of service for Sunday and Wednesday meetings and for the Sunday school is outlined in the Manual. But all matters of building are left to the individual working out of each branch church. There are no stylistic or liturgical requirements, no cost or size requirements, no location or other requirements dictated from headquarters. Building is financed by the work of its own membership; and a church is not dedicated until completely free from debt.

As was before stated, church growth is the normal result of individual growth. Several Christian Scientists may begin to meet (in a locality where there is as yet no church), to read the Lesson-Sermon together on Sunday and to hold testimony meetings on Wednesday. Eventually such a group may gain recognition and be listed at headquarters as a Christian Science Society. This group may become recognized as a branch church when they number 16, and meet certain other requirements. As it
continues to grow, with membership and congregation drawn, perhaps, from a rather wide geographical radius, it reaches a point of development where a new church goes out from it. This offshoot may be the group living farthest away from the original center, (in localities where transportation is a factor), or it may be the group in the next largest town, or simply the next largest group. As the outcome of individual activity and community response thereto, it is impossible to predict where the next church will be.

So it is with the determination to build. As long as an existing building is adequate, or suitable rental property available, a church may not decide to build for itself. It awaits the readiness of the local membership to take this step. No research on the geographical location of existing churches can indicate where it should or is apt to occur.

In urban centers the tendency is for some churches to reach large size, in spite of their sending out new churches. The question arises: is there a desirable maximum? The answer seems to be: yes. When a membership grows too large, mutual acquaintance tends to be less, - a drawback in elections and committee work. Auditorium size, too, is a factor. The Wednesday
evening meeting in a congregation of tremendous numbers might tend to become more of a show than a simple exchange and sharing of experiences. Hearing becomes difficult. Although there is no set rule, the feeling of individuals with experience in large churches seems to indicate a desirable maximum auditorium capacity of 800 to 1000.

The foregoing is a brief outline of the structure, services, and growth of a branch church. The essential sameness of general requirements, irrespective of the size or location of the church, suggested this study as an architectural type-form. Although many Christian Science churches are thriving most happily in buildings designed for other denominations, their particular requirements suggest the unfoldment of a new form - capable of endless variation - which will be more truly expressive.

Subsequent pages will take up in greater detail these requirements; but outlined as follows they constitute the elements of the program:
**ELEMENTS OF THE PROGRAM**

<table>
<thead>
<tr>
<th>Congregation:</th>
<th>Auditorium</th>
<th>Sunday Lectures</th>
<th>parking foyer checking phones wash rooms nursery literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services</td>
<td>Ushers</td>
<td>meeting dressing (?) collection</td>
<td></td>
</tr>
<tr>
<td>Readers:</td>
<td>Platform</td>
<td>Retiring rooms</td>
<td></td>
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<tr>
<td>Music:</td>
<td>Organ (or piano)</td>
<td>Organist (or pianist) performing space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soloist</td>
<td>performing rooms</td>
<td></td>
</tr>
<tr>
<td>Sunday School:</td>
<td>Assembly</td>
<td>Platform Piano</td>
<td></td>
</tr>
<tr>
<td>Classes</td>
<td>Services</td>
<td>Superintendent coats wash rooms phones</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>Administration</td>
<td>Secretary library</td>
<td></td>
</tr>
<tr>
<td>Admin:</td>
<td>Committee work</td>
<td>Literature - storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clerk</td>
<td>Offices and records - vault</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treasurer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical:</td>
<td>Superintendent - janitor</td>
<td>Heating and ventilating equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organ blower</td>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Reading Room:</td>
<td>Sales room</td>
<td>Usually located separate from church. Included here for completeness.</td>
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<tr>
<td>Study room</td>
<td>Services</td>
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<td>Services</td>
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</table>
Existing Church Buildings

Plan-wise, many Christian Science church buildings work satisfactorily. That the expression of the plan is so often clumsy and uninspired is no doubt partially due to the generally low level of architecture in the early part of the century, which was the period when initial building took place. These early buildings unfortunately set fashions which have been perpetuated in much later work.

But before discussing aesthetics, there are several salient points in planning which, I believe, need attention. They will be developed more fully in the sections which follow, but for the evaluation of existing churches they are briefly listed below:

1. Sunday school: often relegated to the basement on grounds of economy! Here, acoustical isolation from the church auditorium is difficult, and the many classes in an unpartitioned space disturb one another. Columns break up the unity of the room. Most of all, the scale is usually very un-childlike, and the daylight meager. From an expression standpoint this department should be almost co-equal with the church auditorium itself.
2. Foyer: often too small and crowded. A less formal, more gracious entrance, - perhaps connected with a garden, - would give a warmer welcome.

3. Administration offices: usually isolated from, instead of adjoining, the foyer, which is the main public circulation area. Passage through the auditorium to reach the offices from the foyer is not desirable.

4. Soloist: usually so placed in connection with the organ console that he must remain visible for the whole of the service.

5. Acoustics: in large auditoriums often unsatisfactory for hearing speakers from the floor on Wednesday nights.

6. Artificial lighting in the auditorium: often cold and gloomy, or else glaring.

These are practical considerations which call for improvement.

The vital nature of Christian Science, its radical position and practice, could never be glimpsed from the various "stylisms" in church buildings throughout this country. The porticoed "Greek bank" variety
reflects American cultural conservatism of a period when the model was the past of Europe. A later romanticism, "Colonial", takes as the model our Puritan heritage, and sentimentalizes the simple clarity of the New England meetinghouse.

But it remains for contemporary architecture to recognize a point of contact here, and to lead on from the real vitality of the early meetinghouse to a true and honest expression which will be the Christian Science churches' own. The absence of stylistic dictation leaves any branch church free to build in the way it sees best, and this fact gives hope of better buildings. Changes come slowly in democratic process. But perhaps this very fact may forestall an outcrop of "modernistic", which would be no better than past "styles".

A few examples of good architecture are encouraging, though even they may not have caught the true expression.*

* An unexecuted project for a church in Minneapolis deserves mention because of its architect, Eliel Saarinen: a very large church, cathedral-like in its scale, bearing little resemblance to his more recent work. Side walls are completely closed, and lighting of the auditorium is from a great skylight.
In this country, First Church, Berkeley, California, by Bernard Maybeck, 1910, is probably the only one of real distinction. Wurster, writing in San Francisco Bay Portfolio 5, says of this building: "difficult to photograph like many great romantic structures, [it] shows a use of growing things and spatial effects, an anti-facadism, often thought to emanate solely from Frank Lloyd Wright. Its exterior walls use asbestos board for the weather surface, a feat more recent moderns will claim to have invented." And from the Architectural Record: 6. "The square central hall is spanned by two colossal diagonal arched timber beams, which in other hands could scarcely have failed to be oppressive. Instead, played against the glass screen walls, scaled with absolute surety against complex minor structural elements, seen against the mysterious extensions of the central space, they speak of serenity and power."

Criticism of this building from those who attend there is sometimes that the architecture is almost too fascinating for one to pay attention to the service!

Examples from Holland and Switzerland seem to come closer:
First Church, The Hague, Holland, by H.P. Berlage, 1927, was probably the first in the modern idiom and has been much photographed in European publications on modern churches. Its yellow brick exterior, typical of much good Dutch work of the period, is better in actuality than in the photograph. Though perhaps not having the radiance one would wish for, it is a clean and honest building. The interior, though a little hard, is clear and direct and fresh. Note especially the fine open organ over the readers' desk.

First Church, Basle, Switzerland, by O.R. Salvisberg, 1936?, with its prominent Sunday school location projected out over the main entrance, is charming in its siting, set well back from the street on an interior lot with a wide planted approach and fine old trees. Its auditorium has a quiet dignity and excellent lighting both by day and night.

First Church, Zurich, Switzerland, by Hans Hofmann, 1938, is perhaps the most gracious and pure in the expression of its exterior, with a vigor and delicacy of proportioning that seems very fitting. Whether this warmth is carried through in the interior is not evident from
the view shown. This building, also, has been much published in discussions of modern churches.
First Church of Christ, Scientist, The Hague
First Church of Christ, Scientist, Basle
First Church of Christ, Scientist, Zurich
These churches are only a beginning in the honest approach that will be made. The freedom from architectural tradition should make this a problem of interest to the contemporary architect. Any dependence on or use of old forms seems inconceivable. This does not mean that a modern "style", any more than an eclectic style, will be tolerable; but it does mean that the purity possible when working from architectural principle, as is the impulse behind the modern movement, is its appropriate expression.
Thesis Scope

Because this thesis could not be done as a real problem, - that is, with an actual program set up by a building committee intending to build on a specific site, - and because of the attendant vagueness inevitable to any theoretical study, I thought it would be most enlightening to approach it from a rather broad basis. It seemed that two important aspects ask for consideration:

1. The matter of growth. The small church, (or society) may wish to build when its membership is at or near the minimum size, and to do this in such a way that its later needs may be taken care of by pre-considered additions to its building. Such a program would not be expected to take care of growth to the maximum. In a small community the church is apt to remain relatively small. But a first-stage building for a congregation of, say, 50, plus provision for the Sunday school, might well be added to successively for capacities of, say, 100, 150, or 200. Growth beyond such a number would normally be taken care of in the formation of new churches or by the sale of the property and the starting out at larger scale. It might be here stated that small churches of capacities 80 to 100 seem to constitute by far the
greatest proportion of building. The small church in a residential setting is an interesting problem in architectural scale, so happily solved on the 18th century village common, barely attempted in today's new conditions.

2. The fully developed urban scheme. The desirable maximum solution, with an auditorium capacity of around 1000, would give opportunity to study the inevitable complexities resulting from size. These complexities include those of acoustics and structure, problems which exist but are more easily solved in smaller buildings; and planning for the Sunday school, which becomes especially interesting when the numbers are very large.

Between these extremes of size there seem to be no new problems. Another possibility would have been to take an average urban church, of about 500 capacity, which in a certain way combines the problems of the largest and the smallest. But I felt that the points above mentioned would be most challenging to consider in their extreme form.

Maximum and minimum solutions could not be combined. Due to the requirements of the church service there
would be no use for an original small church preserved as a chapel in the fully developed scheme. (The reading room actually takes the place of a "chapel" for individual use throughout the week.) The possibility that the original church auditorium might later be used as part of the Sunday school space is conceivable, and yet to go from one extreme of size to the other savor more of a architectural tour de force than a reasonably practical possibility.

Maximum and minimum solutions are two distinct problems, - in the sense that the physical requirements of structure, acoustics, seating, etc., are different, - and yet the essential sameness of requirements before outlined, and the spirit in all Christian Science churches suggested it as a single problem investigated throughout a scale range. Had time permitted, I should have liked to carry out such a study in the design portion of this thesis as well as in this report. The scope of such work, however, exceeds the range of a single thesis and it has been possible only to touch on this oneness here.

Of the two aspects chosen it seemed wise to begin with the maximum, as the many complexities therein promised to be the most demanding on time and effort. Also it
seemed that points crystallized in the large church might be more likely to clarify points arising in the small church than vice-versa.

The program set up for the large church appears in its original form in the appendix, and contains some important details not covered again in the body of this discussion.

The following pages will take up the main considerations more or less in the order of their study in arriving at the design submitted. These are:

1. auditorium shape
2. platform and readers' rooms
3. music
4. Sunday school
5. administration
6. structure
7. acoustics and lighting
8. site
9. over-all schemes
Auditorium Shape

The shape for the audience block was early felt to be a main starting point. Requirements of the Wednesday evening meeting, in which speakers from any part of the floor need to be heard well, dictated from the beginning a compact form of plan without overhanging balconies. The relationship of audience to readers and of audience to itself, for a capacity as large as 1000, suggested curved rows and sloping floor.

The audience wishes to see the readers. This eliminated any idea of an arena sort of scheme, in which parts of the audience would be behind the readers, (even though their voices could be reinforced acoustically). Observation, over a period of time, of audience choice of seats in existing churches confirmed my feeling that an arena plan would not be the answer. Choice seems to run toward the middle distance, fairly evenly distributed right to left, but not too far to the side. An arena might be a good expression for the testimony part of the Wednesday meeting, but would seem to put undue emphasis on the audience's relationship to itself the rest of the time.

The decision to adopt a variant of the conventional
Auditorium made it next necessary to study possible sections. A reversed slope, similar to recent movie theaters, was considered, as a way to get good sight lines to readers without the complications of entry inevitable with the steep sloping section. Although this might be developed satisfactorily, it was rejected in favor of a slope which provides better sight lines to points within the audience itself. A section of the minimum parabolic slope, (without reverse), giving sight lines to the platform over heads in alternate rows, was finally adopted. Exploration was then begun for a plan shape with this section and the curved row (or an approximation of the curved row), which by partially facing the audience toward itself established that relationship sought.

For reasons of simplicity I felt that the plan shape of the auditorium should be a primary form, a readily grasped form. I was inclined from the beginning to the circle as somehow appropriate, but this preconception was set aside to study other shapes to see what would best satisfy the functional considerations.

For 1000 capacity, the following shapes were set up, and circulation possibilities studied:
For the sake of unity in the audience block, circulation seemed best in simple lines from back to front. Seating plans dependent on cross aisles were rejected.

Of all the possibilities studied for the big auditorium the circle seemed by far preferable. It coincides quite exactly with the observed audience choice of seats, having the greatest number in the middle distance. It harmonizes perfectly with the curved row. It approximates the pattern of acoustical intensity of the readers' voices. It brings the audience into the most compact relation to itself, and has the smallest periphery for its area. Above all it has a feeling of simplicity and monumentality and unity.

Circulation study yielded the curved aisle as being a closed, unprocessional walkway, that did not form allées toward the readers' desk. A center aisle was purposely avoided.

Next to the circle, the square form seemed most appropriate for the large auditorium. For smaller churches, some of the forms rejected in this study might become preferable, as reduced size alters problems of hearing and seeing and circulation.
Platform and Readers' Rooms

Focal point of the auditorium is the readers' desk. No particular problem is presented here. Two lecterns are needed, which should be removable on lecture occasions, as lecturers do not like to have to stand behind them. An open platform, therefore, with a light desk, seems more suitable than an enclosed pulpit. Readers are frequently tried by down drafts from organ pipes located above, and by inadequate ventilation when the platform is deeply indented from the auditorium. Auxiliary heating and ventilation for the platform would be appreciated. Main consideration is good lighting on the books. Rheostat control to bring up house lights during the testimony period might be a gracious way of inviting audience participation.

A small retiring room for each reader, preferably with its own lavatory and closet, is used for dressing and study before the service. Access to the platform should be direct and easy, not through the auditorium, and, if convenient, at platform level. Conventional placement of these rooms is immediately behind the platform, where the administrative offices are also usually placed. There is, however, no connection between these functions,
as the readers are quite independent of administrative matters and have no occasion for contact with the clerk.

Similar retiring rooms for the organist and soloist, in the large church, with access to their performing space at the console, should be provided.

With plan and section of the auditorium now roughed in, in relation to the readers' platform, provision for the organ as the next most important item was considered. This meant studying not only the nature and structure of the instrument itself, but also the musical requirements of the church service as a whole.
Music

Although the musical requirements are simple, good music in the Christian Science service is important: congregational singing, three hymns each service, organ prelude and postlude, and the organ offertory and vocal solo on Sunday. There are no special musical services at Christmas, Easter, or other times.

Congregational singing needs no architectural discussion, except to mention its general acoustical environment and accompanying instrument. A live space, and an organ of the type described in the following pages, which has presence and tonal design such as to vivify the singing and not be overpowering, - these are the considerations.

The solo is the only musical focal point in the service. This form of music is at once the most simple and direct, as well as potentially the most personal. To play down this personal element seems to me in accord with the idea of the service, and the soloist's position is the key to its achievement. If the soloist is located where he is not facing the audience - like one on a stage giving a "performance," he is freer to keep his thinking on the music itself. Certainly he does not belong on the readers' platform as is current practice. If he
must be visible at all, he should be able to appear for his part and then retire, and not remain, mutely, all during the Lesson-Sermon.

In small churches the singer often rises from a place in the front row of the congregation, turns and faces the audience for his song, and then sits down again. In a small group, a strong leading voice may help to carry the congregational singing, and a place at the front may be justified. But in a large church this is not necessary, and a less personal location seems better.

The soloist must be close to, and within sight of, his accompanist at the organ console, and fairly close to the pipes themselves in order to consort well. Therefore the location of both musicians and instrument must be determined from their combined requirements.

Organ: tonal design

As the main musical element of the church, the organ deserves considerable study on the part of the architect. A good organ is in large measure an architectural problem, and close collaboration between architect and organ builder from the early stages of planning is necessary.
in order to produce the best instrument. The musical performance of any instrument is governed to some degree by the acoustic character of the space in which it plays, but in the case of the organ acoustical environment is paramount. The auditorium itself constitutes its sounding board, and the shape and material of the auditorium are the architect's decision.

We are in a period of renascence in organ building. Progressive builders* are taking the pipes out of chambers to achieve unforced clarity and purity of pipe speech and musical delineation. They have lowered wind pressure, which enriches the tone. This gives more cohesion in the ensemble, which is of greater concern to us today than the special-effect and imitative solo stops of the romantic or theater organ. It is in one way a return to the "baroque" or "classic" style organ of Bach's time, but progressive builders are going forward in tonal design and aim at producing an instrument which will play all the good organ music from pre-Bach to Hindemith!

The organ sings with much more presence, if unenclosed

* For help in this study I am greatly indebted to Mr. Joseph Whiteford and Mr. G. Donald Harrison, of Aeolian Skinner Organ Co., Boston; Mr. E. Power Biggs, organist; and especially to Mr. Walter Holtkamp, of the Holtkamp Organ, Cleveland.
and projected out in the auditorium space, than when filtered through dummy display pipes, shutters, and grilles. Also the tone of the unenclosed organ is more brilliant, clear, and colorful. If the acoustics of the room are live and well diffused, a smaller amount of open organ will do a bigger job.

One enclosed division, however, is recommended - even by such advocates of the open organ as E. Power Biggs and Walter Holtkamp - for accompaniments and soft passages, and as a legitimate means of shading.

This open organ with one swell box is not only ideal for the music of Bach, but also for the best in romantic music, Cesar Franck for example. The theatrical or operatic has no place in a church, and can best be discouraged by an organ installation of the type described.

In the large auditorium of this thesis, an appropriate organ might have the following specification: 7.
## Organ: Structure

During the study of possible locations, the significance of the structure of the organ choirs was brought out to me, as entities which are called for in organ literature. That a given manual controls a particular choir is a fundamental of organ structure, and should not be violated by any heterogeneous mixing up of pipes or their too great dispersion. *The four choirs: great, swell, pedal, and positiv, have each their identity in organ music, and this identity should be maintained in the location of the pipes.*

* This fact made me give up early thoughts of a side-wall organ surrounding the auditorium, or a dome clerestorey.
Another point brought out to me was the value of having the organist close to the pipes. Technically, with the electric or pneumatic controls of the contemporary mechanism, the console could be located anywhere. Aurally, it will be up to a thirty foot distance from the pipes before the delay in sound travel causes the organist too much difficulty. He can make adjustments for delays in sound travel and unbalance of tone, and compensate in his playing so that the audience will hear approximately what he wants them to hear. But this makes no musical sense! Only when the player is actually hearing what he is doing, under the best possible conditions, can he be really free to think and play musically. This elementary idea, that a performer must be in balance himself to perform his best, is all too often overlooked. He may hear more directionally, just as a conductor will have a 180° range from the orchestra while the audience farther away gets a much flatter picture; nevertheless it is this very proximity in the doing that makes for better playing. It gives more the sense of playing on the instrument.

(Mr. Holtkamp believes that tracker action, if possible today, would heighten the immediacy of contact between
player and instrument, both in the variation in quality of attack and release possible when the finger on the key controls a valve directly, and in the musical effect produced when the volume of tone is proportional to the energy expended by the player; i.e. when a fortissimo with all stops open would require more energy to move more valves than a pianissimo on one stop. But whether or not tracker action becomes producible in this country, the proximity of the console to the pipes will still remain musically desirable.)

All the foregoing factors suggested a single location for organ, organist, and soloist. Consideration was given to the placement of an organ balcony over the readers' desk. A balcony of some sort seems inevitable because of the height required to allow the sound to come forth without obstruction. There are undoubtedly many ways in which the forward position could be well worked out, with the soloist and organist either seen or hidden. But the concentration seemed formal and static, even though the balcony were off-sided slightly. Greater distance between the musicians and readers seemed to give better balance in the space.
The organ itself is visually beautiful, and should be seen, with these many hundred pipes, round and square, of natural wood, of dull and shiny and spotted metal, large and small, with the little accents of stopped pipes, trumpets, and rohrflötes. Even the movement of the swell-box shutters would not be disturbing any more than the movements of the player - except in church!

All these considerations brought me to a rear balcony location. Here the soloist is freed from the tendency toward a personal performance. Here the attention of musicians and audience is allowed to rest on their music. Here the visual beauty of a subsidiary element is not allowed to dominate the reading.

The result is by no means an innovation. In churches of all denominations it has been done frequently. But in this case it has been a re-discovery.

Closely allied to the subject of music is the acoustic form and treatment of the auditorium. But before going into the more technical aspects of the structural solution, the plan requirements of the second most important department of the church need to be considered.
Sunday School

Children are accepted in the Christian Science Sunday School as soon as they are old enough to sit on a chair and remain quiet for the hour. This age varies with individuals, but may be as early as 2 years.

For younger children there is often a nursery provided, so that parents who wish to attend church may leave their little ones in the care of the attendants. Cribs for the babies, and quiet toys for the older ones, together with storage for these facilities, are necessary equipment. The nursery is properly a part of the services and not part of the Sunday School, because the children are only being played with and not taught there. It should not be located too close to the Sunday School room, where it might distract the primary classes by sight or sound, but neither should it be too far away, since "graduations" occur often as children are ready to go into the Sunday School itself.

Children are received and may remain in the Sunday School until they reach the age of 20 years, but not after that time. (There are no adult classes held there.)
Classes are small - preferably not over 6 or 8 pupils - and it is well to have the groups separated from one another in some way during the class period, which occupies the better part of 45 minutes. The opening and closing exercises, which include singing, are conducted by the superintendent with the entire school. Some arrangement should be found which permits all the classes to join in the assembly portion of the service without having to move to and from their class cubicles. Since the assembly periods are short, it is better to avoid the time and confusion of making such a shift.

Though there are no clear lines of demarcation between age groups, it seems as though three kinds of class space are called for: For the littlest ones, it is quite necessary to be able to shut off completely the view of other classes during the instruction period, by means of curtains or movable partitions; also to be not too far from the entrance and wash rooms. For the oldest ones, of late high school and college age, some feeling of being apart from the "youngsters" is appreciated, perhaps a balcony location. In-between ages have not so much need for separation, and this space can probably be the flexible space, without fixed divisions,
to allow for growth of the Sunday School. Chairs grouped around tables, with ample space between, or some half-height booth arrangement to give partial separation, are satisfactory.

The only provision needed in the class spaces, aside from seating and light, is for hymnals and coats. There is never any use of teaching aids such as blackboards, movies, illustrative material, writing or drawing equipment.

The idea of a common coat room for children was rejected as being a place of confusion. Small children will require help in any case, and this can best be given by the teachers at their individual places rather than in a crowded coat room. Only for rainy day use was such a place considered.

The music of the Sunday School is singing. Piano accompaniment is usual, though in a large Sunday School a small organ would be very appropriate. Such an organ might be a single manual 3 or 4 stop section equivalent to a small version of the Positiv of the church organ.
The necessity for quieting the noise during the teaching period, without losing the open space feeling, suggests a rather highly absorptive acoustic treatment in preference to a live singing space. Partitions between classes and almost all available surfaces may be treated with absorption material.

Office space for the superintendent and the secretaries' records and a place for the lending library must be provided. The lending library need be little more than shelf space in a small Sunday School, but in the large school may have a little room of its own.

In planning for the number to be accommodated in the Sunday School the architect must leave the decision to the Building Committee or church membership. Research on existing proportions reveals very little that can be applied to a specific case. In smaller churches Sunday School capacity may equal or exceed church capacity. But this ratio tends not to hold in larger churches, possibly because they are likely to be in cities, where the child population is a lower proportion than in suburban or rural areas. But it is safe to say that half the auditorium capacity should be set as the
bottom limit for the Sunday School capacity. For the purpose of this thesis, 600 was taken as a large Sunday School at present. Expansion beyond this number would be taken care of by holding another session.

Such an important department of the church deserves expression as such. The Sunday School is really a children's church, with its own special requirements determined by its order of service. It should be a place that children love to come to.

Its all-too-usual consignment to the basement has already been noted and deplored as being undignified and belittling to the children's needs. Unless a sloping site affords opportunity for generous above-grade fenestration, it is difficult to convert the space below a large auditorium into a proper Sunday School room. Even if satisfactory inside, it would not be on the exterior an expressive entity appropriate to the importance of this department.

Early studies led me to a skylight solution. Prime consideration here was an atmosphere of light, of sunshine and joy, that should be attractive and not
awesome. A certain intimacy of scale seemed appropriate to children. Natural light in every class was a necessity, and with the separation required between classes it posed a problem. With light coming only from side walls, any shutting off of the outside classes meant that the center would be dark. And even if the outside classes were not shut off, to get enough light from the side in so large an area meant a ceiling height out of the desired scale. Various terrace schemes were tried and abandoned. Sight lines of this nature seemed less preferable than the scale advantage of a lower ceiling.

The flat-floored, skylighted room offers fine opportunity for partial or complete curtaining off of the individual classes during the teaching period, if desired, and still having light and sunshine pouring down from above. A balcony could easily be accommodated without darkening class space, and without raising the ceiling height which would be necessary anyway in so large a room.

Focus was another point in favor of the skylighted space. Actually seeing the superintendent's face from every point, during the assembly period, was felt to be unimportant compared to the general focus that the superin-
tendent represents. This focus toward the center is admirably achieved by the skylighted space and closed peripheral walls.

Six hundred is a very large Sunday School. For a small one the skylight plan would become less necessary, if all classes could be peripheral, and side wall illumination might be completely adequate and very pleasant.

The actual plan shape did not seem critical. Square, circular, or oblong plans, even sharply indented ones, seemed to offer many satisfactory possibilities. In this thesis the circle was chosen. Sitting in a circle has an association of intimacy and brotherhood from the campfire to the council table! And there seemed a certain logic in repeating the form selected for the church auditorium. (The long search ahead for the satisfactory relationship of the two circles was not anticipated!)

Lecture attendance usually taxes the seating capacity of the church to the utmost, requiring overflow provision with P.A. relay in the Sunday School room. Storage space for chairs is needed nearby. It would be especially desirable in the small church, if the plan could be arranged so that the Sunday School space could be thrown
open to the auditorium, although care should be taken not to sacrifice the acoustical isolation between church and Sunday school for the normal Sunday use. (Other means for expansion of facilities at lecture times might be worked out. In warm climates it is easily possible to open a court or garden space for lecture overflow if there is some protection from the weather.)

The time for the Sunday school is usually concurrent with the church service. This allows families to come together. A common entrance seemed the gracious follow-up of this idea, if it could be handled without confusion between children and adults. Ample space in the foyers, with perhaps some minor division between, would make the intermingling of all ages a warm and joyous thing.
Administration

The balance of branch church requirements are covered in the detailed program in the appendix. Administration and committee space is important. The executive board probably meets at least one evening a week, and the clerk or secretary (and sometimes a treasurer's assistant, in a large church) is a full time position. Close linkage of these rooms, together with a small reception or ante-room helps church business to be done easily.

Committees need space for work and meetings. Tables for the sorting and cleaning of literature for distribution, together with ample storage space, is required by the Literature Distribution Committee. (There is a wide secondary circulation of all periodicals including The Christian Science Monitor.) Other large committees, Monitor Advertising, Monitor Circulation, Sunday School, Lecture, etc, which need only meeting space, might use the Sunday school if the regular committee room is in use. Since committee needs may be variable, (note, for instance, the extensive work done on war relief during the war), it may be best to keep committee space as flexible as possible. Movable partitions in the committee room would allow simultaneous meetings of two
or three small groups, e.g. House, Music, Institutions, Publication, Membership, etc., and the scheduling of meetings would not be restricted by insufficient facilities.
Structure

Early in the development of the design, various structural possibilities were up for consideration. Code dictation of first class construction meant a choice between steel and reinforced concrete. Recent progress in pre-stressed thin-shell concrete domes seemed to offer an attractive solution for the big-span auditorium.

The whole subject of concrete shells I found most provocative to the imagination, as the directness and lightness of the curved monolithic slab has a simple elegance especially appropriate, it seems, to church architecture. Technical calculations are, however, extremely complicated at present, and the scarcity of shell construction in this country is partially due to the need for tabulation and publication of the engineering data so that it can be used outside the narrow circle of specialists.

But dome design is not difficult, and employed extensively for tanks such dome structure seems to compete economically with more conventional roofs of similar span.
An idea that presented itself while I was exploring roof and floor systems might be interesting to interpolate here, although it was not carried out in the final design: Trial of the dished floor shape inverted for the roof, (instead of the spherical dome surface), suddenly suggested the shell form. Tapered, arched corrugations, - radiating from a point on the periphery at the front of the auditorium and dropping lower around the circle to the rear, - simultaneously seemed to meet the problems of structure, acoustical diffusion, and aesthetics. Conversation and correspondence with engineers on the practicality of such a non-isotropic form yielded a variety of response.* A copy of a letter from Mr. Fred Severud is included here, as his imaginative reply to my question was the only practical encouragement I could get from the engineering profession!

* For help in my brief study of shell construction I am indebted to the following: Chicago Mr. W.A. Renner, supervising engineer, Roberts & Schaefer Co. Mr. M. Fornerod, chief engineer, Preload Corporation, N.Y.C. Mr. Morris Ketchum, architect, N.Y.C. Mr. Fred Severud, engineer, N.Y.C. Professors Voss and Simpson, Building Construction Dept, M.I.T Professors Norris and Holley, Civil Engineering Dept., M.I.T.
January 19, 1950

Miss Dorothy West Pelzer
64 Mount Vernon Street
Cambridge, 40, Massachusetts

Dear Miss Pelzer:

I read your letter of January 8th with a great deal of interest and I have given some thought to how your problem might be solved along the lines that you suggested.

In comparing the structure with a shell, it should be remembered that a shell is designed not only for vertical load but also as a cantilever against opening. For that reason a shell is strongly reinforced towards the hinge and the curvature there is much sharper than otherwise. The form that suggests itself to me would be corrugations about 6' in depth at the center and smaller near the edges where the spans become shorter.

By giving the corrugations a rise of another 6' or so, at the center, and providing a horizontal tension ring, an integrated system results. Corrugations would create outward thrusts which then are resisted partly by tension in the tension ring and partly by moments to compensate for unequal thrusts at the different corrugations. It would be a system that would not be too easy to analyze accurately, but by proper judgment approximate methods could be employed that would give safe results.

To erect a roof of this kind would be very costly if it were to be formed in the ordinary manner. I believe, however, that it could be built near the ground and the ground could be so graded that the bottoms of the corrugations would rest upon it. At certain intervals, undulated wooden panels could be erected vertically with notches to receive ropes. When these panels are in position, ropes could be strung from one to another to furnish support for canvas which then would act as a form for the underside. By pouring concrete first where the canvas rests on the ground and then progressively up the sides, good results could be obtained. The weight of the concrete on the ground would stretch the canvas over the ropes. There would, of course, be a
certain amount of sagging and the impressions of the ropes would be visible, but the whole effect should be very interesting.

Another method would be to form the corrugations in wood sections and rest these on the ground, spaced properly so that the right taper is attained. After the roof has fully set, it could be raised up along the columns by the Youtz-Slick method. A reprint from the Architectural Record is enclosed, which will explain how this method works.

I hope this description will suffice to give you a general idea of the system proposed. I have purposely not drawn any sketches because I believe that it would be best for you to think about the shape of the roof from the point of view of architectural requirements. If you should find that the shape as suggested would lend itself, you might send a rough sketch and I shall be glad to look it over.

Very truly yours,

Severud-Elstad-Kruger

Fred N. Severud
This idea was dropped somewhat reluctantly. To have based the whole design on a still somewhat fanciful construction would have taken the entire study into a realm of unreality that I felt would not serve the purpose that impelled this work: that of finding a direction for branch church building. As the design for the skylighted Sunday School began to unfold, it seemed logical to consider roofing these two major spaces similarly, - for possible economies to be gained by the re-use of formwork, as well as the unifying repetition of the same visual form.

I therefore decided to adopt the shallow spherical dome for both.

The rest of the construction of the auditorium was so determined by the acoustical requirements that this subject is the next to consider.
Acoustics and Lighting

Good acoustics are a prime requisite in the Christian Science service. The paramount importance of the spoken word, from the desk and from the audience, calls for optimum speech intelligibility. To provide good hearing conditions with speakers from any point in the congregation is a challenging problem.

One of the reasons for choosing 1000 as the maximum auditorium capacity is that it is about the largest for the average speaking voice to be heard without amplification. Amplifiers for the Wednesday meeting would not be good. If those wishing to speak had to go in advance to a particular spot where there was a microphone, the informal and spontaneous character of the meeting would be lost. Microphones scattered throughout the audience would either pick up too much incidental noise, or else have to be switched, by the speaker or by someone at a control point. Such mechanical gadgetry would be out of keeping with the simple sharing period.

A better way to achieve the desired conditions is
by a fairly live space with great diffusion. Too much absorption deadens the organ and singing and requires more voice power for a speaker to be heard. But live space must be diffuse and free from focusing effects.

The circular plan shape for the auditorium was adopted in full knowledge that it is the worst possible one from the standpoint of acoustic focusing. I rather welcomed the opportunity to study how this limitation could be overcome, as the shape itself, for all other reasons, seems so appropriate. To avoid undesirable reflections and creep from cylindrical surfaces, walls must be inclined or splayed or made absorptive. Since the side walls were mainly of glass, the break-up of the cylinder horizontally or vertically was necessary.

The following ray diagrams illustrate:

A. focusing effect of a smooth cylinder
B. break-up of focusing by random angled vertical planes
C. points of focus thrown overhead by out-tilted planes.
A. Focusing effect of circular wall
B. Diffusing by random-angled planes
C. Diffusion by out-tilted planes
Although spherical sound waves do not behave exactly like linear diagrams, some idea can be gained from them.

Any regular break-up of the wall, (or ceiling) surfaces is apt to result in grating effects. This should be avoided by randomizing wherever possible.

The shallow dome tentatively adopted to span the auditorium was tested out, at various radii, in ray diagrams, to check for bad focusing. The following sketch shows that there is none; that it tends to disperse rather than to concentrate. Without additional treatment it would be quite satisfactory. The most difficult speaker to hear, however, is not necessarily the one farthest away but one facing the opposite direction.

Tilted surfaces which will reflect some sound back of the speaker will help markedly the hearing at any point. A suspended ceiling of random-tilted planes of thin plywood could be hung without great cost. Insets might be placed in the forms at the time of pouring, and the ceiling itself added at a later date.) The smooth dome would be visible above the planes and would give a good surface for low frequency absorption.
Shallow dome, without hung ceiling, showing no tendency to focus.

A. Advantageous reflections from random-tilted planes.
B. Canopy to intensify sound at rear seats.
There is obviously no sense in shaping the whole ceiling for the reinforcement of the readers' voices, since we do not have a one-directional requirement, but a small reflector suspended over the desk would help to build up intensity at the rear of the auditorium.

Care should, of course, be taken to isolate outdoor traffic and foyer and Sunday school noises, but as these are more routine matters they are only mentioned here.

Closely connected with the acoustic handling of the glass walls is the question of lighting and sun control. Study of sun angles, at morning service time throughout the year, showed the need of breaking the light through almost 180° of wall. Experiments in the model with various exterior and interior, horizontal and vertical louvres, and with screens of various materials, brought me finally to a simple curtaining of plastic or glass fabric. Translucent curtains, either hung in folds or stretched taut seemed to offer the best solution to the triple problems of sun control, obscurity, and night covering of the dark windows. (Some absorptive effect acoustically, and added obstruction to creep, should be a further benefit.)
The quality of the light admitted can be really determined only on the job, by the proper choice of glass and fabric.

Night lighting is by pin-hole spotlights above the ceiling planes. Such light falls graciously on an audience, without glare.

The quality of light - more than any other factor - is the keynote of the atmosphere; it should be not hard, but radiant.
Insolation Diagram: Extent of Solar Penetration showing need of sun control

Sun Angles
Site

The question of site selection is so involved with the individual building problem, that I felt little was to be gained by extensive site research for a program that was theoretical. Early in the study I expected to choose a real site, and made tentative selections in and near Boston. But site brings up so many questions whose answers would have been sheer fabrication, that I decided to confine the study to the internal requirements. This has meant a wider field of exploration, due to the lack of determining factors which a site impresses on a plan.

As explained earlier, the decision when and where to build rests with the individual branch church. It will want to choose a site that best serves its membership and its community, probably within walking distance for a large part of its congregation. If there were a popular demand for decentralization, the outlying churches would now be the large ones. But at the present time congregations of this size are found in cities, and therefore a fairly urban site is typical. (It should be borne in mind that this is a maximum solution. The tendency is actually
toward more small churches, as this gives greater opportunity for active participation of the members."

With an increasing number of cities passing off-street parking ordinances the site should certainly include a parking lot. Comparative costs indicate that even where land is expensive a larger site will probably be cheaper than building for double deck parking. If the land is available, the advantage of the additional space around the building is obvious.

The site assumed is urban, and in a northern climate.
Over-All Schemes

The following page shows a few of the many over-all schemes explored. Satisfactory relationship of two round elements is not easy, and the circulation requirements in the program turned out to be more complicated than they seemed at the beginning. I continued the search, however, because the two major circular spaces seemed to offer something within themselves, and I became interested to see whether there were not some good way in which they could be brought together. The theoretical problem offered unique opportunity for such a study.
Conclusion: Continuity

A theoretical study is just a beginning. Certain generalities can be thought through without the compromises inevitable to a working out process. But the vivifying factors are missing. Only by meeting and overcoming in actual practice will an expression be truly found - an expression that emanates from the continuing unfoldment and demonstration of Church.
Acknowledgment

To the Architecture Faculty of M.I.T., and to all who have helped in this study, my warmest thanks.
Notes

1. I Kings 8:27
2. Eddy, Mary Baker: *Church Manual*, p.17
3. ibid., p.74
4. Architectural Record, May 1928
5. Magazine of Art, December 1944, p.30
6. Bangs: Maybeck, article in Architectural Record January 1948
7. organ specification, courtesy of Walter Holtkamp
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Manual of The Mother Church

published by The Trustees under the Will of Mary Baker G.Eddy, Boston
Large Church: Tentative Program

Church congregation

Auditorium: capacity 1000

1. Entrance: Prefer same level as foyer; if on 2nd floor, up wide easy steps or ramp, (avoiding bottlenecks), and provide elevator or other means of entrance for wheel chair.

2. Audience shape: compact and unified; no over-hanging balconies; want to see everyone from everywhere because of Wednesday nights. Good sight lines to readers' desk and to all parts of the audience probably means curved rows and sloping floor. Late comers to be seated without disturbing others.

3. Seating: pews o.k. if comfortable; 33" - 34" desirable spacing back to back; allow 20" per place, or 22" if theater seats; should probably be upholstered for acoustic reasons.

4. Acoustics: live space with great diffusion. Paramount importance of the spoken word, from the desk and from every point in the auditorium, requires intelligibility despite optimum reverberation time desired for organ. (These not necessarily in conflict.)

5. Lighting: Want light space; joyous, noble quality, not somber or mysterious. Avoid glare, and direct sun. Control to shift emphasis slightly from desk to audience during hymns and when meeting is open for remarks from floor.

6. Atmosphere: simple, warm, clear. Decoration: no symbolism; no obtrusive patterns, grilles, etc. A couple of quotations on walls are customary but not mandatory; consider lettering and placement.
Foyer: Space needed especially after service, as congregation tends to linger and converse; possibility to open up adjoining meeting space. Avoid cosiness; space should have outgoing feeling. Place for literature collection and sales. (This might be done from Sunday school library.) Connection with garden, and Sunday school foyer. Access to administration offices, especially clerk.

Services

1. Checking: same level as foyer
2. Phones: 2 or 3 booths
3. Wash rooms
4. Nursery: Properly part of congregation services and not connected with the Sunday school. Should be out of sight and hearing of Sunday school, but not too far away, as children may be taken back and forth between. Cribs (or equivalent) and quiet toys; toilets. Baby carriage space outside. Sunshine. (These children will be not over 2 or 3 years.
5. Ushers: say 25, both men and women. Locker rooms adjacent to wash rooms, for ushers who wish to keep clothes at the church. Meeting room - use committee space. Count collection in treasurer's office.

Readers

Platform: Light desk; adjustable heights of top and floor. Auxiliary heat and ventilation; good lighting on desk. Readers generally prefer being at one desk rather than too far separated.

Individual rooms for 1st and 2nd readers for study and dressing; include closet and private lavatory, desk and chair. Entry from outdoors, not through auditorium. Prefer access to platform at same level if possible.
Music

Organ: 45 - 50 stops; unenclosed, except for one division in swell box. May be in front or rear of auditorium; desirable to have actually in the auditorium space, for best presence. Console not over 30' from pipes, better very close. Organist preferably not visible to congregation. Blower in basement, - see Mechanical

Organist and Soloist

1. Place for soloist not on platform with readers, unless he appears only for the solo. Not necessarily visible to audience; should be close to organ console.

2. Individual rooms for organist and soloist. (Sound isolation for soloist would permit practicing) Include closet and lavatory. Entry from outdoors, not through auditorium. Access to console and singer's place. Music library in organists room. (Music committee uses general committee space.)

Provision for membership business meetings

Use auditorium or Sunday school room. Consider means of making space visually smaller by screen wall; membership may be 1/3 to 1/2 of auditorium capacity. Organ may be needed. Access to platform from audience, for those giving reports, etc. Place for clerk

Provision for lectures

Use auditorium, with overflow and P.A. system in Sunday school. Not necessary for overflow to open into auditorium; might be desirable, if possible. Special room for lecturer not warranted; use a reader's room.
Sunday School

Auditorium: capacity about 600

1. Classes: small; 6 - 8 in age groups from about 3 years to 20. Prefer some division between classes during instruction period, especially for youngest children.

2. Assembly: Participation of entire Sunday school in opening and closing exercises, including 2 hymns. Avoid shifting places between assembly and classes. Overhanging space O.K.; not necessary to see everyone, only superintendent.

3. Acoustics: dead space, probably preferable to optimum reverberation time for singing.

4. Lighting: sunlight highly desirable, in every class if possible. (Hour will be same as church service, with possibility of extra session before or after.)

5. Scale: domestic

6. Atmosphere: colorful and joyous, not at all playful or cute; never awesome.

7. Other activities which may use Sunday school space at other times:
   A. Lecture overflow; provide P.A. system
   B. Membership business meetings
   C. Extra committee space

Foyer: entrance through garden; access to church foyer, space for monitors (Sunday school ushers)

Services:

1. Coats: generally, take to classes; provide hooks nearby; place for rainy day things.
2. Phones: access to church phones, or provide one extra.

3. Wash rooms

Sunday School Administration:
1. Platform for superintendent
2. Music: piano (or small one-manual organ)
3. Offices for superintendent and secretaries
4. Lending library

Administration:

Offices:
1. Board room: for meetings of executive board; 5 - 9 members. Table and chairs; desk for secretary; fireplace?
2. Clerk's office, with reception room, adjacent to board room. Access from church foyer. 2 desks; file space.
3. Treasurer's office
4. Vault for records: convenient to clerk's and treasurer's offices, who will probably use it equally.
5. Storage for office supplies

Committees:
1. General meeting room; divide by movable partitions.
2. Work room: including storage for literature committee
Mechanical:

1. Heater: 2 boilers
2. Cooling and ventilating
3. Organ blower: sound-isolated from auditorium
4. Service entrance
5. Superintendent's office: (or apartment)
6. Storage for chairs and miscellaneous

Parking

1. Cars - at least 150; sheltered landing
2. Bicycles: near Sunday school entrance
3. Baby carriages
BALCONY AND REFLECTED CEILING PLAN