

Kit-of-parts Chapels

A. Scott Howe, architect
Kajima Corporation, winter 1996

Introduction

This paper describes a series of chapels that can be assembled with the kit-of-parts building system currently being researched. The chapels are for use in the “block” schedule of The Church of Jesus Christ of Latter-day Saints. Since the number of configurations is virtually limitless, the plans described in this paper only represent a few possibilities. I will begin with a brief review of the logic and concept behind the system, then move into descriptions of the plans.

Concept Review

In contrast to conventional prefab systems which generally are applied to a single plan with little or no variations, the *kit-of-parts* system is conceived as a *library* of components with maximum flexibility for configuration. The

components are easily assembled and meant to be **demountable** for reuse over and over again. Considering the systematic approach adopted by the toy “LEGO”, where no specific final product is suggested but only a library of parts and rules for their assembly provided the designer, the concept of the kit-of-parts building system should become clear.

It is conceived that a library of standard parts could be available through Church distribution networks which could be ordered as needed by individual units. Standard plans could be established for certain sized units, which would be based upon parts from the catalog. Since a component-based system only consists of discreet parts, the number of each part required in a standard plan would be known, and the packageability of the components for shipping to remote sites could be worked out. Nevertheless since the parts are demountable, expansion or contraction of the building could be easily accomplished depending on the needs of each unit, and required parts ordered singly.

The kit-of-parts system is **joint-based**, which means that a rigorous system of standard interfaces between parts is strictly observed, but the actual members themselves are “anything goes”. This could facilitate the use of different materials or the creation of new parts that fit into the system. The joint system would be conceived in such a way that the possibility of incorporating power and communication infrastructures into the parts could be facilitated. This means that structural connection would also automatically complete wiring of the building since the “wiring harnesses” would be **integrated** into each part. The joint system would also have the capability to be “snap together / snap apart” without the use of tools, for the benefit of remote locations where tools and mechanical skills are hard to come by.

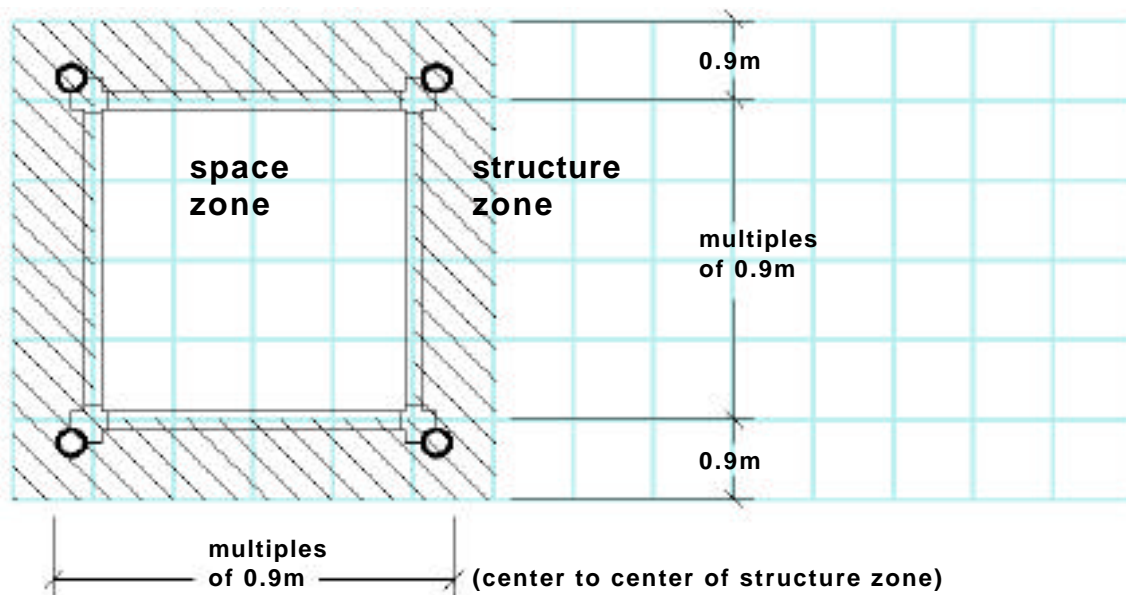


Figure 1: Space zones & structure zones

Architecture is essentially a collection of function-specific spaces. The structure and envelope we conceive in the design process is for the purpose of containing those spaces. In this kit-of-parts system, the process for assembly of the structure has been given priority as well, and the concept behind the containment of spaces is therefore influenced. Figure 1 is a diagram of a single structural bay, showing space zones and structure zones. Two overlapping grids are utilized: the basic grid and structural grid. The basic grid is based on economy of material, which is 0.9m in Japan and four feet in United States. For the plans described in this paper, 0.9m was chosen. The structural grid is derived from the basic grid. The structural grid consists of zones which are multiples of the basic grid in width, and define space zones which are also multiples of the basic grid.

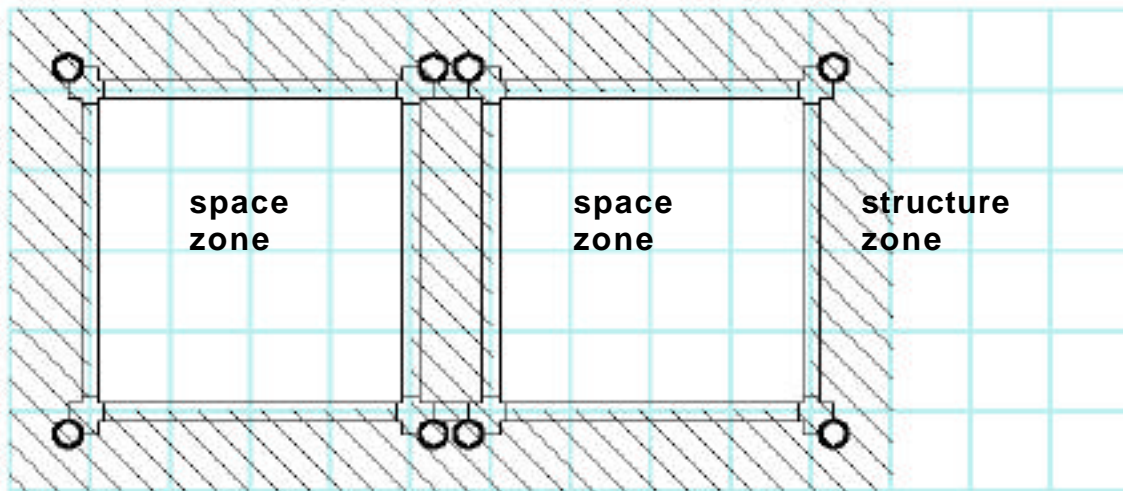


Figure 2: Adjacent bays

When two bays are put together, the adjacent structure zones overlap, but the actual structure may not necessarily do so. In figure 2 the structures of two bays are shown completely independent of each other. By keeping the structures independent, expansion joints, passive seismic connections, etcetera can be facilitated.

In the current research programme, the structures of each bay may be kept independent for another reason: **automated construction**. A set of three construction robots have been devised and control programming developed for the purpose of constructing a single bay up to 8.1 meters wide (center to center of structure zone). Using the automated construction concept, the building would go up a single bay at a time to an indefinite height (limited by the pre-engineered specifications of the members), by building each floor at the bottom and jacking up the entire building a floor at a time using a version of Kajima's AMURAD technology. The independent bay structures would be linked later (with either rigid or seismic expansion connections) to form composite columns in the overlapping structure zones.

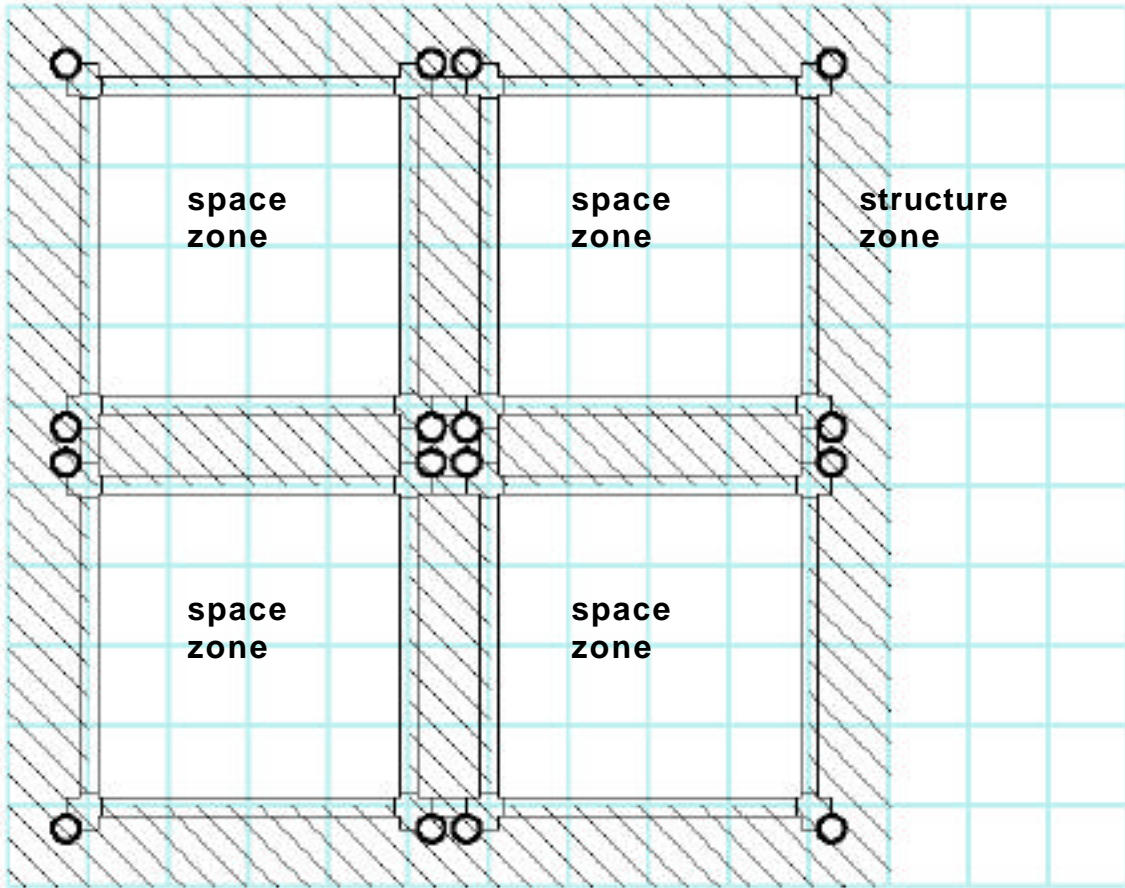


Figure 4: Four bays

In figure 4 four bays are adjacent to each other, showing a four-column composite structure where all the structure zones overlap.

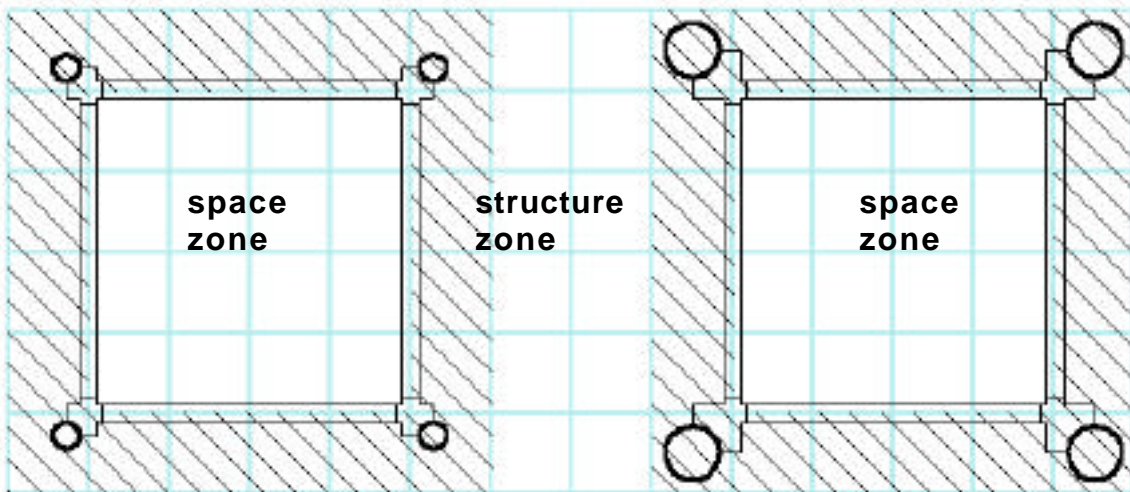


Figure 5: Alternate structure

Using the space-zone / structure-zone concept, various types of structure could be implemented as need requires. In this paper, the chapel plans described do

not utilize composite columns but singular columns pre-engineered for four bays. Though it would be possible to manufacture foundation components for a single story structure, in this paper it is assumed that the foundations would be constructed in the conventional manner.

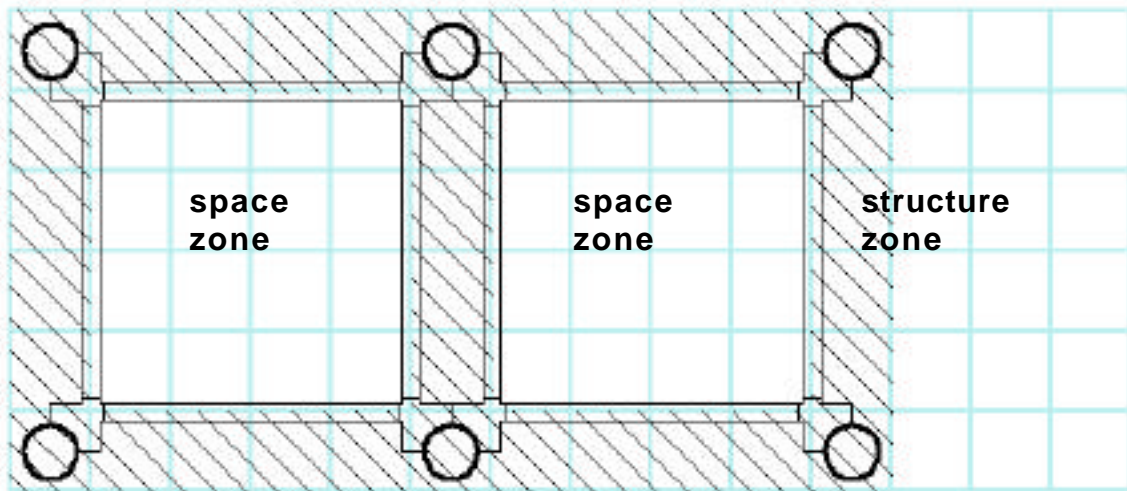


Figure 6: Adjacent bays utilizing common columns

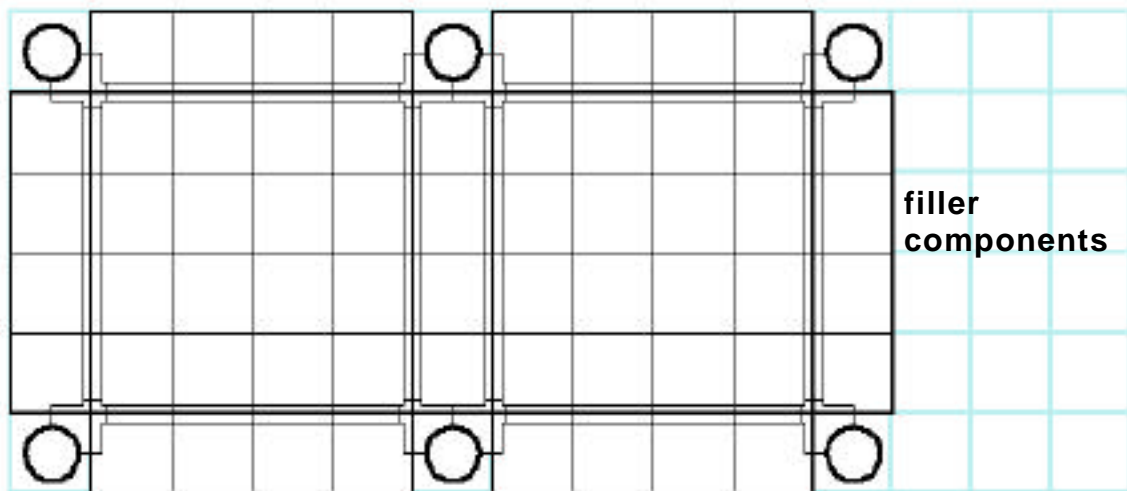


Figure 7: Continuous spaces

Figure 6 shows two adjacent bays with common columns. Since the structure zone is an increment of the base grid, continuous spaces can be facilitated with regular components, as in figure 7. This is the pattern utilized in the chapel plans which follow.

The final concept which needs to be reviewed is the **core module** system. Core modules are pre-manufactured special purpose rooms which are fully self-contained for the specified function. The modules are weatherproof and zip together and to the main structure with rubber gaskets. All plumbing, communications, computer equipment and such are located in the modules. The modules can be fully stocked with necessary equipment at the time of

manufacture, shipped to the site, and plugged into place. Plumbing and power connections would have standard interfaces to ease mounting and demounting. Standard simple modules could be arranged to form more complex spaces such as restrooms or kitchens.

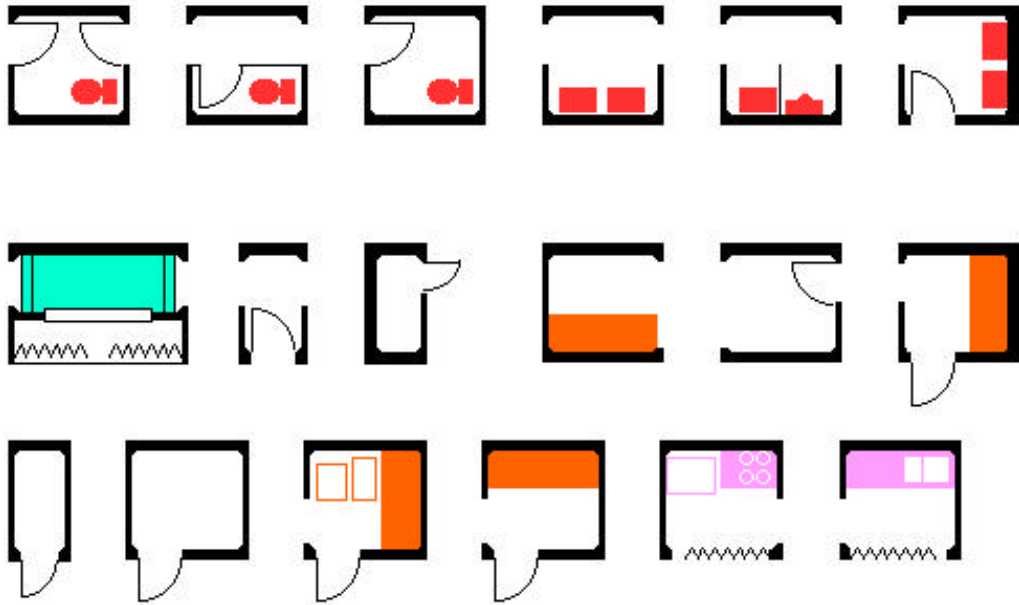


Figure 8: Premanufactured core modules

An example of a core module would be a library module which would be fully stocked at the time of manufacture with all the materials needed for Sunday School teaching aids. Another example would be a kitchen module fully stocked with pots, pans, and other utensils. The clerk's office would be another example, fully equipped with computer, telephone, and paper stock.

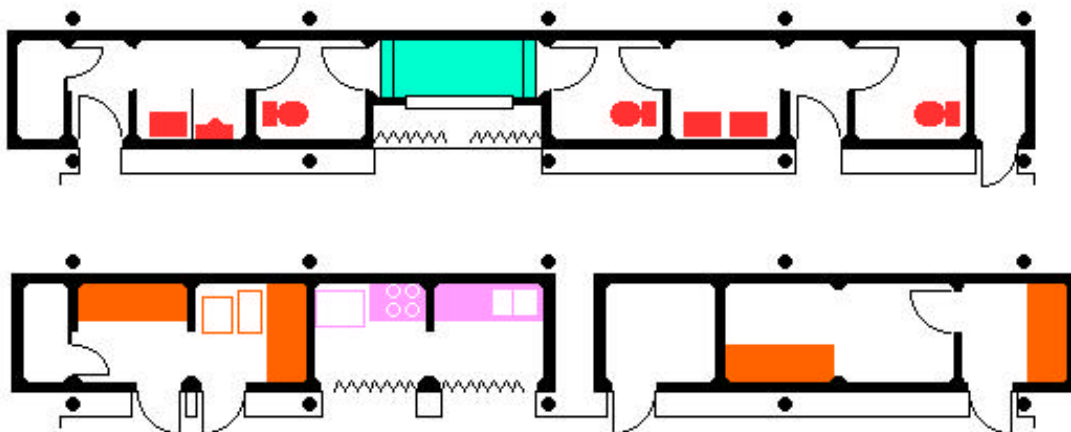


Figure 9: Possible core configurations

Chapel Plans

The following plans are based on a ward of 120 members. Nevertheless since these are conceived based on parts from a component library, any ward building or stake center of any size could be configured on any reasonable site (sloped or flat). The 120 members would break down into the following age groups:

SUNDAY SCHOOL HOUR		
Class	Persons	Classrooms
Gospel Doctrine	43	1
Gospel Essentials	13	1
Family Relations / Family History	10	1
Youth 12-13	10	1
Youth 14-15	9	1
Youth 16-18	9	1
Primary Sharing	8	1
Sun Beams		
Stars		
C.T.R.	3	1
Valiants	4	1
Merry Miss	4	1
Blazers	3	1
Nursery	4	1
Teacher Development	(5)	1
Total	120	13

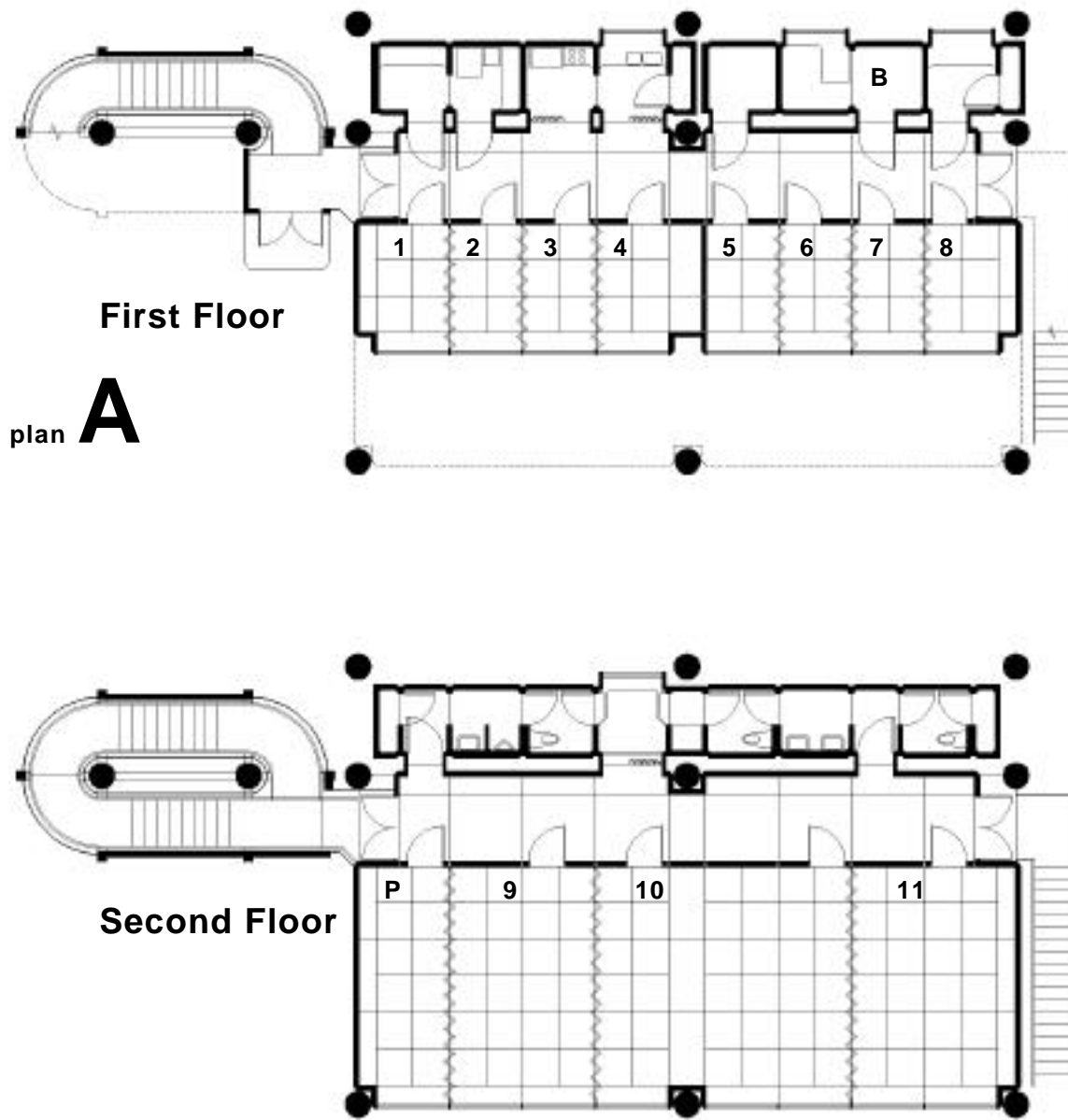
PRIESTHOOD / RELIEF SOCIETY HOUR

<u>Class</u>	<u>Persons</u>	<u>Classrooms</u>
Priesthood	43	
High Priests	7	1
Elders / Prospective Elders	22	1
Priests	5	1
Teachers	4	1
Deacons	5	1
Relief Society	37	1
Young Women	14	
Laurels	4	1
Mia Maids	5	1
Bee Hives	5	1
Primary Sharing	14	1
C.T.R.		
Valiants		
Merry Miss		
Blazers		
Sun Beams	4	1
Stars	4	1
Nursery	4	1
<u>Total</u>	<u>120</u>	<u>13</u>

Based on these numbers, chapel, offices, and classrooms have been laid out in various configurations. The configurations represent various shaped sites. Small scale plans are included in the paper for reference, and larger scale plans are attached at the end.

Plan A

This plan is an adaptation of the original plan presented in the first proposal. A few problems remain. This plan is not handicap accessible in its present state, but could be adapted to be so with an elevator core module. The total floor area is 300m², with 130m² on the first floor and 170m² on the second (the second floor overhangs the first, which space could be used for parking on tight sites). The seating capacity of the chapel is 114, which could be expanded to 135. There is only two offices, a clerk and bishop's office for the use of only one unit. Library, kitchen, and most classrooms are located on the first floor, with restrooms and chapel located on the second floor. The chapel would be dividable into classrooms as well. Including the pulpit area, thirteen teaching stations can be accommodated.



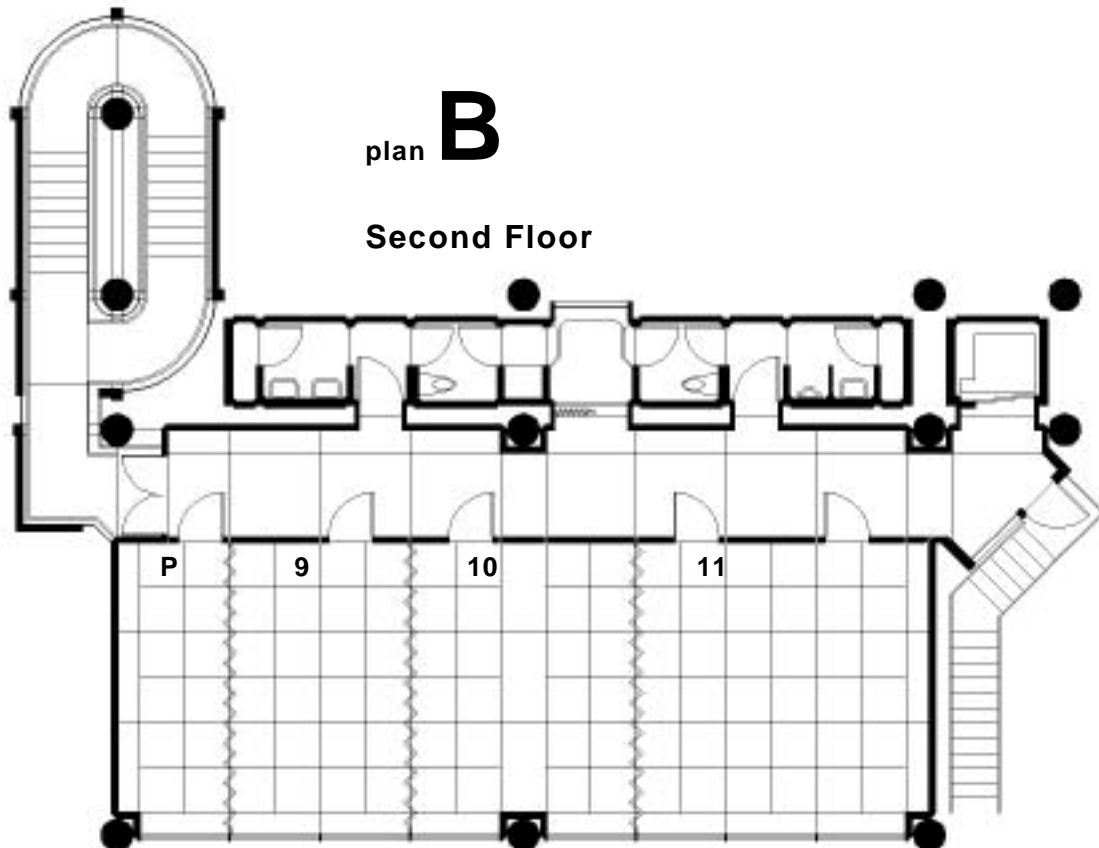
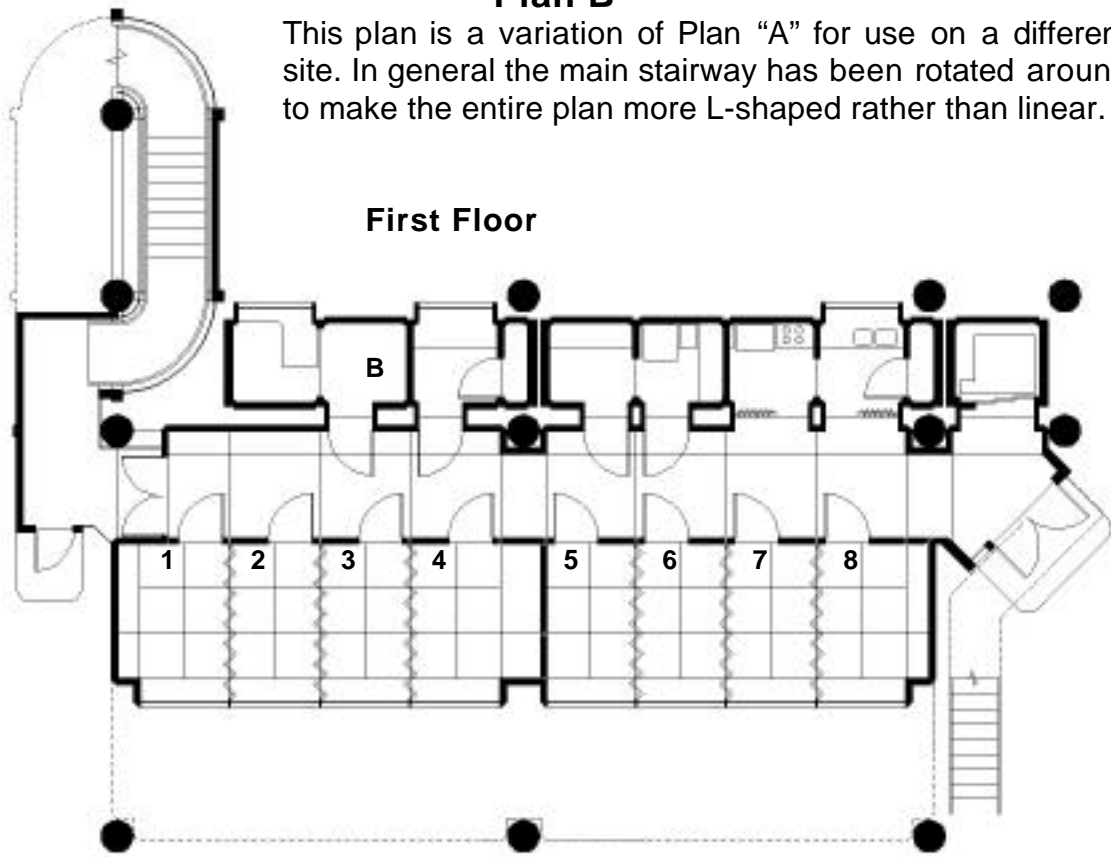
In Plan "A" the classroom usage could be as follows:

PLAN "A" S.S. Hour			PLAN "A" Priesthood / R.S. Hour		
Class	Capacity	Room #	Class	Capacity	Room #
Gospel Doctrine	43	CR 10	High Priests	24	CR 9
Gospel Essentials	34	CR 11	Elders	43	CR 10
Family History	24	CR 9	Priests	5	Bishop
Youth 16-18	9	Pulpit	Teachers	9	CR 8
Youth 14-15	9	CR 8	Deacons	9	Pulpit
Youth 12-13	11	CR 4	Relief Society	34	CR 11
Primary Sharing	9	CR 1	Laurels / Mia Maids	11	CR 4
Sun Beams			Bee Hives	7	CR 3
Stars			Sun Beams	7	CR 5
C.T.R.	7	CR 2	Stars	7	CR 6
Valiants	7	CR 3	Primary Sharing	16	CR 1, CR 2
Merry Miss	7	CR 6	C.T.R.		
Blazers	7	CR 5	Valiants		
Nursery	7	CR 7	Merry Miss		
			Blazers		
			Nursery	7	CR 7

Owing to the situation that Primary Sharing uses two rooms during the Priesthood / Relief Society hour, one teaching station comes up short. It would be necessary to combine two of the age groups in this case. I have the Laurels and Mia Maids combined in this case, with the Bee Hives in a neighboring room so the two rooms could be combined for Young Women opening excersizes. Except for these rooms and the chapel partitions, the collapsible partitions can just as well be hard walls if necessary.

Plan B

This plan is a variation of Plan "A" for use on a different site. In general the main stairway has been rotated around to make the entire plan more L-shaped rather than linear.



In Plan "B" an elevator was added, and due to the new location of the main stairway, the women's restroom has one less toilet and a storage closet was removed. Also, one collapsible partition in the chapel was repositioned to increase classroom #11 capacity to 50, and decrease classroom #10 capacity to 30 seats. This alternate would give the Relief Society more room.

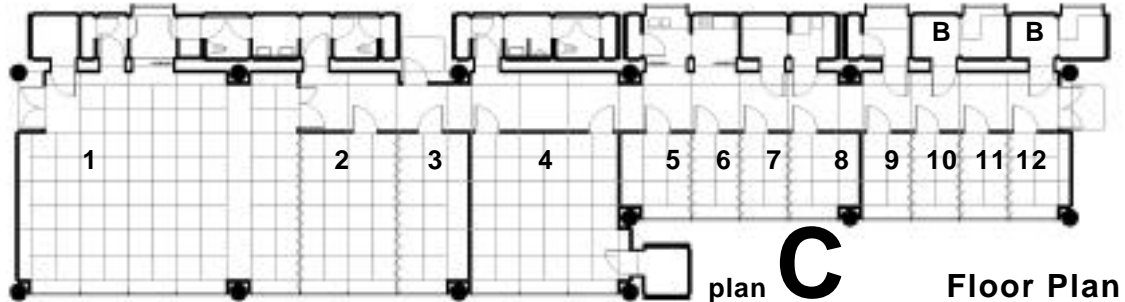
In Plan "B" the classroom usage could be as follows:

PLAN "B" S.S. Hour			PLAN "B" Priesthood / R.S. Hour		
Class	Capacity	Room #	Class	Capacity	Room #
Gospel Doctrine	50	CR 11	High Priests	24	CR 9
Gospel Essentials	30	CR 10	Elders	30	CR 10
Family History	24	CR 9	Priests	5	Bishop
Youth 16-18	9	Pulpit	Teachers	9	CR 8
Youth 14-15	9	CR 8	Deacons	9	Pulpit
Youth 12-13	11	CR 4	Relief Society	50	CR 11
			Laurels / Mia Maids	11	CR 4
			Bee Hives	7	CR 3
Primary Sharing	9	CR 1	Sun Beams	7	CR 5
Sun Beams			Stars	7	CR 6
Stars			Primary Sharing	16	CR 1, CR 2
C.T.R.	7	CR 2	C.T.R.		
Valiants	7	CR 3	Valiants		
Merry Miss	7	CR 6	Merry Miss		
Blazers	7	CR 5	Blazers		
Nursery	7	CR 7	Nursery	7	CR 7

The first floor is 140m² and second floor 170m² to make a total of 310m². The chapel seats a total of 114 persons which is expandable to 135 persons.

Plan C

This plan takes all the functions and puts them on one floor. All of the core functions are lined up on one wall, and an extra bishop's office allows the building to be used by two units. Total floor area is 345m² with a chapel seating capacity of 136 persons (expandable to 175 persons).



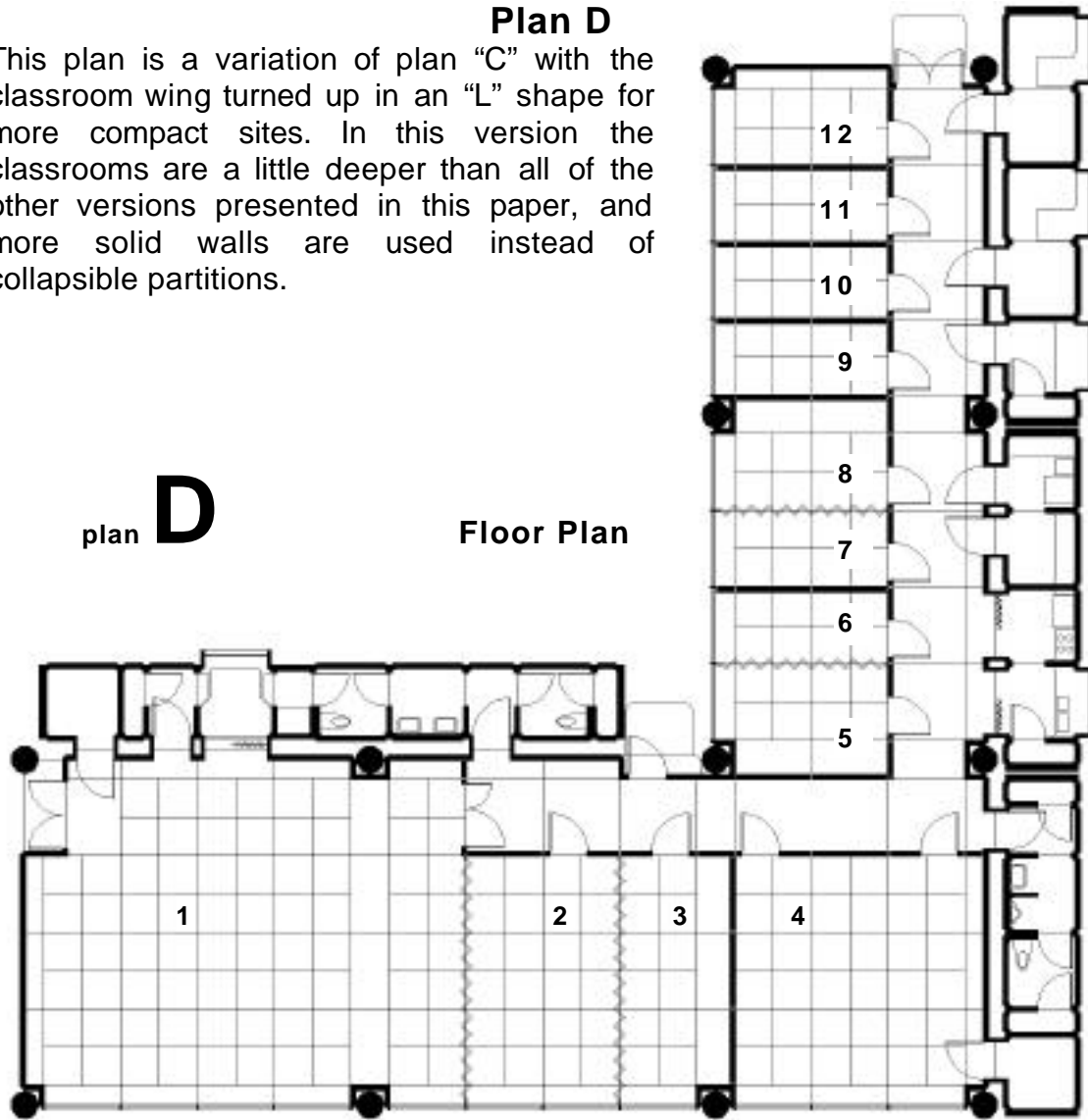
In Plan "C" the classroom usage could be as follows:

PLAN "C" S.S. Hour				PLAN "C" Priesthood / R.S. Hour			
Class	Capacity	Room #		Class	Capacity	Room #	
Gospel Doctrine	85	CR 1		High Priests	18	CR 3	
Gospel Essentials	55	CR 4		Elders	85	CR 1	
Family History	24	CR 2		Priests	5	Bishop	
Youth 16-18	18	CR 3		Teachers	11	CR 5	
Youth 14-15	9	CR 12		Deacons	9	CR 12	
Youth 12-13	11	CR 8		Relief Society	55	CR 4	
Primary Sharing	11	CR 5		Laurels	7	CR 6	
Sun Beams				Mia Maids	7	CR 7	
Stars				Bee Hives	11	CR 8	
C.T.R.	7	CR 6		Sun Beams	7	CR 10	
Valiants	7	CR 7		Stars	7	CR 11	
Merry Miss	7	CR 10		Primary Sharing	24	CR 2	
Blazers	7	CR 11		C.T.R.			
Nursery	7	CR 9		Valiants			
				Merry Miss			
				Blazers			
				Nursery	7	CR 9	

A storage module has been added to Relief Society room. Also, a third exit near the chapel mostly eliminates a dead-end corridor. Since the structure is single story an extra row of columns for support of the core modules is unnecessary.

Plan D

This plan is a variation of plan “C” with the classroom wing turned up in an “L” shape for more compact sites. In this version the classrooms are a little deeper than all of the other versions presented in this paper, and more solid walls are used instead of collapsible partitions.



Plan “D” has a total of 360m² floor area. The chapel can seat 136 and can be expandable to 175 persons. As with plan “C” there are two bishop’s offices in order to facilitate two units. The men’s toilet in this version is not located in close proximity to the women’s toilet or baptismal font. The font can be accessed directly from the women’s restroom, but men must enter from the small vestibule on the left.

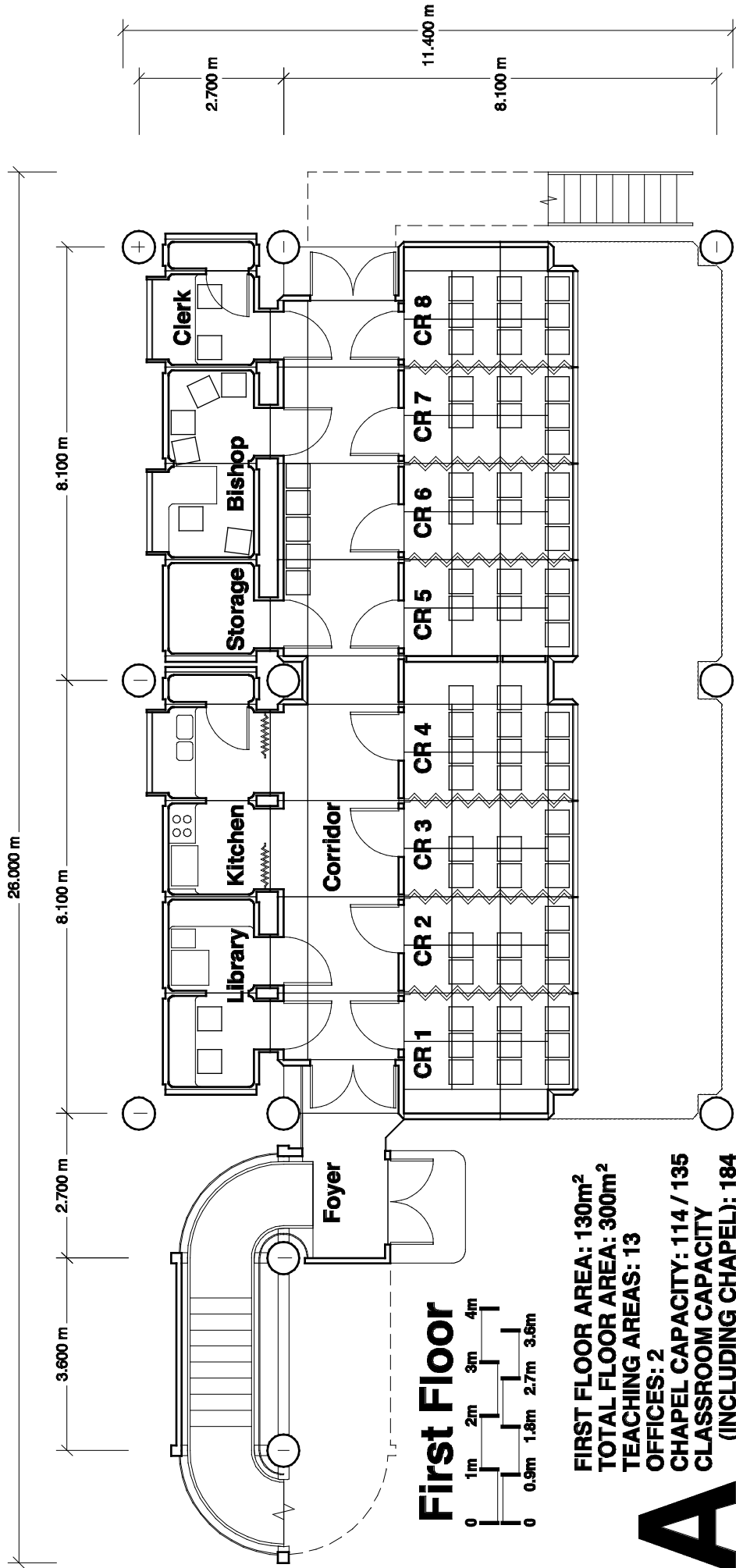
In Plan "D" the classroom usage could be as follows:

PLAN "D" S.S. Hour			PLAN "D" Priesthood / R.S. Hour		
Class	Capacity	Room #	Class	Capacity	Room #
Gospel Doctrine	85	CR 1	High Priests	18	CR 3
Gospel Essentials	55	CR 4	Elders	85	CR 1
Family History	24	CR 2	Priests	5	Bishop
Youth 16-18	18	CR 3	Teachers	15	CR 5
Youth 14-15	12	CR 12	Deacons	12	CR 12
Youth 12-13	15	CR 8	Relief Society	55	CR 4
Primary Sharing	15	CR 5	Laurels	9	CR 6
Sun Beams			Mia Maids	9	CR 7
Stars			Bee Hives	15	CR 8
C.T.R.	9	CR 6	Sun Beams	9	CR 10
Valiants	9	CR 7	Stars	9	CR 11
Merry Miss	9	CR 10	Primary Sharing	24	CR 2
Blazers	9	CR 11	C.T.R.		
Nursery	9	CR 9	Valiants		
			Merry Miss		
			Blazers		
			Nursery	9	CR 9

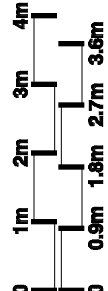
Conclusion

Four chapel plans which are based loosely on a ward of 120 members serve as examples for the kit-of-parts system. Using two grids, a base grid and a structural grid derived from the base grid, with structure zones and space zones, an extremely flexible layout of spaces can be arranged. Using a strict joint system and rules on the interface between parts, easy assembly and creation of new parts can be facilitated. A system of mix-and-match pre-manufactured core modules facilitate flexible layout for restrooms and kitchen facilities. The process of getting a new ward operational can be streamlined by prestocking the plug-in modules with teaching materials and other needed items.

It should be well within the capabilities of the system to accommodate larger buildings such as stake centers, office buildings, and other facilities. In addition, different shaped sites and different sloped sites can also be easily accommodated. For reference, see previous proposal.

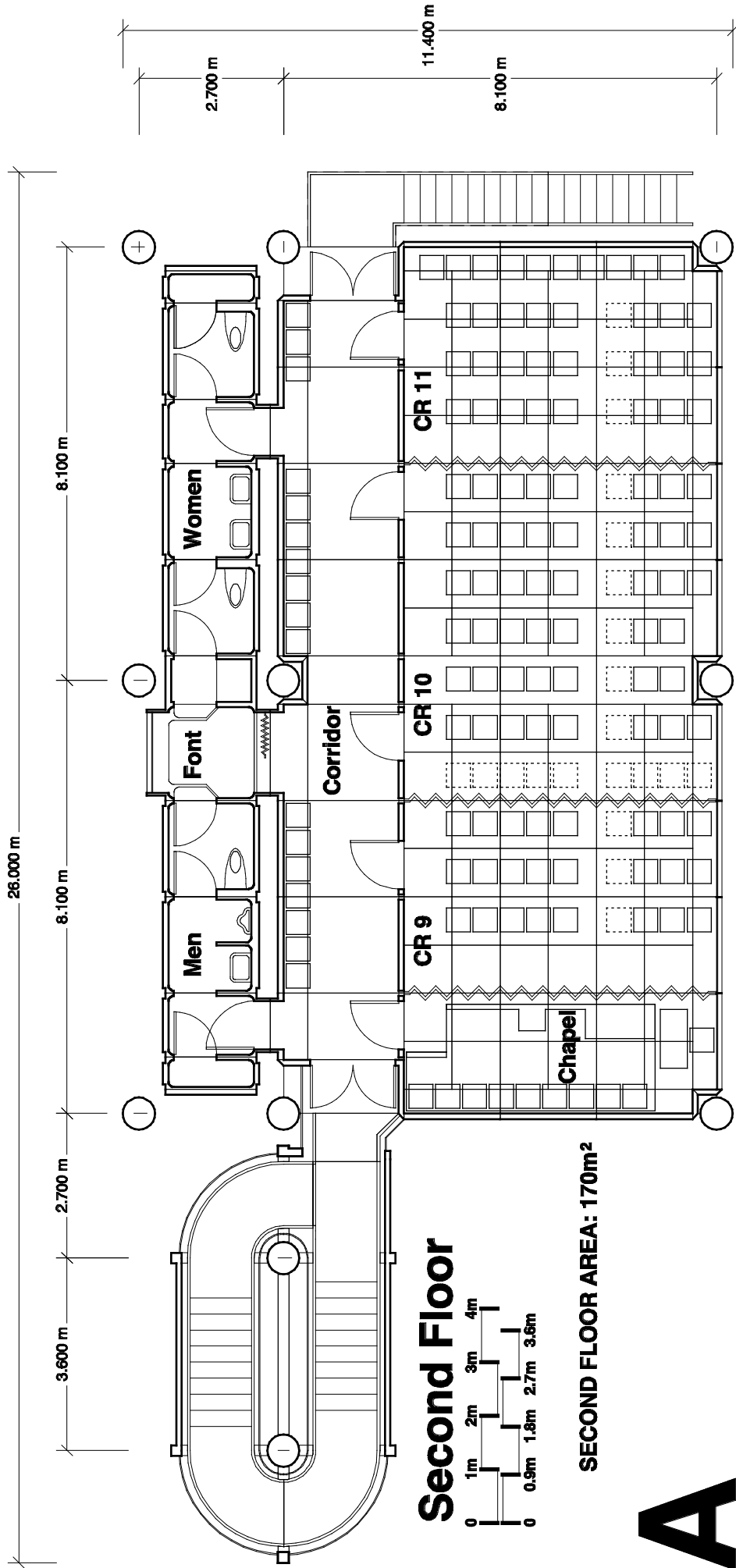


First Floor



FIRST FLOOR AREA: 130m²
TOTAL FLOOR AREA: 300m²
TEACHING AREAS: 13
OFFICES: 2
CHAPEL CAPACITY: 114 / 135
CLASSROOM CAPACITY
(INCLUDING CHAPEL): 184

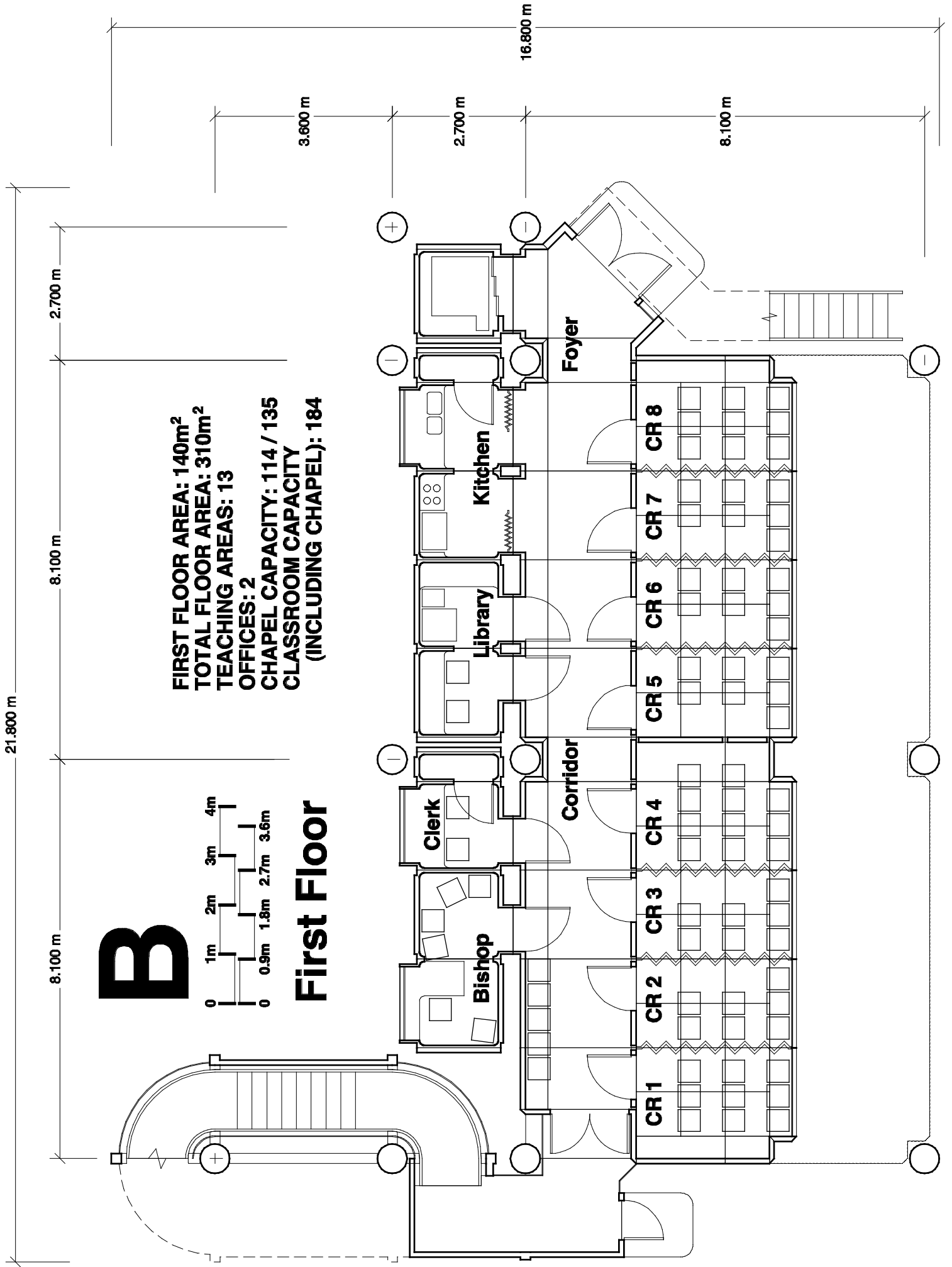
A



Second Floor

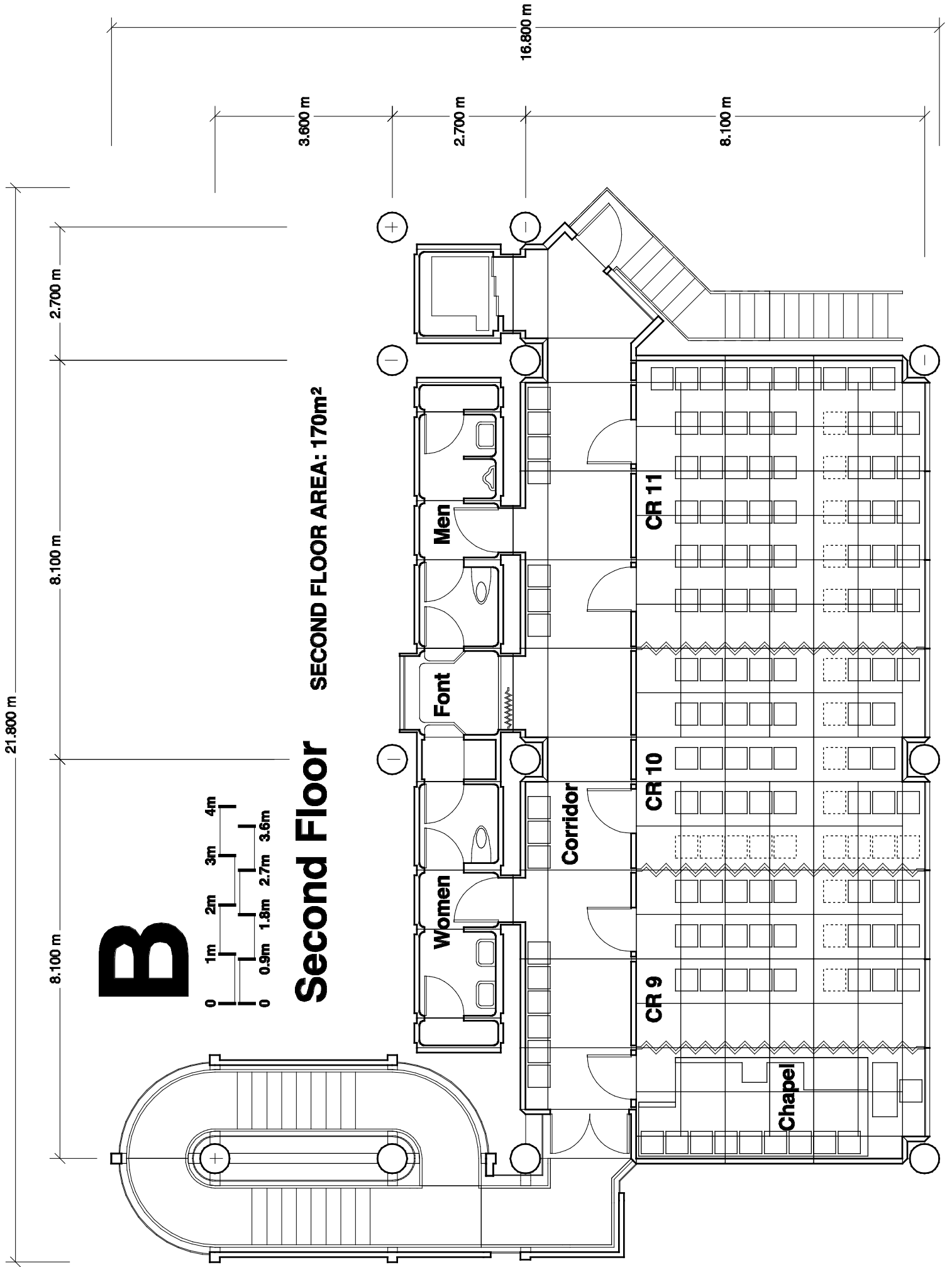
SECOND FLOOR AREA: 170m²

A



FIRST FLOOR AREA: 140m²
TOTAL FLOOR AREA: 310m²
TEACHING AREAS: 13
OFFICES: 2
CHAPEL CAPACITY: 114 / 135
CLASSROOM CAPACITY (INCLUDING CHAPEL): 184

First Floor



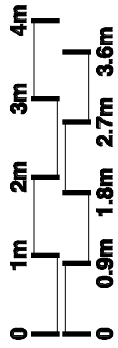
21.800 m

8.100 m

8.100 m

2.700 m

B



Second Floor

SECOND FLOOR AREA: 170m²

3.600 m

2.700 m

16.800 m

8.100 m

Women

Font

Men

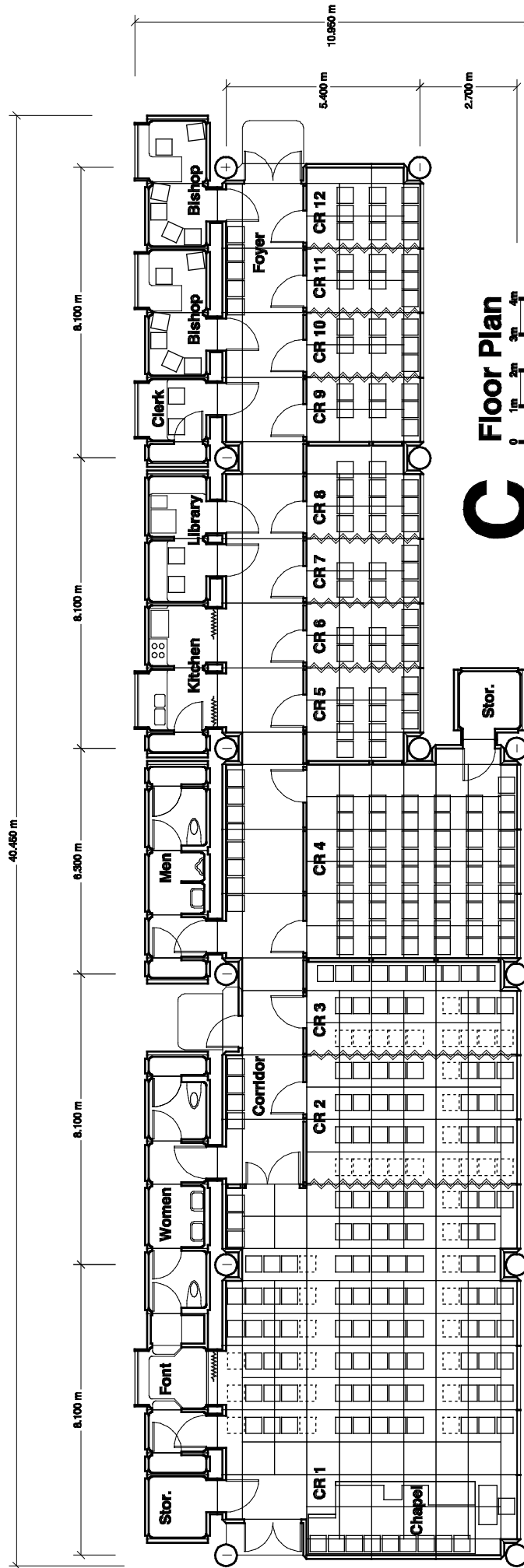
Corridor

CR 9

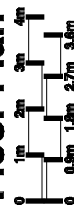
CR 10

CR 11

Chapel



C Floor Plan



TOTAL FLOOR AREA: 345m²
TEACHING AREAS: 13
OFFICES: 3
CHAPEL CAPACITY: 136 / 175
CLASSROOM CAPACITY (INCLUDING CHAPEL): 298

