# ADAPTATION OF THE TAIWANESE ROWHOUSE WITH COMPUTER APPLICATION IN THE DESIGN PROCESS

by

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Submitted to the Department of Architecture on May 15, 1986 in partial fulfillment of the requirements for the Degree of Master of Science in Architecture Studies.

ABSTRACT

This study proposes an approach to the preservation of the spirit of traditional Chinese architecture and its adaptation to the current context and living style. For this purpose, the rowhouse type which emerged in the past for reasons of economic landuse and survived through the modernization has been selected to illustrate this approach.

In order to achieve this objective in the actual process of design, a computer application has been developed as a vehicle for communication between various participants.

This study is developed into 4 parts:

1. Analysis and Description of Traditional Rowhouse Type:

This part introduces the historic context of the traditional rowhouse type and its major character. By the observation and analysis of existing rowhouses in the Taiwan area, certain principles of the type have been founded.

2. Change and New Requirement:

This part deals with the change of the family structure and living style during the modernization process in Taiwan and their effect to the dwelling environment. The new existing rowhouse type is also examined to find the new conventions used by current inhabitants in contemprary context.

3. The Development of New Rowhouse Type:

In this part, 2 steps are used to apply the principles found earlier to physical design. In the first step, SAR methodology is used as a base to reflect the selected rules on the relevant elements. Using these elements, basic units for the composition of houses are established.

The second step uses the rule of "combination" (also generated from the

analysis) to construct a layer (from basic units) or a completed rowhouse (from layers).

A facade system and a dwelling block example are also developed to illustrate the living environment of the rowhouse type.

4. Computer Application:

In this part a proposal for computer system is developed relating to the various levels of decision making and serving the various parties in the design process. A demonstration of the interaction between machine and users is also included.

Thesis Supervisor: N. John Habraken
Title: Professor of Architecture

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CONTENT

CHAPTER 1: INTRODUCTION

# 1. INTRODUCTION

## 1.1 MOTIVATION AND OBJECTIVES

For most developing countries, the living environment have changed through rapid economic development. This phenomena resulted in a serious gap between traditional value and modern life. In Taiwan, traditional Chinese architecture was overwhelmed by western style since late 18th century. In the process toward modernization, much of the valuable traditional heritage were almost abandoned and replaced by the "modern style". Especially in the living environment, traditional dwelling units are replaced by the uniform style of mass-production housing.

Not until last decade, traditional Chinese architecture has the opportunity to be treated as an important asset in the environment. Through the economic progress, the physical requirement for the environment have been achieved by the majority of the society. People begin to ask for more intimate relation with environment reflecting their own social, cultural character. The "International Style" which once implied progressive, fashionable as well as physically superior in most developing countries failed to meet this requirement. Thus, in recent

years, inheriting and transforming traditional Chinese architecture became the central issue in this field. The transformation of dwelling units with the adaptation to current living styles became one of the major tasks. However, for dwelling units, there are more concerns involved besides the inheriting of the Chinese spirit and transformation of the traditional style.

In the traditional dwelling environment, the inhabitants always had direct access to the design process for their own units. Traditional dwelling types of the Srh-Ho Yuan (house with the courtyard of four-sided enclosure), the San-Ho Yuan (house with the courtyard of three-sided enclosure) and Row house type were developed to allow the dweller for rearrangement or new additions. Both based on dwellers' family sizes, living style and unique requirement for the long run development.

However, in the current development, dwelling units are only treated as a commercial product. The uniform layout of mass-housing has very limited variety and is not adaptable for different family structures and their requirement for self-identification.

There exists a serious gap between the "product" and people's desire for dwelling. However, the commercializa

tion of the dwelling unit as a product is only partly responsible for this gap. The construction process of dwelling units today tends to be more complicated. For modern development, a communication model between different people involved in the design and building process is also required to bridge this gap.

The purpose of this study is to preserve the traditional spirit to the extent that it is suitable for the current context and to satisfy people's need by approaching the following objectives:

1. To propose an approach to achieve the preservation of the traditional Chinese character in residential architecture.

2. To modify the traditional principles in Chinese architecture to adapt to the contemprary context and meet new requirements.

3. To develop a efficient computer-aided model to help all the participants choosing their alternatives or developing their own dwelling units.

## 1.2 SCOPE

The scope of this study is limited to the following :

1. In this study, only the townhouse building type of traditional Chinese architecture is selected to illustrated the process.

2. The study of this thesis is based on observation and analysis on the existing well-preserved rowhouses in Taiwan area. The observation and analysis are mainly focused on sections, plans and facades.

3. The observation and analysis of the existing rowhouses are not categorized by a specific period in time or a specific. The focus is on their common principles, implicit rules and the spirit reflected from their physical arrangement.

## 1.3 TASK AND FRAMEWORK

### TASK

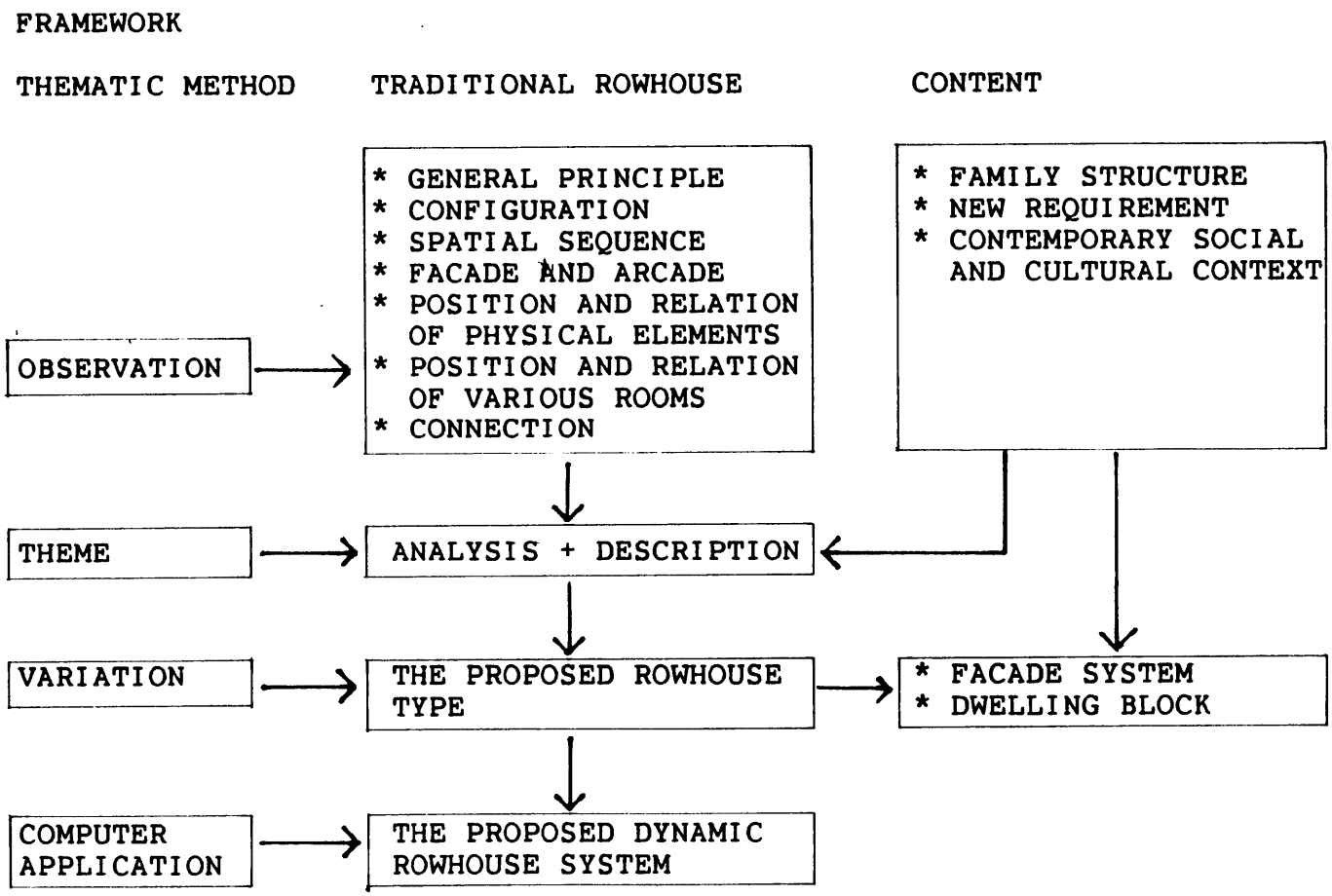
The first task of this study is to find principles or rules reflecting the traditional spirit of Chinese dwelling environment. These principles or rules are drawn from the observation and analysis on existing rowhouse dwelling units relative to the following six aspects

1. configuration
2. spatial sequence
3. facade and arcade
4. position and relation of physical elements
5. position and relation of various rooms
6. connection

The second task is to deal with the adaptation and modification of the principles or rules to contemporary context. The rules will be modified to adapt modern living style in terms of technical requirements for the rowhouse type, new family structure and future structure change in the long span of time.

The third task is to develop a computer-based system for various levels of decision making and for various parties making decisions. This system not only provides a convenient graghic tool, but also acts as a vehicle for communication between

various participants such as developer, land owner, designer or inhabitants. The computer system will help these parties, operating on different levels of decision making to choose alternatives or develop their ultimate preference.

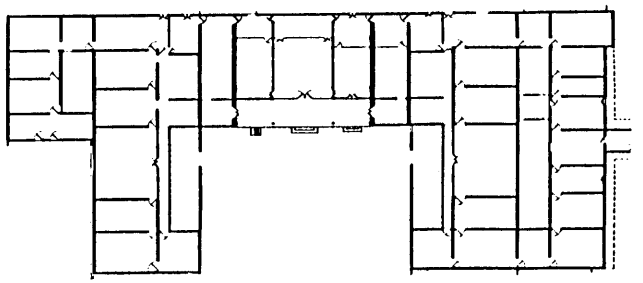


CHAPTER 2: ANALYSIS AND DESCRIPTION OF TRADITIONAL TAIWANESE ROWHOUSE

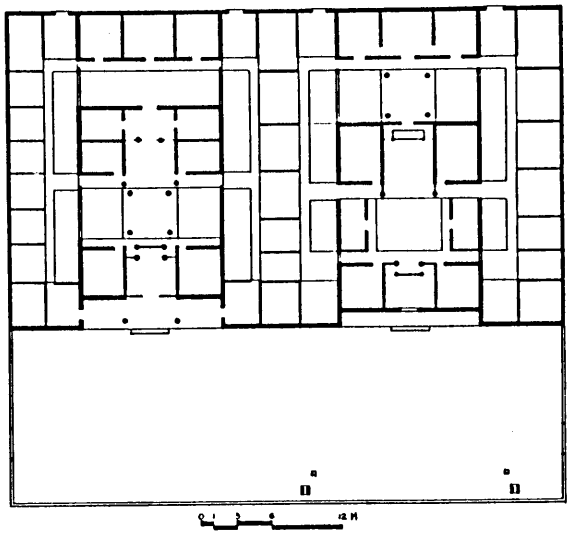
## 2. ANALYSIS AND DESCRIPTION OF TRADITIONAL TAIWANESE ROWHOUSE

### 2.1 HISTORIC CONTEXT

For most of traditional Chinese cities, San-Ho-Yuan and Srh-Ho Yuan are two of the basic building types. The location of these cities were either assigned by the emperor for political reason or grew from the existing agricultural aggregation. In these cities, each San-Ho-Yuan and Srh-Ho-Yuan occupied large parcel and accomodated large family. Parcels were loosely laid out to allow the expansion to the adjacent land in the future if needed.



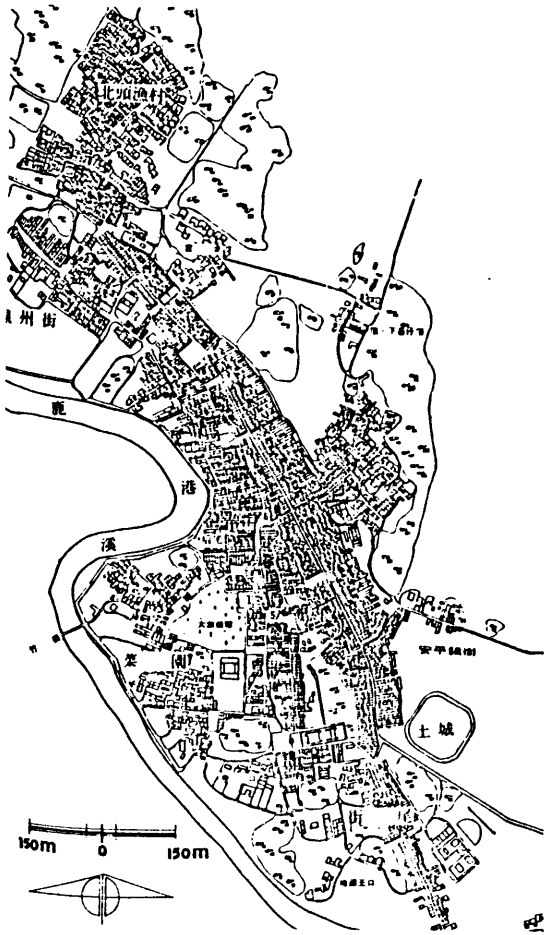
San-Ho-Yuan



Srh-Ho-Yuan

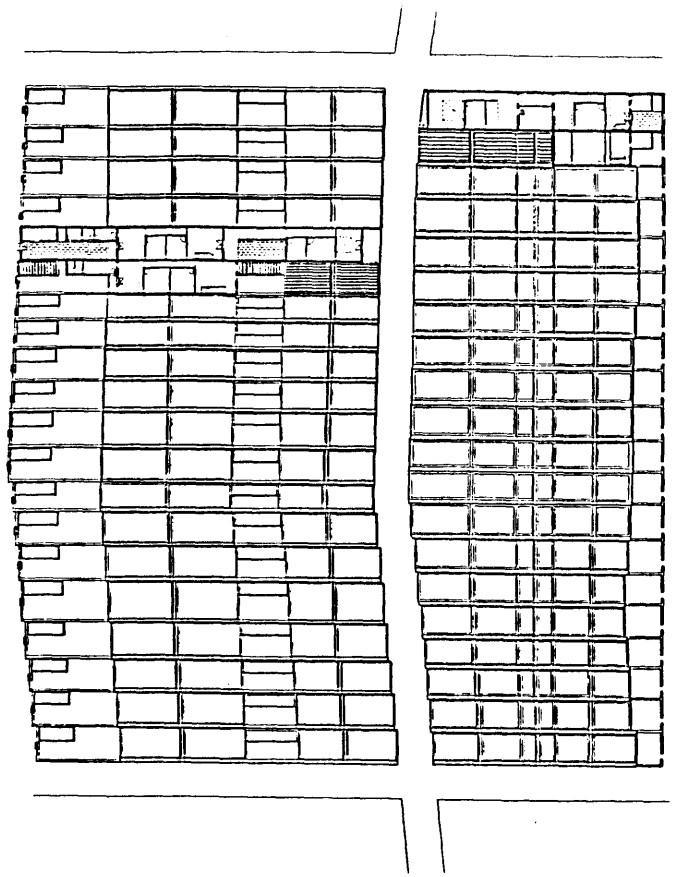
The Rowhouse type accomodated the smaller family size, also in the urban situation. However, the rowhouse type was the basic type for the "commercial cities". These cities were the early coastal trading settlements and were mostly located in southern China.

In Taiwan, Lu-Kang and Tan-Sue were two of the most important harbor cities during the 18th centure. These harbor cities were the trading center for resources and goods from mainland China and other areas of Taiwan. Since the cities were much engaged in the commercial activities, the streets became the most valuable part for the economic development. The rowhouse type was hence developed as the most suitable solution for this situation.




Lu-Kang City

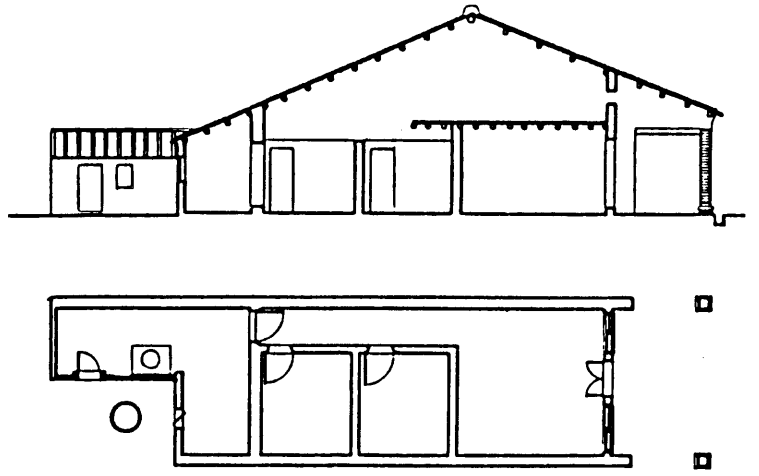
The Rowhouse type is a part of linear develop- ment along the main street. Each house has a short valuable frontage facing the street and a very long depth. This narrow frontage provides access to the commercial activities along the street. The long depth is used to accommodate the residential living space or for storage space. Apart from the economic reasons this solution was also functionally successful. With the long depth, the residential zone behind the front shops was able to be away from the noisy commercial streets.



## 2.2 DESCRIPTION OF GENERAL PRINCIPLES

### 2.2.1 BASIC MODEL

For the traditional rowhouse type of Taiwan, a basic model is composed of three different parts: main unit, affiliated unit and yard. The main unit includes store, living room, bedroom and passage. The affiliated unit includes kitchen, corridor and service spaces. The yard includes a court and other service spaces. The width of a main unit is from 4 meter to 5.5 meter with the length from 8 meter to 18 meter.



Basic Model

For all different spaces within the basic model, four different function

groups are categorized:

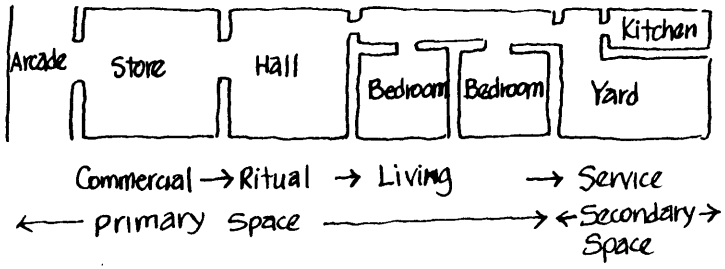
Commercial function: store, commercial service spaces.

Ritual function: ancestral hall.

Living function: bedroom, living service spaces.

Transitional function: yard, corridor, passage.

For this basic model, the relationship among units, function and spaces can be shown as the following diagram:




2.2.2 COMPOSITION

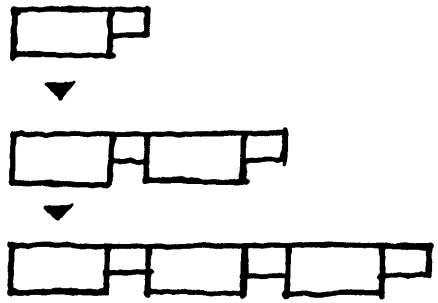
The composition and growth of the rowhouse are based on the basic model of main unit, affiliated unit and yard as given above. Among the three parts, the main unit and the affiliated unit are composed of substantial spaces for different purpose of use. The yard, however, is basically a transitional element connecting other spaces. In the traditional rowhouse type, four types of composition can be distinguished by way of the principles of growth that they result from.

A. Growth in Layer

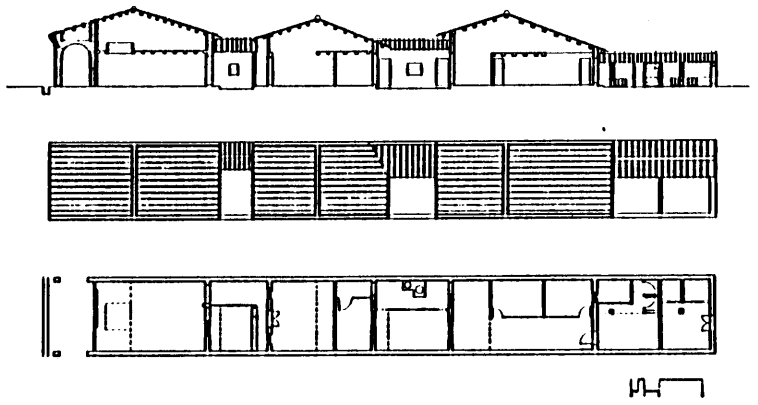
-- Longitudinal Extension

In this type of composition, an

additional building(with main unit, affiliated unit and yard) is added to the yard of the first one. This longitudinal extention can become one bay-two layer or one bay-three layer. The sequence of functions are: (transitional-commercial) - transitional - (ritual-living). For one bay-three layer type, another transitional element and the third layer of (ritual-living) are attached to the second layer. In this composition, the yard as transitional element reduces the conflict between commercial and ritual functions and provide more privacy for living spaces in the second layer. This open transitional element also allows more light to avoid dark rooms in the long depth and furthermore, the ventilation for the whole dwelling unit is improved.



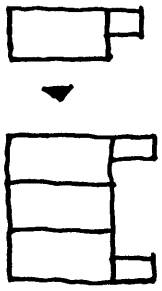
Growth in Layer



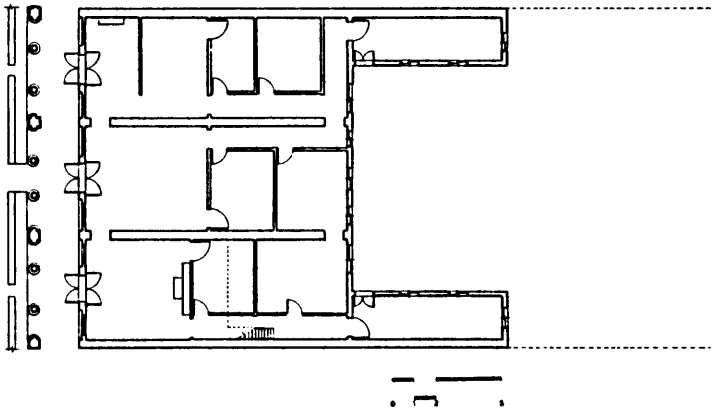
B. Growth in Bay

-- Transversal Extension

Transversal extention is also based on the one bay- one layer model. Traditionally an odd number of bays is combined. With the commercial-ritual sequence in the front part of each bay, the yards are integrated and become a large common space. This makes it similar to the San-Ho-Yuan composition for the farm house. This extention can acquire more valuable frontage along street and at the same time, reflect the hierachy of the family structure as similar to the traditional San-Ho-Yuan.



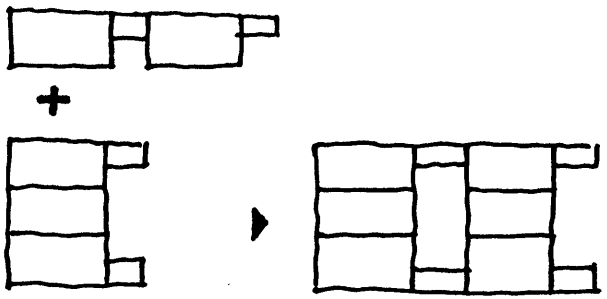
Growth in Bay



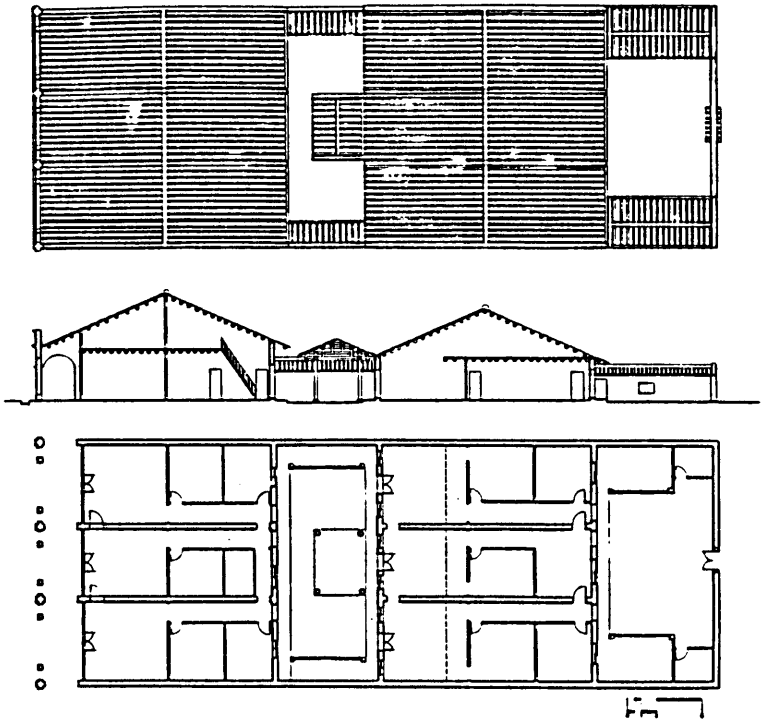
C. Growth in Bay and Layer

-- Longitudinal and Transversal Extension

Longitudinal and transversal extension generally has an odd number of bays and 2-4 layers. In this extension, a composition similar to Srh-Ho-Yuan is the result.This type usually accommodates a large extended family more than three generations. Common courtyards are normally formed between different layers.



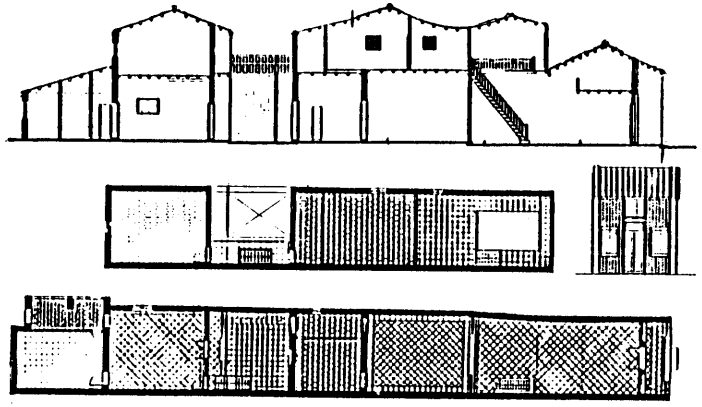
Growth in Layer & Bay



D. Growth in Level

-- Vertical Extension

Owing to the limit of the available land for transversal or longitudinal extension, vertical extension is the economic way in areas of high land value. This extension follows similar principles as longitudinal one. The sequence is also composed by different function zones. Basically, the living spaces are moved to the upper level floor. The middle part of the lower level of the first layer is used for ritual activity. The opening above brings light to the adjacent spaces and also enhances the ritual spaces below.



## 2.2.3 ORIENTATION

For the rowhouse, the street is the most important element which dominantes the commercial activities and affects the layout of the spaces.

For the commercial spaces, the street is naturally treated as the only frontage where the axis is leading to. However, for the ritual and living spaces, there are some other traditional principles to follow in addition to the fact of the street.

The orientation of the ritual space is basically influenced by the principle of Chinese geomamcy as "facing the water with the back to of the mountain" This is always the prefered situation for Chinese landscapes and buildings

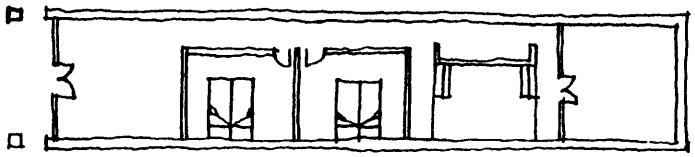
In this principle, the street belongs to the character of "water". The ritual spaces are affected by this principle and the following layouts were developed as:

Street - Commercial - Ritual - Living

This layout is the result of treating the street as the "water". Like the commercial spaces, the orientation of ritual spaces is facing toward the front street.

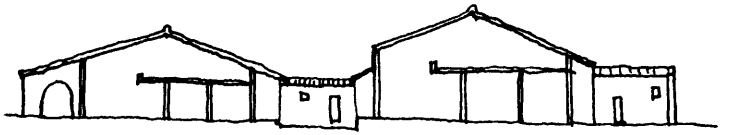
The orientation of the living space is mainly influenced by the sleeping position. The sleeping position should be parallel to the direction of the joists used for the construction of

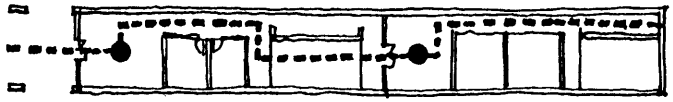
the house. In addition the bed should be arranged in such way that feet will not point toward the frontage of the house unit.



2.2.4 CIRCULATION

The internal circulation crosses several core spaces including commercial space (store) and ritual space (hall). Living space can always be passed by a corridor on one side. The formal quality ofthese core spaces is expressed by the axial position of the doors and columns.

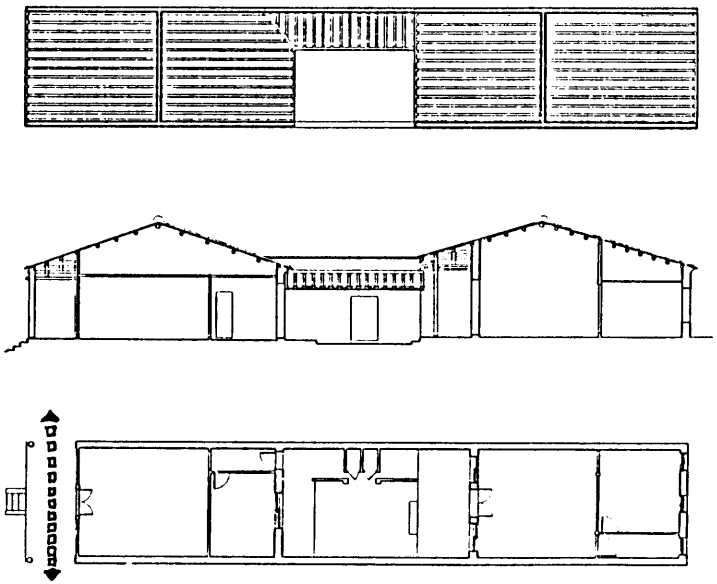




## 2.2.5 TERRITORY

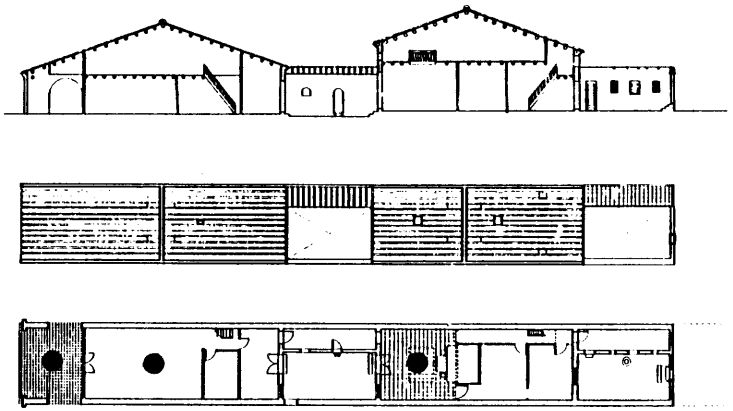
In the rowhouse type, territory is reflected by the organization of different function zones and transitional elements. This can be observed on two levels:

For the street level, the arcade as a passage works as a transitional element between the street (as public space) and the house (as private space). Its role here is not only to separate the internal and external spaces but also to provide a transversal connection on the level of the neighborbood and shelter for the rain season. Besides, the arcade can also be used as an extension of



the internal space for commercial or ritual activities, or for leisure and entertainment of the residents.

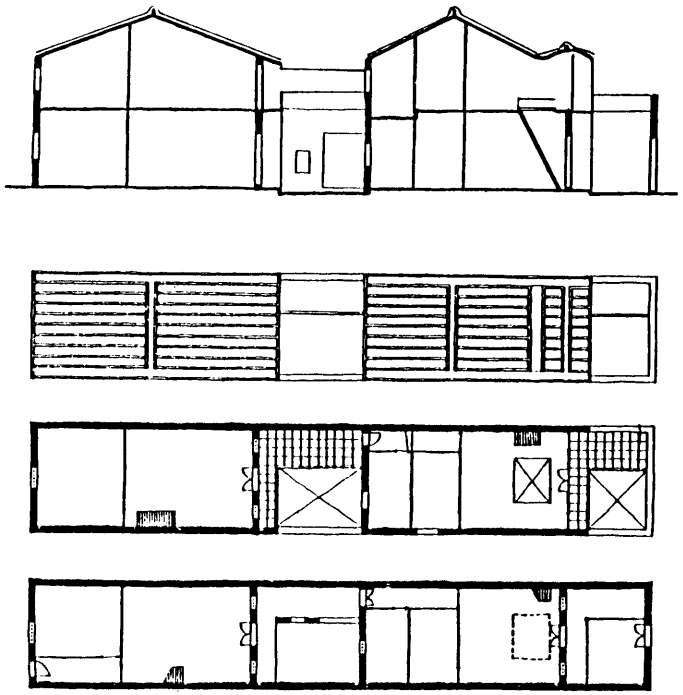
On the building level, the arcade passage, store and ancestral hall are treated as elements with a more public character. The living spaces (bedroom, kitchen and service spaces) are the internal elements with more privacy. On this level, the courtyard is used to connect different layers and also to separate different function zones in order to acquire the required privacy.



## 2.3 ANALYSIS OF THE TYPE

In the construction process for the rowhouse type many factors and constraints are involved. These factors and constraints reprensent from technical, social or cultural concerns. In this study, we would like to understand the spirit of the traditional Taiwanese rowhouse by observing the existing examples. Thus, the analysis is essentially focused on the morphology as:

1. CONFIGURATION
2. SPATIAL SEQUENCE
3. FACADE AND ARCADE
4. RELATION AND POSITION OF VARIOUS ROOMS
5. RELATION AND POSITION OF PHYSICAL ELEMENTS
6. CONNECTION



## 2.3.1 CONFIGURATION

A. Roof Pattern

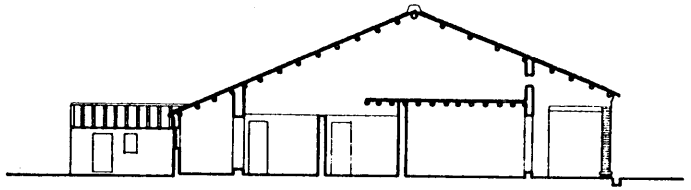
Each layer of the rowhouse could be considered as an individual entity and there are 3 different roof patterns.

A.1. Single-Roof Layer

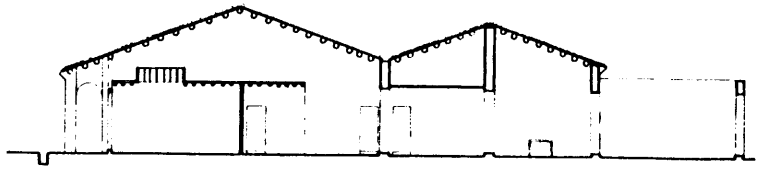
A layer covered by a double-pitched roof. The pitch of the front side is shorter than the later one. This makes the front entrance higher than the rear side.

A.2. Double-Roof Layer

When the depth of the layer increases, the single-roof with a double-pitch becomes inefficient. In order to cover the space of the layer, the roof has to be higher which causes the waste of material. Hence a double-roof type was developed to meet the requirement of space expension.



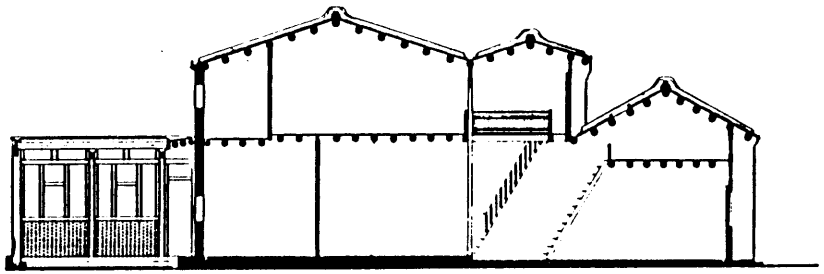
Single-Roof Layer



Double-Roof Layer

A.3. Triple-Roof Layer

This type was developed for the purpose of lighting. When the layer became even longer, the light from the front and rear windows was not enough for the long span of the house. A dormer window between the first and second roof was created for the supplement of the sunlight.This is usually found in the first layer of Lu-Kang rowhouse. The spatial relationship is of the following sequence: arcade - shop - hall - bedroom.



Triple-Roof Layer

B. Combination of Basic Units

Each layer of the rowhouse could also be divided into various units. Each unit was covered by an individual roof. There are four kinds of units with various width: petite unit, small unit, medium unit and large unit.

B.1. Petite Unit:

B.1.a Basic Form

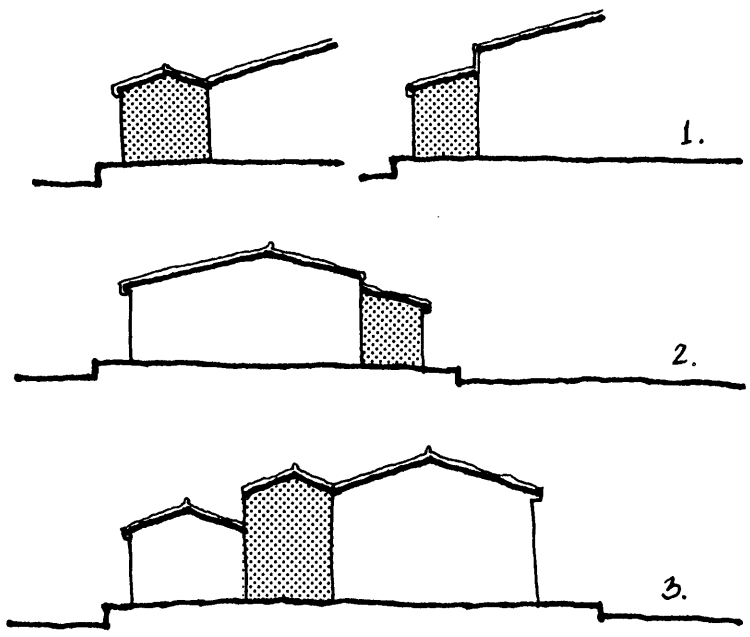
The petite unit has a roof of a single-pitch or double-pitch. The range of the width of a petite unit is from 3M to 4M.

B.1.b Possible Positions

Position 1: attached to the front of main unit as transition space or as arcade.

Position 2: located in the back of the main unit as transition space or as a small bedroom.

Position 3: placed in the midle part of a triple-roof layer, usually used as a ancestral hall.




Position of Petite Unit

B.2. Small Unit

B.2.a Basic Form

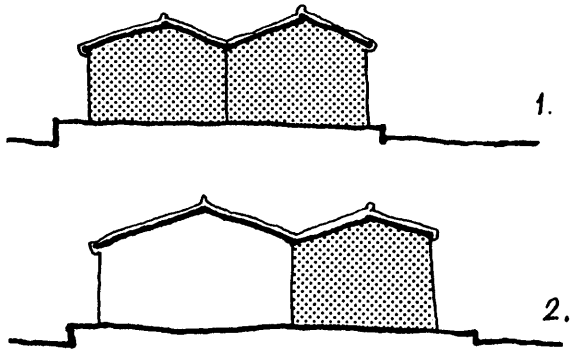
The small unit has a double-pitched roof.

The range of the width is from 4M to 6M.

B.2.b Possible Positions

Position 1: Two small units may be combined as one layer in the house.

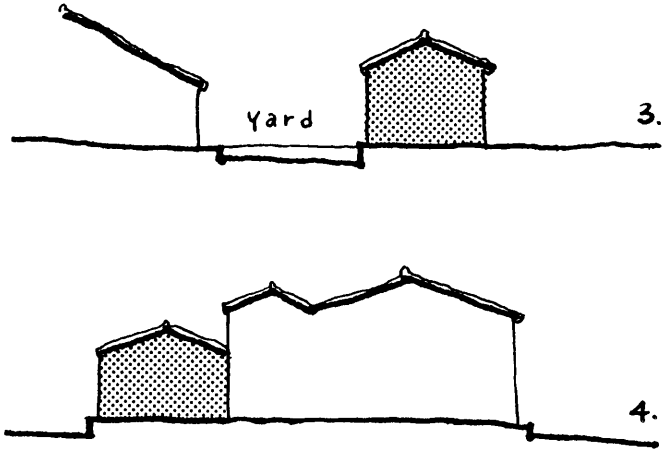
Position 2: A small unit may combine with a medium unit to become a double-roof layer. Usually this unit is the optimum location for a bedroom.




Position of Small Unit

Position 3: located in the second layer of a two-layer house to accommodate a small hall and a bedroom.

Position 4: located in the front part of a triple-roof layer to be used as a store.




Position of Small Unit

B.3. Medium Unit

B.3.a Basic Form

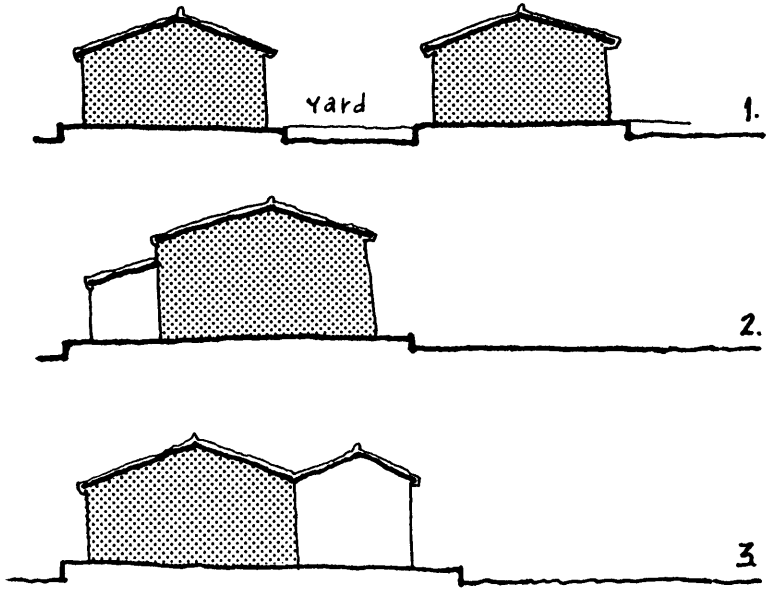
The medium unit is covered by a double-pitched roof with the range of width from 8M to 12M.

B.3.b Possible Positions

Position 1: in the first or second layer of a two-layer house.

Position 2: accompanied by a petite unit as a layer, where the medium unit is used as a hall or a shop.

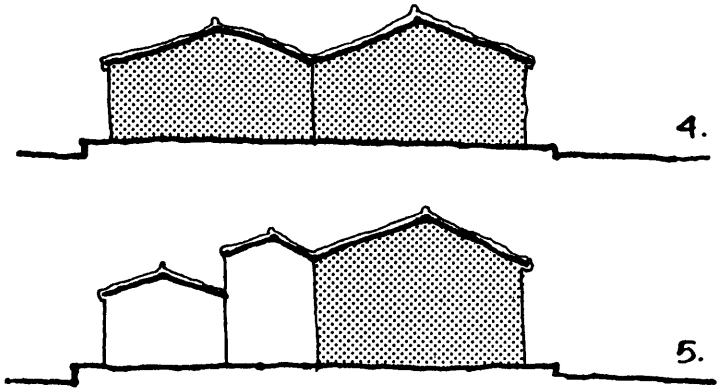
Position 3: combined with a small unit to make a layer. The medium unit is mostly used as a hall or a shop.




Position of Medium Unit

Position 4: Two medium units could be combined together as a double-roof layer in the first or the second layer of a two-layer house.

Position 5: placed in the last part of a triple-roof layer. In Lu-Kang this is always the first layer next to the street.




Position of Medium Unit

B.4. Large Unit

B.4.a Basic Form

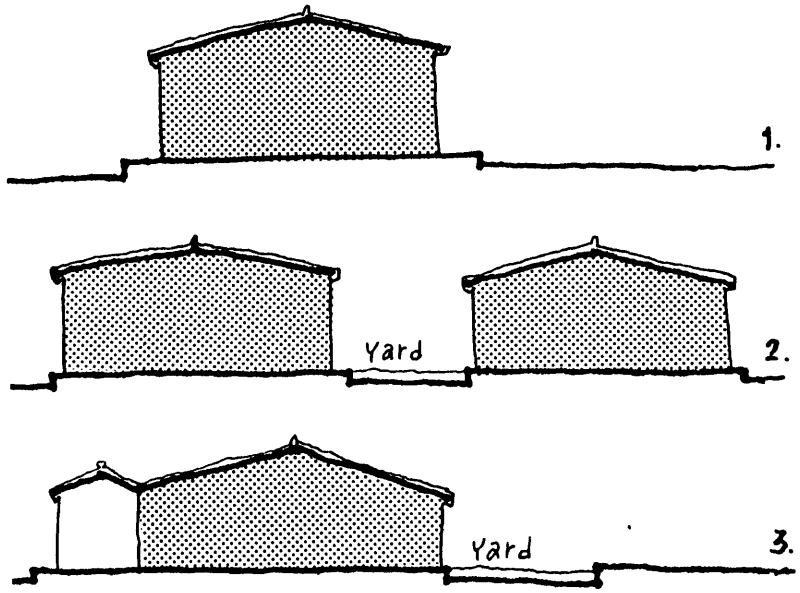
A large unit has a double-pitched roof with the range of width from 13M to 18M.

B.4.b Possible Positions

Position 1: A large unit may be considered as a one-layer house.

Position 2: It may be placed in the first or second layer of a two-layer house.

Position 3: It may combine with a petite unit in the front part of a house to make a double-roof layer.




Position of Large Unit

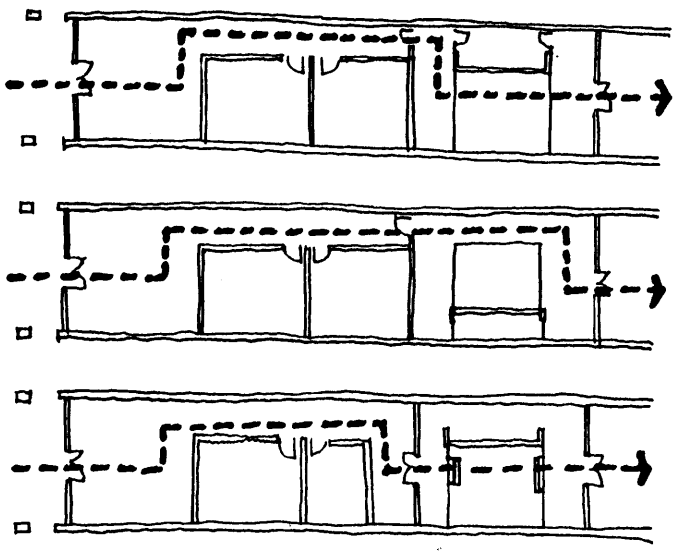
## 2.3.2 SPATIAL SEQUENCE

The axial path of rowhouse is circuitous. All the primary spaces are symetrically arranged along the central axis. For instance, the entrance to the hall must be placed along the axis. When entering the space behind the ritual hall, the axis shifts to connect the back part of the dwelling unit by means of a path parallel but away from the central line.This kind of linkage between the spaces or buildings creates a spatial variety and ensures privacy in various spaces. The circulation path could be described as following in terms of functions:

outside - transition space (arcade) - commercial space - corridor - transition space (gallery) - courtyard - transition space (gallery) - ritual space - corridor - outside.

The circulation path could also be interpreted by the character of spaces as:

light, open space - light, semi-open space - semi-light, large space - dark, narrow space - open, light space.



## 2.3.3 FACADE AND ARCADE

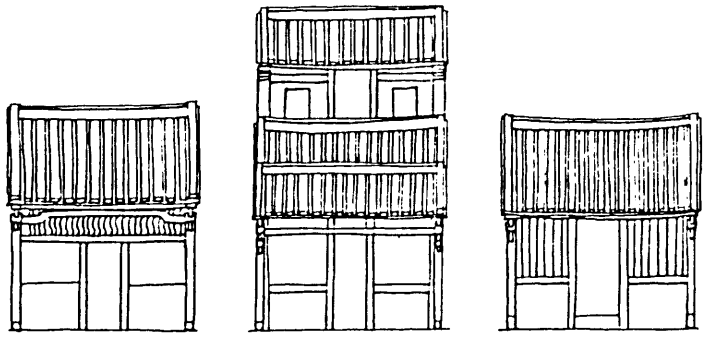
The facade in the rowhouse of Taiwan can be divided into two categories based on the time span: the facade before Japanese occupation and the facade during Japanese occupation.

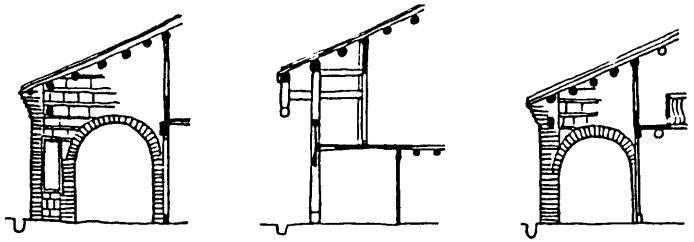
A. Facade Before Japanese Occupation (1750-1895)

During this period, most of the rowhouse were single story. The double pitched roof occupied 2/5 of the total elevation. The facades were mostly made of wood with single pattern similar to that of the harbor cities in Southern Chins where they inherited from. The arcades in this period had less variants along the street. Two major type of arcades were developed:

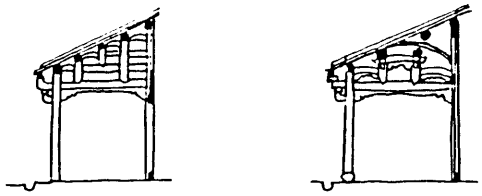
1. Arcade under the same roof of the main house.

1.a In the two-story rowhouse, the arcade usually is one and one half story high. The inhabitants in the second floor can look into the arcade space. Usually the party wall is made of brick.



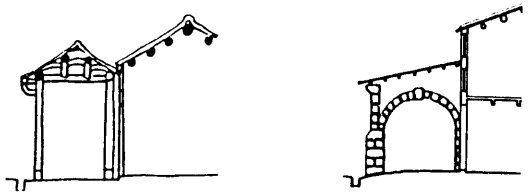


1.b In the single-story rowhouse, the arcade has a well-decorated architrave.



2. Arcade with individual roof

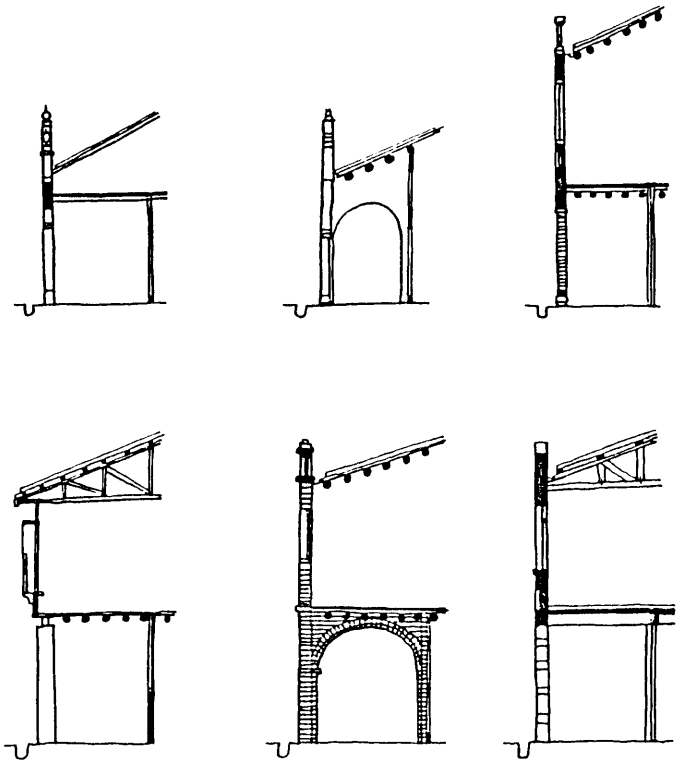
The arcade has its own pitched roof and is attached to the main house. The structure of the main house is separated with that of arcade.



B. Arcade During Japanese Occupation (1895-1950)

Owing to the improvement of construction technique and the influence from western style, the brick and stone mask facades were very popular at that time. Generally, this facade has a complex decoration with ceramic or stone-carving. Although there is still the double-pitched roof for the house, only the facade can be seen from the street. Most of the

rowhouses during this period were two-story buildings. The arcade is in the front part of the first floor with a flat ceiling. The arcade has either two or four pillars along the street.



## 2.3.4 THE RELATION AND POSITION OF VARIOUS ROOMS

A. Internal Organization

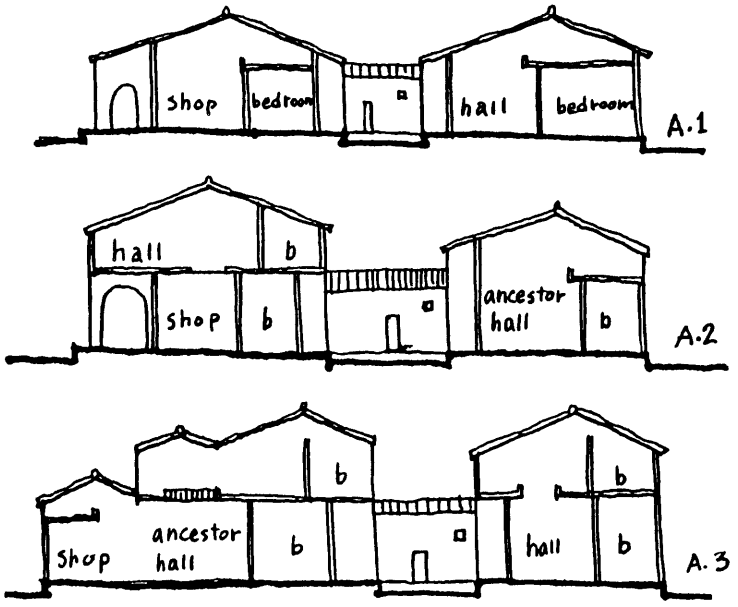
THe internal organization of a rowhouse basically follows the linear character of the space layout and the principle of main unit and affiliated unit as mentioned in 2.2.1. There are three typical international organization in the traditional rowhouse.

A.1 Two layer, one story dwelling -- Usually there is a mezzanine space above the bedroom for the storage purpose in each layer. This makes the ceiling of the bedroom lower than that of the store and the hall. Kitchen is

located in the affiliated unit next to courtyard.

A.2 Two layer, two story dwelling with single-roof or double-roof for one layer -- There are two halls in this dwelling type. The ancestor hall is located in the second layer of the house and the main hall (family room) is located in the front of the second floor facing street. Bedrooms are placed in the rear part of each layer. The ancestor hall has the highest ceiling in the house. The roof type of this dwelling can be single-roof or double-roof.

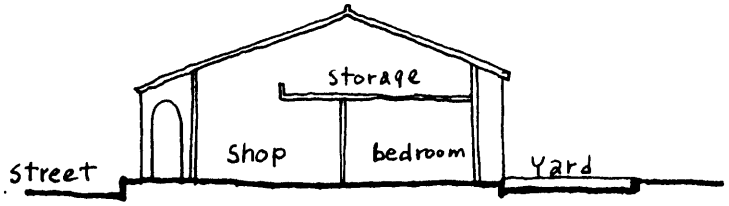
A.3 Two layer, two story dwelling with triple-roof -- This is a popular dwelling style in Lu-Kang area. The first layer has a triple-roof. The ancestor hall is in the middle part of the first layer with a well-decorated mezzanine above. This mezzanine opening is for the purpose of admitting the natural light and to emphasize the importance of the ancestor hall.The main hall in the second layer is used as the living room of the family.



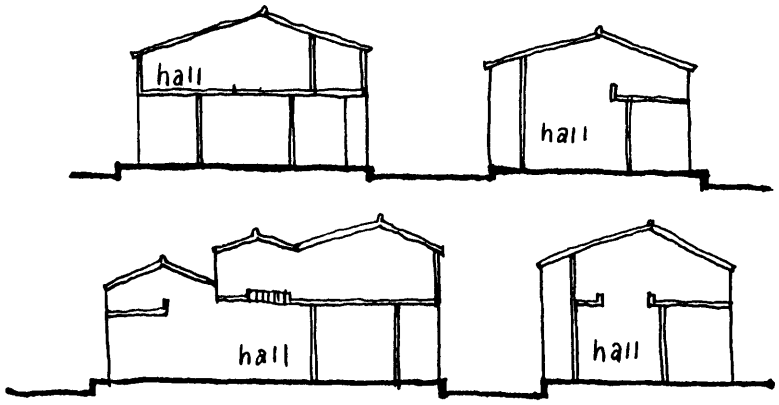
B. Position of Various Rooms

Based on the basic internal organization of the rowhouse, the position of the various rooms could be described as the following situation:

B.1 Store -- the store is always in the front part of the first layer facing to the street. There is a transition space of arcade or doorway between the street and store. Usually a nearby mezzanine storage is faciliated for the commercial use.

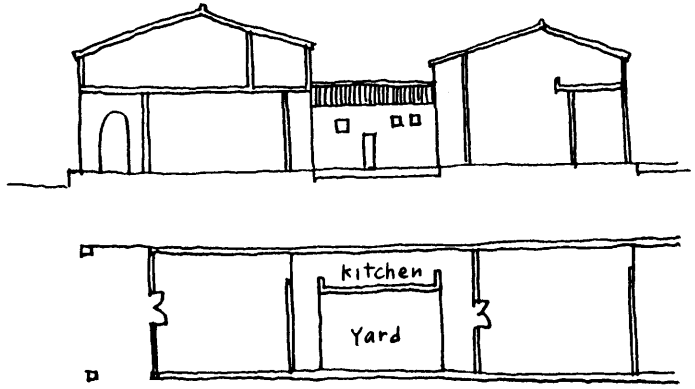



B.2 Hall -- the hall is the public space in the living unit. It could have several functions - ritual, reception or living. A hall could be placed in the first part of the second layer or in the front part of the second floor of the first layer. Only in the triple-roof style, the ancestor hall is located in the middle part of the house as we mentioned above. Usually the ancestor hall has a well-decorated mezzanine opening and/or a transition space.



B.3 Bedroom -- Bedrooms are located in the rear part of each layer. There is a clear order between bedrooms. Bedrooms of the elder are in the last layer which is far away from the noisy commercial street. Although sometimes a bedroom is placed next to a hall, the bedroom's door does not open directly to that public space. A corridor is always added as a connection between public space (hall, shop or courtyard) and bedroom. Owing to the lack of natural light, it is usually very dark within a traditional rowhouse.


B.4 Kitchen -- the kitchen is a less important room in the whole house. Usually it is a narrow and long space in the affiliated unit facing to courtyard. A brick stove is built in the kitchen. Because of the fumes created while cooking, the kithen requires very good direct ventilation.

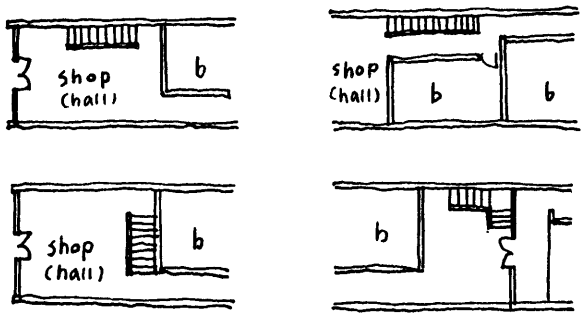


## 2.3.5 POSITION AND RELATION OF PHYSICAL ELEMENTS

Besides the interior spaces, there are other elements to construct a rowhouse type. These elements could be described as 6 categories: staircase, step, balcony, mezzanine opening, courtyard and transition space.

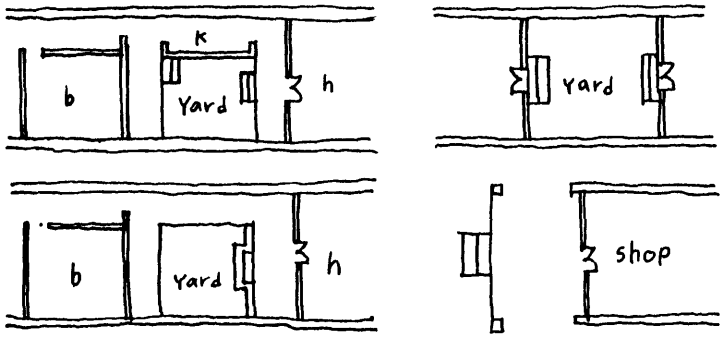
A. Staircase -- the staircase is the element used as the connection between two floors. There are two kind of staircases: temporary and permanent. Both of them are wooden structure. the temporary staircase is movable and mostly used for picking or storing goods on the mezzanine. The permanent staircase usually goes longitudinally parallel to the direction of the rowhouse. There are four posible locations for the permanent staircases.

1. On one side of the shop or the hall connected with load-bearing wall.
2. Next to the corridor and in the circulation path.
3. In the rear part of the main unit.
4. It is between store and bedroom in the transverse direction.



The stair is generally very steep. The slope can be as much as 1:1 or even reach to 3:2 and the width of the stair is from 0.75M to 1M.

B. Step -- The step is used to seperate internal from external spaces. The elevation of courtyard is lower than that of the other spaces. Hence steps are used as a linkage between transition space and courtyard. For the ritual purpose (worship), the steps in front of a main hall are usually well-paved. There are three possible arrangements of steps within the courtyard. Sometimes there is a front step between the street and arcade or other transition space.

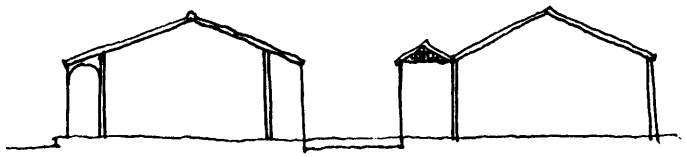


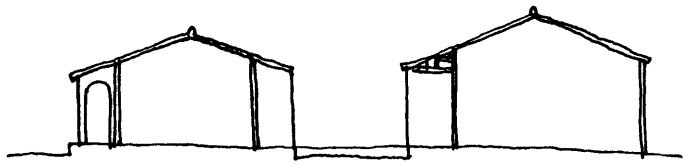

C. Balcony -- The rowhouse type seldom has a balcony facing the street. There are a few cases of front balconies. In most cases, if there is a balcony in the dwelling, it faces to the courtyard.

D. Transition Space -- In the rowhouse type, there is always a transition space between internal and external spaces.

D.1 Arcade: It is a linkage between the street and the shop. It works as a shelter to protect customers from raining season and hot weather. It is also used as an extension space for the usage on the ground floor.

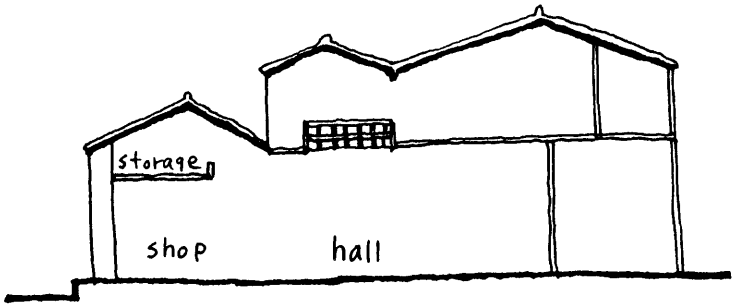
D.2 Gallery: There is usually a platform raised with one or two steps covered by a well-decorated roof between ritual space (ancestor hall) and courtyard. It is a transition space between the interior and the exterior (courtyard). The gallery could also be used as a extension space for ritual activity.

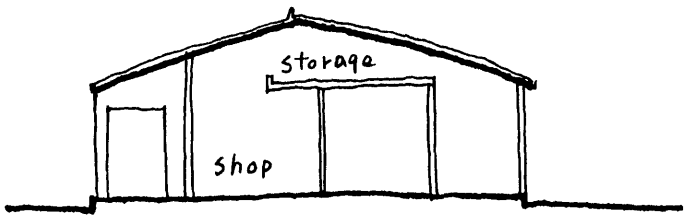




E. Mezzanine Opening -- Mezzanine opening is an essential element in the rowhouse type. Typically it is used for the purpose of utilizing the space under the peak of a roof. A mezzanine is mostly used for storage purposes. However, the meaning and usage of a mezzanine opening in a two story house is different from the storage function. When a layer is long enough,

a skylight is needed to bring natural light in the middle part. The use of the mezzanine opening is to bring the light further to the middle space of the first floor. The handrail of the mezzanine is well-decorated when there is an ancestor hall below.



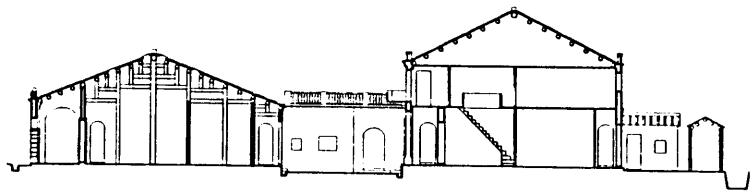

F. Courtyard -- the courtyard is placed between different layers to construct the main spatial sequence. This open space can provide natural light for spaces of two layers and improve the ventilation for the long dwelling unit. It is also used as working space next to kitchen. Usually there is a well in the courtyard, and the lower elevation of the courtyard provides drainage. The courtyard is also a place for family activity. It serves as extension space for ceremonies.

## 2.3.6 CONNECTION

The traditional rowhouse is a well organized dwelling unit. It is composed of layers, various rooms and different elements. In this composition, three type of connections work as integrating elements to bring together different parts as an organized whole. These connections are vertical connection, transversal connection as well as longitudinal connection.

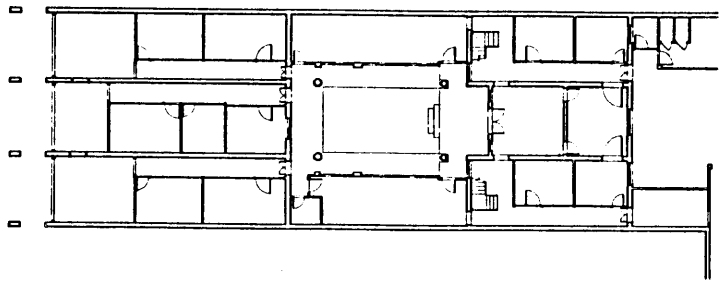
A. Vertical Connection

Vertical connection includes physical connection and visual connection. Physical connection is achieved by the staircase. Visual connection is emphysized by means ofthe mezzanine opening or the courtyard. The mezzanine opening provides internal visual connection in the same layer between living space and store or ancestor hall. The courtyard provides visual connection between different layers. In the courtyard situation, the balcony is the common element for this connection.



B. Transversal Connection

Transversal connections exist in the rowhouse type with several bays. These connections can happen in different positions. In the first layer, each bay has its own corridor leading to the courtyard. In the first part of the first layer (shop), there can be openings in the two party walls to connect the shops. ( The width of the opening is from 1M to 4M.) Sometimes the openings could also be at the end of the first layer. In the multi-bay rowhouse, the yard of the individual bay is integrated and becomes a large courtyard as communication space for the whole family in different bays. The ancestor hall is located in the last layer of the middle bay. And there is a formal semi-open transition space between courtyard, hall and living spaces of other bays. Usually the bedroom of nearby bays have a door open either to the transition space or ancestor hall. The ancestor hall become a spiritual center to connect the living spaces of different bays around it.



C. Longtitudinal connection

With the parallel party walls constriant and the narrow frontage to the street, the longtitudinal direction is the easiest and most common way for growth of the rowhouse. Hence, the longtitudinal connection plays a very important role to tie together different layers. Typically, this connection is achieved by means of the courtyard or affiliated unit. The courtyard is the major element along the circulation path. There usually are steps along the circulation axis between courtyard and transition space to emphasize the longtitudinal connection.

The affiliated unit is used as gallery in the second floor. It is to connect the main units in both ends. In the first floor, except being used as kitchen or storage, an affiliated unit can also be used as gallery for connection and as a shelter for different weather.

CHAPTER 3: CHANGE AND NEW REQUIREMENT

# 3. CHANGE AND NEW REQUIREMENTS

## 3.1 FAMILY STRUCTURE AND DWELLING TYPE

Housing is largely a product of prevailing economic and technological forces. Family relations and structure manifested in everyday household life play a critical role in the determination and transformation of the house form. During the past 40 years, both family structure and dwelling type have been affected by the modernization and industrilization in the Taiwan area.

In the mid 1940's, Taiwan was returned to China from Japan. After the Chinese civil war (1945-1950), thousands of Chinese immigrants swarmed into Taiwan from the Communist controlled Mainland China. At the same time, the industrialization in this area also brought a new class of urban immigrants from the rural areas into the cities. These two factors made the housing shortage a very serious problem. Thus an efficient building technology and a space-saving dwelling type were needed at that time. The traditional Srh-Ho-Yuan and San-Ho-Yuan types no longer met the new requirement. The rowhouse type which was originally developed for reasons of economic use of urban land survived, but the traditional elegant

elements and decoration no longer appear in today's rowhouse type.

Owing to industrilization, the new building technology of concrete column and slab construction using brick infill for walls and partitions became widespread. This method made possible the wide application of the multi-story dwelling. It rapidly replaced brick and wood and became the major construction method. Therefore, the mass housing by way of the multi-story rowhouse and the walk-up apartment with their uniform appearance and modern facilities emerged. These massive rectangular concrete boxes with flat roofs and modern kitchens and bathrooms represented the current fashion and progress. Traditional dwelling units were demolished and replaced them with new constructions. In the mid 1960's, owing to the rapid economic growth and the increase of population density, the high-rise housing unit with elevator became a new building type the urban area. The character of the traditional dwelling continued to be neglected. After physical facilities were improved through economic progress, and the living standard also raised, a new concern for the environment emerged. People began to look for self-identification in the cultural and social aspects of design. More and more new projects tried to use traditional elements and decorations to recapture the spirit of the Chinese style.

Modernization, with the convergence of the moral demand for individual freedom and the industrial demand for an independent labor, had led to the nuclear family. Unlike the housing transformation process, this revolt against the old family structure was not totally successful. Although five-generation extended families are scarce at the present, one fourth of all households still maintain the modified extended family structure which includes the vertical and horizontal extension from the nuclear family. Typically the vertical extension is composed of an elderly couple and a nuclear household composed of one of their sons. The horizontal extension includes the elder couple's other unmarried children. Therefore, the family contains three generations and the membership is from 6 to 10 in size.The other three fourths of all families with the form of the nuclear family tend to live in urban area with members from 2 to 6.

Most of the high-rise buildings and multi-story walk-up apartments are designed for the nuclear families. They are typical examples of so called "3 rooms-2 halls" units with a rigid layout of the three bedrooms, living room, dinning room, kitchen and bathroom. For the modified extended families three new dwelling styles are used for the demands of this family sturcture.

1. Single Rowhouse Dwelling Unit

Most families live in this kind of house. Usually the dwelling is a mass-production rowhouse with 2 to 4 stories. Each family has its own entrance and ownership of the land.

2. Two Interconnected Apartment Unit

A family adjusts two units of apartments into one household within multi-story walk-up apartment or high-rise building. They either combine two units on the same floor, or add a staircase between two units of different floors.

3. Two Intra-neighborhood Dwelling Units

A family lives within two nearby units. The connection between these two units goes through a public space (for example a public staircase, a public corridor or a street). The two units may locate in the same building or different buildings. With this type two families can have both close relation and privacy at same time. Usually it is the desirable arrangement for the brothers who bave their own small families.

## 3.2 ISSUES INVOLVED WITH THE ROWHOUSE TYPE

As I mentioned above, the rowhouse survives because of the economic land use, the mix-use flexibility and the accommodation of the modified extended family. Despite of the rigid uniform appearance, there still are 2 problems:

1. The narrow and long span of the rowhouse type (4.5M x 15M) without a courtyard or skylight creates a large dark space in the middle part of the building. Usually this kind of space cannot be efficiently used.

2. Sharing is very popular in the rowhouse type. When the household size is small, owners usually lease some space, either for commercial use or residential use, to other households. However, there exists the problem of privacy in the rowhouse in which separate territories are not considered in the design.

The rowhouse type maintains the following advantages:

1. The use of the party wall saves material and construction time compared to the free standing house.

2. The ownership of the land is clearly determined. This concurs with

the Chinese principle to own the land you live on and it is also convinent for further extension.

3. The mixed-use function can provide a secondary commercial activity in the neighborhood. This dwelling type can exist in the small town, or in the area of city away from central business district.

By improving the design quality and solving the function problems, the rowhouse type can still be a useful dwelling type from the social, economic and family structure aspects.

## 3.3 NEW REQUIREMENT

### 3.3.1 TRADITION AND CONVERSION OF VARIOUS ROOMS

| | TRADITION | CONVERSION |
|---|---|---|
| FAMILY SPACE | * HALL<br>a. ancestor worship<br>b. religious worship<br>c. representation of social status<br>d. family communication<br>e. important location along axis<br><br>* YARD<br>a. working space<br>b. family communication<br>c. playground for children | * LIVING ROOM<br>a. reception<br>b. family communication<br>c. recreation (T.V.)<br><br>* DINING ROOM<br>a. eating space<br>b. next to kitchen<br><br>* FAMILY ROOM (option)<br>a. religious and ancestor worship |
| PRIVATE SPACE | * BEDROOM<br>a. clear order<br>b. dark<br>c. less privacy | * BEDROOM<br>a. sufficient sun light and ventilation<br>b. more privacy<br>c. a master bedroom with indivisual bathroom |

| | | |
|---|---|---|
| WORKING SPACE | * KITCHEN<br>a. secondary space in the house<br>b. narrow, small space<br>c. courtyard as an extension<br><br>working space next to kitchen | * KITCHEN<br>a. sufficient natural ventilation<br>b. modern facilities ( sink, gas stove, refrigerator )<br>c. next to a balcony<br>d. with laundry equipment<br><br>* WORKSHOP(optionG)<br>a. with laundry equipment<br>b. sewing machine |
| SERVICE SPACE | * BATHROOM<br>a. no formal bathroom or facilities<br><br>* STORAGE | * BATHROOM<br>a. with modern facilities (a bathtub, a sink, a flush toilet )<br>b. minimum requirement of one bathroom and an extra toilet room per three-bedroom house<br><br>* STORAGE |

3.3.2 NEW STANDARD AND REQUIREMENT IN THE BUILDING CODE

| ROOM | STUDIO | 1--2 | 2--3 | 3--5 | MINIMUM DIMENSION | NATURAL LIGHTING |
|---|---|---|---|---|---|---|
| LIVING ROOM | | 12 $M^2$ | 12 $M^2$ | 14 $M^2$ | 2.7 M | * |
| DINING ROOM | | 6 $M^2$ | 8 $M^2$ | 9 $M^2$ | 2.4 M | |
| LIVING and DINING ROOM | | 16 $M^2$ | 18 $M^2$ | 20 $M^2$ | 2.4 M | * |
| KITCHEN and DINING ROOM | | 9 $M^2$ | 10 $M^2$ | 12 $M^2$ | 2.1 M | * |
| MASTER BEDROOM | | 10 $M^2$ | 10 $M^2$ | 10 $M^2$ | 2.7 M | * |
| BEDROOM (A) | | | 7.5 $M^2$ | 7.5 $M^2$ | 2.1 M | * |
| BEDROOM (B) | | 5 $M^2$ | 5 $M^2$ | 5 $M^2$ | 1.8 M | * |
| KITCHEN | 4 $M^2$ | 4.2 $M^2$ | 4.2 $M^2$ | 5.5 $M^2$ | 1.8 M | * |
| BATHROOM | 3 $M^2$ | 3.4 $M^2$ | 3.4 $M^2$ | 4 $M^2$ | 1.5 M | |
| TOILET ROOM | | | | 1.4 $M^2$ | 0.9 M | |
| STORAGE | 2 $M^2$ | 2 $M^2$ | 3.5 $M^2$ | 5 $M^2$ | | |
| LIVING and DINING and BEDROOM | 18 $M^2$ | | | | 2.7 M | * |

CHAPTER 4: DEVELOPMENT OF THE NEW ROWHOUSE TYPE

# 4. DEVELOPMENT OF THE NEW ROWHOUSE

## 4.1 CONSTRAINTS AND RULES

In this section, a new set of rules is defined, on which the new design of rowhouse type should be based. Some of these rules come from selecting or transforming the relevant traditional character. The others stem from the new conventions in the contemporary context and building code.

### 4.1.1 RULES FROM THE TRADITIONAL CHARACTER

A. Configuration

Roof pattern (one-pitched roof, double-pitched roof, triple-ptiched roof) and the distinction of 4 units (petite, small, medium and large unit) to be combined in differnt ways, should be preserved in the new rowhouse type design. The layer of this type is limited to one or two in number.

B. Spatial Sequence

The spatial sequence of the traditional rowhouse type was based on the order of the importance for various spaces. However, in the current dwelling style, this order is less clear as it was in the past. Hence, the traditional spatial sequence is not applicable in the

current rowhouse development. In the new design, the traditional axis should not be emphasized. Only the linear character should be preserved and the path should be placed to one side of the rowhouse next to the party wall.

C. Facade and Arcade

The character of the facade should be preserved according to the possible position of various openings in the traditional rowhouse type. The arcade, according to the new building code, is required at a minimum depth of 3.3M for the commercial area.

D. Relation and Position of Various Rooms

Owing to the change of space order in current living style, most of the relation and position rules for rooms in the traditional rowhouse are not applicable in the new design. Only two principles should still be followed:

1. Only the shop or the living room can be placed in the front part of the first floor next to the street.
2. The kitchen should not be placed in the front part of the building facing to the street.

E. Relation and Position of Physical Elements

E.1 Mezzanine Opening and Courtyard:

The mezzanine opening and the courtyard are two of the crucial elements contributing to the spatial character of the rowhouse type and

provide sufficient natural light to the building. In the new rowhouse design, each house must at least contain one of these two elements.From the observation on the existing rowhouse and for the purpose of lighting and ventilation, the dimension of the mezzanine opening should not be less than 2.5M x 3M,and the dimension of the courtyard should not be less than 4M x 4M.

E.2 Transition Space

There should be a transition space between the street and the house--an arcade for commercial units or a porch for the residential unit.

There should be a gallery around the courtyard as a transition space between layers.

E.3 Balcony

A balcony should be placed facing to the street or to the courtyard.

E.4 Step

There should be steps between the courtyard and the transition space.

F. Connection

F.1 Vertical Connection

Besides the physical connection by stairs, vertical visual connection should also be emphasized for the multi-story rowhouse by means of mezzanine opening or courtyard.

F.2 Longitudinal Connection

A longitudinal connection should be provided between different layers if these layers are inhabitated by the same family.

F.3 Transversal Connection

A transversal connection is used for the internal linkage of the multi-bay rowhouse for the large extended family. It is not applicable in this study of new design.

4.1.2 CONSTRAINTS FROM THE CURRENT REQUIREMENT

A. All the rowhouse type are divided into two categories:

A.1 The rowhouse in the commercial area -- a mixed-use rowhouse with a required arcade.

A.2 The rowhouse in the residential area.

B. The height of the rowhouse is limited to 4 stories.

C. Each house should provide possible territories divisions and possible variations in plan to accomodate different family sizes and living styles.

D. The dimension and area of various rooms should meet the minimum requirement of the building code.

E. The living room should be located either next to the external wall or under the skylight.

F. The staircase, bathroom and storage should be located in the middle part of the house.

G. The kitchen should be placed next to a balcony and directly expose to

the outside for natural ventilation.

H. The dining roon could be either independent or incorperated with the living room.

I. An informal eating space can be situated in the kitchen area.

## 4.2 METHOD

A method should serve as a base on which a design can be made to reflect the selected rules and constraints. In order to optimize the layout flexibility of the dwelling unit a zoning system based on the SAR methodology is used in the new design development. Within the zoning system, all the relations among those identified elements can be explicitly stated.

### 4.2.1 ZONING DISTRIBUTION

In this section, six zoning distributions are developed. Based on these distributions many variations can be made. The zones and margins in

a zone distribution can be defined as following:

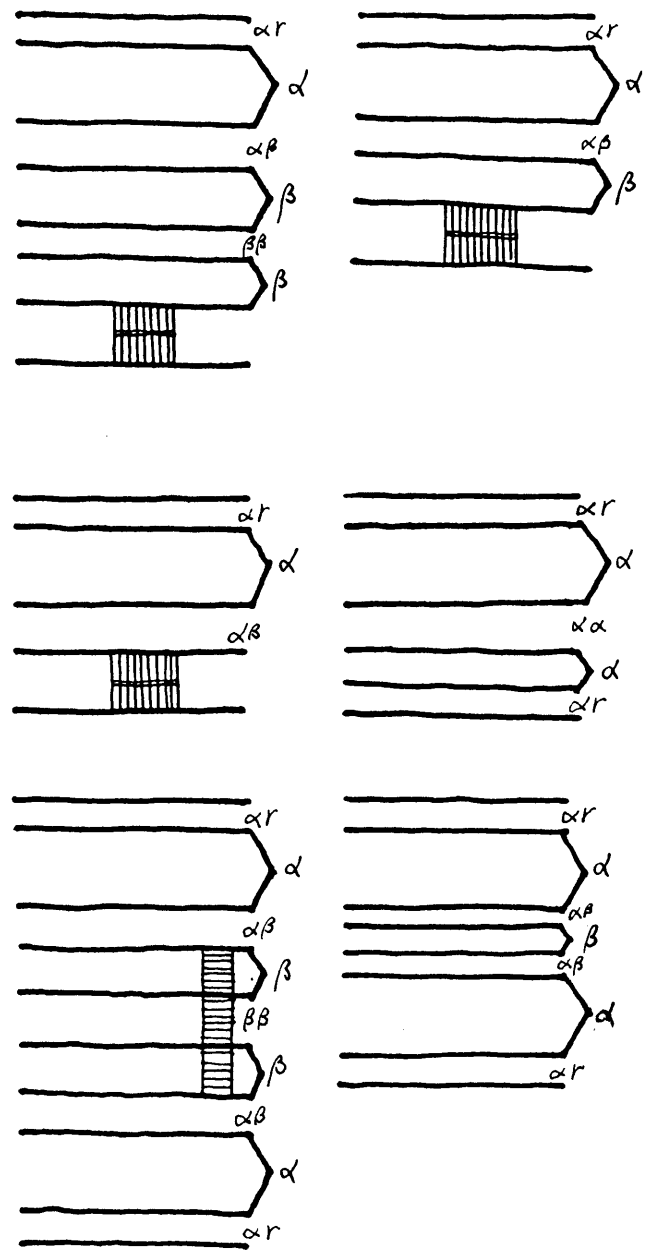
-- An alpha zone is an internal area, intended for private use, and is adjacent to an exterior wall.

-- A beta zone is an internal area, intened for private use, and is not adjacent to an exterior wall.

-- A gamma zone can be internal or external but is intended for public use.

-- A delta zone is an external area intended for private use.

Margin -- A margin is an area between two zones, with the characteristics of both these zones and taking its name from them.



### 4.2.2 POSITION RULES

Position 1:

The minimum depth of the space is the width of an zone. The maximum depth is the width of an zone plus two adjoining margins. The spaces such as master bedroom, bedroom and study room should be located in this position.

Position 2:

The minimum depth of the space is the width of an zone. The maximum depth is the width of an zone plus an adjoining margin. This position can be applied by the spaces for position 1. The kitchen should only be placed in this position with the other margin used as balcony.

Position 3:

The minimum depth of the space is the width of two zones (including an zone) plus the margin between them. The maximum depth is the width of two zones plus three margins. Living room, family room and shop should be located in this position or position 1.

Position 4:

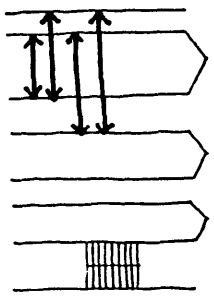
The minimum depth of the space is the width of a zone. The maximum depth is the width of a zone plus two adjoining margins. Dining room, sitting room or workshop should be placed in this position.

Position 5:

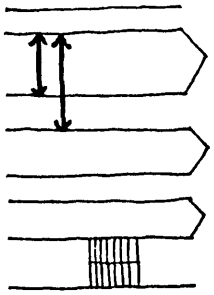
This position rule occurs only when there are two zones in the zone distribution. The minimum depth of the space is the width of a zone plus a margin. The maximum depth is the width of two zones plus a margin between them. The mezzanine opening of the top floor level with a skylight above should be located in this position.The space below the mezzanine opening should have a family-use function such as living room, family room, sitting area or dining room.

Position 6:

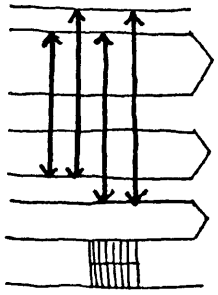
The minimum depth of the space is the width of the margin. Bathroom, toilet room and storage should be located in this position or in position 4.



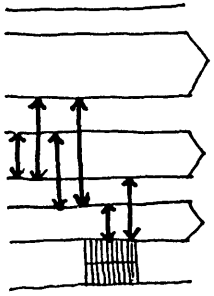
Position 1.



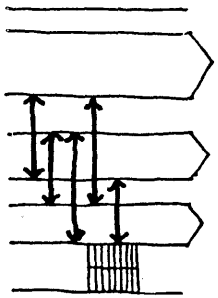
Position 2.



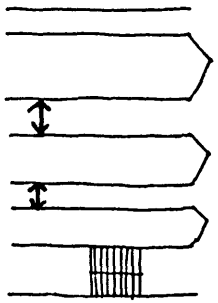
Position 3.



Position 4.



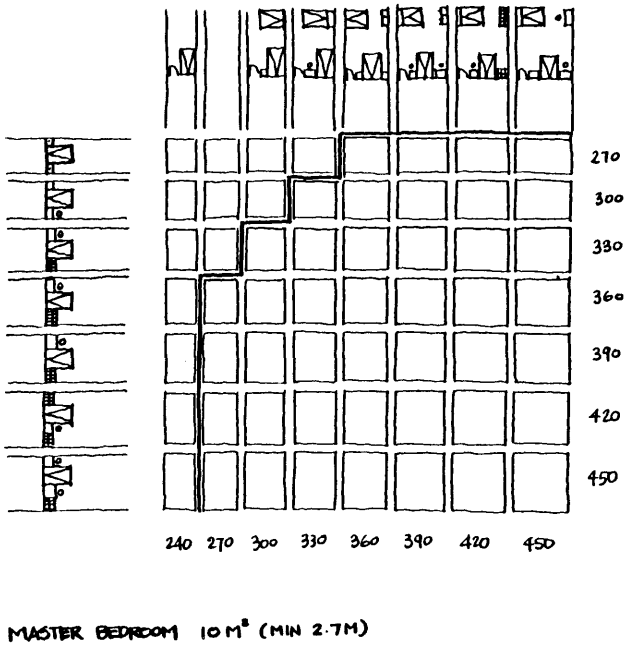
Position 5.



Position 6.

## 4.2.3 DIMENSION OF ZONING DISTRIBUTIONS

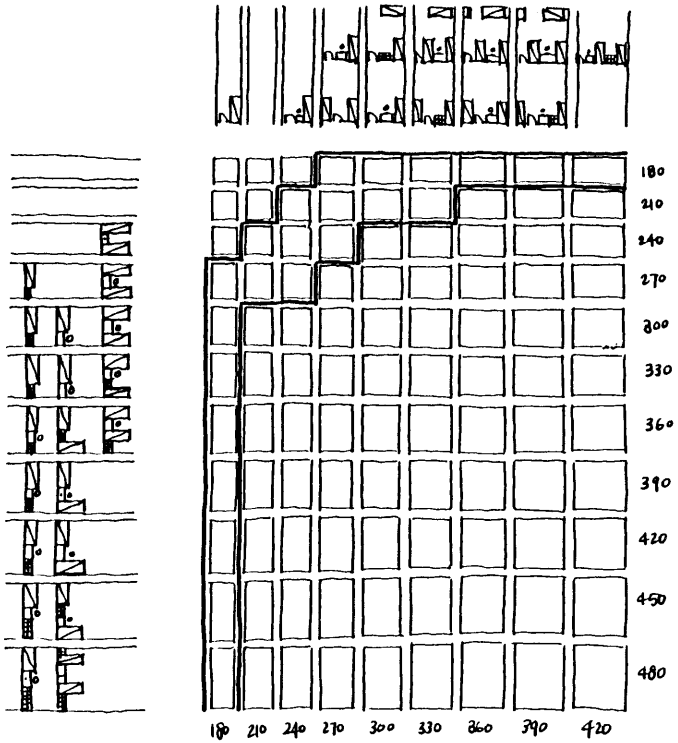
The dimension of a zoning distribution is usually based on the prefered maximum and minimum size of the space in a dwelling unit. Space and function analysis charts can be used as the base to decide the dimension of the zoning distributions. After the dimension of zoning distributions has been desided, the zoning analysis and the sector analysis can be formulated with the aid of space and function analysis chart. The zoning analysis indicates how functions can be located in the zone distribution. The sector analysis indicates the relationship between a sector and the accommodated functions.




Space and Function Analysis Chart

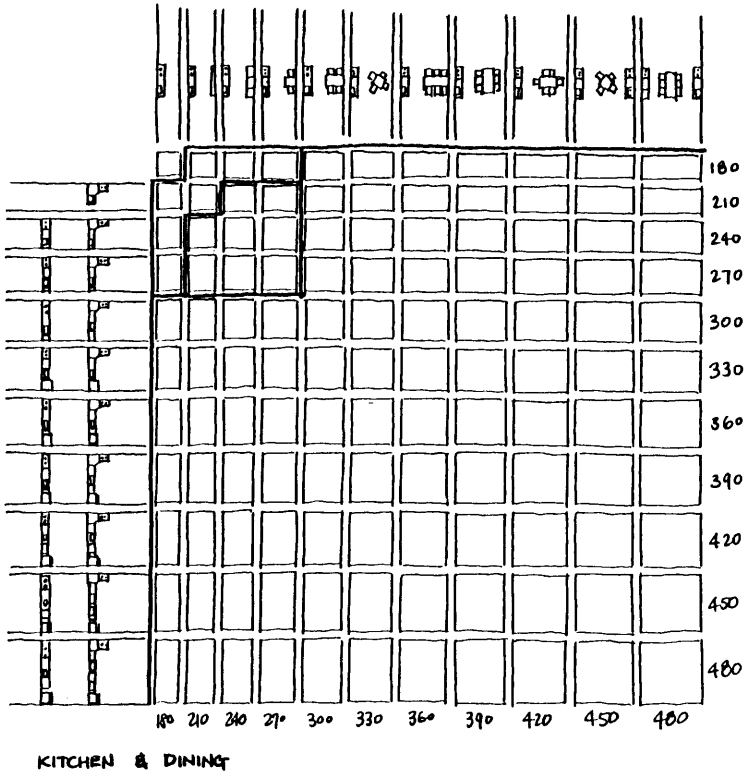
Space and Function Analysis

Chart



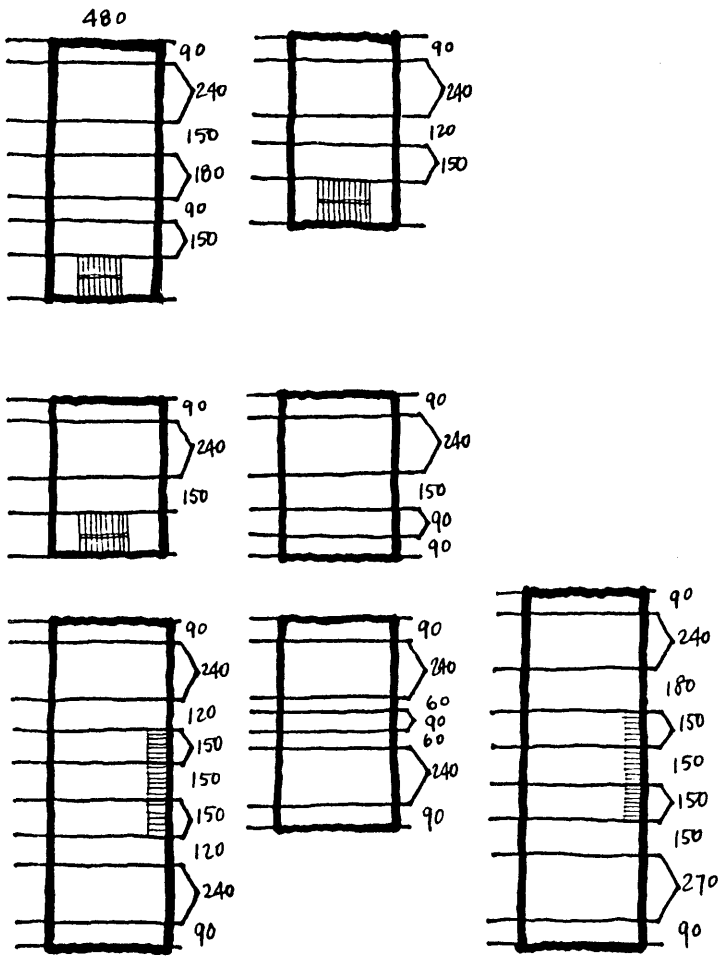

BEDROOM B1 : 5M² (MIN 1.8M)

B2 : 7.5M² (MIN 2.1M)




KITCHEN & DINING

Dimension of Zone Distribution




## 4.3 THE ROWHOUSE SYSTEM

### 4.3.1 FRAMEWORK

In this section, combinatory rules are used to generate various dimensions of the rowhouse. As I mentioned in Chapter 2, each layer of a rowhouse can be described as the combination of various units. In the same way the rowhouse is constructed by the combination of layers with various dimension. Thus in the new rowhouse design this principle of combination is used to construct the whole rowhouse. Combinations can be started from the unit level through the layer level to the house level.

Firstly the seven zoning distributions can be treated as two categories:

A. Basic Unit

Each element in this category can be combined with another element (with thw same or different size) to become one layer.

B. Basic Layer

Each element is an individual layer. Thus a layer of a rowhouse can be either a basic layer or composed by two basic units. Three types of layer can be constructed: small layer. medium layer and larger layer.

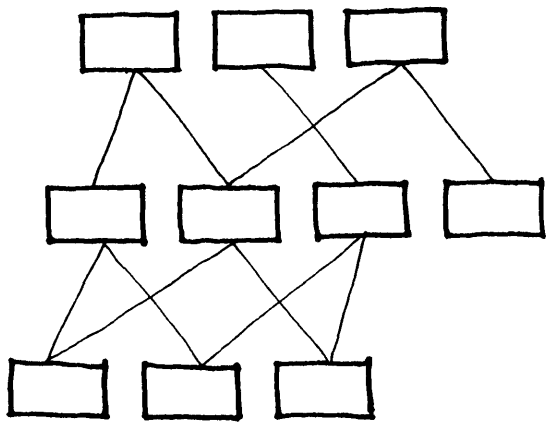
A rowhouse can be either one-layer with mezzanine opening or two-layer with courtyard or both courtyard and mezzanine.

Finally the new rowhouse environment is the collection of the various dimension of houses.

A rowhouse can be located in commercial area or residential area. In commercial area the layout of the rowhouse should contain an arcade (with depth of 3.3M) and a shop in the first floor.

FRAMEWORK

ROWHOUSE SYSTEM

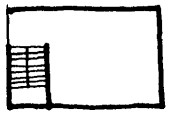


HOUSE

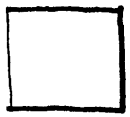
LAYER

UNIT

UNIT



* 1.80 + 4.80 M
* 1.80 + 6.00 M
* 1.80 + 9.00 M



* 4.80 M
* 6.00 M
* 9.00 M

LAYER

1. Small Layer (without stairs)

* 8.70 M
* 6.60 M

2. Medium Layer (with stairs 1.80 M)

2.a.

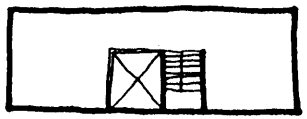
* 4.80 + 1.80 + 4.80 = 11.40 M
* 4.80 + 1.80 + 6.00 = 12.60 M
* 6.00 + 1.80 + 6.00 = 13.80 M

2.b.

* 13.50 M

3. Large Layer(with stairs & mezzanine opening)

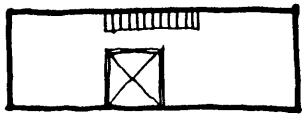
3.a.



* 9.00 + 1.80 + 4.80 = 15.60 M

* 9.00 + 1.80 + 6.00 = 16.80 M

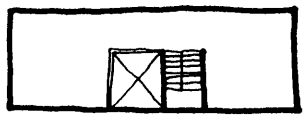
3.b.



* 14.70 M

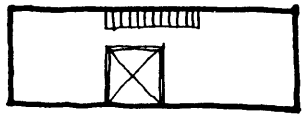
HOUSE

1. One Layer House (with mezzanine opening )



* 15.60 M

* 16.80 M

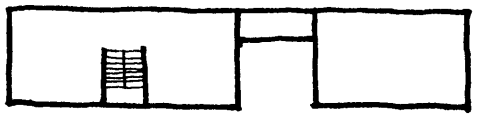


* 14.70 M

2. Two Layer House

2.a With Courtyard (4.5 M)

a.1.Medium Layer + Small Layer



* 11.40 + 4.50 + 6.60 = 22.50 M

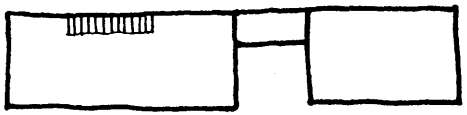
* 11.40 + 4.50 + 8.70 = 24.60 M

* 12.60 + 4.50 + 6.60 = 23.70 M

* 12.60 + 4.50 + 8.70 = 25.80 M

* 13.80 + 4.50 + 6.60 = 24.90 M

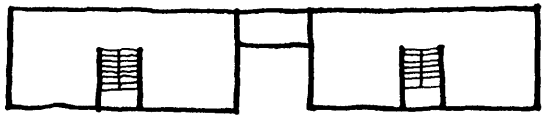
* 13.80 + 4.50 + 8.70 = 27.00 M



* 13.50 + 4.50 + 6.60
  = 24.60 M

* 13.50 + 4.50 + 8.70
  = 26.70 M

## a.2. Medium Layer + Medium Layer



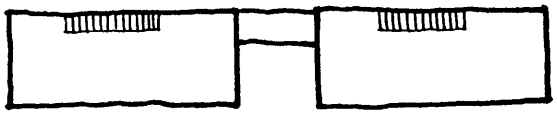
* 11.40 + 4.50 + 11.40
  = 27.30 M

* 11.40 + 4.50 + 12.60
  = 28.50 M

* 11.40 + 4.50 + 13.80
  = 29.70 M

* 12.60 + 4.50 + 13.80
  = 30.90 M

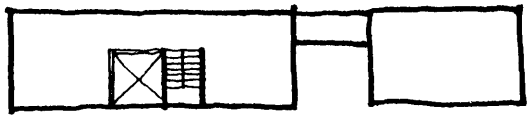
* 13.80 + 4.50 + 13.80
  = 32.10 M



* 13.50 + 4.50 + 13.50
  = 31.50 M

## 2.b. With Courtyard & Mezzanine Opening

### b.1. Large Layer + Small Layer

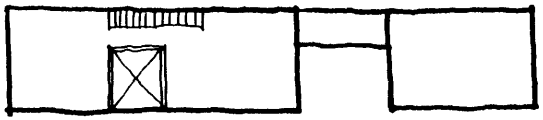


* 15.60 + 4.50 + 6.60
  = 26.70 M

* 15.60 + 4.50 + 8.70
  = 28.80 M

* 16.80 + 4.50 + 6.60
  = 27.90 M

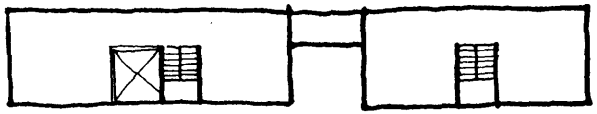
* 16.80 + 4.50 + 8.70
  = 30.00 M



* 14.70 + 4.50 + 6.60
  = 25.80

* 14.70 + 4.50 + 8.70
  = 27.90 M

## b.2. Large Layer + Medium Layer



* 15.60 + 4.50 + 11.40
  = 31.50 M

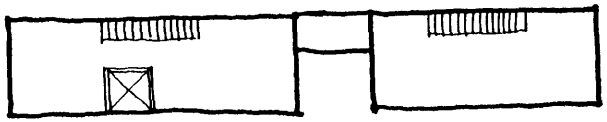
* 15.60 + 4.50 + 12.60
  = 32.70 M

* 15.60 + 4.50 + 13.80
  = 33.90 M

* 16.80 + 4.50 + 11.40
  = 32.70 M

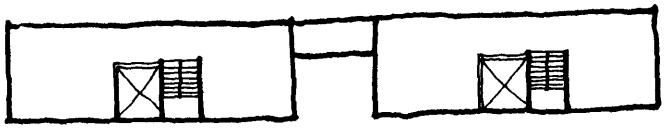
* 16.80 + 4.50 + 12.60
  = 33.90 M

* 16.80 + 4.50 + 13.80
  = 35.10 M



* 14.70 + 4.50 + 14.70
  = 33.90 M

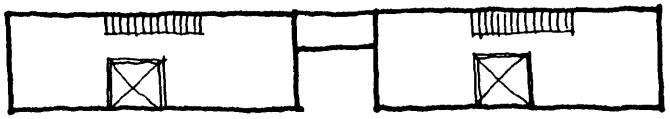
## b.3. Large Layer + Large Layer



* 15.60 + 4.50 + 15.60
  = 35.70 M

* 15.60 + 4.50 + 16.80
  = 36.90 M

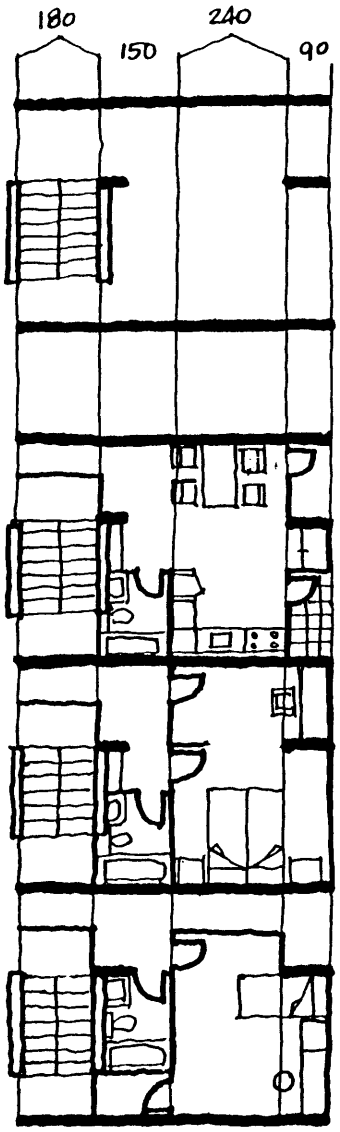
* 16.80 + 4.50 + 16.80
  = 38.10 M

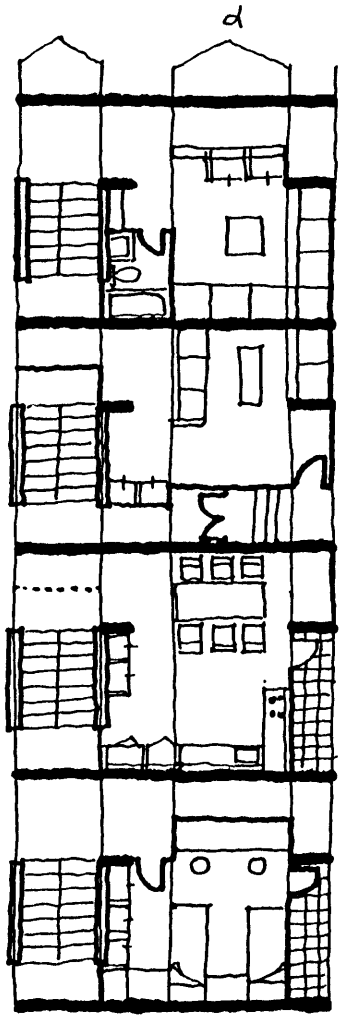


* 14.70 + 4.50 + 14.70
  = 33.90 M

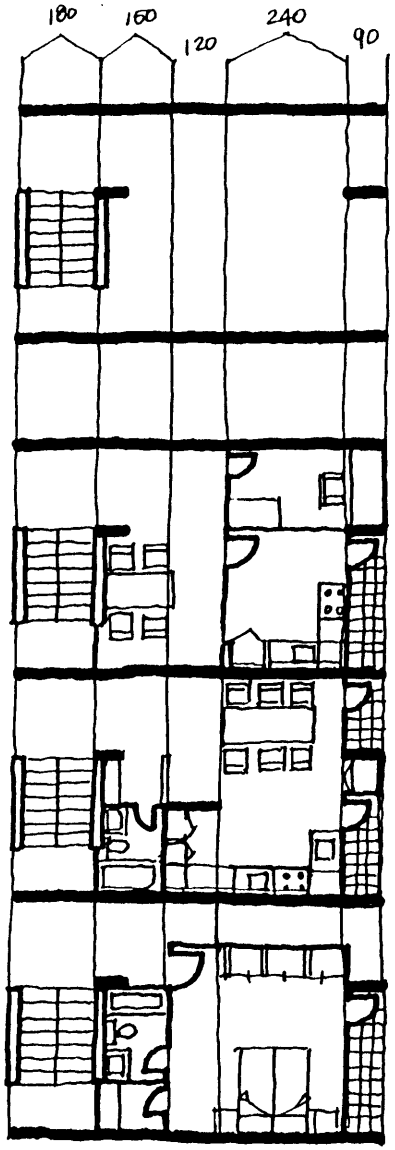
## 4.3.2 SUB-VARIATIONS OF BASIC UNIT AND BASIC LAYER

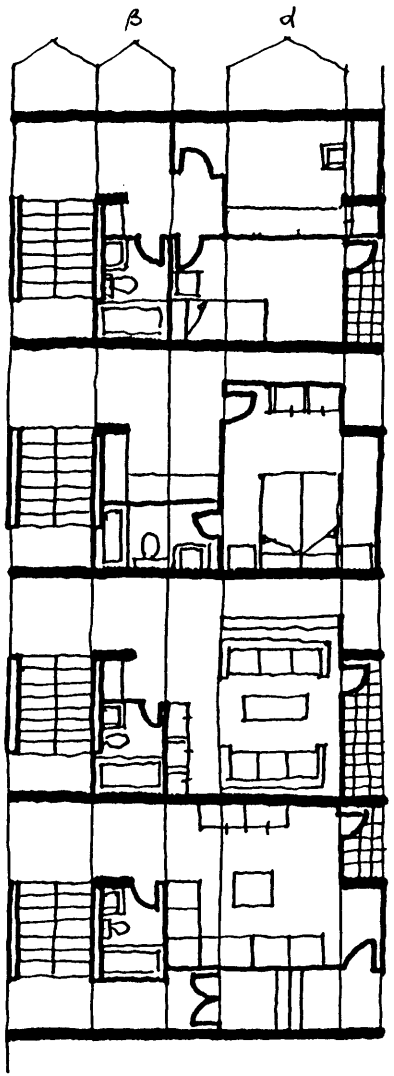
(1.80M+4.80M)×4.80M



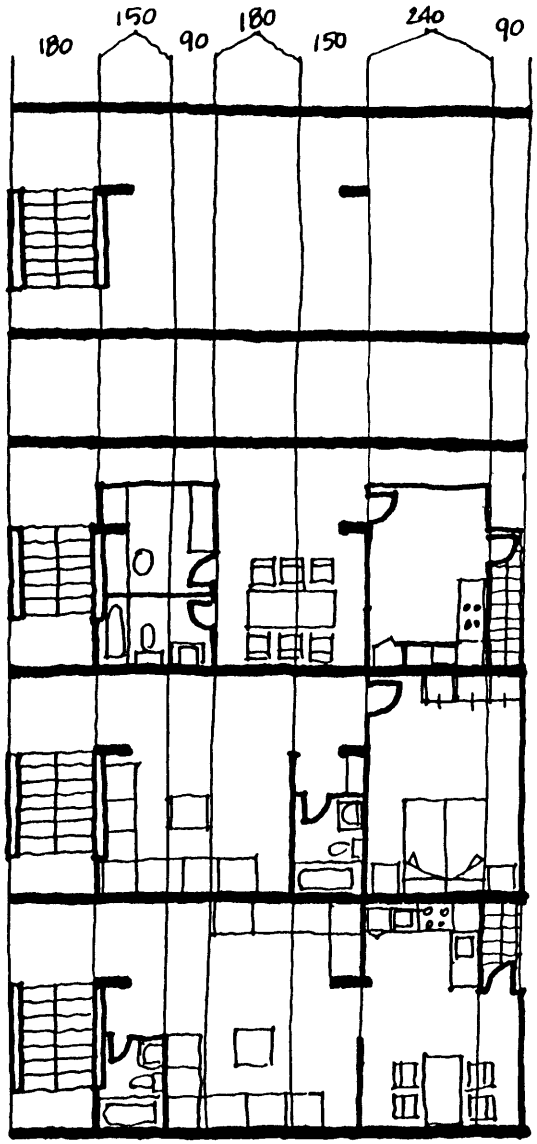



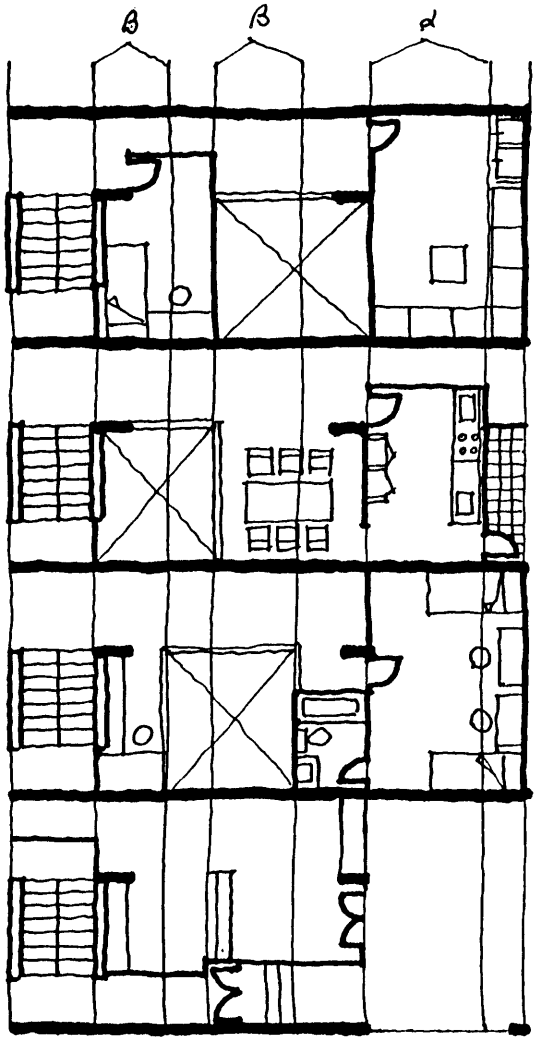
(1.80M+6.00M) × 4.80M.



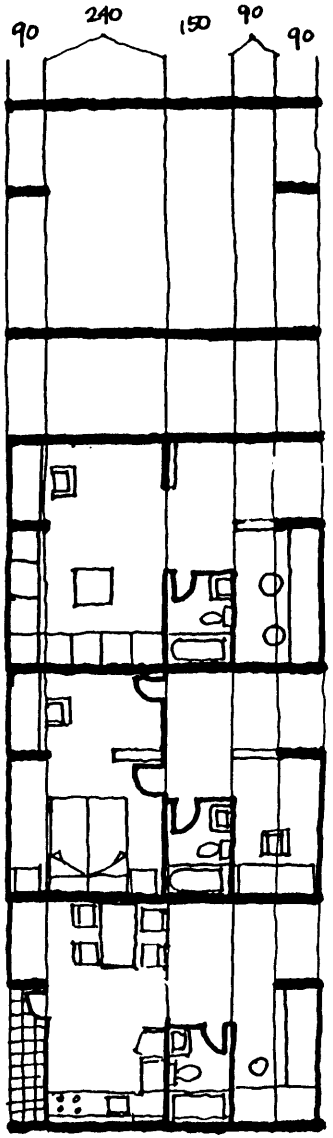



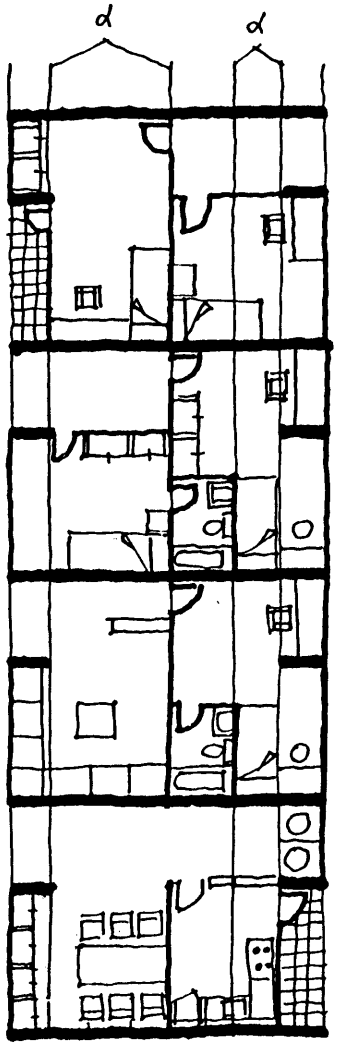
(1.80M+9.00M) ×4.80M



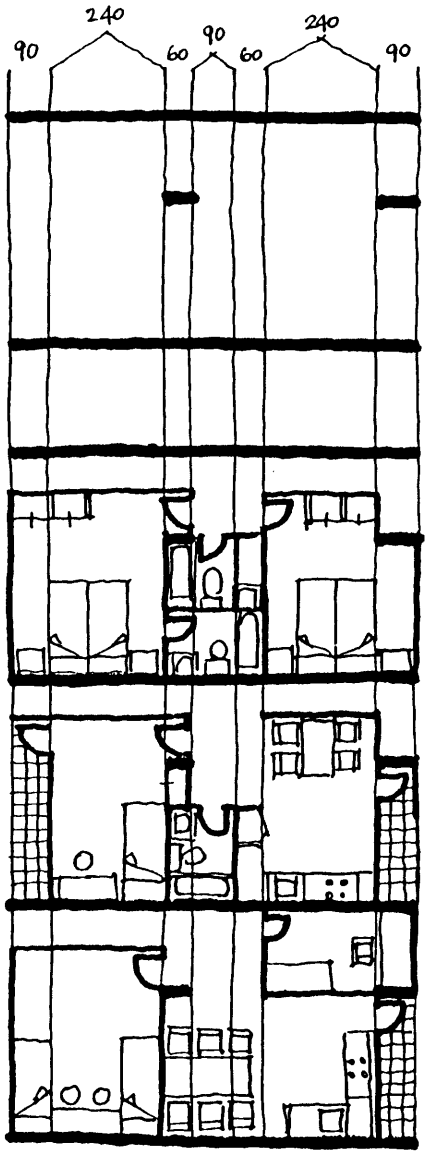



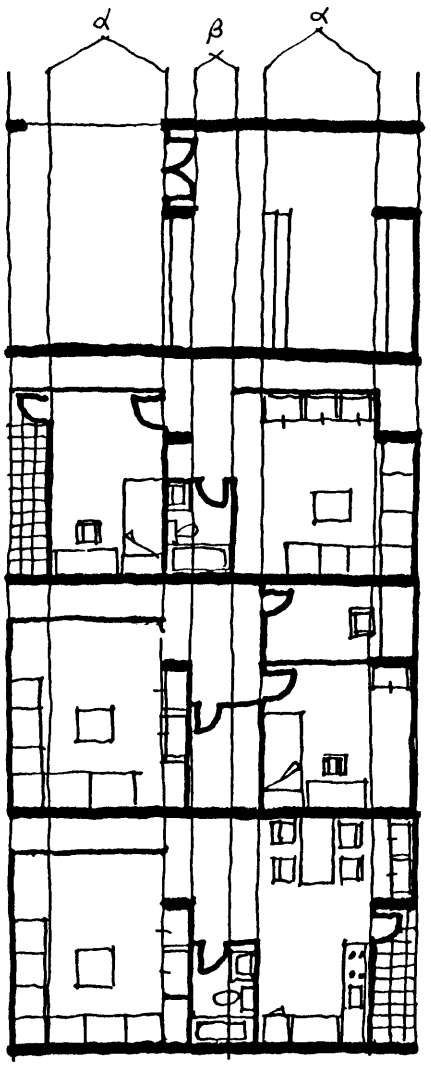
6.60 M x 4.80 M



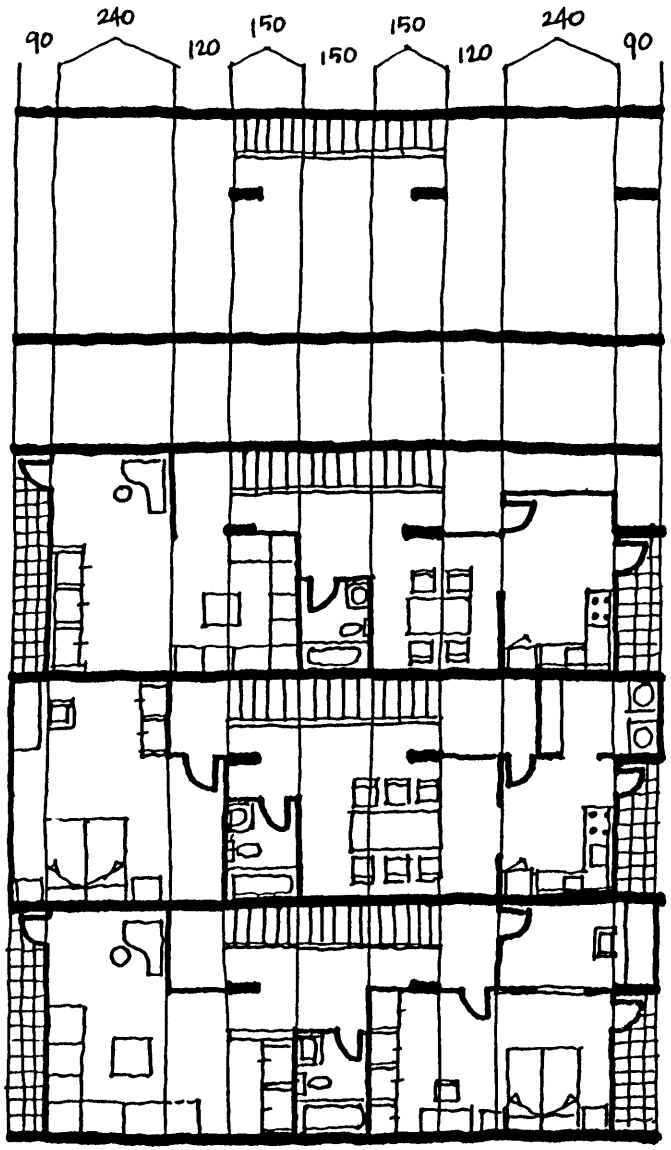



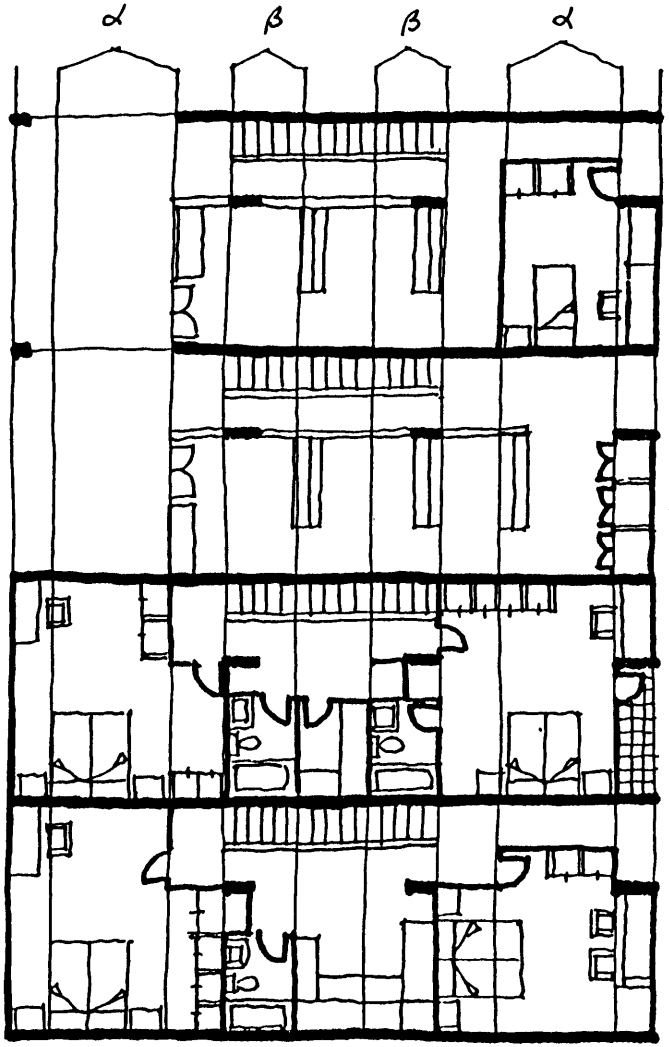
8.70 M x 4.80M



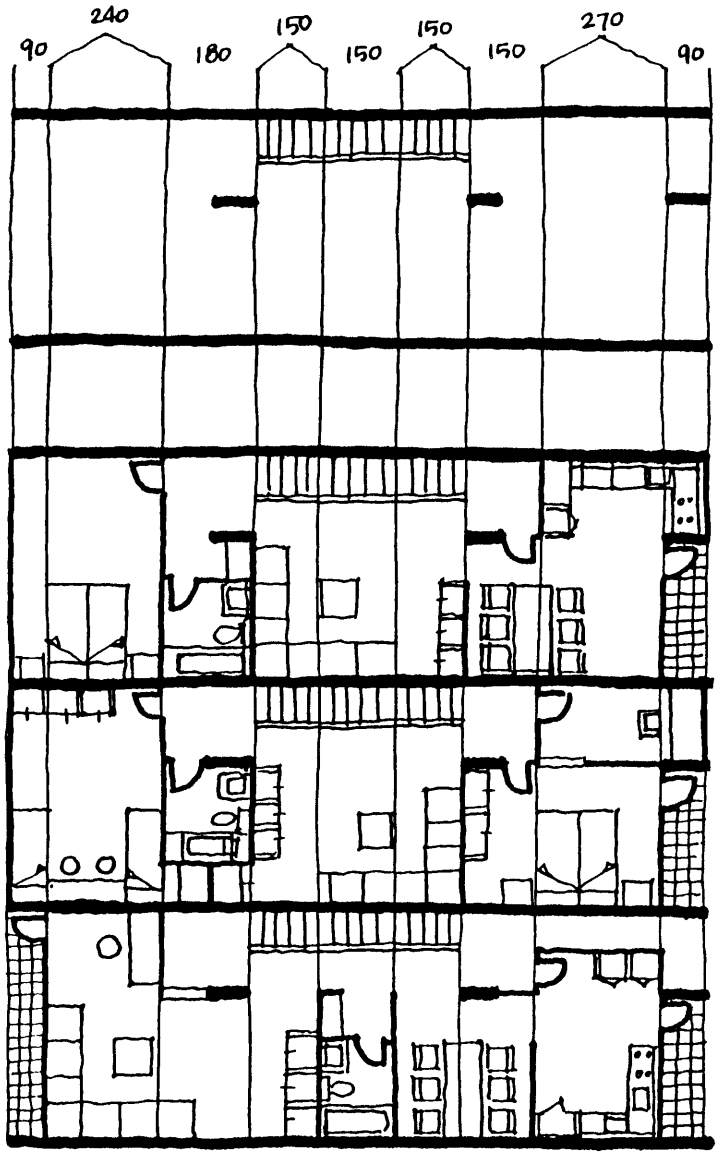



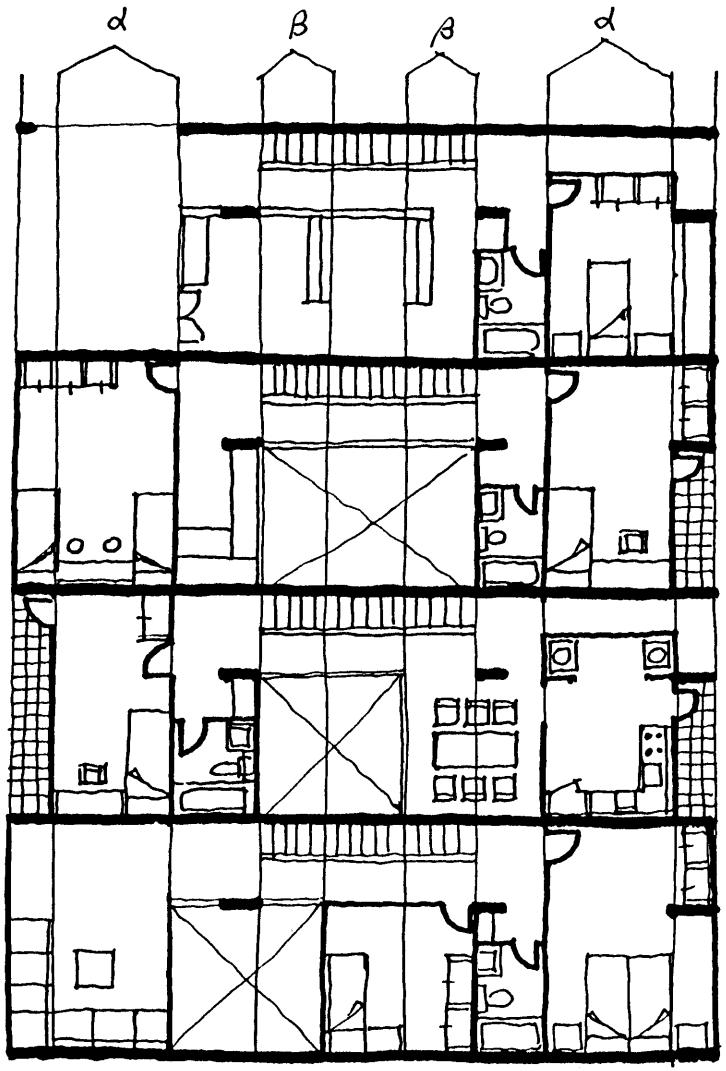
13.50M x 4.80M



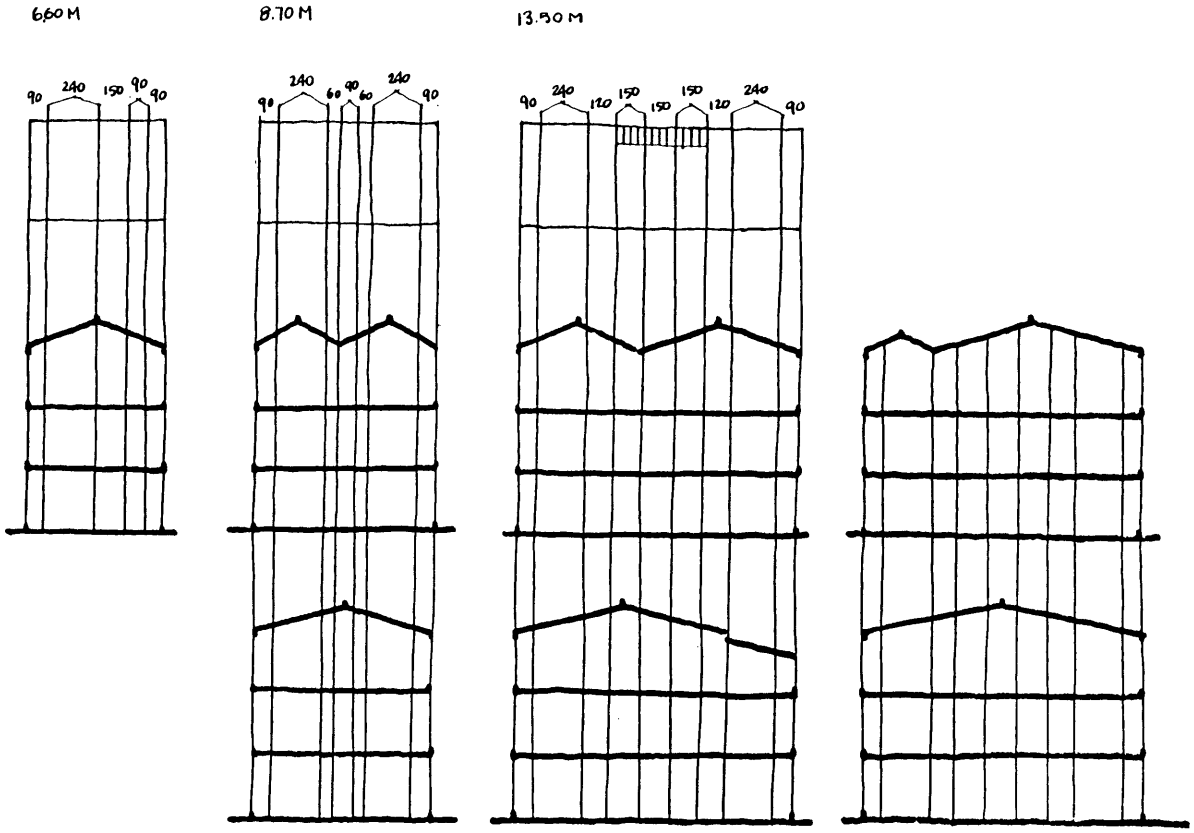



14.70 M × 4.80 M



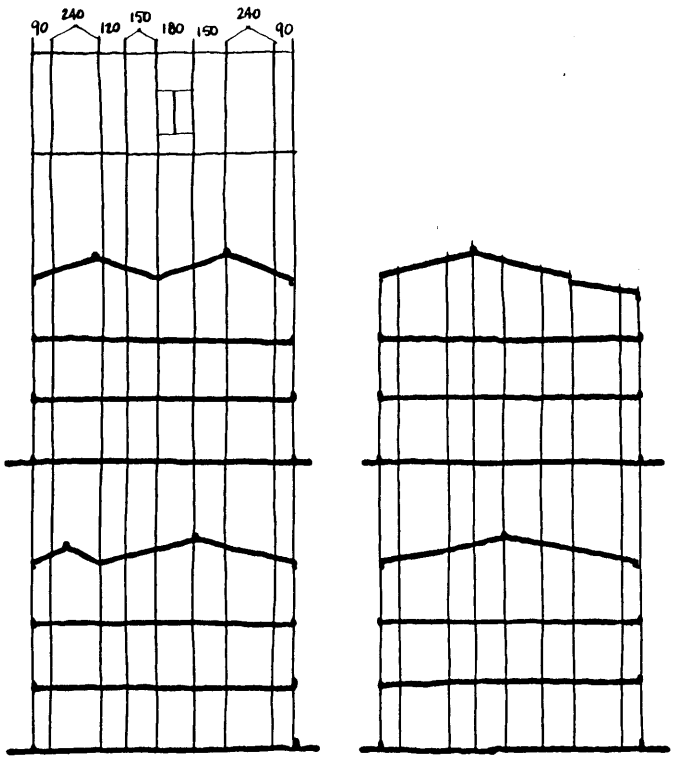



## 4.3.3 ROOF VARIATIONS

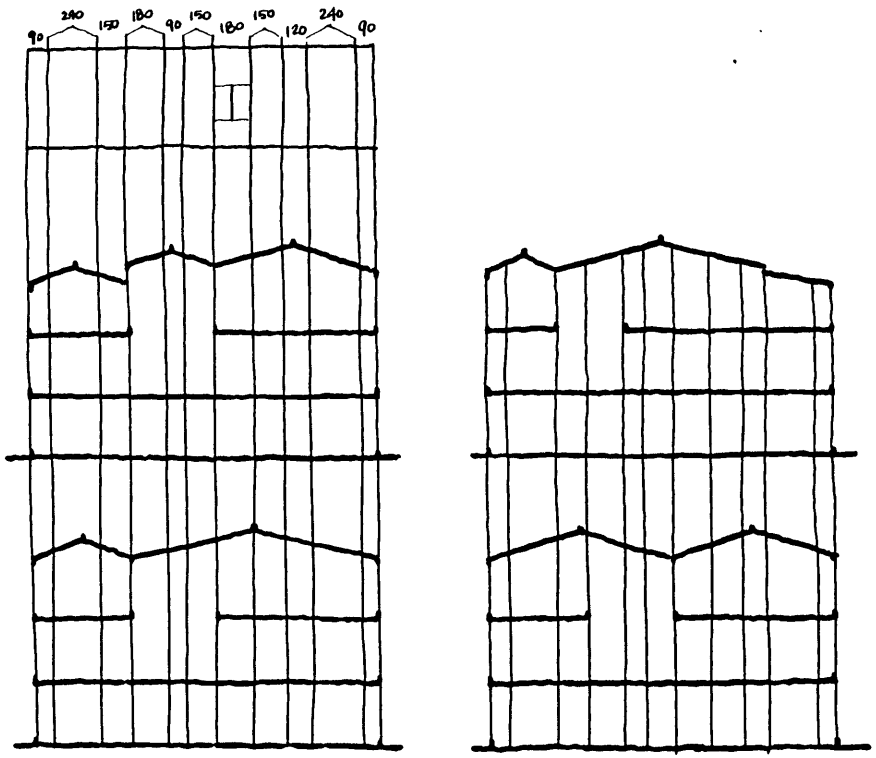


# Roof Variation

12.60M

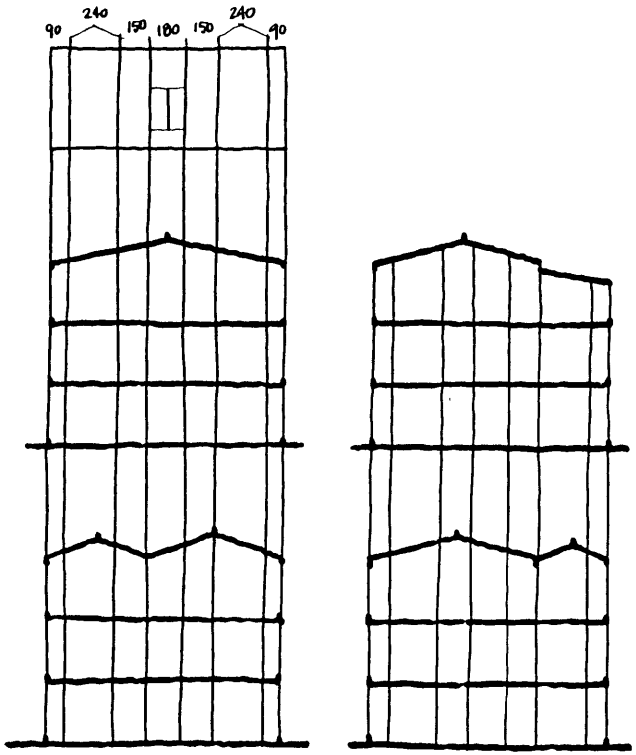



16.80M

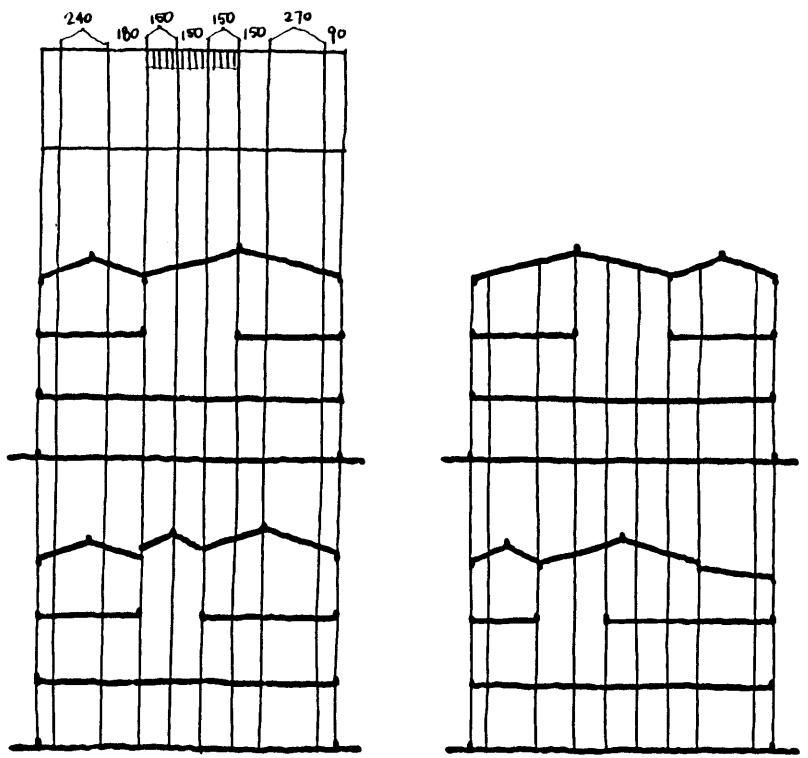


## Roof Variation

11.40 M

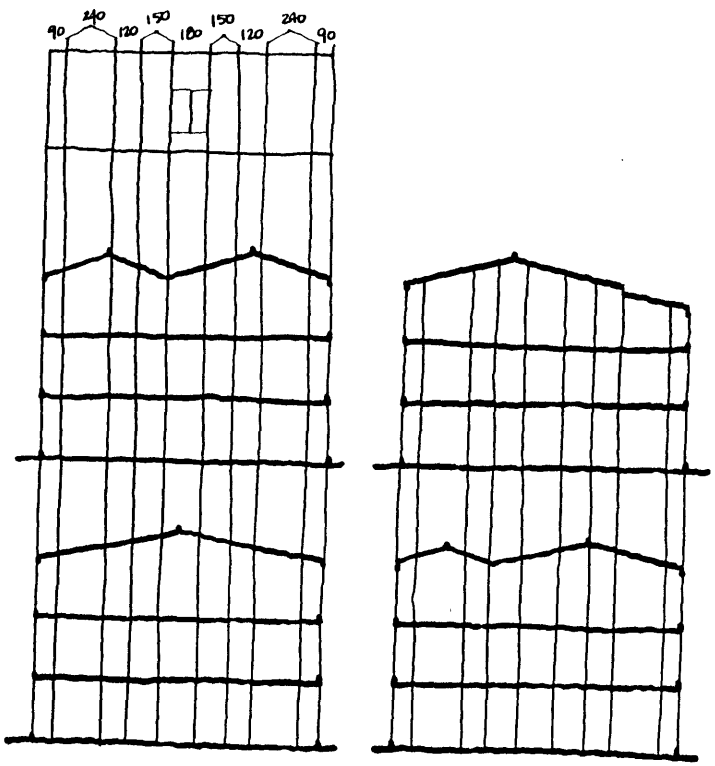



15.00 M

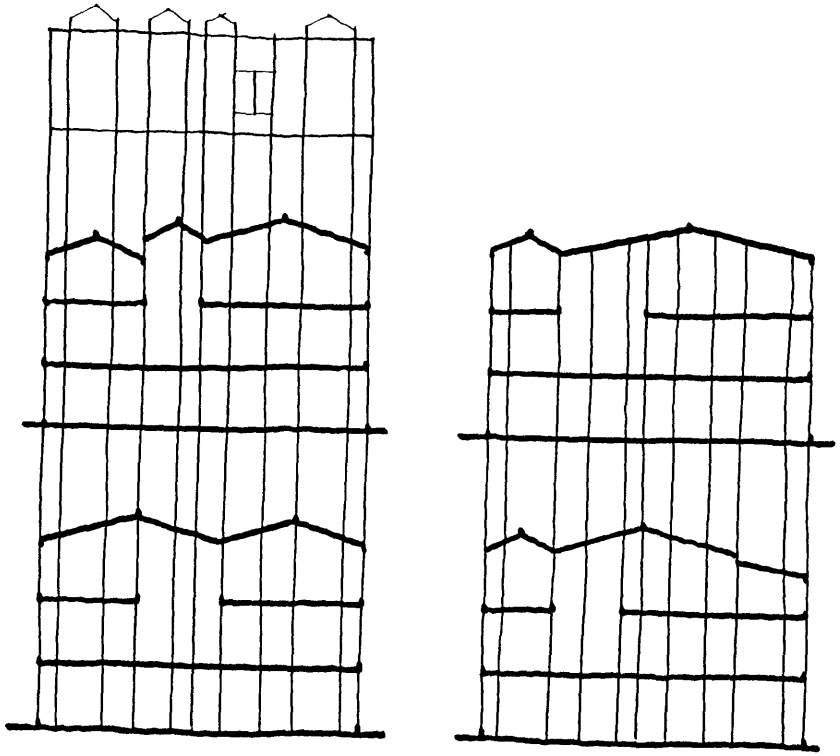


Roof Variation

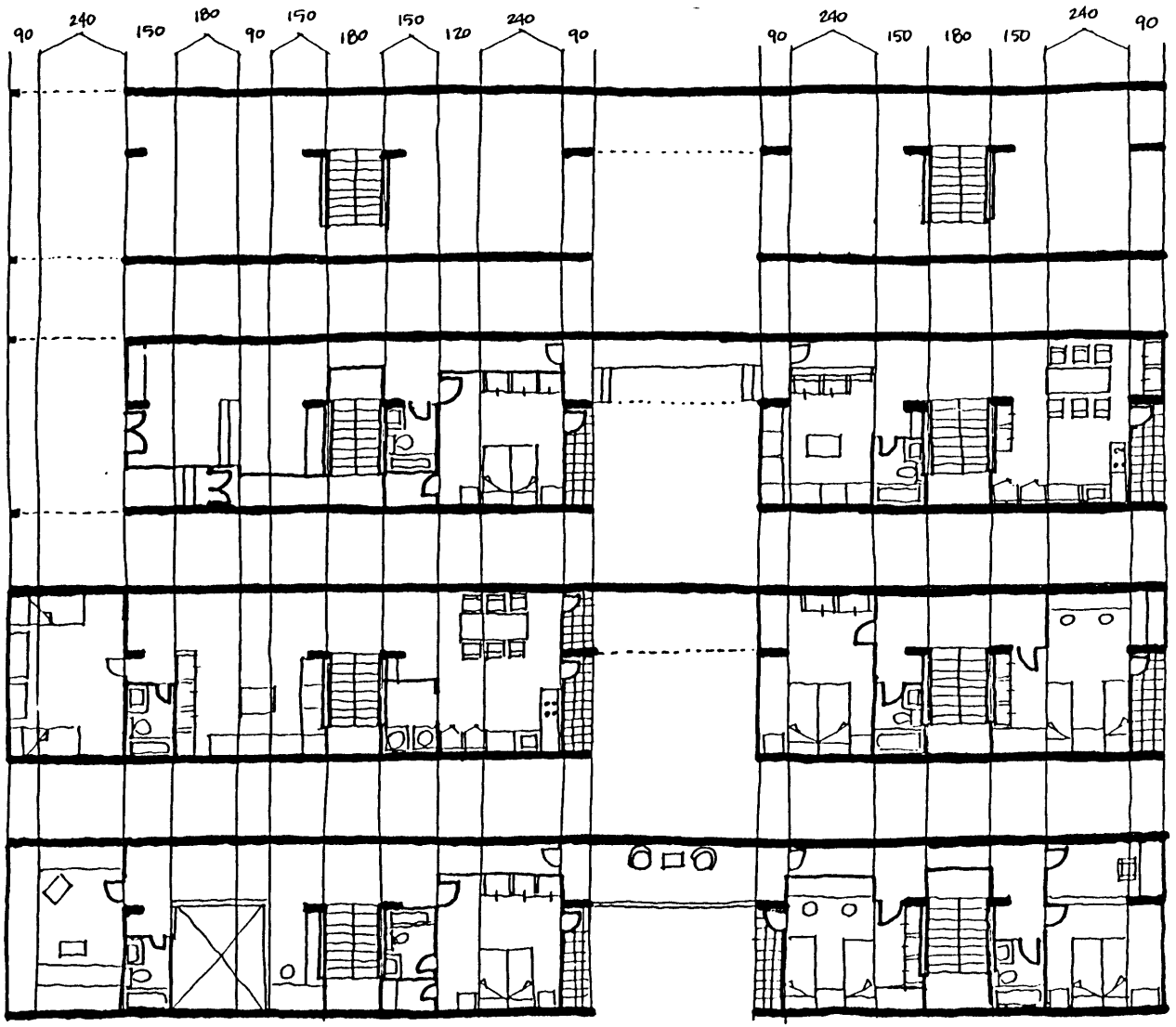
13.80M



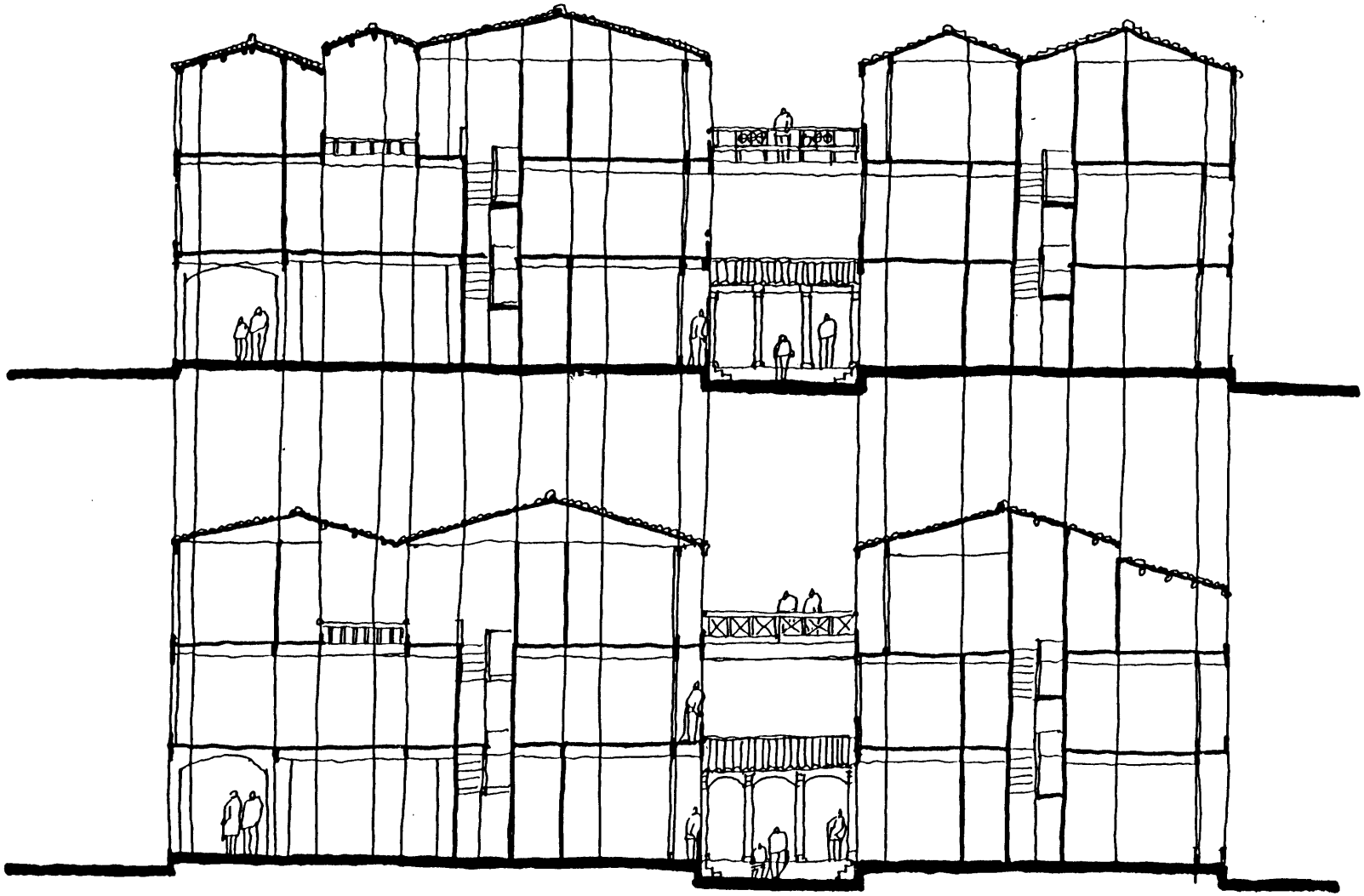

15.60M



## 4.3.4 A ROWHOUSE EXAMPLE



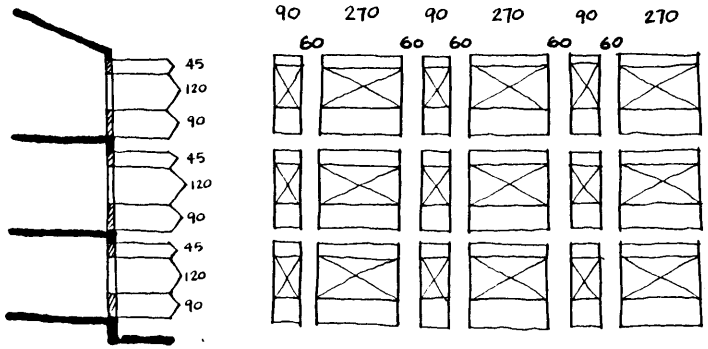
Section



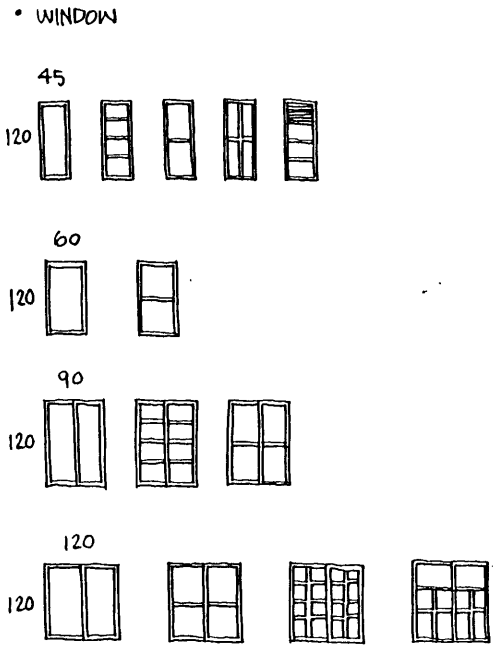
## 4.4 FACADE SYSTEM

The facade system in elevation is organized into two distincts: the framework which establishes a structure at the level of collective control, and the infill which allows for variations at the level of individual control.

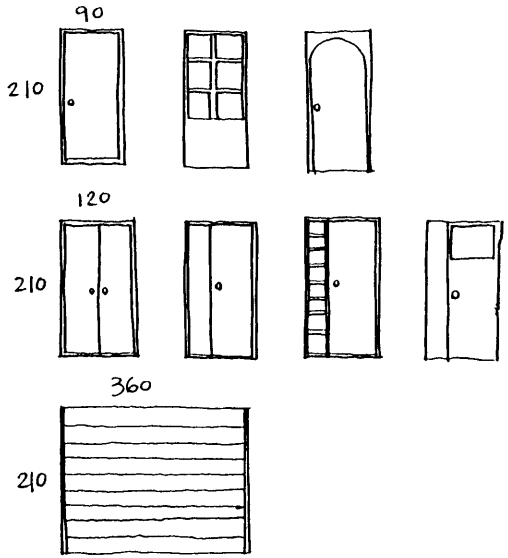
Framework



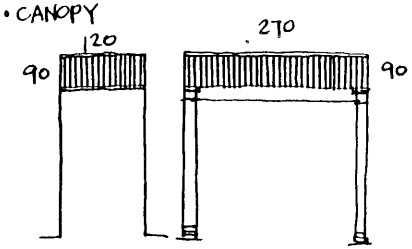

Infill



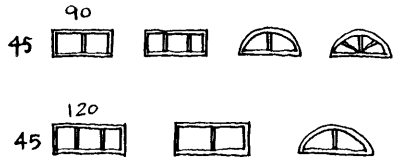
• DOOR



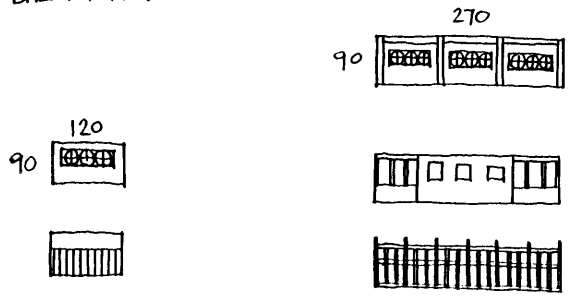

• CANOPY



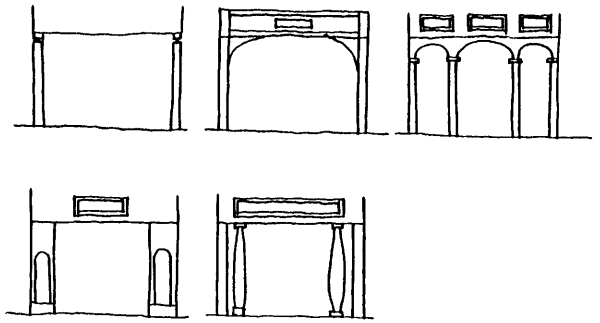

• DORMER



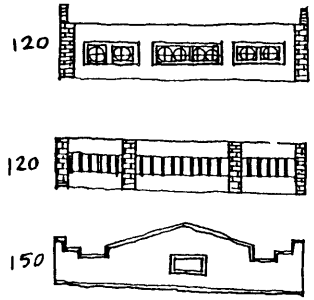

• BALCONY HANDRAIL



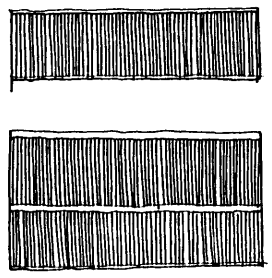

ARCADE



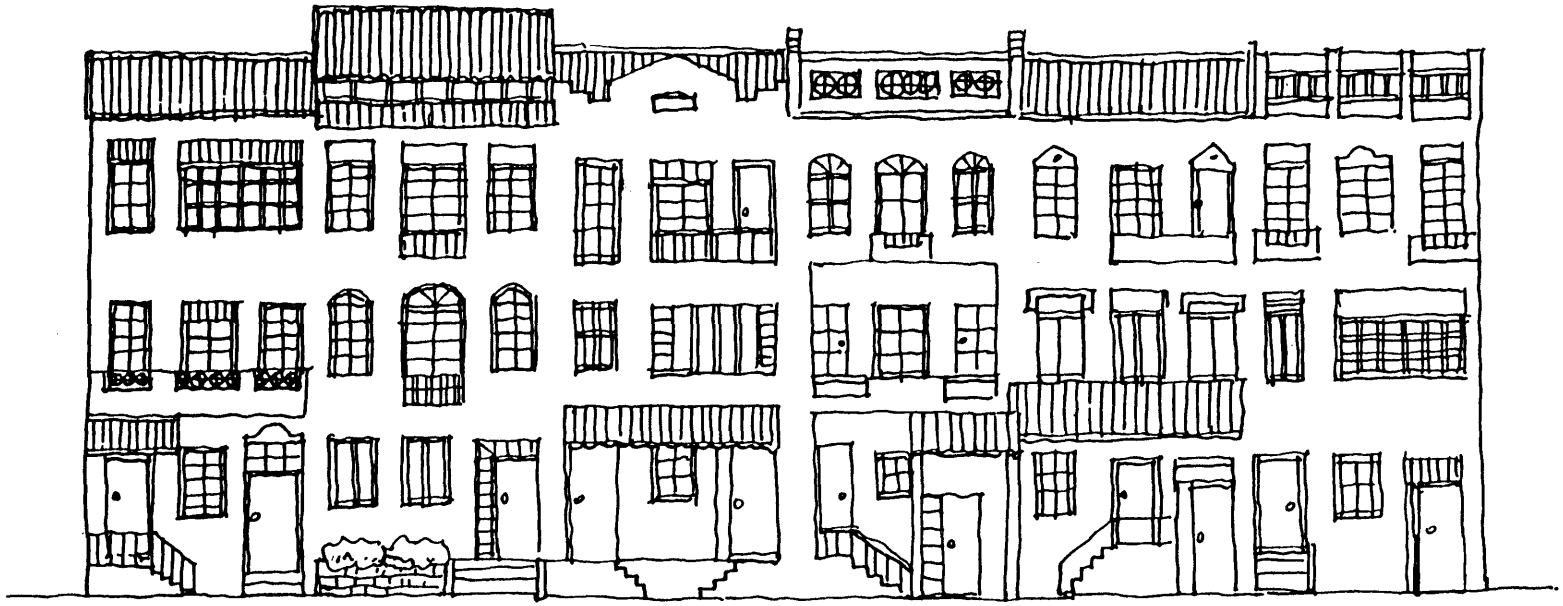
• MASK FACADE




• ROOF



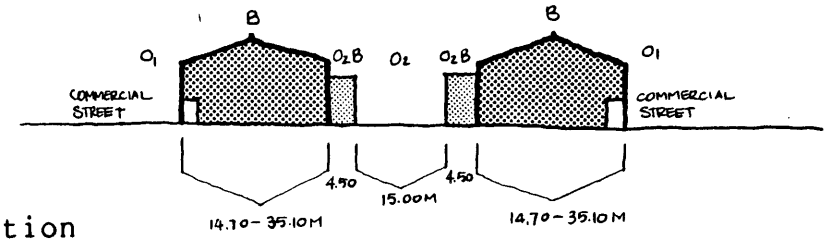
Facade Example



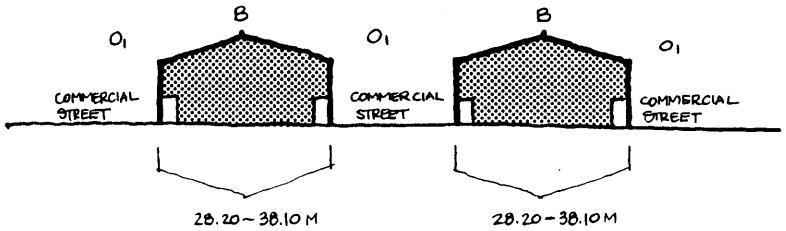
## 4.5 DWELLING BLOCK

### Commercial Area

In this area, each house has its own arcade and shop, and the net width of the commertial street should be larger than 10 M. The dimension of the rowhouse is from 14.70 M to 38.10 M

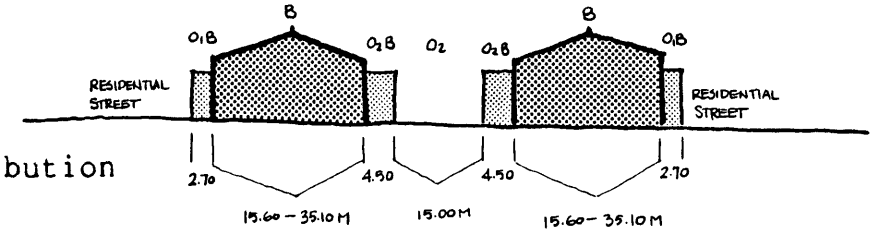



O - B Zone Distribution



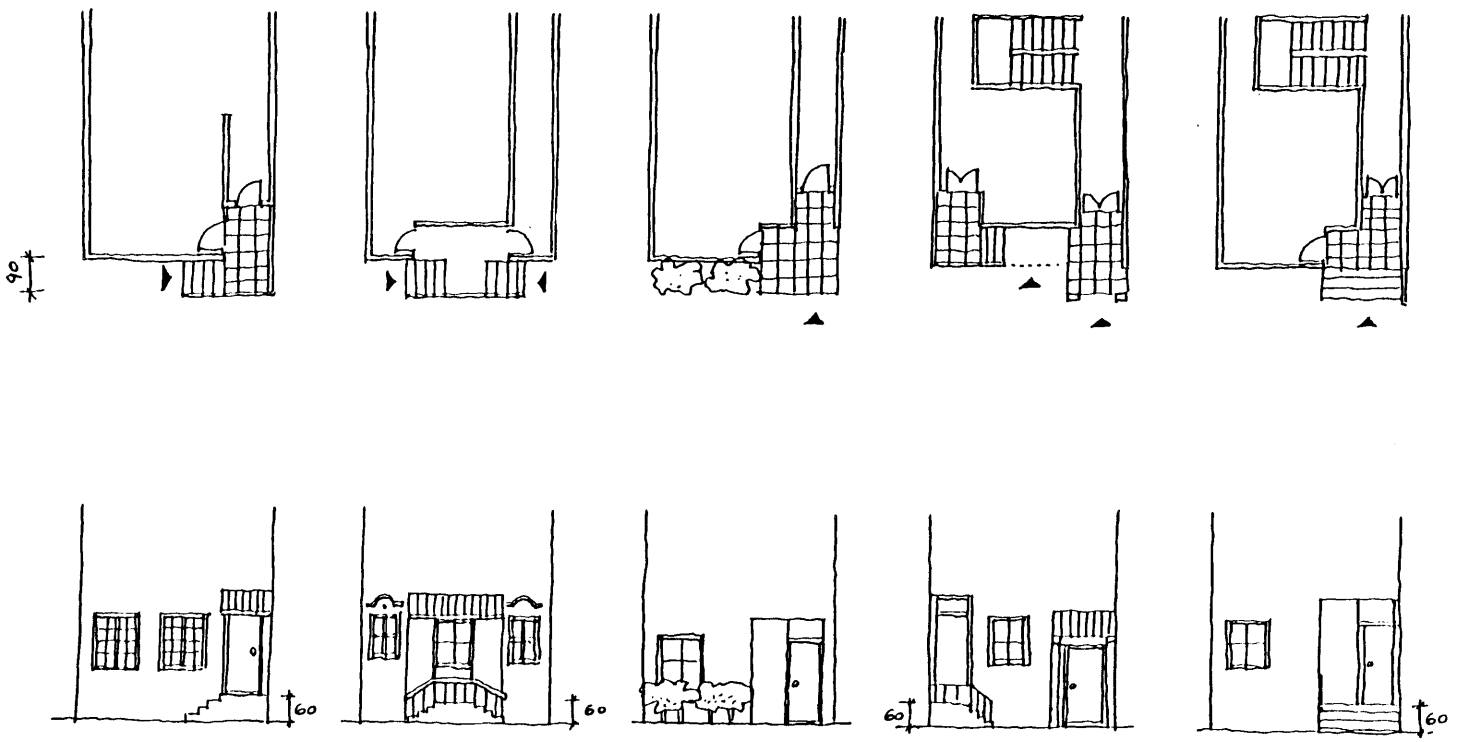

### Residential Area

In this area, the net width of the residential street is from 6 M to 9 M. The dimension of the house is from 15.60 M to 35.10 M

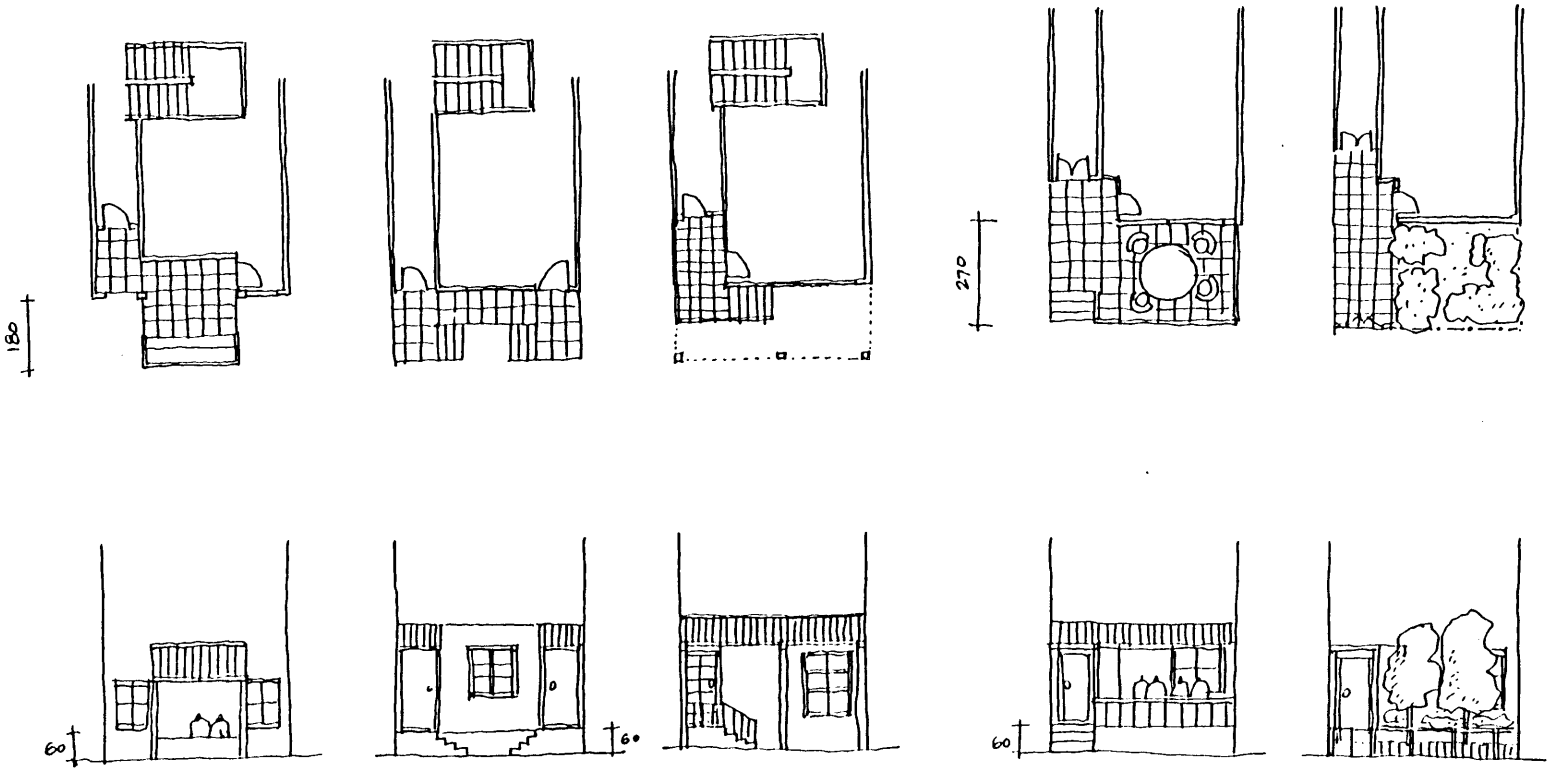



O - B Zone Distribution

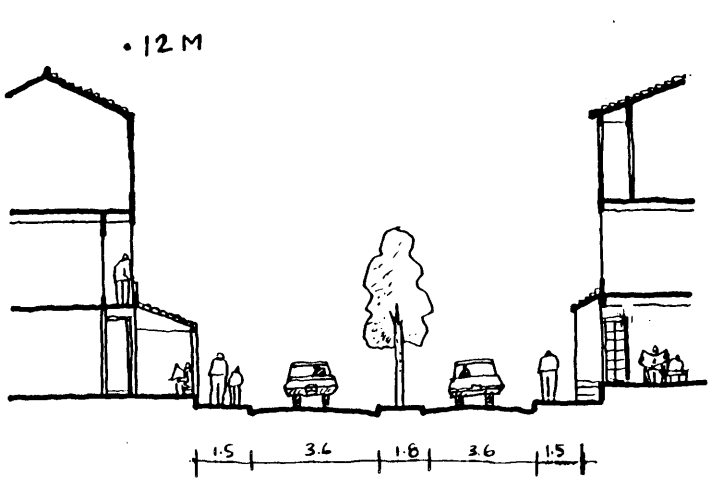
O:B Analysis

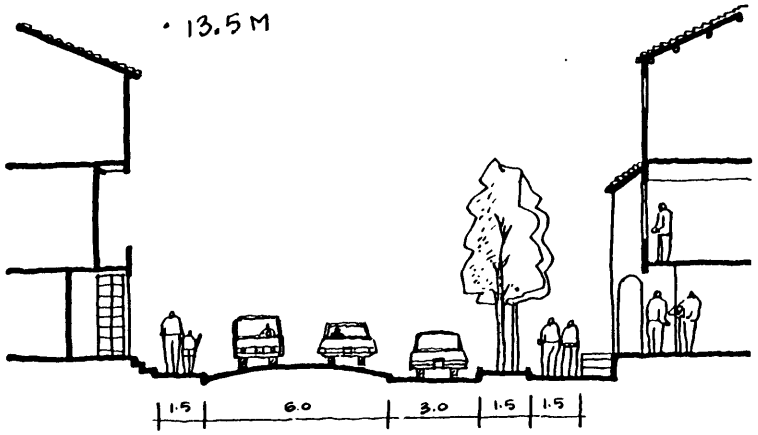


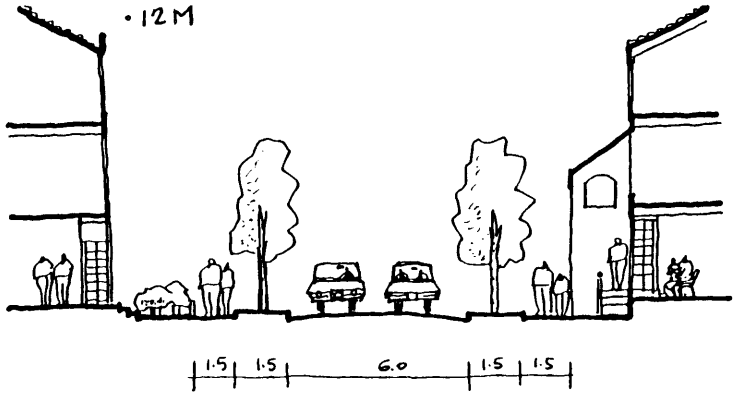
## O1B Analysis

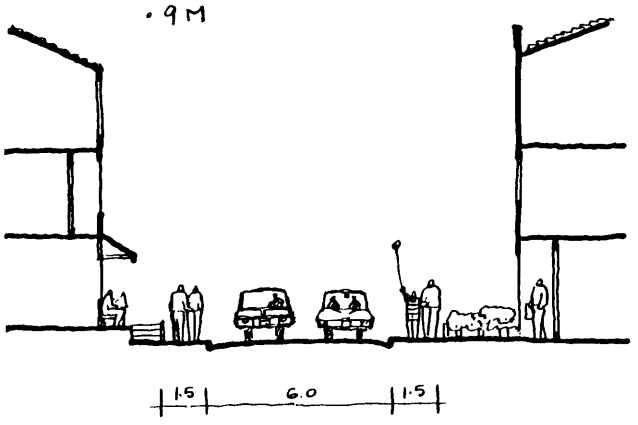


Residential Street



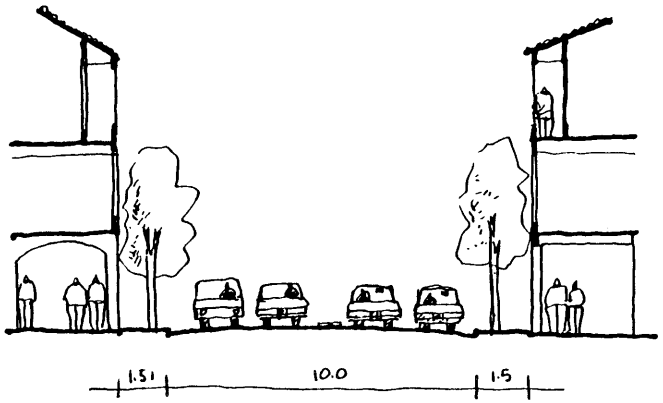



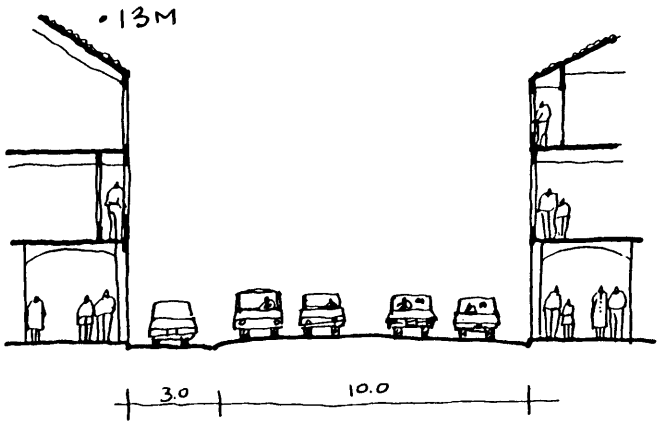



Commercial Street

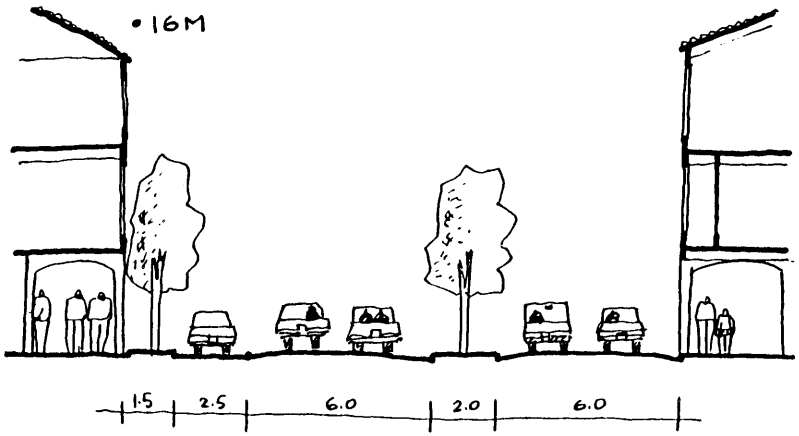
•13M




•13M

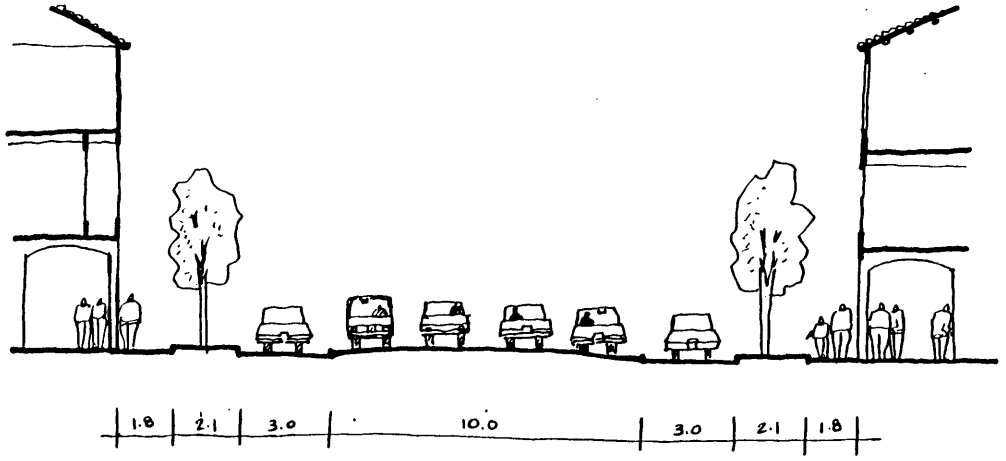


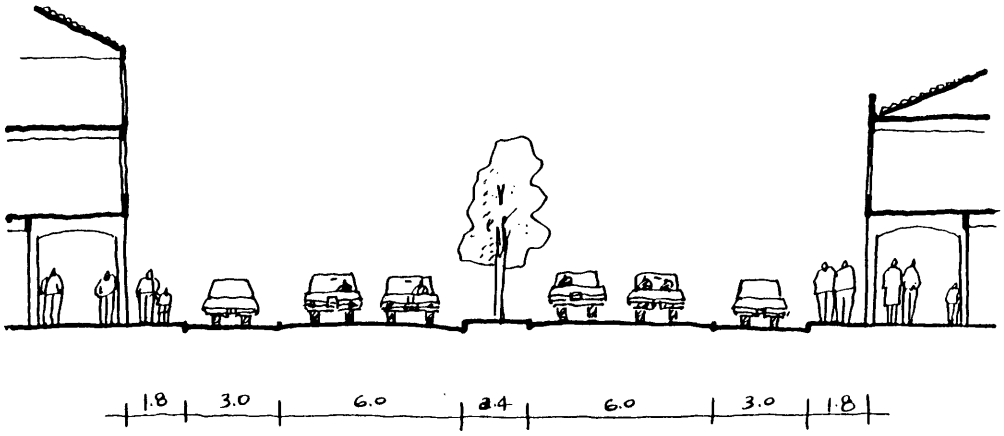

•16M

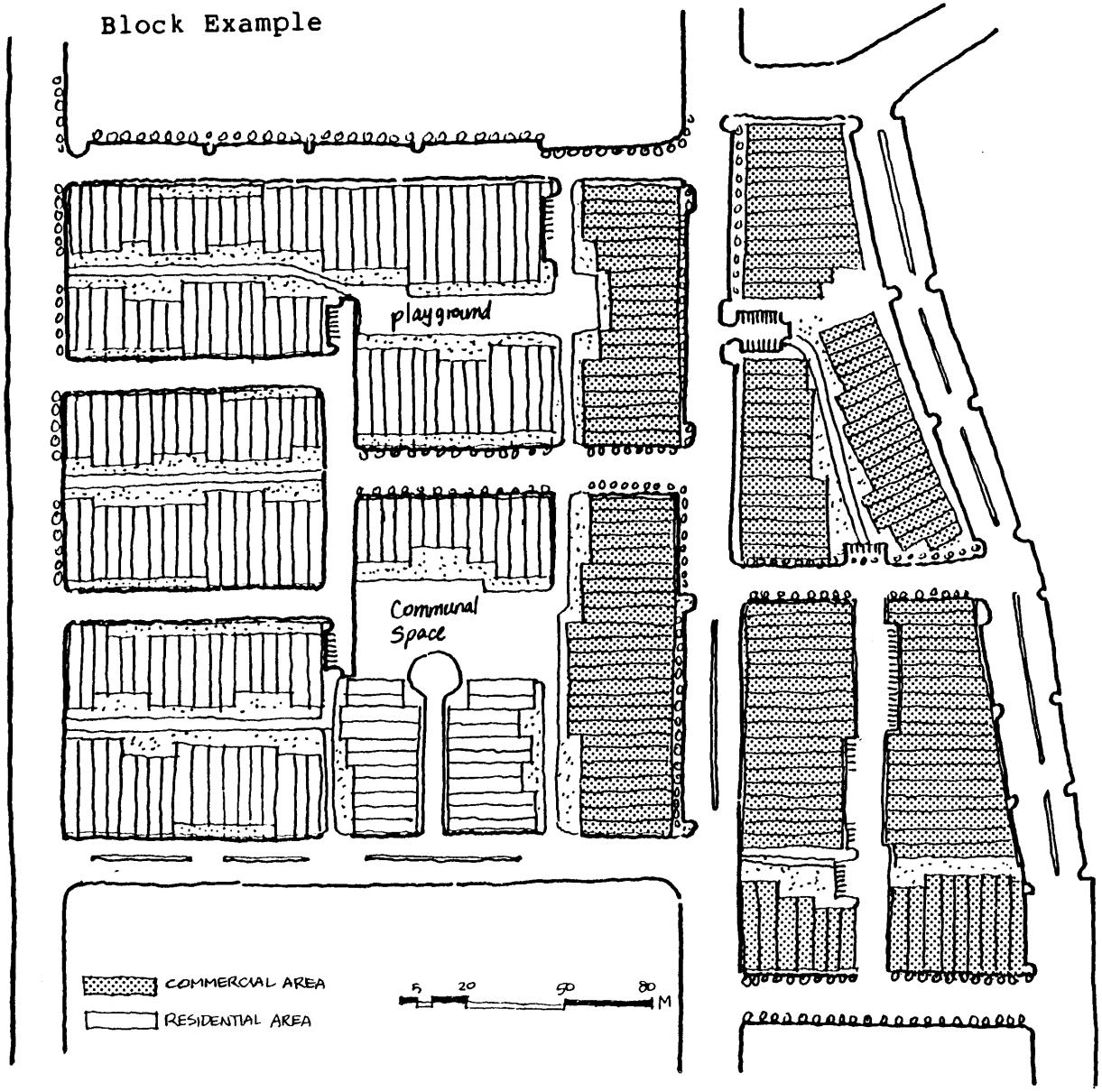


Commercial Street

• 24 M




Block Example
playground
Communal Space
COMMERCIAL AREA
RESIDENTIAL AREA
5
20
50
80
M

CHAPTER 5: COMPUTER-APPLICATION IN THE ROWHOUSE SYSTEM

# 5. COMPUTER APPLICATION IN THE ROWHOUSE SYSTEM

## 5.1 DESIGN PROCESS AND COMPUTER APPLICATION

Since 1960, computer has been gradually involved in the design work to help architects in the design process. Mostly computers are employed in two aspects of architectural practice.

* Information Handling

In this case, a computer is used as a data processing machine. It would store and efficiently retrieve required data which is needed in the design process (such as a material database and building codes).

* Computer-aided Drawing

The graphic device replaces the role of pencil in the drawing board. Computer drawing provides a more economic way both in time and money saving. Its powerful ability in reproduction, enlargment, reduction and perspective drawing helps architects in design process.

The purpose of rowhouse computer system, however, is expected not to be used as a convinent graphic tool for architects but to provide a

communication vehicle for various participants in the process. The main tasks of the computer model are for developers and architects to test the capacity of support system and for different users to select desired variants.

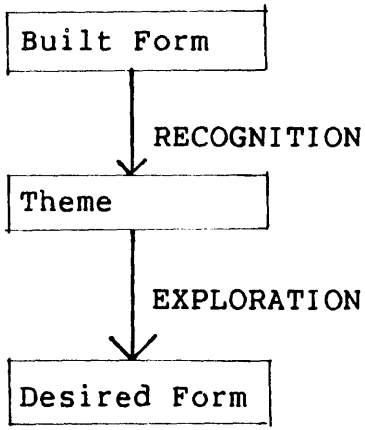
Before the computer system being established, two important issues should be considered in the design process:

1. the essence of design activity
2. the level of decision making

### 5.1.1 THE ESSENCE OF DESIGN ACTIVITY

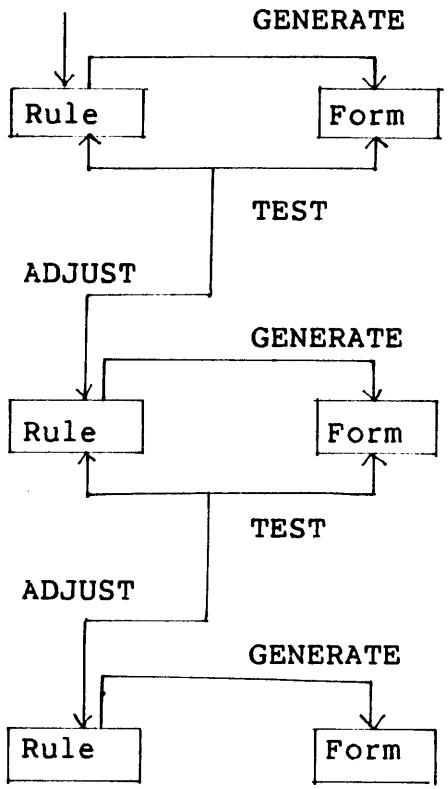
Design is a form-making activity. It contains 2 main tasks: recognition and exploration. Recognition is a rule formulation activity and its process includes observation and analysis.

Through the observation and analysis on the built environment based on people's value judgement, the spatial theme and implicit or explicit rules are abstracted.



Exploration includes 3 steps: generating, testing and adjusting. These three steps alternate between the form and the rules which includes spatial theme formulation in the recognition process and outside criteria which form must fit in. After the form being generated, one can evaluate it by checking with the rules. Then either the rules are adjusted or the form is modified until the proposed form is accepted.

In this process, observation, analysis and generation are more sophisticated human behaviors. They are still dark boxes to our understanding. Therefore, the discussion of their nature is not included in the study.



In some cases, if one sets certain ordered commands into a powerful computer system, it might be operated as similar to the above mentioned adjusting activity. However, this system is only based on the value judgement of a single aspect which is conflicting with the nature of user participation. Therefore, in this study my intention is to apply the computer only in the testing process of the design activity. This testing operation is a very important task in the S.A.R. methodology to evaluate the capacity of a support system. It can easily be applied to the computer to do the routine testing work by using the given criteria described in the prestored data.

### 5.1.2 THE LEVEL OF DECISION MAKING

Design activity can also be described as a sequence of the decision making process and be divided into different levels. The higher level of decision making process provides the context for the lower one. Various participants such as architects, developers, landowners and inhabitants will be involved in different level of decision making. There is no clear line among the responsibilities of the different parties. The decision level is only based on the control and the agreement among them.

Using the advantage of the computer systematic character, one can

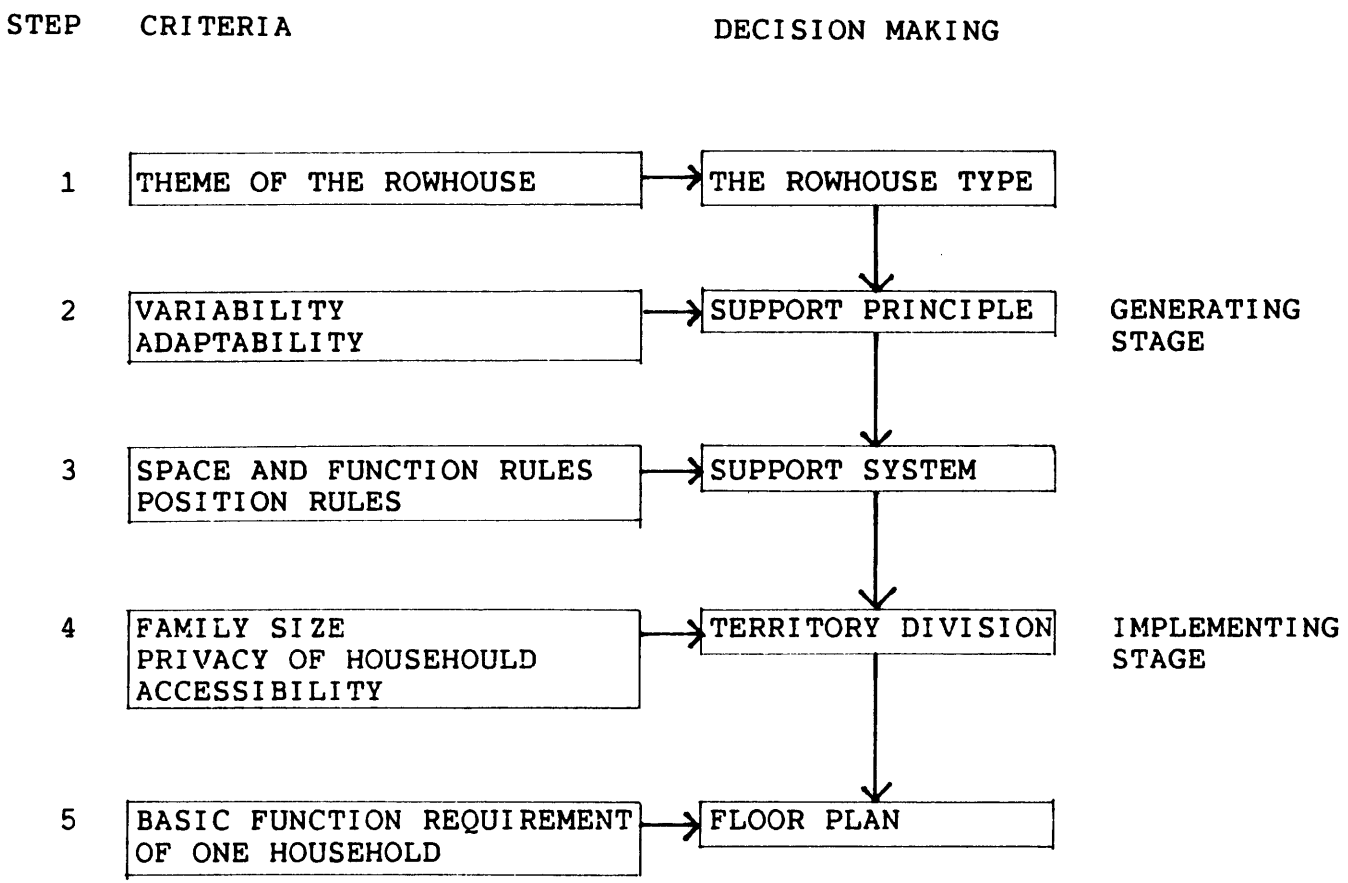
distinguish the process into several levels. Participants in the lower level are not allowed to change the decision which were made by higher level unless the same participant is involved in both levels. In this case, the participant can return to the higher level decision making if he found any improper situation in the lower level.

## 5.2 DEVELOPMENT OF COMPUTER SYSTEM

### 5.2.1 LEVEL OF DECISION MAKING IN THE ROWHOUSE

Before the actural computer system being established, the rowhouse design process could be divided into 5 levels of decision making. Each level has its own criteria. The participants can make decision within the basic criteria and context which the higher levels provided.

The process from step 1 to step 3 is a generating stage through which the rowhouse support system is established. The process from step 3 to step 5 is an implementing stage


STEP
CRITERIA
DECISION MAKING
1
THEME OF THE ROWHOUSE
THE ROWHOUSE TYPE
2
VARIABILITY
ADAPTABILITY
SUPPORT PRINCIPLE
GENERATING STAGE
3
SPACE AND FUNCTION RULES
POSITION RULES
SUPPORT SYSTEM
4
FAMILY SIZE
PRIVACY OF HOUSEHOULD
ACCESSIBILITY
TERRITORY DIVISION
IMPLEMENTING STAGE
5
BASIC FUNCTION REQUIREMENT
OF ONE HOUSEHOLD
FLOOR PLAN

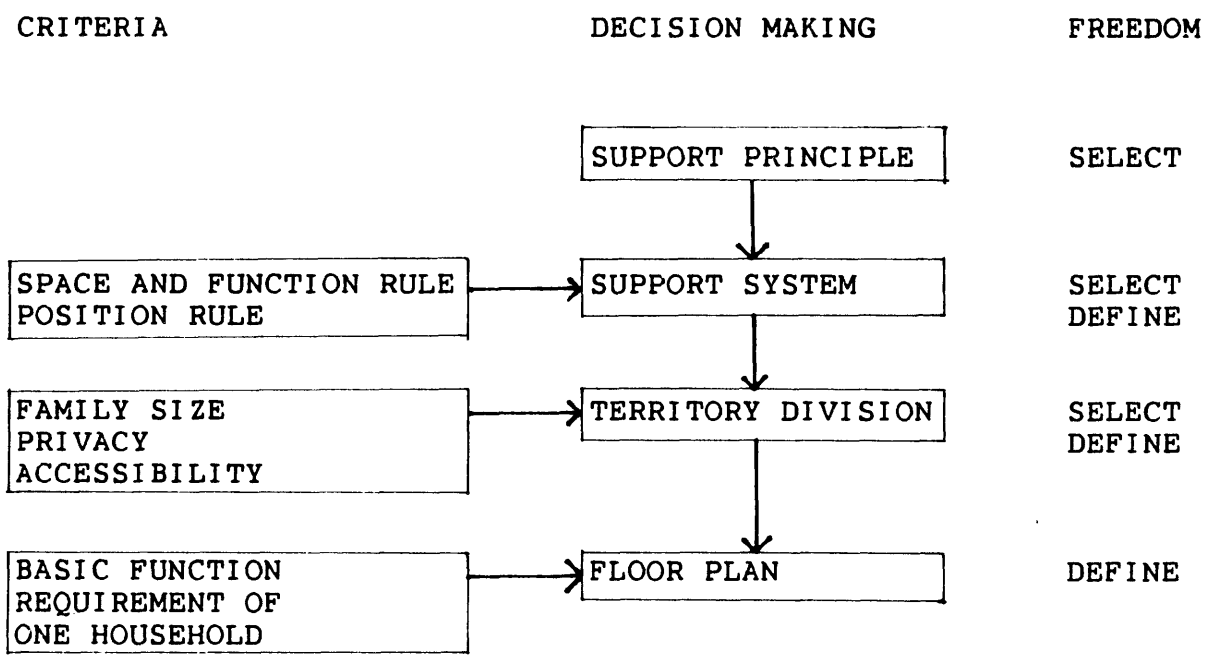
where the support system can be developed to become an actual dwelling unit for various inhabitants. As I mentioned above, the purpose of the computer system is mainly applied in the task of testing capacity and the tool of decision making for the various users. Also because of the difficulty in handling the generating process in the computer system, the computer operation here is only treated as a closed system. The closed system provides complete freedom in the implementing stage but limited freedom in the generating stage (limiting the users to define the dimension of the support system). The rowhouse type (step 1) and support principle (step 2) are treated as given information prestored in the machine. Computer users are not allowed to change them but follow the context.

Hence, there are only 4 levels of decision making in the computer system. Two kind of freedom are provided in the decision making:

A. "Define" -- The users have full freedom. They can imput new data to make decision. The computer will not provide any suggested data.

B. "Select" -- The computer provides suggested choices for users to select the proper one. In this situation the role of user is passive.

C. "Select + Define" -- The user can either select from the suggested choices provided by the computer or input data to make decision.



## 5.2.2 THE DATA SYSTEM IN THE MACHINE

After the basic framework of the computer model is set, the next important issue is what kind of information (data) is necessary for the computer operation.

The data system can be separated into 2 categories:

A. Prestored Data Base
This data is initially set in the computer memory before operation.

A.1 Prime Data System

A.1.a The Data System of Support Principle

This data base is divided into 2 parts for commercial or residential areas. Various support principle have different zone distributions. In the data base each zone, each sector and margin is named with the default dimention.

A.1.b to A.1.d are on the data bases of different criteria levels. This data is used for checking the operation by the computer.

A.1.b Data of Space, Function Analysis and Position Rule

The data of the standard size of a space for a certain function is defined according to the building codes. Data from the position rule

includes the general position rule (bedroom, living room and kitchen in zone, the kitchen must have a balcony etc.) and the rowhouse position rule (kitchen not allowed facing the street, only the living room can be placed in the first floor next to the main entrance etc.).

A.1.c Data of Accessibility and Privacy Analysis

Each support is composed of 3 or 4 parts. Each part and staircase is named. Family units in the second or third floor must have an accessible public staircase. For any family that occupies 2 floors (or 3 floors), there must be a private staircase in their territory.

A.1.d Data of Basic Requirements of the Family Unit

Each family unit must include at least a bathroom, a kitchen, a bedroom and a living room (or in the studio type, the living room can also be treated as bedroom).

ROWHOUSE POSITION RULE

| UNIT | FUNCTION |
|---|---|
| 1A | Sh L |
| 2A 3A | L B |
| 1B 2B 3B | L B K D |
| 1C 2C 3C | L B K D |
| 1D 2D 3D | L B K D |

GENERAL POSITION RULE

| FUNCTION | MINIMUM DIMENSION | POSITION |
|---|---|---|
| L | 2.70 M | Z1 Z3 Z4 Z6 |
| B | 2.10 M | Z1 Z3 Z4 Z6 |
| K | 1.80 M | Z3 Z4 Z6 |
| D | 2.40 M | Z2 Z3 Z4 Z5 Z6 |
| Ba | 1.50 M | Z2 Z5 M2 M3 M6 M7 |

## A.2 Supplementary Data

### A.2.a Data of the Suggested Rowhouse Support System

Each zone and margin sector is defined with dimensions. The data of the zone analysis and the sector analysis are described as a data set in this category.

### A.2.b Data of the Suggested Territory Division

In each support system, there are several suggested territory divisions in terms of the number of family unit and the floor area for each unit. Each set of data separates the sector group of each family unit and the floor area. It also indicates the possible number of bedroom and the character of

DATA OF THE SUGGESTED ROWHOUSE SUPPORT SYSTEM

| ZONE | DEMISION | FUNCTION |
|---|---|---|
| Z1 | 2.40 M | B1 |
| Z1 + M1 | 3.30 M | B1 B2 MB L |
| Z1 + M2 | 3.90 M | B1 B2 MB L |
| Z1 + M1 + M2 | 4.80 M | B2 MB L |
| Z2 | 1.50 M | Ba St |
| Z2 + M3 | 2.70 M | Ba St S D |
| Z3 | 2.40 M | K B1 |
| Z3 + M3 | 3.30 M | B1 B2 MB L |
| Z3 + M4 | 3.60 M | K KD B1 B2 MB L |
| Z3 + M3 + M4 | 4.50 M | B2 MB L |
| Z4 | 2.40 M | K B1 |
| Z4 + M5 | 3.30 M | B1 B2 MB L |
| Z4 + M6 | 3.60 M | K KD B1 B2 MB L |
| Z4 + M5 + M6 | 4.50 M | B2 MB L |
| Z5 | 1.50 M | Ba St |
| Z5 + M6 | 2.70 M | Ba St S D |
| Z6 | 2.40 M | K B1 |
| Z6 + M7 | 3.90 M | K KD B1 B2 MB L |
| Z6 + M8 | 3.30 M | B1 B2 MB L |
| Z6 + M7 + M8 | 4.80 M | B2 MB L |

DATA OF THE SUGGESTED TERRITORY

| TERRITORY | FLOOR AREA | BEDROOMS | PUBLIC STAIRS | PRIVATE STAIRS |
|---|---|---|---|---|
| 1A 1B 1C 1D | 104 M | 2 - 3 | | |
| 2A 2B 2C 2D 3D | 127 M | 2 - 4 | 1S1 | 2S2 |
| 3A 3B 3C | 80 M | 1 | 1S1 2S1 | |
| 1A 1B 1C 1D | 104 M | 2 - 3 | | |
| 2A 2B 2C 2D | 104 M | 2 - 3 | 1S1 1S2 | |
| 3A 3B 3C 3D | 104 M | 2 - 3 | 1S1 1S2 2S1 2S2 | |
| 1A 1B 1C | 80 M | 1 | | |
| 1D 2B 2C 2D | 104 M | 2 - 3 | 1S1 | 1S2 |
| 2A 3A 2B 3C 3D | 127 M | 2 - 4 | 1S1 | 2S1 |
| 1A 1B 1C 1D 2C 2D | 155 M | 3 - 6 | | 1S2 |
| 1A 1B | 77 M | STUDIO | 1S1 | |
| 3A 3B 3C 3D | 104 M | 2 - 3 | 1S1 2S1 | |

the staircase (public or private).

B. Dynamic Data System

In this category, the data system is automatically generated and stored by computer when each level of decision making is finished. (It is generated only when the user inputs new data instead of the suggested one).

B.1 Data of the Rowhouse Support System

The format of this data is the same as A.2.a.

B.2 Data of the Territory Division

The format of this data is the same as A.2.b.

B.3 Data of the Floor Plan

After the residents decide the layout of the rowhouse, the computer stores the information as documents.

### 5.2.3 THE WORK OF THE USER AND THE MACHINE

If we look on the surface level of the relationship between the machine and operator in the computer system, the work of the computer is either to display graphic images, or to show data in the screen. The task of the user is either to type on the keyboard or digitize on the screen. However, if we probe further into the relationship of machine and users, we can separate each operation into different tasks.

A. The Machine's Task

A.1 Retrieve Data

The computer can retrieve the information which is stored in the computer memory including the graphic display.

A.2 Implement Data Syatem

The machine can automatically generates the dynamic information system which is associated with input data and the criteria on the same level and context which the higher level provides.

A.3 Check Input Data

The computer can check if the input data is appropriate in terms of the data of criteria on the same level and responsed to the results.

B. The Operator's Task

B.1 Select

The user can choose from the suggested solutions provided by the system.

B.2 Query

The user can ask the computer questions and computer will retrieve the associated data on the screen.

B.3 Adjust and Test

The user can input a new set of data (a new dimension of a zone or a new boundary of a territory etc.) and ask the computer to check for its propriety in terms of the criteria set on the same level.

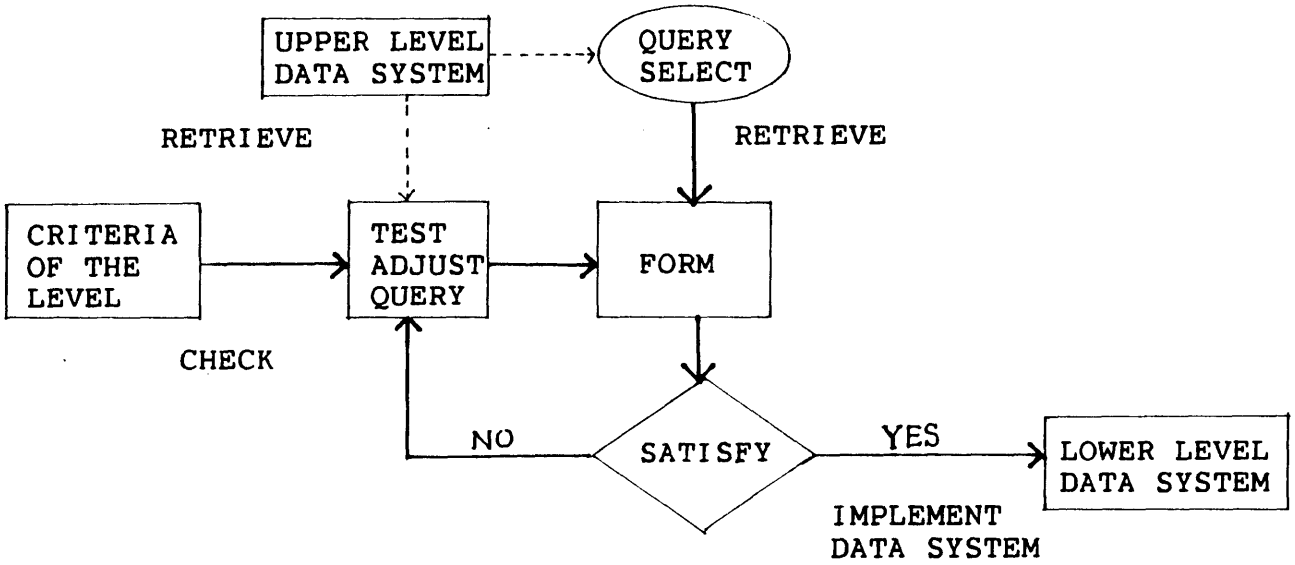
B.4 Satisfy

After the user finds a desired solution and makes the final decision of the level, the computer will automatically implement the dynamic data system of the same level.

Because the computer can not automatically operate without user's instruction, the relationship between the machine and user can be described as 3 pairs of one-to-one actions.

| User's Work | | Machine's Work |
|---|---|---|
| select + query | --- | retrieve data |
| satisfy | --- | implement data system |
| test + adjust | --- | check input data |

As I mentioned above, there are 4 levels of decision making in the computer process. Each level involves different criteria and data base. However, the relation between the user, the machine and the information are the same in each level. A flowchart can be used to describe their relationship.




The Flowchart between User and Machine

## 5.3 OPERATION

### 5.3.1 THE LEVEL OF SUPPORT PRINCIPLE

A. Select a Proper Support Principle

User: select

Machine: retrieve data of support principle

The users choose from several possible support principles which are associated with the character of the site (commercial or residential). The machine will display the suggested width and length of support for the users.

### 5.3.2 THE LEVEL OF SUPPORT SYSTEM

A. Accept a Set of Suggested Dimension

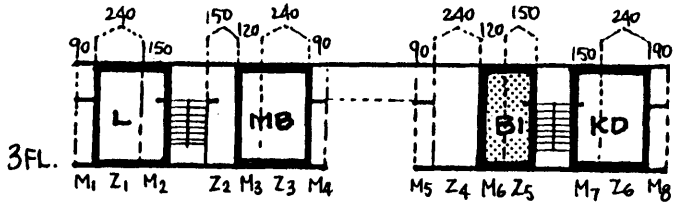
User: query

Machine: retrieve the data of a suggested support system

Within the suggested dimension of support system, users can do 3 tasks:

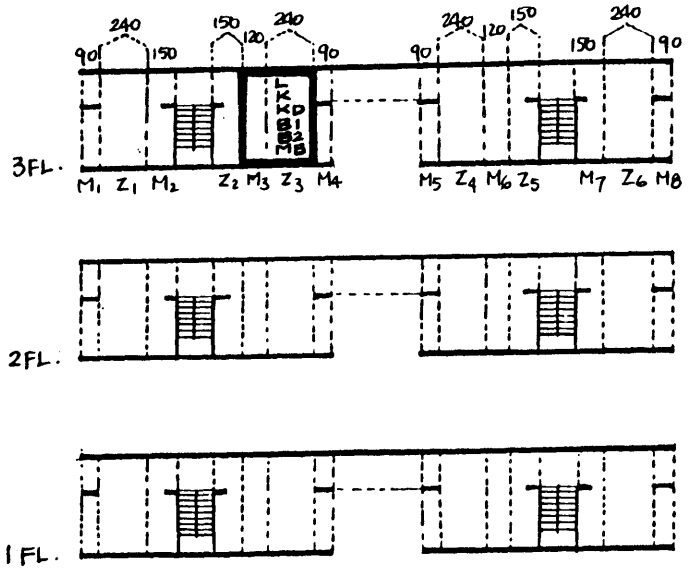
A.1 Place Function or Remove Function and Show the Conflict

The users can draw lines defining space boundaries and place function in the spaces, then ask the computer if it is proper. The machine will send a message if the function is not proper in the space.



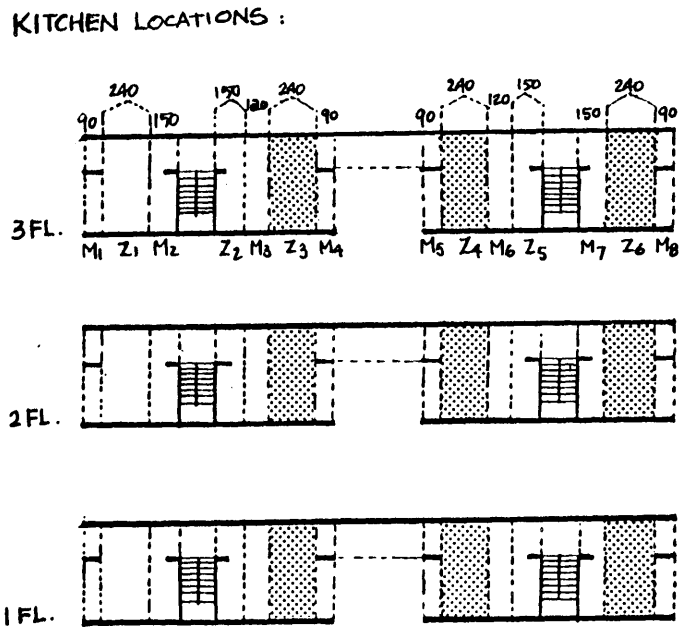
A.2 What Functions Fit into This Space

The users can draw the space location and ask machine what function could be located in this space. The screen will display all the functions that are suitable.




A.3 What Locations Accept This Function

The user can ask the computer what possible place in the support system a particular function can fit into. The screen will display all the possible locations.



B. Change the Dimension of the Support System

The user can change the dimension of support system and test the capacity of the support system. The process could be repeated until the users satisfied.

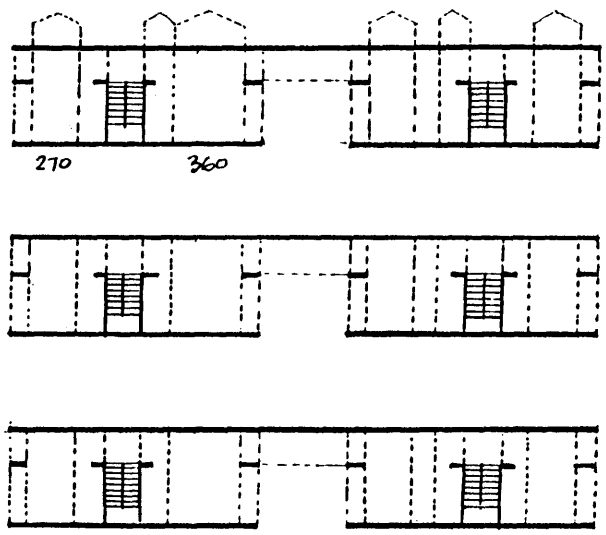
User: adjust + test + satisfy

Machine: check the input data + implement data

B.1 Input the Dimension of Zone, Margin and Sector

The user inputs new dimensions of each zone, margin and sector. The screen will display the adjusted support system.

B.2 Test the Capacity of the Support System




User: test the capacity of the support system

Machine: check input data with data of space, function analysis and position rule in the prestored data.

B.2.a Place Functions, Remove Functions and Show the Conflict

Same as A.1 above.

B.2.b What Functions Fit into This Space

Same as A.2 above.

B.3 Satisfaction

User: satisfy

Machine: implement the data of support system

After testing the capacity, the user will decide the proper dimension of the system. Then the computer will be asked to generate the information of sector analysis and calculate the area of each sector and store all information in the dynamic data system.

5.3.3 THE LEVEL OF TERRITORY DIVISION

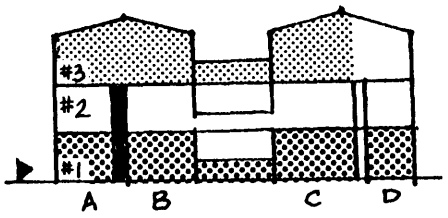
In the level of territory division, the user will first decide the number of family units (from 1 to 4) in the support system.

A. Select from the Suggested Divisions

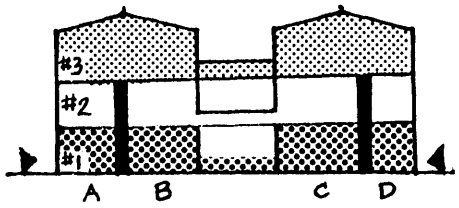
After the user decided the number of the family unit, the computer will display several alternatives. Each alternetive contains the data of total area of each family unit and possible number of bedrooms.

After the user selected a territory division, several tasks could be followed.

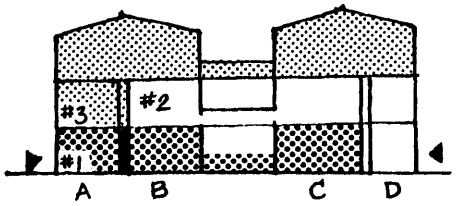
Select from the Suggested Divisions



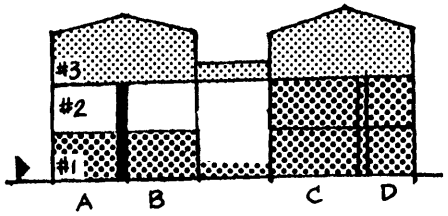

| TERRITORY | FLOOR AREA | BEDROOMS | PUBLIC STAIRS | PRIVATE STAIRS |
|---|---|---|---|---|
| 1A 1B 1C 1D | 104 $M^2$ | 2 - 3 | | |
| 2A 2B 2C 2D 3D | 127 $M^2$ | 2 - 4 | 1S1 | 2S2 |
| 3A 3B 3C | 80 $M^2$ | 1 | 1S1 2S1 | |




| | | | | |
|---|---|---|---|---|
| 1A 1B 1C 1D | 104 $M^2$ | 2 - 3 | | |
| 2A 2B 2C 2D | 104 $M^2$ | 2 - 3 | 1S1 1S2 | |
| 3A 3B 3C 3D | 104 $M^2$ | 2 - 3 | 1S1 1S2 | |
| | | | 2S1 2S2 | |

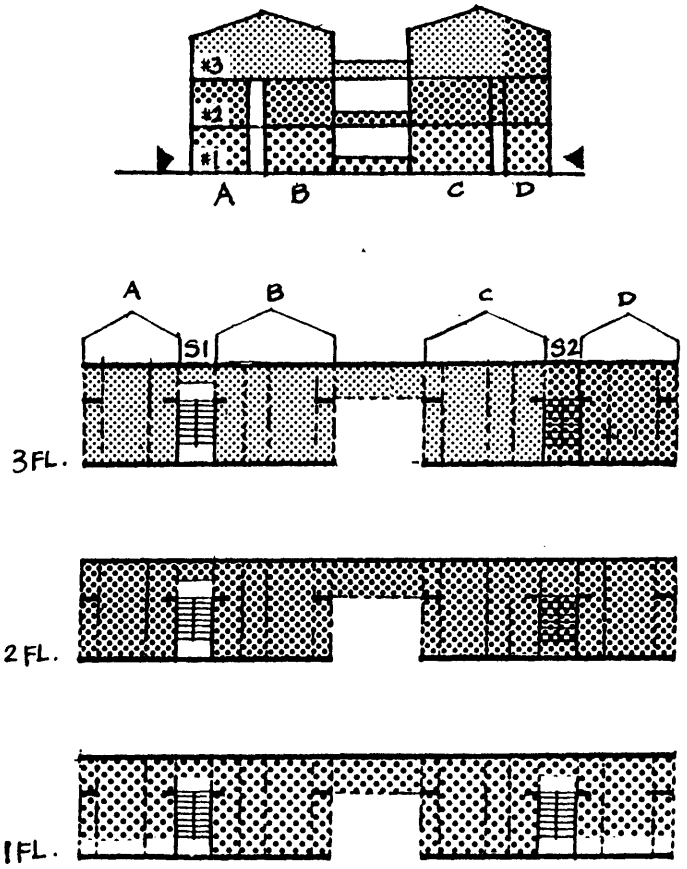



| | | | | |
|---|---|---|---|---|
| 1A 1B 1C | 80 $M^2$ | 1 | | |
| 1D 2B 2C 2D | 104 $M^2$ | 2 - 3 | 1S1 | 1S2 |
| 2A 3A 2B 3C 3D | 127 $M^2$ | 2 - 4 | 1S1 | 2S1 |




| | | | | |
|---|---|---|---|---|
| 1A 1B 1C 1D | 155 $M^2$ | 3 - 6 | | 1S2 |
| 2C 2D | | | | |
| 1A 1B | 77 $M^2$ | STUDIO | 1S1 | |
| 3A 3B 3C 3D | 104 $M^2$ | 2 - 3 | 1S1 2S1 | |

Select One Territory Division




| TERRITORY | FLOOR AREA | BEDROOMS | PUBLIC STAIRS | PRIVATE STAIRS |
|---|---|---|---|---|
| 1A 1B 1C 1D | 104 $M^2$ | 2 - 3 | | |
| 2A 2B 2C 2D 3D | 127 $M^2$ | 2 - 4 | 1S1 | 2S2 |
| 3A 3B 3C | 80 $M^2$ | 1 | 1S1 2S1 | |

User: query

Machine: retrieve

A.1 Place Function, Remove Function and Show Conflict

Same as A.1 at 5.3.2

A.2 What Functions Fit into This Space

Same as A.2 at 5.3.2

A.3 What Locations Accept This Function in a Certain Territory

Same as A.3 at 5.3.2

A.4 Ask the Character of Stairs

The user can ask machine which stairs belong to public use and which ones are private.

A.5 Ask the Entrance Direction

The user can ask the entrance direcion of each household.

B. Change the Territory Division

The user can change the territory division and test if it is appropriate.

User: adjust + test

Machine: check

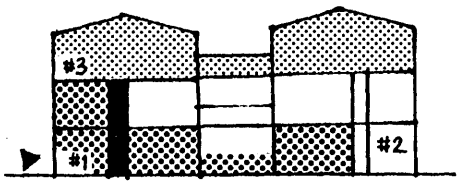
B.1 Draw the Boundary

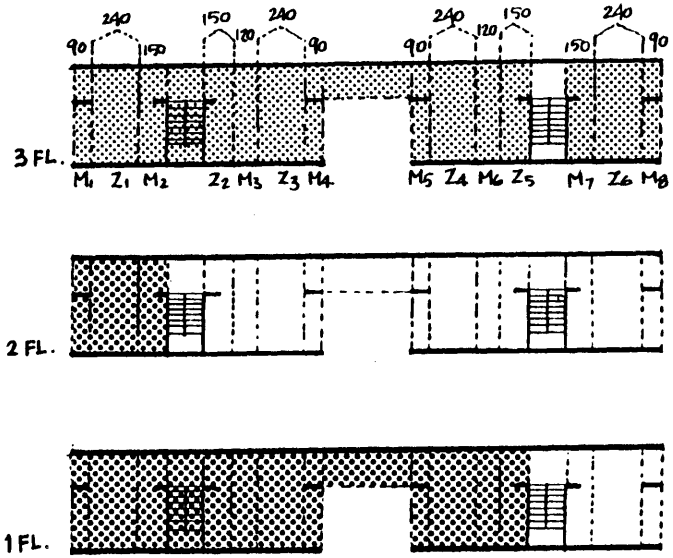
The user draws the boundary of each household, and the machine will display the territories of various households in the screen.

B.2 Check the Division

The machine will check if the territory division is proper according

Change the Territory Division




Error: the territory of #1 will be passed through.

to the data of accessibility and privacy analysis in the pre-stored data system.

B.3 Examine the Possible Basic Variants

User: query

Machine: retrieve the data of the support system

B.3.a Place Function, Remove Function and Show Conflict

Same as A.1 at 5.3.2

B.3.b What Functions Fit into This Space

Same as A.2 at 5.3.2

B.3.c What Locations Accept This Function

Same as A.3 at 5.3.2

B.4 Satisfy

After the user satifies the adjusted territory division, the machine will generate all the data about the sector group and the floor area of each household, and store the information about the number of the possible bedrooms and the character of the stairs(private, public).

## 5.3.4 THE LEVEL OF FLOOR PLAN

User: adjust + test + satisfy

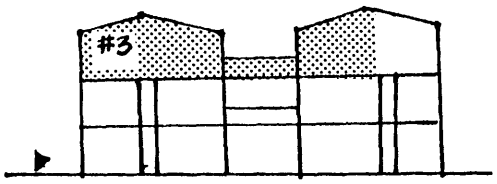
Machine: check input data + store the data of floor plan

A. Draw the Desired Floor Plan

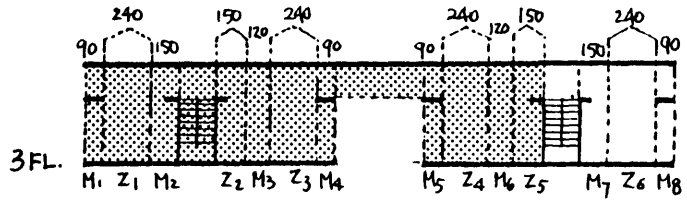
Within each territory of the support, the machine will display the possible functions of each sector. Users can place the desired function in each space and machine will check if the layout meets the basic requirement of a household( a kitchen, a bathroom,a bedroom).

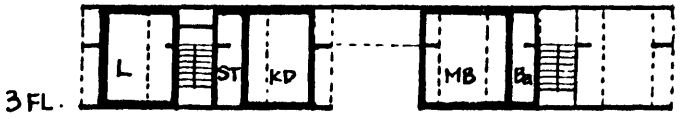
B. Satisfy

Finally the user implement the basic variant (floor plan), then the machine




| ZONE | DEMISION | FUNCTION |
|---|---|---|
| Z1 | 2.40 M | B1 |
| Z1 + M1 | 3.30 M | B1 B2 MB L |
| Z1 + M2 | 3.90 M | B1 B2 MB L |
| Z1 + M1 + M2 | 4.80 M | B2 MB L |
| Z2 | 1.50 M | Ba St |
| Z2 + M3 | 2.70 M | Ba St S D |
| Z3 | 2.40 M | K B1 |
| Z3 + M3 | 3.30 M | B1 B2 MB L |
| Z3 + M4 | 3.60 M | K KD B1 B2 MB L |
| Z3 + M3 + M4 | 4.50 M | B2 MB L |
| Z4 | 2.40 M | K B1 |
| Z4 + M5 | 3.30 M | B1 B2 MB L |
| Z4 + M6 | 3.60 M | K KD B1 B2 MB L |
| Z4 + M5 + M6 | 4.50 M | B2 MB L |
| Z5 | 1.50 M | Ba St |
| Z5 + M6 | 2.70 M | Ba St S D |



will store the layout plan in the data system.

In each level, the users can ask machine retrieve all the data stored in the data system (criteria data, upper level dynamic data). The users can use them as the base to make decision.

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