VARIABILITY OF RESIDENTIAL OPEN SPACE: A CASE STUDY OF BOSTON WEST BROADWAY PUBLIC HOUSING RENEWAL

by

LEE-HSUEH HUNG

B.S. National Cheng Kung University at Taiwan 1981

Submitted in Partial Fulfillment of the requirements for the Degree of Master of Science in Architecture Studies at the Massachusetts Institute of Technology May 1984

© Lee-Hsueh Hung 1984

The author hereby grants to M.I.T. permission to reproduce and to distribute publicly copies of this thesis document in whole or in part.

Signature of Author

Certified by

N. John Habraken, Professor of Architecture
Thesis Supervisor

Accepted by

N. John Habraken, Professor of Architecture
Departmental Committee for Graduate Students

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUN 19 1984

LIBRARIES
Variability of Residential Open Space:  
A Case Study of Boston West Broadway Public Housing Renewal

by

Lee-Hsueh Hung

Submitted to the Department of Architecture on May 11, 1984, in partial fulfillment of the requirements for the degree of Master of Science in Architecture Studies.

ABSTRACT

This is a study of design methodology for residential open space with the purpose of generating various plans according to the different values and needs of the residents. A public housing renewal project -West Broadway Housing renewal- is taken as a case study.

The design starts from the systematic analysis of the relationship between open space and the existing apartment buildings which it surrounds and between that open space and the dwellings in these buildings. Territory and function are two characters for describing this relationship and explaining the potential of the space. Since the space is limited, residents have to decide between various solutions based on certain criteria which are suggested. The final result shows that a plan can be generated by the residents themselves by going through a decision-making process. This process explains what decisions have to be made by different groups of residents in the dwellings, ranging from large group to small group.

Thesis Supervisor: N. John Habraken
Title: Variability of Residential Open Space:  
A Case Study of Boston West Broadway Public Housing Renewal
ACKNOWLEDGMENTS

I would like to express my gratitude to Prof. John Habraken, my thesis supervisor, who provided me with his valuable knowledge and guidance throughout this work. I would also like to thank Prof. Chester Sprague who had helped on defining and framing the topic.

And last, to my grandparents and parents, for their love and support.
TABLE OF CONTENTS

Acknowledgments
Table of Contents
List of Figures
List of Tables

INTRODUCTION ....................................................9

CHAPTER ONE: BACKGROUND OF WEST BROADWAY HOUSING PROJECT .......... 11
  1-1: Original Design ........................................... 11
  1-2: Existing Condition ........................................... 16
  1-3: Renewal - Need for Change of Image ......................... 19

CHAPTER TWO: DESCRIPTION OF THE PHYSICAL ENVIRONMENT ................. 21
  2-1: Define a Study Unit ......................................... 21
  2-2: Organization of Dwelling Units ........................... 24
  2-3: Character of Open Space ................................... 28

CHAPTER THREE: RELATION BETWEEN PARKING SOLUTIONS AND AVAILABLE
  NON-PARKING SPACE ............................................. 32
  3-1: Space for Parking ........................................... 32
  3-2: Increasing Parking Space and Decreasing Non-parking Space 38
  3-3: Comparison Between Different parking Solutions .............. 41
### CHAPTER FOUR: CAPACITY OF SPACE

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-1: Capacity of Public Space</td>
<td>45</td>
</tr>
<tr>
<td>4-2: Capacity of Private Space</td>
<td>51</td>
</tr>
<tr>
<td>4-3: Capacity of Spaces on Site</td>
<td>57</td>
</tr>
</tbody>
</table>

### CHAPTER FIVE: GENERATION OF PLAN FOR ONE COURTYARD UNIT

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-1: Criteria for Choosing Between Different Parking Solutions</td>
<td>62</td>
</tr>
<tr>
<td>5-2: Agreement between Different Group of Dwellings</td>
<td>65</td>
</tr>
<tr>
<td>5-3: Plans Generated</td>
<td>67</td>
</tr>
</tbody>
</table>

### CONCLUSION

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>71</td>
</tr>
</tbody>
</table>

### Bibliography

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>73</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Fig. 1-1 Location of West Broadway Housing Project 12
Fig. 1-2 Site Plan of West Broadway Housing Project 13
Fig. 1-3 Building Design of West Broadway Housing 14
Fig. 1-4 Apartment Type of West Broadway Housing 15
Fig. 1-5 Existing Site Condition of West Broadway 16
Fig. 1-6 Proposed Site Plan of West Broadway Renewal 20
Fig. 2-1 Plan of Village 21
Fig. 2-2 Plan of Courtyard Unit 22
Fig. 2-3 Apartment Reorganization 25
Fig. 2-4 New Entrance and Staircase 25
Fig. 2-5 Organization of Dwellings in One Building 26
Fig. 2-6 Hierarchy of Dwelling Organization 27
Fig. 2-7 Parking Space in Courtyard Unit 29
Fig. 2-8 Location of Public Space 30
Fig. 2-9 Location of Private Space 31
Fig. 2-10 Shifting of Private Territory Boundary 31
Fig. 3-1 Courtyard-Corner Parking Space 33
LIST OF TABLES

Tab. 3-1 Occupation of Parking Spaces 37
Tab. 3-2 Number of Parking Space by Different Solutions 39
Tab. 3-3 Character of Different Solutions Provide 40 Parking Spaces 44
Tab. 4-1 Capacity of Spaces on Site 58-60
Tab. 5-1 Criteria for Choosing Between Different Parking Solutions 63-64
Tab. 5-2 Decisions in Different Group of Residents 65-66
Case A and B 67
INTRODUCTION

The issue of variability - the capability of varying and making things difference from one another - comes from the idea of fulfilling diverse human needs and values. Physical environments should be capable of providing a range of variation to satisfy each specific individual user or group of users. By studying the development of an environment, we can always recognize how the environment is diversified by the action of its users. And the deterioration of an environment is often due to the rigidity and uniformity of its design which can't meet the different requirements of its users. These observations not only prove the importance of variability of an environment, but also stress that the variation should be generated by the users instead of the designers.

During the past twenty years, the notion that "dwellers should have their own choices of what is going to be in their dwelling environment" has become world wide. This notion is particularly related to the design of public housing projects developed after the wars, which have the fundamental problems of uniformity and lack of identity. Since the sixties these problems have been widely considered. The requirement that design should indicate the possibility of users' choice has been agreed upon and worked out in many cases. And the question of "How and how many variants can be generated" has become a basis for the evaluation of design.

In this study, the issue - variability - is to be discussed in housing renewal with emphasis on its open space design. It only deals with the
potential and possibility of physical design,
concentrates on the dimension and organization of
spaces which can support a range of detailed
uses. This study will try to develop a design
method for residential open space. This method
provides a systematic analysis of the open space
and explains the design with regard to the
probability to generate variation of
interpretation by residents themselves.
CHAPTER ONE: BACKGROUND OF WEST BROADWAY HOUSING PROJECT

South Boston, especially the West Broadway neighborhood, is one of the older residential areas in the city of Boston. (Fig 1.1) This area provided rental housing for poor families, but the inferior quality of the buildings was blamed for a wide variety of social evils by the remainder of the population. By the 1930's, construction of public housing projects became part of a crusade to clear the "slum". With this purpose, the West Broadway housing project, accompanied by the other housing projects of Old Colony and Mary Ellen McCormack, was developed by the BHA (Boston Housing Authority) to replace most of the sub-standard dwellings in this area.

1.1 Original Design

The development of the West Broadway housing project was completed in 1949 to provide 972 apartment units for temporary residents. They would be mostly poor people or upwardly mobile people who were temporarily set back by the devastated economy. The whole project which covered about 27 acres, was located in the lower end of South Boston, and was bounded by B street, West 7th street, D street and West Broadway. It comprised 27 three-story and basement buildings which were of reinforced slab and column concrete construction. The only structures on site which predated the construction of the project and were preserved are the church and the rectory of the Lithuanian Parish. (Fig 1.2)

The buildings, which were virtually identical in
Fig. 1-1 Location of West Broadway Housing Project
Fig. 1-2 Site Plan of West Broadway Housing Project
their brick exterior walls with masonry and plaster back-up, were grouped to conform to the original block pattern, forming the basis of a village type organization. The buildings in each "village" were situated in pairs, forming the periphery and sharing a common courtyard. Each building had three sections. Each section had one staircase and common hallway which served twelve apartments (four apartments in each floor). (Fig 1.3) Five basic apartment types provided apartments varying from one bedroom to five bedrooms in size. (Fig 1.4)

The design adopted the super-block layout: through streets were closed, two large parking areas were located at the extremes of a central spine, ground was planted with trees and grass, areas for different activities were defined by fences. The exterior space was undifferentiated in terms of private and public territory. Most of
the outdoor space was shared by all the residents, only a little space was under private control. With its grand scale of institutional style buildings, this project was superimposed on the existing neighborhood and was isolated from the area with its super block layout which is different from the row houses surrounding it.

---

Fig. 1-4 Apartment Type of West Broadway Housing
1.2 Existing Condition

The major change in the environment after it was built included the construction of neighboring Condon Community School in 1975; the conversion of some apartments into a multi-service center, village offices and social service agencies; the construction of Toyce Hayes Way which passed in front of the multi-service center and the Condon School, and is now the principle focus of public activities. (Fig 1.5) Other than these physical constructions, villages were established as administrative units in 1978, and now provide a basic organizational framework for tenants and management activities. This structure reinforced the existing physical configuration of buildings and spaces.

The structural condition of the buildings is still sound. There is no evident deterioration of the exterior walls. But there are problems of

Fig. 1-5 Existing Site Condition of West Broadway
organization and layout of buildings and apartments. These problems include: 1) Too many apartments share one common staircase and hallway which has double entries. Security becomes a serious problem, especially for the first floor apartments. 2) The households are larger than expected; most of the apartments are too small. The unit standard which was established in the 30's, is now below the standards of area, room size and furnishability used by the public housing authority in new construction. 3) Buildings are uniform in character. There is a lack of identity for the residents.

The most serious problem of the environment is the deterioration of the quality of the landscape and maintenance. Many areas were paved with asphalt rather than replanted. This allowed vehicles to move freely through the courtyards and the areas where they were not intended to be. Coming with the breakdown of vehicular circulation, fences, dryingyards, plants and other amenities in the original design were destroyed. Now the site is entirely flat. The vast majority of surface areas are either paved and crumbled, or open dirt lots compacted by traffic. There are only a few trees and shrubs left. The environment is generally in poor condition; only the most public areas of the site—areas along West Broadway and adjacent to the Condon School—are in good condition.

Besides the outdated standard of buildings and the deterioration of open space, there are two major problems which residents complain about. They are strongly related to the design principle of open space and have to be considered for radical change. 1) Pedestrian traffic conflicts with the automobile; people complain that the parking is too far away from their dwellings, and
drive through the courtyard to park as close to the dwellings as possible. 2) The lack of claim by residents; most of the outdoor space is undifferentiated and not privately controlled; people have difficulty establishing and defending their turf, even within their own courtyard. There is no opportunity for residents to take responsibility for improving, maintaining, or securing the spaces which are around their buildings.

Thirty years after the project was built, West Broadway housing has proven to be unmanageable. Unsupervised utility systems and exterior space have been difficult to maintain. The outdated quality of building and unit design also has contributed to the problem of physical deterioration. Lots of abandoned areas and the high vacancy rate have proved the need for renewal and rehabilitation of the neighborhood.
1.3 Renewal - Need for Change of Image

The design of West Broadway housing followed the criteria for urban apartment design established since the 30's. The approach of this design was basically to set standards for: 1) apartments - by providing a typical plan, and 2) open space - by offering an area that is in the right proportion to the built area (which is only a question of density). This project was intentionally isolated from its setting by its collective and undifferentiated community image. The increasing deterioration and the high vacancy rate have made this area now regress into the slums which had been replaced.

The same situation happened in many public housing projects developed by the BHA during the 40's and 50's. By the 70's and the beginning of the 80's, the BHA began to work on the renewal of these projects. A general strategy had been established for these housing projects. This included the following programs: 1) the basic organization and size of the individual apartments must be changed, 2) the basic organization of buildings must be changed radically, 3) the basic site organization and its link to the surrounding community must undergo significant transformation. The BHA also proposed a change of the circulation system by 1) opening new roads breaking through the super block, 2) abandoning the location of the centralized parking and providing parking distributed to each block. (fig 1.6)

There is a strong tendency to transform the original site design into the model of row houses, which will also create private exterior spaces and entries. Based on the model of row houses, the open spaces can be allocated to various uses ranging from private to the very
public. By the transforming of the original physical organization, the renewal scheme should also have the capability of allowing for modification and interpretation to alternative scenarios by users. In time the composition of tenants has changed. Most of the residents were supposed to be only temporarily living there. Instead of taking this project as a stepping stone towards "normal" home ownership, tenants had formed a stable population. It is now important to analyse clearly the territories of different groups of residents for them to take the responsibility of maintaining their spaces; and also for them to have the opportunity to modify their own spaces according to their specific needs and values, and to acquire a sense of identity. The renewal project must make an effort to articulate the exterior spaces of different scales in response to the new organization of buildings and apartments.

These proposals implied that the value of the quality of the housing environment had changed. The image of collective and undifferentiated openness has to be replaced. The new attitude will seek to create a variable, rich and articulated spacial hierarchy.

Fig. 1-6 Proposed Site Plan of West Broadway Renewal
CHAPTER TWO: DESCRIPTION OF THE PHYSICAL ENVIRONMENT

We can describe an environment in different ways. Before the designers can decide about which way they will choose, they must consider certain issues and problems which they are going to stress. In this chapter, the description of the West Broadway housing environment will emphasize the open space and its relation to the buildings. The conditions which relate to the design of open space will also be analyzed here.

2.1 Define a Study Unit

The opening of three breakthrough streets and the central spine divide the site into eight blocks of similar size. Except the Condon School block, the other seven blocks can be generally described as one configuration shown in Fig. 2.1. (The only exception is the block with the church and

Fig. 2-1 Plan of Village
Along with the administration system, the four public streets around each block become the clear territory boundary of the one group of dwellings they surround. We call this group of dwellings a "village".

Assuming that the edge of this typical block along the central spine will be the same as on the other side along B street or D street, each block can be seen as a composition of two pairs of buildings in symmetrical organization. Taking one pair of buildings as an unit, we can define a configuration which consists of two buildings, has three public streets surrounding it, and adjoins another similar configuration on the fourth side. (Fig 2.2) We call this configuration a "courtyard unit", since these two buildings form an inner courtyard in their plan. The West Broadway housing consists of twelve courtyard units, a block of Condon School, and another block with the rectory and church.

This configuration represents the major character of the organization of buildings and their open space. It has a clear boundary on three sides. On the fourth side, it shows the character of

![Fig. 2-2 Plan of Courtyard Unit]
sharing open space with other group of residents. It is reasonable to study such a unit in which the open space surrounds and is available for the dwellings in the two buildings. In the later part of this study, the design of open space between the boundaries and buildings will be the subject discussed, and a courtyard unit will be defined as a basic unit for studying the design problem and process. Here we stress that the design of open space can’t be studied without explaining its relation with the dwellings. And the existence of any open space can only be meaningful in a residential environment, when it can be explained by its relation with dwellings in terms of territory and function. These are two issues which residents are concerned about in obtaining their open space. In this study, we will explore these two issues in the design method of residential open space.
2.2 Organization of Dwelling Units

We have addressed the importance of the relationship between open space and dwellings. Before we study open space design, it is necessary to understand the organization of dwellings in one courtyard unit.

Every courtyard unit is composed of two buildings each of which has an inner corner space. These space emphasize the separating of the dwellings in one courtyard unit into two groups, each of which is called a "building unit". Space in the courtyard unit can be divided into two parts, each of them belongs to a building unit.

Besides adding necessary equipment and improving the physical condition of the buildings, two major proposals made by the BHA for improving the quality of dwelling unit space are: 1) enlarging the size of rooms and apartments, and 2) reducing the number of units sharing one common hallway.

In order to enlarge rooms and apartments, the BHA made the following specific suggestions: 1) Keep the size of the apartment the same while combining the rooms, so that the number of bedrooms will be reduced in one unit, or 2) combine the original units to enlarge the size of apartment by horizontal or vertical breakthrough of the original unit division. (Fig 2.3) To reduce the number of units sharing a common hallway, the BHA suggested: 1) Create private entrances for the ground floor residents, and 2) create new common hallways and staircases to reduce the number of units sharing the original hallway. (Fig 2.4)

These solutions will transform the organization of dwellings in one building into two types: 1) the dwellings in one building can be divided into three groups; or 2) they can be divided into five
Fig. 2-3 Apartment Reorganization

A. HORIZONTAL BREAKTHROUGH

B. VERTICAL BREAKTHROUGH

Fig. 2-4 New Entrance and Staircase

PRIVATE ENTRANCE

UNITS SHARE NEW STAIRCASE

Fig. 2-5 Each "group of dwellings" shares one common hallway or open space. To divide the residents of a building unit into groups will help us to define a smaller group of residents who will share areas of open space separated from the space around the building and
belonging to the building unit. Taking each group of dwellings as a unit, another subdivision can be made which divides the common space among some or all of the individual dwellings.

Now we have a hierarchy of the organization of dwellings ranging from larger groups to smaller groups: 1) village, 2) courtyard unit, 3) building unit, 4) group of dwellings, and 5) single dwelling. This hierarchy of dwelling organization will play an important role in studying the issue of territory in later chapters. (Fig 2.6)
1. A VILLAGE

2. A COURTYARD UNIT

3. A BUILDING

4. A GROUP OF DWELLINGS

5. A SINGLE DWELLING

Fig. 2-6 Hierarchy of Dwelling Organization
2.3 Character of Open Space

We had decided two issues - function and territory - as the basis for explaining the relationship between open space and dwellings. In this section, we are going to analyze the character of space by defining certain categories of space in terms of different function and territory.

First, in terms of function, the two basic categories of open space are: 1) space for parking, which includes parking lot and driveway, and 2) space for functions other than parking, such as recreation, sitting, playing, walking, outdoor working, privacy protection, pedestrian circulation. Because of the limited area of open space, parking in urban housing is always a crucial problem, which will take up a lot of space. Also, because the space for parking has its basic requirements and layout, we can give the definition of these two categories of spaces: 1) space for parking, and 2) space for non-parking functions which has more flexibility.

In a courtyard unit, the possible parking spaces are shown in Fig 2.7. Those spaces can be separated into three types by their position in relation to buildings and streets. They represent three solutions to parking in one courtyard unit:

A) Courtyard parking - This takes up the space inside the courtyard by opening a driveway from the public street to the courtyard. B) Collective parking - This takes up a large block of space near the street. C) Distributed parking - This takes up the small lots at the corner of the building along the street. The spaces for non-parking function are those left over from parking space design.

Second, in terms of territory, space can be
divided into smaller pieces belonging to
different groups of dwellings with different
levels of publicness and privacy. We can separate
space into two basic types: one is public space
and the other is private space.

The public spaces that may be provided in one
courtyard unit in different positions are: 1) space belonging to one village, 2) space belonging to one courtyard unit, and 3) space belonging to one building. (Fig 2.8)

Besides these spaces, which are in shape of a block, there are some linear open spaces that are public too. The spaces along public streets such as the sidewalk or sidewalk bordered with paints, and the pedestrian walkway between two buildings of two courtyard units belong to a village. Finally, there are walkways or linear green spaces along the courtyard sides of the buildings which belong to a courtyard unit or a building.
The private space is formed by assigning front and back yards for each group of dwellings or having a private protection zone to keep a minimum distance between building and public space. Private space has two categories: 1) space belonging to one group of dwellings, and 2) space belonging to a single dwelling. (Fig 2.9)

Depending upon the way of assigning private space, the territory boundary between public and private will change. It shifts between minimum private space (which is the basic private protection zone around the edge of building) and maximum private space (which is the possible extension of the private yard in the front and back sides of building). The space between two boundary lines can be either private or public. (Fig 2.10)
Fig. 2-9 Location of Private Space

Fig. 2-10 Shifting of Private Territory Boundary
CHAPTER THREE: RELATION BETWEEN PARKING SOLUTIONS AND AVAILABLE NON-PARKING FUNCTION SPACE

The open space in a single courtyard unit provides two functions: one is parking and the other is non-parking. Since the open space is limited, the more parking space that is provided, the less open space there will be available for other functions. Parking always is seen as the most crucial problem in the designing of open space. How we decide on the parking solution and assign the parking space will have a strong influence on the overall design. In this chapter, we are going to examine the parking solution in one courtyard unit, and try to understand how parking takes up the open space and what space will be available for the non-parking function.

3.1 Space for Parking

Three parking areas each of which occupies different position on site, have been pointed out. Now we will examine how many parking spaces each area can provide.

A) Courtyard parking: There are three possible areas for parking inside the courtyard:

1) Courtyard-corner: This area takes up the space in the inner corner of the building and also along the driveway. It can provide 31-32 car-parking spaces. (Fig 3.1)

2) Courtyard-middle: This area takes up the space between two buildings and along the drive way. It can provide 19-20 car-parking spaces. (Fig 3.2)

3) Courtyard-average: Unlike the previous two solutions which only leave a minimum distance between building and parking space, the third area leaves a longer distance between building and parking space, while using the whole inner courtyard space. It can provide 18
Fig. 3-1 Courtyard-Corner Parking Space

31-32 SPACES

0 16 32 64'

Fig. 3-2 Courtyard-Middle Parking Space

19-20 SPACES

0 16 32 64'
car-parking spaces. (Fig 3.3)

B) Collective parking: There are two large lots on site which can provide this type of parking. (Fig 3.4)

1) Collective-corner: This area is located in the corner of the block and can provide 8-11 car-parking spaces.

2) Collective-center: This area is located between two courtyard units and can provide 10-12 car-parking spaces.

C) Distributed parking

Six small lots are distributed over the courtyard unit. The lot between two courtyard units can only be available when collective-center parking is provided. This solution can provide 22-27 car parking spaces. (Fig 3.5)

Given the above information about parking spaces, the first step to understanding the relationship between spaces for parking and non-parking functions is knowing what kind of space (either public or private) is taken up by each parking solution. The table (Tab 3.1) below can explain this relationship.
Fig. 3-3 Courtyard-Average Parking Space

18 SPACES

0 16 32 64'

Fig. 3-4 Collective Parking Space

19-21 SPACES

0 16 32 64'
Fig. 3-5 Distributed Parking Space
<table>
<thead>
<tr>
<th>PARKING SPACE</th>
<th>PUBLIC SPACES BELONGS TO PRIVATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VILLAGE</td>
</tr>
<tr>
<td></td>
<td>OUTSIDE</td>
</tr>
<tr>
<td>A. 1) Courtyard-corner</td>
<td></td>
</tr>
<tr>
<td>2) Courtyard-middle</td>
<td></td>
</tr>
<tr>
<td>3) Courtyard-average</td>
<td></td>
</tr>
<tr>
<td>B. 1) Collective-corner</td>
<td>X</td>
</tr>
<tr>
<td>2) Collective-center</td>
<td>X</td>
</tr>
<tr>
<td>C. Distributed</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 3-1 Occupation of Parking Space
3.2 Increasing Parking Space and Decreasing Non-parking Space

We know how parking will take up the space available for the non-parking function. In this section, we are going to examine the interaction between the increasing of parking space and the decreasing of non-parking space.

The first question we are concerned with is the following: if a certain number of parking spaces has to be provided, what solutions (which may involve using one parking area or a combination of several areas) can we choose. Also, we want to understand how many parking spaces can be provided by different solutions or combination of solutions. The table (Tab 3.2) below represents the different combinations of parking areas and the number of parking spaces each can provide. The diagram (Fig 3.6) shows how the increase of needed parking spaces will take away from the open space on site, and how the decrease of non-parking space will be effected by different solutions.
Tab. 3-2 Number of Parking Space by Different Solutions
Fig. 3-6 Parking Space and Non-Parking Space in Different Parking Solution
3.3 Comparison Between Different Parking Solutions

The third step for better understanding the relationship between the two types of spaces is to compare the difference between solutions which provide the same number of parking spaces. We can decide on the number of parking spaces needed in one courtyard unit, find the solutions available, and examine the difference between those solutions.

We can make the assumption that through the combination of units, the number of dwellings in one courtyard unit will be reduced to 70 percent of the original number. If we provide 0.8 parking spaces per dwelling, then we need about 40 parking spaces for one courtyard unit. By checking table 3.2, we see that ten solutions can provide this number of parking spaces. They are:

- **a)** 38 spaces——courtyard-average and collective parking
- **b)** 40 spaces——courtyard-average and distributed parking
- **c1)** 40 spaces——courtyard-corner and collective-corner parking
- **c2)** 42 spaces——courtyard-corner and collective-center parking
- **d)** 40 spaces——courtyard-corner and part of distributed parking
- **e)** 42 spaces——courtyard-corner and courtyard-middle parking
- **f)** 39 spaces——courtyard-middle and collective parking
- **g)** 41 spaces——courtyard-middle and distributed parking
- **h)** 40 spaces——collective and part of distributed parking
- **i)** 39 spaces——distributed and collective-center parking
These ten solutions can be separated into five groups according to whether they provide parking inside or outside the courtyard. The diagram (Fig 3.7) illustrates these solutions ranging from one extreme (all inside parking) to the other (all outside parking) and shows the space available for the non-parking function in each solution.

Which solution the residents in one courtyard unit will choose depends on what kinds of open space will be available after parking has occupied the necessary space. Table 3.3 shows what spaces, private and public, will be available for the non-parking function under each parking solution.
Fig. 3-7 Solutions Provide 40 Parking Spaces
<table>
<thead>
<tr>
<th>PARKING SOLUTION</th>
<th>VILLAGE</th>
<th>COURT YARD UNIT</th>
<th>BUILDING (INSIDE)</th>
<th>GROUP OF DWELLING OUTSIDE</th>
<th>16' EDGE INSIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Courtyard-corner and Courtyard-middle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1 Courtyard-corner and Collective-corner</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>B2 Courtyard-corner and Collective-center</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>B3 Courtyard-corner and part Distributed</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>S L</td>
</tr>
<tr>
<td>C1 Courtyard-middle and Collective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>C2 Courtyard-middle and Distributed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>D1 Courtyard-average and Collective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>D2 Courtyard-average and Distributed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>E1 Distributed and Collective-center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>E2 Collective and part Distributed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S L</td>
</tr>
</tbody>
</table>

Tab. 3-3 Character of Different Solutions Provide 40 Parking Spaces
CHAPTER FOUR: CAPACITY OF SPACE

Which spaces residents will claim for the non-parking function depends on what they can do with the available spaces. It will be helpful for residents to know the possible functions of those spaces in order to understand the potential of the various spaces, and therefore to make their decision. We have already seen what kinds of spaces will be left available for functions other than parking, for each of the different parking solutions. In this chapter, we are going to examine the capacity of each space which has been categorized by it territory and position.

4.1 Capacity of Public Space

Besides the parking lot and driveway, the necessary functions which will be provided by public space include: circulation, leisure, playing, outdoor working, and visual scenery. Each of the functions potentially includes a number of activities depending on the physical conditions available:

1) Space for circulation: Such spaces include pedestrian walkways, sidewalks or sidewalks with plants beside them.

2) Space for leisure: A landscaped and outdoor-furnished dry yard, a plaza or a green space would provide areas for such leisure activities as sitting, conversation, recreation.

3) Space for playing: The space provides fixed playground facilities is particularly for children’s play.

4) Space for outdoor working: A dry yard with fewer plants and outdoor furnitures allows for such activities as facility repair, outdoor
workshop, laundry drying.

5) Space for visual scenery: A green space for increase the quality of the view, though it doesn't provide specific activity.

In this section, we examine the space which forms a recognizable "block" (not linear space) and can be claimed as public communal space at different level of publicness, and consider the capacity of such space by looking at the functions it can perform.

A) Village space - There are two arrangements of this space. (Fig 4-1)

1) Space is largely paved for parking with a single driveway in the middle. The space left on both sides can be sidewalk or linear green space for visual scenery.

2) A communal space with a driveway on each side. This space can be a large playground, a playground with green space at both sides, a large green space, or a landscaped piazza for leisure. Sidewalks can be on both sides of the central space.

B) The corner space belonging to one courtyard unit - There are two arrangements of this space. (Fig 4-2)

1) It can be a collective parking space. The remaining space can be sidewalk or linear green space for visual scenery.

2) It can be a leisure space or green space for visual scenery.

C) The courtyard unit space inside the courtyard - There are three arrangements of this space. (Fig 4-3)

1) Parking takes up the greater part of this space to the edge of the minimum private protection zone. There will be no sidewalk provided on either side.
Fig. 4-1 Capacity of Village Space

1) a. LARGE GREEN SPACE OR PLAZA
   b. PLANTS ALONG SIDEWALK
   c. PEDESTRIAN OR GREEN SPACE ON both SIDES OF PLAYGROUND

2) 48'
   a. LARGE GREEN SPACE OR PLAZA
   b. CHILDREN'S PLAYGROUND
   c. PEDESTRIAN OR GREEN SPACE ON both SIDES OF PLAYGROUND
1) PARKING PLANTS ALONG OR GREEN SPACE SIDEWALK

2) a. EXTENSION OF PRIVATE SPACE OR b. SIDEWALK

3) a. PLAYGROUND OR b. GREEN SPACE

Fig. 4-2 Capacity of Courtyard Unit Space at Corner

Fig. 4-3 Capacity of Courtyard Unit Space Inside
2) Parking takes up part of the space. Sidewalks can be on both sides.

3) The space is not used for parking; instead, it is a communal space which can be a playground, or a leisure space. Sidewalks can be on both sides.

D) Building space - There are three arrangements of this space. (Fig 4-4)

1) Parking takes up most of the space to the edge of the minimum private protection zone. No sidewalk can be provided on this side.

2) Parking takes up part of the space. A sidewalk can be provided along the building.

3) The space is not used for parking; instead, it is a communal space for leisure or outdoor working.
Fig. 4-4 Capacity of Building Space
4.2 The Capacity of Private Space

The private space provides for functions such as gardening, sitting, and children's playing. The capacity of this space is affected by the distance between the edge of building and the territory boundary. In this section we test the capacity of private spaces which are mostly front or back yards, by examining the possible functions in relation to the size of space.

A) Edge of building

Before we study the open space, we have to understand the basic requirements for entrance, terrace, balcony and the space along the edge of building. (Fig 4-5)

1) First floor privacy protection zone -
   Besides the basic 8' privacy protection zone between public and private spaces, it is suggested that there be a 4' zone for first floor privacy protection between the edge of the building and the open space shared by a group of dwellings.

2) Entrance - An outdoor stair is needed for entering the building. Three types of stairways can be added to the building as an entrance, according to the number of unit it serves and its position: a) in the corner, to serve a group of dwellings, b) in the front of a building, also to serve a group of dwellings, and c) in the front of a building, but serving one single dwelling.

3) Balcony - For better connection between indoor and outdoor spaces, a balcony can be built on each floor. It is suggested that its size be limited to a maximum width of 2', and a maximum length of 6'.

4) Terrace - A sunny deck open to the air can be attached to first floor dwellings with stretching no more than 6' from the building, and being no more than 6' long. A 6' deck can
Fig. 4-5 Layout of the Edge of Building
be made for the upper floor residents as well, by carving out 4' from their indoor space and extending the deck out another 2' from the building.

B) Variety of private spaces belonging to a group of dwellings

There are a variety of spaces of different sizes in different positions, which can be private open spaces. The drawing (Fig 4-6) shows the possible extension of private space in different areas of the site, ranging from 4' to 32' and extending from the 8' minimum private protection zone. Those spaces will be shared by a group of dwellings. A variety of layouts will be developed by the residents to serve the different functions they require.

While the possible layout and function of a space is strongly affected by the distance between the territory boundary and the edge of building, we can define four categories of private yard according to their size:

1) Minimum space (the 8' private protection zone, and in same case, a 4' extension): Residents can only plant bushes or grass.
2) Small garden (8' to 12' extension): Residents can plant large trees, flowers and bushes.
3) Garden (16' to 20' extension): Residents can plant trees, flowers or have a small dry yard for children's playing.
4) Large garden (28' to 32' extension): Residents can have gardening area and also a dry yard for sitting and children's playing.

The drawing (Fig 4.7) shows the capacity of these different sized spaces.

C) Single ownership private space

We can also distribute some spaces which belong to a group of dwellings to some single
Fig. 4-6 Spaces Belong to A Group of Dwellings
Fig. 4-7 Layout of Spaces Belong to A Group of Dwellings
dwellings on the first floor. The layout and function of the spaces available for single dwellings are similar to those spaces analyzed above. The 4' first floor privacy protection zone provides a space for private entrances and staircases.
4.3 Capacity of Spaces on Site

We have examined the capacity of spaces, by testing the possible functions they can provide for, depending on the category of territory and the size of the space. Now we reorganize these materials, and put the information into a single table. Table 4.1 shows the possible territories and functions of each space which occupies a specific position. We will have the complete picture of the potential of spaces available in one courtyard unit.
Tab. 4-1 Capacity of Spaces on Site
<table>
<thead>
<tr>
<th>PUBLIC SPACE</th>
<th>PRIVATE SPACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARKING</td>
<td>MIN. SPACE</td>
</tr>
<tr>
<td>PARKING, SIDEWALK</td>
<td></td>
</tr>
<tr>
<td><em>D</em></td>
<td></td>
</tr>
<tr>
<td>LARGE GREEN SPACE OR DRY YARD</td>
<td>8' EXTENSION: SMALL GARDEN</td>
</tr>
<tr>
<td>SMALL GREEN SPACE OR DRY YARD</td>
<td>8' EXTENSION: SMALL GARDEN OR 16' GARDEN</td>
</tr>
</tbody>
</table>

- PLANT ALONG SIDEWALK

<table>
<thead>
<tr>
<th>E</th>
<th></th>
<th>12' EXTENSION: SMALL GARDEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td></td>
<td>28' EXTENSION: LARGE GARDEN</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>32' EXTENSION: LARGE GARDEN</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td>10' EXTENSION:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16' EXTENSION: GARDEN</td>
</tr>
</tbody>
</table>
PUBLIC SPACE

PARKING

SIDEWALK

DRIVEWAY

PEDESTRIAN

PRIVATE SPACE

MIN. SPACE

4' EXTENSION

8' EXTENSION: SMALL GARDEN

12'

PEDESTRIAN

PUBLIC SPACE

PARKING

SIDEWALK

DRIVEWAY

— —

— —

PEDESTRIAN

PRIVATE SPACE

MIN. SPACE (a)
12' EXTENSION: SMALL GARDEN (b)

4' EXTENSION (a)
16' : GARDEN (b)

8' : SMALL GARDEN (a)
20' : GARDEN (b)

12' : SMALL GARDEN (a)
24' : GARDEN (b)

12' : SMALL GARDEN (a)
24' : GARDEN (b)

Tab. 4-1 Capacity of Spaces on Site (continued)
CHAPTER FIVE: GENERATION OF PLAN FOR ONE COURTYARD UNIT

Given the potential of spaces in terms of function and territory as described in the previous chapters. We now analyze how residents decide upon their own plans of open space, choosing the one which will be most suitable and desirable for themselves.

Two premises have to be introduced before a plan can be generated. First, we believe that design, especially when resources are limited, is a matter of decision-making, which is based on users' recognition of values and the comparison between available suggestions. Since the plan should represent the ideas of the residents, what a designer can do is to help the residents to make their decision by providing the information for a better understanding of the potential of space and the criteria they might consider.

Second, decision-making involves the issue of agreement, we suggest a process of agreement. Because of the limited resources, there will be a lot of conflicts in the decision-making process. Agreement is necessary between groups of residents to generate a plan systematically. The process is accomplished by going through different levels of decision-making, each level involving different groups of residents, ranging from a large group to a number of smaller groups.
5.1 Criteria for Choosing Between Different Parking Solutions

The spaces available for functions other than parking are strongly influenced by the parking solution chosen. Thus, which parking solution to adopt will be the most important decision for the residents in a courtyard unit to make. To illustrate how such decisions can be made, we continue the comparison between those solutions which can provide about 40 car-parking spaces in one courtyard unit.

To make constructive suggestions to the residents, we have to list the criteria which they will be concerned with. There are three major criteria for residential open space, each solution satisfies the criteria to a different degree (and residents must weigh their needs accordingly).

1) The position of parking: Parking can be inside the courtyard, near dwelling units along the street, or arranged collectively and connected to the dwelling with a pedestrian walkway.

2) The possibility of having public communal spaces: These spaces may belong to a village, a courtyard unit or a building; some of them can be playgrounds.

3) The major private space: The private space at the corner, along the street, or inside the courtyard can be gardens in different sizes ranging from large to small, or simply bushes and grass area.

Table 5.1 lists the criteria above in relation to different parking solutions.
### Tab. 5-1 Criteria for Choosing Between Different Parking Solutions

<table>
<thead>
<tr>
<th>PARKING POSITION</th>
<th>AVAILABLE PUBLIC SPACE</th>
<th>Street Side</th>
<th>Courtyard Side</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> inside courtyard</td>
<td>village space</td>
<td>P. large garden</td>
<td>min. space</td>
</tr>
<tr>
<td><strong>B1</strong> 2/3 inside courtyard 1/3 collective</td>
<td>village space</td>
<td>P. large garden</td>
<td>large garden (at A)</td>
</tr>
<tr>
<td><strong>B2</strong> 2/3 inside courtyard 1/3 collective</td>
<td>village space</td>
<td>P. large garden</td>
<td>large garden (at A)</td>
</tr>
<tr>
<td><strong>B3</strong> 2/3 inside courtyard 1/3 near dwelling along public street</td>
<td>village space</td>
<td>P. large garden</td>
<td>some large garden (at A)</td>
</tr>
<tr>
<td><strong>C1</strong> 1/2 inside courtyard 1/2 collective</td>
<td>building space(inside)</td>
<td>B. large garden</td>
<td>large garden (at B)</td>
</tr>
<tr>
<td><strong>C2</strong> 1/2 inside courtyard 1/2 near dwelling along public street</td>
<td>village space</td>
<td>B. small garden</td>
<td>large garden (at B)</td>
</tr>
<tr>
<td>PARKING POSITION</td>
<td>AVAILABLE PUBLIC SPACE</td>
<td>STREET SIDE</td>
<td>COURTYARD SIDE</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>D₁ 1/2 inside courtyard 1/2 collective</td>
<td>non</td>
<td>large garden</td>
<td>small garden (at A, B) garden (at C)</td>
</tr>
<tr>
<td>D₂ 1/2 inside courtyard 1/2 near dwelling along public street</td>
<td>village space  courtyard unit space (corner)</td>
<td>P. small garden</td>
<td>small garden (at A, B) garden (at C)</td>
</tr>
<tr>
<td>E₁ 2/3 near dwelling along public street 1/3 collective</td>
<td>courtyard unit space (corner)  courtyard unit space (inside)  building space (inside)</td>
<td>A, P. small garden</td>
<td>large garden (at A) large garden (at B) garden (at C)</td>
</tr>
<tr>
<td>E₂ 1/2 near dwelling along public street 1/2 collective</td>
<td>courtyard unit space (inside)  building space (inside)</td>
<td>A, P. some large garden  B. some small garden</td>
<td>large garden (at A) large garden (at B) garden (at C)</td>
</tr>
</tbody>
</table>
5.2 Agreement Between Different Group of Dwellings

To generate a plan for one courtyard unit, the decision-making process should go through a series of groups consisting of the residents of a village, a courtyard unit, a building unit, a group of dwellings, and a single dwelling. Table 5.2 lists what decisions have to be made by the different groups.

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) use of village space</td>
<td></td>
<td>parking</td>
</tr>
<tr>
<td>2) plants along sidewalk along public street</td>
<td></td>
<td>non-parking: playground, green space or plaza</td>
</tr>
<tr>
<td>3) plants along pedestrian</td>
<td></td>
<td>with or without</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with or without paints on both sides</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COURTYARD UNIT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) parking solution</td>
<td></td>
<td>between 10 solutions</td>
</tr>
<tr>
<td>2) layout of available public space: courtyard unit space at street corner and inside courtyard</td>
<td></td>
<td>yes or no</td>
</tr>
<tr>
<td>3) distributing courtyard unit space inside courtyard to two groups of dwellings</td>
<td></td>
<td>with or without</td>
</tr>
<tr>
<td>4) sidewalk along driveway</td>
<td></td>
<td>with or without</td>
</tr>
<tr>
<td>5) plants along sidewalk</td>
<td></td>
<td>with or without</td>
</tr>
</tbody>
</table>

Tab. 5-2 Decisions in Different Group of Residents
BUILDING

1) organization of dwelling units
2) size and layout of building space (if available)

- 3 or 5 groups
- large parking space, minimum private space
- small parking space, small private garden
- no building space,
  3 large gardens belong to 3 groups of dwellings

GROUP OF DWELLINGS

1) organization of dwelling units
2) layout of available open space
3) position of walkway and outdoor staircase

SINGLE DWELLING

1) layout of available open space
2) position of walkway, entrance and outdoor staircase
3) position of balcony and terrace
5.3 Plans Generated

In this section, we will show two plans generated according to the process discussed above. They represent two possible layouts.

Case A

Village
- village space: parking, sidewalk provided
- plants along sidewalks
- without plants along pedestrian walkway

Courtyard Unit
- parking solution: collective and part distributed
- courtyard unit space at street corner: parking, sidewalk provided
- courtyard unit space inside courtyard: distributed to two groups of dwellings
- pedestrian walkway between two buildings
- without plants along pedestrian walkway

Building
- organization of dwellings: 5 groups
- building space: small green space and part of space distributed to two groups of dwellings (16' extension)

Group of Dwellings
- without single dwelling entrance and open space

Case B

Village
- village space: no parking, green space
- without plants along sidewalks
- plants along pedestrian walkway

Courtyard Unit
- parking solution: courtyard-corner and collective-corner
- courtyard unit space at street corner: parking, sidewalk provided
- courtyard unit space inside courtyard: playground
- without sidewalk along driveway

Building
- organization of dwellings: 3 groups
- building space: large parking space
- minimum private space

Group of Dwellings
- all first floor dwellings have private entrances (either front or back) which are in their front or back yards
CASE A

CASE B

- VILLAGE SPACE
- COURTYARD UNIT SPACE
- BUILDING SPACE
- SPACE BELONGS TO A GROUP OF DWELLINGS
- SPACE BELONGS TO SINGLE DWELLING
CASE A
(continued)

43 CAR-PARKING SPACES

48 DWELLING UNITS

A, E: ONE LARGE APARTMENT, EACH FLOOR

B, C, D: TWO SMALL APARTMENTS, EACH FLOOR

0  8  16  32'
CASE B
(continued)

38 CAR PARKING SPACES
52 DWELLING UNITS

A.C: ONE LARGE APARTMENT, 1ST FL.
TWO SMALL APARTMENTS, 2ND, 3RD FL.

B: ONE LARGE APARTMENT, EACH FL.
CONCLUSION

This study emphasized the design of residential open space to generate various plans to satisfy the different needs and values of the residents. The most important procedure is to understand the potential of available open spaces by testing its capacity. We studied a specific site, in which the buildings were already there and the floor areas of the dwelling space were provided.

The capacity study was not able to deal with two problems which are important in residential open space design, because of the existing construction. The first problem is that the residents don't have any choice about the position of their public space because the organization of buildings (location of buildings and streets) is fixed. The second problem is that they don't have any choice about the position of their private space because the type of building (distribution of apartment units, location of staircases and hallways) is given. Here the position of space means its location in the given site and its relationship with the dwellings.

Owing to these two restrictions, the capacity study tested only the function and territory of the available spaces which had a fixed dimension and position. It can be continued as a feedback to test the organization and type of buildings. The issues for describing the capacity of space will not only territory and function, but also position.

We can go further to discuss the design of open space by providing an open lot and suggesting the
floor areas of dwelling space. The capacity study will be a tool to test and compare the different schemes of building organization and type. It should provide suggestions to correct the dimension of space between buildings or the dimension of buildings themselves, as well as suggestions to change the position of buildings, the apartments, staircases and hallways in the buildings.
BIBLIOGRAPHY

Transformations of the Site
N. John Habraken; Awater Press; 1982

Variations: The Systematic Design of Supports
NJ Habraken, J Th Boekholt, PJM Dinjens, AP Thijssen;
Laboratory of Architecture and Planning MIT; 1976

SAR 73: The Methodological Formulation of Agreements Concerning the Direct
Dwelling Environment
Stichting Architecten research, Eindhoven; 1973

Flexibility in Supports: an analysis of the effectd of selected physical
design variables upon the flexibility of support
type housing systems
Robert Oxman; Thesis, Technion, Israel Institute of Technology; 1977

A Pattern Language
Christopher Alexander; Oxford University Press; 1977

Community and Privacy: Toward a New Architecture of Humanism
Christopher Alexander, Sergius Ivan Chermayeff;
Garder City, N.Y.; 1965

Houses Generated by Pattern
Christopher Alexander; Berkeley, Ca; 1969

Community of Interest
Oscar Newman; Anchor Press; 1980
An Introduction to Housing Layout (a GLC study)
   The Architectural Press, London; 1978

Master Plan of West Broadway Comprehensive Renewal Program: Prepared for the
B.H.A. in Cooperation with the Massachusetts Department of Community Affairs
and the West Broadway Task Force
   Lane/Frenchman, Inc. and Goody, Clancy and Associates, Inc.; 1981

Public Housing: Versatile Building Stock for Changing Clientele. Some Thoughts
Prompted by Change in the design of Four public Housing Projects: Fidelis
Way, Franklin Field, Jefferson Park, and West Broadway.
   Chester Sprague; Unpublished MIT paper; 1983