HOUSING & URBAN MODELS: A CASE FOR AN URBAN, HIGH-DENSITY, LOW-RISE HOUSING IN SINGAPORE

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Thesis submitted for the Degree of

Doctor of Philosophy

at the School of Architectural Studies

University of Sheffield

September 1997

PAGE NUMBERING AS ORIGINAL

ACKNOWLEDGEMENTS

I would not have come this far if not because - to borrow Isaac Newton's words - "I've stood on the shoulders of giants". It is with my deepest gratitude that I thank my "gaints", many of whom were architects, urban designers, theorists, researchers, social engineers, planners, academics and practitioners, and especially I would like to thank Mr. Peter G. Fauset for his wise and efficient supervision. His intellectual support, insight and encouragement were decisive to the completion of this thesis.

Thanks are also due to Lois Burt and Elaine Ashton, for their able assistance with the library materials; to Melvin Broady for his assistance with the computer facilities and to Peter Lathey for his assistance with the photographic equipments.

My thanks also go to all my colleagues and friends, and specially to Dr. Leonard Yip and Paula, Nicholas and Betty, Duu Sheng and Kok Lien, Mr and Mrs John Waite, Mr and Mrs Lo K. K. , Dr. and Mrs Heng, Daniel and Carrie, Anthony Coppins, Peter Tan, and Thiam Teck for their friendship and encouragement throughout the stay in Sheffield.

The scholarship provided by the Housing and Development Board, Singapore was definitive for the possibility of this thesis.

I would like to express my deep thanks to my parents, who have consistently called long-distance to show us their concern and love, and to my brothers and sisters and family, particularly to Ten San who first encouraged me to take up architectural studies when I was at the crossroads of deciding what to do.

Finally, I am especially thankful to my wife, Lee Har, and my two sons, Yong and Lii, for backing me up with their love and affection and enthusiasm without which I would not have been able to achieve this goal. They have never failed to inspire me.

It is never a day without God's grace

SUMMARY

Title: **HOUSING & URBAN MODELS: A case for an urban, high-density, low-rise housing in Singapore.**

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The environment in Singapore is becoming more and more urbanised and public housing forms a major part of the urban development. The continual process of adopting the current high-density, high-rise built forms in a fast changing society has resulted in 87% of the population living in a homogenous urban environment which lacks variety and choice. It was in view of this limitation in the present model that this research was initiated.

This thesis is an investigation on the possibility of an alternative high-density, low-rise built forms which is applicable in Singapore's context. By relooking at the theories of Martin and March on built form and land use, this thesis seeks to distill out the principles on high-density, low-rise patterns of urban development. By applying these principles in the housing design of a modern society with all its complexities and its changing nature can in fact path the way forward in the housing and urban design in the 21st century.

Within the housing context, this thesis seeks to formulate a conceptual framework in which the alternative housing model can be feasible. Within these framework, the thesis also addresses the issues of regional identity in the use of the traditional shophouse built form. It looks at the problems and arguments which generated the shophouse typology and considers the directions which are now open to us.

By examining urbanism and by keeping housing as the central focus and a strategic vehicle, the object of this thesis is to consider an alternative model so that in addition to the existing high-rise pattern of housing, it will be possible to design a way forward which provides a wider range of choices and will lead to a greater opportunity for a variety of patterns of living to develop. The result of applying the shophouse typology using Martin and March's theory holds the key to the solution to the problem of urban variety in high-density housing.

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Chapter One:

INTRODUCTORY CHAPTER

1.1: An introduction

Public housing forms a major part of the urban development in the physical environment of Singapore. Since the beginning in the 1960s, the archetypal high-density, high-rise housing model today houses 87% of the population. To a large extent, this model has resulted in a stereotyped and homogenous urban environment which lacks variety and choice. It was in view of the limitations with the present model that this thesis was initiated.

This chapter aims to provide the reader with an introduction to the issues which are at stake in the present high-density, high-rise housing and the overall structure of the thesis by describing the organisation and content of each chapter.

1.2: Issues at stake

The object of this thesis is to deliberately consider an alternative model so that in addition to the existing model, it may be possible to design a way forward in the housing design in the next millennium. By considering urbanism in the built environment and by keeping housing as the central focus and a strategic vehicle, the main issue that is being addressed in this thesis is to consider an alternative high-density, low-rise housing model as a means of exploring a wider range of choices and of developing a variety of patterns of living. Within this alternative model, the following two sub-issues are also being considered:

(i) to address the issue of regional identity in the built form which is responsive to the local climate and is part of the local context and

(ii) to reconsider the traditional shophouse typology as an appropriate form of living/working built form in putting forward a case for an alternative high-density, low-rise housing.

1.3: Thesis Structure

The following section aims to provide the reader with an overall view of the structure of the thesis.

Chapter 2, introduces the present high-density, high-rise housing in Singapore by outlining the development of public housing since the beginning. It seeks to give a quick analysis on the history of housing problems under three main periods. By mentioning the increasing homogeneity in the built environment and by raising the issue of the inadequacy of the present model in the face of the present and future changing society, the thesis is set as - Singapore needs a greater variety of public housing built form than the predominantly high-rise image presently evident.

Chapter 3 and 4 look at the two issues at stake in the urban environment of Singapore:-

Chapter 3, addresses the issue of regional identity which is lacking (Yeang, 1987) in the many rampant and insensitive modern architecture projects within Asian cities including Singapore. The focus is on an architecture which is responsive to the local climate and the planning of new urban spaces and their reorganisation and reintegration which is contextual. This would eventually lead to an expression of a new streetscape and tropical urban architecture that would be both relevant in time and place to its specific culture, heritage and people of this part of the world. This chapter also forms part of the framework for an alternative model which is both responsive to the cultural heritage and the climatic conditions prevailing in this region.

Chapter 4, reconsiders the traditional shophouse built form as an appropriate alternative model for high-density, low-rise housing. It looks first at the origin of the Singapore shophouse and then presents the strategy derived from the shophouse form. The chapter also describes the possibility of a pedestrian friendly tropical city and the use

of the five-footway which is part of the shophouse typology as an urban design element and connector. The various aspects of the shophouse design, particularly its physical characteristics which make it responsive to the local climate and yet versatile in containing the various changes in its function, will be discussed. This chapter also includes density analysis of two shophouse developments in the Central Area.

Chapter 5 forms the main thrust of the thesis. Chapters 5.1 and 5.2 seek to rediscover the theory developed by Professor Sir Leslie Martin and Lionel March at the Centre for Land Use and Built Form Studies at Cambridge University. Their mathematical approach to residential planning proved that the courtyard layout had a higher land use intensity than other built forms. This then lead to the Perimeter Housing in Chapter 5.3 which naturally links with the previous Chapter 4 on the Shophouse which is proposed to be the appropriate alternative model for high-density, low-rise urban form in the local context.

Chapter 5.1 reconsiders the theory according to Martin and March particularly with reference to the relationships that exist in the physical structure of the city. Once this has been done it may be possible to explore a wider range of choices, and this may lead to a greater opportunity for a variety of patterns of living to develop. It addresses the concern by rediscovering "those neutral guidelines that set out the least restrictive framework and allow the maximum elaboration by use" (Martin, 1972). It would be clear that there are in any urban situation, certain simple interrelations of street pattern, plot size and building form and the patterns of living which elaborate these. This chapter introduces and forms an important part of the theorectical framework for an alternative high-density, low-rise housing model which itself offers choice and within which a plurality of choices can operate.

Chapter 5.2, considers in detail the case for speculations as a research approach by looking at Martin and March's (1972) speculations set out in their book, "Urban Space and Structures". Together with the previous chapter, this chapter sets out the possibility of an alternative high-density, low-rise built form to exist in contrary to that of the typical Modern Movement's slab and tower blocks. As an important part of the theorectical framework for this thesis, it establishes a way forward in developing an

alternative housing paradigm.

Chapter 5.3, introduces the principles behind perimeter housing. The differences between perimeter housing as compared to the Modern Movement tower block is most clearly evident here in its various case studies considered. Most importantly, the application of the principles of the fresnel square in the design of high-density, low-rise housing is significant in its influence on the possible built form of the development. In addition, similar impact is achievable when the principles of the fresnel square are applied using the shophouse typology.

Chapter 6, naturally flows from the analysis in the previous chapters. As part of the conceptual framework and the culmination of this thesis, this chapter presents the application of the lessons gleaned so far especially the theory of Martin and March in developing a conceptual alternative high-density, low-rise housing model.

Chapter 6.1 begins by comparing the intensity of land use in two housing areas, one based on the high-density, high-rise model and the other on the shophouses development within the Central Area which is low-rise.

Chapter 6.2 then presents the conceptual framework for the alternative model with 3 case studies on a larger site, at the neighbourhood level. The alternative high-density, low-rise model is tested on large parcels of housing sites where the high-density, high-rise model has been used. These layouts are conceptual and serve as diagrammatic comparisons between the two models.

Chapter 6.3 takes the testing of the alternative model a step further by proposing a conceptual framework applied at a specific site level. It first describes some planning issues which governs the site selected for the testing of the alternative high-density, low-rise model. The various socio-economic characteristics of the residents living in the area will be discussed and its implication will be addressed in the alternative model. This is then followed by the conceptual design of two alternative layouts with details of its comparative analysis in each case. The differences between the existing layout planned according to the present high-density, high-rise model as compared to the alternative layout planned according to the alternative high-density, low-rise model will be presented. The application of the shophouse principle in the design of the dwelling units

would also be shown towards the end of the chapter.

Chapter 7, addresses the general conclusions and recommendations of the overall research work. It sums up the various findings of this thesis on the testing of the alternative high-density, low-rise model which evidently demonstrates its feasible application. It points out the potentialities and the limitations of the conceptual framework which combined the shophouse model with Martin and March's mathematical principles.

Chapter 2:

A Frame of Reference

Chapter 2:

A Frame of Reference

2.1: An introduction

This chapter outlines the development of public housing in Singapore from the beginning. It begins by giving a quick analysis of the history of housing problems under three main periods. It continues by outlining the experiences of public housing design by adopting the high-density, high-rise model. By raising the issue of the inadequacy of the present model in the face of the present and future changing society, the thesis is set as "Singapore needs a greater variety of public housing built form than the predominantly high-rise image presently envisaged".

2.2: Public housing in Singapore

Three distinct periods can be discerned in the history of housing problems.

First period (1819 - 1926): During this period there was no official attempt to tackle the housing problem, despite the rapid population increase (as a result of heavy migration) and growth of slums in the central city area.

Second period (1927 - 1959): Under the Colonial Administration, the Singapore Improvement Trust (SIT) was established to "provide for the Improvement of the Town and Island of Singapore" (Teh, 1975). However as SIT was much less a housing authority than a municipal body; its work was confined largely to the construction and widening of roads and the creation of open spaces.

Third Period (from 1960 onwards): The Housing and Development Board (HDB) was formed and built more than 50,000 units within the first five years of its inception, thus breaking the backbone of the housing shortage in Singapore for the first time. According to Teh (1975) by the end of March 1974, the HDB had about 175,000 units under its management, housing about 43 per cent of Singapore's entire population.

2.2.1: The first hundred years (1819 - 1926)

This period saw a very rapid growth in population together with the growth of slums, especially in the city area, but with no concomitant growth in the supply of decent shelter. The astronomical growth of population can be seen in Table 1 which shows that in 1824 the population was 10,683, and by 1921 it had reached 418,358. The increase in population was mainly due to immigrants from China and India. The overwhelming majority of the immigrants were Chinese. Most of them were single, male and poor, attracted to Singapore because of its geographic position and the employment opportunities resulting from the development of rubber and tin in Malaya (now West Malaysia) to meet the growing needs of the European nations. In terms of shelter, most of the immigrants could only afford a bed for the night and roof over their heads, especially in the already overcrowded slums of Chinatown (Teh, 1975).

A report on the sanitary conditions of the town of Singapore was made in 1907. The need to alleviate conditions of overcrowding in the Central Area was stressed. Following the report, the Municipal Building Ordinance was amended to improve the conditions of the buildings. The construction of shophouses in the Central Area subsequently followed the minimum requirements of the amended Building Ordinance.

Year	Population
1824	10,683
1849	52,891
1871	97,111
1881	137,755
1891	181,612
1901	227,592
1911	303,321
1921	418,358

Table 1. Population growth by selected years (from Department of Statistics, 1973)

In 1918, a Housing Commission was set up to report on the housing conditions in the Central Area and to make proposals for the improvement of the housing situation.

The Commission recommended the formation of an Improvement Commission and , as a result, the Singapore Improvement Trust (SIT) was conceived in 1924 and started functioning in 1927.

2.2.2: Public housing under the SIT (1927 - 1959)

2.2.2.1: The pre-war period (1927 - 1942)

Under its original function with regards to public housing, SIT was empowered to provide homes only for people actually made homeless under Improvement Schemes. However, by 1932 it was realized that with the rapid population growth, efforts must be made towards accommodating the urgent need for more new housing. So in 1932, SIT was given more powers to construct its own buildings, and during the remaining pre-War period it carried out two major housing schemes, i.e. Lorong Limau and Tiong Bahru. The latter could be considered as representing Singapore's first public housing estate. However, by 1942 SIT had completed only a total of 2,049 houses and 53 shops. The reason for this poor performance in public housing lay in the fact that SIT's energies were mostly directed towards road improvements, opening up of back lanes, drawing up improvement schemes and demolishing insanitary buildings.

2.2.2.2: The post-war period (1947 -1959)

The housing situation further deteriorated after World War II. The demand for low rental housing rose sharply as a result of heavy immigration and very high birth rates, due to a more or less balanced sex ratio. By then, the population had lost its temporary immigrant character and become a permanently settled one. This meant that the housing needs changed from that for single persons to one of families which could not conceivably be met by much of the existing and sub-divided housing stock. Moreover,

residential construction was practically at a complete standstill under the Japanese Occupation.

The severity of the problem can be seen from the report of the Housing Committee set up in 1947 to study the housing situation (Teh, 1975). The report revealed the most appalling conditions. Out of a population of 938,000 persons, 680,000 or 72 per cent were housed within the Central Area. What was even worse was the fact that about a third of the population was "herded into about 1,000 acres in the heart of the city with densities up to 1,000 or more to the acre".

Year	Cumulative Number of units	Proportion of Population in Public Housing (%)
1947	224	1.5
1950	2,754	2.8
1955	12,836	6.9
1959	20,907	8.8

Table 2. SIT dwelling units built and the proportion of population housed, 1947-1959 (from HDB Annual report, 1973/74)

When the supply of housing in the Central Area had reached the saturation point, new immigrants, unable to find accommodation, moved out to the fringe of the city where they erected haphazard shelters of wood, attap, corrugated iron or scrap materials. These eventually grew into squatter colonies forming a ring of squalor and misery around the central city area. These areas often became death traps and breeding grounds for disease, crime and fire hazards.

In view of the atrocious conditions which the report had revealed, from 1948 onwards the SIT tried to concentrate its main efforts on housing construction. Between 1947 and 1959, 20,907 units were completed, as shown in Table 2. Such effort was still inadequate in the face of the huge population increase of 641,000 persons, from 0.938 million in 1947 to 1.579 million in 1959. The number of units built by the SIT, together

with the private sector during this period amounted for only 40,000 units which could have accommodated less than 300,000 persons, even assuming high density occupancy. Therefore, the SIT could not provide shelter for even half of the population increase, not to mention the huge backlog already waiting for decent housing.

Figure 1. Queenstown housing estate (1960s) (from Designed for Living, 1985)

2.2.3: Public housing since 1960.

In 1959, Singapore was granted self-government and the newly formed socialist People's Action Party (PAP) was elected to power. The investment climate was terrible; there were frequent strikes and demonstrations and available financial resources were limited. Against this uncertain political backdrop, the government recognised the realities of the situation. On the one hand, there was an urgent necessity to start a sizable housing programme to meet the acute shortage of accommodation and on, the other hand, the government could only successfully operate within the constraints of available financial and technical manpower resources.

2.2.3.1: Formation of the Housing and Development Board

The government dissolved the SIT and on 1 February 1960, it formally established the Housing & Development Board (HDB) as a statutory board under the Ministry of National Development. The HDB had wide powers to construct and redevelop , to clear slums and resettle people and to manage new housing estates. At that time, the administrative and professional experience and capability of the housing authority was very limited, especially after the abrupt exodus of colonial expatriates.

However, aware of the appalling living conditions of the urban poor, the government launched a very ambitious five-year housing programme. Initially, flat units were small and their design and layouts were dull and unimaginative. They were built at the maximum density permissible by practical constraints on the limited supply of cleared land. Contractual procedures were streamlined and construction costs were kept low. In the process, the HDB was able to fulfill its projected construction target and delivered large numbers of reasonably priced housing units. By the end of the sixties the living conditions of the urban poor at last began to show visible signs of improvement.

2.2.3.2: *Successive building programmes*

Two Five-Year Building Programmes were prepared in the 1960s: 50,000 and 60,000 units of public housing were planned under the First and Second Five-Year Building Programmes (1960-65 and 1966-70) respectively. As can be seen in Table 3, by the end of 1970, the Board had completed a total of 120,669 units of flats and shops (Teh, 1975).

Including the units built by the SIT, there were some 175,000 housing units under the management of the Board by the end of March 1974, housing about 43 per cent of Singapore's population.

Year	Cumulative Number of units	Proportion of Population in Public Housing (%)
1960	1,682	9.1
1965	54,430	23.2
1970	120,669	34.6
1973/74	185,490	42.7

Table 3. HDB dwellings units built and the proportion of population housed (1960 - 1973/74) (from HDB Annual report, 1973/74)

Figure 2. Woodlands housing estate (1970s) (from Designed for Living, 1985)

2.2.3.3: *The independent state*

Singapore became an independent state in 1965. The political leadership initiated various actions to establish a favourable investment climate and to generate economic growth. Immigration was strictly controlled and serious efforts were made to lower the high birth rate. Industry and tourism were encouraged. The necessity to acquire land at an affordable cost was accepted as an absolute prerequisite for effective long-term development programmes. Tough legislations were introduced to acquire land and properties for public purposes (Land Acquisition Act, 1966). At that time, this land acquisition policy became the subject of much criticism. In the process of land acquisition, the interest of landlords was adversely affected and when slums and squatters were cleared, considerable hardships were created. However, the continued success of delivering large numbers of housing units to the public at an affordable price in Singapore was only possible when large areas of prime land were made available at a reasonable cost to the housing authority (Lim, 1982).

Within a decade, Singapore had successfully changed its economic base from a major trading and administrative out-post of the British Empire to a prime regional centre for banking, trade and commerce. Since the mid-seventies, the government had evolved a development strategy based on the concept of Singapore - the global city. Much emphasis is now given to the development of tele-communication networks, to the rapid introduction of computers and robots, to the restructuring of Singapore's industrial base towards high-skilled technology and to the upgrading of worker's skills and education.

2.3: *Experiences with the high-density, high-rise model*

2.3.1: HDB's experience

2.3.1.1: New towns

In order to construct large housing developments, the HDB located these in the new towns. Their sizes ranged from 25,000 to 50,000 residential units with populations ranging from 100,000 to 250,000. Each new town was sub-divided into neighbourhoods of around 4,000 to 6,000 dwelling units housing about 20,000 to 30,000 people. Each neighbourhood had its own centre with local shopping facilities. The centre was usually located within five minutes average walking time from the residential blocks. Because of the small physical size of Singapore, the most distant of the new towns were located less than 25km from the Central Business District (CBD). They were sometimes in close physical proximity to each other.

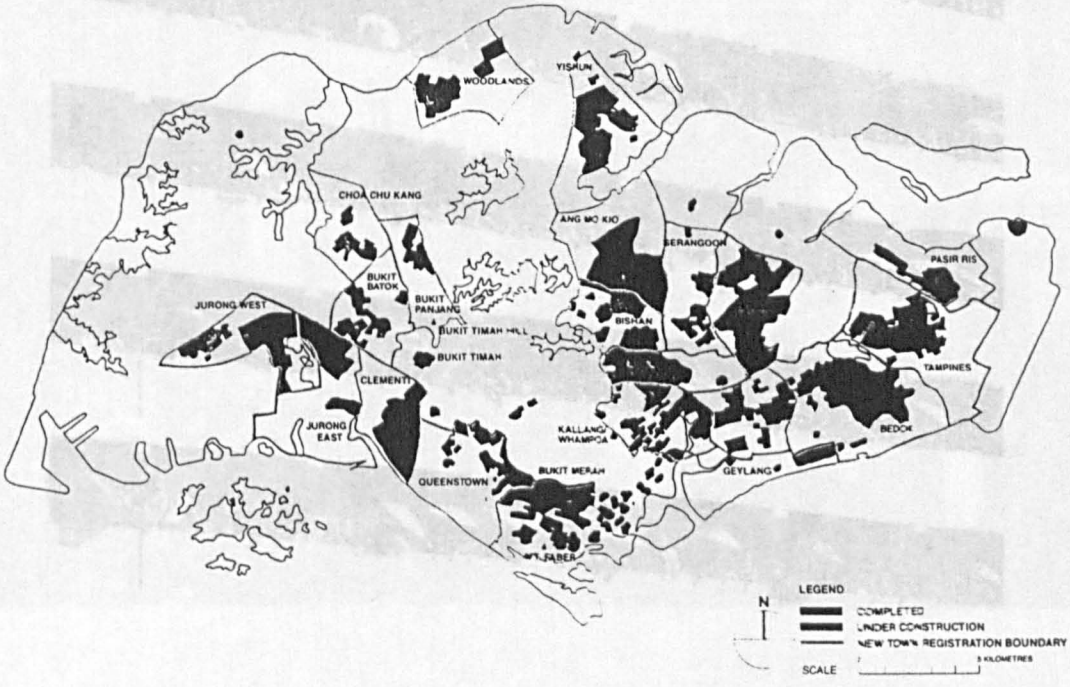


Figure 3. Location of HDB Developments (from HDB Annual Report, 1991/92)

2.3.1.2: Basic design criteria

The HDB's basic design criteria was based on three dimensions: social, environmental and visual.

On the social dimension, HDB considers it more important to provide affordable and appropriate housing rather than good architecture. Most of its buildings were limited to 12-storey which kept construction cost down and unforeseen lift breakdown manageable. A precinct concept was introduced with each precinct consisting of 500-1000 housing units, grouped around a landscaped square which had communal facilities to encourage social interaction.

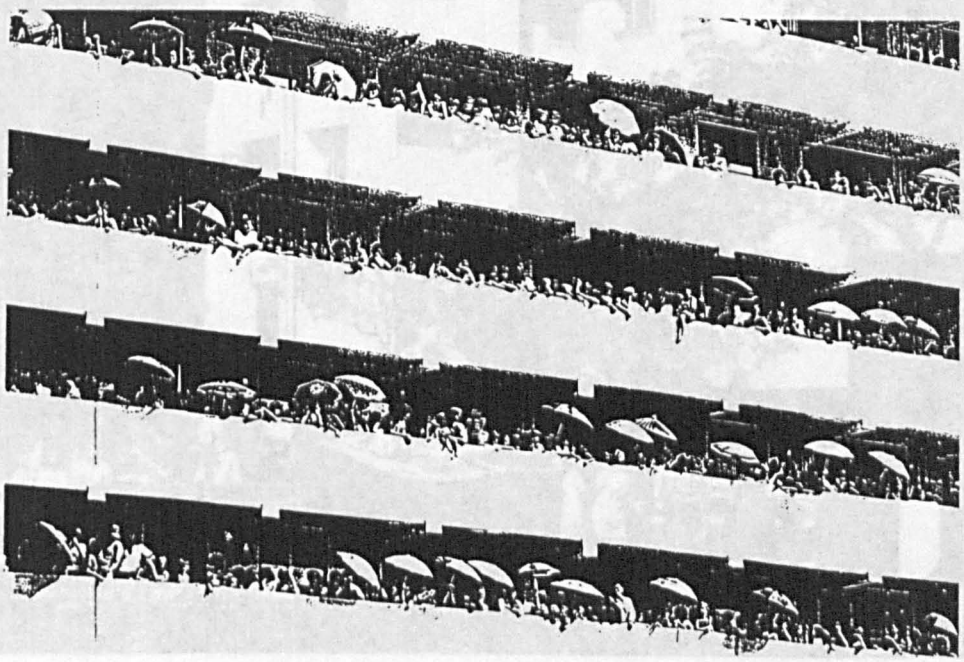


Figure 4. Vertical villages (from Designed for Living, 1985)

On the environmental dimension, the public housing was structured on a hierarchy of communal spaces which HDB described as a "flow from the courtyard-in-the-sky. to precinct square, to neighbourhood centre, and lastly, to the town centre." A conscious effort was made to provide more external communal spaces. For example, the placing of 4-storey blocks perpendicular to the roads defined spaces and also served as traffic noise barriers for the high-rise buildings.

Figure 5. High-rise housing environment (from Designed for Living, 1985)

A large number of residential slab blocks were used as back-drops for the high-rise density urban environment rather than as design statements in themselves. This was because a large proportion of the HDB's architects were still young and inexperienced and the objective was to constantly and gradually raise the design standard. More important than architectural consistency was the necessity to provide a sense of growth over time in the new towns. The town and neighbourhood centres were not conceived as finite pieces of architecture. They had a sense of growth in time with the introduction of a mixture of architecture styles, scales and forms. Within the new towns, some areas of strategically located land were deliberately reserved for future infill developments.

Figure 6 - Tampines housing estate (from Designed for Living, 1985)

2.3.1.3: *The Housing Environment*

According to Chen & Tai (1977), the man-made environment though created by man exerts its influence on people in a variety of ways, physically and psychologically. On the one hand, functional and beautiful architecture and housing with various conveniences have a positive effect. On the other hand, featureless residential districts, the absence of greenery, and air and noise pollution have a harmful effect on man. In addition, the physical aspects of a man-made environment will also affect the social systems of the community and the relationship between man and his social structure. It would be a mistake to think that the whole question is just one of providing a number of housing units for the people and a certain amount of floor space per person.

Housing and residential areas are designed so as to provide a maximum of convenience and comfort. They should be provided with all kinds of facilities and amenities. This involves, therefore, measures to provide more and better housing, health and community services and recreational facilities as well as to increase the opportunities for intellectual, cultural and community development. As stated by Liu (1973), public housing is not just building, but a way of life.

2.3.1.4: *Potential Environment and Effective Environment*

Physical environment, especially housing and recreational areas, cannot work in the isolated context of design and planning considerations. It should be designed to meet the needs and aspirations of the people. This is best illustrated by Gan's (1968) discussion between the potential environment and the effective environment:

> *The basic conception to be argued here is : the physical environment is relevant to behaviour insofar as the environment affects the social system and culture of the people involved or as it is taken up into their social system. Between the physical environment and empirically observable human behaviour, there exists*

> *a social system and a set of cultural norms which define and evaluate portions of the physical environment relevant to the lives of people involved and structure the way people would use (and react to) this environment in their daily lives.*

In practical terms, Gans points out that a park proposed by a planner is only a potential environment. It is the social system and culture of the people who would use it that determine to what extent the park becomes an effective environment. Therefore, it is essential that the planning and design for the physical environment should be aimed at creating a better match between potential environments and effective environments.

There is no simple way to evaluate this process. A feasible approach would be to investigate the social and psychological implications of high density in the public housing estates as well as to examine the accessibility of the HDB tenants to the service facilities (Hassan, 1975). Findings from these studies indicate that the HDB housing is identified with high population density, which tends to produce serious pathology. With regard to the accessibility to service facilities, findings show that poorer HDB tenants do not fare as well as their counterparts in the better socio-economic groups who reside in the larger units of HDB flats. These findings imply that there is much improvement yet to be made to better the living environment in HDB estates.

Chen & Tai (1977) attempted to use a different and indirect approach to answer the following questions:- Is there any difference in the life-styles between the people in HDB high-rise flats and those living in low-rise houses in kampongs and rural areas? They conducted a survey and carried out interviews on the people living in HDB areas and in kampong and rural areas.

The findings from Chen and Tai's survey showed that:-

- The physical environments of the two types of survey areas, i.e., the HDB areas and the kampong the rural areas, are quite different.
- That people living in different areas express their appreciation for different

features of the environment.

- That the different features physical environments affect, to a large extent, the human activity patterns and the social systems of the community.

Their findings show that kampong and rural dwellers have a lower degree of population mobility as compared to HDB dwellers. They have been living in the same place for a longer period of time, have more close friends and relatives living near where they live, and have a stronger sense of attachment to the place they live in. Compared to those of kampong and rural dwellers, the levels of satisfaction among HDB dwellers are higher in the following aspects:

- Convenience of public transportation,
- Play facilities for children, and
- Recreational facilities.

However, HDB dwellers have lower levels of satisfaction with

- public security in the neighbourhood,
- mutual assistance from neighbours,
- sense of belonging to the community,
- amount of noise in the neighbourhood,
- environment for bringing up children, and
- sense of responsibility among neighbours.

These findings indicate that although there are conducive physical environments and infra-structures in HDB estates, there is still weak cohesion among the neighbours and a lack of a sense of responsibility and belonging to the community among them. Findings from the above survey by Chen and Tai (1977) illustrate that physical environment and human behaviour are in mutual interaction with each other. Due to their

different physical and social environments, life-styles and human interaction patterns of HDB dwellers differ from those of kampong and rural residents.

The large-scale public housing programme has successfully provided better housing, better living facilities and better social infrastructures for the majority of the population in Singapore as reflected in the findings of this survey and in many other studies. However, the improved man-made environment in high-rise public housing estates still cannot be as effective as the environment of kampong and rural areas in fostering community ties, close human relationship and strong attachment to the family and the community.

In general, HDB residents feel that they are provided with good recreational facilities, good commercial and community services, adequate play facilities for children, convenient public transportation and other infrastructure facilities, but they are usually annoyed by noise pollution, poor social environment, and crowding. There are also lack of mutual assistance from neighbours, weak public security in the neighbourhood, lack of a strong sense of belonging to the community, little neighbourliness, and weak primary group contacts. Although kampong and rural people face problems of poor transportation facilities, inadequate community and commercial services, inadequate drainage facilities, unhealthy environment and inadequate public utility facilities, they enjoy, however, close community ties, good neighbourhood relationship, close attachment to the community, strong familial ties and primary group contacts. Therefore, it is very important that in addition to a healthy physical environment, improvements must be made to better social conditions for HDB residents to promote closer community ties and neighbourhood contacts, a stronger sense of belonging and attachment to the community, and better public security and mutual assistance.

To achieve these objectives, the crucial question is how one could close the gaps between potential environments and effective environments. As discussed earlier, the potential environment is projected by the planners and architects, whereas the effective environment is created and participated in by the people and it meets the needs and

aspirations of the people as well as the social systems and structures which are relevant to the daily lives of people. To succeed in producing effective environment in the context of Singapore society, the following are, among others, some important areas worthy of further consideration.

Firstly, certain elements of the natural environment should be preserved or incorporated into man-made environments in high-rise public housing estates. People may argue that to keep certain elements of nature in HDB estates is not possible because HDB estates are high-rise, high-density areas and there is not enough space for such provision. This of course is not true. There are ample spaces in HDB housing estates for such provision. Fonseca (1975) observes that in general, built-up area for residential and commercial structures and community services in HDB estates is between 20 and 25 per cent of the total land area. Using Toa Payoh Neighbourhood II for example, he says that 12.9 per cent of the total land area is used for residential and commercial structures; 13.0 per cent is used for community services (schools, utilities, hawkers, temples, community centres) and recreation (Parks, court-games, play-house); and the remaining 74.1 per cent for other purposes. Thus space for the provision of some natural environments in HDB housing estates is not a problem. We should therefore consider bringing in some natural environments to HDB housing estates. To have some small ponds and rivers, to keep some instant forests and small fruit orchards and to build some gardens around the areas are some feasible and possible natural environmental features which will improve the quality of living for the people living in HDB housing estates.

Secondly, the public housing environment is often criticised for being too impersonal and monotonous. This is of course a relative concept and it depends very much on what it is compared with. But it is quite obvious that almost all HDB building blocks have standardised designs and are painted with similar or identical colours. There are also no distinctions in building designs in different HDB housing estates, all are of the same types of building. The monotony of the public housing environment can, of course, be improved.

Thirdly, public housing is identified with high-rise and high-density. High-rise public housing is a predominant feature and high-rise living is an acceptable way of life in Singapore. There is no dispute that high-rise public housing is a functional and effective measure in providing adequate housing and solving the problem of housing and land shortage in Singapore as demonstrated by the current 87% of the population housed. But we should not think that high-rise housing is the only option and exclude all alternative possibilities. Much has been mentioned about low-rise high-density blocks as a possible option. Low-rise high-density housing can to some extent generate certain conducive social elements in promoting the quality of life and human relationships which are lacking in high-rise high-density estates. Low-rise high-density housing can play a more important role in the form of housing in Singapore which will be evident in the findings of this thesis.

2.3.2: The author's experience

By 1993, the author's growing involvement in new town planning, housing design and commercial design within the public housing context, motivated the author to seek for more innovative solutions to meet the rising expectations of the general public. The working experience within the Architectural Department in the Singapore office has led him to question the rationale and appropriateness of the adopted high-density high-rise model in present day context.

At that time, standard tower and slab blocks with their standard dwelling unit floor plans were being used to design the layout of a precinct within the neighbourhood. The author often tried very hard to come out with innovative design within the high-density high-rise system of designing. Not satisfied with the solution of the standard floor plans, he often tried non-standard designs. However, the difficulties that surfaced during the process of designing non-standard plans were at times, not so easily resolved. The situation was aggravated by the fact that the Planning Department and the Architectural

Department were segregated as two different departments within the hierarchy of the office management. As a result, the great potential of a creative synergy of the two departments was not being fully explored. No one would think of the possibility of an alternative model for high-density living. In a busy office of architectural design, no one would have the time to research into the high-density low-rise model.

The experience and knowledge of designing high-density with high-rise raised many interesting issues and questions. Therefore, when the opportunity came, the author decided to take up a research scholarship in pursuit of innovative ideas and possibilities in designing for living within a high-density context. However, high-density low-rise model for public housing was a rare subject for research in very few universities.

From this experience, two important considerations came up:

- how long would an architect be able to explore innovative and non-standard designs in public housing before giving up within the continual process of adopting the same high-density, high-rise model under the increasing pressure of workload and administration?
- what alternative is there to the present high-density, high-rise model which would allow further breakthrough in housing design so that it is possible to design a way forward in the face of a changing society?

These two questions contributed, significantly, to the direction taken by this research work.

At Sheffield University, among the first steps of his research work, the author faced the task of learning the various social theories and issues of housing to support the idea of an alternative high-density, low-rise model. Not forgetting to mention that since Singapore is an urban island city: he has to reconsider the various theories and models of urban design as well to further help him to put forth the alternative paradigm in housing in Singapore.

The introduction of Martin and March's theory by his supervisor prompted him to take advantage of the potential offered by that theory. It was decided that in solving the

problem of housing using the alternative high-density, low-rise model; the issues of regional identity which are not resolved satisfactorily in the present model should be addressed and naturally the shophouse typology is seen as the most appropriate form in the local climatic conditions. As a result, within the scope of the research; it is most realistic and reasonable to in the end propose a conceptual framework for an alternative urban, high-density, low-rise housing design which would be applicable to the local context.

2.4: Why an alternative model?

I want to make it clear at the outset that it is not my intention in this thesis to demonstrate that high-density, high-rise model is bad and that the alternative high-density, low-rise model is good. Singapore's public housing programme has been going on for more than 35 years and there is no doubt that this form of high-rise living has been well accepted by the majority of the public. My intention is to show that, in a changing society like Singapore where the general public is becoming more and more affluent and the people's aspirations of living standards increasing, the high-density, high-rise model is failing. It is failing not because it is being applied ineffectively but because there are deep-seated inadequacies in the system itself (for example: issues of the ageing population, sustainability and the depleting energy sources are not dealt with sufficiently within the model).

Does this mean that the high-density, high-rise model is wrong? To answer with a simple 'Yes' or 'No' would be to fail to see it in its historical context. High-density, high-rise model as the only model is failing because it is not designed to deal with change. The main fault lies in the esteem and complacency with which we have allowed ourselves to be satisfied with an inadequate system.

Further analysis and judgement within the same system are not enough when there is a need to design a way forward. It is not my intention simply to point out the

limitations and faults of the high-density, high-rise model. I intend to lay out within the scope of this research, a conceptual framework outlining the nature and operating systems of a different housing and urban design model. By laying alongside the existing model an alternative paradigm, we open up the possibilities of housing design into the next millenium. In this manner, instead of using the standard towers and slab blocks of the high-density, high-rise model, we design forward from a field of parallel possibilities using an alternative high-density, low-rise model.

This thesis is more concerned with 'what can be' than with 'what is'.

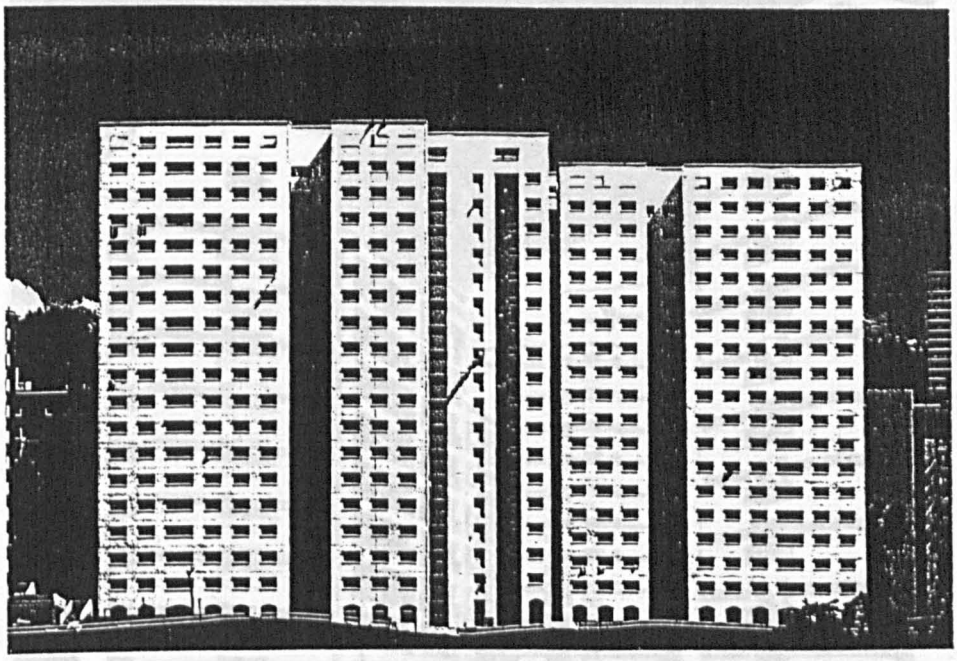


Figure 7 - Alexandra Hill housing (from Designed for Living, 1985)

2.4.1: A review of the high-density, high-rise approach

No assessment of HDB housing can ignore the central issue of high-rise, high-density living, especially in Singapore where high-rise living has become 'a way of life' for the large majority of the population.

The HDB has frequently argued its case for high-rise living on the basis of limited land availability in the island-state. A possible reason for such high density development was the need to keep the apportioned cost of land to each flat unit at an acceptable level.

According to Liu (1979), the key elements that make high-rise living in Singapore acceptable are that "residents are by and large adaptable to change....The cooperation and discipline of our people also help keep human conflict and vandalism to a very low level....The tropical weather in fact makes high-rise living desirable and the open-to-sky courtyard usable." The excellent maintenance facilities provided by the HDB are also an important factor, especially services which see to the breakdown of lifts.

Figure 8. Choa Chu Kang housing estate (1990s) (from HDB Annual 1991/92)

There are three other major factors which account for the acceptance of HDB housing units. First, the majority of the residents are owners of the flat units. Second, the good space-standards (averaging about 14 square metres per person) together with

increasing provisions of supporting facilities which satisfy the various needs of the residents. Third, in Singapore there is little adverse social and class-stigma attached to living in public housing. Surveys that have been carried out on public housing have shown a high level of satisfaction among residents. The complaints are generally directed to specific issues, such as lack of lifts, some vandalism in public areas, noise levels, etc. However, the implied acceptance of high-rise living by Singaporeans should be qualified, as no viable alternative of housing has been offered. In the longer term, rising incomes, changing life styles and higher expectations need to be taken into consideration.

Teh (1975) had also observed that:-

> *One of the complex problem of public housing is the loss of personal identity in relation to the physical environment and the community. It is, images and perception and its relationship to the individual's own value system of a particular cultural environment. In an industrial urban society, environmental identity is crucial to the well-being of the population. When public housing is provided in infilled development or in small numbers, the identity problem is not serious. The relationship of housing to the surrounding environment is generally well-defined, though these can still be the serious problem of environmental identity within the housing estate.*
>
> (Teh, 1975)

In the sixties, when the housing programme in Singapore was concentrating its efforts to providing minimum housing for the urban poor, the issues of identity and visual quality of the environment were sadly neglected.

In the seventies, the HDB gave more attention to planning the layout of housing estates and the design of housing blocks. This was particularly obvious in the late seventies, when experiments of considerable scale provided a variety of building forms and design solutions. However, only a few projects consciously and successfully contributed towards environmental identity.

The change to prefabrication and standardization in the eighties greatly curtailed individual design experiments. At the same time, HDB was more aware of the need to provide environmental identity as an important ingredient for community development. In

design terms, the scope and constraints of prefabrication had to be understood, digested and effectively utilized. The traditional image of prefabricated housing was deadly dull and boring. When similar housing blocks were repeated many hundred times, despite minor variations, they became stereotypes. The focus should have been to concentrate on visual image creation. Such an exercise would require an innovative design ability and an understanding of the problems and a personal commitment.

Figure 9. Bukit Merah housing estate (20th century) (from HDB Newletter, 1995)

In the high-rise environment, it is necessary that much more attention be given to the visual image and perception of the blocks at ground level. Spatially exciting plan layouts, deliberate changes of scale with low-rise buildings, the introduction of well-located point blocks, the effective use of tree planting, landscaping and playgrounds are

all important inter-related elements. Their careful design treatment can collectively generate more exciting spaces.

2.4.2: A new direction forward

Singapore's public housing programme has been one cornerstone of its transformation as remarked by Liu (1985) "..the residential environment of Singapore has come a long way in twenty-five years. When people in many other cities are still struggling for roofs over their heads and to keep floods out, or where water and electricity supplies, sewer and drainage systems are privileged accessories, in Singapore. these basic needs have long been met and good housing is taken for granted."

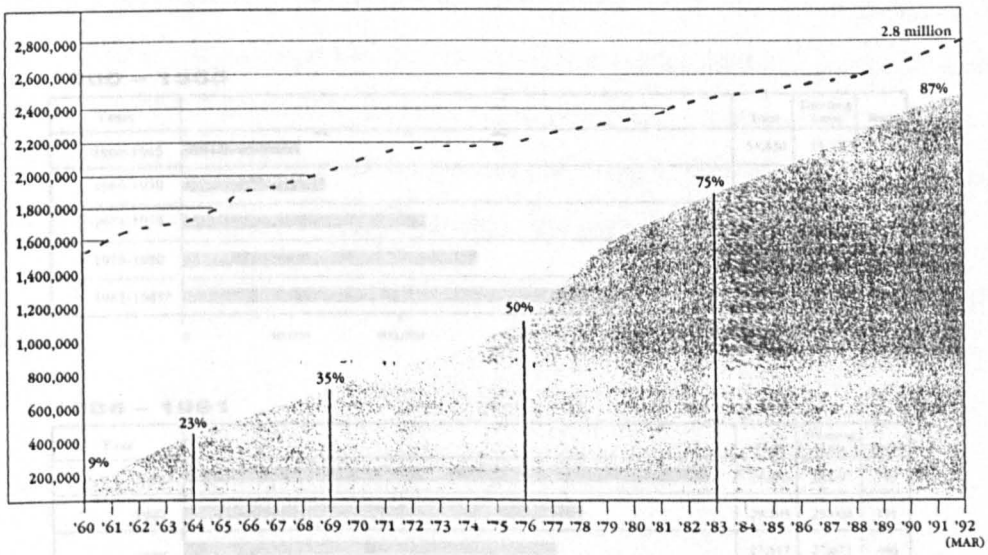


Figure 10. Population housed in HDB flats (from HDB annual report, 1991/92)

The predominant "image" of the island is its high-rise apartment blocks. It is argued that a small island like Singapore needs to have much greater contrast than presently envisaged. There could be a much greater variety of urban form throughout the island with a greater mixture of natural and man-made environments.

By the year 2030 about 30 per cent of Singaporeans are expected to live in medium and low-rise housing. The figure is depressingly low for an affluent country and

this is partly because there is a legacy of an enormous stock of HDB high-rise flats and we are continuously adding to it (Raman, 1992).

Probably no other developing country has solved its housing problems as effectively as Singapore. Nevertheless, it would be a glaring omission in any serious criticism if one did not point out the shortcomings of the HDB type of housing.

According to Raman, the HDB layouts follow the stereo-typical pattern of neighbourhoods of a standard pattern with the same catchment areas of 6,000 families each. Experience elsewhere suggests that where the improvement of transportation systems, self-contained neighbourhoods are not a viable concept and they need to be replaced with highly interacting, vibrant and mutually competing districts with a degree of specialisation in terms of the provisions each of them offer for culture, recreation and shopping.

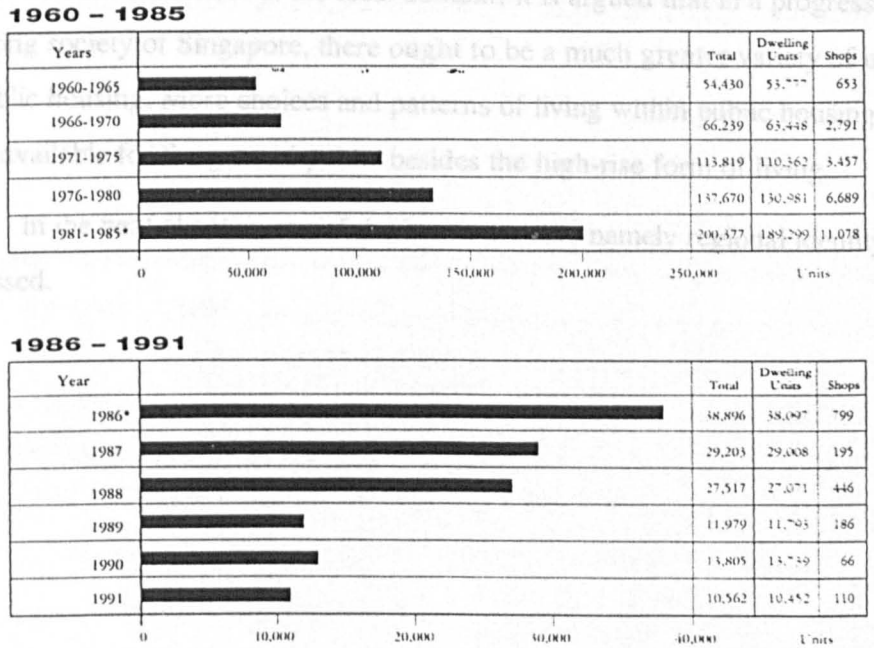


Figure 11. HDB building statistics (from HDB annual report 1991/92)

Considering the volume of the housing stock that has been built since

independence, alternative forms of housing with variations in density, layout, mixture of house types and so on has not been explored. A considerable body of public housing work has been done in many countries and innovative projects have been built in Britain, Holland and Scandinavia, all of which offer valuable lessons.

2.5: Conclusions

Throughout this chapter, the high-density high-rise model used as the frame of reference of this thesis has been positioned in the general history as a necessary strategy employed in solving the acute problems of housing in the growing population of Singapore. An important recognition is that despite the fact that the high-density high-rise model has been successful in the local context; it is argued that in a progressive and changing society of Singapore, there ought to be a much greater variety of urban form in its public housing. More choices and patterns of living within public housing should be made available for the general public besides the high-rise form of living.

In the next chapter, one of the issues at stake namely regional identity will be discussed.

Chapter 3:

Issues At Stake 1 - Regional Identity Approach

3.1: An introduction

This chapter discusses the importance of evolving an architecture which is regional. It suggests an architecture which is responsive to the local climate in this part of the tropics. Furthermore, it looks at how the climatic demands of Singapore's tropical heat have been responsible for the early development of assimilated architectural styles than any other factor in the process.

3.2: The Background

According to Yeang (1987), regionalism seeks to incorporate in the built environment the 'spirit' of the place. Its intentions are for a contextual built environment which responds to the local conditions rather than to international trends and which relates to the deeper sensibilities and tangible realities of the place. More specifically, the emergent regional urban environment of these intentions, seeks its architectural significance through relating its built configuration, aesthetics, organisation and planning, landscaping, materials and technologies to the particular place and time. Powell (1992) notes that Singapore is the most advanced city in Southeast Asia in terms of housing and infrastructure development. Yet, these considerations should form the underlying intentions in developing the urban identity for the Singapore's new town. The present pursuit "Toward a Tropical City of Excellence" should include the tropical aesthetics in its landscape and urban form and not simplistically adopt the styles from developed nations in temperate areas of the world.

Yeang proposes that there is a need for a committed pursuit for a tropical city that considers the issues of local and regional contextualism. The cities in the Asian region have inherent potentialities in becoming cities of identifiable character and charm. He feels that "whatever the differences in terms of their individual physiology, location, culture and period, we might hold that the basic premises and criteria for their urban design remain largely the same and are particularly relevant at this juncture of rapid development." He further recommends:

> *Due consideration should be given to an ongoing programme of investigative urban design to derive, develop and consolidate the principles of the idea of a tropical city. Without this committed and collective endeavour, our Asian cities would end up looking no different from cities in the developed countries.*
>
> (Yeang, 1987)

Rampant insensitive modern development with segregation of functions within the Asian city, inarticulate zoning patterns, and lack of provision for adequate transport and recreation facilities have all contributed to the destruction of the continuity of the cityscape with its traditional consideration of activities at street level. We might hope that the planning of new urban spaces and their reorganisation and reintegration contextually with the existing typologies and regional climate would eventually lead to an expression of a new streetscape-responsive and tropical urban architecture that would be both relevant in time and place to its specific culture, heritage and people.

The use of indigenous and locally produced materials and forms of construction are factors that can contribute towards the development of a regionalist built environment and local identity. However, imported technologies and materials need not be totally excluded from design considerations. The design challenge is how the imported technologies and materials can be effectively localised and adapted to meet the needs of the local community while retaining the identity of the place.

The projected urban growth in Asia suggests that urban development efforts will have to be redoubled as we move into the next millennium, if some of the solutions are to be found to cater for the growing population. The issue of high-density housing will need to be appraised. The opportunity for rapid urban development comes perhaps once in several decades and it is vital that when the opportunity is there, it should be optimised and not be wasted on built mediocrities (Yeang, 1987).

The commitment for a bold contextual experimentation at the city level, at the new town level, at the site-specific level; and the avoidance of mistakes learned from other cities and traditions, are needed to make our conception of the tropical city of excellence a reality. Our pursuit of a critical architectural vernacular that is particular and pertinent to a regional context should be aimed at the development of similar

useful prototypes and models that will provide the basis for subsequent development, interpretation, articulation (and future re-assessment) in our search for an identity that is recognisably tropical, memorable and meaningful.

At the new town level, the habitat as an urban tropical garden can be held as a relevant metaphor for Singapore because of the obvious abundance of natural landscape. The appeal of a Singapore new town as an urban park with its connective features like the streets, squares, focus, hills, rivers, vistas, boulevards, gateways, quarters, etc is compelling and engaging. The intermixing, integration and juxtapositioning of these natural landscape features with the built form should unite to form the tropical city. However, added to this greening of Singapore must be the need to make the place pedestrian orientated. The shophouse typology, because of its vernacular and urban character should be developed as the alternative high-density, low-rise model for housing. Likewise, the "five-footway" because of its origin and early role in the city's streetscape should be used as a unique connecting physical and visual feature for the city. Both the shophouse and its "five-footway", as a historically representative urban feature, is clearly apparent. Its adaptative use as a model for housing and an organising principle for urban design responds to the regional climate and gives validity to the local life-styles besides providing a distinctive Asian image to this region.

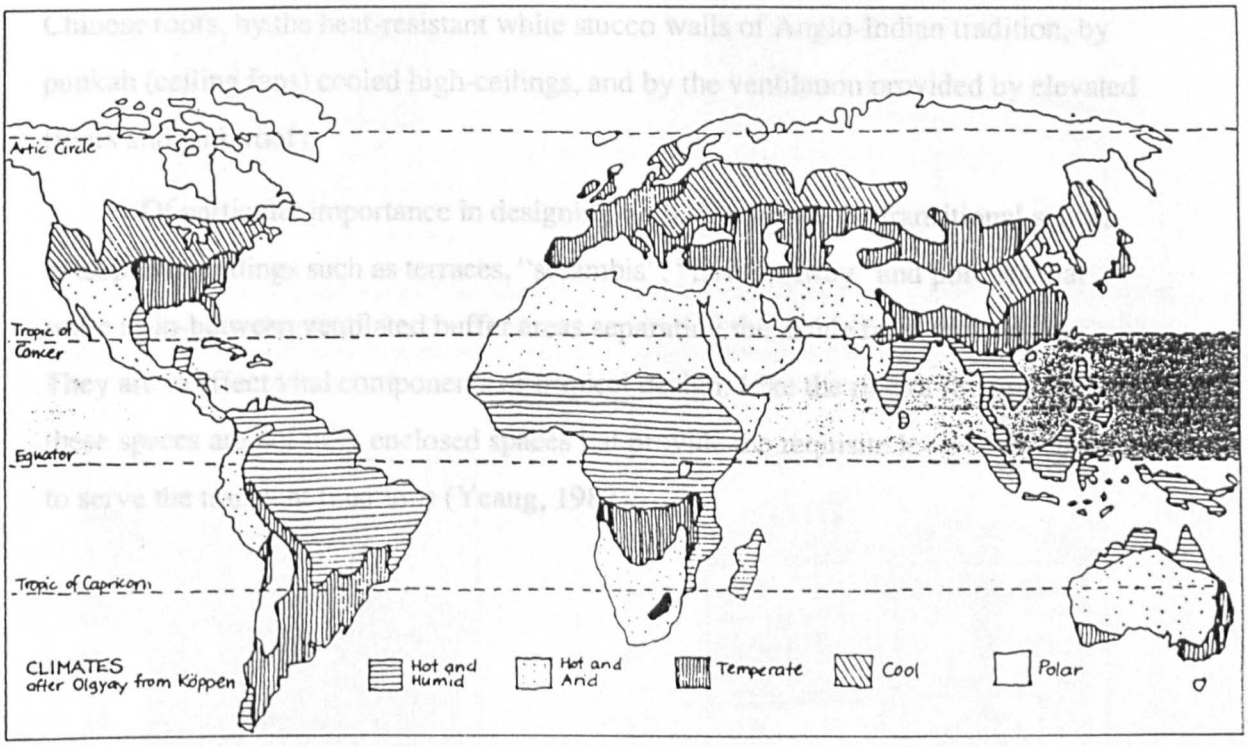
3.3: Architectural responses to climate.

Yeang, (1987) notes that climate when viewed in the overall perspective of human history and built settlement is probably the single least immutable factor in the landscape, besides perhaps bedrock. Our human societies evolve and change in a locality, but its climate remains more or less the same. Responding to climatic constraints and opportunities should be our first design strategy. Traditionally, it has always been one of the key determinants of building. In comparison, in colder climates, the outside environment would require that the hostile climate be totally excluded and the inside of the buildings be sealed and self-sustaining with an artificially-maintained internal environment. While modern mechanical and electrical

systems permit this, the built environment would inevitably require high energy consumption to maintain it, besides making it isolated from its surroundings. One of the reasons why people live and travel to the tropics is because of the climate. Rather than design structures that negate the existence of climate, we should acknowledge it as part of our design responses. In temperate climates, compact planning is often economical to reduce the external walls and to retain the heat inside. By contrast, in the tropical context, the reverse is true. There is a need for good cross ventilation and this requires the planning of buildings to be loosened and to be opened up to increase the external wall area for cross-ventilation.

The warm-humid climate of Singapore is characterised by its intense tropical sunshine, heavy seasonal rainfall and prevailing winds. These influence the country's soils, vegetation and fauna. In responding to climate by design in Singapore, buildings should use natural ventilation and be naturally cooled. Orientation of internal spaces and building configuration in relation to solar movement patterns and prevailing winds become important in relation to space planning. The climate, the site context, and the internal space-use influence the design of the outer envelope for the building.

3.4: Tropical Climatic Data



- Warm-humid climate: Tropical rain forest, wet monsoon.
- Temperature: Annual range of 4°C is smaller than diurnal range of 5.5°C. Both ranges are small.
- Relative Humidity: Average 55-100%. Vapour pressure steady 2.5 - 3.0 kPa (1kPa = 10mb 1000N/m².
- Rainfall: Up to 75mm/h. Mean 2000mm/year.
- Vegetation: Luxuriant. Must be controlled. Vegetation obstructs winds. Ground moist,
- Sky: Hazy, white cumulus (7000cd/m²), dull grey when covered (850cd/m²). Cloud cover of 60-90% prevents night cooling. Annual solar radiation (6GJ/m²). High ratio of indirect radiation to direct. High heat storage capacity of ground. Low ground reflection.
- Wind: Gusts up to 30m/s with rainstorms. Usually two dominant directions. Rainstorms on 120- 140 days per year. Tropical cyclones over the maritime areas.
- General: Constant warm humidity favours mould and fungus. High subsoil water table. Monotonous, fatiguing climate. High thermal stress. Mosquitoes and other insects. Wet monsoon zones have a short dry season and typical monsoon alternate winds; cyclones of 40-70m/s. Maritime zones have steady sea winds of 6-7m/s. Corrosion problems.

Figure 12. Tropical climatic data (from Yeang, 1987)

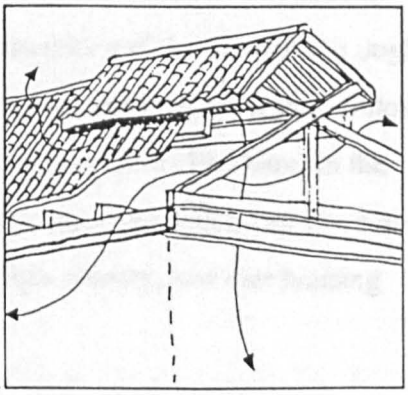
Yeang notes that it is likely that the climatic demands of Malaysia's tropical heat may have been more responsible for the early development of assimilated architectural styles than any other factor in this process. The same is true for Singapore. For instance, cool interiors are made possible by the courtyards in the shophouses, the large verandahs of Malay houses, by the extensive archways of Chinese roofs, by the heat-resistant white stucco walls of Anglo-Indian tradition, by punkah (ceiling fans) cooled high-ceilings, and by the ventilation provided by elevated floors and jack-roofs.

Of particular importance in designing with climate are the transitional spaces in tropical buildings such as terraces, "serambis", "five-footway" and porches that serve as in-between ventilated buffer areas separating the inside from the outside. They are in effect vital components of tropical design. Like the role of the umbrella, these spaces are not fully enclosed spaces but provide the requisite level of enclosure to serve the transient functions (Yeang, 1987).

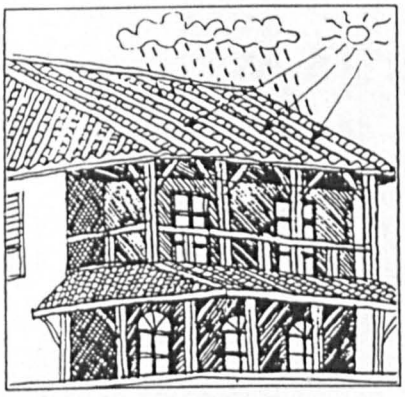
Figure13: Traditional Responses to Tropical Climatic Influences

The following provide general principles and devices for creative adaptation or interpretation in contemporary programmes.(Yeang, 1987)

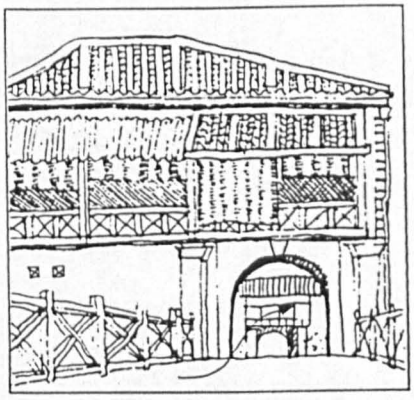
a. The raised stilts, serambi, and one-half inch slatted-floor gaps of the Malay kampong house provide for ventilation, shade, and protection from ground moisture, flood water, and animals.



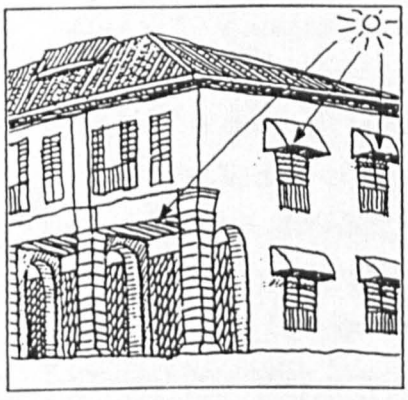
d. A typical jack-roof over a shophouse. This elevated gabled roof segment, shelters a clerestorey opening which separates it from the main roof, enhancing cross-ventilation effects to reduce heat.



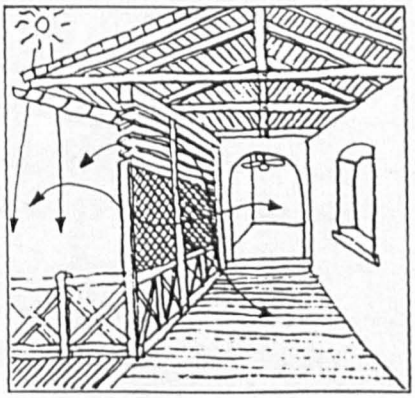
b. High pitch roofs, large overhanging eaves, wide shaded verandahs at the ground and upper floors of a colonial bungalow, give protection from the sun and rain.



e. A typical colonial house with chick-blinds over shaded verandahs, porch, air vents, etc., to facilitate cooling effects by encouraging cross-ventilation.



c. Traditional shophouses with jack-roofs, louvred doors, covered verandah-ways, canopies, etc., offer protection and shade from the heat and rain.



f. Deep roof overhangs, ventilation grilles at high levels, geometrically patterned grilles for sun-shading, fans, etc., all add to a tropical response to the warm-humid climate.

3.6: Conclusions

Clearly in the pursuit "Toward a Tropical City of Excellence", the issue of regional identity cannot be ignored. The tropical aesthetics and the urban form ought to be the focus in which sensitive and sympathetic future development should follow closely. They cannot be simplistically an adoption of styles from elsewhere. In the next chapter, the focus is on the traditional shophouse typology which can serve as an appropriate built form to be used in the alternative high-density, low-rise housing model.

Chapter 4:

Issues At Stake 2 - The Shophouse

4.1: An introduction

This chapter first looks at the origin of the Singapore shophouse and then consider the strategy of applying the shophouse form as an appropriate form for high-density, low-rise housing. The various aspects of the shophouse design will be outlined in particular the physical characteristics which make it responsive to the local climate and yet versatile in containing the various changes in its function. In addition, the study on the density of shophouse development will be instructive. The chapter continues to describe the possibility of a pedestrian friendly tropical city and the application of the five-footway as an urban design element and connector.

4.3: The origin of the Singapore Shophouse

The Singapore shophouse typology is found in the Chinese settlement of the Singapore townscape. According to Yeang (1987), "historically, the verandahway is found predominantly in the shophouse-type with its origin dating back to various sources found in Southern China, British India and Dutch Batavia in the 18th century". He commented that:

> *Their progressive assimilation followed the establishment of trading centres in Malacca, Singapore and Penang. The verandahway is also found in the traditional Malay house in the form of the serambi or shaded porch, usually on the northern side of the building.*

In tracing the origin of the Singapore shophouse, Lim (1990) commented that these shophouses with their "five-footways" were often seen as the outcome of Raffles' instruction to the Town Planning Committee which stated that "houses.....should have a uniform type of front each having a verandah of a certain depth, open to all sides as a continuous and open passage on each side of the street". However, according to him,

"this instruction from Raffles did not support a commonly held assumption that the shophouse typology originated from South China". In particular, the "five-footway" was not found in the shophouses of South China where the practice of erecting bamboo lattice or oyster shell awnings constituted a temporary solution for shade during the summer period" (Figure 14). He explained:

> *Etymologically, the term 'shophouse' appears to have a vernacular source; it is a literal translation of 'tiam chu', meaning shophouse in the Hokkien dialect. As this term pertains to the Hokkien who migrated from Malacca and Amoy to Singapore, it is assumed that the original source of the word 'shophouse' came from this dialect, in Mandarin the term is 'dian wu'; there also is an associated term, 'shang dian' , meaning a 'business shop'.....In England, Muthesius' (1982) closest reference to the idea of the 'shophouse' is 'terrace house....with shops or shop windows'.*
>
> (Lim, 1990)

It was evident that there were differences between the shophouse in Singapore and those in Xiamen, Amoy. The Singapore shophouses were aligned along a system of rigid rectilinear grids and feature open spaces and common backyards interweaving into large public spaces. However, Lim noted that in the city of Amoy, there was no such public spaces and that the shophouses were tightly packed in parallel rows along serpentine streets. Evidently, there was no verandah as the shopfront opened directly onto the street.

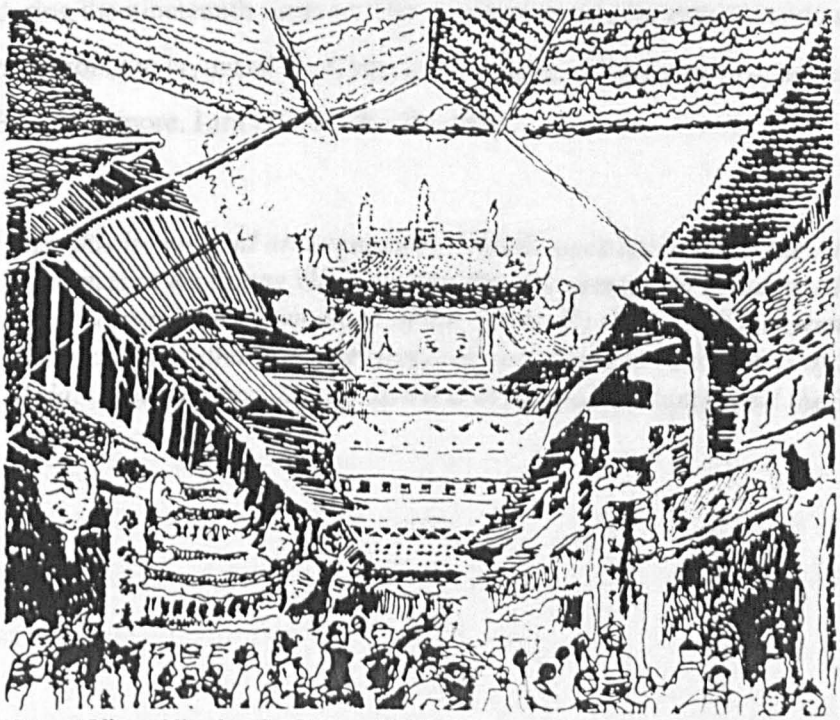


Figure 14.. 'Street View, Ningbo, S. China, 1844', from a painting by Edward Cree who states: 'The street roofed over with screen of transparent oyster shells formed a pleasant arcade'. (from Lim, 1990)

In Singapore, the shophouses as recorded by J. T. Thomson may be called 'Early permanent shophouses'. Kohl (1884) proposed that this term also embraced the shophouse form in Penang and Kuala Lumpur. However, Lim noted that Kohl's dating "to the nineteenth century is imprecise". For instance, Thomas Cree did not include five-footways in his picture of shophouses entitled 'A Street in Penang' (1845)'. Therefore, Lim suggested that it is was unlikely that the 'Early permanent shophouse' in mid-nineteenth century Penang had five-footways. Also, it was only in 1887 that the Municipal Act first defined the town limit, and required through its bye-laws that five-footways be included in the Straits Settlement. He further concluded that the 'Early permanent shophouse' and five-footways originated in Singapore (even predating the ones in Penang) and spread from there to South East Asia.

Further evidence was furnished by Chulasai (1985). He stated that the first shophouses in Bangkok were introduced by King Rama V after having seen the developments in Singapore and Batavia during his royal visit. Likewise, shophouses like those in Penang were seen in nearby Phukett which dated back to the early twentieth century. Whereas in Batavia, shophouses in isolated streets during the eighteenth century were realigned along linear grids, complete with five-footways. These linear grids would have been introduced in Batavia after similar developments in Singapore which took place during the nineteenth century. The development in Glodok, Batavia suggested influences from the layout of the Chinese 'kampong' which was first started in Telok Ayer Bay, Singapore. Lim (1990) also observed:

> *that this linear grid arrangement of shophouses spread into the Arab and Bugis precincts in Kampong Glam during the late nineteenth century, which can be clearly seen in the town maps of the 1890s. By the turn of the twentieth century, the shophouse and five-footways concept spread to other parts of South East Asia, including the Chinese districts in Rangoon, Manila and the Treaty Ports of China.*

Figure 15. The 'Shophouse Rafflesia' at Zhong Shan Road, Xiamen (Amoy), built c. 1910. This resembles to some extent Regent Street, London, with its tetrastyle facade at two levels above the sweeping Tuscan colonnade forming the 'five-footway'. Compare with Figure 193., showing the use of canopies and awnings facing the shophouses (1844) in Ningbo, S. China. (from Lim, 1990)

Thus, the shophouse form which originated from South China and took root in Batavia, was transformed in Singapore by the addition of five-footways. Yet, Lim noted that it was not a 'Chinaman' who introduced this hybridisation but Raffles, who had studied the Chinese and Dutch buildings of Batavia. He added that the Singapore shophouse, therefore, might be termed 'Shophouse Rafflesia' as its innovation by Raffles was also adopted by other South East Asian cities. This was not only an appropriation of form but also a re-appropriation when the diffusion of the 'Shophouse Rafflesia' reached the Treaty Ports of South China (Figure 15).

4.3: *The Shophouse as an appropriate urban form for high-density, low-rise housing.*

4.3.1: The Background

In the rural Guangzhou province of China, the town and villages have common brick party-walls. These houses are often terraced and arranged in two or more parallel rows along roadways and separated by narrow lanes. The shopfronts are lined with a diversity of vertically hung or stone based resting pendant signboards of variously painted inscriptions. Wooden counters and finely carved shelves for display of various manufactured craftwork occupy the front with the rear and upper floors serving as sleeping quarters, dining-rooms and kitchens.

In Malaysia, the rowhouses of Malacca are the oldest example of prototype housing in Malaysia with their long and narrow site plan, ancestral hall, sitting room, internal air wells and courtyards. The covered "five-footway" linkage at the front of these attached houses unifies them as a continuous entity with parallel similarities to the shophouses. The early wooden and atap shops in Penang were susceptible to fires and legislation to eliminate fire hazard was suggested as early as 1808 (Yeang, 1987). They were perhaps typological variations of earlier temporary structures of wood and atap.

The introduction of building regulations in 1822 by Sir Stamford Raffles in Singapore had the effect of regulating building control which resulted in colonnaded streets. These permanent shophouses were approximately of the same period as those found in Penang in 1826, when a major fire severely damaged Georgetown. The 1880s saw a period of great building activity in Ipoh and Kuala Lumpur, where Sir Frank Swettenham, the British Resident of Selangor, introduced building by-laws in 1884 which allowed for a "five-footway" covered passage by the road and the use of brick or wattle with tiled roofs to avert fire hazards in the street-by-street reconstruction of the central business district.

Throughout the evolution of these earlier examples of shophouses from Chinese to European decorative and ornamental motifs, the plan remained basically the same. The

transition saw a period of enriching eclectic interplay of Palladian-inspired motifs and a mixture of old Dutch, pattern-book Regency and Venetian arcades. Window arrangements with stylistic motifs, hierarchical divisions for lower and upper floor levels, a consistent floor and cornice height, all contributed visually to establishing the shophouses as a uniform urban identical entity.

By 1925, the advent of new construction techniques by using structural reinforced concrete permitted the development of shophouses into multi-storeyed office blocks. The introduction of modern architecture in the 60s and 70s with its utilitarian concepts eventually eclipsed the traditional shophouses with their "five-footways". Their emphasis on mechanical environmental control, servicing, commercial high-rise aesthetics, eventually eliminated the pedestrian and street relationship. Since the 1980s, with the introduction of the half mezzanine floor, the walkways became double-storey enclosures with the cantilever floor above. The use of reinforced concrete construction for the cantilever meant that the pillars which lined the walkway, defined the street rhythm and its enclosure, was structurally no longer needed. In the late 1990s, after having enjoyed the tremendous success of the urban renewal projects in the Central Area, the issue then was concerned with the preservation of Singapore's heritage in which the earlier shophouses formed a major part. Desperate steps were taken in conservation projects and thus retaining the old urban core which consisted of the present Chinatown, Little India, Kampong Glam, and the Singapore river among the most important districts.

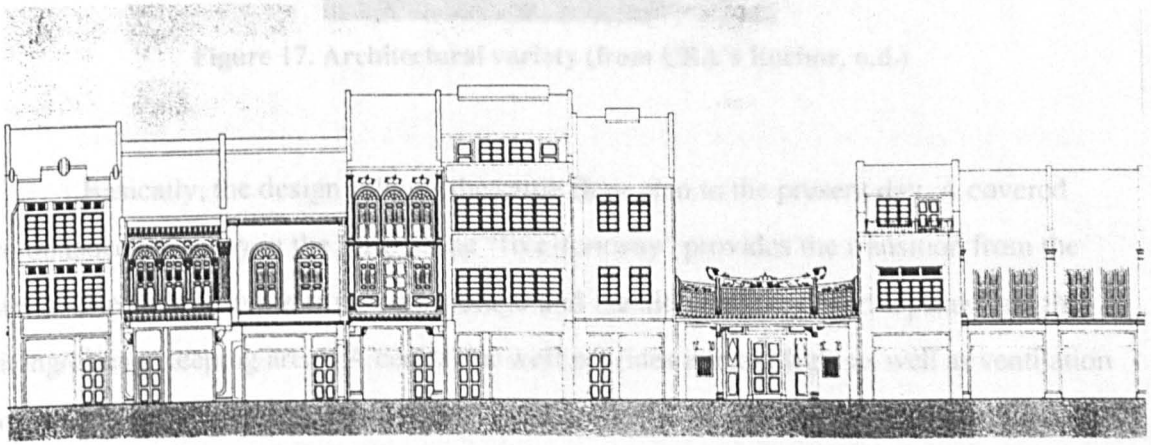


Figure 16. Typical street evelation in Central Area (from URA's China Square, n.d.)

4.3.2: The Shophouse Design

Shophouse blocks follow the floor plan and elevation style typical of shophouses of the early nineteenth century which are in existence in Singapore today. As a time-proven useful architectural form, the shophouse was a popular building type in the early days. It is generally a commercial and private structure, usually of two or more storeys, in which the tenants conduct commercial activities and also have their residence. Traditionally it is a long deep building with a narrow street frontage, and common party walls with similar adjacent structure. The structure is flexible enough to contain a variety of businesses, including sundry shops, light industry and godowns (warehouses). It is a form that evolved to allow merchants to live and work in the same building.

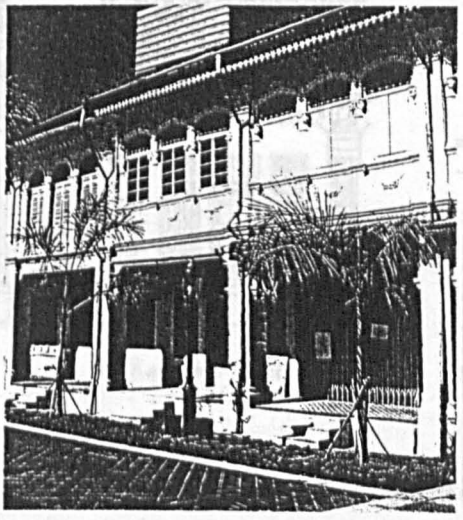


Figure 17. Architectural variety (from URA's Rochor, n.d.)

Basically, the design follows the same floor plan to the present day. A covered colonnaded walkway in the form of the "five-footway" provides the transition from the street. The shop is in the front with storage and the kitchen at the rear. Upstairs are the living/dining/sleeping areas. A central air well provides internal light as well as ventilation and facilitates the collection and disposal of rain water. These long narrow buildings are repeated in rows to create streets and squares in an identifiable pattern related to the human scale. From the beginning, the facade of the shophouse evolved according to

elevational styles in Europe but the basic plan itself did not alter significantly. The five-foot covered passageway became an important component of the local urban cultural life-style, constituting a unique architectural element.

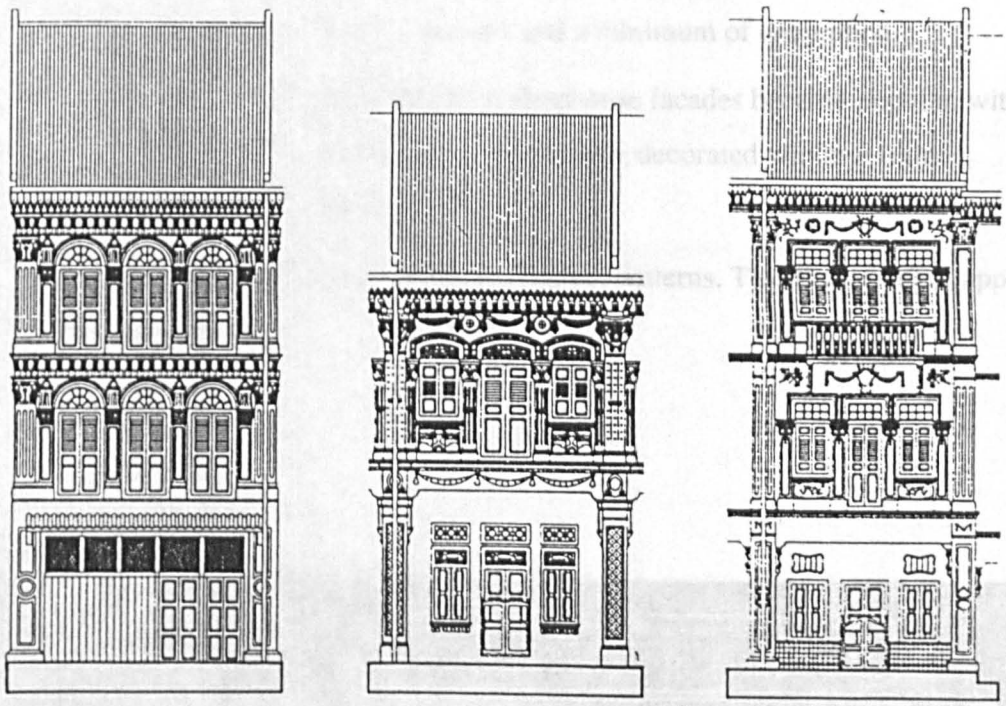


Figure 18. The Late shophouse style (from URA, n.d)

Looking at the front facade in figure 18, the three windows on the facade reduce the wall space to a minimum and provide maximum ventilation. The construction techniques of the early shophouses were based on locally available materials combined with Chinese architectural influences. Building regulations in the 1880's dictated that all buildings should be erected of durable materials such as brick and tiles, with a five-foot covered passageway in front. This policy was soon adopted in most urban communities in Malaya (West Malaysia and Singapore before the separation).

The above regulations, combined with design principles imported from the west, initiated the advent of the typical two storey shophouses, with the ground floor for trading and the first floor for residential use. This building type is still a standard feature in the Central Area in Singapore. According to Yeang (1992), the shophouses type may be classified under three principal varieties:-

- 'Utilitarian' with simple wooden shutters and a minimum of decoration,
- 'Neo-Classical' where embellishment of shophouse facades became popular, with elaborate Greek and Roman columns and ornately decorated window frames, pediments, parapets and cornices, and
- 'Art Deco' with simplified lines and geometrical patterns. This latter variety appeared in the 1930's and 1940's.

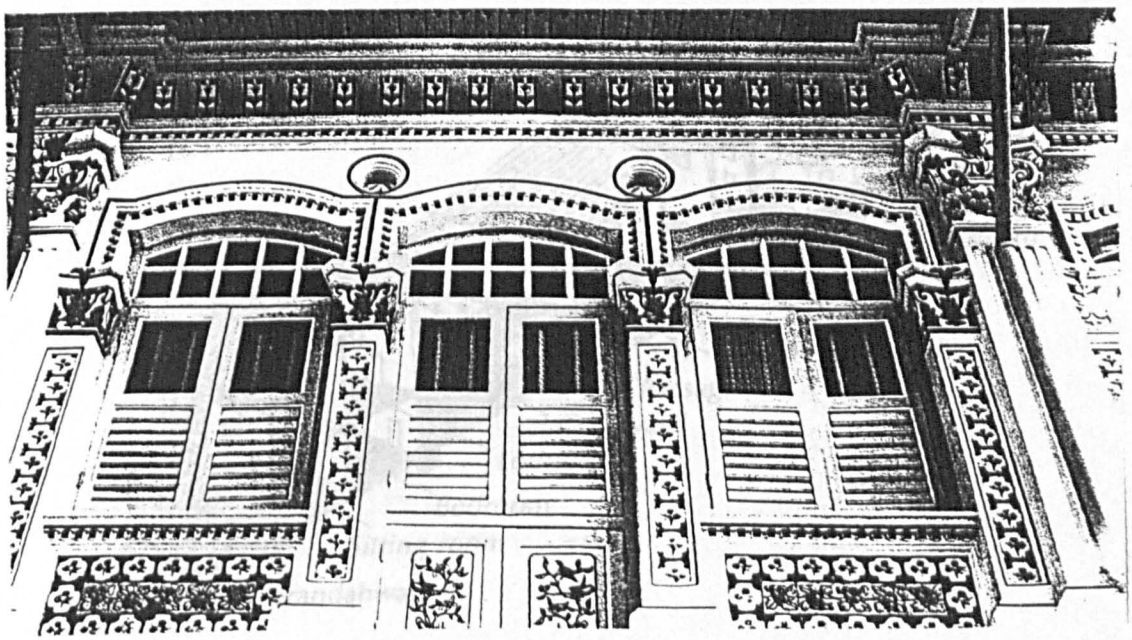


Figure 19. Rich Peranakan Architectural Heritage (from URA's Geylang, 1994)

4.3.3: The physical characteristics of the shophouse

1. The typical shophouses in Malacca were built by the Straits Chinese families for use as warehouses and residences:

- reception, living and dining facilities at ground floor level,
- covered five-footway at ground floor level facade,
- air-well openings at ceiling level to ventilate and light up interior spaces, especially first floor bedrooms, and
- louvred shutters, windows, and lattice work at upper level of most room partitions.

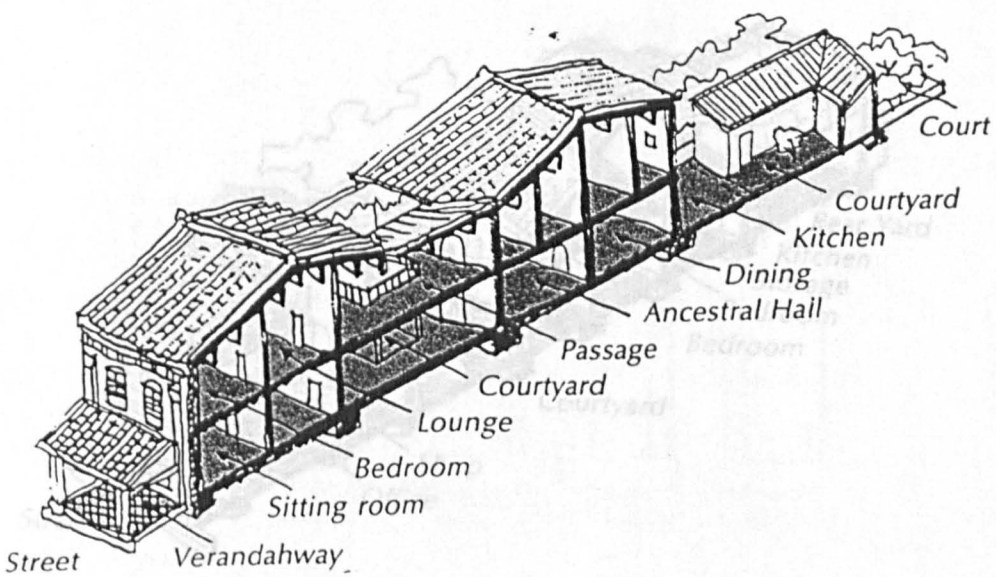


Figure 20. Longitudinal section through a traditional shophouse in Malacca. (from Yeang, 1987).

2. The typical urban shophouses are found mostly in the old city centre of Singapore, and regionally in Penang, Malacca, and Kuala Lumpur.

They are characterised by the following features:

- covered "five-footway" at ground floor level facade,
- ornamentation of the facade by the use of Chinese and European motifs,
- profusion of use of tiles, stucco, and timber as materials for construction,
- shoplot at ground level with storage, backyard, and central air-well for ventilation,
- bedrooms, living, dining, and kitchen at first floor level, capped by a jack roof.

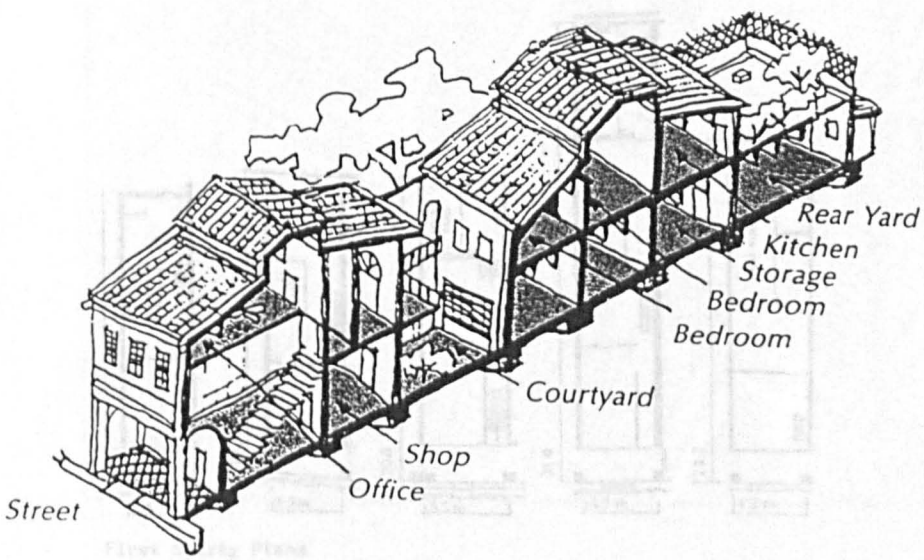


Figure 21. Longitudinal section through a typical shophouse in Singapore. (adapted from Yeang, 1987).

4.2.4: *The Density of Shophouse Development in the Central Area*

According to the Outline Proposals of Master Plan 1955, in the Central Area in the early 1950s, the net residential densities of over 1,000 persons per acre (2500 pph) have been found in certain blocks, where people were living on less than 25 square feet of floor (2.25 square metre). An average gross residential density of 400 persons per acre (1000 pph) persisted over the whole of the Central Planning Area. In the Urban Planning Area, the existing average gross residential density approximates to 60 persons per acre (150 pph). In the Rural Planning Area, residential density in some urban development is appreciable but very low elsewhere.

Shophouses are known to be built on sites with narrow frontages. In the first Singapore Master Plan (1955), shophouse was described as "narrow frontage of 20 feet (6 m) or less built in terrace without side ventilation to a depth of 60 or 70 feet (18 to 21m)".

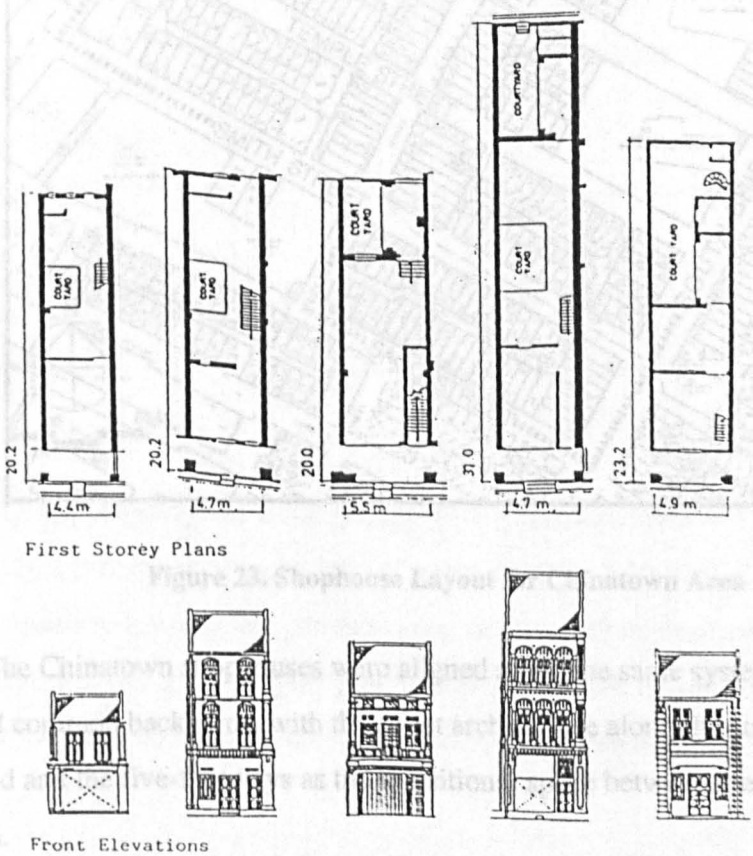


Figure 22. Examples of plan form and elevation of traditional shophouse

The width (varying from 4.5 to 6.0 metre) of the shophouses was believed to be determined by the construction using the span of the timber joist. Therefore, the plan is always very compact due to its elongated form.

4.2.4: DENSITY 1: Chinatown

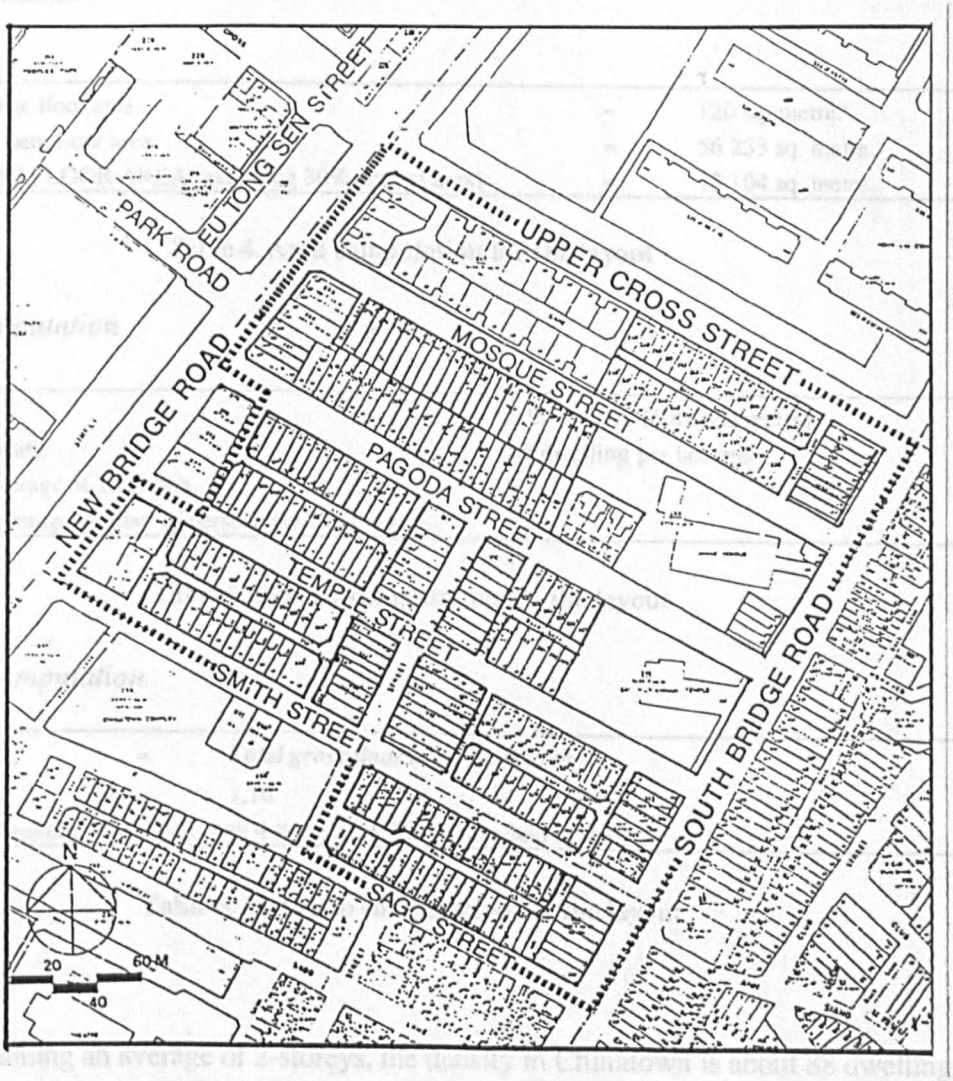


Figure 23. Shophouse Layout for Chinatown Area

The Chinatown shophouses were aligned along the same system of rectilinear grids and common backyards, with the street architecture along the street very well controlled and the five-footways as the transitional space between the streets and buildings.

The statistics for Chinatown

Basic information:

Total number of residential blocks: 27

Total number of dwelling units: 610 (assuming an average of 2 storeys)

Site Area: 6.90 hectare

Area computation

1a.	Average floor area	=	120 sq. metre.
	Total nett. floor area	=	56 233 sq. metre.
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	73 104 sq. metre.

Table 4. Area computation for the layout

Density computation

Site area	=	6.90 hectare (69000sq.metre)
Residential density	=	88 dwelling per hectare
Based on an average of 1000 pph,		
The average number of persons per dwelling	=	11

Table 5. Density computation for the layout

Plot ratio computation

Plot ratio	=	*Total gross floor area ÷ site area*
Therefore, P.R	=	1.10
If the average building height had been 4 storeys, the Plot ratio could be 2.10		

Table 6. Plot ratio computation for the layout

Assuming an average of 2-storeys, the density in Chinatown is about 88 dwellings per hectare. This is in terms of a plot ratio of approximately 1.10. If the average building height is increased to 4 storey, the corresponding density will be doubled to 176 dwelling per hectare and this will yield a higher plot ratio of 2.20 which is comparable to that of the high-rise housing plot ratio. In comparison to the high-rise housing of equivalent plot

ratio at 2.20, the slab blocks would have been at a height 3 times the shophouse i.e at 12 storeys. This is consistent to Martin and Martin's theory which will be elaborated in later chapters.

4.2.4.2: DENSITY 2: Boat Quay, Singapore River

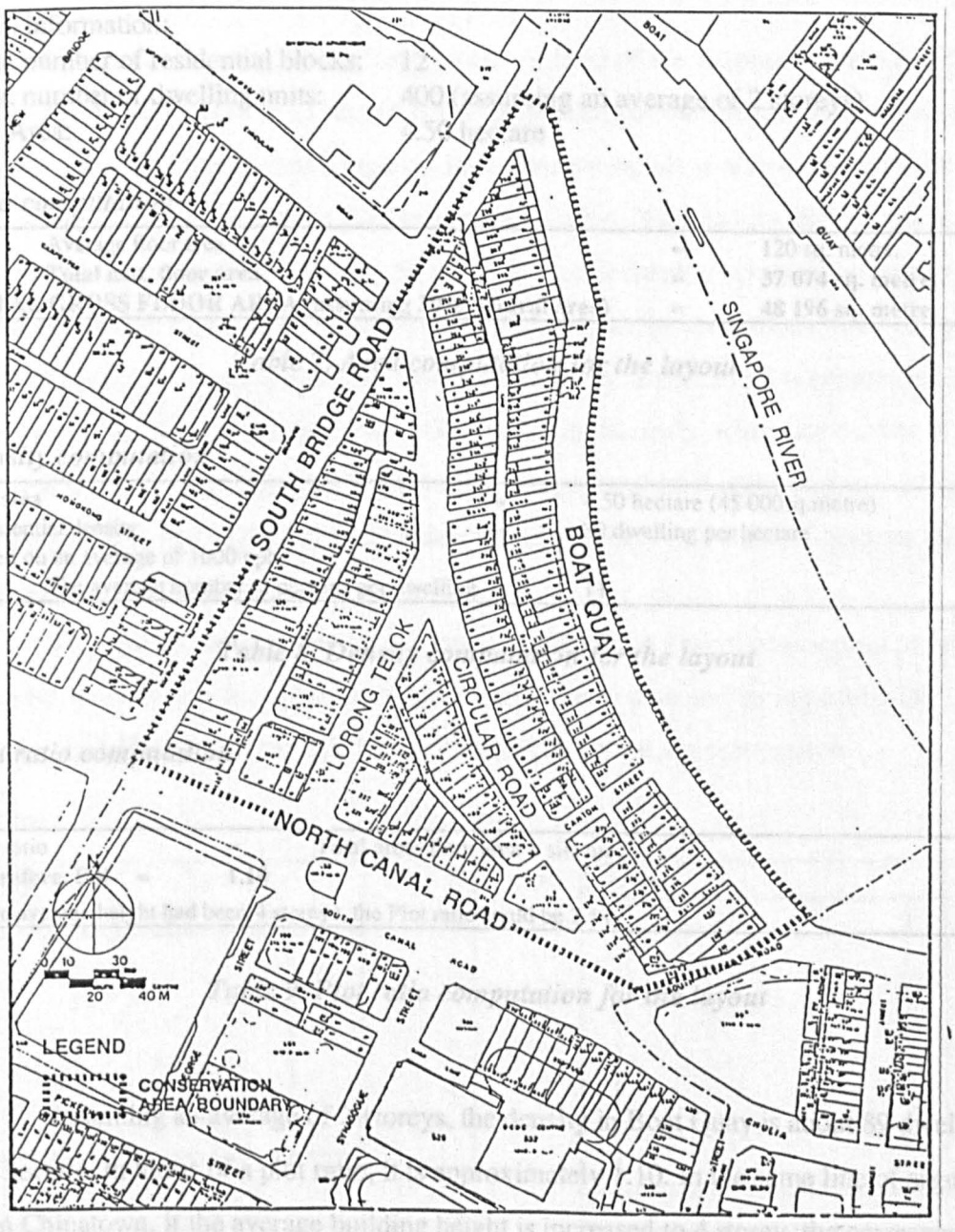


Figure 24. Shophouse Plan for Boat Quay, Singapore River

Similar to Chinatown, these long narrow buildings in Boat Quay are repeated in rows to create streets and squares in an identifiable pattern related to the human scale.

The statistics for Boat Quay, Singapore River

Basic information:
Total number of residential blocks: 12
Total number of dwelling units: 400 (assuming an average of 2 storeys)
Site Area: 4.50 hectare

Area computation

1a.	Average floor area	=	120 sq. metre.
	Total nett. floor area	=	**37 074 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**48 196 sq. metre.**

Table 7. Area computation for the layout

Density computation

Site area	=	4.50 hectare (45 000sq.metre)
Residential density	=	89 dwelling per hectare
Based on an average of 1000 pph,		
The average number of persons per dwelling	=	11

Table 8. Density computation for the layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R = 1.10		
If the average height had been 4 storeys, the Plot ratio could be 2.14		

Table 9. Plot ratio computation for the layout

Assuming an average of 2-storeys, the density in Boat Quay is about 89 dwellings per hectare. In terms of a plot ratio, it is approximately 1.10. In the same line of argument as in Chinatown, if the average building height is increased to 4 storey, the corresponding density will be doubled to 178 dwelling per hectare and this will yield a higher plot ratio

of 2.14 which is comparable to some of the existing high-rise housing development.

4.2.5: *Density Consideration - Its relationship with the residential plan*

The narrow frontage of 20 feet (6 metre or less) of the shophouse terrace with a depth of 60 to 70 feet (18 to 21 metre) is similar to many of the low-rise high-density housing schemes in the United Kingdom. Its 3-window facade is also a characteristic of "row house" development in the 19th century in London, Bloomsbury, Edinburgh New Town and in Armsterdam. Generally there is a close relationship between this narrow frontage structure to the density yield of the development. In comparison, the average width of the public housing high-rise flats is about 10 to 12 metre and is approximately twice that of the shophouse. And interestingly and significantly, where the density is kept constant, the difference between the narrow frontage shophouse compared to the high-rise slab block is that in the former, the development is only at 4 storeys, whereas the latter will be at 12 storeys.

By using an idealised model, we can construct a theoretical comparison between using the narrow and deep plan or the wide and shallow plan and its impact on the density yield. The size of the unit is kept constant as a basis for comparison.

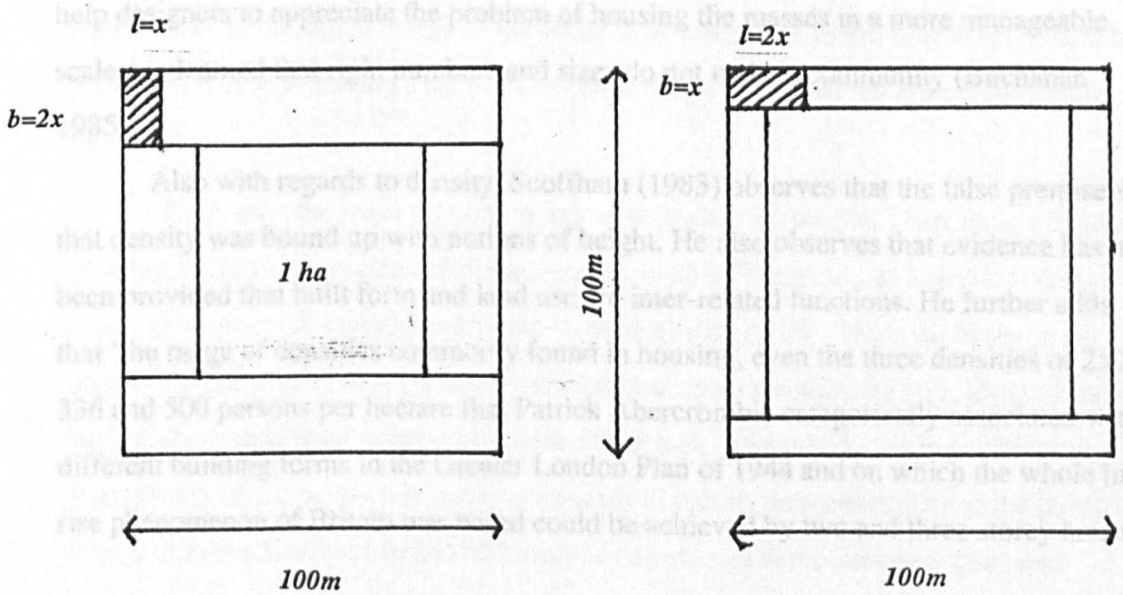


Figure 25. Comparison between the narrow and deep plan and the wide and shallow plan

In (a) if the dimension of a unit are such that the length is x and the breadth is 2x , then the area of the unit is $2x^2$. The number of units is (100/x)2 + ((100-4x)/x)2, which is (400-8x)/x. The density yield (D1) will be (400-8x)/x.

In (b) assuming the area of the unit being constant except that the length is 2x and the breadth is x, then the number of units on site is (100/2x)2 + ((100-2x)/2x)2, which is (200-2x)/x. The density yield (D2) in this case will be lower at (200-2x)/x.

Since x is always positive and less than 100 metre, D1 can be proven to be always be greater than D2. If the value of x becomes smaller, D1 will be increasingly greater than D2.

As can be seen from the above model, the narrower the width of the residential unit, the higher the density when compared to a unit of the same area but with a wider frontage. In other words, to achieve similar density, the wider the frontage, the higher in height it needs to go. On the contrary, the narrower the plan width, the lower will be the development.

As mentioned in Appendix 3 on 'Density Limitations and Its Opportunities', the aim of creating new communities and in fostering neighbourliness must not be seen as a statistical problem that is involving the determining of ideal population and area of a neighbourhood around its shopping centre and secondary school, its sub-neighbourhoods around primary schools and then precincts around play-lots; and each circumscribed by its appropriate circle denoting however minutes of walk. Though the 'game of numbers' help designers to appreciate the problem of housing the masses in a more manageable scale, we learned that right numbers and sizes do not make a community (Buchanan 1985).

Also with regards to density, Scoffham (1983) observes that the false premise was that density was bound up with notions of height. He also observes that evidence has now been provided that built form and land use are inter-related functions. He further adds that 'the range of densities commonly found in housing, even the three densities of 250, 336 and 500 persons per hectare that Patrick Abercrombie categorically associated with different building forms in the Greater London Plan of 1944 and on which the whole high rise phenomenon of Britain was based could be achieved by two and three storey housing

with gardens.....The same evidence demonstrated that the commonly assumed data regulating size of housing areas suffered from the same false precision as did the conceptions of density. Assumptions involving walking distances, size of neighbourhood and length of cul-de-sac adversely affected built form solutions through their too rigid adherence. A small change in the distances inferred by these assumptions induced a significantly larger change in area and hence in density.'

4.4: Towards a pedestrian friendly tropical habitat

At the urban design level, it is essential to provide in the urban new town, a network of pedestrian walkways (covered, semi-covered and uncovered), of landscaped areas, of open spaces, side-walks, hawker's spaces, public transportation points and parking. In planning, as in spatial economics, the environment is considered to be a set of activity locations and their linkages. Each activity has preferences for its site and/or its connection to other activities. The urban design for the new town should seek an optimum pattern of locations and linkages considering the relative importance of each activity. This planned pattern must include a movement network that becomes the framework for the urban image of the urban new town. The urban new town here is being viewed as a city, as having a network of interacting systems which affects the quality of living.

Evidently, the main element in any new town is its people. Their daily efforts in meeting the basic necessities of life are clearly visible. Therefore, any physical design effort to enhance this would contribute to their quality of life. The man in the street enjoys the comfort of moving though transitional spaces within the city. Most of the time he is discouraged from doing so because of the lack of provision for the pedestrian. The friendliness of a new town or a city is equated in part to its accessibility to the public. There should not only be open walkways but a series of semi-enclosed areas and

promenades.

The provision of a new town-wide "five-footway" system will reduce the pressure on public transport by encouraging pedestrian movement, with the further advantages of the reduction on energy consumption in transportation. Particularly between buildings and with public open and transitional spaces, a connectivity of pedestrian routes that respond to the micro-climate enhances their accessibility. Current modern development has resulted in a change of character of the urban environment in the new town away from the tightly-knit, efficiently functioning, human-scaled streets characterised by the older shophouses, towards loose, massively scaled, inefficient roads as far as pedestrian and public transport circulation, and so on, are concerned.

Most of the new neighbourhood centres which are local shopping and recreational areas are each sited in the centre of its own piece of ground, with large setbacks from the street usually separated by a new service road, and parking is approached through generous drives that break the continuity of pedestrian circulation along the streets. Alternatives to this form of development would mean buildings closer to the site boundaries bounded with "five-footways", sometimes with covered shopping malls at street level and with parking provided above and below ground; or buildings with covered internal courtyards to funnel wind and improve air circulation, which exploit planting as an integral part of each building's design. Opening up building volumes will improve their climatic performance.

The shophouse has many advantages, for example, maximum ground occupancy, arcaded sidewalks, low-rise, close proximity of car access to pedestrian circulation and a form which permits both formal and informal shopping. In itself, it has a strong imagery and streetscape and its retention should be part of an overall framework. The shophouse can be upgraded while maintaining its "five-footway" to accept a higher density and to accommodate increased off-street parking. Further parking can also be supplied on the periphery of the site, filtering shoppers into the area and limiting traffic on the street itself. A system of "five-footway" - some in glassed-interior alleys, some cutting across blocks - can create diverse and dense shopping and living opportunities for the people in

this area. By maintaining these walkways and developing them as a network, the new town's accessibility to the pedestrian will be more friendly.

4.4: The five-footway strategy

Modern high-rise developments during the last few decades in Singapore have broken the connectivity of pedestrian movement from its intimate scale and street-level relationship. The provision of frontal service roads and peripheral building setbacks around most buildings has often ignored pedestrian-user requirements. Pedestrian linkages are lost. Yeang (1987) when commenting on similar developments in Kuala Lumpur remarked that "the destruction and elimination of the verandahway was shortsighted and it was crucial to retain and to reintroduce it as an autonomous urban design device for preserving the streetscape". He stated:

> *As an organising principle, it has the flexibility of integration with the varying urban forms that arise from the individual architect's independent requirements peculiar to each development undertaking. Its potential as a multi-functional urban feature that can interact at various levels to form innovative possibilities with variant building configurations enhances the possibility for its implementation as a model for the city on a wider scale.*

In his book entitled, "The Tropical Verandah City", he proposed an urban design mechanism that could be utilised in city planning and design. In a similar line of argument, the five-foot way concept from the traditional shophouse can be held as being appropriate for Singapore new town for the following reasons:-

- It is an inherent part of the Singapore streetscape found in the old city core of shophouses. It defines an in-between public realm which serves as a transitional space that has multi-functional uses: namely a public pedestrian way, a transient space for hawkers, cobblers and fortune-tellers etc. However, this is rapidly disappearing in the process of urban renewal. The issue here is that the "five-footway" character should

be rediscovered and reintroduced as a valid contemporary urban design element for the new town of Singapore.

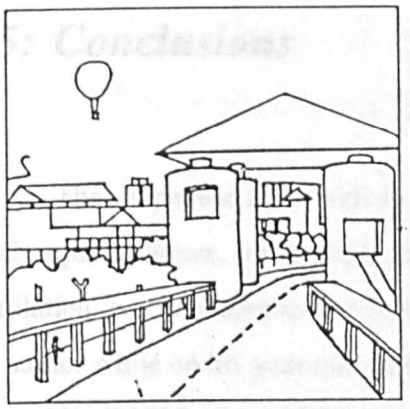
- It is visually legible and therefore "imageable" (Lynch, 1960) and can give a clear, unifying and cohesive image to the new town of Singapore.
- It is one part of the architectural element which responds to the tropical climate of Singapore by providing a semi-covered walkway for pedestrians away from the sun and rain.
- It is an important part of that architectural heritage which comes from the traditional shophouse typology which is unique to Singapore and to this region including Malaysia.
- It is a significant clue contributing to the creation of a local and regional identity in the expression of architecture.

The proposal here is that a strategy of connections and linkages can be formulated using the concept of the "five-footway" and a network of such elements can be integrated in the layout of housing in the new town. By doing so, not only do we seek to preserve an important part of the architectural heritage but also reintroduce and reinforce the element of streetscape in the new town. The approach proposed here is to have a urban design action plan which includes among others the network of "five-foot-way" so that the overall imageability of the new town can be greatly enhanced and the possibility of linking the entire new town with a semi-covered walkway is therefore a reality.

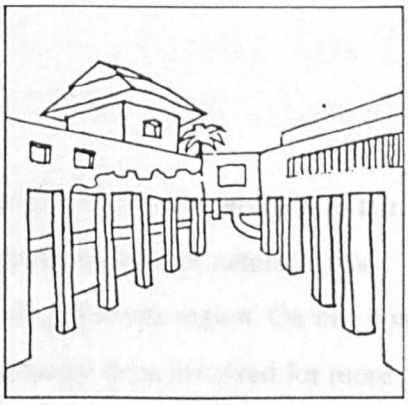
In addition, the coherent uniformity of appearance in the older central business districts of most Singapore can be attributed to the "five-footways" being a transitional urban space and their connectivity. They constitute a distinctive urban feature in the narrow street pillars and upper-floor windows.

Figure 26. The "Five-footway" as an Urban Connector

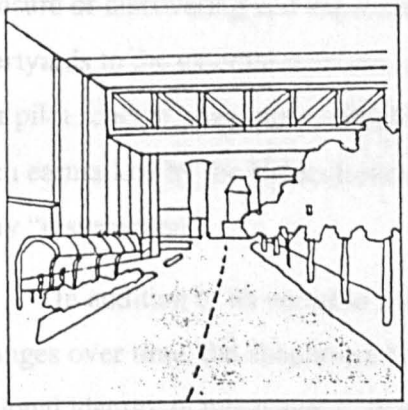
The "five-footway" can serve as urban connectors. The following are some examples of the various urban design devices which can be used to enhance the cityscape (paraphrased from Yeang, 1987)



a. The ceremony of going through a gateway can be used to enhance the entry and exit points of a new town, helping to define its limits

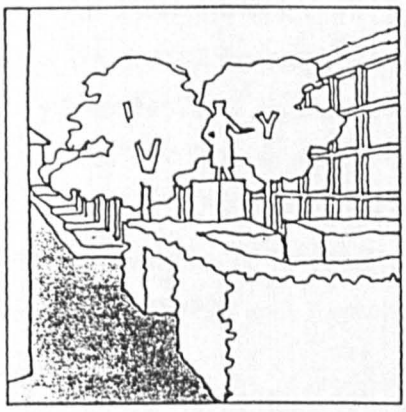


d. The location of towers as reference points and for viewing can help to give a secure sense of direction to the pedestrians.

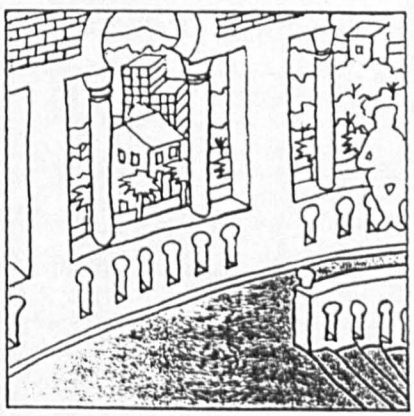


b. The connecting overhead bridge can act as an indicative celebrating feature to frame important views and demarcate boundaries, apart from its utilitarian use as an urban connector.

e. The location of sheltered pavilions at vantage points would give a better perspective of the city from the top.



c. The past can be recollected by the location of statues and memorials at vantage points of historical importance within the city.



f. The provision of viewing areas in taller buildings would give its users a sense of the urban fabric from the top amidst the routine of daily work.

4.5: Conclusions

The shophouse form with its many characteristics which are responsive to the local tropical climate, for example, its internal courtyards which helps natural cross-ventilation, is a very appropriate form of building typology for this region. On this note, the author while on his year-out training had the opportunity to be involved for more than a year (April 1987 - June 1988) in the restoration of shophouses in Tanjong Pagar (in the Central Business District) which was the first pilot project of its kind in Singapore. The pleasure of discovering and experiencing the various hierarchy of spaces from the internal courtyards to the external ones was sheer delight. And as a result of the great success of that pilot scheme, many more shophouses in various districts within the Central Area had been earmarked by the Urban Redevelopment Authority (URA) for restoration or should I say "resurrection".

In addition to its versatile nature in adapting to the various functions which changes over time, the shophouse form can be seen as the answer to the question of regional identity in this context. Therefore, in the proposal for an alternative high-density, low-rise housing, this shophouse form would be used as an appropriate form for both living and working retaining the flavour of the traditional arrangements.

Chapter 5:

The Theoretical Framework - A Study On The Theory According To Martin and March

5.1: The Grid as a Generator

5.1.1: An introduction

In relation to the studies that have been undertaken so far, this section presents preliminary findings on certain attitudes towards architecture and planning. The objective of this study is to understand the relationships that exist in the physical structure of the city. Once this has been done it may be possible to explore a wider range of choices, and therefore may lead to a greater opportunity for a variety of patterns of living to develop. It addresses the concern by discovering "those neutral guidelines that set out the least restrictive framework and allow the maximum elaboration by use."(Martin & March, 1972). In an earlier article, they commented:

> *The limitations of certain predetermined building forms like the slab or the tower were recognised and an attempt was made to investigate the potentialities of other geometries, for instance various types of spreading forms within which individual faculties could more easily intercommunicate and changes of size could be more readily accommodated*
>
> (Martin and March 1964)

It appeared from these studies, carried out by Martin and March in Cambridge, that the form of a building had a considerable effect on the efficiency of land use. One form of building with precisely the same light angles, with the same number of floors and on exactly the same area of land, could provide 50% more floor space than another.

Further and more detailed studies of land use in central urban areas again raised a question: how was it that one form of building with a floor area to ground space ratio of 3:1 could be accommodated in 8-storey buildings, whereas elsewhere, in some situations, the same plot ratio apparently required tall towers? In addition, Martin and March said that:

> *The existing chequerboard of buildings and streets is one pattern. But if the geometry of the pattern is changed then precisely the same amount of floor space*

can be accommodated in the same general height of building but with a considerable increase in open space.

(Martin & March, 1972)

It seems that in most towns which appear to be overcrowded, all the land that is needed is there if the right principles are used to find it. Brooke (1994) says that despite the vagaries of fashion (the subjectivity of taste) there are qualities and principles of architecture and urban design that must endure, however fast-changing the modern world may be. The task facing architects today is to discover what those principles are in architecture and urban design that endure, and then consider how those principles can in turn influence the kind of built form which we propose in the overall built environment. This is by no means an easy task, but there are in any urban situations certain simple interrelations of street pattern, plot size and building form and the patterns of living which elaborate these. There is also a framework which itself offers choice and within which a plurality of choices can operate.

5.1.2: The grid as generator.

The above is the title of a paper by Leslie Martin which examined the influence of the grid as the generator for many great cities. He says:

.....this paper by its insistence on the relatedness of things; by its emphasis of the effect of the initial framework of a city on the future elaboration and development of this by patterns of living; by the stress that it lays on neutral measurement and finally by its suggestion of the possibility of mathematical analysis and comparative assessments of various built forms, begins to outline, at least, one way of looking at the physical structure of a city.

(Martin, 1972)

Martin's method of analysis on the physical structure of a city has left architects a very important principle but sadly it is one which has not been well understood. He

continues by saying:

> *It links back to one of the more neglected aspects of Unwin's work: for instance his use of comparative measurement in 'Nothing to be Gained by Overcrowding' or his geometrical application of the Fresnel diagram in his illustration of town expansion.*
>
> (Martin, 1972)

The activity called city planning, or urban design, or just planning, is being sharply questioned. What is being questioned is the adequacy of the assumptions on which planning doctrine is based. What are those assumptions? To put these in the most general terms, they resolve themselves into two powerful lines of thought:-

- The first, stems from the work of Viennese writer Camillo Sitte (1889), whose book City Planning According to Artistic Principles, can be called the doctrine of the visually ordered city. To Sitte, the total city plan is the inspired and the all encompassing work of art. He also emphasises that civic art must be an expression of the life of the community, and finally 'works of art cannot be created by committee but only by a single individual'. The planner then is the inspired artist expressing in the total city plan the ambitions of a society.

There are indeed many who, though not prepared to accept this total role of the planner, have nevertheless been profoundly influenced by Sitte's doctrine of the visually ordered city. The doctrine has left its mark on the images that are used to illustrate high-density development of cities. It is to be seen equally in the layout and arrangement of the Garden City development.

- The second line of doctrine is severely practical. It can be called the doctrine of the statistically ordered city. It is the basis of those planning surveys in which uses are quantified, sorted out and zoned into particular areas, population densities are assessed and growth and change predicted. It is the raw material of the outline analyses and town maps of the 1947 Town and Country Planning Act.

Jane Jacobs (1962) in her book The Death and life of Great American Cities criticised sharply these two aspects of planning. Firstly, it was concerned with the visual

images and secondly with the procedures which sometimes used in combination by planners. For Jacobs, both 'the art of city planning and its companion, the pseudo-science of city planning, have not yet embarked on the effort to probe the real world of living'. For her, a city can never be the total work of art, nor can there ever be the statistically organised city. In fact, to Jacobs, the planning of any kind of order seems to be inconsistent with the organic development of cities which she sees as a direct outcome of the activities of living. Planning is a restrictive imposition: the areas of cities 'in which people have lived are a natural growth.....as natural as the beds of oysters'. Planning, she says, is essentially artificial. Martin adds:

> *It is of course just this opposition between 'organic' growth and the artificial nature of plans, between living and the preconceived system within which it might operate, that has been stressed so much in recent criticism.*
>
> (Martin, 1972)

Christopher Alexander (1966) in his essay 'A city is not a tree' puts the point succinctly when he says:

> *I want to call those cities that have arisen spontaneously over many years 'natural cities'. And I shall call those cities or parts of cities that have been deliberately created by planners 'artificial cities'. Sienna, Liverpool, Kyoto, Manhattan. are examples of natural cities. Levitown, Chandigarh and the British New Towns are examples of artificial cities. It is more and more widely recognised today that there is some essential ingredient missing in the artificial cities.*
>
> (Alexander, 1966).

According to Martin (1972), in a large number of American cities, the artificial grid originally laid down remains the working frame within which vigorous modern cities have developed. It is quite clear that an artificial frame of some kind does not exclude the possibility of an organic development. The artificial grid of streets that was laid down throughout Manhattan in 1811 had not prevented the growth of those overlapping patterns of human activity which caused Alexander to describe New York as an organic city. Life and living have filled it out but the grid is there. What Alexander is criticising is

the notion that the activities of living can be made into 'parcels' like separate entities, and can be fixed forever by a plan. Martin continues:

> *The assumption is common in much post-war planning. Housing is thought of in terms of density: 75, 100, 150 people per acre. That will occupy an area of land. Housing requires schools and they need open space: that will occupy another specific area. These areas in turn may be thought to justify another need: an area for recreation. That is one kind of thought about planning. But alternatively an effort may be made to see the needs of a community as a whole. It may be discovered that the way housing is arranged on the ground may provide so much free space that the needs of schools or recreation will overlap and may even be contained within it.*
>
> (Martin, 1972)

The above points of discussion may be summarised as follows:

- In the first instance, the uses are regarded as self-contained entities: Alexander equates this kind of thinking with an organisation as demonstrated by a mathematical tree.
- In the second instance, the patterns of use overlap: the organisation in this case is much closer to a far more complex mathematical structure, the semi-lattice.

The illustration of the separate consideration of housing, schools and open space is elementary. However, it is Alexander's argument that whole towns may be planned on this basis. And it is this attempt to deal with highly complex and overlapping patterns of use, of contacts and of communications in a way which prevents this overlap from happening that Alexander deplores.

The argument can also be put in a different way. It can be argued that the notion (implied by Jacobs) that elaborate patterns of living can never develop within a preconceived and artificial framework is entirely false. This can be developed by saying that an 'organic' growth, without the structuring element of some kind of framework, is chaos. Finally, that it is only through the understanding of that structuring framework, that we can open up the range of choices and opportunities for future development.

The grid of streets and plots from which a city is composed, is like a net placed or

thrown upon the ground. This can be called the framework of urbanisation. The framework has remained the controlling factor of the way we build whether it is artificial, regular and preconceived, or organic and distorted by historical accident or accretion. In addition, the way we build may either limit or open up new possibilities in the way in which we choose to live.

Lynch (1954) comments that:

> *among designers.....there is a reaction against the grid, mainly because of its lack of adaptability and its 'monotony'. It causes difficulties on irregular ground, as in San Francisco and Priene. When diagonal motion must be applied over it, as in Washington, it produces confusing intersections and awkward pieces of land. If used unthinkingly, it may allot the same kind of ground for factories as for homes, the same width for main arteries as for local streets. Sensitive design can avoid this, but not without departing from a uniform grid. The impression of monotony arises in part from the lack of necessary specialization; it is not inherent in the pattern.*

Hertzberger (1991) says that on confrontation with this grid, a world of possibilities opens up before the architect's eyes. In other words, the grid is capable of generating or even of provoking solutions.

The understanding of the way the scale and pattern of this framework, net or grid affects the possible building arrangements on the land within it, is fundamental to any reconsideration of the structure of existing towns. It is equally important in relation to any consideration of the developing metropolitan regions outside existing towns. The pattern of the grid of roads in a town or region is a kind of chequerboard that sets out the rules of the game. The rules outline the kind of game; but the players should have the opportunity to use to the full their individual skills while playing it.

5.1.3: Case Studies

How does the framework of a city work? In what way does the grid act as a generator and controlling influence on city form? How can it tolerate growth and change? Martin (1972) in his article addresses the above questions in the study of three cities:

1. SAVANNAH

In a view of Savannah in 1734, illustrated in John Reps' book, one can see how the plots and streets of the embryo city are being laid out and how some buildings are completed. The unit of the Savannah grid was the square, it was called a ward and is separated from its neighbours by wide streets. Within each square (or ward), building plots for houses were arranged along two sides, the centre itself was open, and on each side of this open square were sites for shops and public buildings. Savannah grew by the addition of these ward units. In 1733 there were four units, in 1856 no less than twenty-four. The city became a chequerboard of square ward units, marked out by the street pattern. The central open spaces of each ward were connected in one direction by intermediate roads; in the other direction the central areas became a continuous band of open spaces and public buildings. Here is a unit grid with direction and orientation.

2. MANHATTAN

This second example of a grid is laid down extensively and on a uniform pattern of streets and plots. In 1811, this became the largest city grid ever to be created and imposed upon a landscape. Surveys in 1785 and 1796 extending up the centre of Manhattan set out the basis for a grid, and in 1811, the special State Commissioners confirmed this in an 8-foot long plan which plotted the numbered street system of Manhattan as far north as 155th Street. The plan showed 12 north-south avenues each 100 feet wide and 155 cross streets each 66 feet wide. The size of the rectangular building plots set out by this grid were generally 600 feet by 200 feet. There were some

public open spaces. Central Park was of course carved out later. And it is this framework that has served the successive developments of the built form from 1811 to the present day.

3. CHICAGO

According to Martin (1972), this city grid is of interest because of its dimensional links with the land ordinance, suggested by Thomas Jefferson and passed by Congress in 1785. Under the ordinance, a huge network of survey lines was thrown across all the land north and west of the Ohio river. The base lines and principal meridians of the survey divided the landscape into squares 36 miles each side. These in turn were subdivided into 6-mile squares or townships and further divided into 36 sections each one mile square. The mile squares were then subdivided by acreage: the quarter section 160 acres with further possible subdivisions of 80, 40, 20, 10, or 5 acres. The 5-acre sites underwent themselves to further divisions into rectangular city blocks (not unlike those of Manhattan) and subdivision again into lots or building plots.

OBSERVATIONS

Here then are three types of grid, that of Savannah, the gridiron of Manhattan and that of Chicago. Each one is rectangular. Each one has admitted change in the form and style of its building. Each one has allowed growth, by intensification of land use or by extension.

- Savannah, as it grew, tended to produce a green and dispersed city of open squares. The example in Figure 27 shows the effective way in which this layout opens up broad bands of green space and public buildings running across the developed areas.

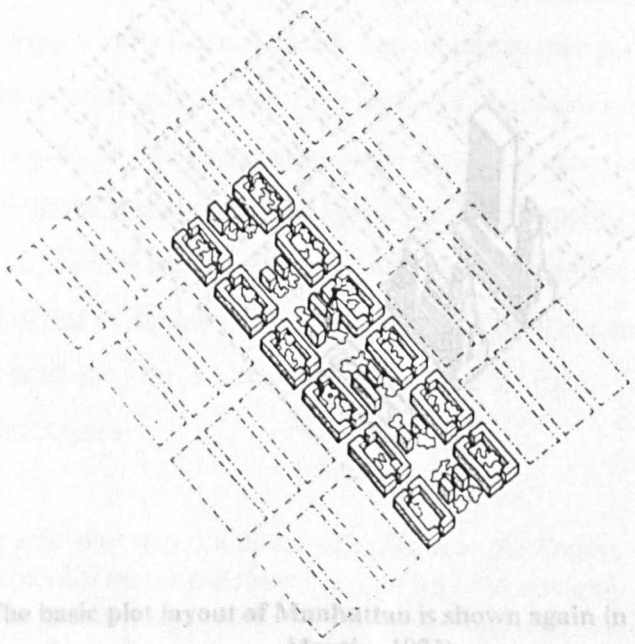


Figure 27. The four wards of the Savannah type of development are superimposed on the basic plot layout of Manhattan which is shown in the dotted lines (from Martin, 1972).

- In Manhattan, the small scale subdivision of the grid and the exceptional pressure to increase floor space within this, forced buildings upwards. The building forms in Figure 28 show three stages of development including the original 4 to 6 storeys perimeter form with a garden at the centre which was characteristic of the city in the 1850s. The other two are examples of the more intensive development during the present century.

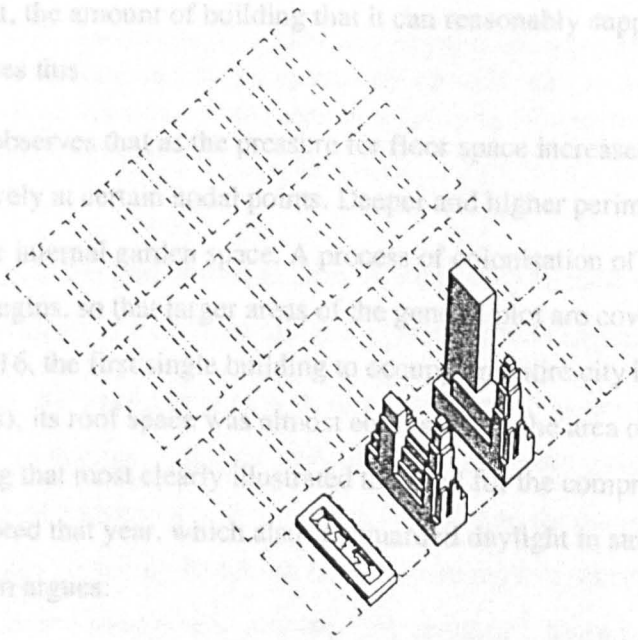


Figure 28. The basic plot layout of Manhattan is shown again in the dotted lines (from Martin, 1972).

- Chicago spread outwards, continually opening out the pattern of its grid.

In each case the influence of the original grid remains with each one offering different possibilities and choices of building and of living.

Martin continues to trace the influence of the grid by examining the building

arrangement that developed within it in New York. He identifies the streets and the system established by the grid. Within this general plot pattern the separate building plots are being established. To the north, on the building frontier, there is a line of huts and shacks. Further south, more permanent but separate buildings are being built. And in the most developed area further towards the tip of Manhattan the full building arrangement has solidified into connected terraces of four to six-storey houses arranged around the perimeter of the site and enclosing private gardens. Views of Manhattan in the 1850s showed a city developed in this way: and this pattern of building arrangement can still be seen in many areas. At this point, the building land is replete. A balance is maintained between the plot, the amount of building that it can reasonably support and the street system that serves this.

Martin observes that as the pressure for floor space increases, the building form changes intensively at certain nodal points. Deeper and higher perimeter buildings first of all submerge the internal garden space. A process of colonisation of the individual building plots begins, so that larger areas of the general plot are covered by higher buildings. In 1916, the first single building to occupy an entire city block rose a sheer 600 feet (180 metres), its roof space was almost equivalent to the area of its ground plan. It was this building that most clearly illustrated the need for the comprehensive zoning ordinances adopted that year, which also safeguarded daylight in streets and adjoining buildings. Martin argues:

> *But the grid now exerts a powerful influence: the limited size of the grid suggests the notion that increased floor space in an area can only be gained by tall buildings on each separate plot. The notion suggests the form; the regulations shape it into ziggurats and towers.*
>
> (Martin, 1972)

Under the regulations that prevailed until recent years, if all the general building plots in central Manhattan had been fully developed, there would have been one single and universal tall building shape. And, to use an old argument by Raymond Unwin, if the

population of these buildings had been let out at a given moment, there would have been no room for them in the streets (Martin, 1972). In short, the balance between area of plot, area of floor space and area of street has disappeared.

Now these descriptions of the grid, which have been used as a basis for Martin's argument, have exposed the points at which they have been extensively attacked for more than a century. A grid of any kind appears to be a rigid imposition on the natural landscape. It is this reaction against the grid that is voiced by Olmstead and Vaux writing in support of their design for Central Park in 1863:

> *The time will come when New York will be built up, when all the grading and the filling will be done and the picturesquely varied rocky formation of the island will have been converted into formation for rows of monotonous straight streets and piles of erect building.*
>
> (Reps, 1965).

In their opposition to the grid, the relief from its monotony became a specific aim. Central Park itself is an attempt to imitate nature and to recreate wild scenery within the grid.

To Martin, the garden suburb with its curving streets is one form of attack on the grid system, and an attempt to replace it. And at the end of the century, the Chicago Fair (1893), Cass Gilbert's schemes in Washington (1900), and the plans for San Francisco (1905) and Chicago (1909) by Burnham are other attempts to transform the urban desert by means of vistas and focal points, into the 'city beautiful'. Martin observes:

> *However, we recognise at once a contrast. The various types of grid that have been described opened up some possible patterns for the structure of a city but left the building form free to develop and change within this. The plans of the garden city designers or those concerned with making the 'city beautiful' are an attempt to impose a form; and that form cannot change.*
>
> (Martin, 1972)

5.1.3.1: From Process To Principles

Martin goes on to extract some principles for the above processes in which artificial grids of various kinds have been laid down. They are:-

- The choice of the grid allows different patterns of living to develop and different choices to be elaborated.
- The grid, unliked the fixed visual image, can accept and respond to growth and change.
- The grid can be developed unimaginatively and monotonously or with great freedom.
- There can be a point at which the original grid fails to respond to new demands (Figure 29). As in Manhattan, it congeals. And it is at this point that we must try to discover from the old framework a new ordering principle that will open up new opportunities for elaboration by use.

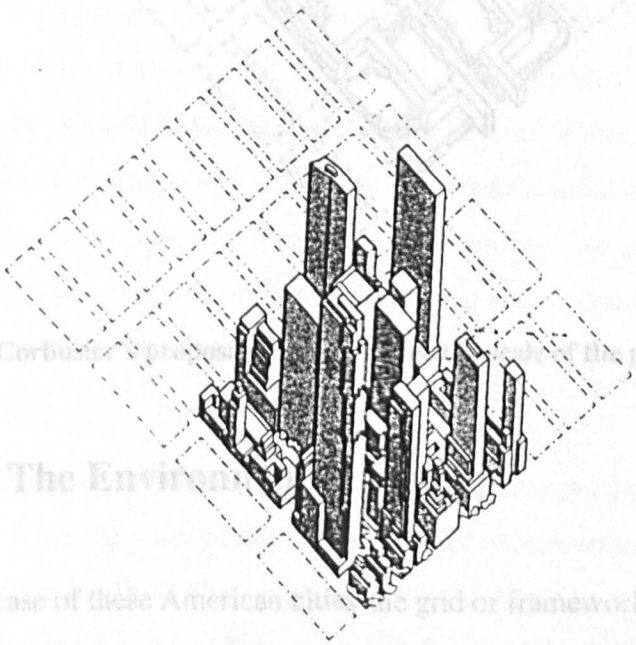


Figure 29. Building plot development in its most intensive form (from Martin, 1972).

In 1935, when Le Corbusier first visited New York, he commented: "What about the road?" The diagrams by which he illustrated this remark show the regenerative process that is necessary. By increasing the size of the street net in Manhattan, Le Corbusier showed that the grid cease to restrict. He did this by superimposing his proposals for dwellings with setbacks (from his proposals for a city for 3 million people) on the Manhattan grid. Martin observes that what Corbusier did was to open up new possibilities in the building form as shown in Figure 30.

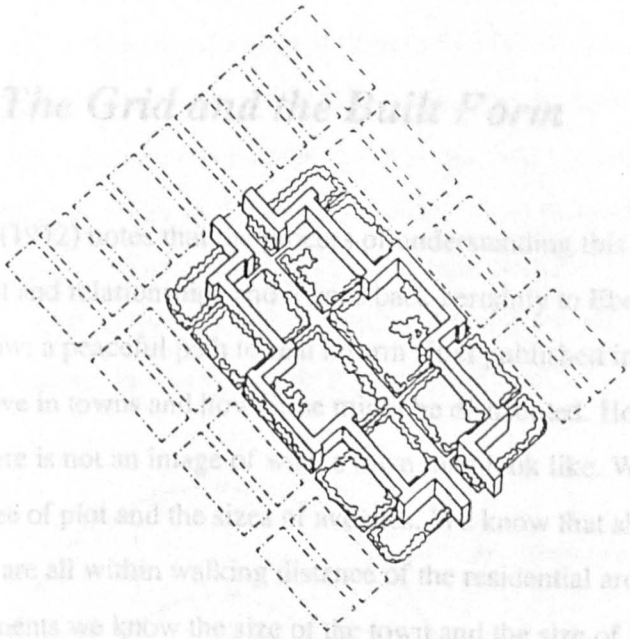


Figure 30. Le Corbusier's proposals which change the scale of the grid (from Martin, 1972).

5.1.3.2: The Environmental Game

In the case of these American cities the grid or framework can be regarded as an ordering principle. It sets out the rules of the environmental game. It allows the player the freedom to play with individual skills. The argument can now be extended by saying that the grid, which is so apparent in the American examples, exerts as much control and

importance in cities that would normally be called organic. For example, London, Liverpool or Manchester too have a network of streets and however much the grid is distorted, it is there. At a certain scale and under certain pressures, the grid combined with floor space limits and daylight controls, is just as likely to force tall building solutions. And it is just as likely to congeal. It lends itself just as readily to regenerative action. The theoretical understanding of the interaction between the grid and the built form is therefore fundamental in considering either existing towns or the developing metropolitan regions.

5.1.4: The Grid and the Built Form

Martin (1972) notes that the process of understanding this theoretical basis rests in measurement and relationships and it goes back certainly to Ebenezer Howard. His book 'Tomorrow: a peaceful path to real reform' first published in 1898 was about how people might live in towns and how these might be distributed. However, the important thing is that there is not an image of what a town may look like. We know the type of housing, the size of plot and the sizes of avenues. We know that shopping, schools and places of work are all within walking distance of the residential areas. On the basis of these measurements we know the size of the town and the size of Howard's cluster of towns which he calls a city federation. We know the choice that is offered and we know the measurements that relate to these. If we disagree with the choice we can change the measurements.

Ebenezer Howard's ideas were principally put into practice by Raymond Unwin. The strength of this argument above rests in a simple demonstration of a mathematical fact. According to Martin (1972), in an essay 'Nothing gained by overcrowding' Unwin presented two diagrams of development on ten acres of land. One was a typical development of parallel rows of terraced houses; the other places dwellings round the perimeter. The second development placed fewer houses on the land but when all the

variables were taken into account (including the savings of road costs) the total development cost was lower. From the point of view of theory, the important aspect of this study was the recognition of related factors; the land available, the built form placed on this and the roads necessary to serve these.

"How many angels could stand on a needle point?" was the title of a lecture by Unwin on tall buildings which surrounded a controversy that had profoundly moved the theological world of its day (Martin, 1972). His method of confounding the urban theologians by whom he was surrounded was to measure out the space required in the streets and sidewalks by the people and cars generated by 5-, 10- and 20-storey buildings on an identical site. The interrelationship of measurable factors is again clearly demonstrated. One of Unwin's most forceful contributions to theory is his recognition of the fact that 'the area of a circle is increased not in the direct proportion to the distance to be travelled from the centre to the circumference, but in proportion to the square of that distance'(Figure 31). Unwin used this geometrical principle to make a neat point about commuting time: as the population increased round the perimeter of a town, the commuting time was not increased in direct proportion to this.

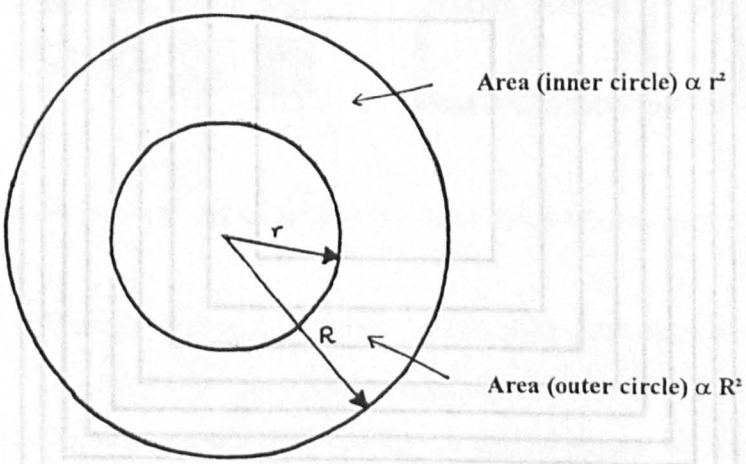


Figure 31. The geometrical principle used by Unwin
r (distance from the centre to the circumference of the inner circle or radius)
R (distance from the centre to the circumference of the outer circle or radius)

The importance of this geometrical principle is profound. Martin remarks that Unwin did not pursue its implications. He was too concerned to make his limited point about low density. This principle is demonstrated again in Fresnel's diagram (Figure 32). Each successive annular ring diminishes in width but has exactly the same area as its predecessor. The outer band in the square form of this diagram has exactly the same area as the central square. And this lies the root of our understanding of an important principle in relation to the way in which buildings are placed on the land.

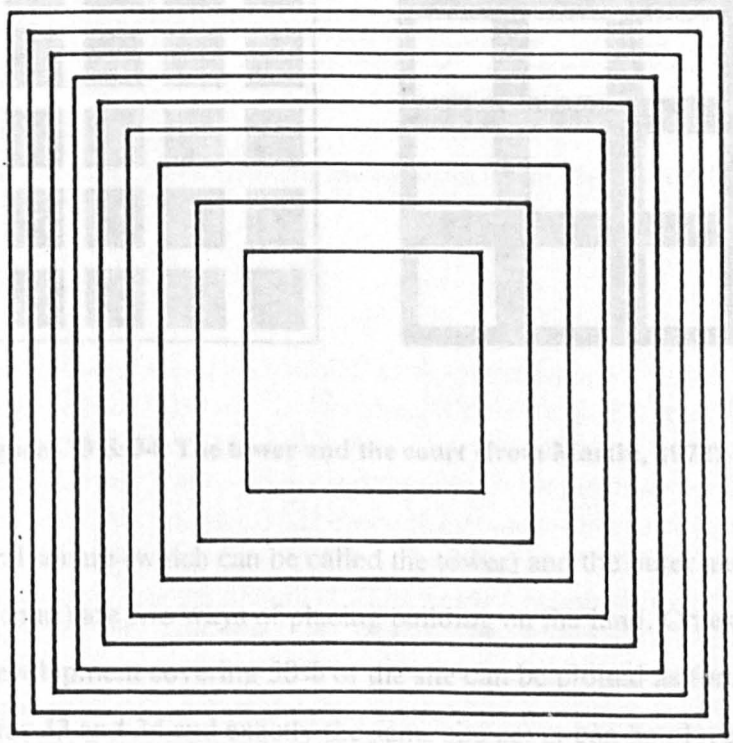
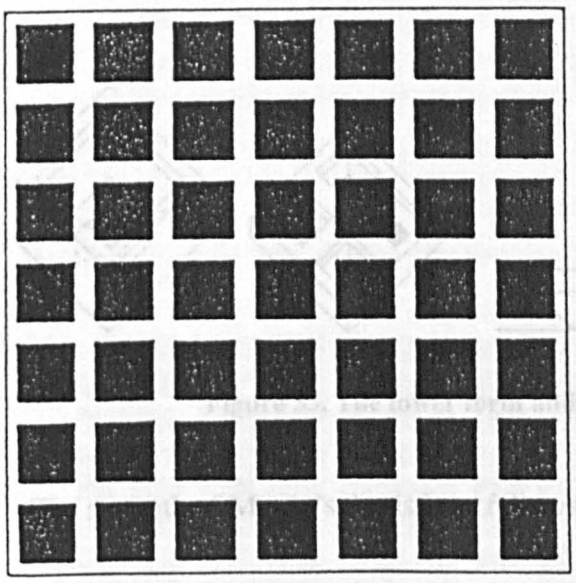
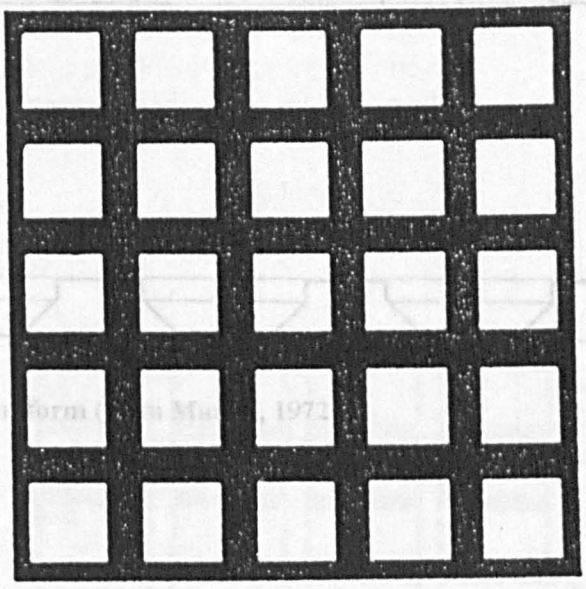


Figure 32. The Fresnel's Diagram (named after A.J. Fresnel (1788-1827), a French physicist (from Martin, 1972).

Supposing now that the central square and the outer annulus of the Fresnel diagram are considered as two possible ways of placing the same amount of floor space on the same site area. It is clear that the two buildings' arrangement will pose a totally different set of access, of how the free space is distributed around them and what natural lighting and view the rooms within them may have. By this process, planning parameters which have been defined will therefore need consideration in any theoretical attempt to understand land use by buildings.





Figures 33 & 34. The tower and the court (from Martin, 1972).

This central square (which can be called the tower) and the outer annulus (which can be called the court) are two ways of placing building on the land. On extension, on any large site a development covering 50% of the site can be plotted as forty-nine towers, as shown in Figures 33 and 34 and exactly the same site cover can be plotted in court form. A contrast in the ground space available and the use that can be made of it is apparent. In fact, this contrast can be extended further, the forty-nine towers can be plotted in a form which is closer to that which they will assume as buildings (that is a low

slab with a tower form above). This can now be compared with its antiform: the same floor space planned as courts (Fig 35). The comparison must be exact; the same site area, the same volume of building and the same internal depth of room. And when this is done we find that the antiform places the same amount of floor space into buildings which are exactly one third the total height of those in tower form (Martin and March, 1966).

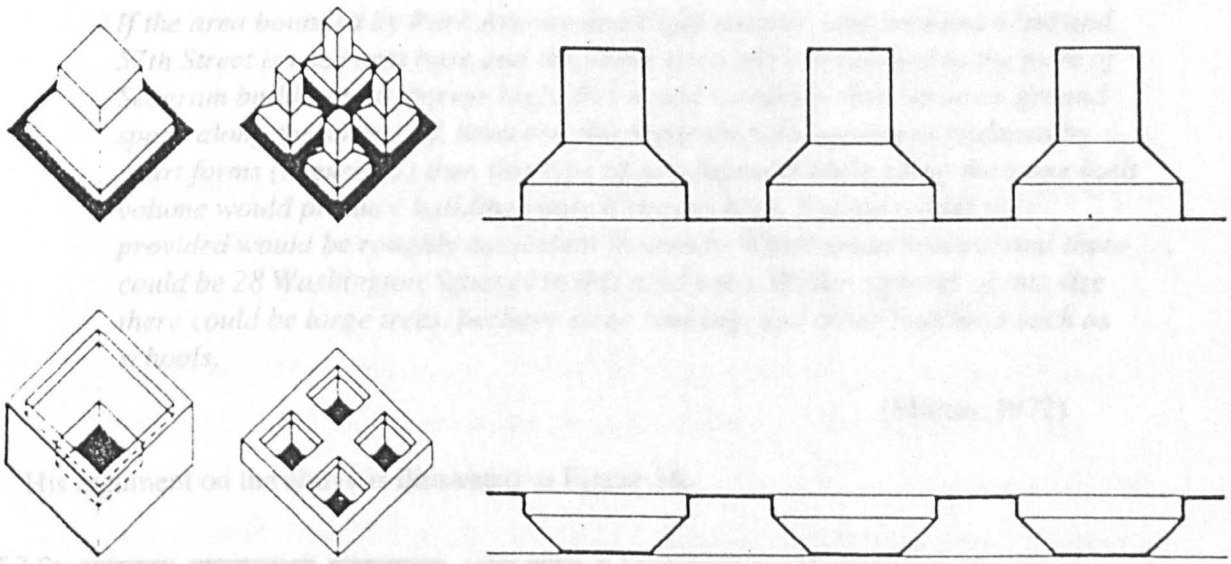


Figure 35. The tower form and its antiform (from Martin, 1972).

The strength of Martin's thesis is as follows:

> *This brings the argument directly back to the question of the grid and its influence on the building form. Let us think of New York. The grid is developing a certain form: the tall building. The land may appear to be thoroughly used. Consider an area of the city. Seen on plan there is an absolutely even pattern of rectangular sites. Now assume that every one of those sites is completely occupied by a building: and that all these buildings have the same tower form and are twenty-one storeys in height. That would undoubtedly look like a pretty full occupation of the land. But if the size of the road net were to be enlarged by omitting some of the cross streets, a new building form is possible. Exactly the same amount of floor space that was contained in the towers can be arranged in another form. If this floor space is placed in buildings around the edges of our enlarged grid then the same quantity of floor space that was contained in the 21-storey towers now needs only 7-storey buildings. And large open spaces are left at the centre.*
>
> (Martin, 1972)

Martin continues his argument by being very specific. This is the ultimate crunch in his analysis of the grid as the generator and it is here architects may find the clue in the search for the alternative model for high-density, low-rise built form as against the high-density, high-rise model.

> *If the area bounded by Park Avenue and Eight Avenue, and between 42nd and 57th Street is used as a base and the whole area were developed in the form of Seagram buildings 36 storeys high, this would certainly open up some ground space along the streets. If, however, the Seagram buildings were replaced by court forms (Figure 35) then this type of development while using the same built volume would produce buildings only 8 storeys high. But the courts thus provided would be roughly equivalent in area to Washington Square: and there could be 28 Washington Squares in this total area. Within squares of this size there could be large trees, perhaps some housing, and other buildings such as schools.*
>
> (Martin, 1972)

His argument on the above is illustrated in Figure 36.

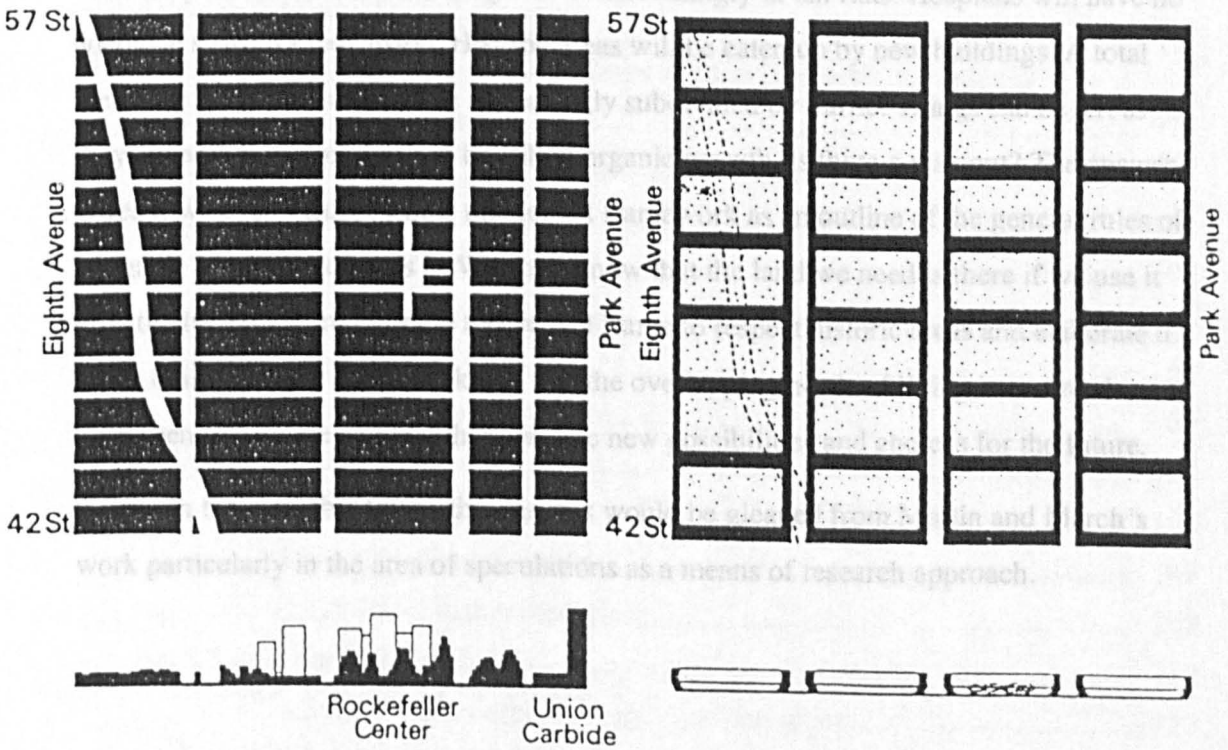


Figure 36. Martin's antiform in the city of Manhattan (from Martin, 1972).

5.1.5: Conclusions

According to Martin, he is not suggesting that this antiform is the alternative. It is simply a demonstration of a possible choice within a general strategy. However, it is important to know that the possibility exists, and that, when high buildings and their skyline are being described, the talk is precisely about this and not about the best way of putting built space on the ground space. The alternative form of courts is not a universal panacea. It suggests an alternative which would at once raise far-reaching questions. For instance, the open space provided in the present block-by-block (or tower) form is simply a series of traffic corridors. In the court forms, it could become traffic-free courts.

All that may sound theoretical and abstract. On the contrary, to know what is theoretically possible is to allow wider scope for decisions and objectives. We can choose. We can accept the grid, the streets as it is. In that case, we can never avoid the constant pressure on land. Housing will be increasingly in tall flats. Hospitals will have no adequate space for expansion. Historic areas will be eaten up by new buildings. A total area once unified by use will be increasingly subdivided by traffic. Things can be left as they are and developments can be called organic growth. Is there a way out? The answer is yes if we could accept a new theoretical framework as an outline of the general rules of the game and work towards it. We shall know that the land we need is there if we use it effectively. We can modify the theoretical frame to respect historic areas and elaborate it as we build. And we shall also know that the overlapping needs of living in an area have been seen as a whole and that there will be new possibilities and choices for the future.

In the next chapter, further lessons would be gleaned from Martin and March's work particularly in the area of speculations as a means of research approach.

Chapter 5:

The Theorectical Framework

5.2:

The Case for Speculations as a Research Approach according to Martin & March

5.2.1: An introduction

> *Rational and speculative thought are not opposite modes stemming from opposing attitudes of mind. Nor are they to be associated with particular activities, for example science and art. They are in fact essentially complementary and interrelated forms of thought. Through one we understand the factual nature of a problem more accurately and through the other we extend the range of our thought about it. Once this is recognised, measurement and geometry become a valuable means of testing existing assumptions. The new evidence that arises from this in turn gives rise to new ideas about application.*
>
> (Martin & March, 1972)

5.2.2: The lessons from the 1920s and 1930s

The work resulting from the 1920s and 1930s is of interest and value today because of the ideas that it embodies. According to Martin & March (1972), one manifestation is the change from art and craft intuition towards rational analysis, measurement, technical innovations and speculative thought. However, against this attempt to reintroduce rationalism as a basis of architecture, there is, all along the line, the opposition of a powerful wing of "individualist" creators. For example, Lynch regarded the "arts and crafts tradition" with a view of "individualistic society" (Banerjee & Southworth, 1990). He felt that rational thought about needs and processes by one school was in some way considered by another to be dangerous and inhibiting. Therefore, practical reason and intuition were seen as opposites.

According to Martin & March (1972), from the 1920s, three powerful lines of thought appeared:

1. the belief that there had to be some complete and systematic re-examination of human needs and that, as a result of this, not only the form of buildings, but the total environment,

2. the second line of thought, interlocking with the first, was that change in the form of buildings, or environment could only be achieved in totality through the full use of modern technology, and these two ideas produced a third, and
3. the third line was that each architectural problem should be constantly re-assessed and thought out afresh.

To date, not a single one of these principles had been completely demonstrated. They remain only as lines of action which are sometimes followed up separately and sometimes together.

In the 1930s, the products of practical reason were being demonstrated on an impressive scale in the Dutch and German's housing projects. The principle involving rational thought with regard to use and construction then was that it must produce its own formal systems. And it required a continuous reassessment of every aspect of a problem. Knowledge would be established by analysis, advanced by experiment and confirmed or corrected by test. A ruthless reassessment of each achievement was an essential part of this process. But the question is: where does it lead to? Martin & March observes:

> *.....in that important and major housing achievement of the 1930s, the process stopped. The speculative thought that could have extended the range of built forms into totally new environments dried up. In Germany and elsewhere the set housing solution solidified into parallel rows of slab blocks.*
>
> (Martin & March, 1972)

The fact that these happened was of enormous consequence. The rational approach was regarded with suspicion and the end result of practical reason appeared to be sterility, and it was assumed that this could be countered only by intuitive processes - by feeling. Thus, the old nineteenth-century oppositions continue till the present time.

5.2.3: *The problem and its remedy?*

Martin & March argue that what is wrong with parallel slab layout is not the rational thought that it contains, but the failure to extend this further by a speculative and formal invention. They quote A. N. Whitehead (1929) who points out that "it is speculation that makes rational thought live: and it is rational thought that gives speculative invention its basis and its roots. To analyse, to measure and to rationalise the problem is an essential part of the process of scientific thought." In the scientific process, intuition (or what Alfred North Whitehead [1929] prefers to call conjecture or speculative reason) is itself entirely arbitrary unless it is guided by thought or system. Practical reason is the means by which methods are developed for dealing with different kinds of facts. Speculative reason is an extension of this into theoretical activity. Progress depends on a lively interest in speculative reason. Furthermore, Whitehead adds that the massive advance of modern technology is due to the fact that these two forms of thought (rational and speculative) have made contact. In the same note, Martin & March continues:

> *That, translated into architectural terms, is equivalent to saying that the rational understanding of a problem and the extension of this into speculative (intuitive) thought is one single process: that is, that thought and intuition are not opposed but complementary. We may recognise at once an older (pre-nineteenth century) concept of architecture in which the design process cannot be isolated from the thought processes by which the problem is analysed and solved.*
>
> (Martin & March, 1972)

The decisions that are taken about the planning of buildings, their form and the grouping in relation to the land available may be based on assumptions which appear to be eminently sensible and rational. However, rigorous reassessment despite the initial form of refutation of what it may assume will always prove productive. The one consistent line of argument presented in Martin & March's series of speculations is that things are not always what they seem to be. Refutation can begin as an intuition of

imposture, but to prove that, speculation and rational formulations must be able to demonstrate first the fallacy and then the alternative and more useful solutions. Fallacy may exist at any scale, for example, of site resources assumed to be needed, of the relationship of rooms within the building to the corridor space connecting them, of grouped buildings to each other's uses, of buildings within the city and the streets by which they are connected.

In the following, some of the speculations which are put forth by Martin & March will be discussed. The speculations are best described as speculations because they are not contained within a formulated body of theory. Interestingly, Martin & March believe that it is out of speculation that research has its beginnings.

5.2.4: The place of speculations and conjectures in research and inquiry - demonstrated

5.2.4.1: Speculation 1

The study in this section poses a number of questions that need further examination:-

- What are the factors that are related when one considers the efficiency of buildings?
- What form of building makes the most effective use of land?
- How reliable are the measures that we are accustomed to being used in planning?

Current planning techniques offer two measures which have dominated the planning and architectural scene for many years:-

- the first is a measure of floor space index (or its alternative plot ratio).
- the second is concerned with daylight considerations.

This first measure is assumed to provide a rational relationship of floor space to the site. The second provides an assurance that buildings will be adequately lit. The use of the first measure has sometimes been extended to give an indication of the size of the population

which can be accommodated in buildings. Martin, March and Taylor (1965) examine this last point by producing a set of graphs (Figure 37) to show the relationship of three of the factors which may be considered in determining the population capacity of a given site:-

1. In relation to a typical site area of 10,000 sq. metre, the plot ratio may be 2:1, 3:1, or 4:1.
2. This generates floor areas of 20,000, 30,000 and 40,000 sq. metre (Figure 37a).
3. The gross area may then be used with varying degrees of efficiency, for example 25%, 50% or 75%.

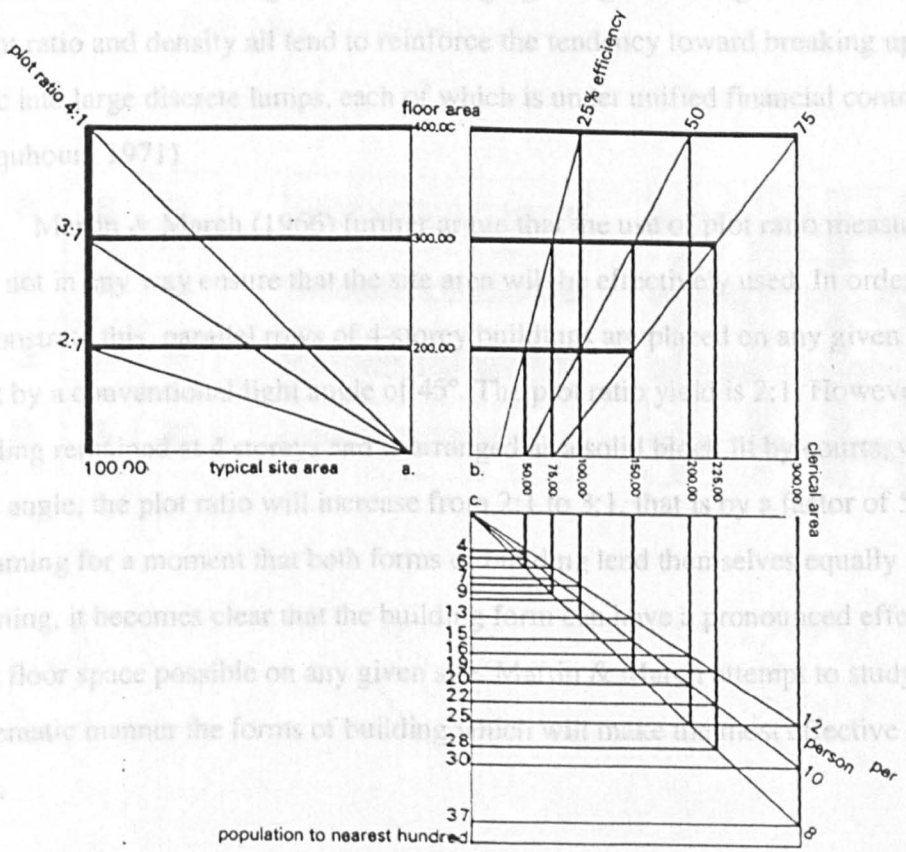


Figure 37. Population density as a function of plot ratio (from Martin & March, 1972).

4. The areas generated from these (figure 37b) yield nine possible results ranging from 5,000 - 10,000 sq metre at 25%, to 15,000 - 20,000 sq. metre at 50%, and to 15,000 - 30,000 sq. metre at 75%.
5. If these possible areas are now related to an allocation of square metre per person (Figure 37c) and fall within allowances of 8,10 or 12 sq. metre per person.
6. The result is that out of these, they can give rise to 17 different populations ranging from 400 to 3700 from the same site area because of these relationships of plot ratio, general plan efficiency and floor space allocation per person.

It is clear that plot ratio in itself is no satisfactory measure of population, though it is useful as an assessment of the total floor space provided by buildings on any given site in any area of a town. The regulations covering light angles, zoning laws, and laws relating to plot ratio and density all tend to reinforce the tendency toward breaking up the city fabric into large discrete lumps, each of which is under unified financial control. (Colquhoun, 1971)

Martin & March (1966) further argue that the use of plot ratio measurements does not in any way ensure that the site area will be effectively used. In order to demonstrate this, parallel rows of 4-storey buildings are placed on any given site spaced apart by a conventional light angle of 45°. The plot ratio yield is 2:1. However, if the building remained at 4 storeys and is arranged as a solid block lit by courts, with the same light angle, the plot ratio will increase from 2:1 to 3:1, that is by a factor of 50%. Assuming for a moment that both forms of building lend themselves equally to internal planning, it becomes clear that the building form can have a pronounced effect on the total floor space possible on any given site. Martin & March attempt to study this in a systematic manner the forms of building which will make the most effective use of ground area.

5.2.4.2: Speculation 2.

The site utilisation of various layouts can be studied by classifying the built forms under three building types: the tower, the street and the court. The properties of the three forms are as summarised below:-

- Tower - finite in its plan form
- The street - extends potentially and infinitely along one axis.
- The court - extends infinitely along two axis.

From these built forms rectangular lattices can be derived. The tower, the street and the court constitute points of recognition in what may be seen as a continuous transformation from one extreme to the other. In other words, it can be seen as an array of isolated blocks elongated into continuous parallel rows, and these joined in the perpendicular direction to form a net of courts(Figure 38).

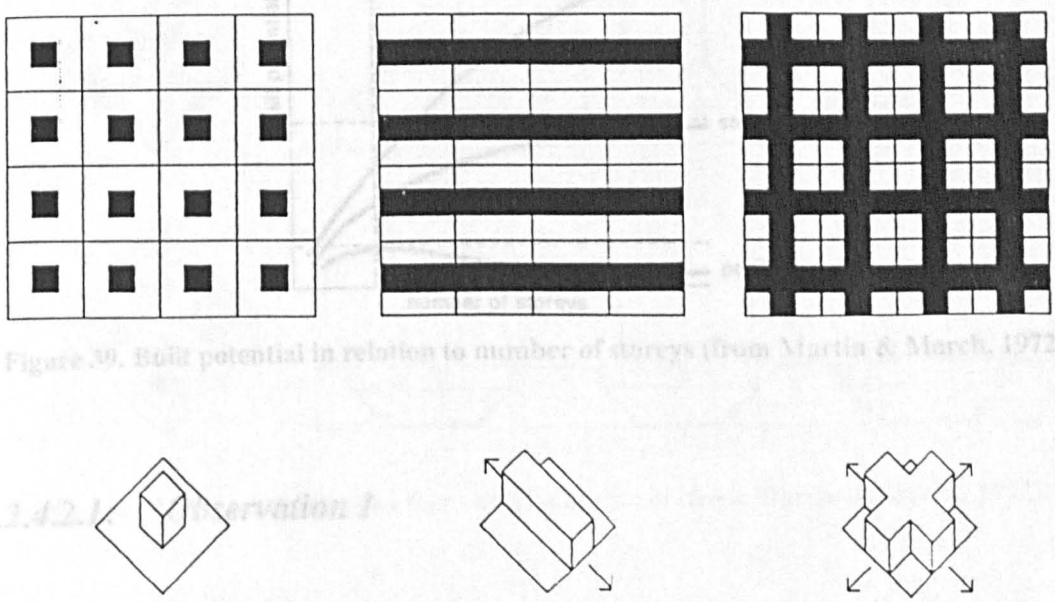


Figure 38. Schematic diagram showing the tower, the slab and the cruciform in a pattern of courts (from Martin & March, 1972).

Before the forms are being examined, the following parameters are kept constant for each case:

- the same site area,
- the same block depth,
- the same width of interspace and
- the same floor height.

Two factors reveal certain aspects of the problem:-

1. the site utilisation factor, that is the ratio of the site covered to the area not covered.
2. the "built potential", that is the ratio of the floor area of the built form to the site area.

Following this, the built potential is plotted against the number of storeys for each one of the three built forms described and the results is shown in Figure 39.

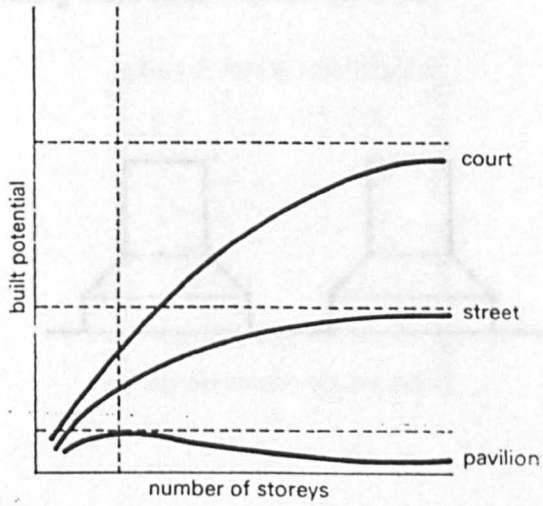


Figure 39. Built potential in relation to number of storeys (from Martin & March, 1972).

5.2.4.2.1: Observation 1

Based on the graph plotted, after a certain height, the tower form ceases to use land with increasing efficiency. In fact, the lower towers which are more closely packed together, will give the same degree of built potential. According to Martin & March (1966), this may be one reason why the 'city of towers' that is free standing towers in a

park-like setting, has never been built. It is inherently inefficient in terms of land use.

In comparison to the tower form at its maximum, the built potential of the street form has twice its value. And the built potential of the court form is no less than three times as great. In other words, one form of building with a floor to ground space ratio of 3:1 can be accommodated in 8-storey buildings, whereas elsewhere, in some situations, the same plot ratio will require tall towers.

Similarly, the form of a typical high density development, a tower with low podium, corresponds closely to the building envelope obtained by using daylight protractors. Day lighting controls have determined to a large extent the massing of building seen in the central city of today (for example New York City). The type of study described can be developed by considering pyramidal forms which approximate more closely to the actual building form as shown in Figure 40.

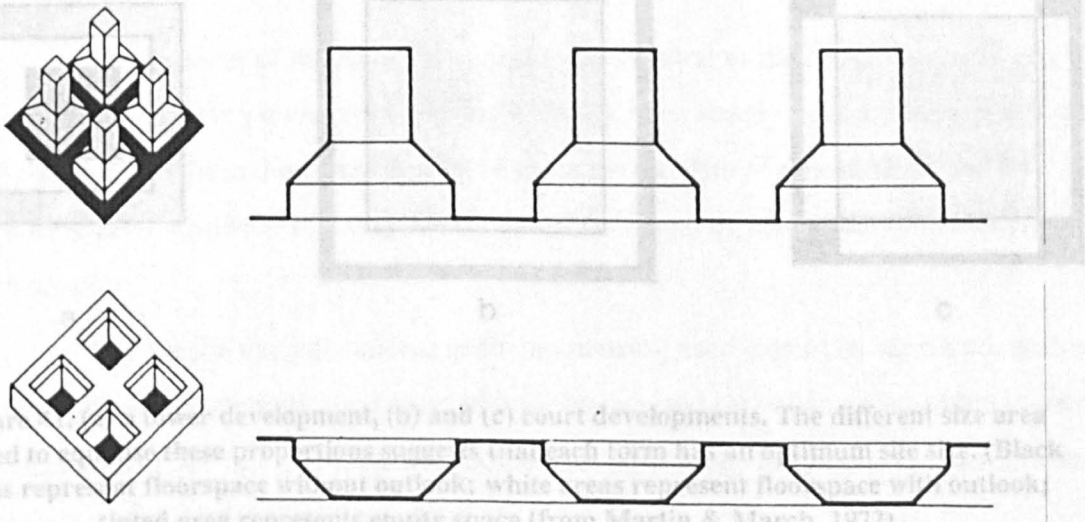


Figure 40. Generalised tower form and its antiform (from Martin & March, 1972).

5.2.4.2.2: Observation 2.

The generalised tower form is again compared with its antiform, the court. And the verdict, the court form is seen to place the same amount of floor space on the same

site area with the same condition of building depth and in approximately one-third the height required by the tower form. Again, this result corresponds to that found in the earlier Observation 1.

5.2.4.3: Speculation 3

If the built potential is held constant for the tower and the court by having the same number of storeys, and if the proportion of the built form having outlook and that with no outlook is held constant, then the size of the site for these two developments will differ. (Figure 41)

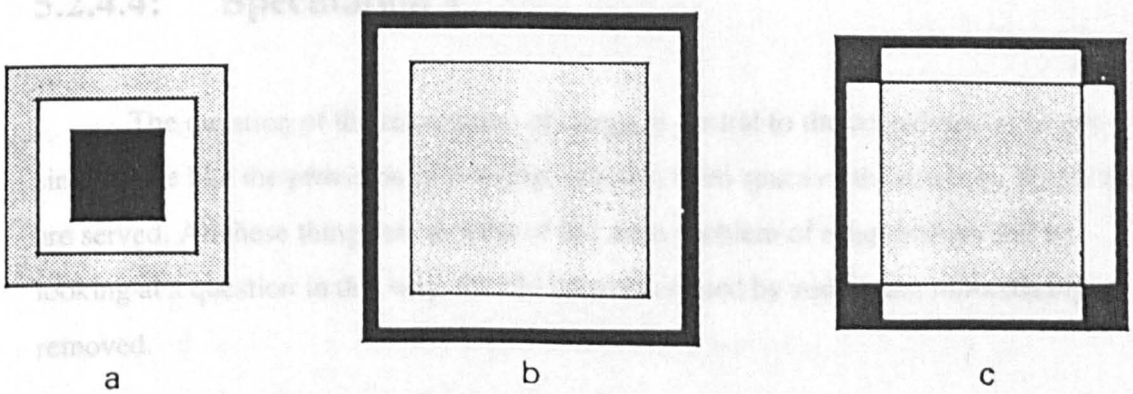


Figure 41. (a) a tower development, (b) and (c) court developments. The different size area needed to equalise these proportions suggests that each form has an optimum site size. (Black areas represent floorspace without outlook; white areas represent floorspace with outlook; tinted area represents empty space (from Martin & March, 1972).

5.2.4.3.1: Observation

This seems to suggest that each form of development probably has its own optimum size. If the highest densities were to be allowed only on larger sites, then it appears to be the case that high and deep buildings will be unnecessary in terms of land

use, although they may be required on other functional grounds. Furthermore, Martin & March (1966) observes that:

> *.....this kind of consideration could lead to the general loosening up of the texture of building on ground space. In which case a new relationship of building to road must be sought.*
>
> (Martin & March, 1966)

The development of larger areas of land and the possibility of buildings occupying less ground space offers the possibility of a new scale of road network in which the interrelationship of land, building content and the traffic which it generates is made more balanced. This observation leads us into Martin & March's following speculations.

5.2.4.4: Speculation 4

The question of the relatedness of things is central to the consideration of any single issue like the provision of housing, schools, open space or the roads by which they are served. All these things are aspects of the main problem of relationships and by looking at a question in this way, the old barriers created by zoning are immediately removed.

They argue that educational need and housing need cannot be separated, both are part of the larger theoretical problem of how we use land by building. When the issue is considered in this light the results are sometimes surprising. They first consider an area of land in a nineteenth-century industrial city.

5.2.4.4.1: The scenario

- Imagine 50 acres (20 hectares) of terraced housing within a framework of busy commercial and shopping streets (Figure 42).

Figure 42. A 50-acre (20-hectare) site developed with typical bye-law streets at a density of 100 persons per acre (250 pph) (from Martin & March, 1972).

- Assume that the residential density is 100 persons per acre (250 pph).
- Assuming that there is one obsolete primary school embedded in the housing and most of the children attend schools elsewhere.
- Next consider the rebuilding of this area.
- Can houses be provided for the present population at the same time that schools are made available for its children? There appear to be competing land use, and in any rebuilding there may be the added requirement of public open space.

5.2.4.4.2: The statistics

Looking from the point of view of schools:

- 50 acres (20 hectares) generate 5000 people.
- Assuming these will demand an infant school of 300 pupils, a junior school of over 400, and for the sake of argument a secondary school of around 600.
- The school buildings alone will occupy 7 acres (2.8 hectares) of land.
- Playing fields will require an extra 14 acres (5.7 hectares). Altogether 21 acres (8.5 hectares) (42%) of land will be required for educational purposes.
- If another 4 acres (1.6 hectares) per thousand population is to be claimed within the area for recreational needs, then another 20 acres (8 hectares) will be needed.
- Finally, housing will have to take place on the remaining 9 acres (3.6 hectares), or 18% of land, in which there will be some demand from access roads.
- In terms of sheer space the housing will occupy a solid block of building three storeys high (Figure 43).

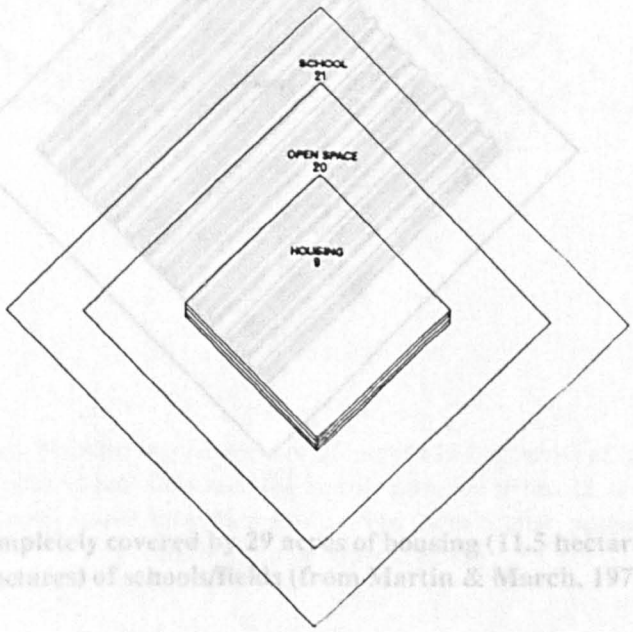


Figure 43. The land-use requirement of the 5000 people on the 50-acre site (from Martin & March, 1972).

The quantification immediately draws attention to an important issue, why is so

much land needed? What is it that demands an area large enough to allow the simultaneous use by over 100 pupils playing five different soccer matches at the same time? What about overlapping uses of recreational land by a far wider range of activities - in farming terms, a double or triple cropping of the land?

5.2.4.4.3: Further statistics

Looking from the point of view of housing, a 50-acre (20-hectare) site redeveloped at 100 persons per acre (250 pph) will be completely covered with houses and roads. In this case there would be no sites a for school which is not realistic.

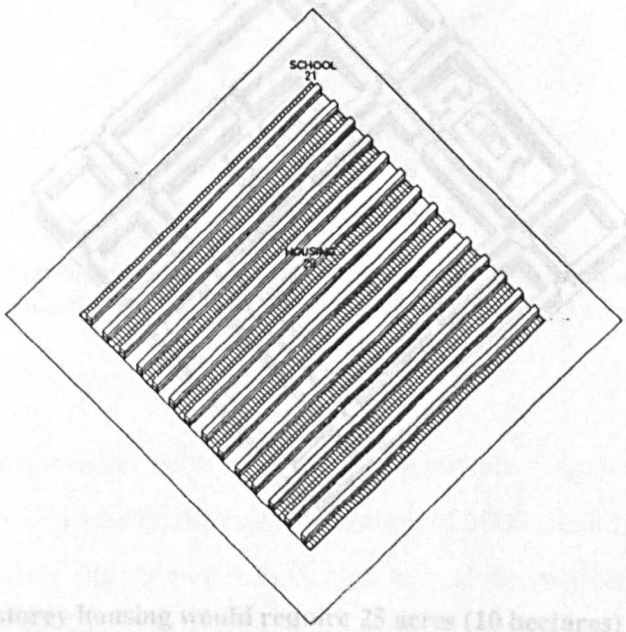


Figure 44. A site completely covered by 29 acres of housing (11.5 hectares) and 21 acres (8.5 hectares) of schools/fields (from Martin & March, 1972).

A primitive layout will be as follows:

- Assuming that school sites remain at 21 acres (8.5 hectares) with playing fields.

Housing will occupy the remaining 29 acres (11.5 hectares) of land. If 3,600 people could

be accommodated in 2-storey housing in the simplest layout possible, then 5000 people would require most of the site (Figure 44).

But if some sharing of the school land and open space were acceptable, this combined-use land (Figure 45) could provide urban rooms within the layout and the new distribution of built form could accommodate the total population of 5000 in three-storey houses. This corresponds approximately to the layout of some of the squares in Bloomsbury (Figure 46).

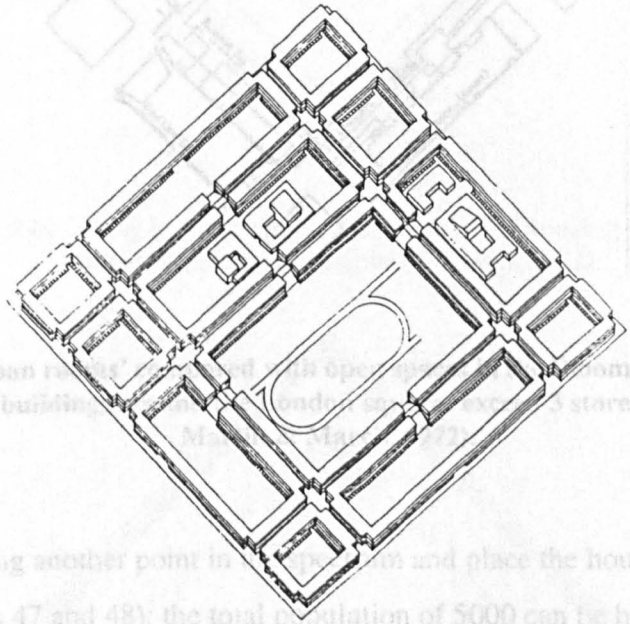


Figure 45. Three-storey housing would require 25 acres (10 hectares) of land including roads and small 'outdoor' room space. This housing is only possible if the 21 acres (8.5 hectares) of school land and the open space allocation are used to form 'urban rooms' of varying size. (from Martin & March, 1972)

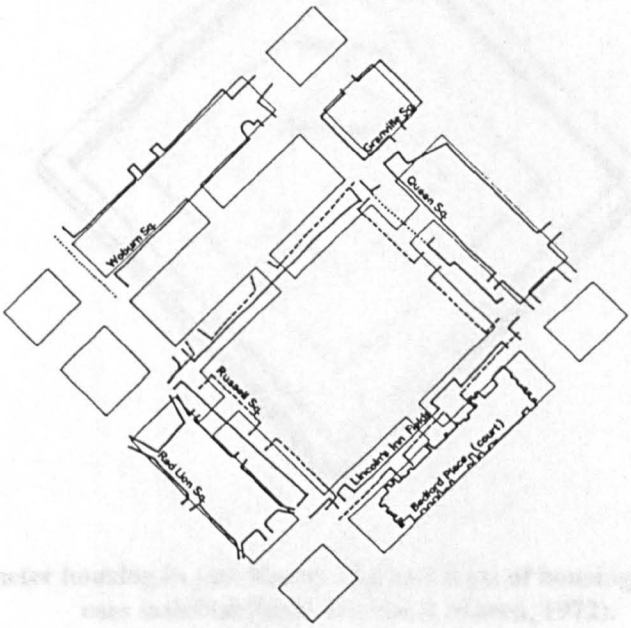


Figure 46. The 'urban rooms' compared with open spaces in the Bloomsbury, London. [Note that most of the buildings around the London squares exceed 3 storeys in height] (from Martin & March, 1972).

By accepting another point in the spectrum and place the housing round the edge of the site (Figures 47 and 48); the total population of 5000 can be housed in narrow-fronted houses or flats, four or five storeys high around the perimeter of the site. They could all overlook out and have a band of open space 180 ft wide. And at the centre of this is the 21 acres (8.5 hectares) of land required by the schools. In this case both the housing and the schools can be provided for.

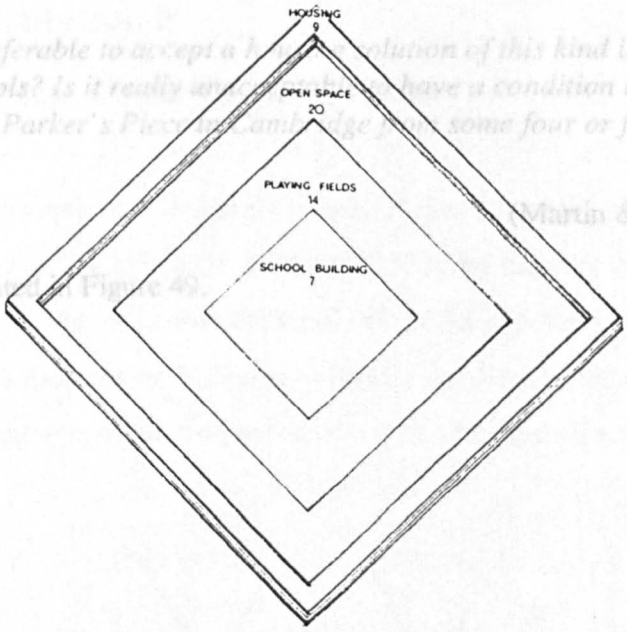


Figure 47. Perimeter housing in just 9 acres (3.6 hectares) of housing land, with other land uses satisfied (from Martin & March, 1972).

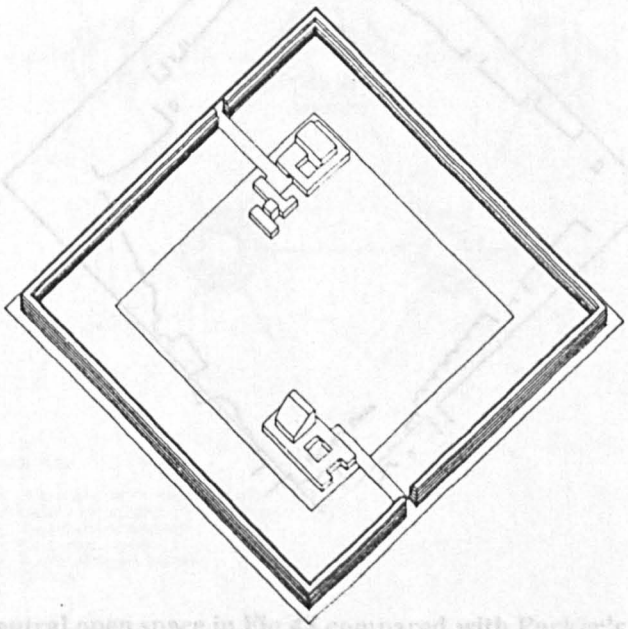


Figure 48. A four and a half storey of narrow-fronted housing band could accommodate 5000 people at a density of 500 persons per acre (1250 pph). But they all look out onto a vast open space (from Martin & March, 1972).

They further argue:

> *Is it now preferable to accept a housing solution of this kind in order to find land for the schools? Is it really unacceptable to have a condition rather like that of overlooking Parker's Piece in Cambridge from some four or five-storey terraces around it?*
>
> (Martin & March, 1972)

The above is illustrated in Figure 49.

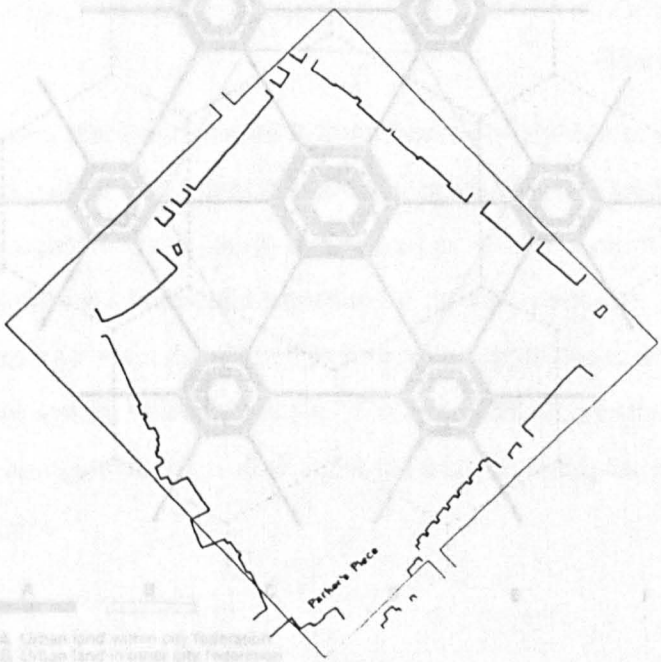


Figure 49. The central open space in Fig 48 compared with Parker's Piece in Cambridge (from Martin & March, 1972).

Following this, the same line of argument is developed around the systematic study of the

pattern of forms in relation to the city.

5.2.4.5: Speculation 5

5.2.4.5.1: Ebenezer Howard's garden cities

Figure 50 is a version of Howard's cluster of towns forming a city federation of 250,000 persons. According to Martin & March (1972), by the year 2000 we would need 250 of these clusters to accommodate the whole expected population of England and Wales. Suppose for a moment we built these clusters and demolished everything else. 250,000 people would live within easy reach of one another and all social facilities.

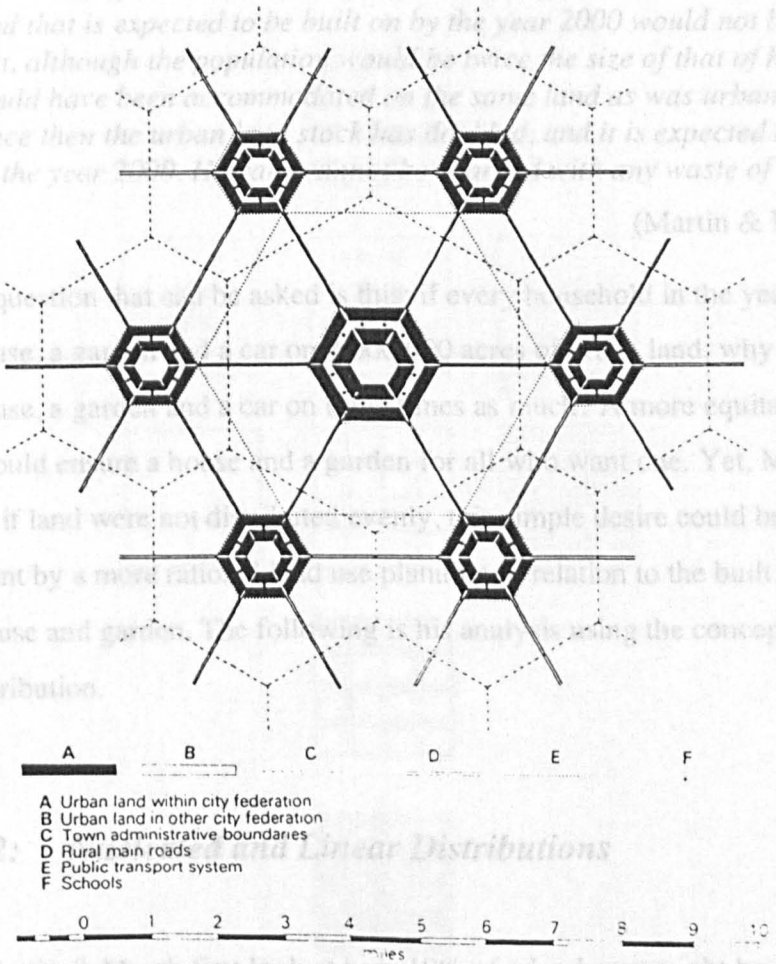


Figure 50. Ebenezer Howard's cluster of garden cities forming a city federation of 250,000 persons (from Martin & March, 1972).

Schools would be within walking distance of all homes. Shopping would take place indoors. Everyone who wanted to would have a house and garden. The minimum plot size is 20 ft by 100 ft (6 m. by 30 m.). The towns have hollow centres and the road system is more like a simple grid wrapped round upon itself than a radial and circumferential system. The minimum road width is 60 ft (18 m.) while the six principal boulevards are 120 ft (36 m.) as are the two principal avenues. The nation would then be living in towns, which could accommodate the motor car yet be small enough to permit easy pedestrian access to many different functions. They observe:

> *Yet the really remarkable thing about the proposition is this: 4,000,000 acres of land that is expected to be built on by the year 2000 would not be required. In fact, although the population would be twice the size of that of Howard's day it would have been accommodated on the same land as was urbanised in 1898. Since then the urban land stock has doubled, and it is expected to have trebled by the year 2000. Howard cannot be charged with any waste of land.*
>
> (Martin & March, 1972)

A simple question that can be asked is this: if every household in the year 2000 could have a house, a garden and a car on 2,000,000 acres of urban land, why will they not have a house, a garden and a car on three times as much? A more equitable distribution of land would ensure a house and a garden for all who want one. Yet, Martin & March add, even if land were not distributed evenly, this simple desire could be answered to some extent by a more rational land use planning in relation to the built forms required for the house and garden. The following is his analysis using the concept of nucleated and linear distribution.

5.2.4.5.2: Nucleated and Linear Distributions

Martin & March first look at how 10% of a land area might be covered by urban uses. This 10% is the proportion of urban land to all land in England and Wales and it includes urban open spaces like parks, but not agricultural land within urban

administrative boundaries. The 10% coverage distributed in a concentrated nuclear form (one single blob) is shown in Figure 51c. Figure 51e shows a dispersed nuclear pattern (all together 256 blobs). In contrast, Figures 51f to 51g, show the same amount of urban land distributed in a linear manner. The patterning in Figure 51f may be described as concentrated linear (a coarse mesh) and Figure 51h as dispersed linear (a fine mesh). Figure 51a shows 90% coverage, while Figures 51i and 51j show the inverted scheme of linear coverage.

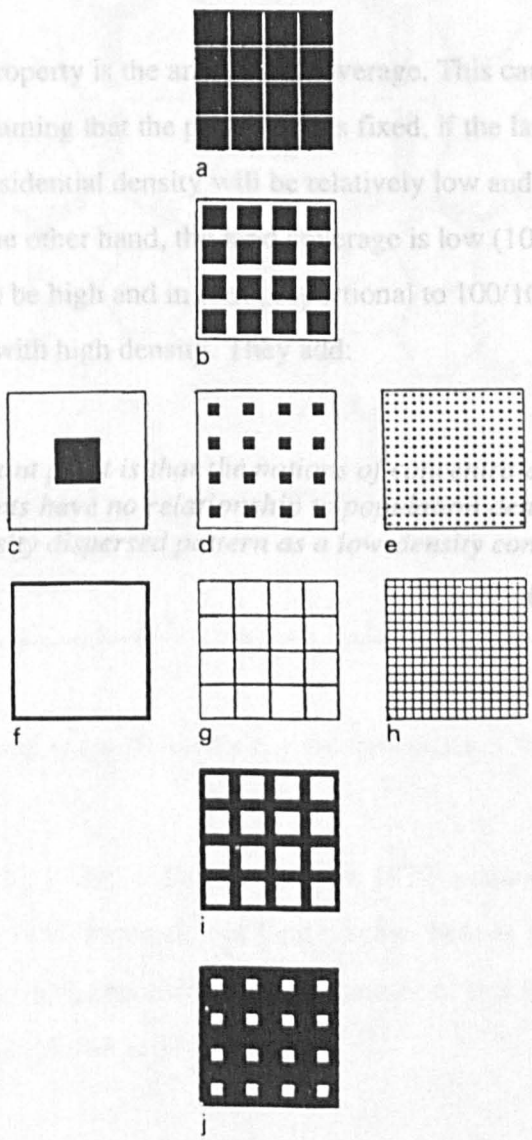


Figure 51. Range of nucleated and linear distributions from 10% to 90% coverage (from Martin & March, 1972).

Martin & March observe three properties in the distribution:-

1. The first is the topological property of being nuclear or linear corresponding to thinking blobs, or thinking of the spaces between.

2. The second property is concerned with scale. The property of being concentrated or dispersed is dependent on the scale chosen to observe the pattern. If for example, 1/256 of the dispersed blob pattern (51e) were to be seen at close range, it would look exactly like the concentrated blob pattern (51c). The only difference is the scale.

3. The third property is the amount of coverage. This can be high (90%) or low (10%). Assuming that the population is fixed, if the land coverage is high (90%), the gross residential density will be relatively low and proportional to 100/90 = 1.1. If on the other hand, the land coverage is low (10%), the gross residential density will be high and in turn proportional to 100/10 = 10. The low coverage is associated with high density. They add:

> *The important point is that the notions of concentrated or dispersed developments have no relationship to population density. It is as possible to have a high-density dispersed pattern as a low-density concentrated pattern.*
>
> (Martin & March, 1972)

5.2.4.5.3: *The case for linear form.*

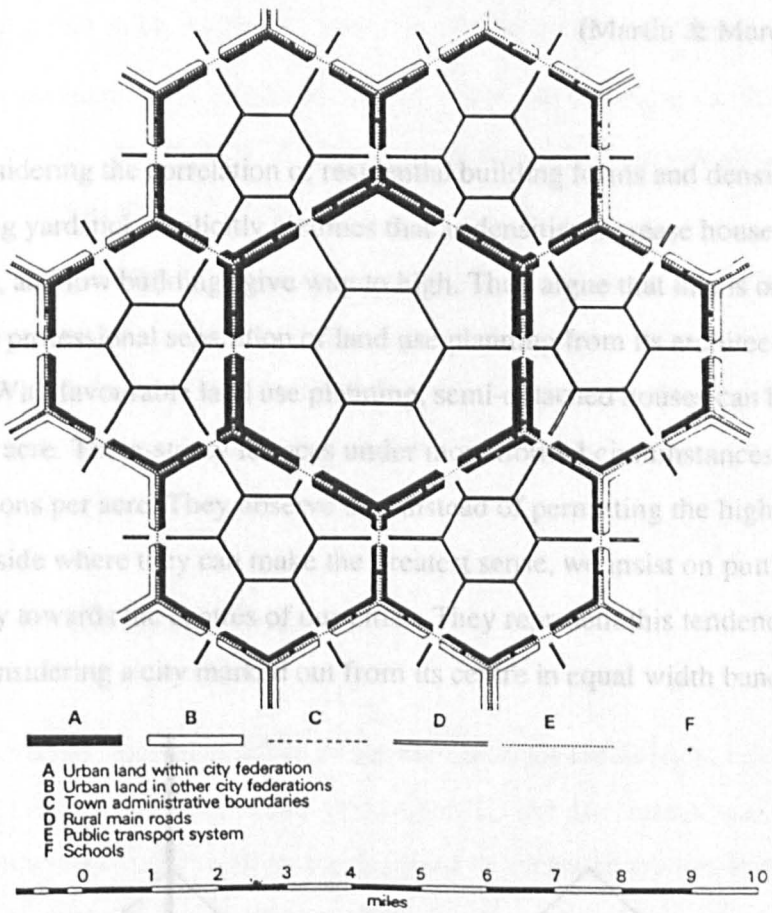


Figure 52. Linear antiform of Howard's city federation (from Martin & March, 1972).

Figure 52 shows the "think-line" (Martin & March, 1972) version of Howard's city federation. Exactly the same proportion of land is urban here as in the "think-blob" arrangement. In comparison, approximately one-quarter of this urban land is open space. It is not solidly built-up. Martin & March add:

> *It can be shown mathematically that the schools are likely to be more accessible in the linear form. The same is true of any other social function that is distributed evenly with the population. But perhaps the most significant*

difference between the two arrangements is that in the nuclear pattern driving across country requires movement across the town (or alternatively the construction of a special ring road). whilst the linear pattern is interrupted only briefly by urban development and , if the urban parks are placed at these points, cross-country routes need not pass through built-up areas at all.

(Martin & March, 1972)

In considering the correlation of residential building forms and density, the present housing yardstick implicitly assumes that as densities increase houses decrease in favour of flats, and low buildings give way to high. They argue that this is only true because of the professional separation of land use planning from its architectural implications. With favourable land use planning, semi-detached houses can be built at 200 persons to the acre. Three-storey terraces under more normal circumstances can be built up to 265 persons per acre. They observe that instead of permitting the highest densities in the countryside where they can make the greatest sense, we insist on putting the highest density towards the centres of our cities. They represent this tendency very cleverly by considering a city marked out from its centre in equal width bands (Figure 53a).

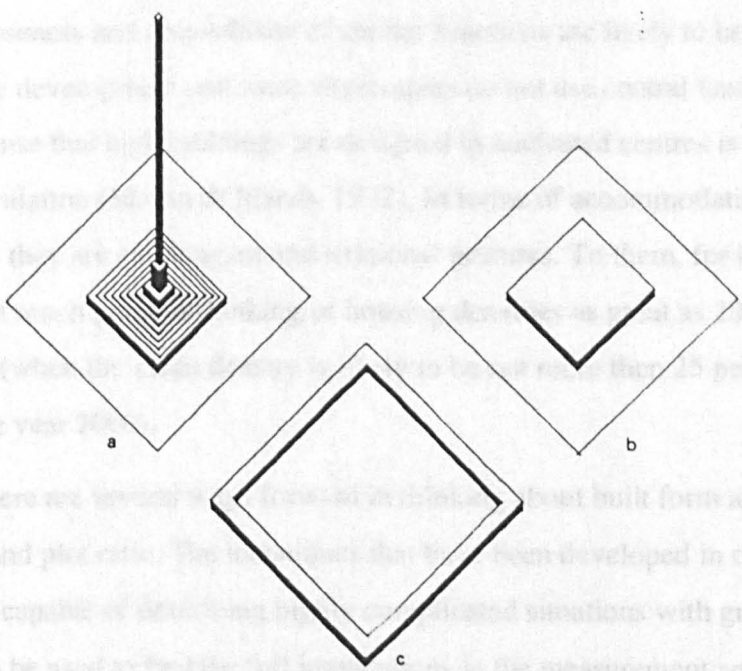


Figure 53. Housing density in relation to its distribution (from Martin & March, 1972).

According to Martin & March:-

- Each of these bands accommodates an equal amount of built space.
- Close to the centre, the built space will have to be achieved in the sky while on the perimeter this same quantity of space will be found on the ground.
- In conventional terms, if the plot ratio is 4:1 in the centre, at the 9th and outermost ring it will be only 0.055:1. If a building on the outskirts is one storey high, in the centre, 72 storeys will be required.
- Abandoning the density cone concept, the whole built form could be disposed at an average plot ratio of 0.11:1 (Figure 53b), or just twice that of the 9th ring. This plot ratio of 0.11:1 is only marginally higher than the mean of the five inner rings. Figure 53c shows the same built space distributed in a linear form.

5.2.5: Conclusions

Closeness and accessibility of similar functions are likely to be improved in a linear route development and since skyscrapers do not use central land very efficiently, the only sense that high buildings are designed in nucleated centres is in terms of real estate speculation (Martin & March, 1972). In terms of accommodating built space on urban land they are extravagant and irrational gestures. To them, for housing densities, there is not much point in thinking of housing densities as great as 200 persons per acre (500 pph) (when the mean density is likely to be not more then 25 persons per acre (60 pph) in the year 2000).

There are several ways forward in thinking about built form and its effects on densities and plot ratio. The techniques that have been developed in other disciplines and which are capable of describing highly complicated situations with greater certainty and clarity can be used to find the full implications in the measurement and the invention of built forms. For example, the latest development in the study of fractals by Bovill (1996), Ostwald & Moore (1996) and other researchers, even in other fields of sciences, perhaps

can be utilised in the prediction on the possibilities of various built forms generated by an alternative high-density model. The full impact of the alternative paradigm together with the existing model can then be analysed and better appreciated. The possibility of an alternative new town structural model based on the principles of high-density, low-rise model can then be generated and be used to guide any future new town development.

5.3:

Perimeter Housing And Its Evolution

5.3.1: An introduction

What are the principles behind perimeter housing? What are the differences between perimeter housing compared to the Modern Movement housing block?. The application of the principles of the fresnel square in the design of high-density housing is significant in its influence on the possible built form of the development, and the result is seen in perimeter housing.

This chapter seeks to rediscover the secret found in the fresnel square by tracing the evolution of perimeter housing by using case studies.

5.3.2: The secret of the fresnel square discovered

The advantages of Perimeter Housing were highlighted by Professor Leslie Martin and Lionel March in the 1960s. From 1966 to 1967, they presented papers which analysed the notions that by using the geometry of the Fresnel Square, new relationships of housing and land could be worked out. The 'Fresnel Square" is in actual fact two squares, one smaller than the other and arranged symmetrically within it. They are sized so that the area of the rim between the two is equal to the area of the inner, smaller square. The result is startling because the inner area always seems greater than it really is.

That study examined a 20-hectare built up part of an industrial city, complete with terraced housing accommodating 5,000 people and containing virtually no open space. By arranging the housing as a continuous band around the perimeter of the site, 8.5 hectares of land would be available for public open space. To accommodate 5,000 in this perimeter block would require a four to five-storey building, which might not be acceptable. If courtyard planning were developed around the perimeter, the overall height of the buildings would be reduced to three storeys, with 8.5 hectares of school land and public open space in the form of squares, comparable in size to those in the Bloomsbury

area of London.

Richard MacCormac(1980) says that this kind of 'geometry could convert a dense object with inherent planning problems (which at the time might have been solved with a ziggurat) into a shallow band with prospect, aspect and privacy'. The traditional Modern Movement block, isolated in its sea of green, was to be exploded into a thin ring round a green. The resulting central space is both more controllable and perceptually richer than the freestanding block surrounded by open space which was favoured by early modern planners. When translated into architectural terms this means that the traditional tower block isolated within a square of green could be developed as a thin ring around the green without the loss of dwellings (Colquhoun and Fauset, 1991).

The approach had other implications. MacCormac commented: 'Considered at the scale of planning strategy, it raised the ideal that housing land might be arranged around other land uses with spectacular increases in net housing density.' In 1968, Martin elaborated the rim-round-a-green idea by suggesting that, by inserting other uses, for instance schools or playing fields into the central square, 'double or triple cropping of the [central] land' could be achieved and that the housing rim would greatly benefit from the richer mix of activities within it.

This notion that education, recreation and housing could be harmoniously integrated within a new geometry ran directly counter to Modern Movement theories of separation of function pioneered by people like Tony Garnier. According to Davey (1980), by the late 60s these theories were part and parcel of the planning legislation and bereaucratic structures of most Western countries - particularly Britain which enjoyed the most elaborate separatist planning legislation in the world.

MacCormac recalls the evolution from the simple Fresnel notion as being;

> *difficult to describe without giving a false impression of an orderly sequence. In fact the attempt to find a pattern for high density low rise housing was highly frustrating and abortive. Interestingly this was partly because we assumed that the scheme would be achieved through choosing a courtyard grid of the right*

scale and density. The problem with such grids, in relation to family housing with gardens is what to do with the intersection and how to introduce roads and car parking. Eventually the solution emerged from thinking not about grids but about the properties of traditional cul-de-sac to achieve a convolution which had the geometric advantages of courts but admitted vehicles and achieved a density of 100ppa (0.250pph)'.

(MacCormac, 1980)

Furthermore, his 'convolution', by which the pristine Fresnel idea was adapted to the realities of twentieth-century car ownership, is most easily thought of as a corrugation of the perimeter strip which look at the Fresnel square from the traffic-free inside. Imagine that by surrounding the perimeter with a thin strip of corrugated cardboard. The inward pushing corrugations form car parking cul-de-sac; approached from the peripheral access road; the outward pushing ones become extensions of the central space, but more intimate and immediately controllable by the people living in the adjacent houses. The result is remarkably like Radburn planning but it avoids some of the problems of conventional Radburn estates by allowing cars to drive up to every home and by providing gardens and privacy on the soft side of the houses.

5.3.3: *The secret of the fresnel square applied - case studies*

Perimeter planning were put into practice by MacCormac In several of the schemes in which he was involved in:-

At Pollards Hill, Merton; the geometry of the corrugations was entirely rectilinear. This sometimes led to unfortunate clashes of house types, with windows facing walls across narrow alleys and to some mean, arid car parking spaces.

At Duffryn, Newport in Wales, Richard MacCormac designed 977 dwellings on a 38.5-hectare site achieving a density of some 185 bedspaces per hectare. The planning geometry was much more buckled and flexible so it could avoid the obvious nastinesses

of Pollards Hill. However, Duffryn enjoys three other great advantages over the Merton scheme; first, the authorities agreed to inserting a school within the perimeter, second, the site, which with its profusion of well-grown vegetation, is much richer than the empty inclined green plane at Pollards Hill. Third, the nett density is lower (185 pph as opposed to 287 pph in Pollards).

The relatively low density of the Duffryn scheme at first seems to negate one of the prime points of perimeter planning - economy of land use. But the figures should be seen against a change in central government density guidelines.

In his appraisal of the schemes in the Architectural Review of April 1980, Peter Davey places Newport's Duffryn scheme as the largest and the latest example of perimeter development, which is a uniquely British contribution to low rise high density housing. The aims of perimeter development are simple and conflicting: to obtain high net densities and efficient use of land while at the same time providing dwellings as houses (as opposed to flats) with gardens emerging out of a natural setting.

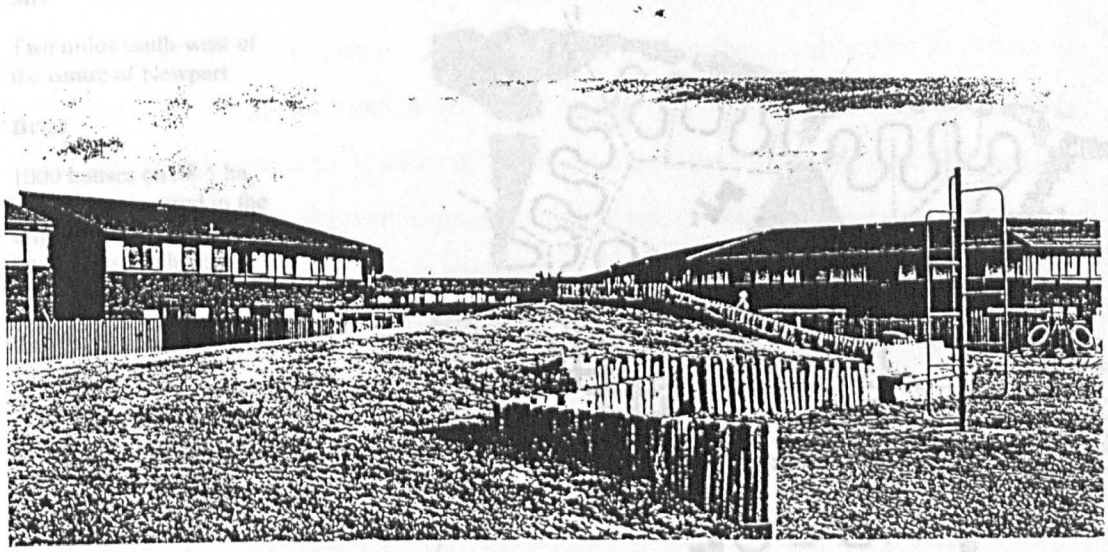


Figure 54. Play area in the central space

Peter Davey also criticized the uniformity of the Duffryn scheme. To achieve the crinkle perimeter, house types were located with no regard to orientation. Probably about a quarter of the dwellings would never get sunshine into their living rooms and gardens. Richard MacCormac discounted this because the estate offered so many other physical advantages, nevertheless it demonstrated a fundamental problem when individual dwellings were compromised to achieve an overall concept. Also, the great size of Duffryn made it a most adventurous experiment. By looking at the figures today, it is difficult to believe that this giant, one class scheme could possibly work then.

Housing in Duffryn, Newport, South Wales.

Site

Two miles south-west of the centre of Newport.

Brief

1000 houses on 38.5 ha. The shops required in the original brief were not built. Low-rise housing throughout.

Town-planning requirements

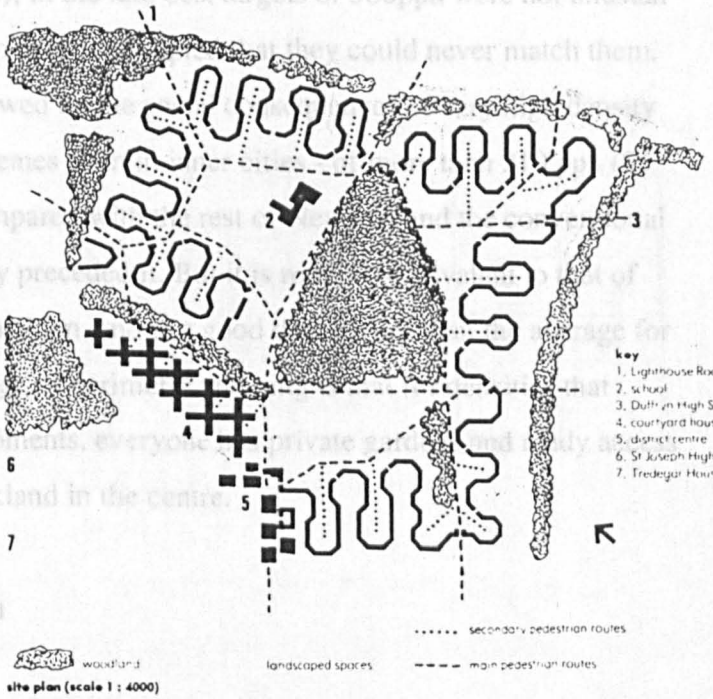
All houses to have direct vehicular access. Ready access to green open spaces from all dwellings.

Density

185 bed spaces/ha.

Construction

Timber frame structure was adopted for lightness, flexibility and speed of construction. The entire scheme was built in two years.



site plan (scale 1 : 4000)

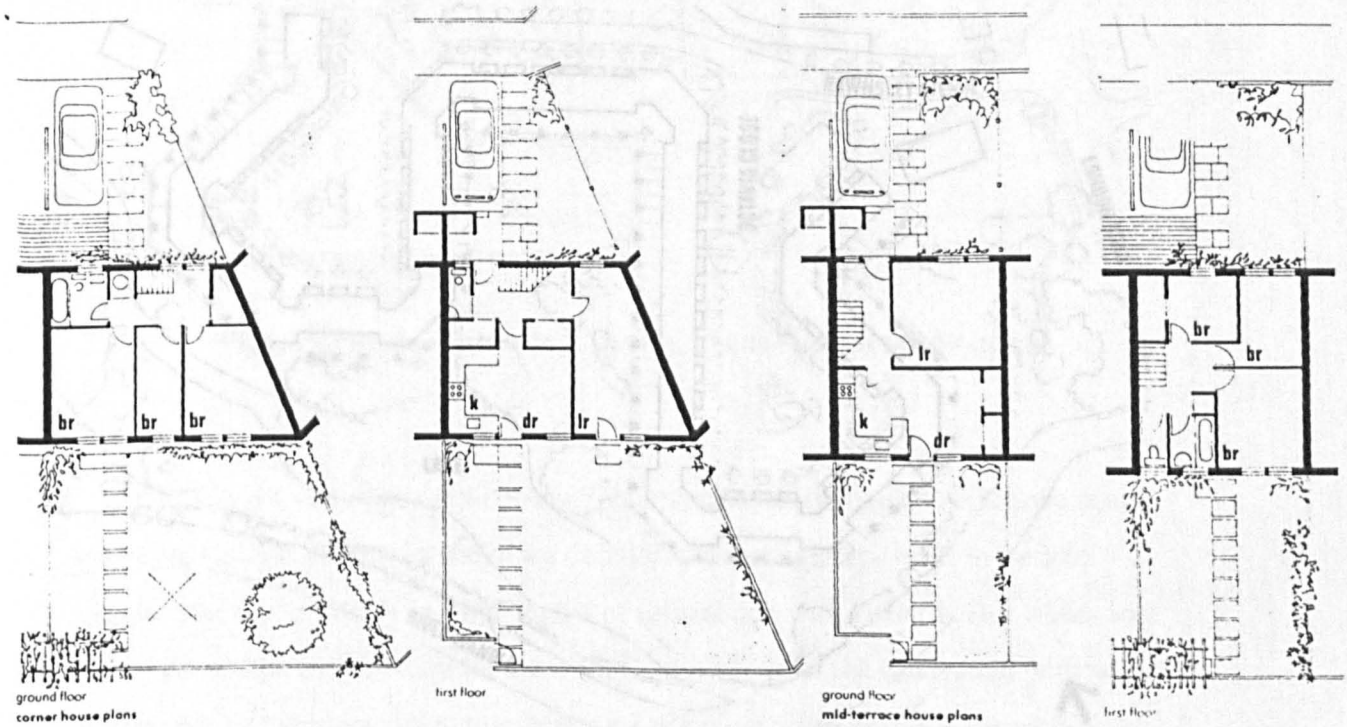


Figure 55. Perimeter Housing, Duffryn, Newport, South Wales

According to Davey (1980); in the late 60s, targets of 500pph were not unusual and the protagonists of perimeter planning accepted that they could never match them. By the late 70s, the government, awed by the social consequences of very high density living, was reluctant to accept schemes even in inner cities - of more than 210 pph (85 ppa). Duffryn's density is low compared with the rest of Newport and the conventional housing estates which immediately preceded it. But it is roughly equivalent to that of Britain's first New Towns, like Basildon, and is a good deal higher than the average for Milton Keynes. The great advantage of perimeter planning is that for densities that compare well with similar developments, everyone has private gardens and ready access to a great area of vehicle-free parkland in the centre.

Housing in Merton, London

At Watermeads, Merton, the Borough Architects Department under Bernard Ward designed dwellings on a four hectare site to a density of 311 bedspaces per hectare leaving approximately 1.4 hectares of public open space.

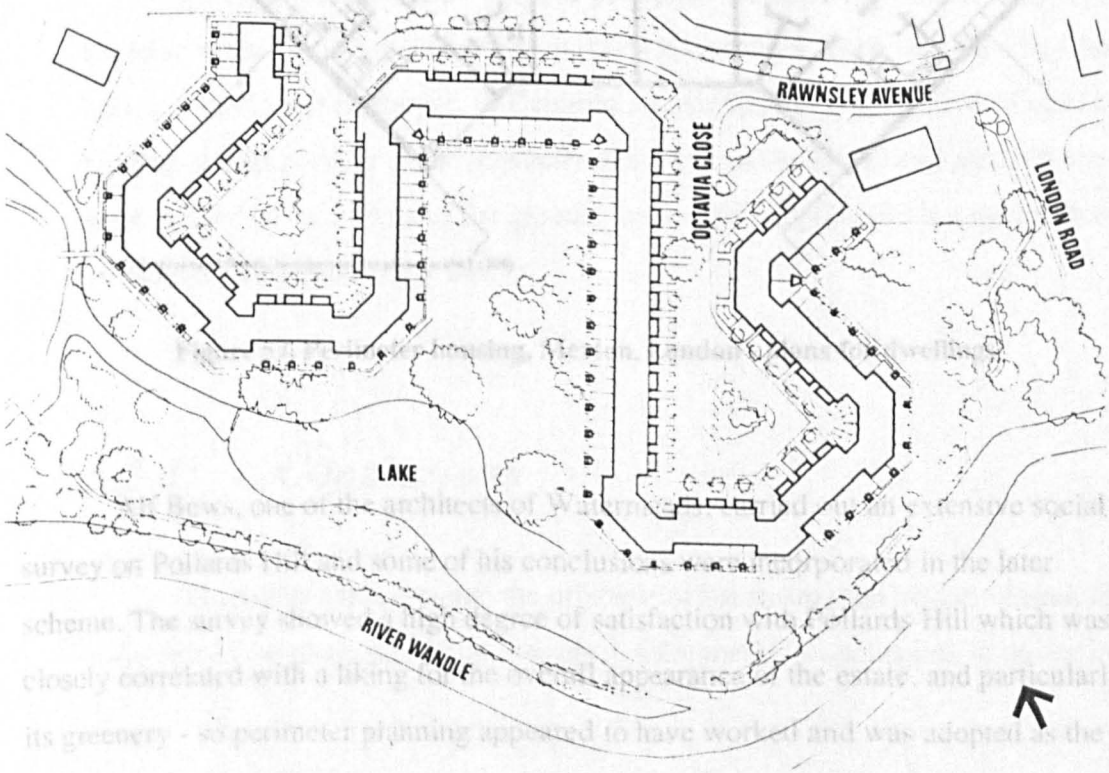


Figure 56. Site Plan of Merton

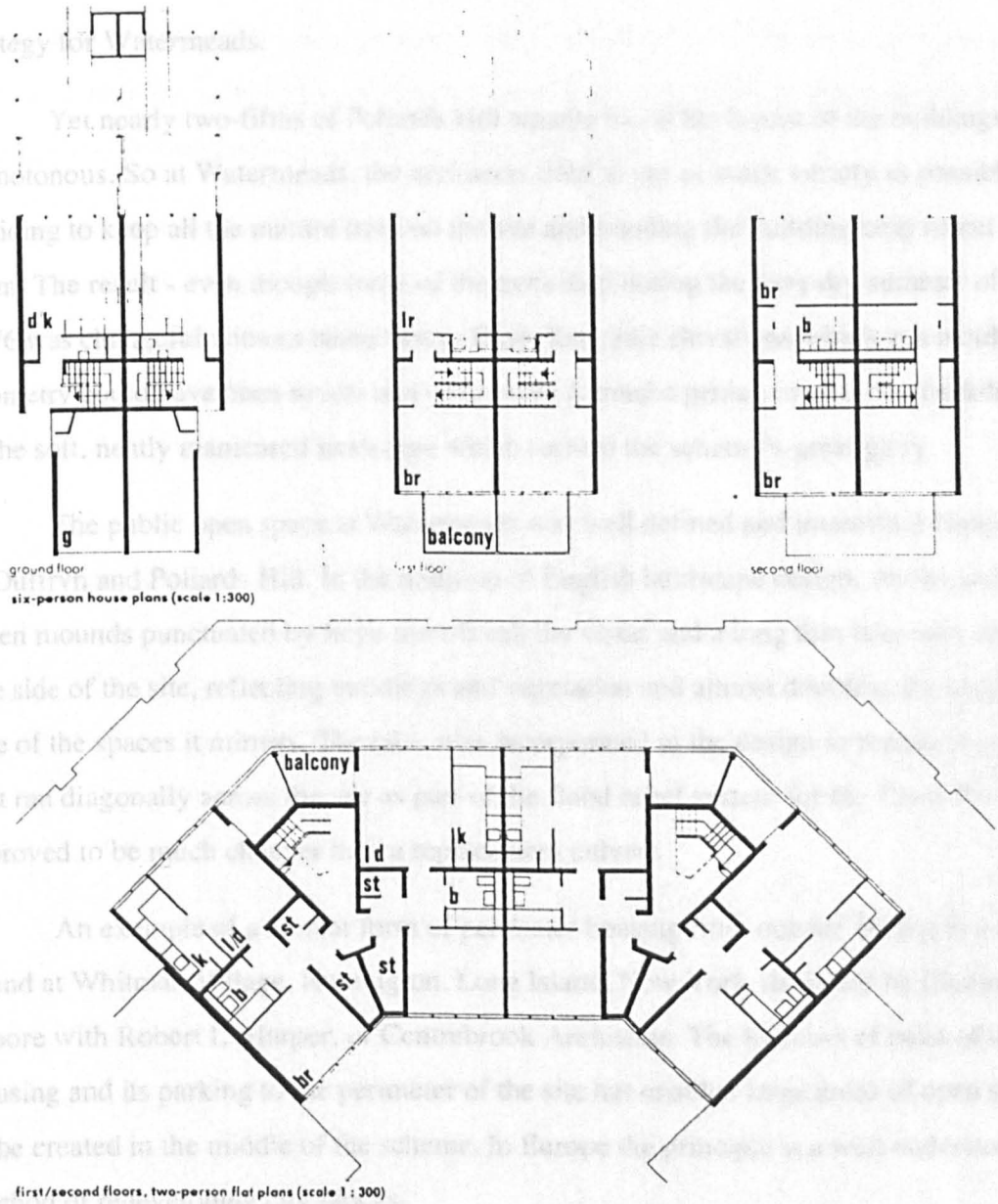


Figure 57. Perimeter housing, Merton, London - plans for dwellings

Alf Bews, one of the architects of Watermeads, carried out an extensive social survey on Pollards Hill and some of his conclusions were incorporated in the later scheme. The survey showed a high degree of satisfaction with Pollards Hill which was closely correlated with a liking for the overall appearance of the estate, and particularly its greenery - so perimeter planning appeared to have worked and was adopted as the

strategy for Watermeads.

Yet nearly two-fifths of Pollards Hill tenants found the layout of the buildings monotonous. So at Watermeads, the architects tried to get as much variety as possible by deciding to keep all the mature trees on the site and winding the building strip round them. The result - even though some of the trees died during the very dry summer of 1976 was changeful without being fussy. Those long pale elevations which in a rectilinear geometry could have been severe and oppressive formed a genial, unassertive backdrop to the soft, neatly manicured landscape which formed the scheme's great glory.

The public open space at Watermeads was well defined and interesting compared to Duffryn and Pollards Hill. In the tradition of English landscape design, shrubs and green mounds punctuated by large trees break the vistas and a long thin lake runs down one side of the site, reflecting buildings and vegetation and almost doubling the apparent size of the spaces it mirrors. The lake, was incorporated in the design to replace a culvert that ran diagonally across the site as part of the flood relief system for the River Wandle - it proved to be much cheaper than a replacement culvert.

An example of a similar form of perimeter housing from outside Britain is to be found at Whitman Village, Huntington, Long Island, New York, designed by Charles W. Moore with Robert L. Harper, of Centrebrook Architects. The location of most of the housing and its parking to the perimeter of the site has enabled large areas of open space to be created in the middle of the scheme. In Europe the principle is a well understood method of redeveloping city blocks.

5.3.4: Conclusions

Throughout this chapter, the principle of the fresnel square can be seen in its influence in the planning of high-density development. Its application in the various case

studies shown clearly that a new geometry can evolved and its planning of the various facilities within the housing parcel ran counter to that of the Modern Movement theories of separation of function pioneered by people like Tony Garnier.

In contrast to that of the Modern Movement high-rise built form, the alternative low-rise built form in a high-density development is a direct result of this approach. It would be interesting to see in the later chapters how the further application of the principle of the fresnel square could yield further possibilities in the design of high-density situation.

Chapter 6:

Application of Martin & March's Theory To Singapore

6.1: Intensity of land use - comparing the two models

6.1.1: An introduction

Fonseca (1975) in his paper "Planning and Land-Use in Singapore" observed that land is not being used as intensively as it was in the early stages of Singapore's growth. In his argument, he drew a comparison between a historical section of the town with a new development in the former rural zone, which will be discussed.

6.1.2: Intensity of land use - comparing Tao Payoh and Kampong Glam.

	Kampong Glam	Toa Payoh Neighbourhood 2
1. Area (acres)	38.8 (15.5hect.)	112.9 (45.2hect.)
2. Population	14,234	42,790
3. Density (persons per acre)	367 (917 ppha)	379 (947 ppha)
4. Plot ratio	1.35	1.39
5. Average number of floors	2.00	10.75
6. Site coverage	67.40	12.94

Table 10 Intensity of land use in Kampong Glam and Toa Payoh New Town (Neighbourhood 2) (adapted from Fonseca, 1975)

Table 10 contrasts the intensity of land use in Kampong Glam (high-density, low-rise), with that of Neighbourhood 2 in Toa Payoh New Town (high-density, high-rise). Six important measures of land use are used to enable one to evaluate the intensity at which land is utilised. Both communities under study have similar densities. But the site coverage for Kampong Glam is 5 times compared to Toa Payoh, it follows that the average building height in Toa Payoh will be about ten storeys as opposed to two storeys in Kampong Glam. In other words, Kampong Glam achieves the same density in two-storey structures. An important conclusion at this point is that high-density is not synonymous with high-rise; high-density, low-rise is also possible. In addition, high rise is not necessarily indicative of high intensity of use

of land. Item 6 on site coverage in Table 10 is instructive. It reflects the crucial difference in planning between the two communities. On the one hand, the spatial configuration of Kampong Glam with 67% of the ground occupied by residential and commercial structures may be described as "close-packed". On the other hand, Toa Payoh, planned on "garden-city" principles, is a dispersed configuration with only 13% of its site occupied by structures.

Figure 58 Aerial view of the Kampong Glam District (URA 1988)

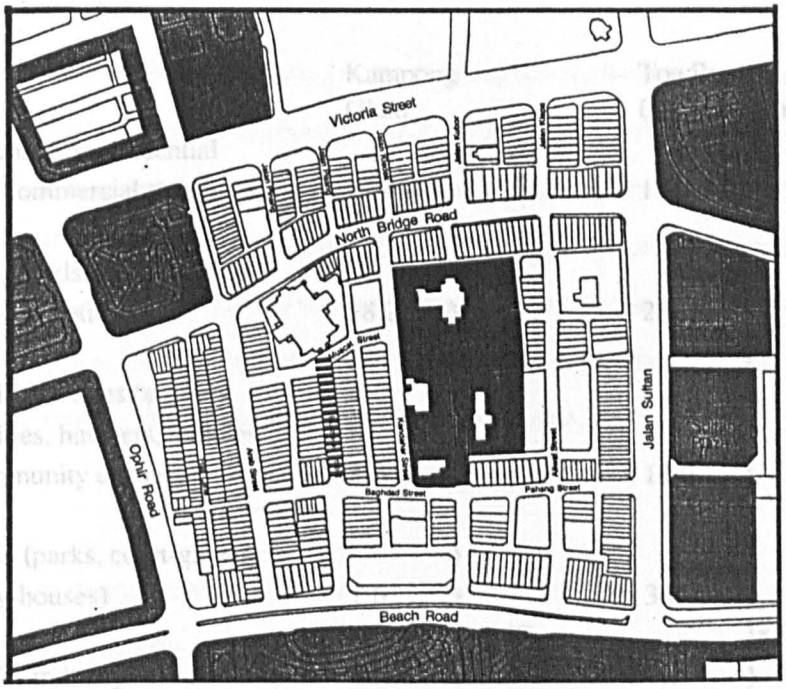


Figure 59. Layout of Kampong Glam District (URA 1988)

Table 10 amplifies this crucial difference in the intensity of use of land and pin-points an important penalty that follows from the tenets of contemporary planning in Singapore, i.e the kind of spatial environment it imposes and the intensity of use of land it presumes people are willing to tolerate.

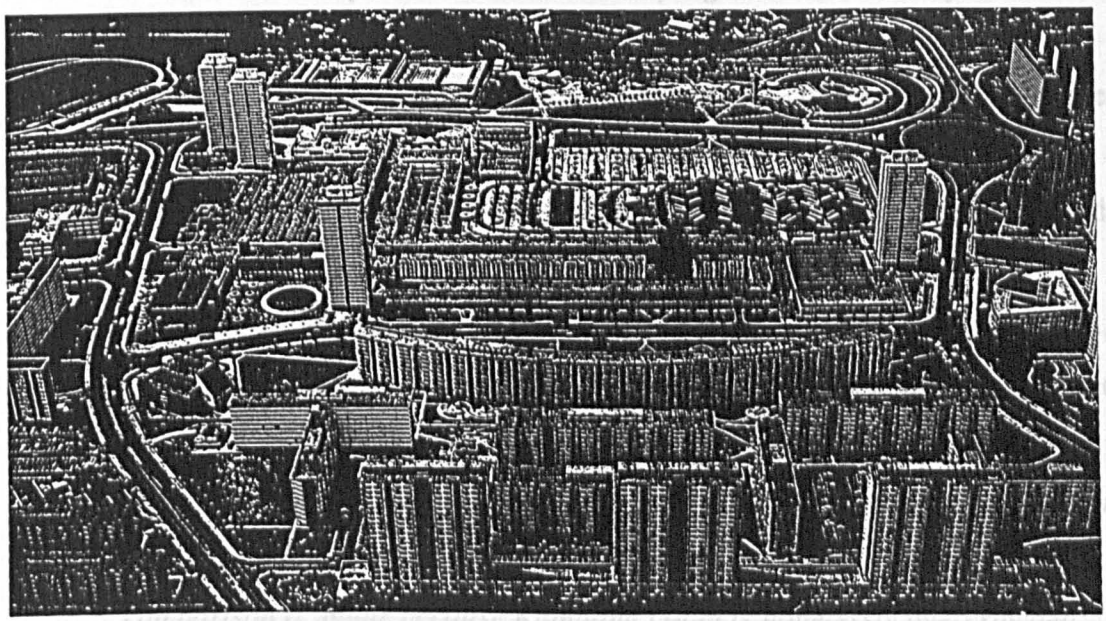


Figure 60. Aerial view of Toa Payoh New Town (HDB 1973)

	Kampong Glam		Toa Payoh (Neighbourhood 2)	
1. Land occupied by residential and commercial structures	67.4%		12.9%	
2. Transport (roads, parking, service stations)	18.2		28.6	
3. Community services (schools, utilities, hawkers, temples, community centres)	8.0		10.0	
4. Recreation (parks, court-games, play-houses)	1.6	32.6%	3.0	87.1%
5. Reserve for industry	---		4.1	
6. Building setback (7.5 feet on each side of buildings)	---		3.1	
7. Other uses	4.8		---	
8. Residual land	---		38.1	
	100.0%		100.0%	

Table 11. Comparative land use - Kampong Glam and Toa Payoh

The most significant aspect of Table 11 is that 38 % of the ground space (item 8) of Toa Payoh Neighbourhood 2 is residual land distributed as space between buildings. This represents in actual land area of 43.0 acres (17.2 hectares). This land is marginally used, and cancels out the original saving in ground space gained by building high-rise structures. According to Fonseca (1975), in hard economic terms, this land is withdrawn from economic use and its development potential is unrealised. He argues:-

> *One may argue that compared to Kampong Glam, which uses 67% of ground space, Toa Payoh is doing remarkably well to use only 13%, so that the comparison is unfair because Kampong Glam is hopelessly overcrowded; also that there is redeeming social merit in providing for air-movement, sunlight and privacy, and that these amenities can be achieved only by building slab blocks, orienting them in certain directions and spacing them*

approximately 80 feet apart. In the first instance, Kampong Glam has the same density.....as Neighbourhood 2, so if the former is overcrowded, the latter is too. Secondly, to argue that discontinuous, evenly spaced and uniformly oriented slab blocks and low intensity of site coverage are the only means to achieving air-movement, sunlight and privacy is to adopt a position that can quickly become an embarrassment, to say the least. The indisputable fact remains - that dispersed configurations are not conducive to conserving land.

Fonseca further argues that the configuration of New Town developments derives largely from economic and technological constraints and he adds:-

....it can easily be demonstrated that skilful designers and land-use planners can, without too much difficulty, can achieve a reduction in the percentage of withdrawn land (without sacrificing existing social and personal amenity) by redeploying it more usefully, even given the economic and production constraints prevailing in Singapore.

Contrary to what we may like to think, Fonseca feels that it is not economic and production constraints that restrain our imagination, rather we are bound by design ideologies that predispose us to routine spatial responses in terms of neat rows of discontinuous blocks that necessarily require a fair amount of space around them. He adds that foremost among these ideological constraints is our preoccupation with visible states rather than processes, which is most commonly manifested in our concern for neatness, uniformity and our habit of disaggregating complex social processes into discrete parts that are not "function-preserving". For example, blocks are assembled into precincts, precincts into neighbourhoods and neighbourhoods into elegant towns that reflect our preconceptions of how people ought to live.

6.1.3: Conclusions

The peculiar fact about land is that once allocations are assigned they become

highly durable, they persist. The planning tenets which discourage multiple land use and the zoning approach are pushed as fundamental planning principles and this has resulted in an increased in the need to travel as settlements become dispersed. On the other hand, in Asia, we have a bazaar tradition of mixed land use and we have used land intensively in the early settlements in shophouse form. There is the alternative to intensify land use by building more compactly at low-rise instead of going high-rise. The next few conceptual frameworks will demonstrate how the principles of high-density, low-rise can be used in intensifying land use.

Chapter 6:

Application of Martin & March's Theory To Singapore

6.2: Conceptual Layout For An Alternative Urban, High-Density Low-Rise Housing

6.2: Conceptual layout for an alternative urban, high-density, low-rise housing

6.2.1: An Introduction

In order to test the feasibility of the alternative form of housing, this part of the thesis looks into 3 case studies before proposing the use of the alternative model in a particular site, which will be covered under Chapter 6.3. The case studies follow similar systematic and analytical methods in comparing the various planning parameters adopted in the design.

6.2.2: CASE STUDY 1: Pasir Ris Housing

In this case study, the existing layout will first be discussed followed by the conceptual layout of the alternative high-density, low-rise model.

6.2.2.1: The existing layout

The Paris Ris Housing layout is based on the neighbourhood unit concept. For the purpose of clarity, the background to the development of the neighbourhood unit concept will be briefly discussed.

The neighbourhood unit concept attributed to Clarence Perry (1929), earned the enthusiastic support of people like Walter Groupius and Frank Lloyd Wright. Since then, many new towns all over the world including Singapore have adopted this concept. The concept is derived from the basic assumption that a self-sufficient community is the optimal solution to a over-crowded city or the suburban sprawl. To this end the HDB has used it mainly as a planning tool in organising its mass housing

programme.

When Clarence Perry first proposed the neighbourhood theory in 1929, he intended it both to be a social as well as a physical planning tool. One of the aims of the neighbourhood was to introduce a principle of physical order into the chaotic, fragmented urban aggregate with of the hope of defining some sense of community.

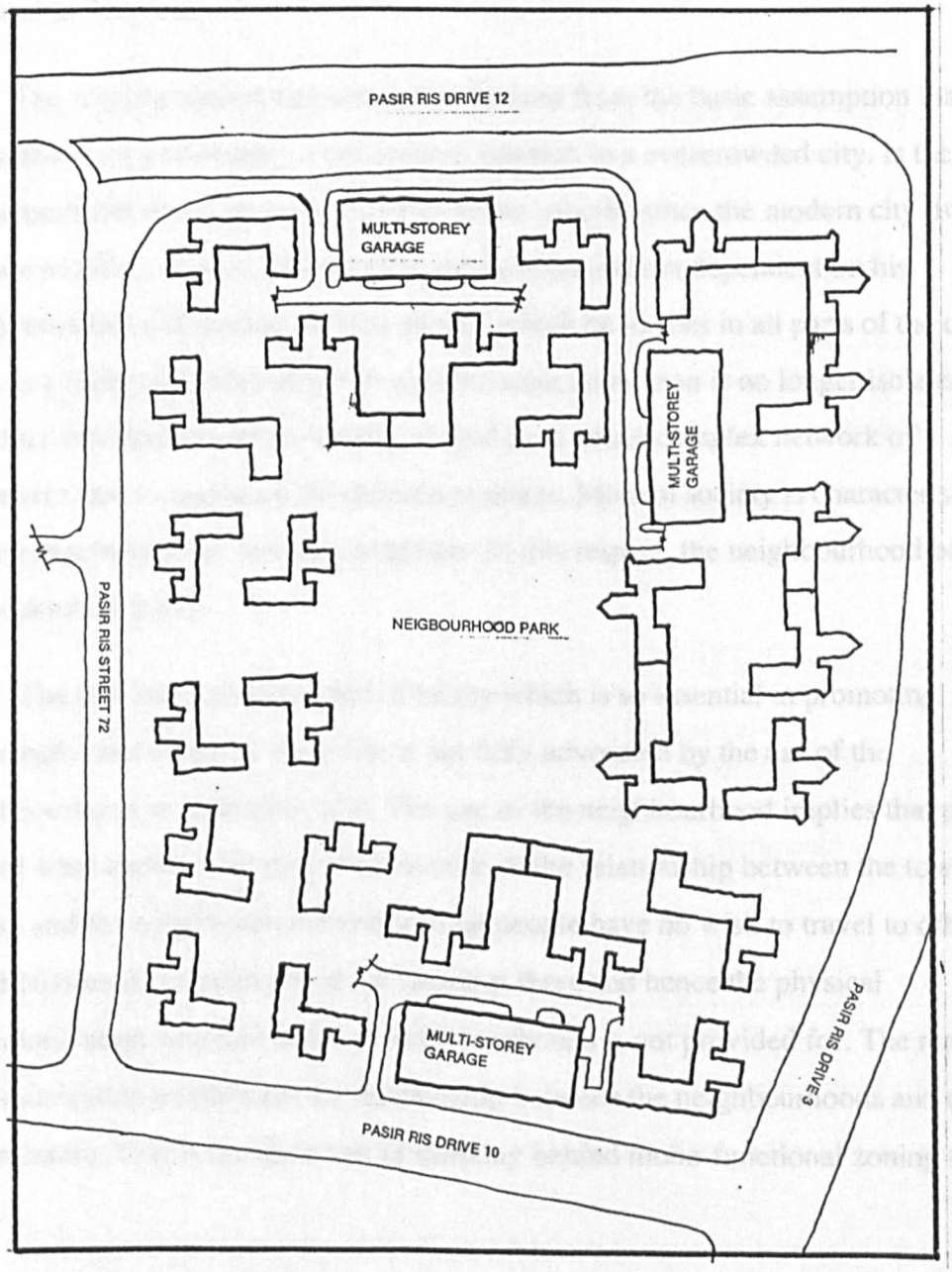


Figure 61. The existing layout of Pasir Ris Housing

The Paris Ris Housing layout was planned in the late 1990s. The basic block key is L - shape, repeated to form the housing precinct. There are 26 blocks of residential blocks with 3 multi-storey garages serving the residents. The housing are planned around a neighbourhood park in the centre of the layout. The density in this layout is approximately 595 person per hectare with a plot ratio of 2.2. Figure 61 in the previous page shows the layout of this housing parcel.

The HDB has adopted this model with some modification made to suit our local context. The use of the neighbourhood as a planning tool has its implications and limitations. They are:-

a. The neighbourhood unit concept is derived from the basic assumption that a self-sufficiency community is the optimal solution to a overcrowded city. Is the neighbourhood structure more suitable for the suburbs since the modern city dweller is more mobile, rootless, prefers to be anonymous and not dependent on his neighbours but with special interest groups which he locates in all parts of the city. Also as a result of availability of mass communication, man is no longer isolated from his other counterparts. Man is being shaped by a whole complex network of influences due to increased information contacts. Modern society is characterised by its heterogeneity more than anything else. In this respect, the neighbourhood becomes a limitation as a tool.

b. The provision of choice and diversity which is so essential in promoting meaningful and complex urban life is not fully advocated by the use of the neighbourhood as a planning tool. The use of the neighbourhood implies that people do not want choice. The physical structure of the relationship between the town centre and the neighbourhood implies that people have no wish to travel to other neighbourhoods to make use of the facilities there and hence the physical communication structure between neighbourhoods is not provided for. The main communication emphasizes the relationship between the neighbourhoods and the town centre. This is the same sort of thinking behind mono-functional zoning type of city.

c. The neighbourhood unit concept is based on very homogeneous community and therefore the needs of the people are generally similar. The basic size of the

neighbourhood which is based on a walking distance of 400 metres is about the same for every neighbourhood with little regard for other factors that may give identity to a neighbourhood such as the specialness of the area where the neighbourhood is found. By and large the neighbourhoods are too similar in design, layout, shops and facilities from each other to foster any kind of community identity.

The statistics for the existing layout

Total number of residential blocks: 26

Total number of dwelling units: 1599 (assuming an average of 13 storeys)

Site Area: 11.02 hectare

Area computation

1a.	Average floor area	=	115 sq. metre.
	Total nett. floor area	=	**183 885 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**239 050 sq. metre.**

Table 12. Area computation for the existing layout

Density computation

Site area	=	11.02 hectare (110 200 sq.metre)
Assuming 4.1 persons per household, total population in the area	=	6555 persons
Density	=	**595 person per hectare (pph)**

Table 13. Density computation for the existing layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**2.2**

Table 14. Plot ratio computation for the existing layout

Plot ratio has been shown in the calculation to be consistent with the local land valuation policy and also to be in line with the Planning Requirement. HDB has in the past used to calculate the intensity of development by using residential density in

terms of person per hectare (ppha), but since 1990 has been using the method of plot ratio control in all its development.

In terms of number of dwelling per hectare, the existing layout is achieving approximately 145 dwelling unit per hectare.

6.2.2.2: *The alternative layout*

In this alternative layout, the high-density, low-rise model is tested on the existing site so serve as a comparative study.

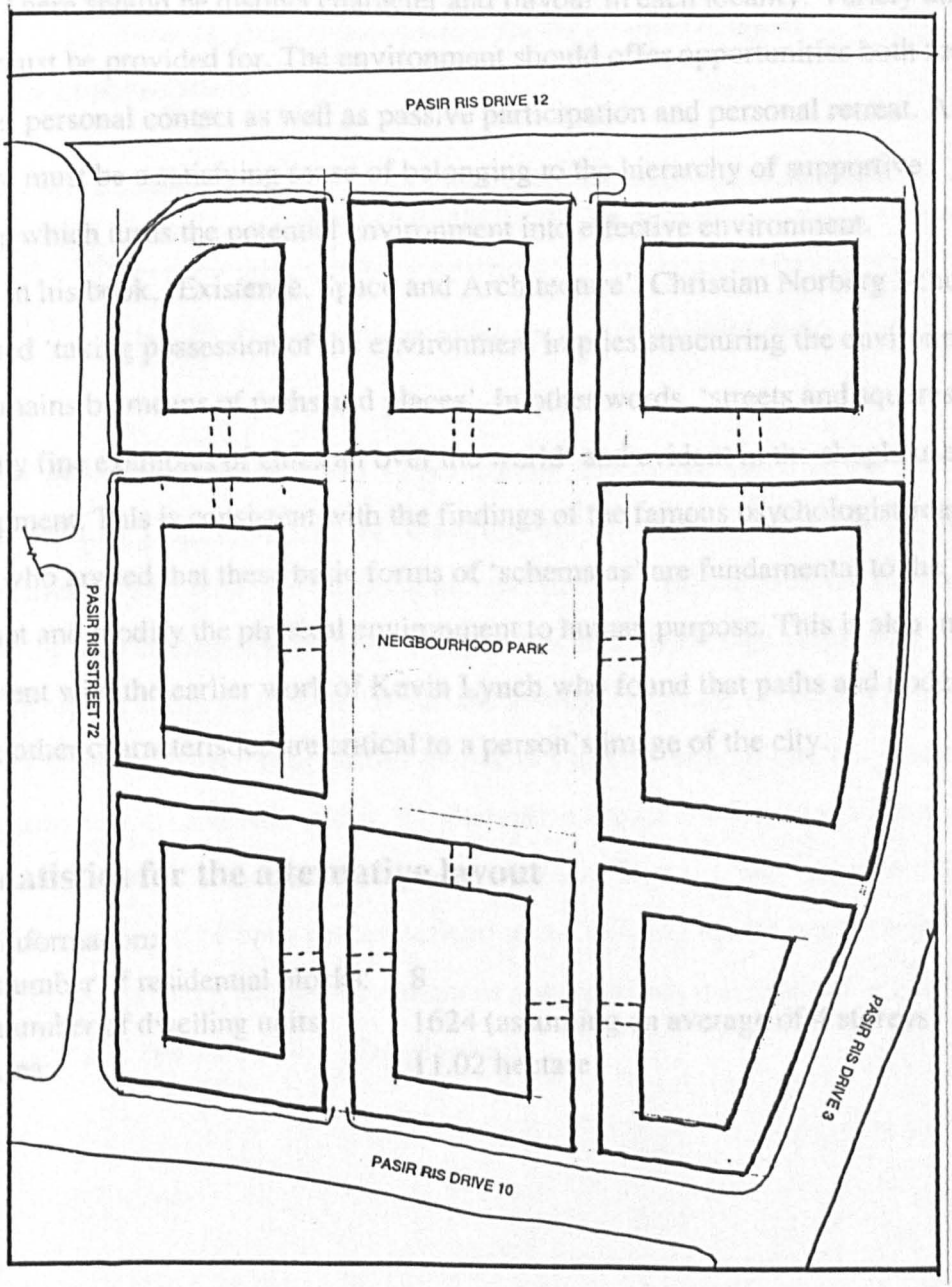


Figure 62. The alternative layout

By the use of Fresnel square principle, i.e. building blocks along the perimeter of a city block can bring about a very different street architecture. The street blocks can also enhance street life which is consistent with the urban strategy of bringing back the streets. Figure 62 in the previous page shows the alternative layout planned according to the principles of Fresnel square and Martin and March's theory. There are altogether 8 blocks surrounding the central neighbourhood park. Basement carpark instead of multi-storeyed carpark is assumed in the layout.

The new towns should invariably be rich in its urban life and so structured to do so. The spaces both within and without the homes should become places where life occurs. There should be distinct character and flavour in each locality. Variety and choice must be provided for. The environment should offer opportunities both for intimate, personal contact as well as passive participation and personal retreat. Above all, there must be a satisfying sense of belonging to the hierarchy of supportive contexts which turns the potential environment into effective environment.

In his book, 'Existence, Space and Architecture', Christian Norberg Schultz suggested 'taking possession of the environment implies structuring the environment into domains by means of paths and places'. In other words, 'streets and squares of the many fine examples of cities all over the world' and evident in the shophouse development. This is consistent with the findings of the famous psychologist Jean Piaget who argued that these basic forms of 'schematas' are fundamental to the way we adapt and modify the physical environment to human purpose. This is also in agreement with the earlier work of Kevin Lynch who found that paths and nodes among other characteristics are critical to a person's image of the city.

The statistics for the alternative layout

Basic information:

Total number of residential blocks:	8
Total number of dwelling units:	1624 (assuming an average of 4 storeys)
Site Area:	11.02 hectare

Area computation

1a.	Average floor area	=	100 sq. metre.
	Total nett. floor area	=	**162 400 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**211 120 sq. metre.**

Table 15. Area computation for the alternative layout

Density computation

Site area	=	11.02 hectare (110 200 sq.metre)
Assuming 4.1 persons per household, total population in the area	=	6658 persons
Density	=	**604 person per hectare (pph)**

Table 16. Density computation for the alternative layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**1.9**

Table 17. Plot ratio computation for the alternative layout

In terms of number of dwelling per hectare, this layout based on the alternative model is achieving approximately 147 dwelling unit per hectare, which is comparable to the existing layout with 145 dwelling unit per hectare. But the essential difference between the two layouts is that the existing blocks is at an average height of 13 storeys, whereas in the alternative layout, the average height of the blocks is at 4 storeys. This is consistent with Martin & Martin's theory. In addition, the kind of open spaces defined and enclosed in the alternative layout is a lot more human, usable and friendly in terms of its scale and quality of space. That is a vast improvement compared to the kind of open spaces defined in the existing layout based on the high-rise model. In the latter, the spaces remain as spaces which is a result of setback requirement and spaces leftover after planning.

6.2.2.3: A Comparative Analysis of the Existing and Alternative Schemes

6.2.2.3.1: Statistical Analysis

	Existing Layout	Alternative	Changes
Total no of flats	**1599**	**1624**	**+25 (2%)**
Average size of flat	**115 sq. metre.**	**100 sq. metre.**	
Total nett floor area	**183885**	**1162400**	**-21485 (-12%)**
Assumed neutral area	**30%**	**30%**	
Total gross floor area	**239050**	**211120**	**-27930 (-12%)**
Assumed 4.1 persons per household (current estimate)			
Density	**595 pph**	**604 pph**	**+9 (2%)**
Plot Ratio	2.2	1.9	-0.3 (-14%)

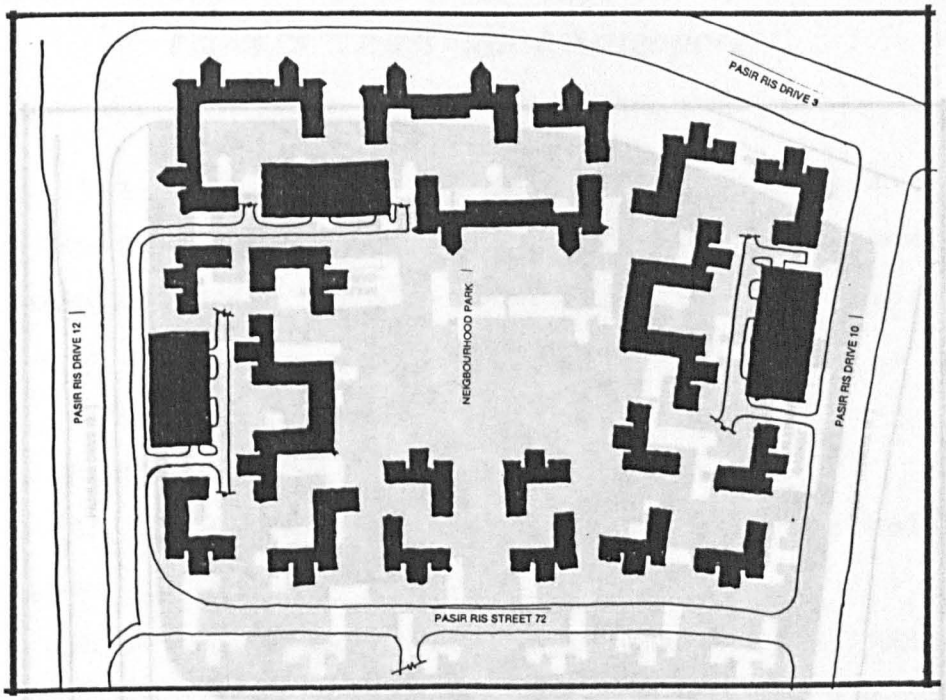
Table 18. Statistical Comparison between the existing and the alternative layout

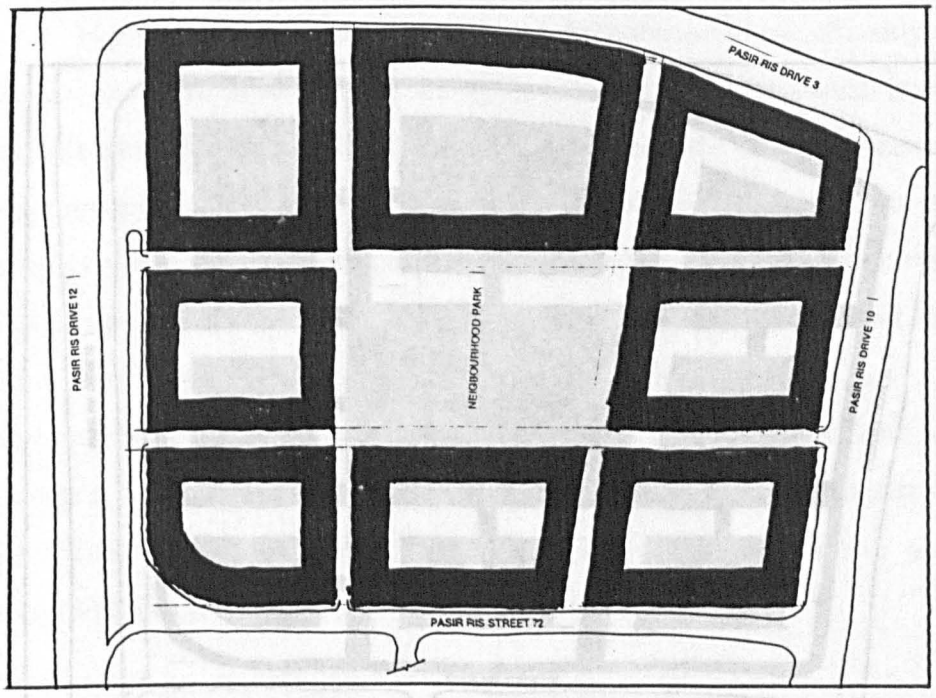
The plot ratio yield of 1.9 in the alternative scheme is 0.3 lower than that of the existing layout at 2.2. However the density yield of 604 pph in the alternative layout is 2% higher than that in the existing layout. The decrease in the Plot Ratio can be explained by the smaller flat size which is used in the alternative scheme. This is despite the fact that the alternative layout has 2% more flat compared to the existing layout. In terms of height, the existing layout is at 13 storeys compared to only 4 storeys in the alternative layout.

6.2.2.3.2: Figure/Ground Analysis 1

Although the plot ratio achieved in the alternative layout is lower than that in the existing layout, clearly the quality of spaces achieved within the built environment is vastly different. Perhaps this the kind of trade-off which planners and architects should be concerned with, in terms of the impact of built form on the immediate physical environment. The question is whether there is a real need to build at a higher plot ratio has to be answered with the consideration of the overall land use and land distribution of the entire new town, or even at the island wide scale. The possibility of an alternative way of building which provides better building versus spatial relationship should not be ignored.

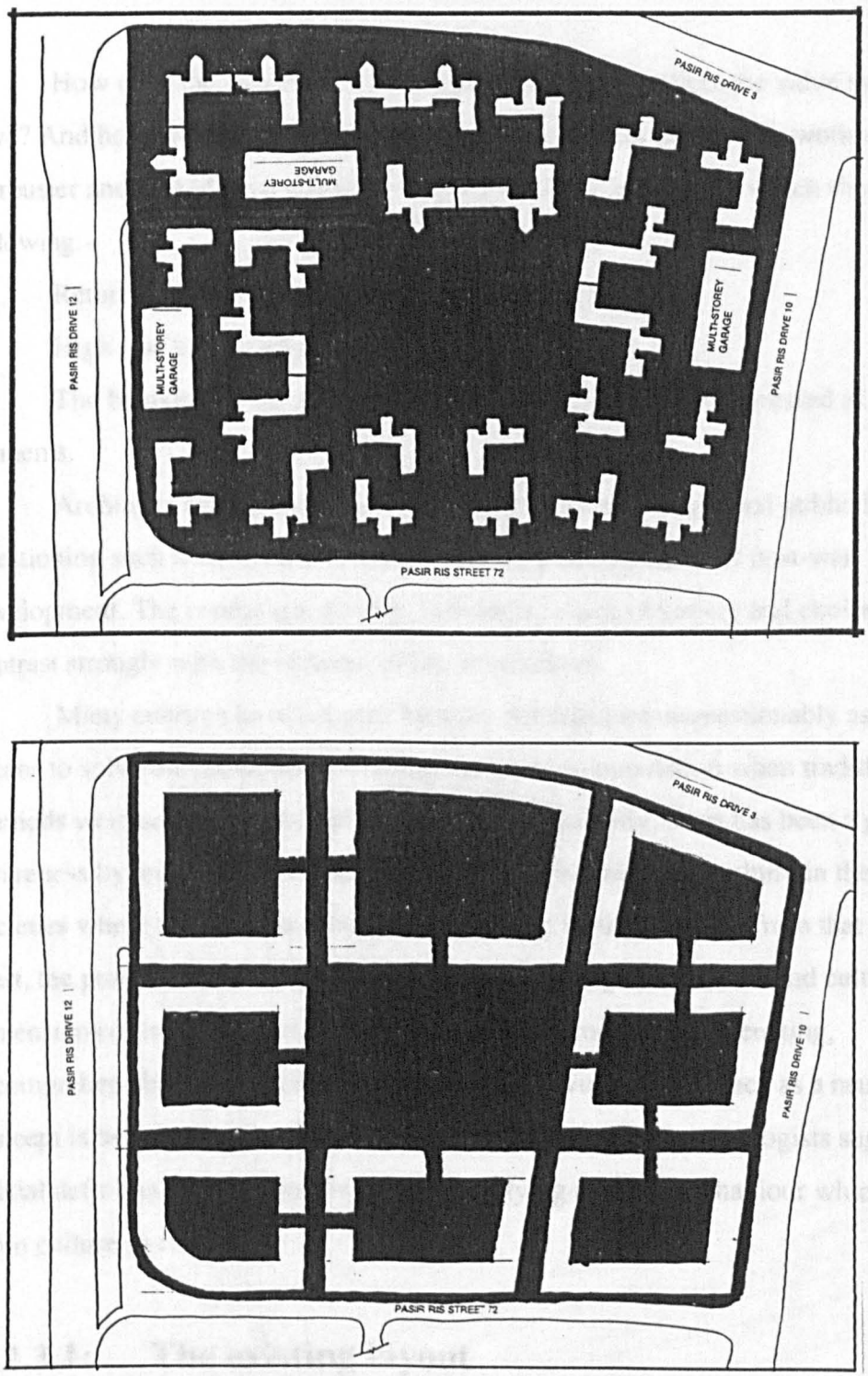
The use of figure/ground analysis shows clearly the relationship of the built form to that of the streets, it becomes traffic-free courts, safe for the children to play, as well as having all the qualities of defensible space according to Newman (1972) In both the figure/ground analysis; the open spaces in the alternative scheme are no longer spaces leftover after planning and open spaces. The alternative built form also raise far-reaching questions in the way it encloses and defines the open space. For instance, the open space provided in the present block-by-block form is simply a series of traffic corridors whereas in the alternative layout, they are well-defined courtyard space. The differences in spatial definition is clearly seen in Figure 65 & 66 when the buildings are white and the open space are black.





Figures 63 & 64 Comparison of figure/ground analysis 1
(buildings in black, open spaces in white)

6.2.2.3.3: Figure/Ground Analysis 2



Figures 65 & 66. Comparison of figure/ground analysis 2

(building in white, open spaces in black)

6.2.3: *CASE STUDY 2: Neptune Court - "City of Towers", East Coast, Singapore*

How does the structure of our present new towns reflect the value systems we have? And how are they meeting the needs of our present times? The works of Le Corbusier and CIAM crystallised a vision of the 20th century city which showed the following:-

1. Return to and celebration of the large city scale.
2. High-rise living as a desirable objective.
3. The breaking of the city into functions and zones, to be expressed as visual elements.

Architects and planners have only recently joined the general public in questioning such a vision. Such seems to be the case in almost all post-war development. The results are sterility, blandness, a lack of variety and choices which contrast strongly with the richness of life in old cities.

Many cultures have adopted Modern Architecture unquestionably as a quick means to solve the problems of housing the growing population when traditional methods were seen as outmoded and inefficient. Recently, there has been a growing awareness by architects of the subsequent loss of meaning and culture in these societies where the lifestyles and world views are totally different from that of the west, the proponents of Modern Architecture. The neglected social and cultural dimensions of indigenous built environment have produced an alienating, incomprehensible and a monotonously uniform environment. Space as a neutral concept is being questioned. Studies done by environment psychologists suggest that spatial definitions are dependant on the underlying norms of behaviour which varies from culture to culture.

6.2.3.1: The existing layout

The Neptune court housing was developed in the 1980s, meant for the middle income housing group. There are altogether 9 tower blocks with a density of approximately 481 person per hectare, as shown in the figure in the next page. Car

parking are on the surface taking up a huge area of the ground space. There is also a cluster of communal buildings in the centre serving the local residents.

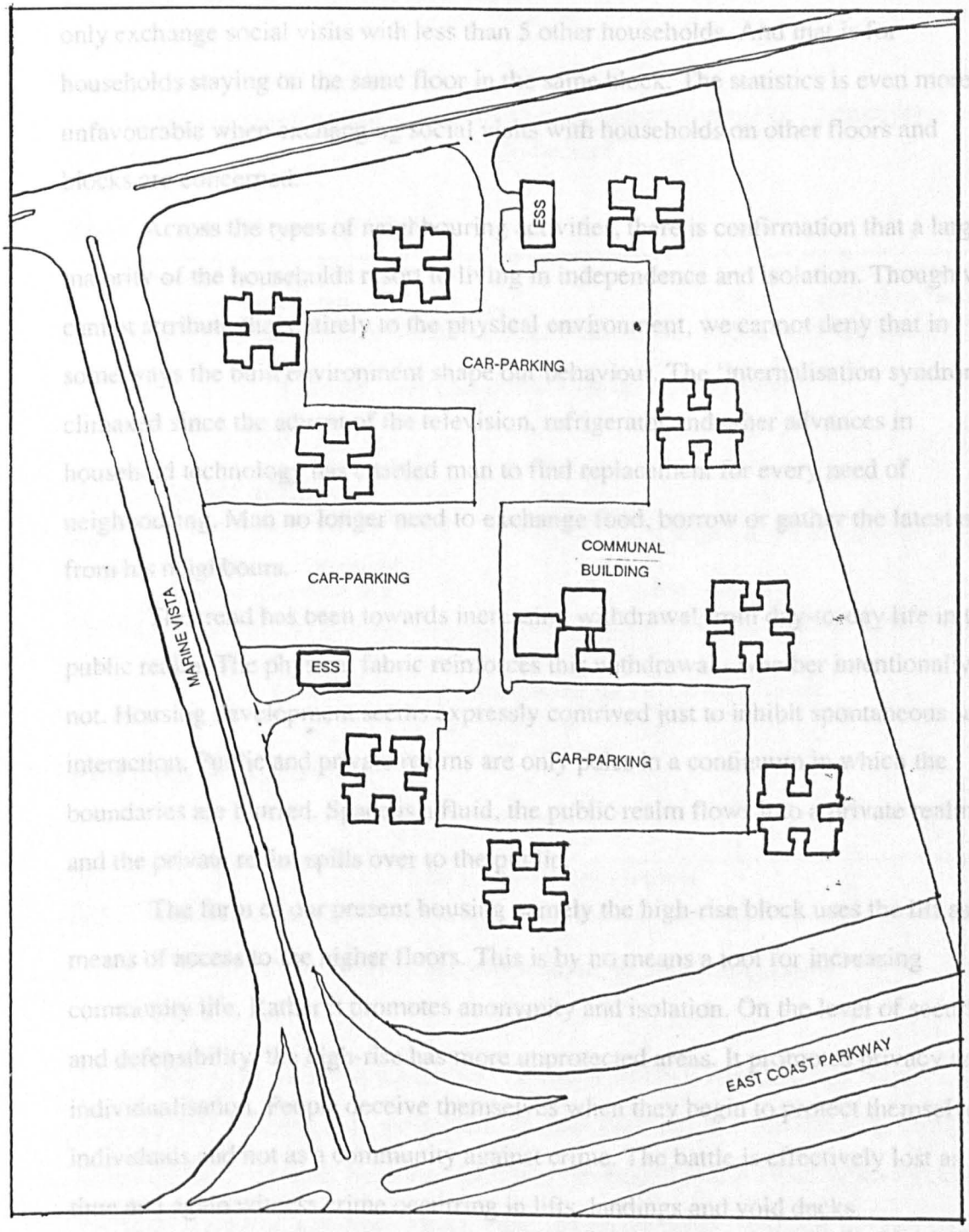


Figure 67. "The City of Towers" - Neptune Courts

Buildings have been invariably conceived as isolated and unrelated structures. As for the spaces left between buildings whether dedicated to the car and its storage or left simply as green, are not defined as places.

Statistics gathered from household surveys regarding neighbouring activities such as exchanging social visits reveal the fact that the majority of the households only exchange social visits with less than 5 other households. And that is for households staying on the same floor in the same block. The statistics is even more unfavourable when exchanging social visits with households on other floors and blocks are concerned.

Across the types of neighbouring activities, there is confirmation that a large majority of the households resort to living in independence and isolation. Though we cannot attribute that entirely to the physical environment, we cannot deny that in some ways the built environment shape our behaviour. The 'internalisation syndrome' climaxed since the advent of the television, refrigerator and other advances in household technology has enabled man to find replacement for every need of neighbouring. Man no longer need to exchange food, borrow or gather the latest news from his neighbours.

The trend has been towards increasing withdrawal from day-to-day life in the public realm. The physical fabric reinforces this withdrawal - whether intentionally or not. Housing development seems expressly contrived just to inhibit spontaneous social interaction. Public and private realms are only poles in a continuum in which the boundaries are blurred. Space is a fluid, the public realm flows into a private realm and the private realm spills over to the public.

The form of our present housing namely the high-rise block uses the lift as a means of access to the higher floors. This is by no means a tool for increasing community life. Rather it promotes anonymity and isolation. On the level of security and defensibility, the high-rise has more unprotected areas. It promotes privacy and individualisation. People deceive themselves when they begin to protect themselves as individuals and not as a community against crime. The battle is effectively lost as we time and again witness crime occurring in lifts, landings and void decks.

Children too are victims of this so called urban environment. They are made prisoners of the estate. Their sphere of action is limited by traffic, the high-rise form of living and the playgrounds and play spaces specially designed for them. The trend

shows that they play more and more within the confines of their homes and when they play outside the home, they must be supervised. This discourages independent social contact, something which is important to them later on in their lives.

The Statistics for the existing layout

Basic information:

Total number of residential blocks: 9

Total number of dwelling units: 864 (assuming an average of 25 storeys)

Site Area: 7.36 hectare

Area computation

1a.	Average floor area	=	125 sq. metre.
	Total nett. floor area	=	**108 000 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**140 400 sq. metre.**

Table 19. Area computation for the existing layout

Density computation

Site area	=	7.36 hectare (73 600 sq.metre)
Assuming 4.1 persons per household.		
total population in the area	=	3542 persons
Density	=	**481 person per hectare (pph)**

Table 20. Density computation for the existing layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**1.9**

Table 21. Plot ratio computation for the existing layout

When compared to the earlier case study of Pasir Ris Housing, Neptune Court has only 117 dwelling unit per hectare whereas Pasir Ris has 145 dwelling unit per hectare. This is because Neptune Court was developed in the 1980s when in general the density control was much lower. Pasir Ris on the other hand was developed in the 1990s, at a higher density control.

By applying Martin and March's theory and the fresnel square, two alternatives are worked out. The first alternative is just to test the plot ratio and

density achievable by having a perimeter housing arrangement on the site. This option created a huge open space in the middle. With only a plot ratio of 1.4, there is the possibility of increasing the plot ratio with the introduction of more housing units in the middle of the open space. By so doing, the vast open space could be further subdivided to serve the residents better. This gives rise to the second alternative with a higher plot ratio of 2.3 which is higher compared to that in the tower situation. In both cases, it is assummed that basement carparking is provided.

The following show the two alternatives of high-density, low-rise built form as opposed to the tall tower blocks.

6.2.3.2: The alternative #A layout

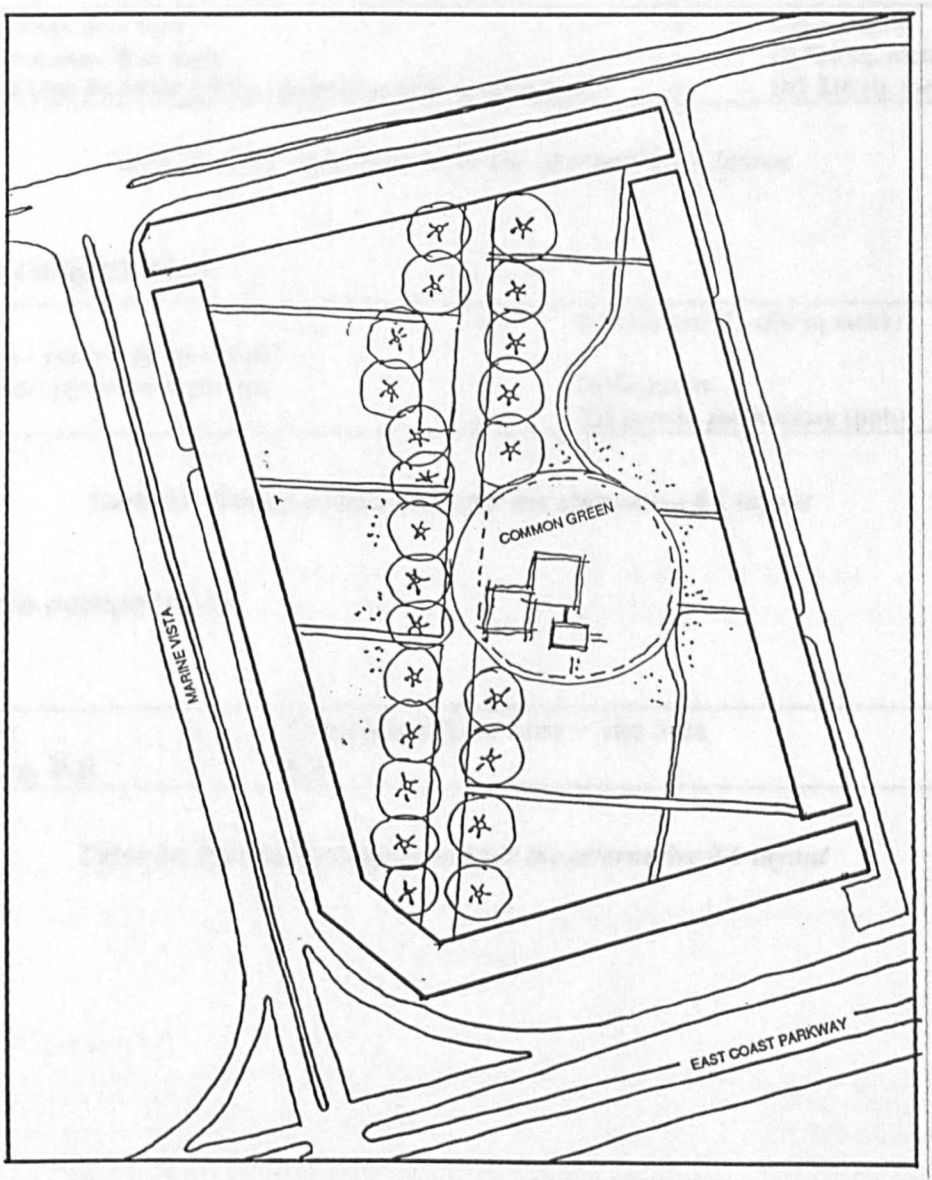


Figure 68. The Alternative #A layout

As mentioned earlier, the initial application of courtyard housing in the first alternative#A results in a big open space in the middle. Because of the land size, this big open space is further sub-divided into smaller open spaces in the second alternative#B. Before that layout is discussed, the statistics for alternative #A is presented.

The Statistics for the alternative #A layout

Total number of residential blocks: 4
Total number of dwelling units: 656 (assuming an average of 4 storeys)
Site Area: 7.36 hectare

Area computation

1a.	Average floor area	=	120 sq. metre.
	Total nett. floor area	=	**78 720 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**102 336 sq. metre.**

Table 22. Area computation for the alternative #A layout

Density computation

Site area	=	7.36 hectare (73 600 sq.metre)
Assuming 4.1 persons per household, total population in the area	=	2690 persons
Density	=	**365 person per hectare (pph)**

Table 23. Density computation for the alternative #A layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**1.4**

Table 24. Plot ratio computation for the alternative #A layout

6.2.3.3: The alternative #B layout

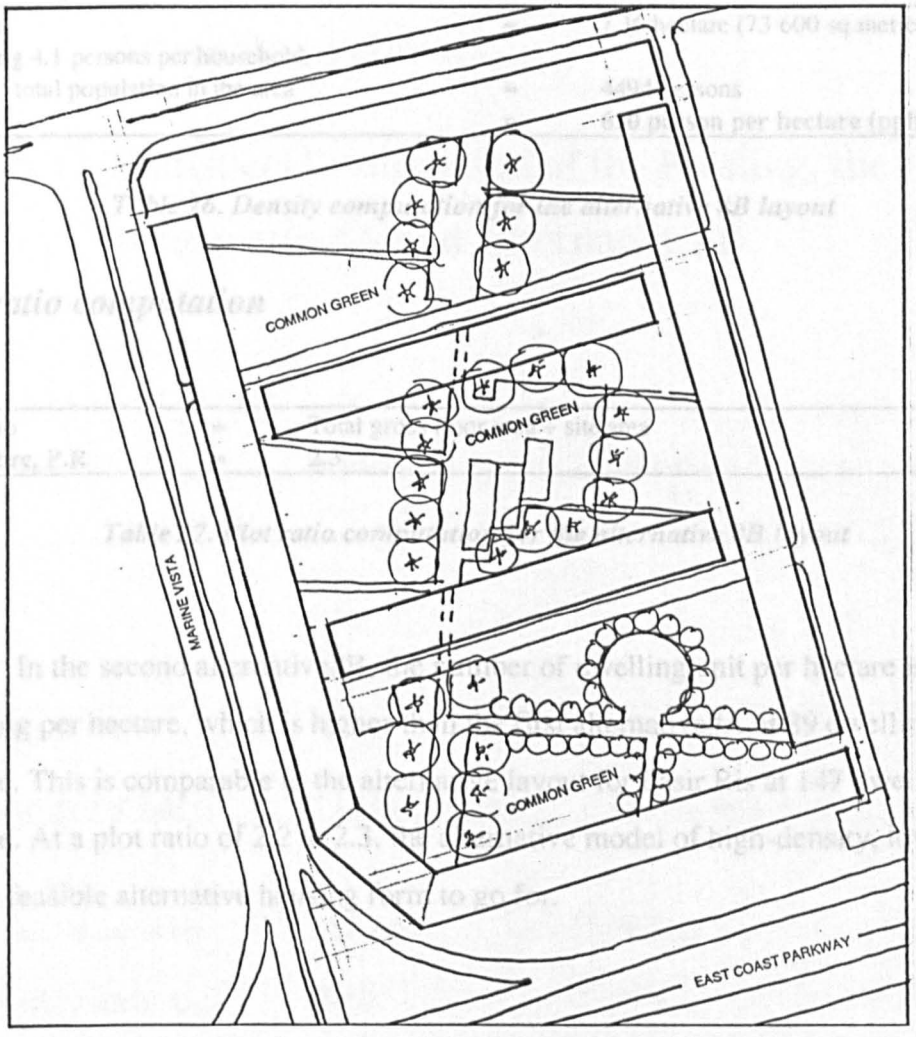


Figure 69. The alternative #B layout

The second alternative with the smaller open spaces is more compact compared to the first alternative. A higher density is achieved as can be seen from the statistics below.

The Statistics for the alternative #B layout

Basic information:

Total number of residential blocks:	6
Total number of dwelling units:	1096 (assuming an average of 4 storeys)
Site Area:	7.36 hectare

Area computation

1a.	Average floor area	=	120 sq. metre.
	Total nett. floor area	=	**131 520 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**170 976 sq. metre.**

Table 25. Area computation for the alternative #B layout

Density computation

Site area	=	7.36 hectare (73 600 sq.metre)
Assuming 4.1 persons per household.		
total population in the area	=	4494 persons
Density	=	**610 person per hectare (pph)**

Table 26. Density computation for the alternative #B layout

Plot ratio computation

Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**2.3**

Table 27. Plot ratio computation for the alternative #B layout

In the second alternative#B, the number of dwelling unit per hectare is 149 dwelling per hectare, which is higher than the first alternative#A at 89 dwelling per hectare. This is comparable to the alternative layout for Pasir Ris at 147 dwelling per hectare. At a plot ratio of 2.2 to 2.3, the alternative model of high-density, low-rise is a very feasible alternative housing form to go for.

6.2.3.4: A Comparative Analysis of the Existing and Alternative Schemes

6.2.3.4.1: Statistical Comparison of the Existing, the Alternative #A and Alternative #B

	Existing Layout	Alternative #A	Alternative #B
Total no of flats	**864**	**656**	**1096**
Average size of flat	**125 sq. metre**	**120 sq. metre**	**120**
Total nett floor area	**108 000**	**78 720**	**131 520**
Assumed neutral area	**30%**	**30%**	**30%**
Total gross floor area	**140 400**	**102 336**	**170 976**
Assumed 4.1 persons per household (current estimate)			
Density	**481 pph**	**365 pph**	**610 pph**
Plot Ratio	1.9	1.4	2.3

Table 28. Statistical Comparison of the Existing, the Alternative #A and Alternative #B

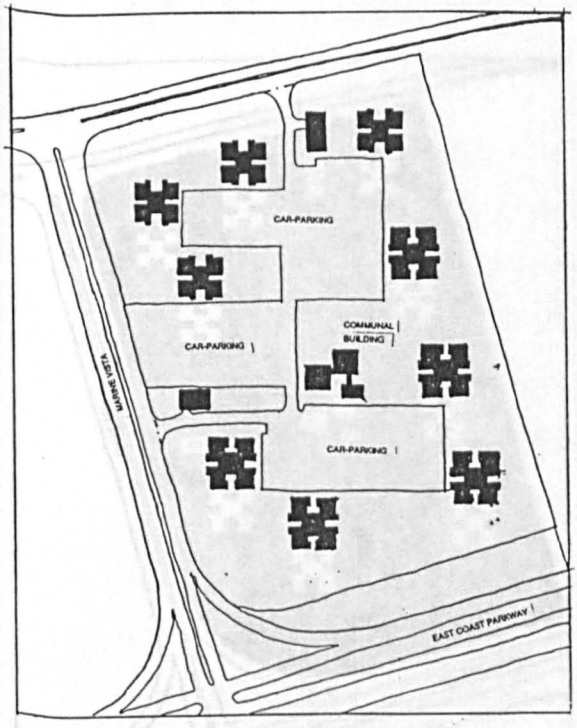
The plot ratio yield of 1.4 in the alternative #A scheme is 0.5 lower than that of the existing layout at 1.9. However, the plot ratio yield of 2.3 in the alternative #B scheme is 0.4 higher than that of the existing layout, achieved by adding 2 blocks in the big central space thus dividing this space into smaller courtyard spaces. The effect

of courtyard layout on the plot ratio from big to smaller courtyards can be immediately seen from the above examples. This is despite the fact that the flat size is reduced by 5 sq. metre from 125 to 120. Further, the density yield of 610 pph in the alternative #B layout is 27% higher than that in the existing layout.

6.2.3.4.2: Figure/Ground Analysis 1

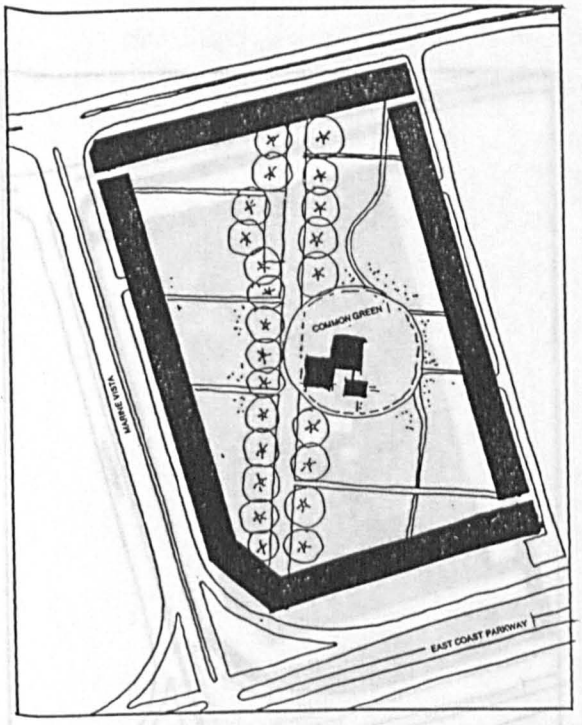
Although the plot ratio achieved in the alternative #B layout is much higher than that in the existing layout, what is even more significant is the quality of spaces formed within the residential environment. Here, unlike the previous case study need not be seen as a kind of trade-off between high-density and the quality of the environment. This case study shows the possibility of an alternative built form which is not only capable of meeting the high plot ratio but also providing a better building versus spatial relationship which greatly improve on the quality of the environment. The significant difference is that one is low-rise at 4 storeys, whereas the other is high-rise at 25 storeys.

The use of figure/ground analysis shows clearly the relationship of the built form to that of the streets and open spaces. For instance, the open space provided in the present block-by-block form is simply a series of traffic corridors. In the alternative courtyard forms, it becomes traffic-free courts, safe for the children to play. In both the figure/ground analysis; the open spaces in the alternative scheme are no longer spaces leftover after planning and open spaces.

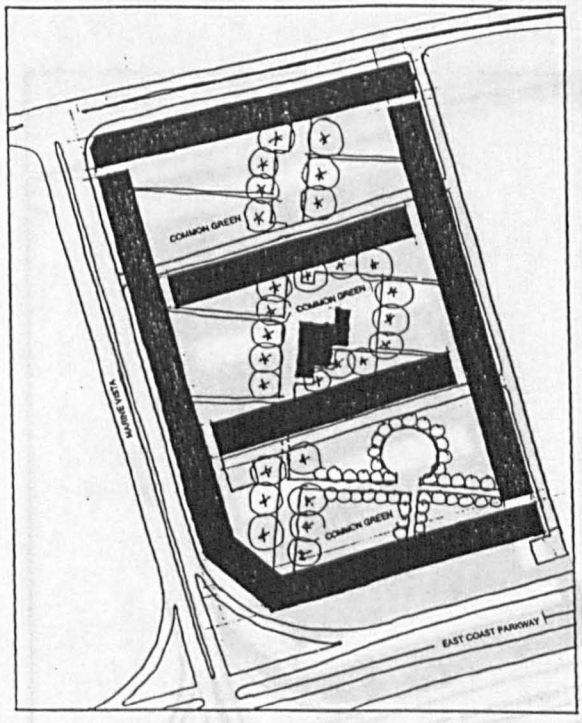


70

The difference between the two is in terms of their spatial enclosure i.e the city of towers with buildings conceived as isolated and unrelated structures, whereas in the alternative high-density, low-rise model, the buildings are enclosing and defining the open space.



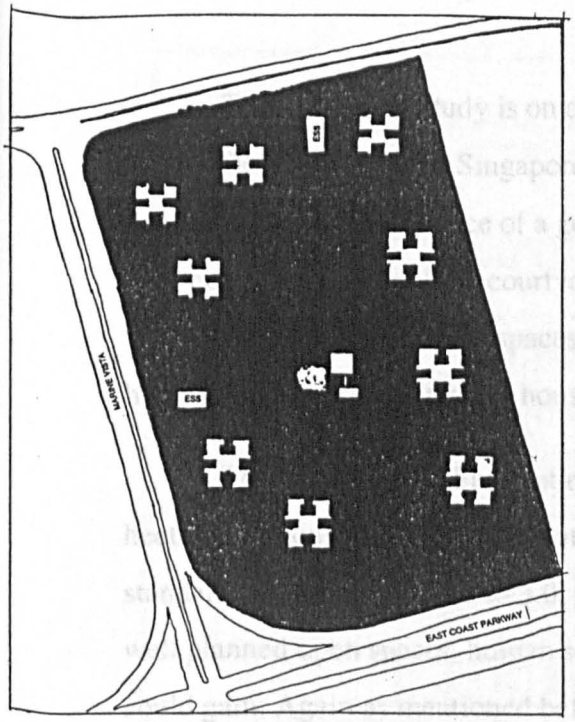
71a



71b

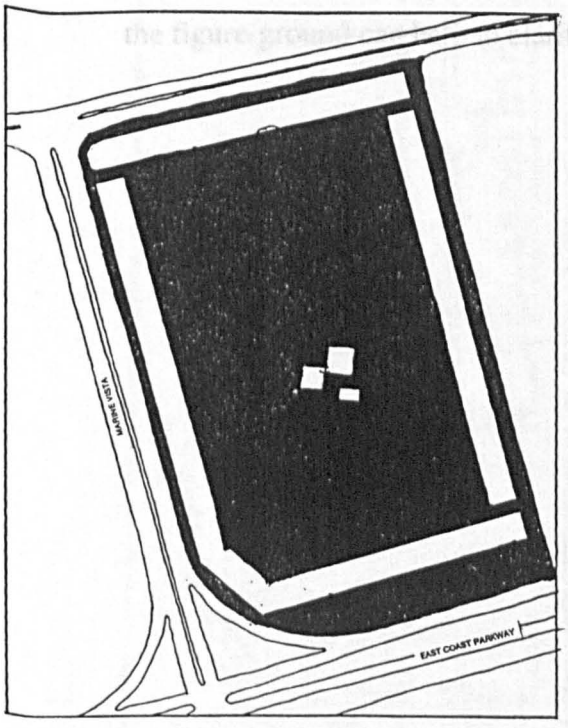
Figures 70 & 71. Comparison of figure/ground analysis 1
(buildings in black, open spaces in white)

6.2.3.4.3: Figure/Ground Analysis 2

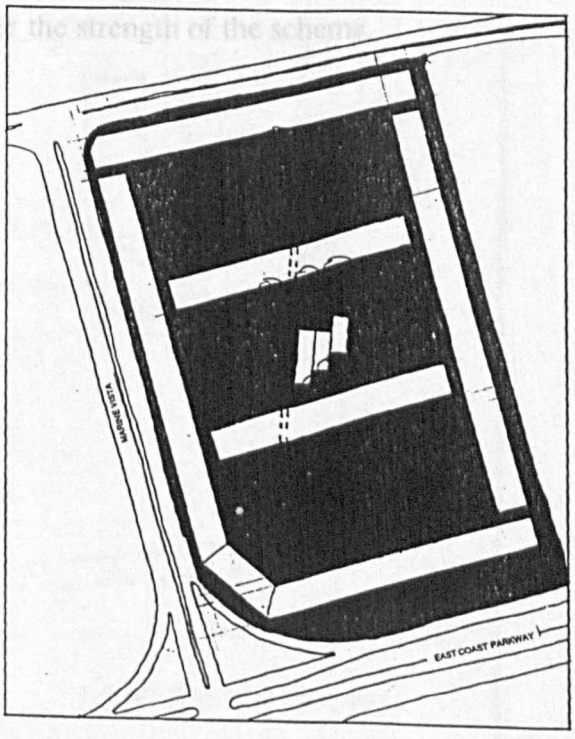


72

The differences in terms of spatial definition is clearer with the building in white and the open spaces in black.



73a



73b

Figures 72 & 73. Comparison of figure/ground analysis 2 (building in white, open spaces in black)

6.2.4: CASE STUDY 3: Tiong Bahru Housing

6.2.4.1: The layout

This third case study is on one of the earliest public housing scheme in Tiong Bahru. Developed by the Singapore Improvement Trust (SIT), it is low-rise high-density with all the evidence of a good housing environment. From the figure in the next page, one can see how courtyards are used in the layout of the housing blocks with very well defined open spaces. Altogether there are three groupings of courtyard housing and the rest in terrace housing form.

The 21 blocks yield a plot ratio of 1.7 with a density of 474 person per hectare. Although this layout is not as as dense when compared to the present standard of plot ratio of 2.8 to 3.0, nevertheless the overall environmental quality of well planned open spaces, human scale etc can be seen as the beneficial trade-offs one could gain. Again as mentioned before, it is a question of how effective the environment is and whether the potential environment seen on the plan is being translated into an effective environment serving the people's needs. The analysis on the figure/ground can help to clarify further the strength of the scheme.

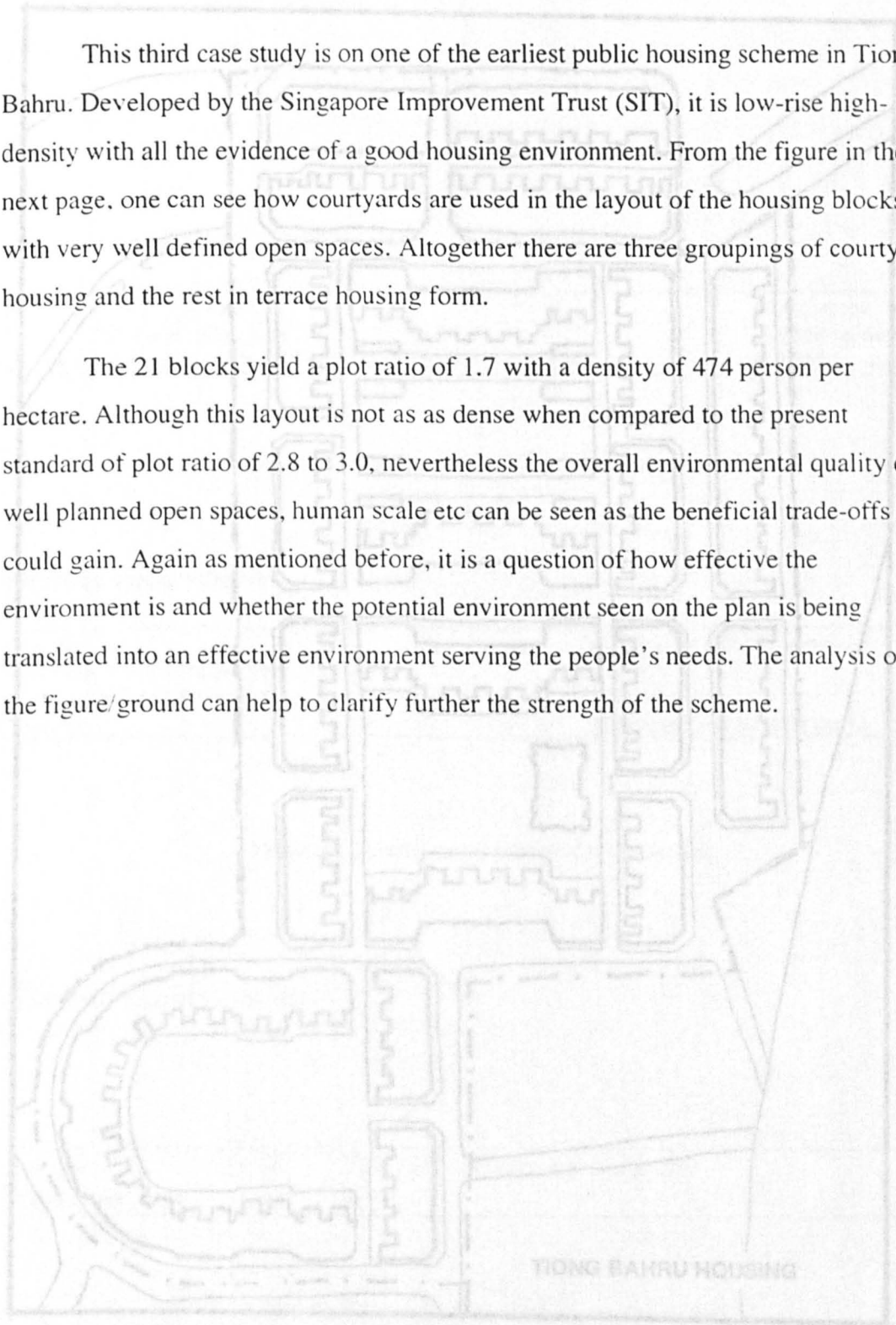


Figure 74. Layout of Tiong Bahru Housing

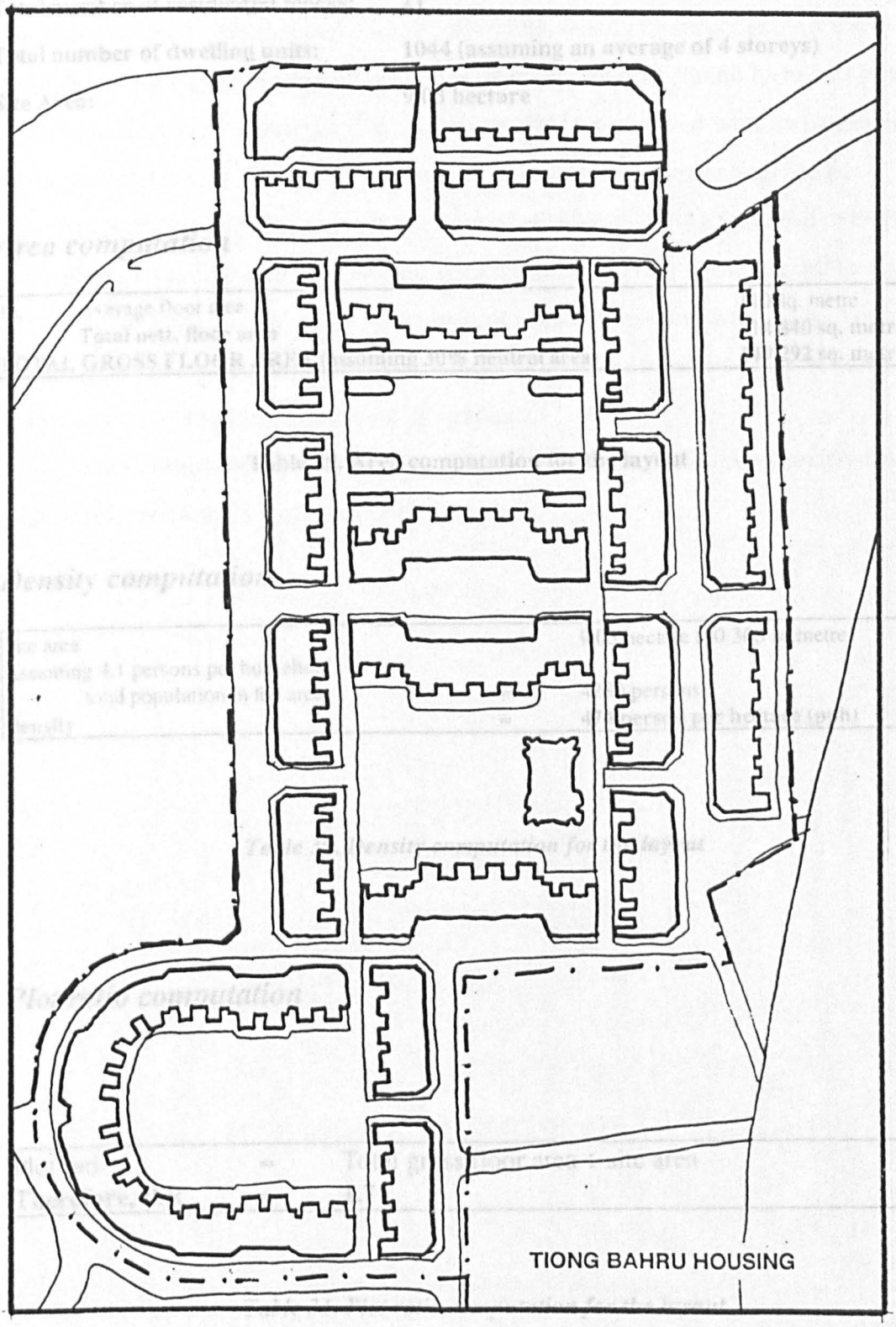


Figure 74. Layout of Tiong Bahru Housing

6.2.4.2: The statistics

Basic information:

Total number of residential blocks: **21**

Total number of dwelling units: **1044 (assuming an average of 4 storeys)**

Site Area: **9.03 hectare**

Area computation

1a.	Average floor area	=	110 sq. metre.
	Total nett. floor area	=	**114 840 sq. metre.**
TOTAL GROSS FLOOR AREA (assuming 30% neutral area)		=	**149 292 sq. metre.**

Table 29. Area computation for the layout

Density computation

Site area	=	9.03 hectare (90 360 sq.metre)
Assuming 4.1 persons per household, total population in the area	=	4280 persons
Density	=	**474 person per hectare (pph)**

Table 30. Density computation for the layout

Plot ratio computation

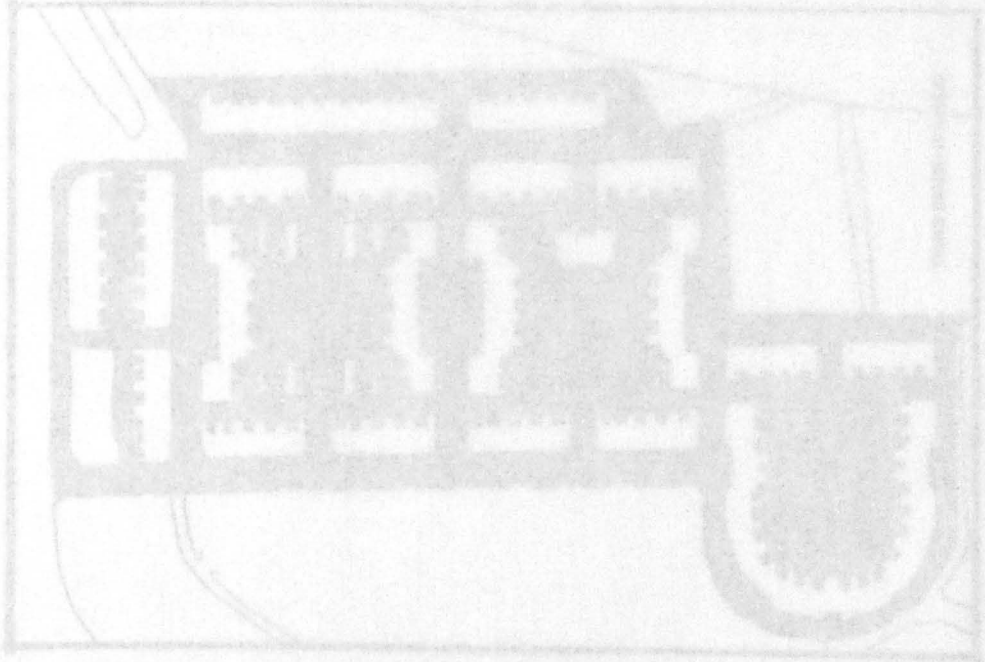
Plot ratio	=	Total gross floor area ÷ site area
Therefore, P.R	=	**1.7**

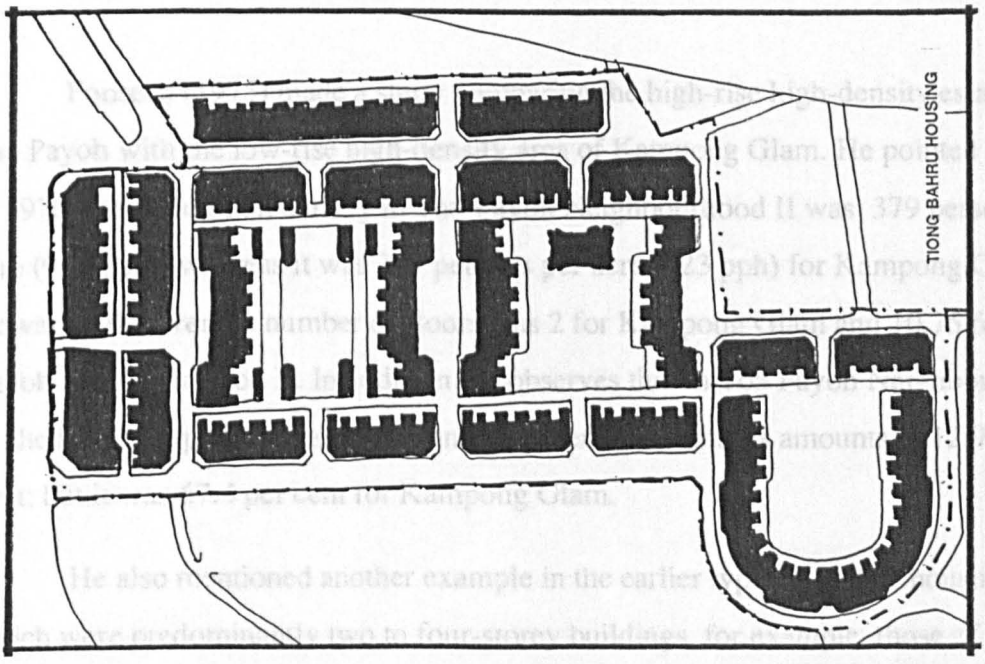
Table 31. Plot ratio computation for the layout

6.2.4.3: Figure/Ground Analysis

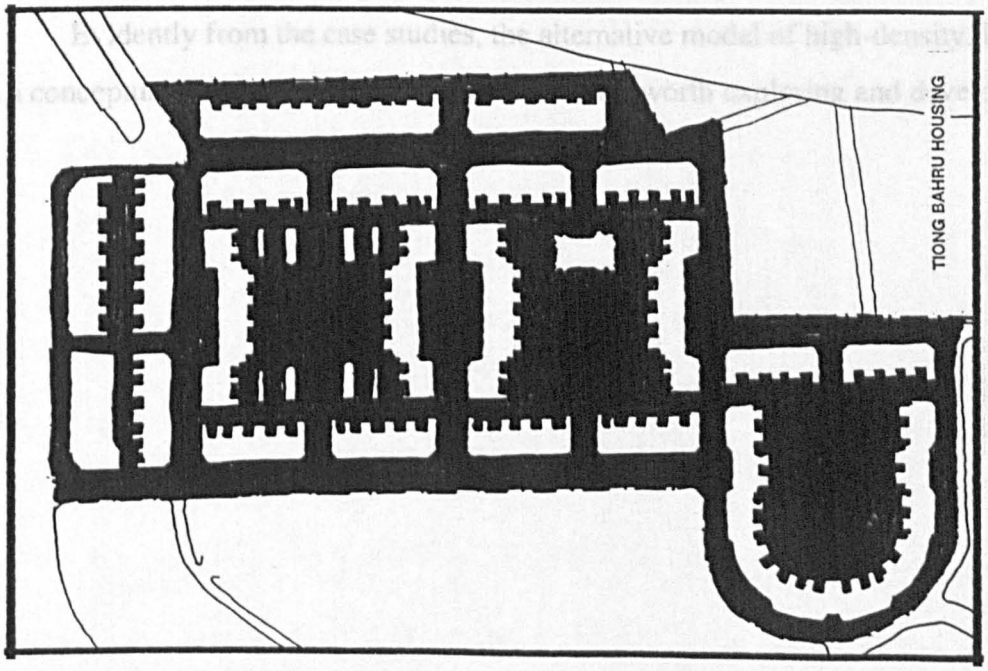
Similar to the previous two case studies, although the plot ratio achieved in this layout is lower than that in the norm, clearly the quality of spaces achieved within the built environment is vastly different. This kind of trade-off should form part of the considerations which planners and architects should be concerned with. In particular the impact of the built form on the immediate physical environment ought to be assessed carefully. The fundamental question of whether there is a real need to build at a higher plot ratio has to be answered with the consideration of the overall land use and land distribution of the entire new town, or even at the island wide scale. The possibility of an alternative way of building which provides more effective building versus spatial relationship should not be ignored.

In the following figures, the use of figure/ground analysis shows clearly the relationship of the built form to that of the streets.





Figures 75. Figure/ground analysis 1
(buildings in black, open spaces in white)



Figures 76 . Figure/ground analysis 2
(building in white, open spaces in black)

6.2.5: Conclusions

Fonseca (1975) made a study comparing the high-rise high-density estate of Tao Payoh with the low-rise high-density area of Kampong Glam. He pointed out that in 1970, the population density in Tao Payoh Neighbourhood II was 379 persons per acre (948 pph), whereas it was 367 persons per acre (923 pph) for Kampong Glam. However, the average number of floors was 2 for Kampong Glam and 10.75 for Toa Payoh Neighbourhood II. In addition, he observes that in Toa Payoh Neighbourhood II, the land occupied by residential and commercial structures amounts to 12.9 per cent; but it was 67.4 per cent for Kampong Glam.

He also mentioned another example in the earlier types of public housing which were predominantly two to four-storey buildings, for example, those of the Moh Guan Terrace development in Tiong Bahru. He noted that then, the density of Moh Guan Terrace was 55 dwelling units per acre (137 dwelling per hectare), which compared very well with the latest new towns then - Clementi was 59 (148 dwelling per hectare) and Telok Blangah was 51 dwelling units per acre (128 dwelling per hectare).

Evidently from the case studies, the alternative model of high-density, low-rise as a conceptual framework is a feasible alternative, worth exploring and developing.

REFERENCES

References

Alexander, C. (1966) 'A City Is Not A Tree', *Design*, **206,** Feb. 1966. 46-55.

Alexander, C. Ishikawa, S. and Silverstein, M. (1968) *A Pattern Language: Towns, buildings, construction,* Centre for Environmental Studies, Berkeley, California. Republished (1977); New York: Oxford University Press, Centre for Environmental Studies Vol. 2.

Appleyard, D & Sue, M. G. & Lintell, M (1981) *Livable Streets*, University of California Press: Berkeley and Los Angeles.

Bacon, E. (1991) 'What will you do when the oil runs out as it assuredly will by the year 2040?' *Trans-Asia '91 Symposium mapping New Directions in Urban Transport and Planning, Singapore,* Sept 16-17, 1991.

Banerjee, T. & Southworth, M. (eds) (1990) *City Sense and City Design: Writings and Projects of Kevin Lynch.* London: The MIT Press.

Barton, H. & Davis, G. & Guise, R. (1995) *Sustainable Settlements: A Guide for Planners, Designers and Developers.* Luton, The Local Government Management Board.

Barton, H. (1996) 'Going Green By Design' in Billingham, J. (ed) (1996) *Urban Design,* January 1996, **57**, 13.

Beinhart, Julian (1985) 'Golden Triangle Area Study, Kuala Lumpur: Design for High Intensity Development'. *International Conference on Urban Design* . The Malaysian Institute of Architects (PAM) and the Aga Khan Program at Harvard University and MIT, Kuala Lumpur, Malaysia, Aug 4-6.

Bentley, I. (1990) 'Ecological Urban Design', *Architects' Journal,* 24 October, 1990, **192**, 69-71.

Bentley, I. et al. (1985) *Responsive Environments: A Manual for Designers,* London: Architectural Press.

Bloomer, K. C. & Moore, C. W. & Yudell, R. J. (1977) *Body, Memory, and Architecture,* New Haven and London: Yale University Press.

Blowers, A. (1993) *Planning for a Sustainable Environment*, London: Earthscan Publications Ltd.

Bovill, C. (1996) *Fractal Geometry in Architecture and Design.* Basel: Birkhäuser.

Broadbent, G. (1990) *Emerging Concepts in Urban Space Design.* London: Van Nostrand Reinhold (International).

Brooke, P. (1994) `Foreword by the Secretary of State for National Heritage', in *The Royal Fine Art Commission, What makes a good building,* London: The Royal Fine Arts Commission.

Brundtland Report, 1987 *World Commission on Economic Development,* Oxford: Oxford University Press.

Buchanan,P. (1985) *Architectural Review*, October 1985.

Cappon, D. (1971) Mental Health and High Rise. *Canadian Public Health Association,* April.

Carmona, M. (1996) 'The Local Plan Agenda', in Billingham, J. (ed) (1996) *Urban Design,* January 1996, **57**, 18.

Chen, P. S. J. & Tai, C. L. (1977) *Social Ecology of Singapore.* Federal Publications: Singapore.

Cheshire County Council (1988) *Design Aid Housing: Roads*, 2nd edn 1988, 54.

Chulasai, B. (1985) 'Architecture in Development', *Mimar,* **15**, 24-25.

Coleman, A. (1985) *Utopia on Trial: Vision and Reality in Planned Housing*, Hilary Shipman.

Colquhoun, A. (1971) `The Superblock' in Colquhoun, A. (1981) *Essays in Architectural Criticism: Modern Architecture and Historical Change.* The MIT Press: Cambridge.

Colquhoun, I and Fauset, P.G. (1991) *Housing design in practice.* Harlow, Longman Scientific & Technical.

Colquhoun. I. & Fauset, P. G. (1991a) 'Vera Co-operative Housing, Vancouver, Canada', in *Housing Design: An International Perspective.* B. T. Batsford Ltd, London. 61-63.

Colquhoun. I. & Fauset, P. G. (1991b) 'Elm Village, Camden, London (1985)', in *Housing Design: An International Perspective.* B. T. Batsford Ltd, London. 64-67.

Colquhoun. I. & Fauset, P. G. (1991c) 'Les Epinettes, Evry, near Paris, France', in *Housing Design: An International Perspective.* B. T. Batsford Ltd, London. 80-83.

Cullen, G. (1961) *Townscape.* London: Architectural Press.

Cullen, G. (1966) *The Scanner.* London: Alcan Industries Limited.

Cullen, G. (1971) *The Concise Townscape.* London: Architectural Press.

Davey, Peter (1980) Perimeter planning and its evolution. *Architectural Review* , **CLXVII, (998)**, April 1980. 207-213

Department of Statistics. (1973) Report on the Census of Population 1970, Singapore. Singapore: Government Printing Office, 1973, **Vol.1**, 31.

Designed for Living (1985) Public Housing Architecture in Singapore, Housing and Development Board: Singapore.

Fanning, D. M. (1967) Families in Flats. *British Medical Journal,* November, No. 198.

Fonseca, R (1975) "Planning and Land-Use In Singapore", Sociology Working Papers No. 48. University of Singapore: Singapore.

Gans, H. J. (1968) *People and Plans.* Basic Books, Inc. Publishers: New York.

Gosling, D., Cullen, G., & Donaghue, D. (1974) *Development Plan for Maryculter New Town, Aberdeen,* Chiristian Salveson.

Halprin, L. (1970) Lawrence Halprin makes the city scene, in *Design and Environment,* Fall 1970.

Hassan, R. (1975) in "Social and Psychological Implications of High Population Density", Sociology Working Paper No. 47, Department of Sociology, University of Singapore: Singapore.

HDB (1985) *Designed For Living, Public Housing Architecture in Singapore.* Housing and Development Board: Singapore

HDB Annual Report (1973/74) Housing and Development Board: Singapore. 12-13.

HDB Annual Report (1991/92) Housing and Development Board: Singapore.

HDB (1994) HDB Planning Norm for Gross Plot Ratio, July 1994.

HDB Newsletter (1995) **July 1995. Vol. No. 106**. 12.

HDB (1995) *Profile of Residents Living in HDB Flats*. Housing and Development Board: Singapore.

HDB (1995a) *Profile of Residents Living in HDB Flats*. Housing and Development Board: Singapore. 49.

HDB (1995b) *Profile of Residents Living in HDB Flats*. Housing and Development Board: Singapore. 48.

Heck, S. (1987) 'Oscar Newman revisited', *The Architect's Journal*, **8 April 1987**, 30-32.

Hertzberger, H. (1991) *Lessons for students of architecture*. Uitgeverij 010 Publishers, Rotterdam.

Jacobs, J. (1962) The Death and Life of Great American Cities: The Failure of Town Planning, Random House, New York.

Kohl, D. (1984) *Chinese Architecture in the Straits Settlement and Western Malaya*, Kuala Lumpur: Heinemann Asia, 179.

Land Acquisition Act (1966) Cap. 272/70. Singapore Land Acquisition (Amendment) Act,. 1973. A.S. 8/74.

Lang, J. (1994) *Urban Design: The American Experience*, New York: Van Nostrand Reinhold.

Lim, W. S. W. (1982) 'Land for housing the urban poor in free-market economy of third world countries - with Singapore as a case study.' Proceedings on 'Land for housing the poor: towards positive action in Asian cities,' International Seminar held at the Asian-Institute of Technology, Bangkok, 18 - 31, January, 1982.

Lim, J. S. H. (1990) citing from the Journal of the Indian Archipelago, 1854, **VII**, 101-109 in 'The Origin of the Singapore Shophouse' in Sabapathy, T. K. & Lo, C. N. (eds) (1990) *Architecture Journal 1990: School of Architecture, National University of Singapore*, **1990**, 23.

Liu, T. K. (1973) "Reflection on Problems and Prospects in the Second Decade of Singapore's Public Housing", in Chua, P. C., (1973) (ed) Planning in Singapore. Chopmen Enterprises: Singapore.

Liu, T. K. (1979) 'Public Housing - The Singapore Experience,' in Proceedings of the 17th IFAWPCA, Convention, Singapore, 23 - 28, September, 1979.

Liu, T. K. (1985) "Overview" in Wong, A. K. & Yeh, S. H. K. (1985) *Housing A Nation: 25 Years of Public Housing in Singapore*. Singapore: Maruzen Asia.

Liu, T. K. (1991) 'Implementing the Concept', *Trans-Asia '91 Symposium mapping New Directions in Urban Transport and Planning, Singapore*, Sept 16-17, 1991.

Lynch, K. (1954) 'The form of cities', in Banerjee, T. & Southworth, M. (eds) (1990) *City Sense and City Design: Writings and Projects of Kevin Lynch*. London: The MIT Press. 45-46

Lynch, K. (1960) *The Image of the City*, Cambridge, Mass. and London: MIT Press.

MacCormac, R. (1980) quoted by Davey, P. (1980) Housing, Duffryn, Newport, South Wales. *Architectural Review* , **CLXVII, (998)**, April 1980. 205-213.

Martin, L. & March, L. & Taylor, J. B. (1965) *Whitehall: A Plan for a National and Government Centre,* Her Majesty's Stationery Office.

Martin, L. & March, L. (1966) `Land Use and Built Forms', *Cambridge Research.*

Martin, L. & March, L. (1964) 'Study of a Building Type', *Architectural Design,* Dec. 1964.

Martin, L. & March, L. (eds) (1972) *Urban Space and Structures,* Great Britain: Cambridge University Press.

Martin, L. (1972) `The grid as generator' in Martin, L. & March, L. (eds) (1972) *Urban Space and Structures,* Great Britain: Cambridge University Press.

McHarg, I (1969) *Designing with Nature,* New York, American Museum of Natural HIstory.

MLTW (1966 - 1974) in Moore - Turnbull with Buchanan et al., 'Kresge College, University of California at Santa Cruz.' *A & U,* **5**, 1978.

Muthesius, S. (1982) *The English Terraced House,* London, Yale University Press, 3,38-39. cited by Lim, J. S. H. (1990) 'The Origin of the Singapore Shophouse' in Sabapathy, T. K. & Lo, C. N. (eds) (1990) *Architecture Journal 1990: School of Architecture, National University of Singapore,* **1990**, 23.

Newman, O. (1972) *Defensible Space: People and Design in the Violent City,* Macmillan Co., New York, 1973 edn; London: Architectural Press.

Newman, O. (1973) *Design Guidelines for Creating Defensible Space, National Institute of Law Enforcement and Criminal Justice, Washington* (Published by the Architectural Press, London 1976)

Neylan & Ungless (1973) 'Setchell Road Redevelopment', *The Architect's Journal,* **9 May 1973**. 1117-1118

Ostwald, M. J. & Moore, R. J. (1996) "Fractal Architecture: Towards A Critical Evaluation Of Scientific Definitions And Their Architectural Appropriations." in Kan, J. W. T. (1996) *Proceedings of the 30th Conference of the Australia and New Zealand Architectural Science Association,* The Chinese University of Hong Kong, **July 17 - 19, 1996**, 137 - 148.

Powell, R. (1992) 'Singapore: Planning a Global City', *Singapore Institute of Architects Journal,* Singapore. **May-June, 172.** 7.

Poyner, B. (1983) *Design Against Crime, Beyond Defensible Space.* London: Butterworth.

Raman, P. G. (1992) 'Faltering visions of the Concept Plan', *SIA Journal,* **May/June, 1992.** 18-21.

Reps, J. W. (1965) *The Making of Urban America,* Princeton University Press.

Rowe, C. & Koetter, F. (1975) Collage City, *Architectural Review*, **CLVIII, (942), August 1975**, 66-91. Republished (1979) as *Collage City*, Cambridge, Mass. and London: MIT Press.

Scoffham, E. R (1984) "What Rise High-Density - How Dense High-Rise?" in *High-Rise, High-Density Living*, SPC Convention 1983, Singapore Professional Centre: Singapore.

Singapore Authority (1955) 'Colony of Singapore Model' showing Outline of Proposals of Master Plan 1955, Singapore.

Sitte, Camillo (1889) *City Planning According to Artistic Principles,* translated by Collins, G.R. and C.C. (1965). Phaidon Press.

Taylor, N. (1973) *The Village in the City: Towards a New Society*, London: Temple Smith.

Teh, C.W. (1975) "Public Housing in Singapore: an overview." in Yeh, S. H. K. (1975) *Public Housing In Singapore: A Multi-disciplinary Study.* Singapore: Singapore University Press.

Tibbalds, F. (1992) *Making People Friendly Towns,* Harlow, Longman.

Turnbull, W. (1977) Kresge College, quoted in Chang, C. Y. (ed) *Process Architecture*, **No. 3.** 1977.

Urban Design Group (1994) *Urban Design Source Book 1994,* Oxon, UDG.

URA (1994) *Queenstown Planning Area: Planning Report 1994.* Urban Redevelopment Authority: Singapore.

URA (n.d) China Square, Urban Redevelopment Authority: Singapore.

URA (n.d) Geylang, Urban Redevelopment Authority: Singapore.

URA (n.d) Rochor, Urban Redevelopment Authority: Singapore.

URA (n.d) *Understanding The Shophouse*, Urban Redevelopment Authority: Singapore.

Venturi, R. (1966) *Complexity and Contradiction in Architecture.* Museum of Modern Art: New York.

Ward, C. (1973) (ed) *Vandalism,* Architectural Press: London.

Whitehead, A. N. (1929) *The Function of Reason,* Princeton University Press quoted by Martin, L. & March, L. (eds) (1972) *Urban Space and Structures,* Great Britain: Cambridge University Press.

Yeang, K. (1987) *The Tropical Verandah City*, Selangor: Longman Malaysia Sdn. Bhd.

Yeang, K. (1992) *The Architecture of Malaysia.* Amsterdam: The Pepin Press. 134.

Yeh, S. H. K. (1975) (ed) *Public Housing in Singapore*, Singapore University Press: Singapore.

Yeh, S. H. K. & Tan, S. L. (1975) in "Satisfaction with Living Conditions" in Yeh, S. H. K. (1975) (ed) *Public Housing in Singapore*, Singapore University Press: Singapore.