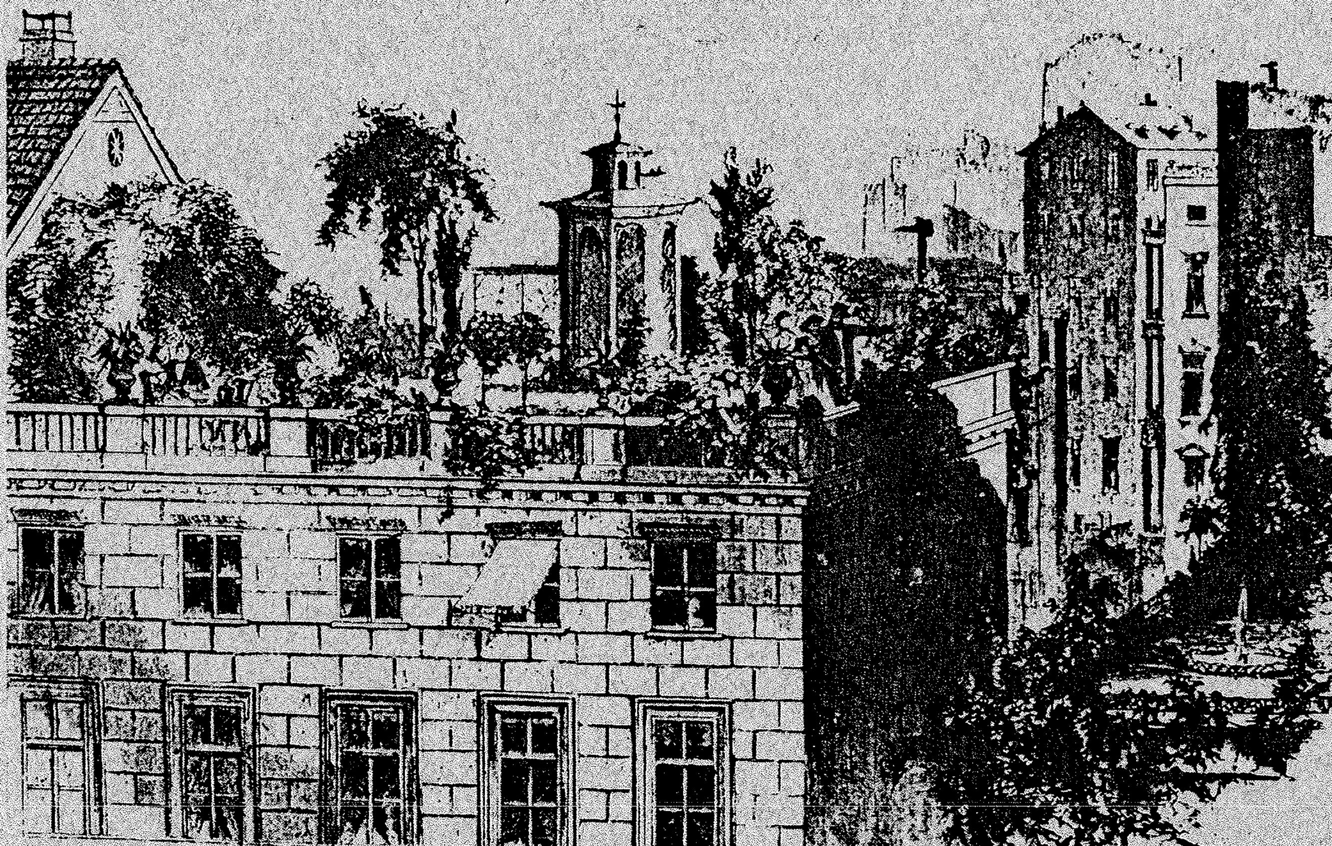
Islands in the Sky



AN INVESTIGATION INTO THE NATURE AND HISTORY OF ROOFSCAPING, AND RECOMMENDATIONS FOR FUTURE ROOFSCAPING IN WINNIPEG

Islands in the Sky

An Investigation into the Nature and
History of Roofscaping and Recommendations for Future
Roofscaping in Winnipeg.

by

Randall Mark Epp

A practicum
presented to the University of Manitoba
in partial fulfillment of the
requirements of the degree of
Masters of Landscape Architecture
in
The Department of Landscape Architecture, Faculty of
Architecture, University of Manitoba

Winnipeg, Manitoba

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ABSTRACT

In many parts of the world the flat roof has always been an important part of the vernacular architecture. In most cases these roofs have been used as living space. In some cases they have also been covered with vegetation.

The history of the more formally designed roof garden is almost as old. From the 5th century B.C. Hanging Gardens of Babylon, to the late 19th century roof garden of mad King Ludwig of Bavaria, the roof garden remained almost totally within the realm of the very wealthy. During the 20th century roof gardens have undergone a democratization, and now the most important roof gardens are the ones on the rooftops of public, commercial, and apartment buildings.

For over half a century the flat roof has been the predominate roof form for urban architecture. Today, as urban densities continue to climb, as the amount of green urban open space declines, and as realty prices soar, the need to develop our rooftop landscape -- or roofscape -- has reached a critical point. Also, as more and more people are living and working in high-rise buildings, and as air travel increases, the depressing appearance of our undeveloped roofscape is becoming more and more visible.

The following study examines: 1) the many special attractions and opportunities which rooftops can offer us, 2) the long and illuminating history of rooftop developments, and 3) the much shorter history of rooftop development in Winnipeg. Following this, the many environmental and economic benefits of rooftop developments, as well as the many benefits of increased rooftop amenity space, are examined. Finally, these benefits and opportunities are analysed in terms of their applicability to the specific situation in downtown Winnipeg. The study ends with a list of general recommendations as to the direction in which roofscaping should progress in Winnipeg in the future.

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Finally, I would like to express my special thanks to my father, who translated into English for me a large amount of literature on the history of roofscaping.

This practicum is dedicated to my parents, Eileen and Hardy Epp, in gratitude for all their encouragement and support throughout my many years of university.

UP ON THE ROOF

When this old world starts getting me down
And people are just too much for me to face,
I climb right up to the top of the stairs
And all my cares just drift right into space.
On the roof's the only place I know
Where you just have to wish to make it so.

When I get home feeling tired and beat
I go up where the air is fresh and sweet.
I get away from the hustling crowd
And all that rat race noise down in the street.
On the roof its peaceful as can be
And there the world below can't bother me.

I keep telling you that right smack dab
In the middle of town
I've found a paradise that's trouble proof,
And if this old world starts getting you down
There's room enough for two.
At night the stars put on a show for free,
And darling, you can share it all with me.

-- G. Goffing/C. King

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Chapter I

INTRODUCTION

> The touching care which American city dwellers take of the smallest few yards of open space is symptomatic of man's longing to leave the desert he has created and return to paradise, not the one from which his ancestors were ejected, but that which, of his own free will, he has destroyed.
>
> -- Madge Garland

As seen from above, our urban centres consist of thousands of barren, desert-island rooftops amidst a network of ever-flowing vehicular currents. Each one of these islands, now lying fallow, is a potential oasis. Sown with the seeds of imagination, and watered with the innovations of technology, these now fallow islands can blossom into lush gardens, from which every urbanite can reap the benefits.

The use of rooftops for things other than shedding rain is not new. For centuries people have been eating, sleeping working, and relaxing on rooftops. However, the need to develop roof space has never been as great as it is today in urban centres. In most North American cities more than one-third of the total core areas are covered with unused and unattractive flat rooftops. As the cost of land continues to climb, the last vestages of open green space disappear. And yet, architects, planners, and developers remain blind to the fact that much of that wasted roof space could be developed in ways that would significantly improve the quality of urban life.

Technological advances in the building industry have made it possible to do (at least theoretically) anything in a rooftop situation which can be done at grade level. It is now the job of the planner, the architect, and the landscape architect to provide the 'vision' for using this technical knowledge in a way which will be most beneficial to us and our environment.

The aim of this study is to 1)rediscover the 'roots' of the roof garden, to explore its historic raison d'être, as well as its present ecological and social benefits, and 2)to apply these rediscovered concepts to a present situation. To determine the best direction for future development, it is necessary to examine first our past successes and failures. It is the hope of this writer that the study will spark new and further investigation and exploration into this neglected area of urban design.

Technical information on rooftop developments has been kept to a minimum here. Instead, emphasis has been placed on the creativity of design and on the variety of functional and aesthetic development types which have evolved throughout the long and rich history of roof gardens.

The second chapter examines the phenomenon of 'roof:' its function and its various forms. It looks at the roof in general, and the flat roof in particular. The examples presented are from the vernacular architecture of various countries and climates.

The third chapter traces, in some detail, the long history of rooftop development from ancient times to the present. Whereas Chapter II deals with vernacular architecture, Chapter III deals with consciously designed roof gardens.

The fourth chapter focuses on roof gardens in Winnipeg, from the first apartment roof gardens build just after the turn of the century, to the most recent rooftop projects.

In the fifth chapter the information and insights gleaned from the research and investigations into 4,000 years of roofscaping are distilled and a list of benefits and limitations is drawn up.

In the final chapter the general benefits and limitations listed in Chapter V are examined in light of the Winnipeg situation. Winnipeg's density, architectural composition, climate, environmental quality, and economic condition all affect the use and type of development possible, as well as the economic and environmental benefits of roofscaping in Winnipeg.

A few lines about some of the terminology used in this study may be necessary at this point. A rooftop landscape or 'roofscape' is any "man-made outdoor environment, designed with or without planting, to serve some of the functions as a landscape area at ground [level],but separate from the ground by man-made structures" (Lee, 1982, p. 2). This means it may be at street level if some sort of structure (such as an underground car park) lies beneath it, or may be one or more storeys above street level on a building roof. The terms 'roof garden' and 'roof deck' may be used interchangeably, but 'roof garden' usually implies that some sort of vegetation is included. The difference between these last two terms and 'roofscape' is generally one of scale; 'roofscape' being the more inclusive term.

Chapter II

GENERAL ROOF FUNCTIONS AND FORMS

> The roof plays a primal role in our lives. The most primitive buildings are nothing but a roof. If the roof is hidden, if its presence cannot be felt around the building, or if it cannot be used, then people will lack a fundamental sense of shelter.
>
> -- Christopher Alexander

This chapter deals with the archetypal properties of the roof. There is no other architectural element which involves as many functional, socio-cultural, or aesthetic issues as does the roof. As Alexander points out "'roof' is a symbol of home, as in the phrase 'a roof over one's head'" (1977, p.571). Indeed, in some cultures a home is no more than just that: the North American teepee, for example, is a pitched roof which extends from peak to foundation, and the arctic igloo is nothing more than a domed roof resting on the ground. In both cases the roof surrounds the living space and provides that fundamental sense of shelter.

Section 2.1 explores briefly the almost universal attraction to rooftops. Section 2.2 deals with the practical, psychological, and socio-cultural functions of the roof in vernacular architecture, and section 2.3 deals with some aesthetic issues surrounding the roof in general and the flat roof in particular, and the way in which roof forms have affected urban skylines.

2.1 UNIVERSAL ATTRACTIONS TO ROOFTOPS

In his book, High-Rise Buildings and Urban Form (1961), Tyrwitt writes: "The most expensive apartments are at the top . . . on a hillside, overlooking a large park or body of water . . . In other words, the most desirable place to live is high up with a fine view" (p. 69). There are two parts to this almost universal attraction to high places: one involves the nature of the special view which only high places can provide, and the other part involves the physical act of actually ascending to these places.

Because of air travel, aerial photography, and the view from high-rise buildings, we are now accustomed to viewing our world from above. But this view is actually a very recent phenomenon. As Robert Hughes writes:

> The most spectacular thing about it [the Eiffel Tower] in the 1890's was not the view of the tower from the ground. It was seeing the ground from the tower. . . . Most people lived entirely at ground level, or within a few feet of it, the height of an ordinary apartment house. . . . But when the Tower was opened to the public in 1889, nearly a million people rode its lifts to the top platform; and there they saw what modern travellers take for granted every time they fly - the earth on which we live seen flat, as pattern from above. As Paris turned its once invisible roofs and the now clear labyrinth of its alleys and

> streets towards the tourists' eye, becoming a map of itself, a new type of landscape began to seep into popular awareness. It was based on frontality and pattern, rather than on perspective recession and depth. (p.14)

The world we live in always appears more ordered and manageable when viewed from high places. Grid roads and crop patterns are immediately recognizable from an airplane window. The grime, noise, and hustle of urban streets disappears when looking down from a 30th floor office window, leaving a seemingly ordered pattern of roads, buildings, and automobiles. Altitude provides us with a way of distancing, and disengaging, ourselves from our chaotic world. It transforms reality into a miniature of itself, a miniature which appears charming the way a doll house or a toy train set does. Small things often appear to us to be more precious, as well as more easily controlled, understood, or dismissed. When one views the world from the roof of a tall building all the blemishes visible at ground level disappear, the confusing details melt into a whole, and the complexity of the world can be grasped _en masse_.

In the book _My Name is Asher Lev_, Chaim Potok describes the kind of flight to the rooftop which almost everyone has experienced at sometime or another:

> Sometimes on a festival afternoon, my father and I would climb the stairs to the top floor of our apartment house. Then we would go up the last flight of stairs and my father would push open the huge metal door and we would step out onto the roof. We would stand near the clotheslines and the brick chimney and stare out across the tops of

> trees and the roofs of houses at the distant sky and smoky haze of the city. We could barely see the trees of Prospect Park for the tall buildings, and we could not see the lake at all. But the traffic noise floated up to us muted by distance, and the wind felt cool and clean. There was the feeling of being away from the world, alone away from the world, and near the sky, somehow nearer even to the Ribbono Shel Olom [Master of the Universe] (p. 157).

The omniscient view provided by high places gives one a sense of power. By climbing, or somehow ascending to these high places, we are freeing ourselves from some of the shackles of everyday life. As Wayne Attoe writes: "Ascending, rising up into the sky, is a defiant act. It challenges the traditional territory of the gods and defies a basic law: gravity. We take pleasure in that defiance . . .' (1981, p. 75).

In addition to the attraction of 'being above it all,' certain rooftops offer an added attraction to certain people. That is, the character or atmosphere of the traditional undeveloped urban rooftop. The chimneys, vents, glowing skylights, chain-link fences, metal fire escapes, clothes lines, pigeons, and the dome of blue skies or flickering stars, and the surrounding sea of glittering city lights, all make up a very unique landscape. Such roofs are usually deserted, lonely, dirty, and oddly appealing in their ugliness. They are the last islands of solitude left in our dense urban centres.

2.2 ROOF FUNCTIONS IN VERNACULAR ARCHITECTURE

The primary functions of the roof are to shed rain or snow, to screen wind and solar radiation, and in some cases to act as a thermal barrier for the space below it. The simplest way to protect a space from rain is to cover it with a pitched roof. Like the tree canopy which directs rain water down towards its dripline where its feeder roots can make use of it, the pitched roof directs water quickly away from the space below and the walls which support it. The pitched roof is generally the norm in wetter climates (see figure 1). The simplest way to screen a space from solar radiation, and/or trap radiant heat below it, is with a flat roof. The mass of straw on top of a Kirdi hut in Africa, for example, protects the space below from both sun and the limited amount of rain it receives (see figure 2).

In addition to these practical functions, roofs also fulfill an important psychological function. The roof which "contains, embraces, covers, surrounds the process of living," the roof which is "placed so that one can touch it - touch it from the outside," provides the inhabitants with a very real sense of protection, of shelter (Alexander, 1977, pp. 570 and 573). The A-frame cottage is a perfect example of a roof which "embraces" the space within, and it is probably for this reason that it is such a popular cottage type for woodlands and wilderness area where the the desire for a cozy, protective interior space is strong. Roofs, no matter

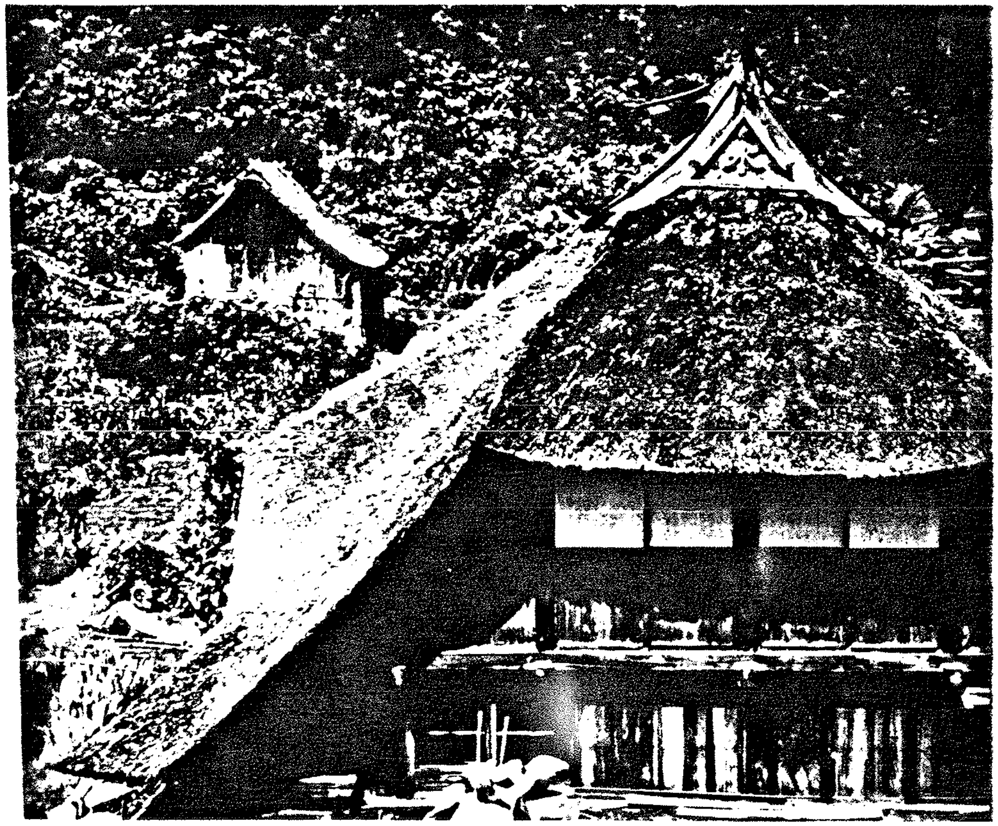


Figure 1: Northern Japanese Farmstead (Note how the character for 'water' is carved on the gable end of the thatched roof to ward off fire. Photo from Rudofsky,1964.)

what form they take, protect their inhabitants from the elements, covering "their inmates as a hen covereth her brood" (John Burroughs, Signs and Seasons as cited in Alexander, 1977, p.572).

Besides the practical and psychological need which the roof fulfills, it also performs a great many socio-cultural functions. The roof may be the primary means of declaring the building's function or type, as in the case of the domed mosque or "onion-domed" Greek Orthodox church. In many cultures the height of one's roof signifies importance. Citi-

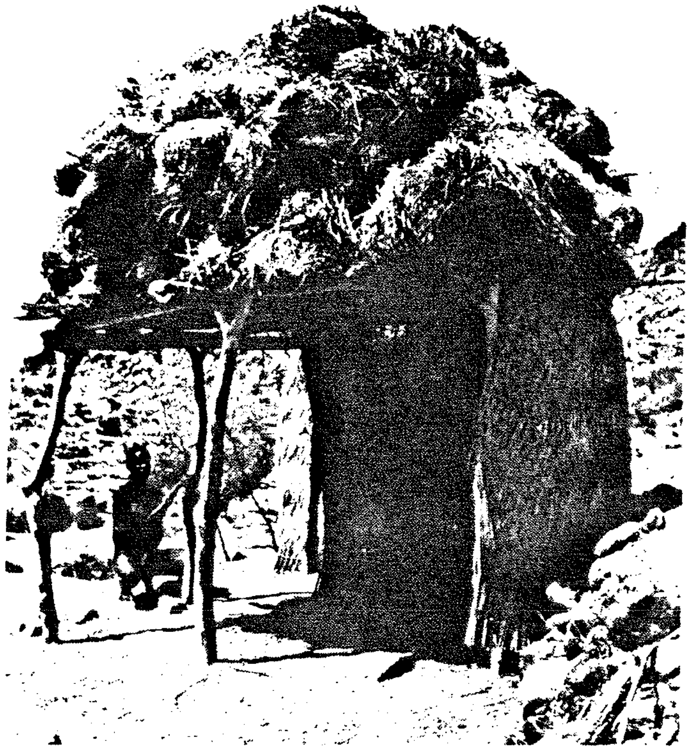


Figure 2: Kirdi Hut (The roof of the Kirdi hut is little more than a parasol or umbrella. Photo from Rudofsky,1964.)

zens of numerous English towns became extremely concerned when, during the Industrial Revolution, smoke stacks replaced the church spires as the dominant feature of the skyline (Attoe, 1981). In San Gimignano (see figure 3) and other Italian cities, noble and merchant families competed with each other in constructing towers to assert their identity and wealth or status (Attoe, 1981). Even as recently as a few years ago a bylaw was passed in Winnipeg which attempted to ensure that the Legislative building would remain the tallest building in the immediate area. A roof, especially in religious architecture, can be a symbol of heaven or of the sky, as in the circular roofs of the Temple of Heaven in Beijing (see figure 4), or the huge domes of the Pantheon or Hagia Sophia.

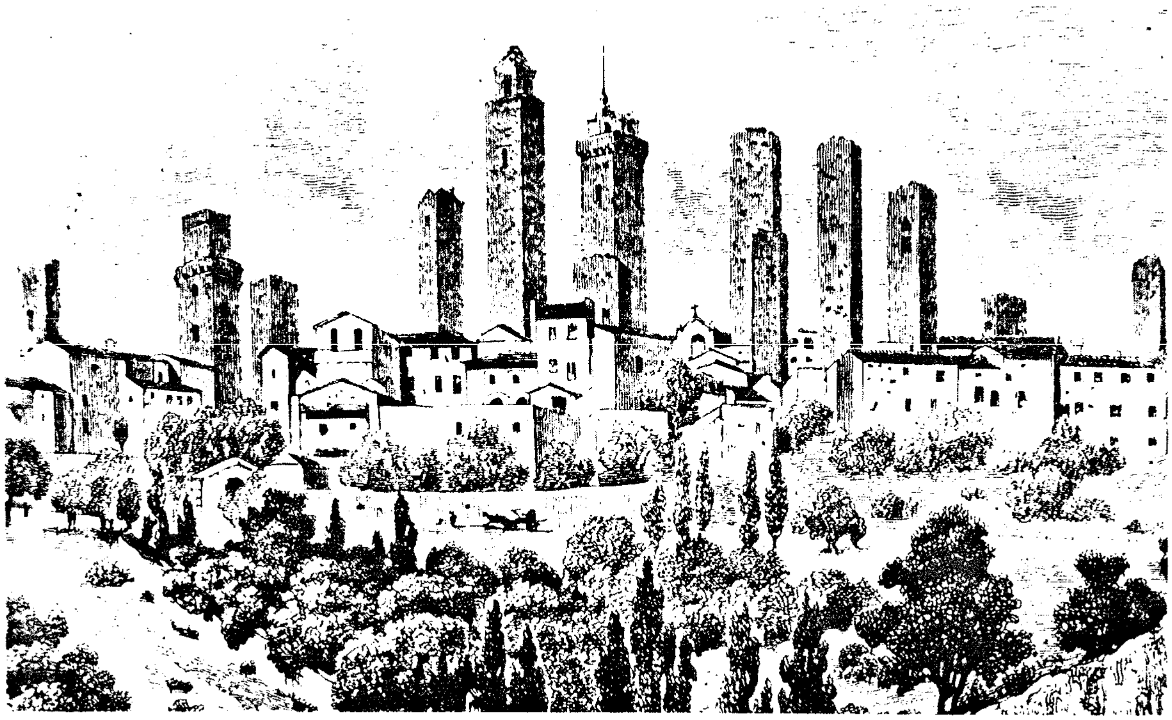


Figure 3: San Gimignano, Italy (Etching from Attoe,1981.)

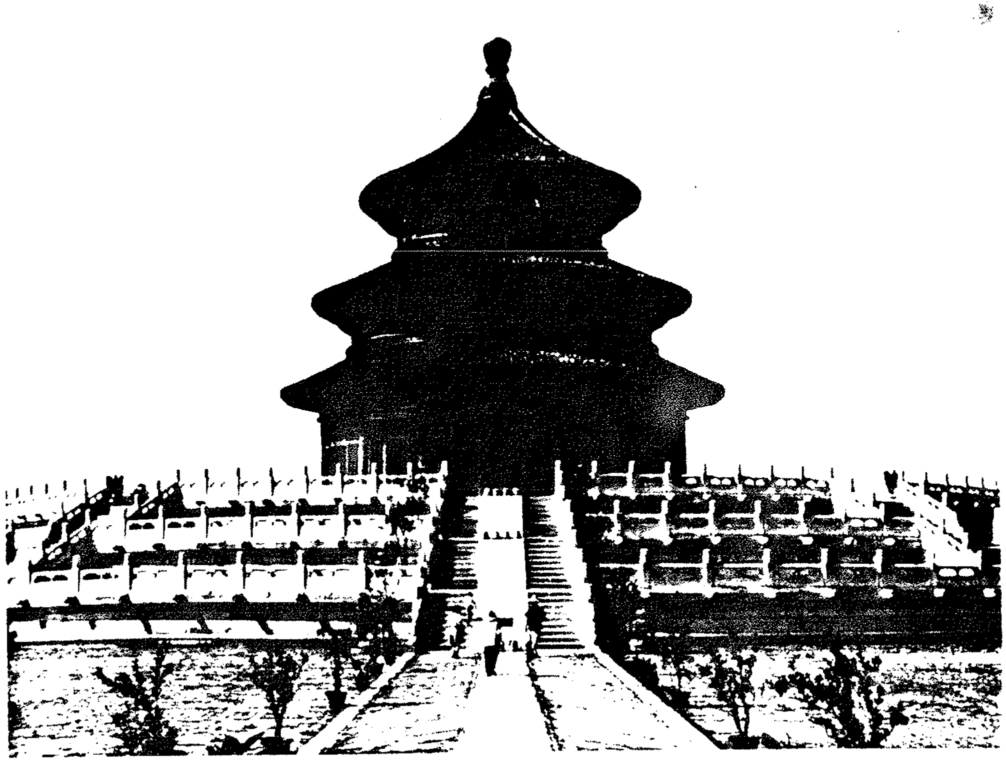


Figure 4: The Temple of Heaven, Beijing (Photo from Norberg-Schulz,1979.)

The roof, probably more than any other architectural element, is indicative of the cultural mileu from which a building originates. A very general, but by no means universal, rule of thumb is that flat roofs predominate in the vernacular architecture of warm, dry climates, and pitched roofs dominate in cool, moist climates. In nothern Europe, for example, pitched roofs have been the norm (figure 5), while flat roofs have been predominate in southern Europe (figure 6). Climate may have dictated that the roof forms of the vernacular architecture of a specific area be flat or pitched, but cultural traditions and preferences play just as important a role in making the roofs of various cultures distinct from one another. For example, the sweeping pitch of a Chinese roof (figure 7) is very different from the straight pitch of a Greek temple roof (figure 8). The triangular form of the Greek pediment is akin to the geometric forms of the Greek alphabet, just as the sweeping curve of a Chinese temple is akin to the flowing brush stroke of a Chinese character. The roof, then, has a socio-cultural rôle to play in so far as it projects an image representative of a specific culture, class, or region.

The flat roof can perform all the functions of other roof forms (that is, shed rain and snow, provide a sense of shelter, and project an image representative of its geograhic region, or building type), but the flat roof generally performs all these functions in a slightly less efficient, or

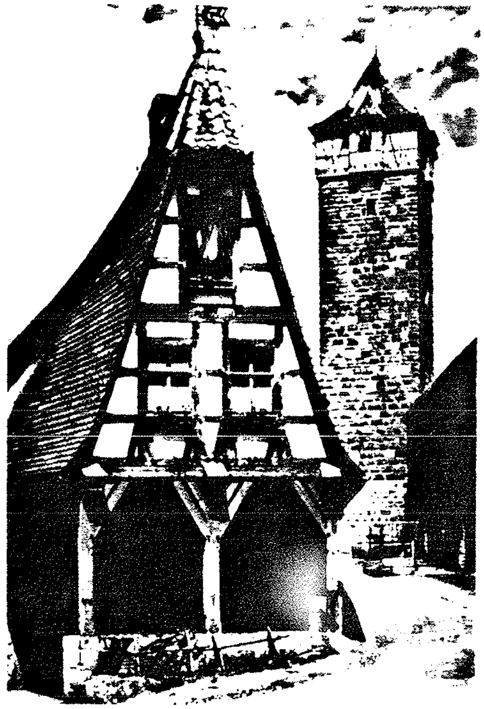


Figure 5: Old House in Rothenburg (Photo from Norberg-Schulz,1979.)

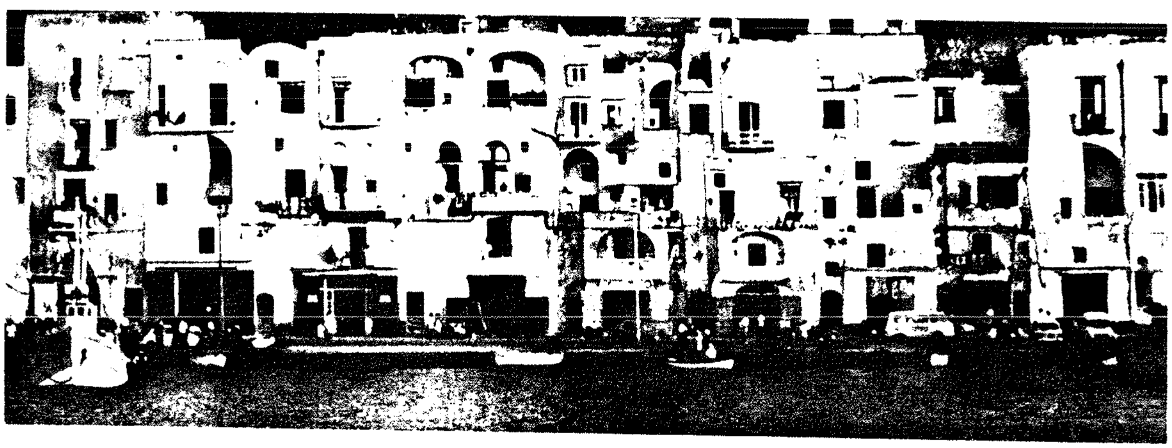


Figure 6: Houses at Procida Naples (Photo from Norberg-Schulz,1979.)

more limited, way. One thing it can offer, which none of the other roof forms can, is the provision of a special, accessible living space. Over the centuries the flat roof has

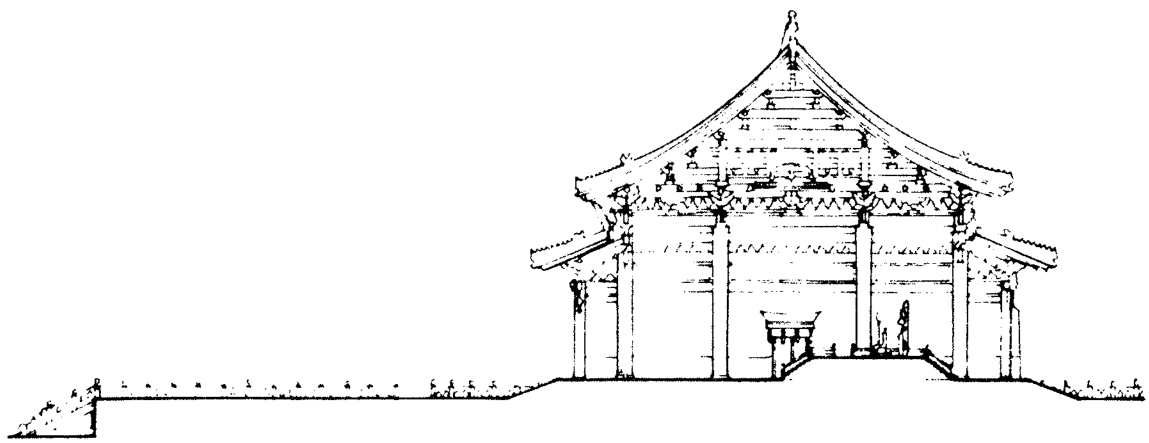


Figure 7: Taihe Dian (Pavilion of Supreme Harmony), Beijing (From Ching, 1979.)

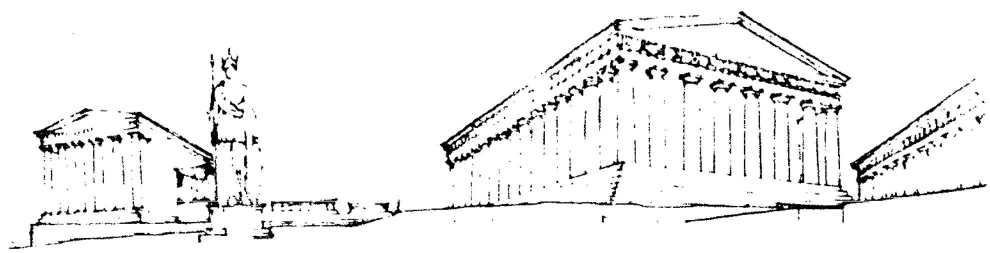


Figure 8: The Parthenon, Athens (From Ching, 1979.)

been used for a great variety of activities. It has been used as an observation deck to watch for the enemy (see figure 9), as a place to sleep and escape the trapped heat of the day (see figure 10), as a place to dry fruits and vegetables or cook and eat on warm days. In some cases the roof has even been used for transportation arteries and agricultural fields, as in northern China where entire villages are carved out below the earth's surface (see figure 11).

Here in North America the roof of farm homes was sometimes used as a convenient place to let the cow graze, as is evident in the photo of the pioneer farmstead in Nebraska (see figure 12). The mud house was carved out of the hillside and native grasses were allowed to grow on the roof. The roots of the grasses stabilized the soil roof, making it more solid, and soaked up the moisture before it could drip down into the living space below. The grass also helped to insulate the home against the cold of winter and the heat of

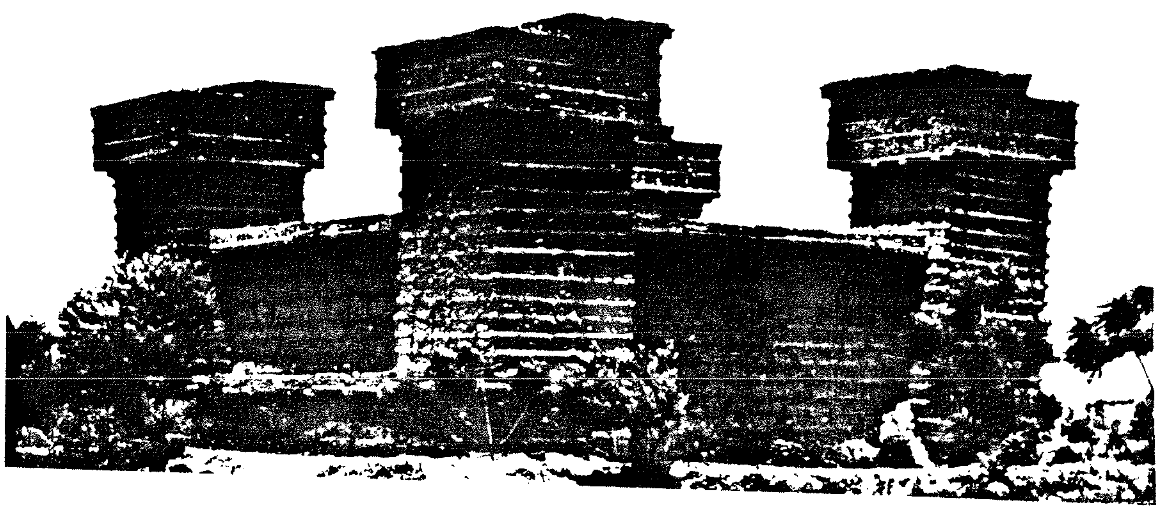


Figure 9: Fort in Swat State, Pakistan (Photo from Rudofsky,1964.)

summer.

In ancient Greece and Rome the flat roof played an important part in the cult of Adonis, a cult which originated in

Figure 10: Roofs of Sind district of Pakistan (Note air scoops which channel breezes down into the homes. Photo from Rudofsky,1964.)

the orient but flourished in the Greco-Roman world (Gollwitzer and Wirsing, 1962). Adonis, a nature deity, symbolized the blossoming and withering of nature. His annual death was celebrated by erecting effegies of the god on rooftops and balconies and surrounding them with large pots of soil in which were planted the seeds of plants which quickly grew

Figure 11: Underground Village near Tungkwan, China (Photo from Rudofsky,1964.)

and withered. In Imperial Rome rooftops were covered with potted flowers, shrubs and fruit trees for the feast of Adonis and laucus pensiles ('hanging' lakes or fish ponds) were even constructed on the rooftops for this celebration (Gollwitzer and Wirsing, 1962).

One other curious use of the rooftop started a major trend in Victorian New England residential architecture, and Mississippi Valley plantation homes: that of the 'widow's walk' (see figure 13). The widow's walk originated on houses in coastal villages where seamen's wives would wait up on

Figure 12: Pioneer Famstead with Mud House in Nebraska (Photo from Hancocks, 1971.)

the rooftops in the hopes of catching a glimpse of their husbands' ships returning to port, thus the name was derived from those women who continued to wait for ships that never would return. These small, square or long and narrow, fenced-in roof decks soon became stock features for two and three storey homes, and although seldom used, these widow's walks continued to decorate the roofs of large houses throughout the 19th and into the 20th centuries, and can still be found on a number of homes in Winnipeg today, including Government House.

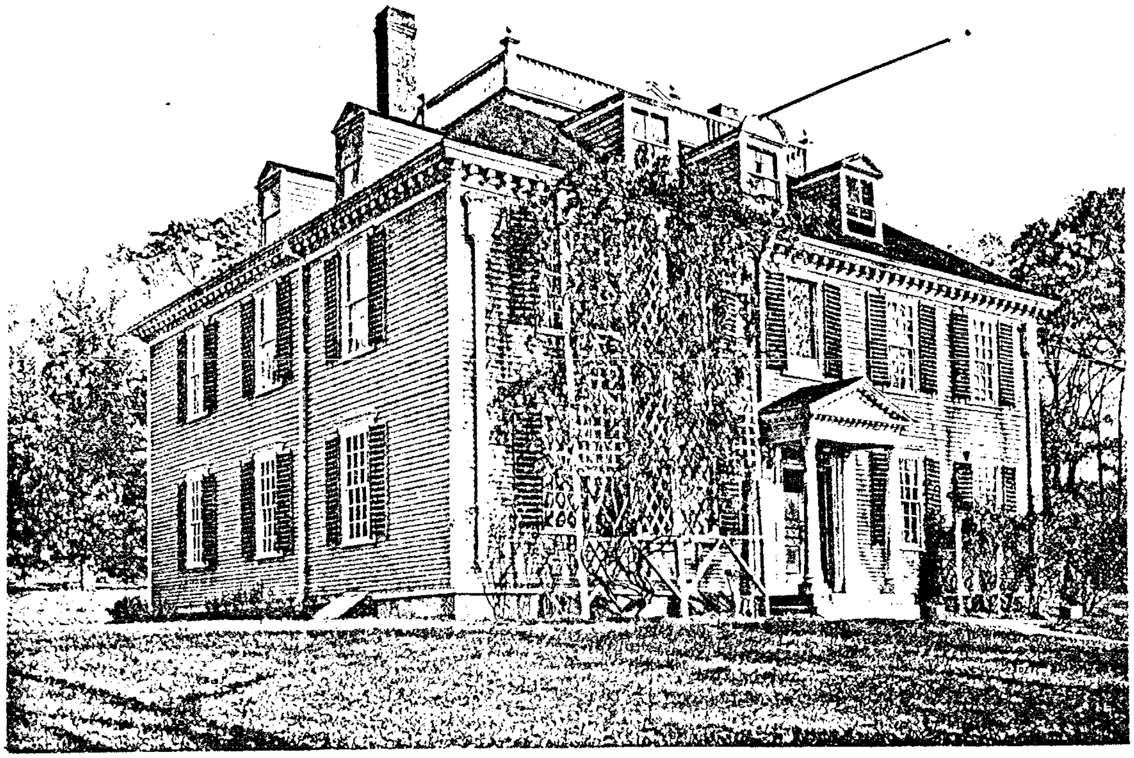


Figure 13: Widow's Walk above a typical New England Home (Sketch after photo of Saltonstall House, Haverhill, Mass. in Northend, 1914.)

2.3 ROOF FORMS AND URBAN SKYLINES

Any roof must overcome two structural problems: 1) it must defy gravity and span interior space, and 2) it must support its own weight, and often the weight of snow. Any roof which receives physical use such as foot traffic, must also be able to support this added weight or "live load." So long as a roof overcomes these structural problems it can take any form its builder wishes. The Penguin Dictionary of Architecture lists the basic forms which a roof may take: gambrel roof (Dutch hip in North America), helm roof ("four inclined faces joined at the top, with a gable at the foot of each"), hipped roof, the lean-to roof, the mansard roof, the saddleback roof (gable roof in North America), wagon roof (a horse-shoe shapped roof), and hyperbolic parabaloid roof (Fleming, 1972, p.242). In addition there is also the shed roof, butterfly roof, Dutch gambrel, A-frame, vaulted, cylindrical parabaloid, conoid, domed roof, and simplest of all, the flat roof. As soon as one begins to consider all the variations and combinations of these basic roof forms, it becomes obvious that the number of possible roof forms is virtually limitless.

And yet, since the first decades of this century the whole of the western world, and much of the eastern, has used the simplest form of all for almost every urban building built (except for single family dwellings and churches). Compare, for example, the skyline of 19th century Oxford (figure 14) with that of present day Atlanta, Georgia (figure 15). As Wayne Attoe writes:

> Most cities do not have a distinctive and memorable skyline . . . Instead their skylines are anonymous, composed of ubiquitous rectilinear highrise buildings grouped on a featureless landscape. Unless one has made a special effort to notice the differences, it is difficult to distinguish between the skylines of Winnipeg, Louisville, Brisbane, Perth, Phoenix, and Cincinnati, for example. (1981, p.19.)

Some attempts have been made to add variety to city skylines: Philip Johnson's AT&T Building in Manhattan, and the Transamerica pyramid in San Francisco, for example. In many cases one unusual and clearly visible structure is enough to

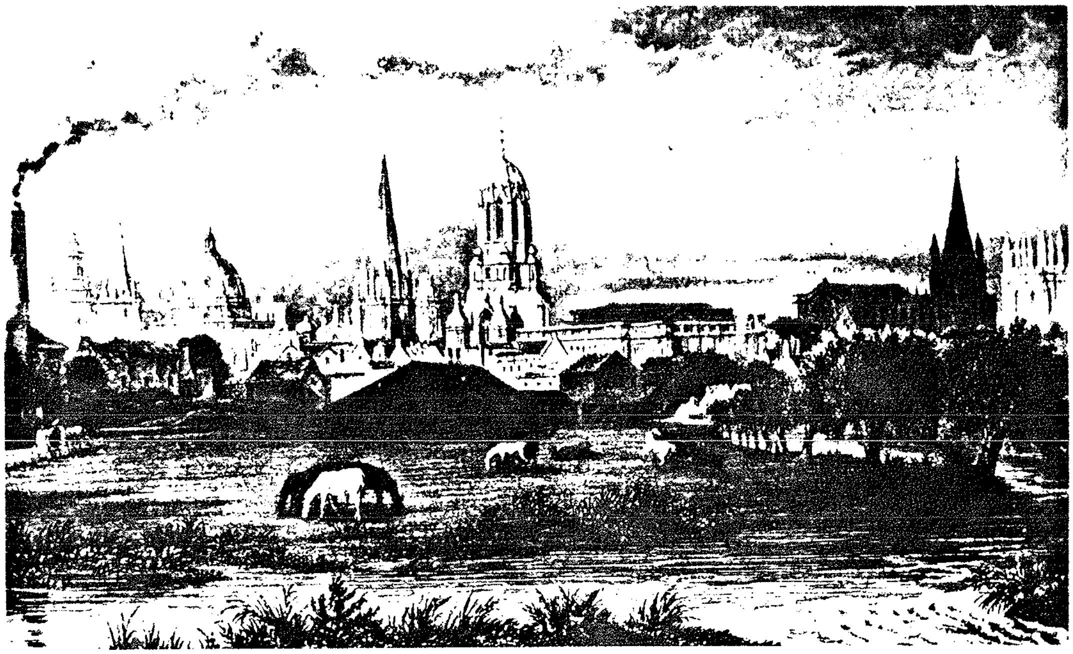


Figure 14: Oxford Skyline (Photo from Attoe,1981.)

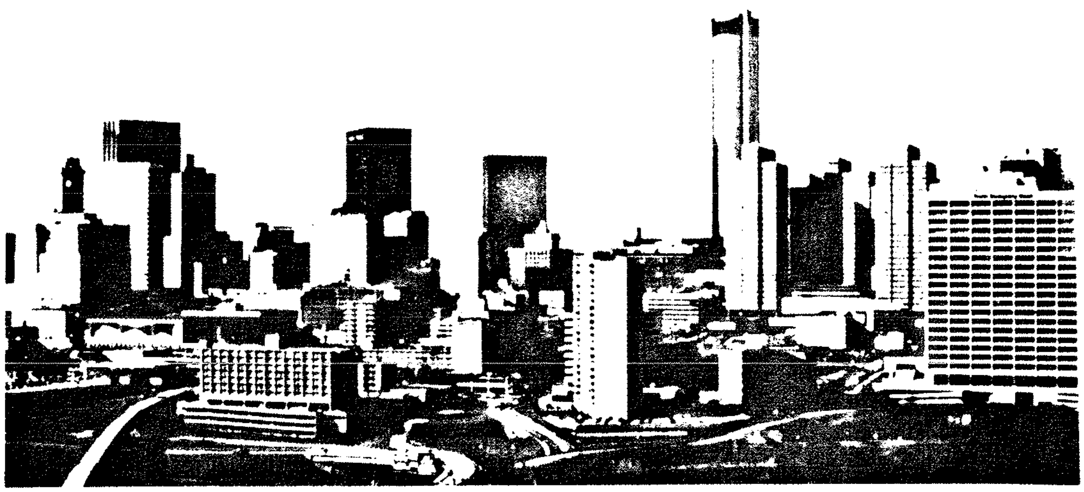


Figure 15: Georgia Skyline (Photo from Attoe,1981.)

give a city a distinctive skyline (as the CN Tower in Toronto, or the Gateway Arch in St. Louis), but the flat roof still accounts for 99 percent of the urban skyline in all parts of the world. Vanderberg writes:

> buildings in Britain and northern Europe normally had steeply pitched roofs, with a variety of textures created by small-unit cladding or thatch, enlivened by dormers and chimney stacks; and the skyline was punctuated by the dramatic spires and domes of more important buildings.
>
> Today , roofing has become almost too easy, and the line of least resistance (for the designer) tends to lead to the ubiquitous featureless flat roof . . . (1974, p.194).

Tom Wolfe writes in his unfair but witty treatise "From Bauhaus to Ourhouse:"

> It had been decided, in the battle of theories, that pitched roofs and cornices represented the "crowns" of the old nobility, which the bourgeoisie spent most of their time imitating. Therefore, henceforth, there would be only flat roofs making clean right angles with the building façades. (Harper's Magazine, June 1981, p.41.)

There are, of course, a number of good reasons why the flat roof has become ubiquitous over the past decades. The flat, unadorned roof is the form which best suites the function-oriented Bauhaus aesthetic (a style which is still very much with us today despite the post-modern and transitional movements of the past two decades), it is the quickest, least taxing roof form to design and therefore the least expensive in terms of architectural and engineering fees, it allows for the addition of extra storeys in the future (providing that the building foundations are adequate), it is easily accessed for maintenance, and provides a level place for lift housings, air conditioner compressors, exhaust fan vents, and so on.

There is one other argument which has often been given in support of flat roofs, one which, unlike the above arguments, has never been a valid one: that is, the argument that the roof of any building over six or eight storeys cannot be seen from the street because of one's angle of vision (see figure 16) and therefore does not warrant any special aesthetic consideration. If buildings were viewed only from street level the argument would have some merit, but buildings are also viewed from a distance at which the roof does fall within our 60 degree angle of vision. They are viewed from freeway overpasses and skywalks, from airplanes, and most of all, from inside other tall buildings.

During the past five or six decades the psychological, socio-cultural, and functional purposes of the roof have largely been neglected and the "flat roof" has come to be understood visually as "no roof." Instead of designing and constructing a visually significant "cap" for the building, a membrane is simply stretched over the top of the building once an arbitrary height is reached. The best reason of all for constructing flat roofs, the reason why the flat roof evolved in the vernacular architecture of so many cultures, has been almost entirely ignored in our modern urban centres. That reason is, of course, that flat roofs can provide very special living and recreational spaces.

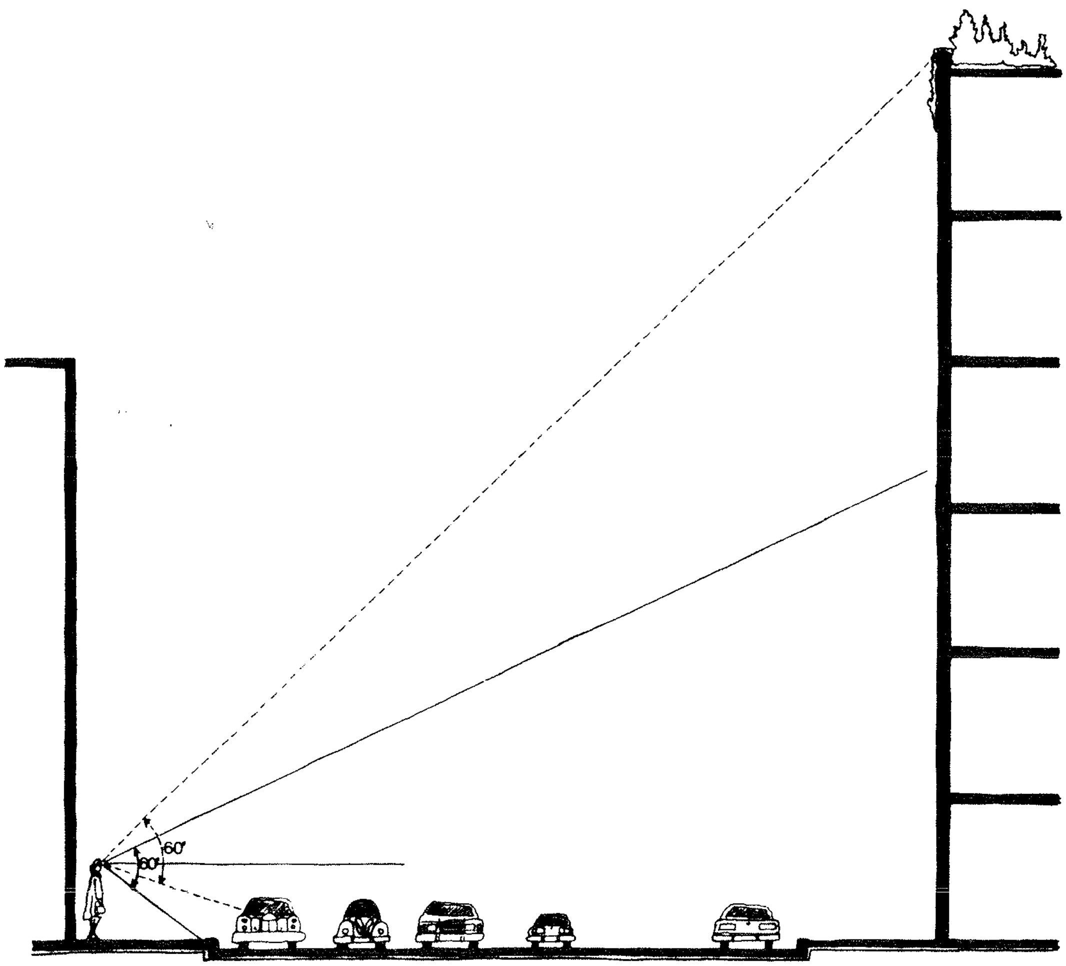


Figure 16: Visibility of Roof Spaces from Street Level
(From street level the roof of even a six-storey building may be within the normal scope of vision.)

Chapter III

THE HISTORICAL DEVELOPMENT OF ROOF GARDENS

> It happened towards evening when David had risen from his couch and was strolling on the palace roof, that he saw from the roof a woman bathing; the woman was very beautiful. David made inquiries about this woman and was told, 'Why, that is Bathsheba . . .'
>
> -- 2 Samuel 11:2-3

This chapter looks at the evolution of roof gardens from the earliest recorded occurrrences to the present. While the last chapter looked briefly at some examples of vernacular roof gardens which have existed for centuries in some countries, this chapter deals with specific examples of more elaborate, more consciously designed roof gardens.

In the warmer southern climates the simple roof garden or roof deck has always been a common architectural feature among the residences of all social classes. In all other parts of the world, however, roof gardens have historically belonged excusively to the wealthy. It was not really until Le Corbusier's Unité d'Habitation at Marseille, that the roof garden moved into the realm of the middle class.

The first section of this chapter looks at the elaborate, often spectacular roof gardens which emerged among the residences of the wealthy from the earliest recorded examples until the beginning of the 20th century. The second section deals with a few of the most important or successful examples of rooftop developments which have emerged during this century on the roofs of residential, commercial, and public buildings

3.1 4,000 YEARS OF ROOF GARDENS: FROM ANCIENT TIMES TO 1900

While the Hanging Gardens of Babylon are cited in most literature as being the first documented roof gardens, Theodore Osmundson (1979) points out that roof gardens probably existed as much as 1500 years earlier than the Babylonian Gardens. A 1920's excavation by Sir Leonard Wolley indicated that large trees had been planted on the upper terraces of a ziggurat in the Sumerian city of Ur as early as 2000 B.C. Osmundson also points out, however, that "Ziggurat plantings were not true roof gardens, for these towers had solid cores of rubble or soil" (1979, .p.498).

Hanging gardens were not uncommon in the Near East (Gollwitzer and Wirsing, 1962). Located in the lush area of the Euphrates and the Tigris Rivers, these gardens were laid out as a series of ascending terraces so as to create the illusion that they were floating or suspended. Greek authors who had seen these gardens referred to them as kremastos which the Romans translated as <u>horti pensiles</u> or "hanging gardens" (Gollwitzer and Wirsing, 1962), and the Roman term seems to have persisted in literature through to the end of the 18th century. Excavations near Ninevah revealed a hanging garden built by the Assyrian King Sanherib (705-681 B.C.) which supported not only large trees but also some sort of water feature (Gollwitzer and Wirsing, 1962).

The most famous hanging garden is the one which, when the Greek author Heroditus visited it in the 5th century B.C., so impressed him that he declared it one of the Seven Wonders of the World. This elaborate structure was built by King Nebuchadnezzar II (604-652 B.C.) in Babylon, possibly for his wife, Princess Amytis, "who was pining for the hills and forests of her native Persia" (Parrot, 1961); or perhaps as Gollwitzer writes, because he simply wanted to keep the royal apartments cool (Gollwitzer and Wirsing, 1962).

Exactly what the Hanging Gardens of Babylon actually looked like is still pretty much a matter of conjecture (see figures 17, 18, 19, and 20), but excavations by the German archaeologist Robert Koldewey at the turn of the century revealed:

> an irregular rectangle, narrowing towards the north from the south, with measurements of 50 X 40 X 35 meters. In this rectangle, in the so-called vaulted cellar, on both sides of a central passage, there were 14 similar chambers, surrounded by a strong wall. Around this entire complex ran a narrow corridor which was bounded in the north and east by the castle wall and in the west and south by further rows of chambers. The central chambers had strikingly heavier walls than those

> of the outside chambers, all of equal width, leading one to believe that they were required to bear a greater weight. An expansion joint between the central chambers and the surrounding wall, whereby the entire fourteen-tonne vault could move freely inside its enclosing wall, confirms this supposition. In this surprising construction the Hanging Gardens of Babylon were without precedent. They were also the first Babylonian construction where a passable vault was risked as a foundation for a heavy weight.
>
> \- - -
>
> The height of the highest terrace (30 meters above ground level) was flush with the defenceline walk on top of the castle wall; the width of the terraces being about 3.5 meters and the height differential between them being about 5 meters. (Gollwitzer and Wirsing, 1962, trans. by H. Epp, p.14)

These terraces were irrigated with a "Paternoster system," (a continuous chain of pails) raising water up from either a well or supply canal to the highest level of the building and depositing it there. From here the water was directed down the series of terraces by irrigation pipes. The reason the structure was able to withstand the continuous irrigation without deterioration was because of the elaborate waterproofing system used (see figure 21) (Gollwitzer and Wirsing, 1962).

Elaborate roof gardens were common among the Roman Villas built around the turn of the millenium. The "House of the Mosaic Atrium" at Herculaneum, for example, (see figure 22) had a large atrium roof garden with fountains, large shrubs, and hedges (Gore, 1984). Excavations of Pompeii revealed that the Villa of Diomedes, the House of Sallust, the Villa

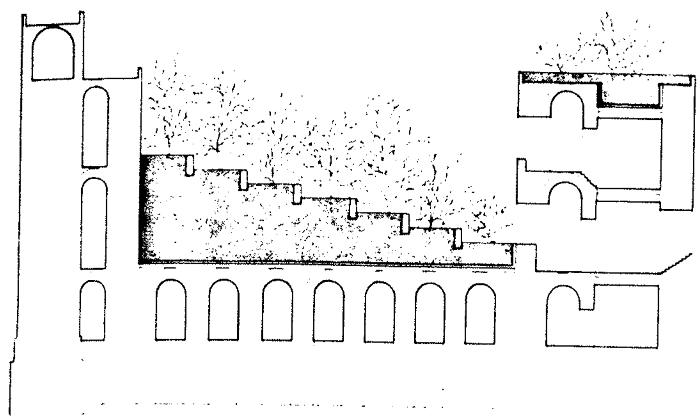


Figure 17: Reconstruction of the Hanging Gardens of Babylon by Koldwey (From Gollwitzer and Wirsing,1962.)

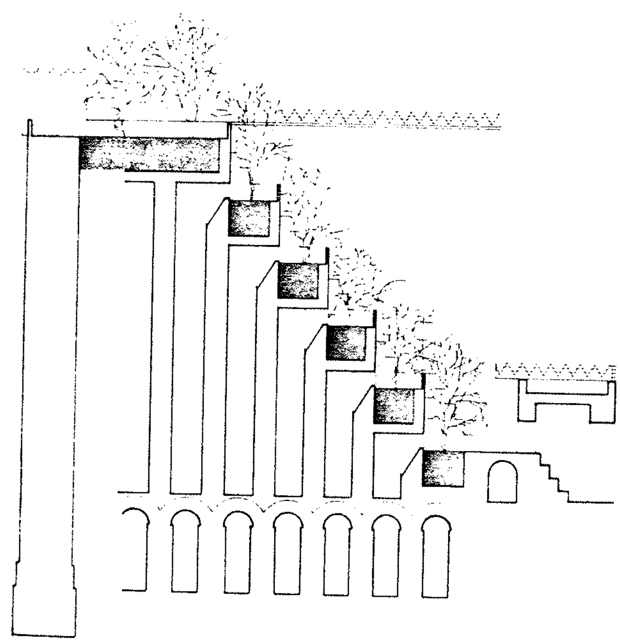


Figure 18: Reconstruction of the Hanging Gardens of Babylon by Krischen (From Gollwitzer and Wirsing,1962.)

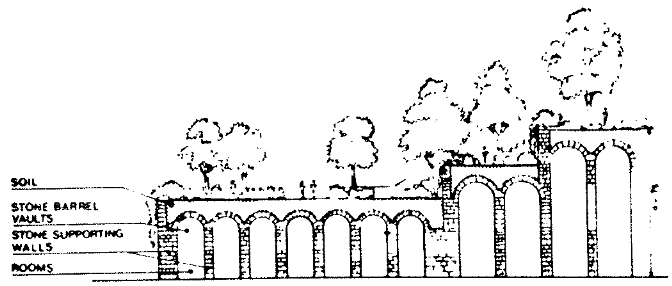


Figure 19: Reconstruction of the Hanging Gardens of Babylon by Osmundson (From Osmundson, 1979.)

Figure 20: Reconstruction of the Hanging Gardens of Babylon by Halprin (From Halprin, 1972.)

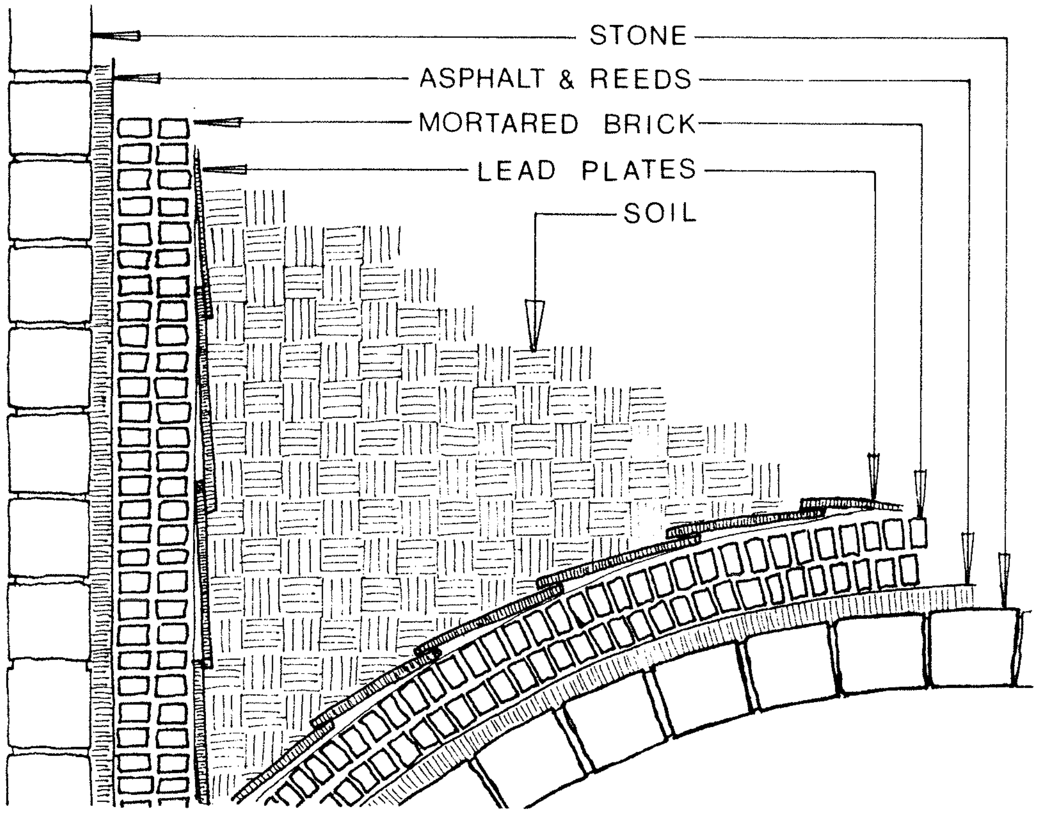


Figure 21: Section through Babylonian wall showing water proofing system (Illustration after description in Gollwitzer and Wirsing,1962.)

of the Mysteries, and the Cassa di Championnet, as well as many other partriarchal homes all sported large roof terraces, over both storage spaces and living spaces, which would have been covered with plants in large tubs and pools of water (Gollwitzer and Wirsing, 1962).

Roof gardens continued to grace the rooftops of the wealthy during the Roman, Byzantine, and Medieval periods and the Indian miniature art of the Mogul Emperors of the 11th and 12th centuries indicate that roof gardens also continued to flourish in the east (Gollwitzer and Wirsing, 1962).

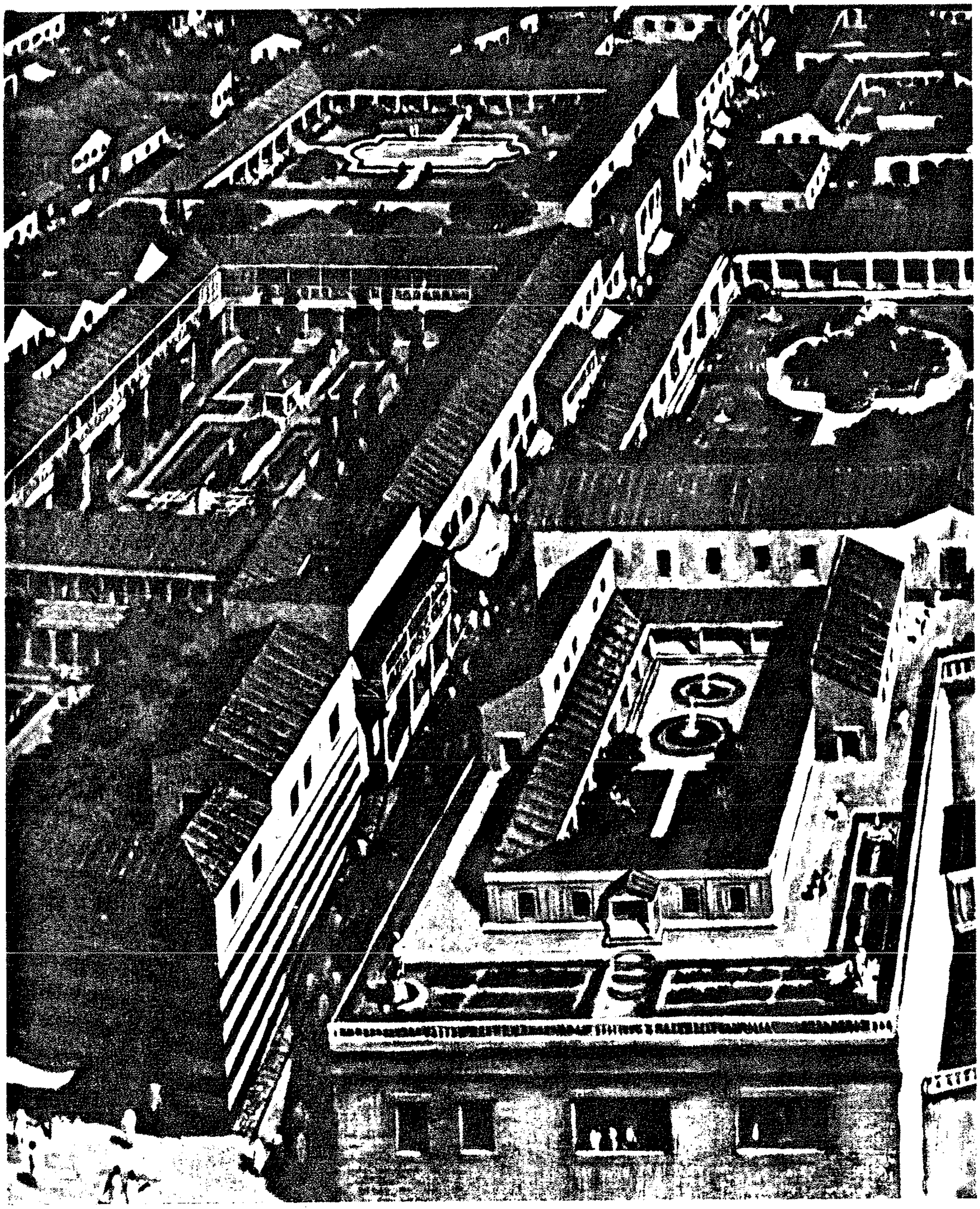


Figure 22: House of the Mosaic Atrium, Herculaneum (From Gore,1984.)

During the Renaissance there was a renewed interest in garden culture and the roof gardens and hanging gardens of the noble families blossomed with exotic plants collected in far off lands. In 1440 Cosimo de' Medici crowned his Villa Careggi in Florence with one of the richest botanic collections anywhere, and at their Mantua castle the Gonzaga family constructed a hanging garden overtop gigantic arches. In 1530 Cardinal Andrea della Valle built his own hanging gardens in Rome, under which he housed his private museum. Count Maffei planted the roof of his palace in Verona and had fountains installed, but poor planning and moisture problems forced him to later remove the garden (Gollwitzer and Wirsing, 1962).

Between 1632 and 1671 the Borromeo family of Milano built what Filarete, a writer and architect in the court of Sforza, said was a hanging garden even more magnificent than the Hanging Gardens of Babylon. On the flat rock isle of Isola Bella in Lago Maggiore, Count Carlo Borromeo, and later his son, constructed an enormous palace and series of gardens (see figure 23). On the south end of the island ten ascending, planted terraces built over gigantic substructures rose up from the bedrock to a height of 32 metres. All of the terraces were covered with luxuriant growth and spotted with pavilions. The top terrace housed a cistern for irrigation. (Gollwitzer and Wirsing, 1962; and Newton, 1971.)

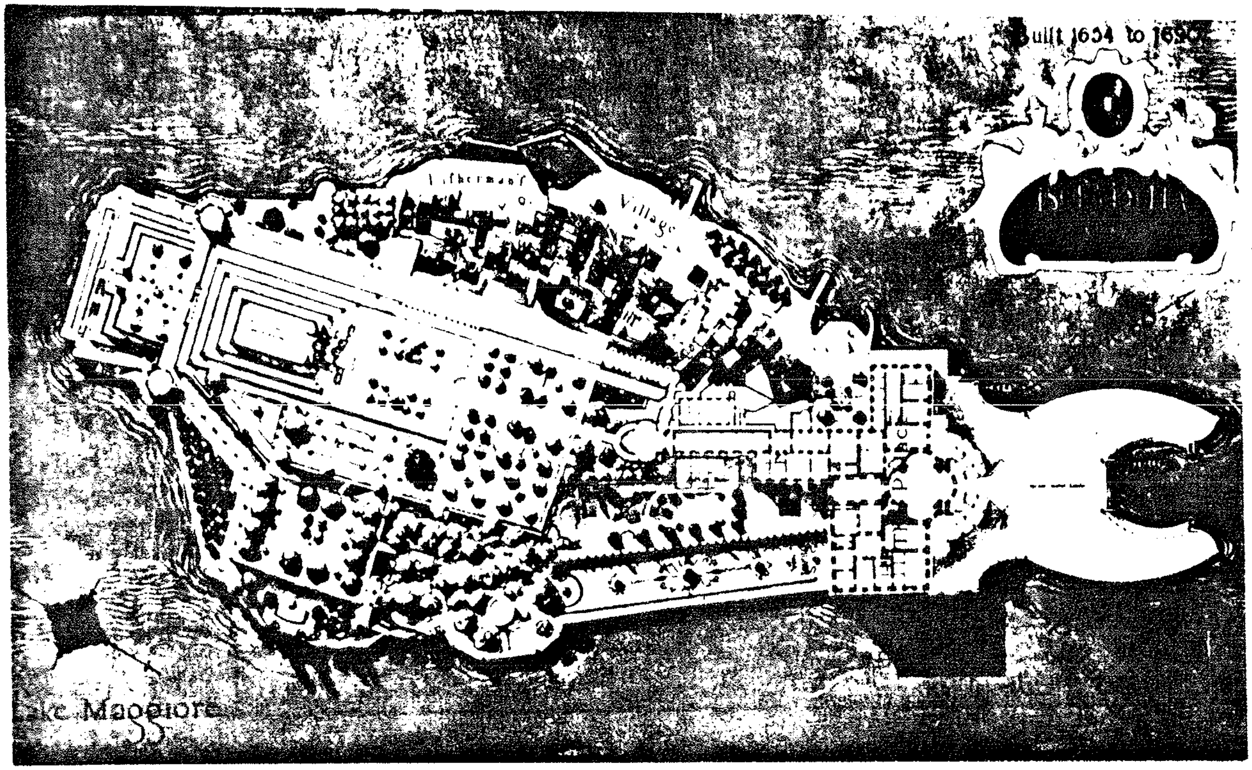


Figure 23: The Hanging Terraces of Isola Bella in Lago Maggiore (From Newton,1971.)

Roof gardens could be found all over Europe during this period but their numbers increased when, during the 18th century, a passion for grottos developed in Italy, and later spread to the rest of Europe. Most of these grottos were constructed above grade and the rooftops developed into terraces, usually with formal planting and water features. Villa Madama in Rome, Eleonore Gozaga's Villa Imperiale in Pressaro, the Villa di Castello in Florence, Castle Meudon in France, Castle Saint-Termain-en-Laye at Versailles, Castle Hellbrunn near Salzburg, Fersen Terrace in Sweden, and Wilton House in England, all had grottos with roof gardens above.

One of the best examples of a baroque roof garden was constructed around the year 1700 by Cardinal Archbishop Johann Philipp von Lamberg above his three-storey residence in Passau (see figure 24). This expansive, two-level pleasure garden was walled on three sides and open to a beautiful view on the south side. The end walls were painted with trompe l'oeil scenes to give the impression of added distance. The depth of soil had to be kept to a minimum because of the weight of the insulation and waterproofing layers used, and the plants therefore consisted mostly of flower beds, border plants, and potted shrubs and trees. Only a small portion of the roof garden remains today. (Gollwitzer and Wirsing, 1962.)

In 1722 a landlord and building authority by the name of Paul Jakob Marperger (1656-1730) published a treatise in which he called for the "abolition of house-roofs" (that is, pitched roofs), and the "universal introduction of balconies and roof decks," admitting that this would be "somewhat unusual and new" (as cited in Gollwitzer and Wirsing, 1962, p.11). Marperger recommended balcony and roof space be used for drying wash, and as germ-free or quarantine areas during plagues and periods of contageous diseases. He also recommended the use of roofs and balconies for growing plants:

> For pleasure and amusement the head of the house could have a small "hortum pensiles" or garden greenery in pots and boxes on such balconies; could build arbours thereon as the Jews in Nehemiah 8:16 did; establish this or that foreign growth and seed, and thereby learn to admire the omnipotence of God and the powers of nature. (Cited in

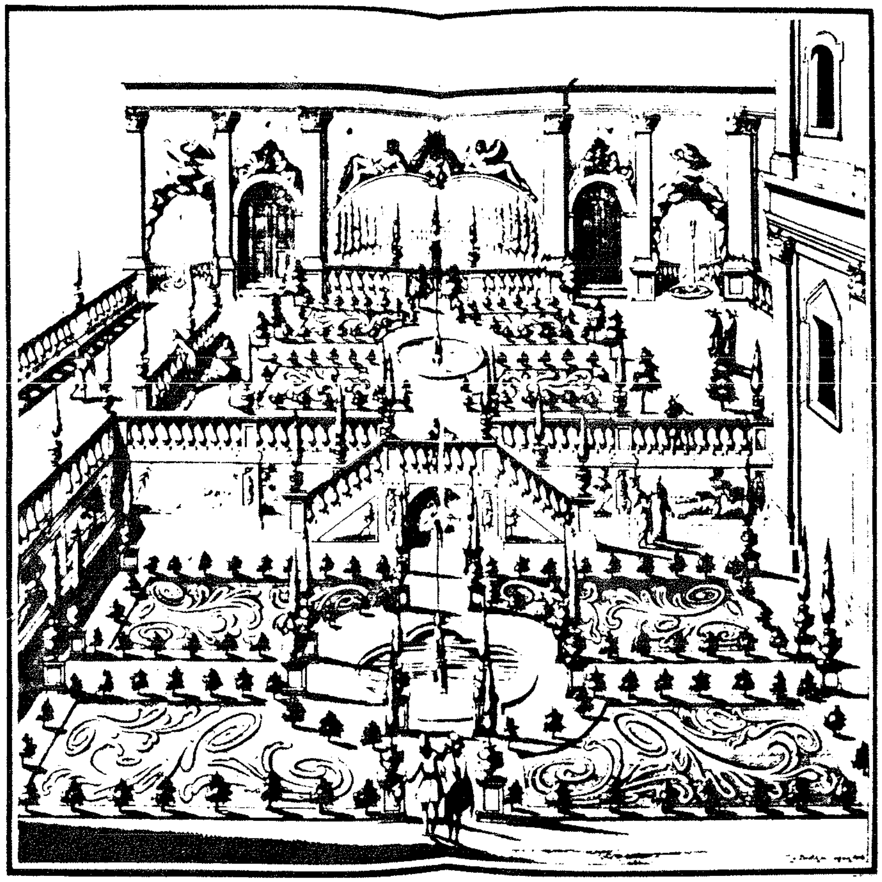


Figure 24: Archbishop Lamberg's Roof Garden, Passau Residence (From Gollwitzer and Wirsing,1962.)

Gollwitzer and Wirsing, 1962, p.11, trans. by H. Epp.)

Carl Rabitz, master mason of Berlin was the next authoritative figure to advocate the general adoption of flat roofs. In 1867 he published a brochure titled "Nature Roofs of Volcanic Cement or Modern Hanging Gardens, more fire-safe, superior quality, more beautiful, more durable and economical than any other roofing material." (See figure 25) The primary reason why Rabitz emphatically recommended the use of flat roofs was not because of the gardens which could be constructed upon them -- although that was certainly mentioned as one of the important reasons -- but because he saw volcanic concrete (cement with volcanic rock aggregate) as the best roofing material. It was lightweight, and did not therefore put any extra stress on the foundation or supporting walls, and yet was as strong as other concrete. At this time precast concrete was still unheard of, and the only way to roof a building with concrete was to pour it <u>in situ</u>. This, of course, made pitched concrete roofs rather imprac-

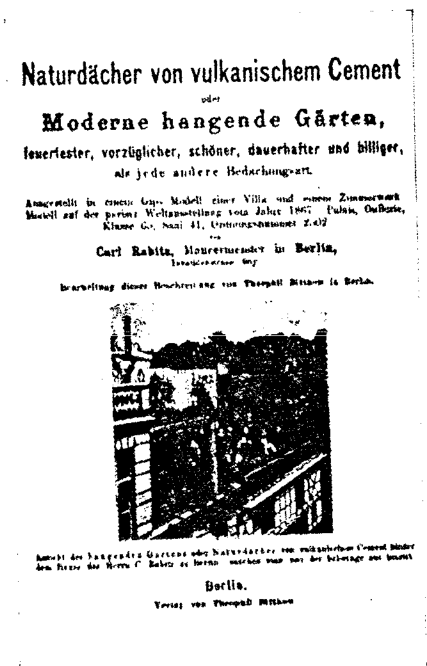


Figure 25: Cover of a brochure published by Rabitz, c.1860
(From Gollwitzer and Wirsing,1962.)

tical.

Rabitz ends his pamphlet with a picture of his roof garden (see figure 26) and this senario:

> 'An evening completed on the nature-roof of volcanic cement.' In it [the roof garden] a friend of the household wishes to say thank you for the costly, large grapes which Herr Rabitz had grown in his hanging garden, and nearby, the spouse is engaged in wifely handwork, surrounded by three lively children in the hanging garden. Finally the master mason comes home, eats his supper in the open and enjoys a long respite on the roof-garden. In the night the most splendid starry sky spreads itself before him and he ponders the stimulating wonders before his eyes. (Cited in Gollwitzer and Wirsing, 1962, p.17, trans. by H. Epp.)

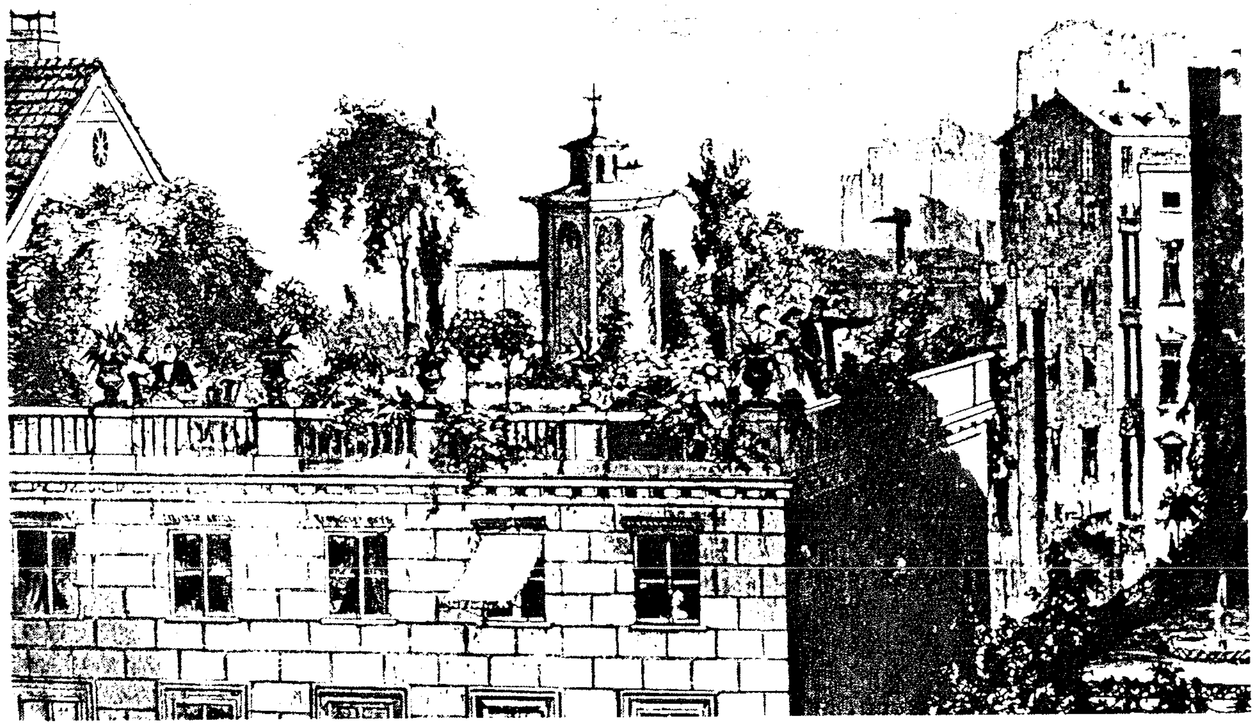


Figure 26: Carl Rabitz's Roofgarden, Berlin (From Gollwitzer and Wirsing,1962.)

At the World Exposition of 1867 Rabitz exhibited a plaster model of his Villa in Berlin with a roof garden. After viewing this model a reporter for the <u>Leipziger Illustr-</u>

ierte Zeitung wrote an article titled "Hanging Gardens on Nature Roofs," in which he stated:

> These nature roofs are flat, just slightly inclined; they are perfectly water-proof and protect the house against flying sparks (even without the construction of a garden with its cover of earth); they are only slightly more expensive than pasteboard and felt roofs. Furthermore, the nature roofs are expected to withstand considerable sway in the building without developing cracks because they form an entity on their own, and have only an indirect cohesion with the building. A poor heat conductor, the roof, according to experts, keeps the healthful rooms beneath warmer in winter and cooler in summer, which makes it especially valuable as a cover for abattoirs, markets halls, granaries, mortuaries, ice-, wine-, and beer-cellars. But what will contribute especially to the introduction of this roofing are the hanging gardens which can be established on them. Naturally, such plants, trees and shrubs which would thrive best would be the ones which do not require very deep roots, but ones now seen in the established gardens in Berlin: long-stemmed roses, vines, lilacs, and similar vegetation planted freely in the layers of earth. Birdhouses and fountains and valuable shady arbours are easily constructed thereon . . . Fresh green lawns alternate between gray roofs which still cover our dwelling places, and a new area opens up for recreation, which until now, has been the domain of only the sparrows and cats. What skillful architects can still do with this new structure decoration is yet to be seen, but it appears that the floating gardens are splendidly suited to enter the present and future building styles. (Cited in Gollwitzer and Wirsing, 1962, pp.17-18, trans. by H. Epp.)

In the same year that Rabitz exhibited the model of his Villa at the World Exposition, a gardener by the name of Monnier patented steel-reinforced concrete planters -- the first use of reinforced concrete. Twenty years later in 1887 François Hennebique constructed a villa in Lombardy -- the first building to be made of reinforced concrete.

(Gollwitzer and Wirsing, 1962.) This new structural technique brought about a revolutionary change in building forms and aesthetics, and made flat roofs a more attractive option than ever before.

Before moving into the 20th century, one more 19th century roof garden remains which demands recognition. That is the extravagant Winter Garden on the Roof of the north wing of King Ludwig II's Munich residence. King Ludwig's father, King Maximilian II, had had a 47 X 24 metre roof garden above the 8 metre high Max-Joseph-Platz which he could enter from his work cabinet in the palace. This "Old Winter Garden" included a pergola with sofa and writing desk, paths, and benches, a carpet of lawn, and masses of Northern Italian vegetation. King Ludwig is said to have only rarely visited this "Old Winter Garden," but as soon as his father died and he ascended the throne, he began plans for the "New Winter Garden." (Gollwitzer and Wirsing, 1962.)

The New Garden was begun in 1867, the year of the Paris World Exhibition, but was not completed until 1874. The roof garden was completely glazed over like the "palm houses" which were fashionable in most of Europe at the time but still unheard of in Munich (see figure 27). The garden was a "combination of stage-set, nature, architecture, and the special features of contemporary exhibitions and conservatories" (Blunt, 1970, p.234). (See figure 28 .) On the back wall was hung a huge painted back-cloth of the Himalaya

Mountains. In front of this was a large fish pond with artificially agitated water upon which the king boated amidst live swans and water lilies. There was also a palm-thatched fisherman's hut, a grotto with waterfall, a stone kiosk and arched bridge. In and around all these features tropical vegetation flourished and exotic birds flitted about while musical groups concealed in the bushes played snatches from Wagner's operas. Only the King and a very select few had access to the garden. The young Spanish Infanta Maria de la Paz, a distant relative and friend of the King described her first visit to the garden:

> With a smile the King drew the curtain aside. I was dumbfounded, for I saw an enormous garden, lit in the Venetian manner, with palms, a lake, bridges, pavilions and castellated buildings. 'Come,' said the King, and I followed him fascinated, as Dante followed Virgil to Paradise. A parrot swinging on a golden hoop cried 'Good evening!' to me, while a stately peacock strutted past. Crossing by a primitive wooden bridge over an illuminated lake we saw before us, between two chestnut trees, an Indian town . . . Then we came to a tent made of blue silk covered with roses, within which was a stool supported by two carved elephants and in front of it a lion's skin.
>
> The King conducted us further along a narrow path to the lake, in which was reflected an artificial moon that magically illuminated the flowers and water-plants . . . Next we came to an Indian hut, from whose roof native fans and weapons were hanging. Automatically I stopped, but the King urged me forward. Suddenly I felt as if I had been transported by magic to the Alhambra: a little Moorish room, in the centre of which was a fountain surrounded by flowers, carried me to my homeland. Against the walls were two splendid divans, and in an adjoining circular pavilion behind a Moorish arch supper had been laid. The King invited me to take the centre seat at the table and gently rang a little hand-bell . . . Suddenly a rainbow appeared. 'Heavens!' I involuntaily cried. 'This must be a dream!' (Cited in Blunt, 1970, p.92.)

King Ludwig was constantly adding to this garden and in 1871 he ordered Effner, the Royal Gardener, to plant banana trees and date palms, and to find a pair of gazelles and a young elephant for the garden. Obviously, the palace had not been designed to support the huge iron and glass structure, the metre-deep layer of soil, the lead waterproofing plates, and the huge pond, (let alone an elephant). The walls were under tremendous stress and the roof leaked onto the servants quarters below (some of the servants had to sleep under open umbrellas if they wanted to stay dry). The garden was therefore closed immediately upon the mad King's death in 1886 and was torn down in 1897 (Gollwitzer and Wirsing, 1962).

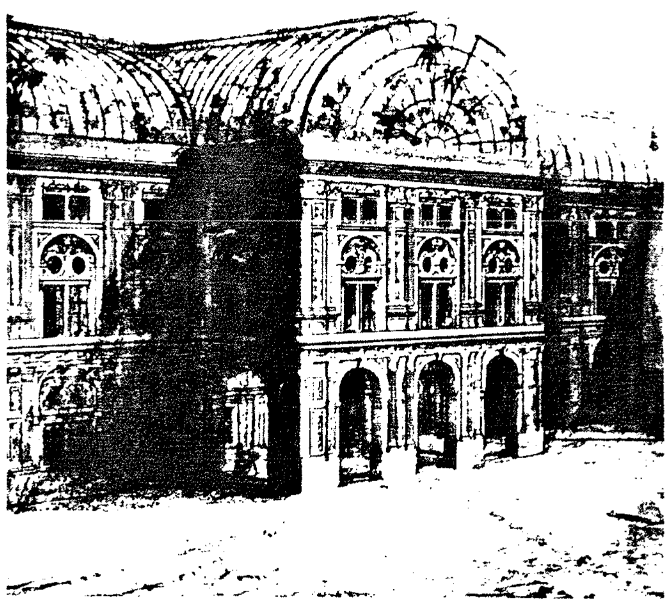


Figure 27: Glazed Roof Garden over Ludwig II's Munich Residence (From Gollwitzer and Wirsing,1962.)

Figure 28: Interior of Munich Residence Roof Garden (From Gollwitzer and Wirsing,1962.)

3.2 TWENTIETH CENTURY DEVELOPMENT OF ROOF GARDENS

Until the last decade of the nineteenth century, the only important rooftop developments were the elaborate pleasure gardens atop the private multi-storey residences of the wealthy. Then during the last decade of the century theatre and hotel managers in the United States and Europe began to realize the potential of roof garden cafés and amusement parks. Slowly roof gardens began to spring up on the rooftops of, not only private residences, but also of commercial and public buildings like office towers, hospitals, schools, police stations, libraries, train stations, car parks, and shopping centres.

3.2.1 1900 to 1950

Although rooftop developments became icreasingly more popular during the first half of this century, they still remained, more than anything, a novelty. The urban crowding and shortage of space was not yet as critical in most North American cities as it is today, and because of technical limitations, the opportunities and advantages of developed roof space were not yet as apparent.

3.2.1.1 Apartment Buildings

Apartment blocks have played a particularly important part in the development of roof gardens. It is here, where semi-private outdoor space is usually very limited and private outdoor space is non-existant or limited to miniscule balconies, that the need for roof gardens is most critical. The higher the density of apartment units, the greater the need for roof gardens. High-rise apartment blocks are as much a part of urban centres today as automobiles.

Apartment blocks have been around almost as long as cities have. Seven storey buildings occupied by several unrelated families could be found in Europe as early as the classical times (Tyrwitt, 1961). Their primary reason for existence was a lack of space; once there was no ground left to build on, one could only build up.

By the year 1700 the city of Paris already had 22,000 apartment blocks, each from five to seven storeys high and occupied by up to 25 families (Tyrwitt, 1961). In North America the first apartment blocks were the "railroad flats" of Manhattan. These cramped and ugly flats were occupied mainly by Irish and East European immigrants who were poor and had no tradition of urban living (Tyrwitt, 1961). Those who lived in these flats lived there only because they could not afford better accommodations. Blocks of flats or apartment blocks have, therefore, had a bad reputation in North America right from the start.

By 1900, 88 percent of Manhattan's population lived in apartment buildings, mostly railroad flats, and the construction inventory shows that while a total of only 56 private houses were built in Manhattan in 1903, over 4,000 apartment buildings were built (Tyrwitt, 1961). Manhattan was not the only place in North America where apartment buildings surpassed all other types of housing: in 1921 new apartment buildings amounted to only a quarter of all new dwellings built in 255 American cities, but within seven years they amounted to 54 percent of new dwellings (Tyrwitt, 1961). This dramatic rise in the number of apartment buildings during the first two decades of this century was due, to a great extent, to the invention of the hydraulic lift or elevator by the American firm named The Otis Elevator Company.

The elevator was invented around 1850, but before 1900 they were used only to lift coal and heavy furniture up to the upper floors of apartment and office buildings. When passenger elevators were introduced after 1900 they reversed the value of upper floor suites. Because of the long climb up to the higher storeys, the upper floors were always relegated to low income tenants. But, once the upper floors were as easily accessed as the lower floors, the better view from the upper floors made them more attractive than the lower floors.

The years 1924 to 1929 saw the emergence of the penthouse apartment (Tyrwitt, 1961). The word 'pent' is derived from the latin <u>appenticum</u> or appendage. The penthouse was often an actual "house" built on the roof of an apartment building, and the view plus the surrounding open rooftop space made the penthouse the most valuable property in the building.

Since their emergence, penthouse suites have remained the most valuable private urban property available; however, the communal roof garden has usually proved to be economically more advantageous because, while the penthouse garden increases the value of one or two suites, the communal roof garden increases the value of all the suites in the builing.

The first significant apartment block roof garden built during this century was devoid of any type of vegetation (and has probably for this reason been overlooked in every piece of literature on roofscaping of which the present author is aware). Although it has no soil, water, or plants, the roof of Antionio Gaudi's Casa Mila, begun in 1905, was a functional roofscape as creatively and as carefully designed as any today. Gaudi had created fantastical roofscapes above some of his earlier works, such as the Palacio Guell (1885-1889), and Villa Bell Esguard (1900-1902), but it is behind the undulating mánsard roofline of his Casa Mila that Gaudi most fully developed the concept of roof as useable, enjoyable, attractive space (see figures 29, 30, and 31). Biographer George Collins writes of Casa Mila:

> The pride of this building is its roof, a lunar landscape of erratic up and down stairways as in a dream. It is inhabited by bizarre ventilators and chimneys, which at first seem to be sheer whimsey. But when it is realized that the whole building was to be the base for a gigantic statue of the Virgin de la [Pasio de la] Gracia, the demonic versus chivalric appearance of these figures is understandable. (Collins, 1960, p.21)

On the roof of this remarkable building Gaudi created a fantasyland where tenants could lose themselves in the surrealist maze of chimneys, stairs, and doors high above the everyday world below. Tenants could use the roof to bask in the Barcelona sun, enjoy a view of the city, or hang up their laundry to dry while visiting with neighbours. Note the way in which Gaudi used one of the many mosaic archways to frame the silhouette of his famous 'Sagrada Familia' church (see figure 32). One of the attractions of urban rooftops has always been the distinctive character of the typical urban rooftop created by the chimneys, vents, lift housings, skylight covers, and chain link fences. In Casa Mila, Gaudi has somehow managed to create that distinctive rooftop character while using very unconventional materials

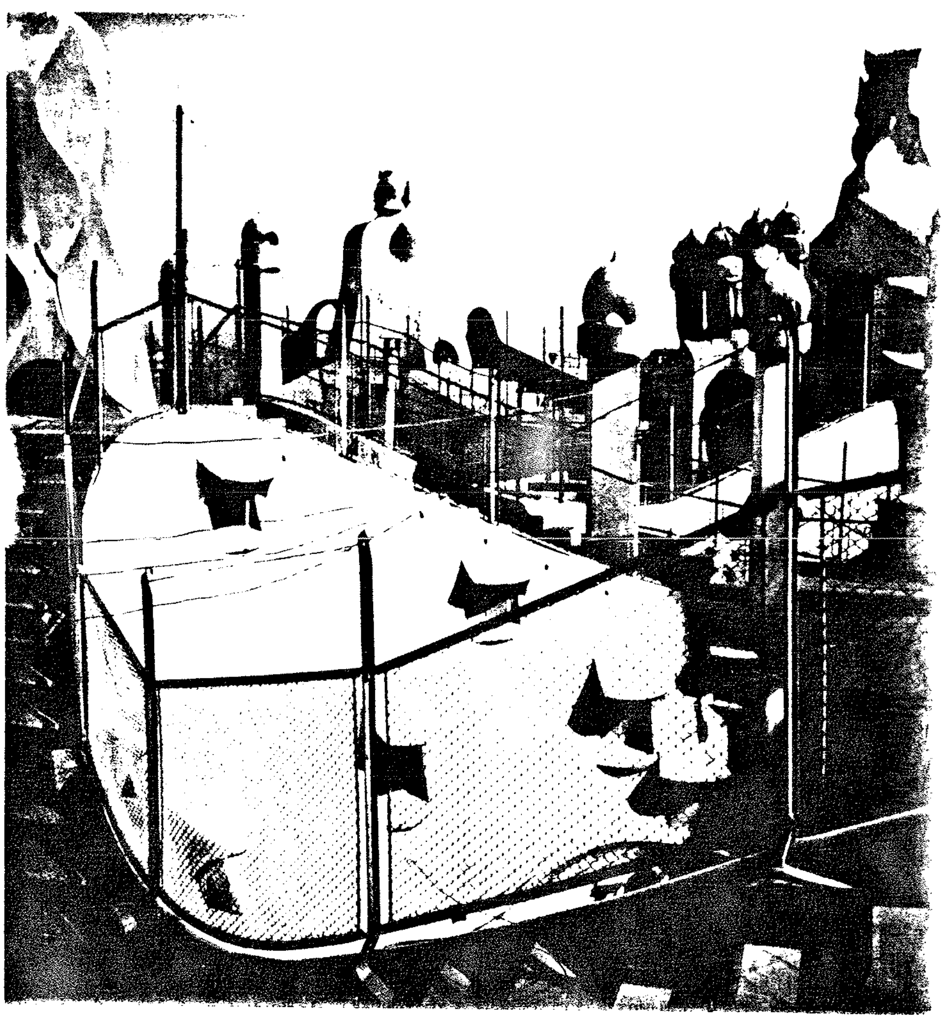


Figure 29: Casa Mila Roof Garden, Barcelona (From Martinell, 1975.)

Figure 30: Casa Mila Chimney Sculptures (From Martinell, 1975.)

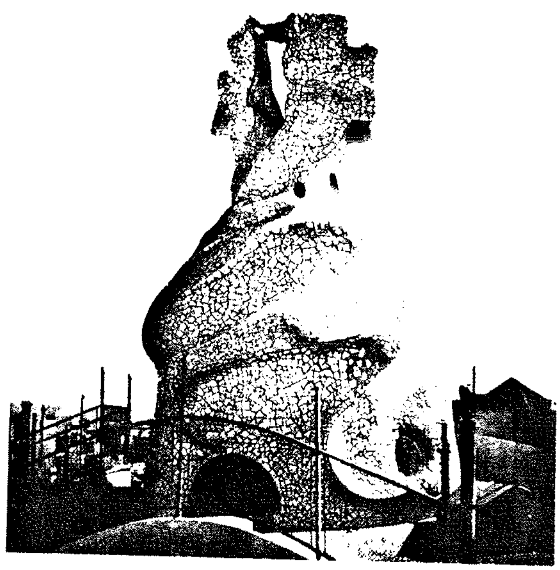


Figure 31: Casa Mila Stairwell Entry (From Martinell, 1975.)

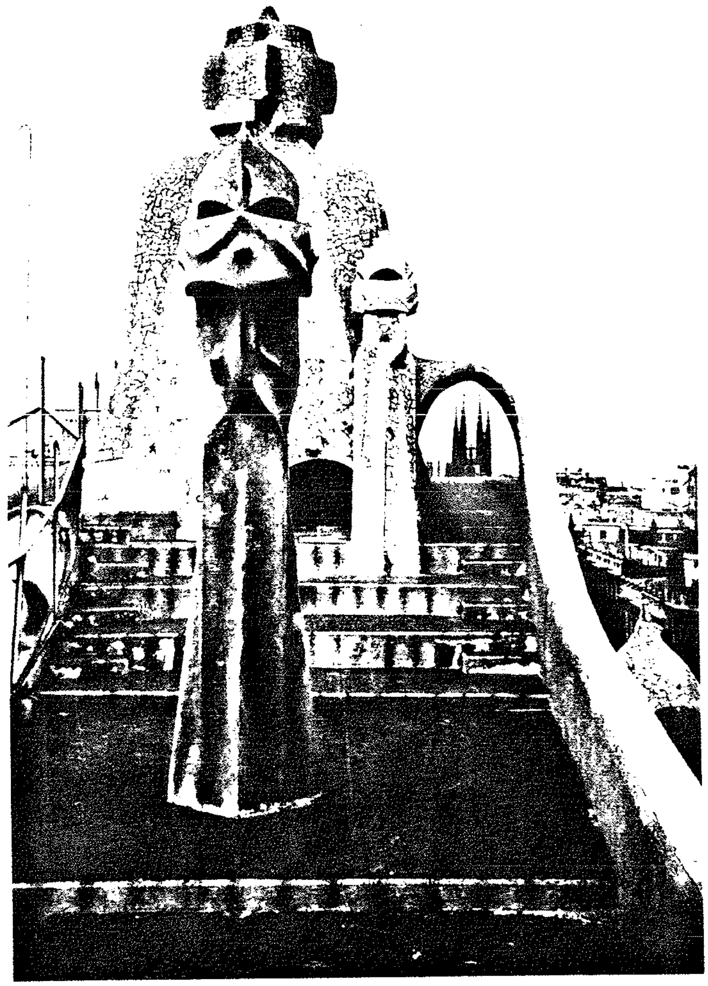


Figure 32: Casa Mila Roof Sculptures (From Collins, 1960.)

and forms.

Le Corbusier was one of the strongest forces in promoting the utilization of roof space in this century. Henry Sauvage, Frank Lloyd Wright, Mies van der Rohe, Auguste Perret, Ernst May, Marcel Breuer, and many others all designed private residences and commerical buildings with rooftop gardens during the first two decades of this century, but it was Le Corbusier who fought most strongly to make the roof garden an integral and important element in apartment block design.

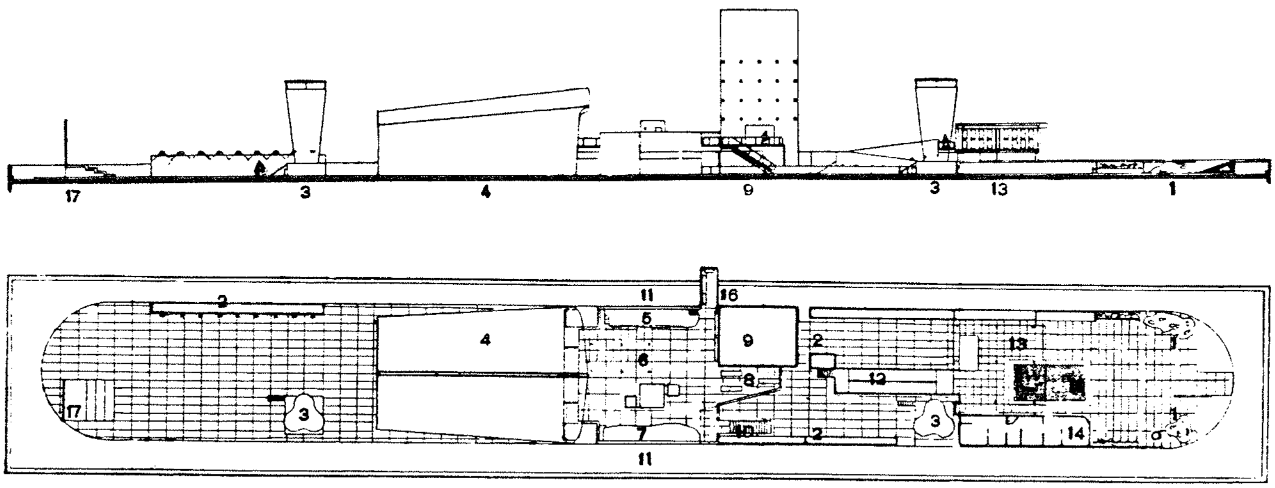
The most important apartment block built during the first half of this century which featured a roof garden was Le Corbusier's Unité d'Habitation (1947-1952). This building, probably more than any other single building, helped kindle the new interest and serious attention which roofscaping received after 1950. Le Corbusier had already designed numerous apartment blocks and row houses with roof gardens before 1947: the Housing Development project for Pessac, near Bordeaux (1925), the Wiessenhof Development in Stuttgart (1927), and Immeuble Clarté in Geneva (1930-32), to name a few. But it was in his Unité d'Habitation at Marseille (the first of a series of apartment blocks with that name) that the roof garden reached its full potential. In his treatise 'Five Points of a New Architecture,' Le Corbusier described his philosophy of roof as usable space:

> (1) The house used to be sunk in the ground: dark and often humid rooms. Reinforced concrete offers us the columns. The house is in the air, above the ground; the garden passes under the house, the garden is also on the house, on the roof.
>
> (2) The roof-gardens: For centuries the traditional rooftop has usually supported the winter with its layer of snow, while the house has been heated by stoves.
>
> From the moment central heating is installed, the traditional rooftop is no longer convenient. The roof should no longer be convex, but should be concave. It must cause the rainwater to flow towards the interior and not the exterior.

> A truth allowing of no exceptions: cold climates demand the suppression of the sloping rooftop and require the construction of concave roof terraces with water draining towards the interior of the house.
>
> Reinforced concrete experiences a great deal of expansion and contraction. An intense movement of this sort can cause cracks in the structure . Instead of trying to rapidly drain away the rain-water, one should maintain a constant humidity for the concrete of the roof-terrace and thereby assures a regulated temperature for the concrete. An especially good protection: sand covered by thick cement slabs laid with staggered joints; the joints being seeded with grass. The sand and roots permit a slow filtration of the water. The garden terraces become opulent: flowers, shrubbery and trees, grass.
>
> Thus we are led to choose the roof terrace for technical reasons, economic reasons, reasons of comfort and sentimental reasons. (Cited in Boesiger, 1967, p.44.)

Le Corbusier closes the treatise with the statement: "The roof garden becomes the preferred spot in the house and in addition signifies the reclamation of a town's entire cultivated area." (Cited in Gollwitzer and Wirsing, 1962, p.12.)

Despite the many references to the desirability of rooftop planting and reclamation of cultivated areas, most of Le Corbusier's designs exhibited a conspicuous absence, or a very minimal amount, of planting. Like the roof garden of Gaudi's Casa Mila, Le Corbusier's roof garden on Unité d'Habitation at Marseille (1947-1952), was first and foremost an architectural space (see figures 33, and 34). It was, however, a highly functional, architectural space. Unite d'Habitation at Marseille featured a jogging track, a playground with an artificial hill and reflecting pool which doubled as a paddling pool, a gymnasium, sundecks, a bar and eating spaces, and even an outdoor stage. The roof of the building was treated as the site for a total recreational village, and the elements within this village were treated as sculp-



1. Artificial Playhill
2. Planter
3. Ventilation Shaft
4. Gymnasium
5. East Sundeck
6. Dressing-room and arbour
7. West Sundeck
8. Concrete Tables
9. Lift Housing and Entrance to the Bar
10. Exit/Entrance
11. 300 metre Jogging Track
12. Entrance ramp to 17
13. Playground
14. Play Niches
15. Paddling/reflecting P
16. Observation Deck
17. Windscreen/Backdrop with Stage for Open Air Theatre

Figure 33: Unité d'Habitation Roof Garden, Marseille (From Gollwitzer and Wirsing, 1962.)

tural elements arranged both by function and form.

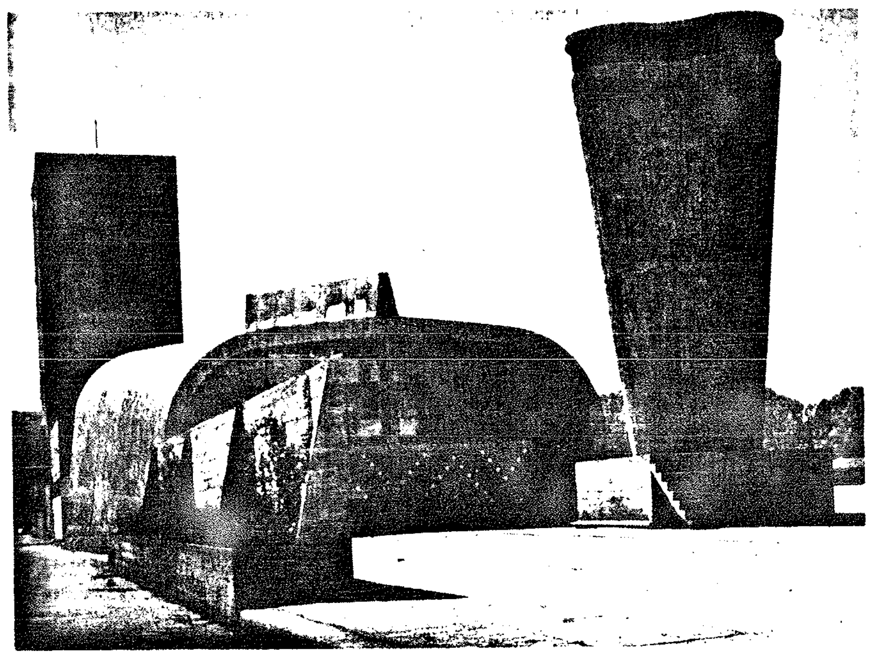


Figure 34: Gynmasium and Ventelation Shaft of Unité d'Habitation (From Gollwitzer and Wirsing, 1962.)

3.2.1.2 Private Residences

Before Le Corbusier designed his major apartment blocks of the 1940's and 1950's he had already designed a good number of private residences, or "living-machines" as he called them, with roof gardens. For example: The Citrohan House project, Paris (1920-27), the Jeanneret Houses in Paris (1932), the Villa at Carthage (1929), and the well known Villa Savoye at Poissy just outside Paris (1929). (See figure 35 .)

The roof garden of the Villa Savoye was a bi-level garden. The lower level was actually an atrium (see figure 36), surrounded on three sides by interior spaces and by a wall on the fourth side. The upper level, or sun patio, was reached via a ramp in the atrium (see figure 37). A large wall on the north side of the sun patio protected the space from the wind and created a sun catch for sun bathing. The roof garden of the Villa Savoye captured what Le Corbusier called "the most precious space of all, the space beneath the sun" (cited in Besset, 1968, p. 78). Although the roof garden was treated as an architectural space with carefully delineated edges or walls, the glazed and open penetrations in these edges made possible a very real integration of interior and exterior -- an integration of interior rooms and roof garden, of roof garden and surrounding landscape.

The notion of roof garden as roofless interior space was brought to an amusing extreme in the design by Le Corbusier and the Compte Carlos de Bestegui for the latter's flat on the Champs Elysées in 1936 (see figure 38). Madge Garland describes the room or 'solarium,' as it was called:

> Here the ground was covered with a carpet of imitation grass complete with daises, comfortable chairs disposed around a table near a fire-place with a decorative mantel piece [sic], over which an oval window framed a view of the city beyond. Pots with plants were arranged as they would be in a drawing room and no attempt was made to grow real flowers. Nature was even more strictly banished than in the Roman atrium, and the effect was a roofless room in mid-air, not an attempted garden. (1973, p.118.)

Gaudi and Le Corbusier were not the only noted architects designing roof gardens during the first half of this century. Mies van der Rohe, Walter Gropius, Richard Neutra, Mar-

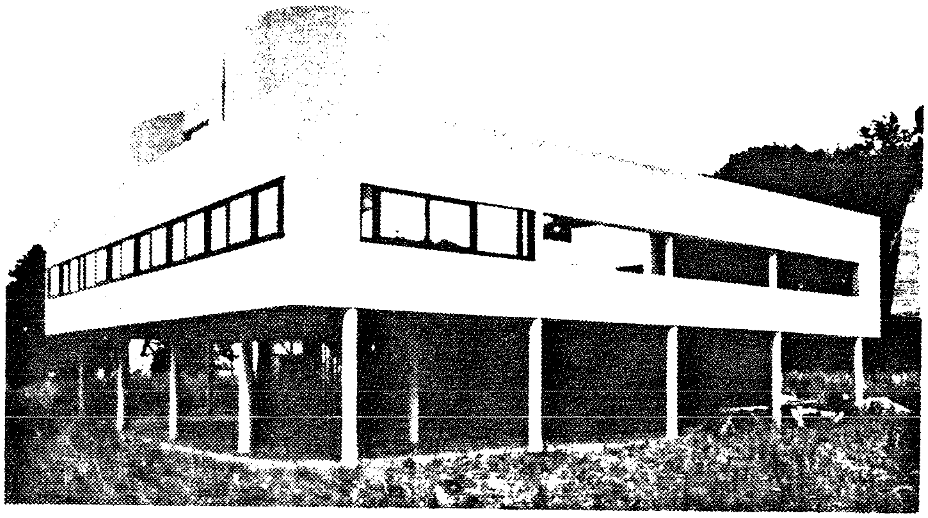


Figure 35: Villa Savoye, Poissy (From Besset, 1968.)

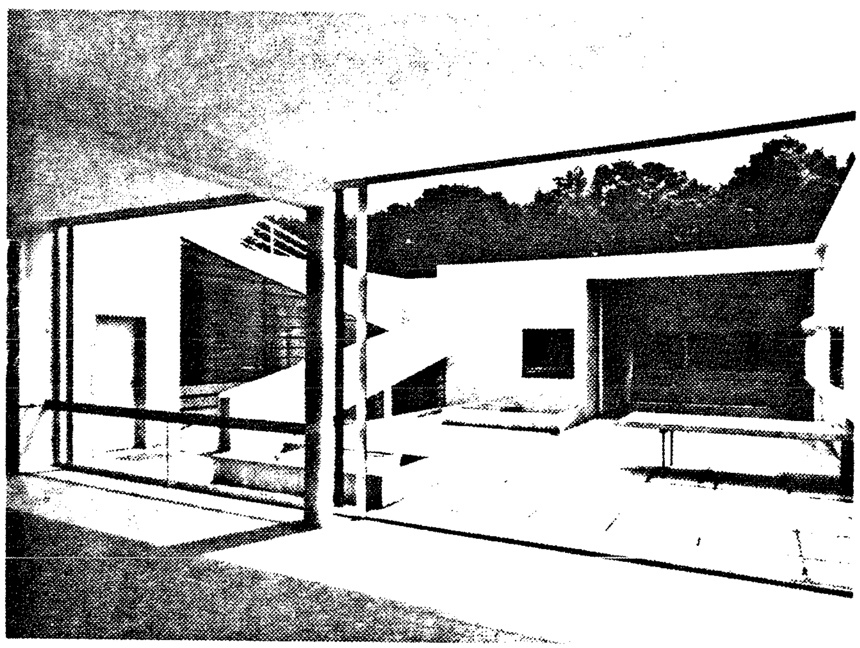


Figure 36: Lower Level of Villa Savoye Roof Garden (From Besset, 1968.)

cel Breuer, E.D. Stone, and many others also experemented with roof gardens, as did Frank Lloyd Wright. Plants cascaed magically down from the strong horizontal rooflines and terraces of Wright's work (at least in the renderings of his

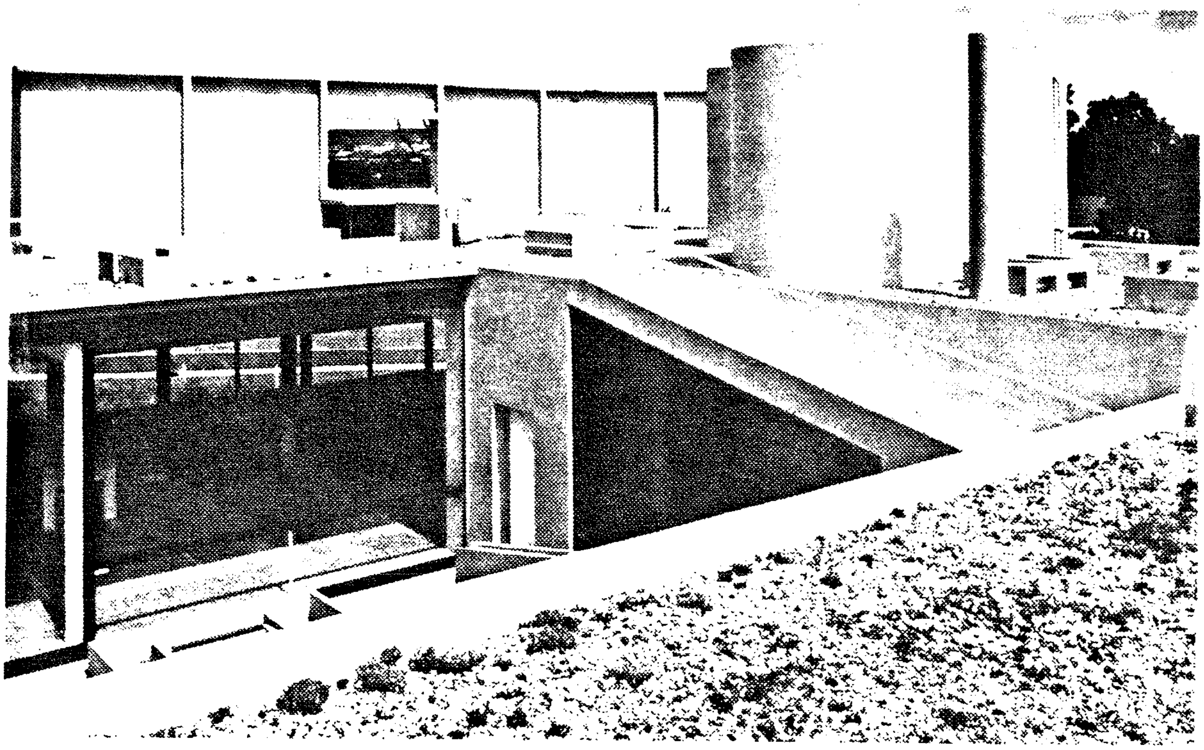


Figure 37: Villa Savoye Sun Patio (From Besset, 1968.)

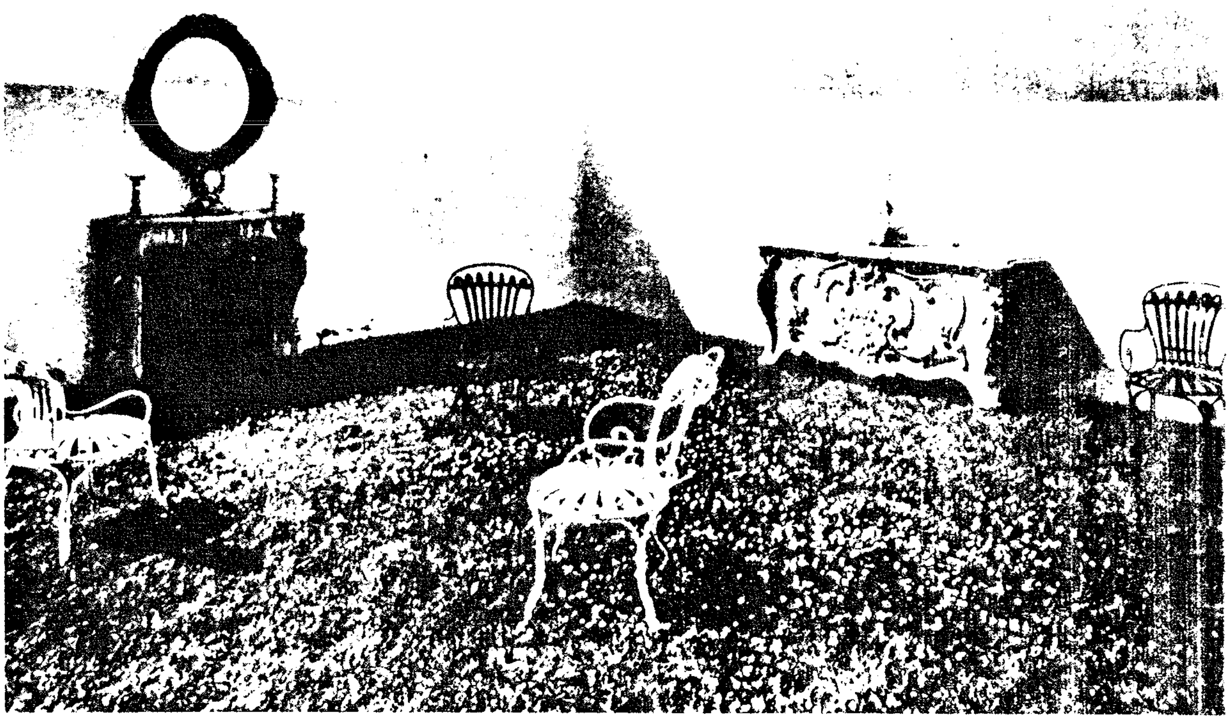


Figure 38: Roof 'Solarium' on Count Carlos de Bestegui's Paris Flat (From Garland, 1973.)

works if not in the actual built structures). No one knew better than Wright how vegetation could soften hard architectural edges and help integrate a building with its site. The plants tumbling from the roof of the Herbert F. Johnson residence, for example, (see figure 39) suggest a symbiotic relationship between building and nature. It is as if the rugged landscape was allowing the structure to rest on its shoulders, and the structure in turn, allowing the vegetation to sprawl out on its roof, each supporting and being protected by the other.

Many of Wright's larger projects, such as the Monona Terrace Civic Center in Wisconsin (1955), Elizabeth Arden's Desert Spa in Arizona (1945), and the Doheny Ranch Development near Los Angeles (1921), featured very elaborate and extensive roof garden schemes. His one attempt at developing usuable roof space over a small single family residence (1939) was, however, rather less successful than the residencial roof gardens of Le Corbusier and Mies van der Rohe. (See figures 40 and 41 .) The horizontal wooden parapets which worked so well on the Herbert F. Johnson residence (as well as on the Arch Oboler's House in 1941, the Pauson's House, and the John C. Pews House in 1940, and in many other of Wright's projects) gave this house a rather clumsy appearance.

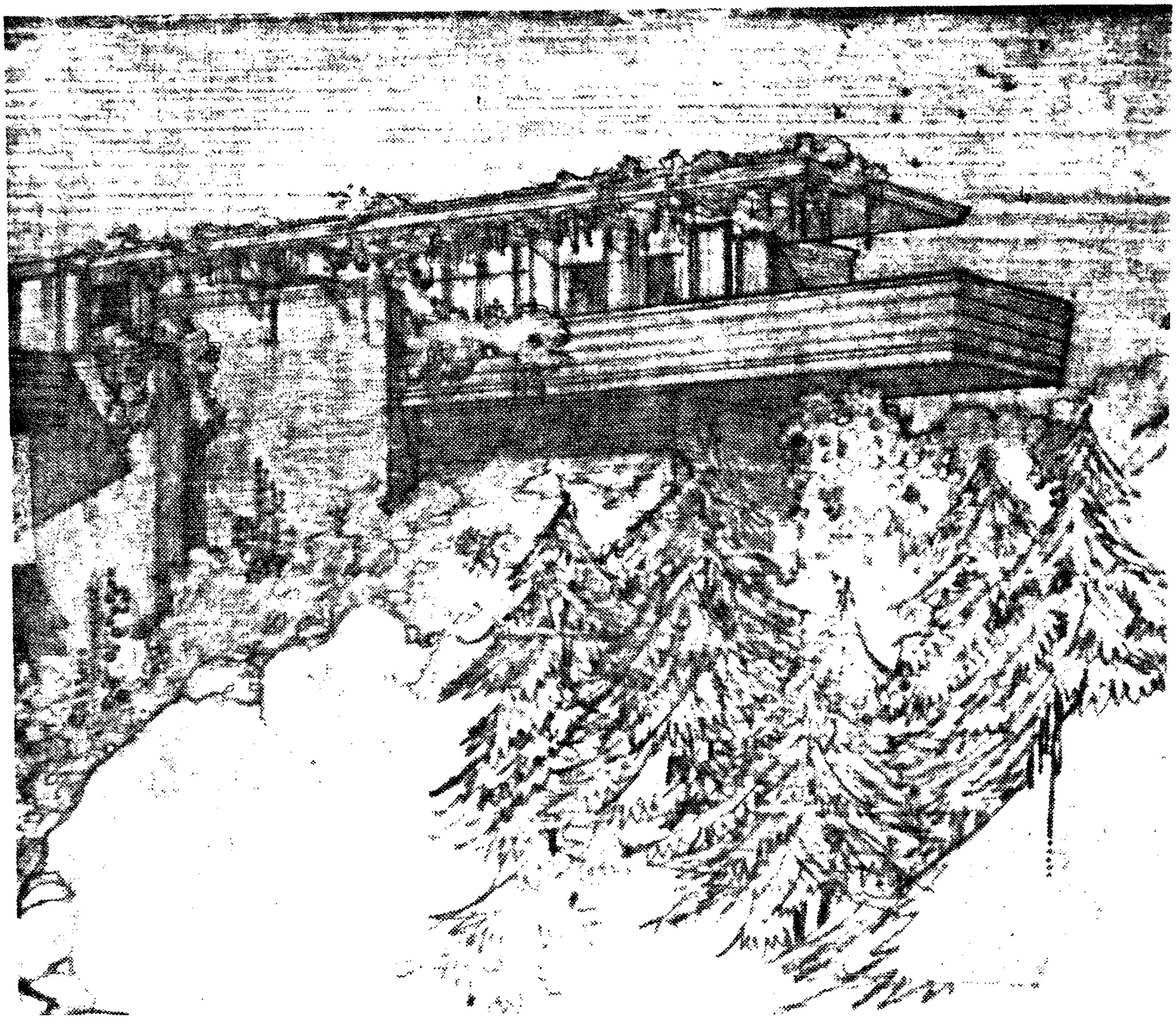


Figure 39: The Herbert F. Johnson Jr. Residence by F.L. Wright (From Samona, 1959.)

3.2.1.3 Commercial Buildings

The roof gardens which now abound in Manhattan first began to appear in the early 1930's after the construction of the Rockerfeller Center roof gardens. In an article in the Journal of the Society of Architectural Historians (XVIII, May 1958, p. 54) Winston Weisman proclaimed the RCA Building to be the "the first landscaped skyscraper in history." The

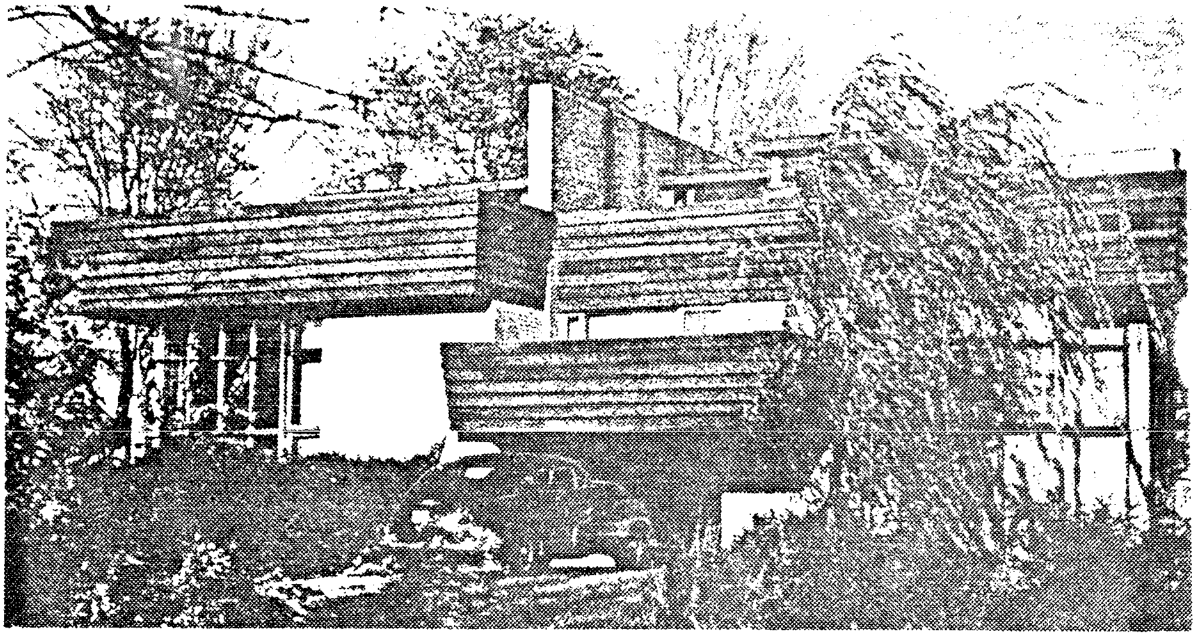


Figure 40: Single-Family Residence with Roof Garden by F.L. Wright (From Gollwitzer and Wirsing, 1962.)

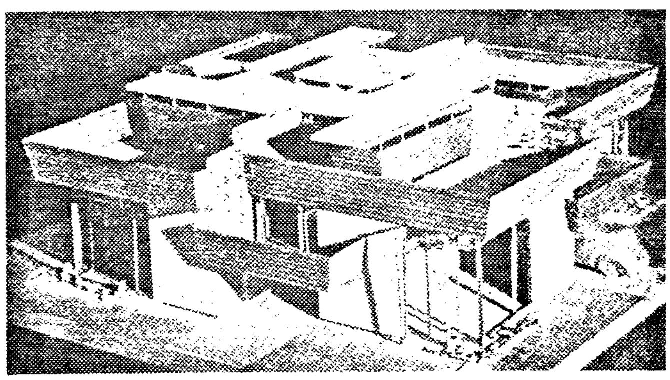


Figure 41: Model of Single-Family Residence by F.L. Wright (From Gollwitzer and Wirsing, 1962.)

original design for the Rockerfeller Center, as drawn up by John Wenrich, included a great many more roof gardens than were actually built, but Wenrich's plan was scrapped and another design by R. Hood, W. Harrison, and R. Reinhard, was adopted. All of the roof gardens included in this second scheme are still maintained and used today. They are: the terrace garden on the eleventh storey set-back of the 70-storey RCA Building (see figure 42), and the four gardens above La Maison Française, the British Building (originally the British Empire Building), the Palazzo d'Italia, and the International Building (known as Das Deutsches Haus until the rise of Hitler) (see figures 43, 44, and 45).

Channel Garden, which links the Plaza with Fifth Avenue, and the Plaza garden itself, are also technically roof gardens since they are built over an underground transportation route and storage space. The four gardens over the group of buildings known as the International Group "became one of the Center's best known features despite the fact that they were never opened to the public" (Fitsch, 1974, p. 8). It is interesting to note that the roof gardens of Rockerfeller Center (the Plaza and Channel Garden in particular) have always been celebrated for their botanic displays, considering that the site was originally occupied by a public botanic garden (the Elgin Botanic Gardens).

At the same time as the Rockerfeller Center gardens were being constructed in Manhattan, some important developments were occurring on the other side of the Atlantic. Up until this time roof plantings were limited to shrubs and small ornamental trees, but in 1937 architects of the Casinoterrace in Berne, Switzerland, dared to plant mature street trees on the roof of the casino garage. They were planted in 1.7 metres of soil on top of a base of 30 centimetres of

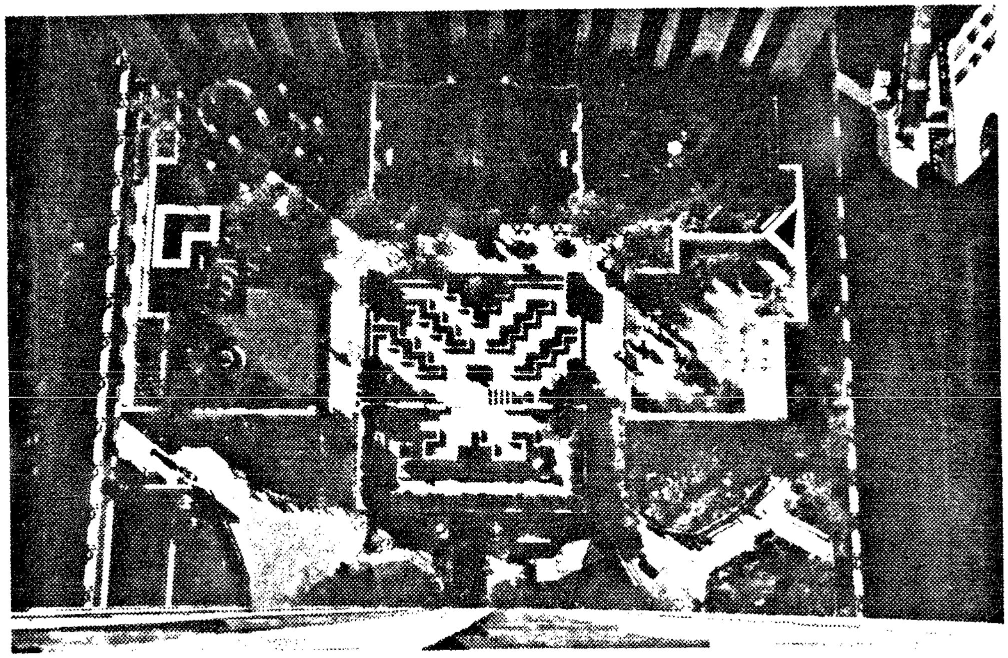


Figure 42: RCA Building Roof Garden, New York (From a brochure on Rockerfeller Center by Chamberlain, 1951.)

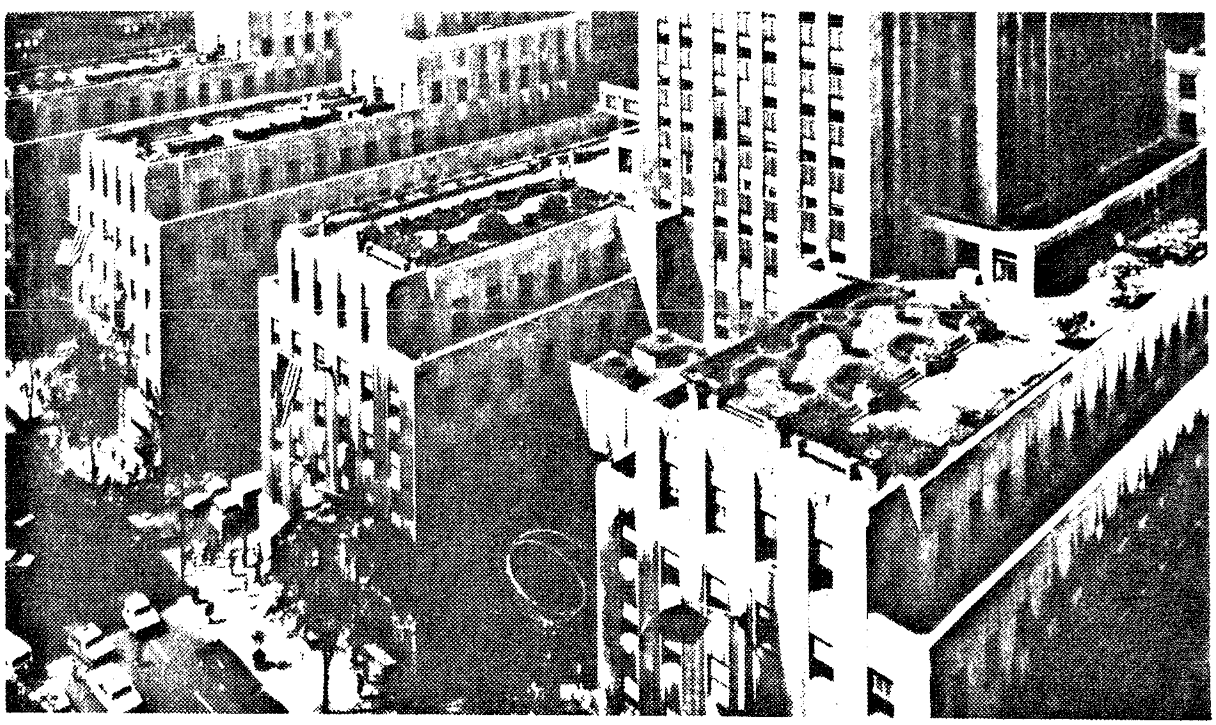


Figure 43: International Group Roof Gardens, New York (From Chamberlain, 1951.)

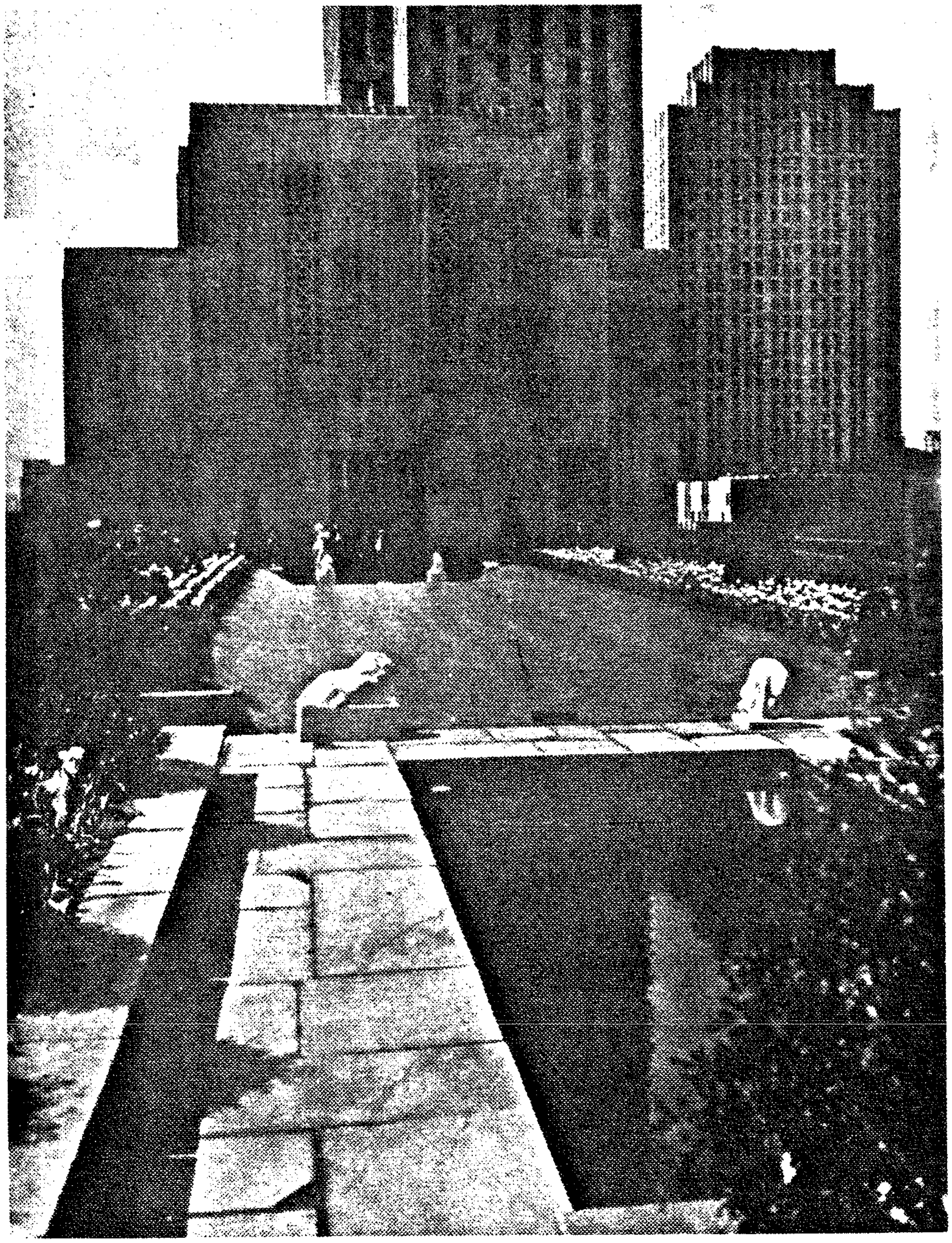


Figure 44: La Maison Française Roof Garden (From Chamberlain, 1951.)

gravel. These Chestnut trees which were already mature when planted in 1937 are still alive and healthy today (Southard, 1968).

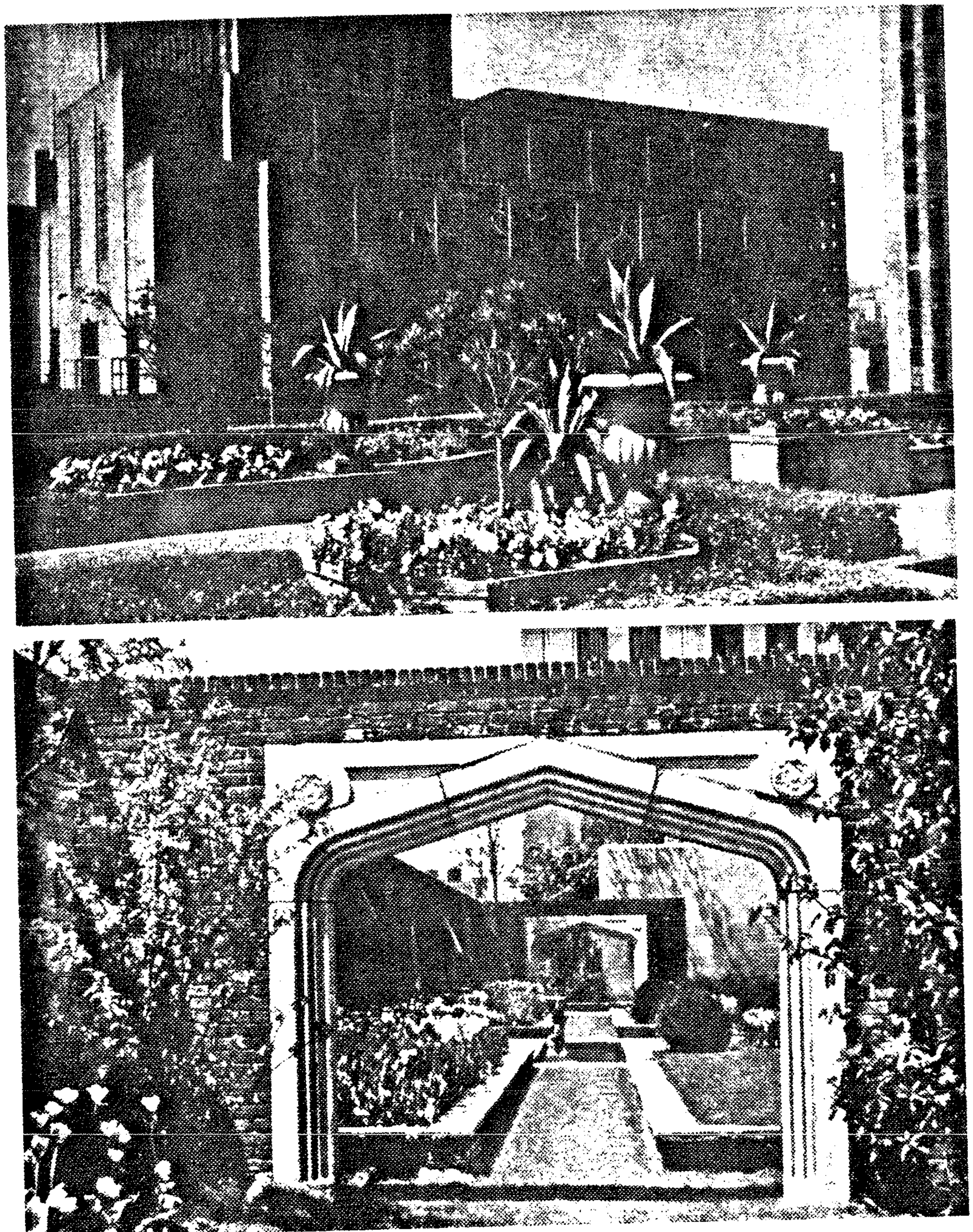


Figure 45: Roof Gardens over the International and British Buildings (From Chamberlain, 1951.)

A much more ambitious project was being undertaken at the same time (1935-1938) above Derry and Toms Departmental Store in Kensington High Street, London. (See figures 46 and 47 .) This 1.6 hectare roof garden designed by Ralph

Handcock was by far the largest roof garden in Europe when completed. The roof featured a large glass tea pavilion and three main gardens: a formal Italian garden, an English Tudor garden, and a large English woodland garden with a stream, bridges, woodland, hills, and open lawn. The stream and ponds were home to native and exotic birds, including flamingoes. The garden was constructed as an afterthought on top of the completed building, but the structure was so solid it could accommodate an almost unlimited load. The entire roof was enclosed by a 2.5 metre high parapet and since none of the surrounding buildings projected up over the top of the parapet, one tended to forget the garden was indeed seven storeys up in the air.

In 1973 the departmental store went in to liquidation and in 1978 the roof garden underwent considerable renovations under its new owners (British Land): the tea pavilion was converted to a night club, the original 500 varieties of trees and shrubs was greatly reduced, more lifts were added, and the plumbing was updated. The basic layout and character of the garden was, however, preserved and the garden is as popular today as it was when first opened (Scrivens, 1980).

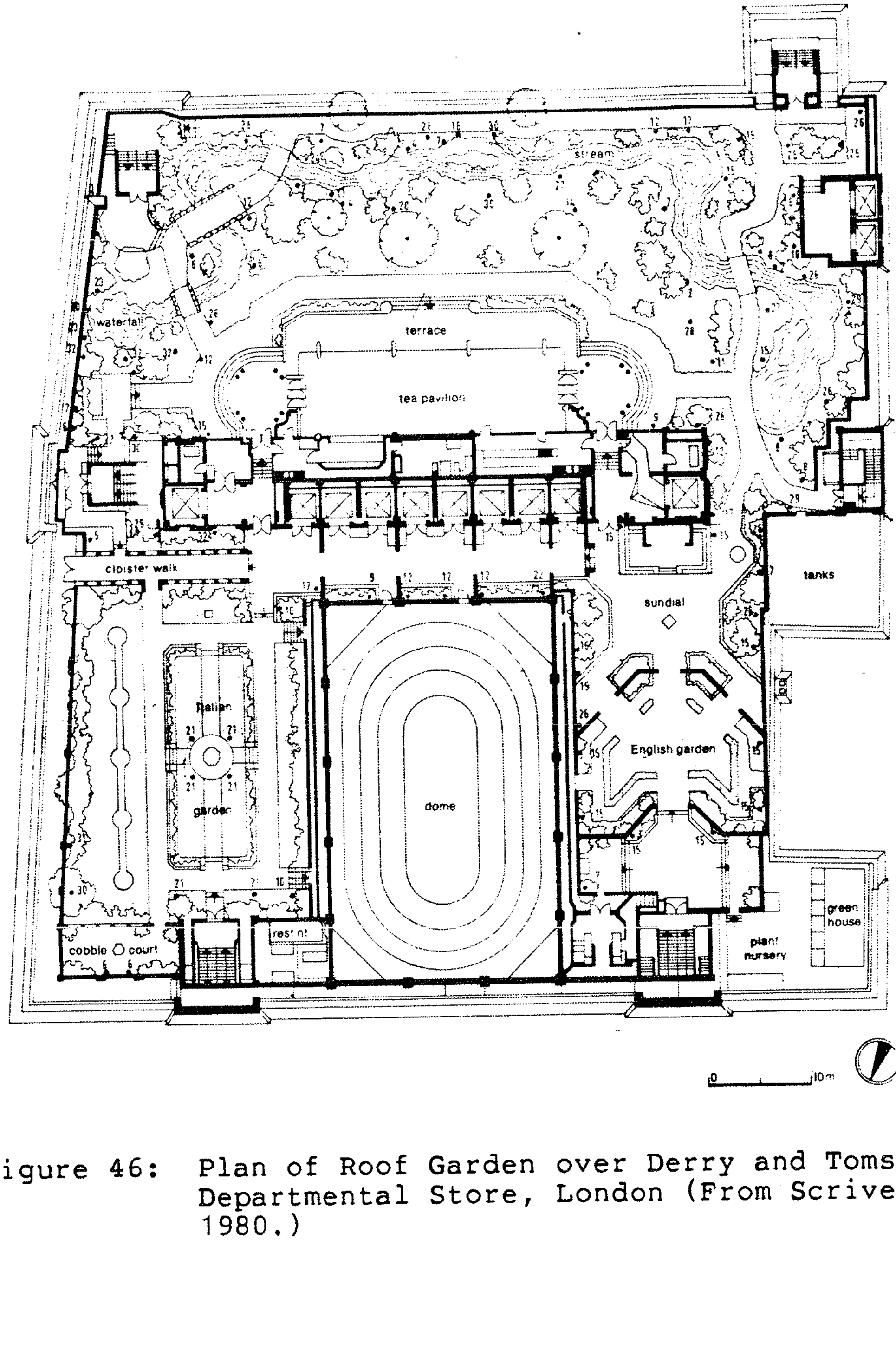


Figure 46: Plan of Roof Garden over Derry and Toms Departmental Store, London (From Scrivens, 1980.)

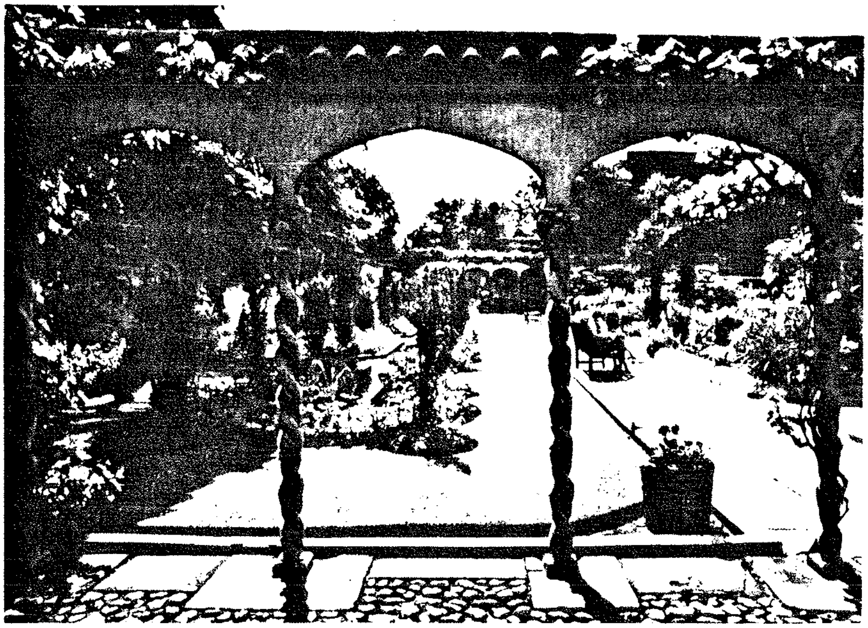


Figure 47: View of the Spanish Gardens over Derry and Toms, London (From Scrivens, 1980.)

3.2.2 1950 to the Present

By 1950 the rooftop development was no longer a novelty but a practical, often exigent, alternative. Urban crowding, the ever increasing loss of urban open green space, technical advances in the construction industry, and the trend towards underground parking schemes all forced planners and architects to take roofscaping more seriously. During the 1950's and 1960's architects in all parts of the world began in earnest to develop the roof spaces of, not just private residences and apartment buildings, but also the rooftops of commerical and public buildings.

A discussion of all the important rooftop developments since 1950 is impossible within the scope of this paper.

The developments discussed below were chosen because they best demonstrated the wide variety of ways in which roof spaces of private, commercial, and public buildings, can be developed to improve the quality of urban life.

3.2.2.1 Private Residences

In 1951 landscape architect, Lawrence Halprin, designed a small roof garden (11 by 14 metres) on the roof of a house on Oakland Bay, San Francisco (see figure 48). Halprin did not attempt to recreate a natural environment in miniature, but rather, an abstraction of nature which acknowledged the functional needs of the owners and the artificiality of the site. Elements from the surrounding landscape, such as gravel from the shoreline, native succulents, mosses, and junipers, were integrated into the grid pattern of duck-board flooring, thus creating an abstracted, but easily maintained and enjoyable outdoor environment.

Another modest residential roof garden was designed by Zvi Miller and M. Blum in Haifa, Israel, 1957 (see figure 49). This roof terrace provided the building's occupants with a horizontal, outdoor extension of the living room, which would not have otherwise been possible because of the slope of the site. The terrace is actually a large reinforced concrete 'trough' filled with a thick layer of earth and covered with traditional suburban lawn and shrubbery. Below the terrace is a large carport and entryway.

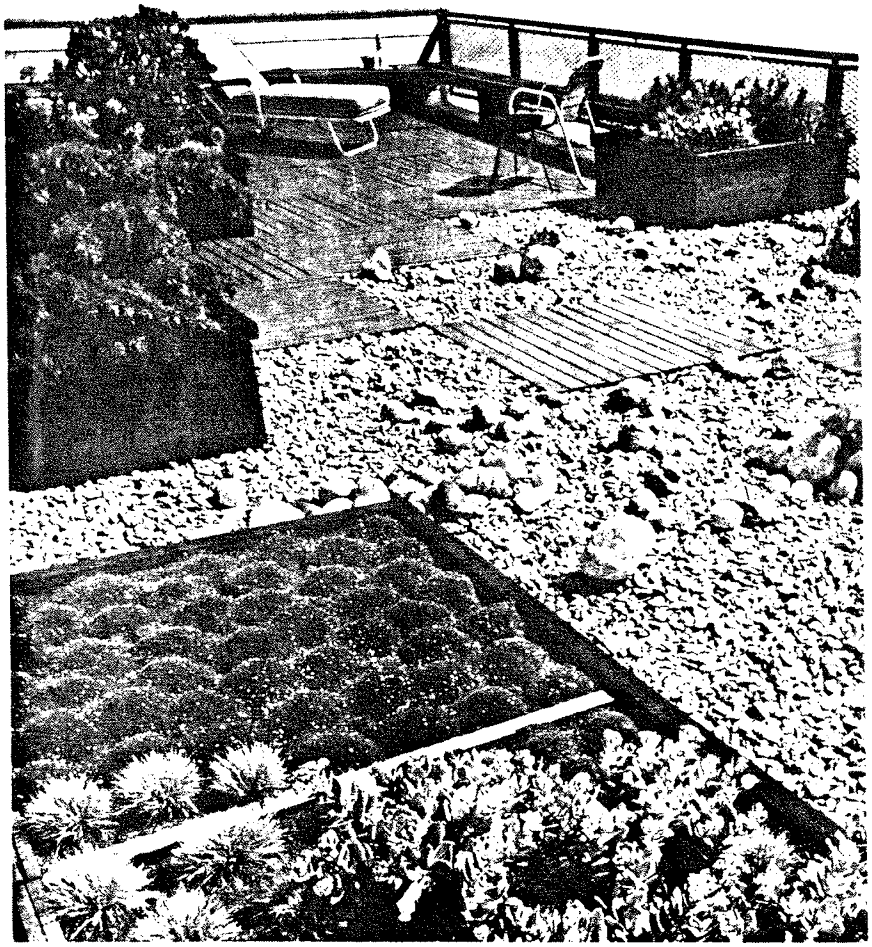


Figure 48: Roof Garden by Halprin and Associates, San Francisco (From Gollwitzer and Wirsing,1962.)

In 1964 landscape architect Pietro Porcinai used an underground structure and roof garden to creatively solve the problem of how to expand and modernize a 16th century Villa without destroying its character (see figure 50). The residents of the Villa (near Florence) required a large entrance hall and entertainment space but did not wish to destroy the finite, classical proportions of the building. So, instead of adding on to one of the building's façades, Porcinai designed an underground space and covered it with an elabo-

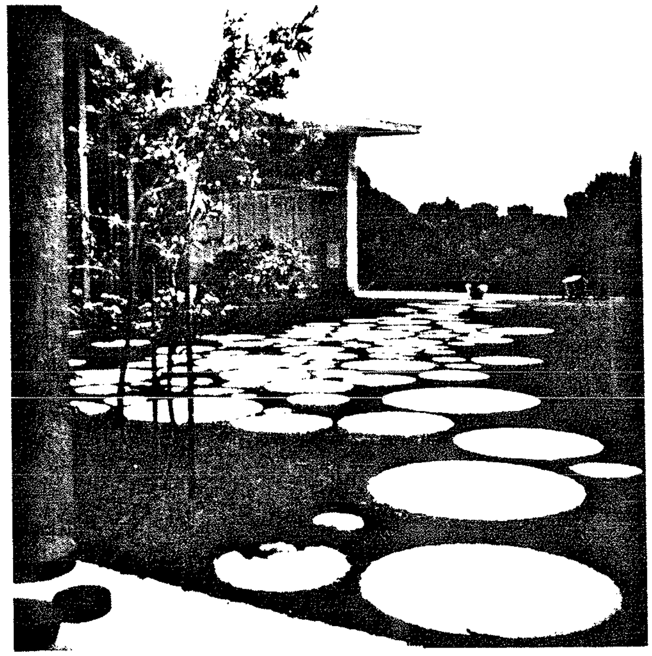


Figure 49: Residential Roof Garden in Haifa, Israel (From Gollwitzer and Wirsing, 1962.)

rate, Florentine-style parterre. The space was designed so that guests could drive down into the entrance hall and be received directly from their cars. The entrance hall was connected to the garden above by a large winding staircase drapped with vines and potted flowers. Several occuli, or circular fenced openings, in the roof garden allowed air and sunlight to penetrate down into the space below.

Some of the best examples of water used as an architecural element occur in residences designed by Richard Neutra in the late 1950's and 1960's. Keenly aware of the relfective qualities of water, Neutra took full advantage of both water's aesthetic and functional properties when he designed his 'water roofs.' Many of Neutra's residences were con-

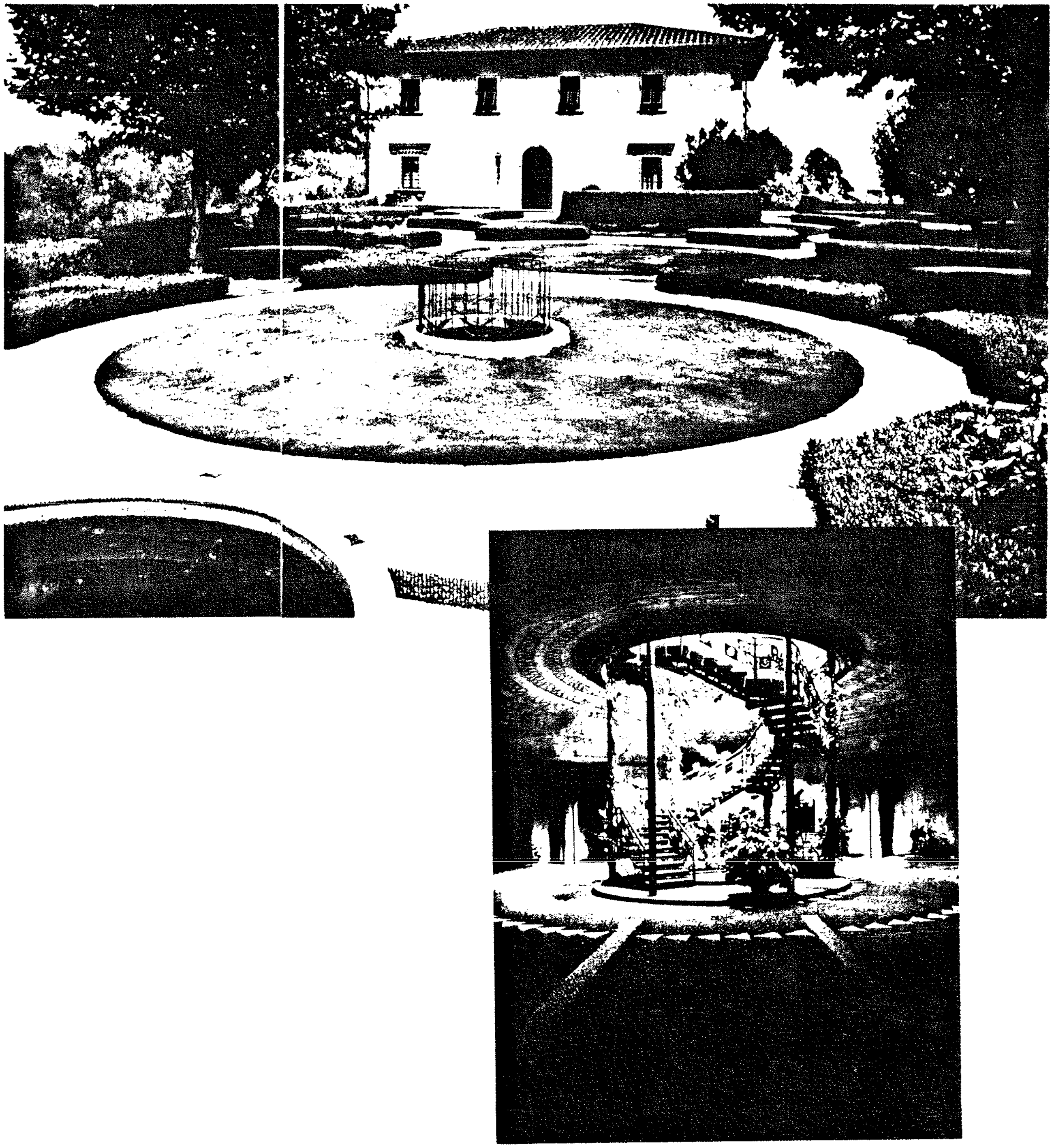


Figure 50: Roof Garden of Villa Toscana, near Florence (From Gollwitzer and Wirsing,1971).

structed in the California deserts where temperatures reached 40° Celcius, and more. By covering the carports and interior spaces of these residences with large flat roofs and then flooding the roofs with a few centimetres of water, Neutra significanlty reduced the temperature of the spaces below. The sun's rays bounce off the still, shiny surface of the water and the water absorbes heat from the spaces below during the process of evaporation. Moreover, these water roofs, when viewed from second floor living spaces, provide a psychological cooling effect. They also delight the senses with reflections of the surrounding sky and surrounding landscape, with the sound of breeze-blown ripples, with floating autumn leaves, with morning mist, and night-light drama. Some examples of Neutra's residential water roofs are the Moore House in Ojai Valley, California (1956) (see figure 51), the Delcourt House in Croix-Roubaix, France (1969) (see figure 52), the Cytron House in Beverly Hills, California (1960), the V.D.L. Research House in Los Angeles, California (1966), the Rang House in Königstein, Germany (1968), the Kemper House in Wuppertal, Germany (1969), and the Ebelin Bucerius House in Novegna/Ascona, Switzerland (1966).

In 1974 architect Roland Coate, Jr. designed the earth-covered Alexander House in Montecito, California (see figure 53). Here, in the Santa Barbara suburbs, free from the usual spacial constraints of urban settings, Coate created a building which was very much a part of the landscape. Instead of treating the roof as an isolated plane above grade

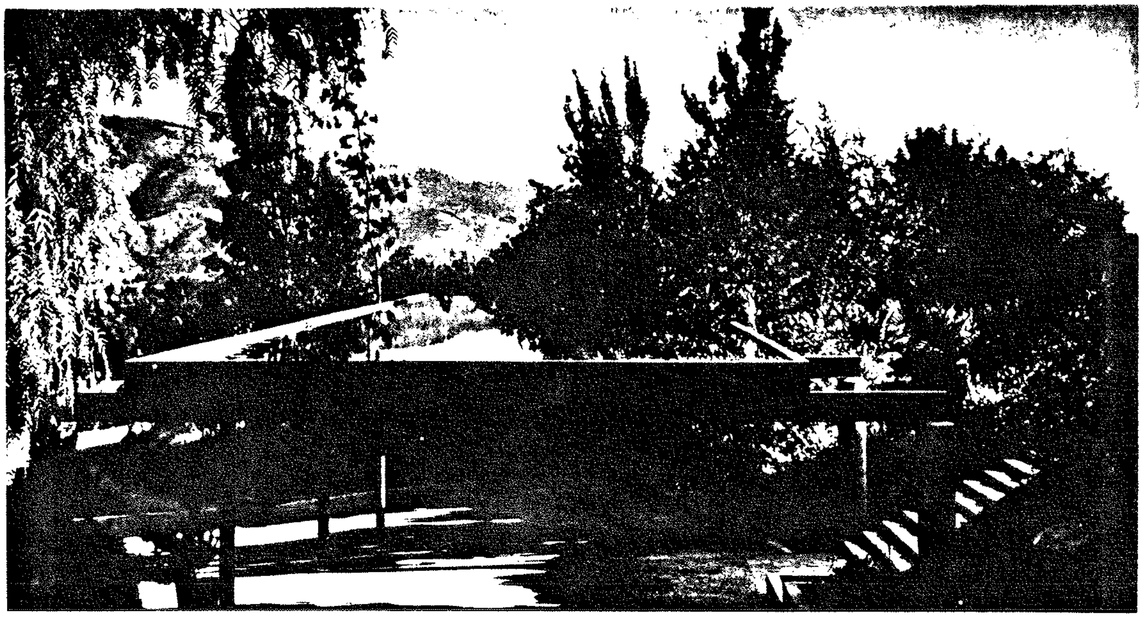


Figure 51: 'Water Roof' over the Moore House Carport, Ojai Valley,California (From Exner and Neutra, 1974.)

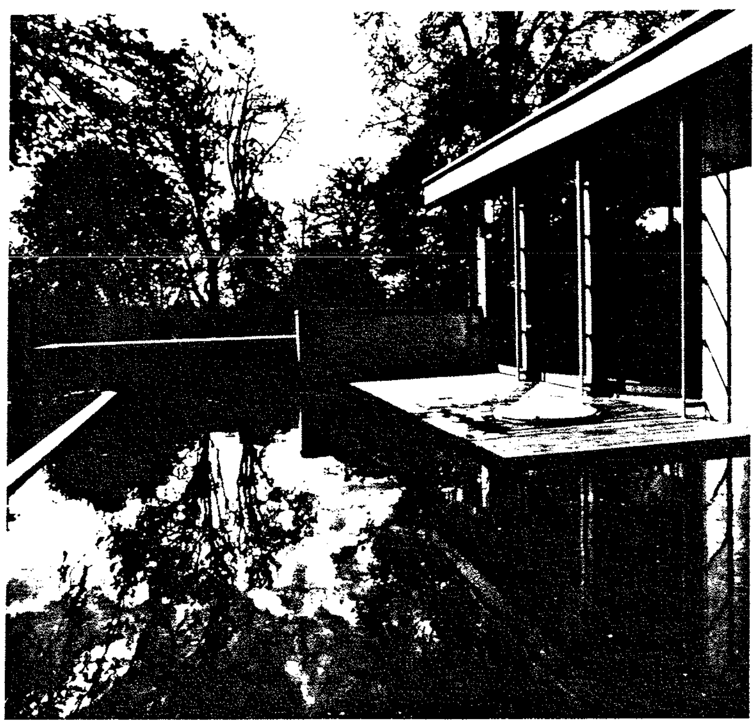


Figure 52: 'Water Roof' over the Delcourt House, Croix-Roubaix, France (From Exner and Neutra, 1974.)

level, Coate swept the surrounding landscape up the sides of the building and over the top, making it almost invisible from the air. The roof proper was composed of interspersed brick plazas and densely sodded areas which spilled out onto the berms and into the surrounding landscape. It was punctuated by angular retaining walls which doubled as parapets, by cylindrical chimneys, and by a large circular tower in the centre which enclosed a circular staircase and served as the main entrance to the house below. Although the roof garden offered no protection from the hot sun or strong winds, it afforded a viewing platfrom which was both beautiful in its simplicity, and in complete harmony with the landscape.

As E.R. Finsches and his wife proved, Residential roof gardens need not be large or expensive to be enjoyable. After receiving permission from their landlord, this retired Viennese couple converted the roof of the block in which they lived into a private Arcadia, and did it without spending a 'Pfennig' (see figure 54). Bernd Lötsch described the Finsches' garden:

> Instead of a swimming pool there is an old cast iron bath tub -- it provides the same refreshment Finches says. He takes his after dinner rest in an arbour of bean plants, and drinks his coffee with his wife on a swing seat. He keeps in touch with the wide world by radio. He has even run a telephone line from his flat on the second floor. Around him everything is blooming and thriving, from the most splendid flowers to fresh fruits and vegetable [sic]. Lovingly cultivated and half overgrown at the same time. When the local authority destroys another allotment garden site, or a motorway alignment cuts across a piece of green countryside, Finsches is there saving the most valuable plants from the mechanical shovel for his

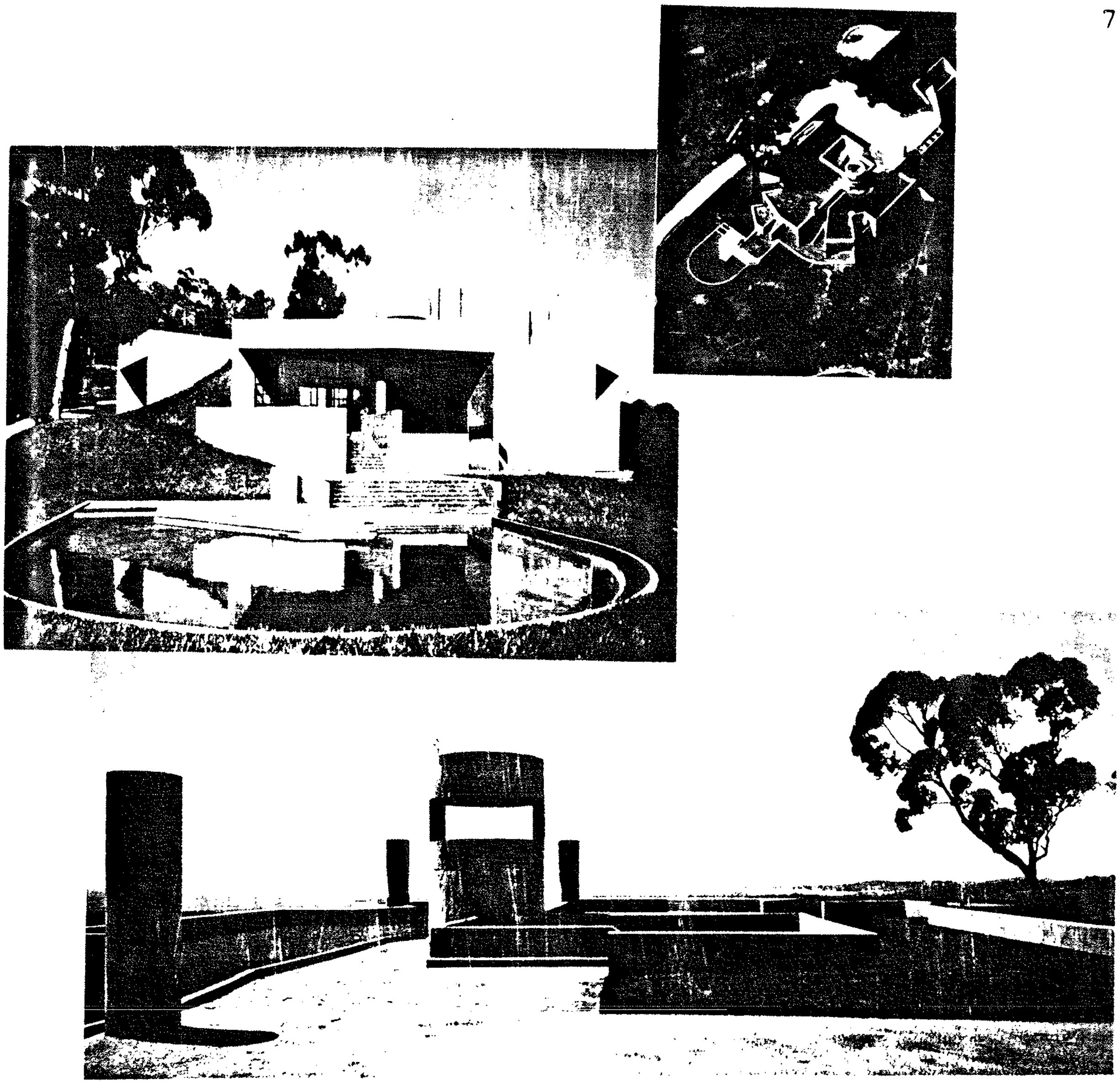


Figure 53: Alexander House, Montecito, California (From Hines, 1976.)

green Noah's Ark above the rooftops of the big city. For Finsches this is more than a Spitzweg idyll -- it is almost a recipe for survival. For the body: exercise in the fresh air and natural vitamins for the soul: the pleasure of the growing and thriving garden, at the beauty of every blossom.

"I've already had two heart attacks. Then you learn to appreciate every day as a gift. If I hadn't started the roof garden a few years ago I think I would be dead already." (1984, p.26.)

Figure 54: E.R. Finsches' Roof Garden, Vienna (From Lötsch, 1984.)

3.2.2.2 Apartment Buildings

Most multiple-unit dwellings or apartment complexes with roof gardens built since 1950 fit into one of two categories: the multi-storey block form with a communal roof garden on top (such as Unité d'Habitation at Marseille), or the more complex form of cascading units, each with its own smaller garden on the roof of the unit below (such as Habitat 67 in Montreal).

Each type has its own advantages. The block form is more economical, takes up less area, the roof garden can be much larger and can offer a much greater number of facilities and opportunities because it services many more people. The cascading form is more interesting, can be built on a steeply sloping site, can provide a greater variety of unit types, and the gardens are more private and immediately accessible from the apartment units.

The block from is, of course the more common type, and in densely populated areas, often the only possible type. Unfortunately, the roof gardens above these buildings have, more often than not, been as uninspired as the building forms below them.

The Canadian Mortgage and Housing Corporation manual, "Roof Decks Design Guidelines," (1979), outlines the four basic types of roof gardens associated with the block form apartment building: 1)the building roof deck, 2) the garage roof deck, 3) the court roof deck, and 4) the promenade roof deck (see figure 55). Each has its own advantages and disadvantages, and, of course, there are many variations and combinations of the four basic types.

Apartment block roof gardens first started to appear in the denser North American urban centres like Manhattan and Chicago in the early 1960's. Before this time roof sun decks or 'tar beaches' were common on top of apartment blocks all over North America, but they seldom consisted of anything more than a chain-link fense and duck-board flooring over a tar and gravel rooftop. During the late 1950's and 1960's the popularity of these 'tar beaches,' and an increasingly more competative rental market, prompted developers to experiment with more elaborate roof decks, especially on the luxury blocks.

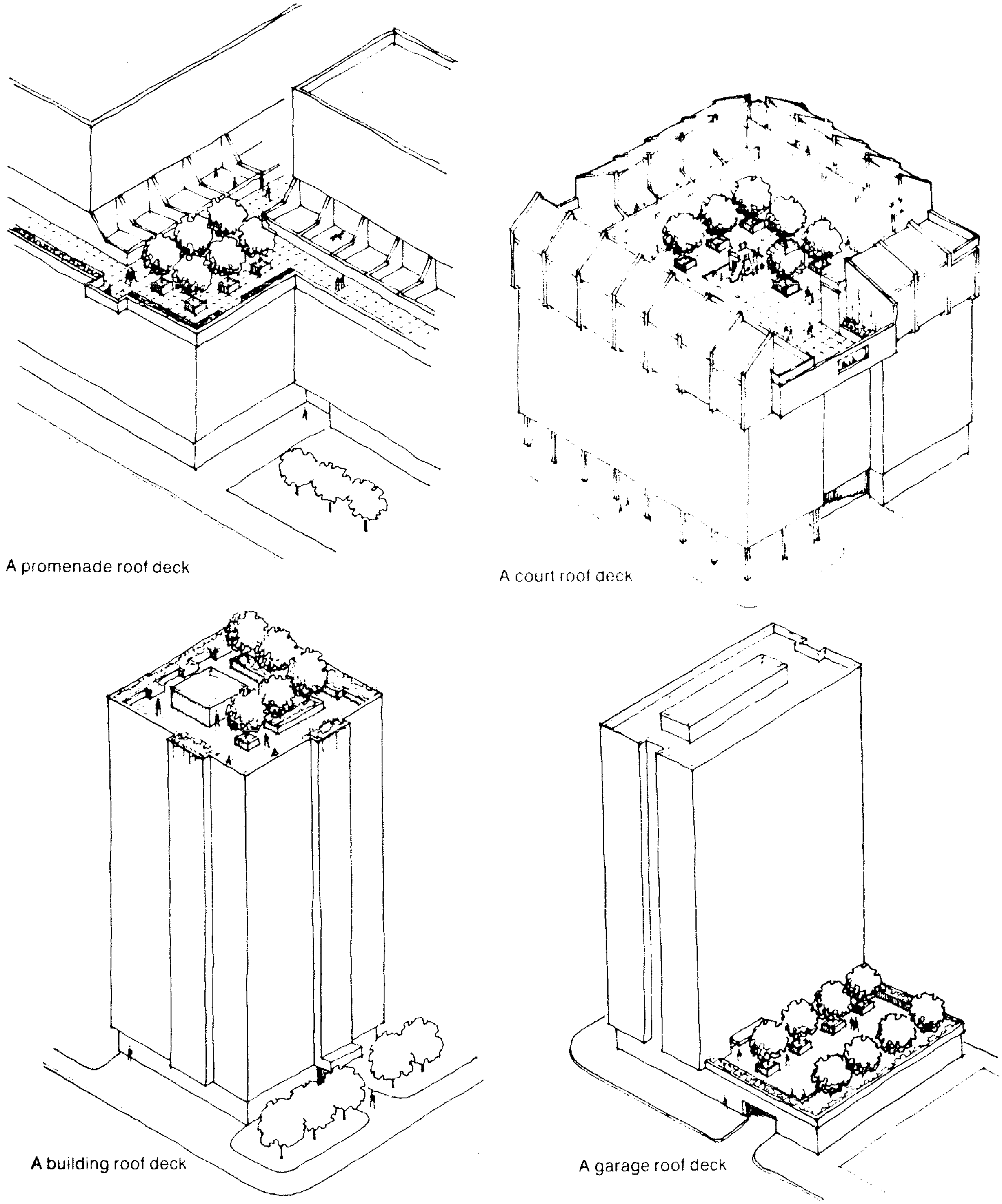


Figure 55: The Four Basic Types of Apartment Block Roof Gardens (From "Roof Decks Design Guidelines," 1979.)

In the early 1960's the Imperial Towers on Lake Shore Drive in Chicago were opened. (It's 2,300 residents made up a voting precinct by itself.) The roof garden offered a children's playground, shuffleboard courts, 500 lounge chairs, picnic tables, and a 23 metre long pool. ("Boom at the Top," p.65.)

In 1964 New York City's largest apartment block was built in the Upper East Side. Atop the 35-storey block were built six different roof gardens which together contained well over 300 large coniferous and deciduous trees. ("Boom at the Top," p.65.)

On the other side of the Atlantic, blocks of flats with roof gardens were also going up. One modest but attractive design was the one built by Vittorio Boracchia and Carlo Santi in Milan (see figure 56). A narrow space between the actual roof and the flagstone paving protected the building below from the solar radiation and allowed room below the finished grade for the reflecting pool and planting beds. Exposed concrete walls blocked unattractive views and protected plants and people from the wind. Teak benches, and awning material strung between tube frames provided shady walkways and sitting areas.

Roof gardens became popular above apartment block car parks when, in the 1960's, the architectural trend towards underground, and covered, car parks began. Examples of this

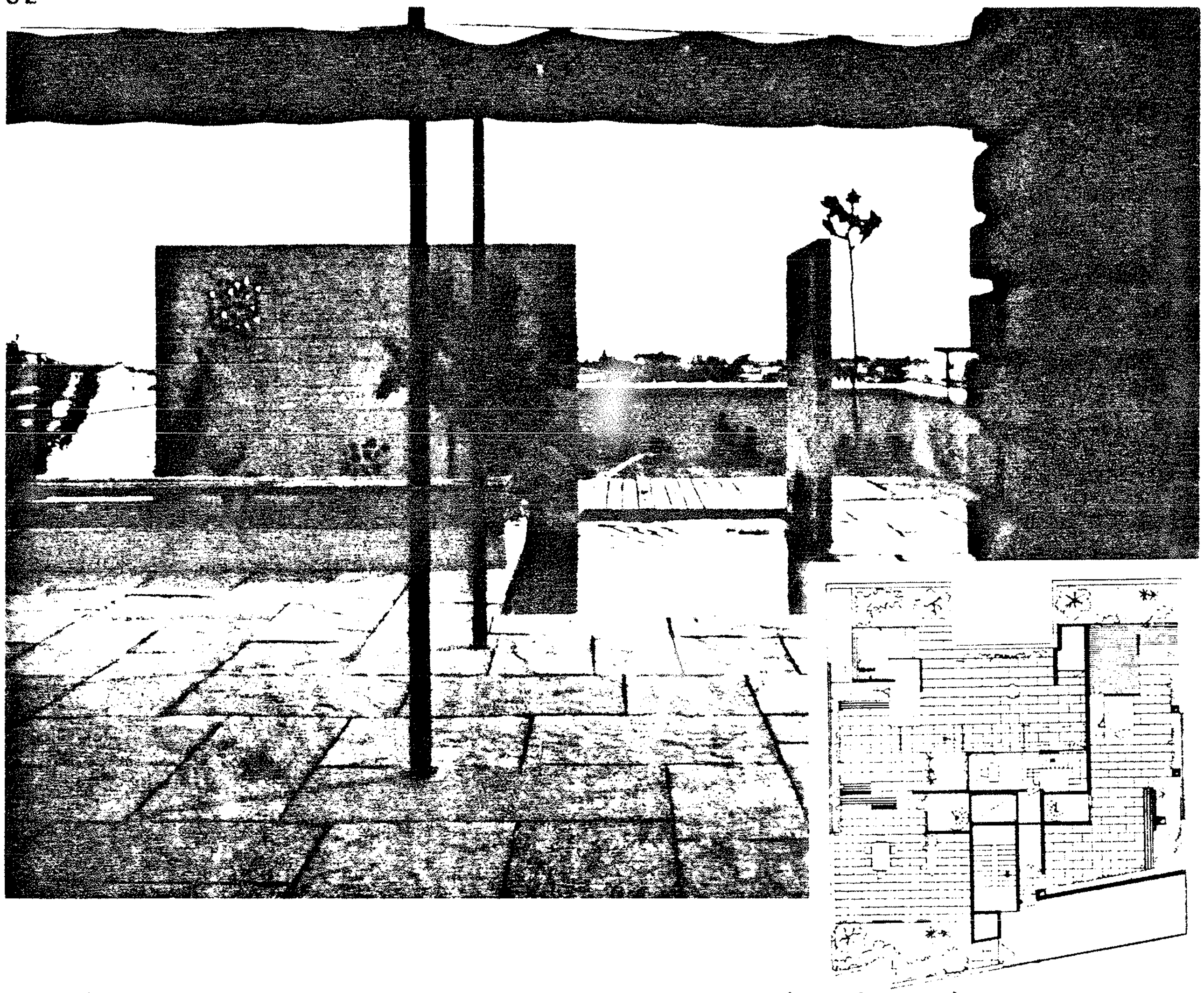


Figure 56: Apartment Block Roof Garden in Milan (From Gollwitzer and Wirsing, 1971.)

type of roof garden are abundant: Willowick Apartments in Houston (1962), Philip Hicks's designs for Sussex Gardens and Cadogan Place in London (c.1967), and 'Couperusduin' in The Hague (1975), to name just a few. Most often, they were covered with lawns and small trees or shrubs.

One unusual use of an apartment block car park was the one built in San Francisco in 1965-67 by the firm of Wursten, Emmons, and Bauschild (see figure 57). Above this three-storey car park the developers built a 'little village' composed of two-storey semi-detached housing units and pedestrian streets. Sandwiched between high-rises, but 12 metres above street level, this 'little village' became an island unto itself with its own climate, atmosphere, and pace of life. The elevated units are high enough to catch the sea breeze and escape the heat and noise of the asphalt streets below, as well as the cold moist morning smog emanating from the thousands of exhaust pipes. Children play freely and senior citizens stroll leisurely through the

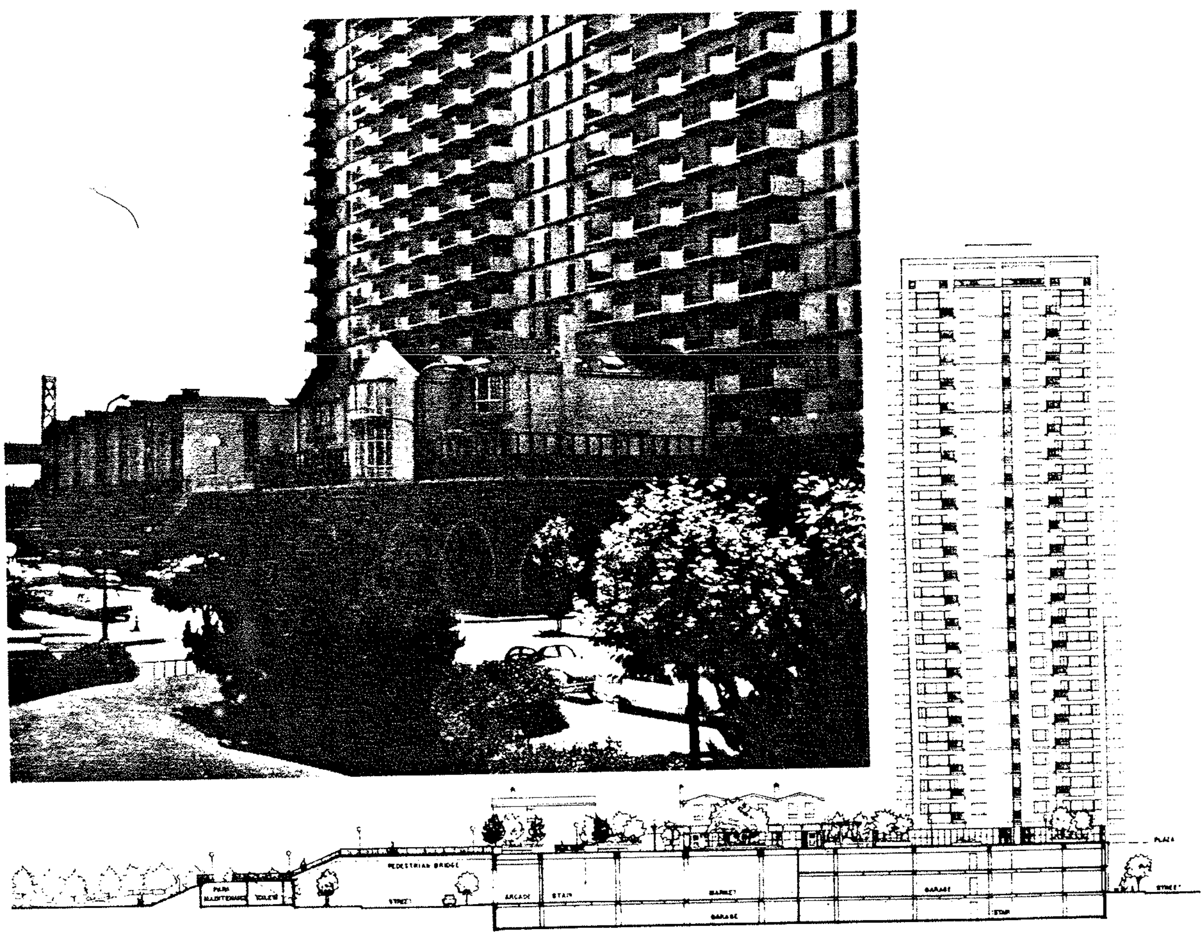


Figure 57: Rooftop Village, San Francisco (From Gollwitzer and Wirsing, 1971.)

treed, car-free streets.

While most architects and landscape architects were concerning themselves with ways of putting cars underground, several architects took the opposite approach. In Coventry, England, a series of interconnected rooftop parking lots was constructed. In Tokyo an expressway was built above the urban rooftops. More interesting still, was the design proposed by Geoffrey Jellicoe in his book Motopia. In it he described his poposal for an apartment building community consisting of a grid of straight and doughnut-shaped apartment blocks with all vehicular traffic relegated to the rooftops. The ground level was therefore free to be devel-

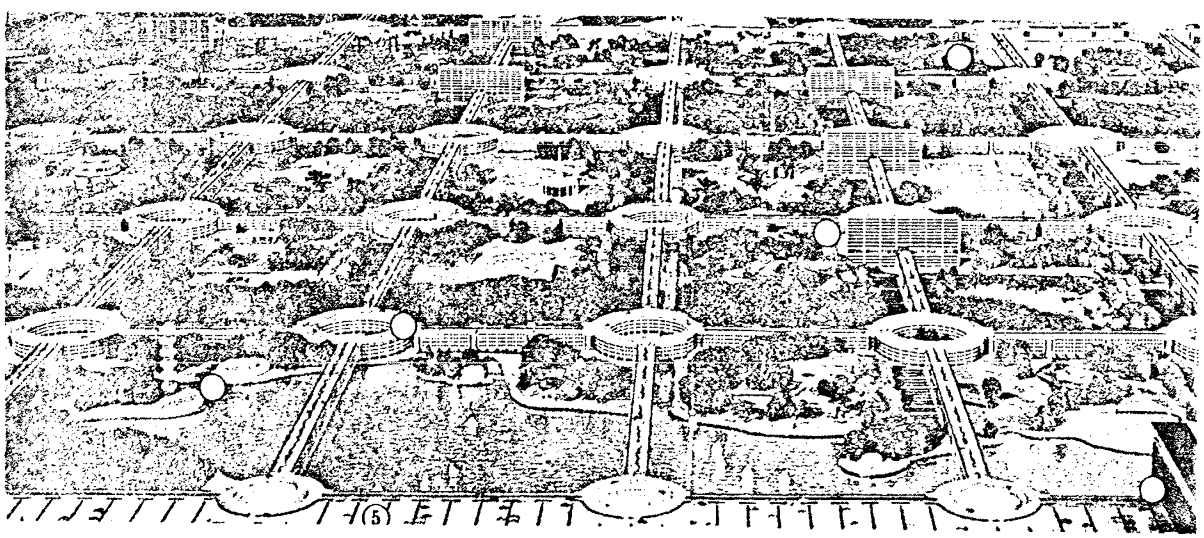


Figure 58: Aerial View of Jellicoe's Motopia (From Clay, 1962.)

oped as recreational space (see figures 58 and 59).

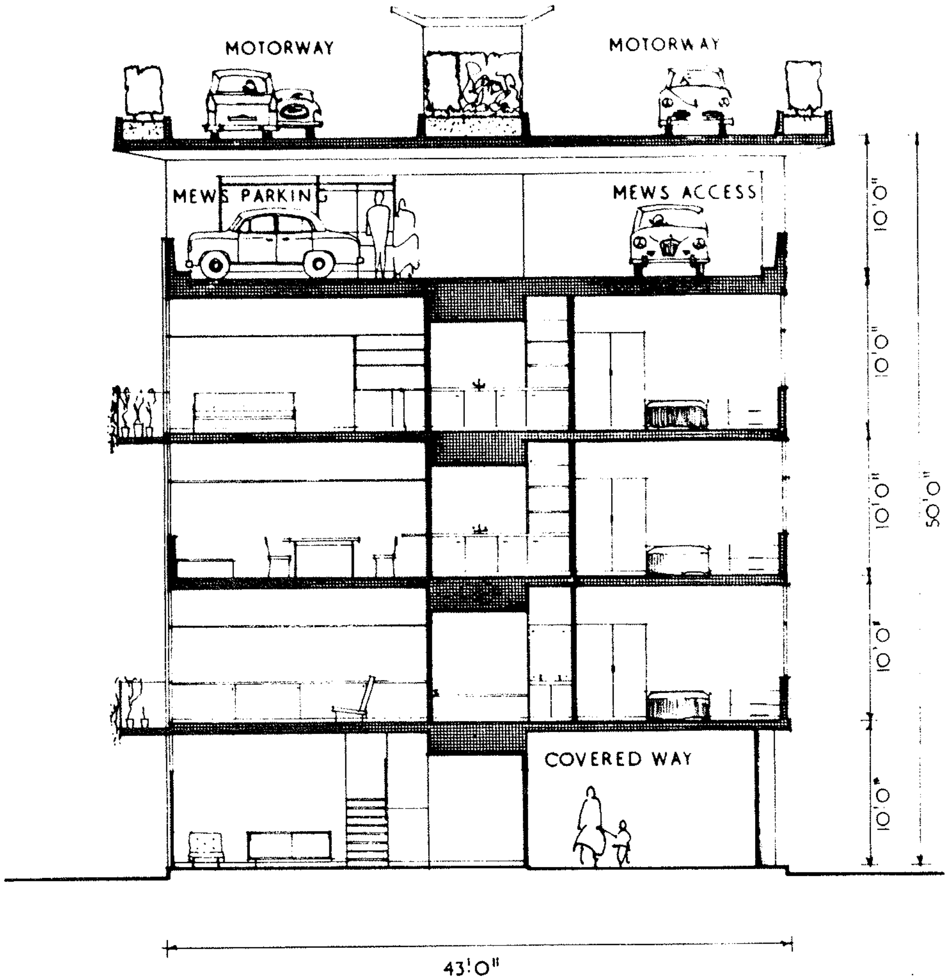


Figure 59: Section through Jellicoe's Motopia (From Jellicoe, 1961.)

Examples of the cascading form of apartment building were, and still are, much less common than the apartment block form. The ziggurat-like development built by De Mars and Reay in Santa Monica, California, provided its residents with both private roof gardens and a communal swimming pool roof deck (see figures 60 and 61). Parking was provided for the single-family units in the pyramidal core. Each unit had direct access by stairways and bridges to the hidden automobiles. The white façades and vaulted roofs of the cascading units were made to appear reminiscent of Mediterranean vernacular architecture.

Figure 60: Redevelopment Project in Santa Monica by De Mars and Reay (From Gollwitzer and Wirsing,1962.)

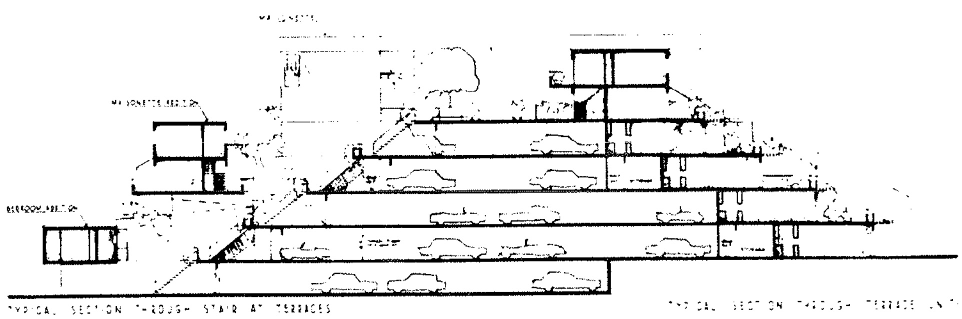


Figure 61: Section through De Mars and Reay Project in Santa Monica (From Halprin,1972.)

While De Mars and Reay were designing the Santa Monica project in California, the firm of Oiza, Errazu, and Moneo were designing 'Ciudad Blanca' in Alcudia, Mallorca (see figure 62). This series of 100 terraced units was sited so as to capitalize on the view of the ocean, and designed to provide a maximum amount of optical and acoustic privacy, as well as 'plantable' outdoor space. The wide planting beds on the front edge of each terrace made it impossible to look down into the neighbour's terrace below. The roof of the

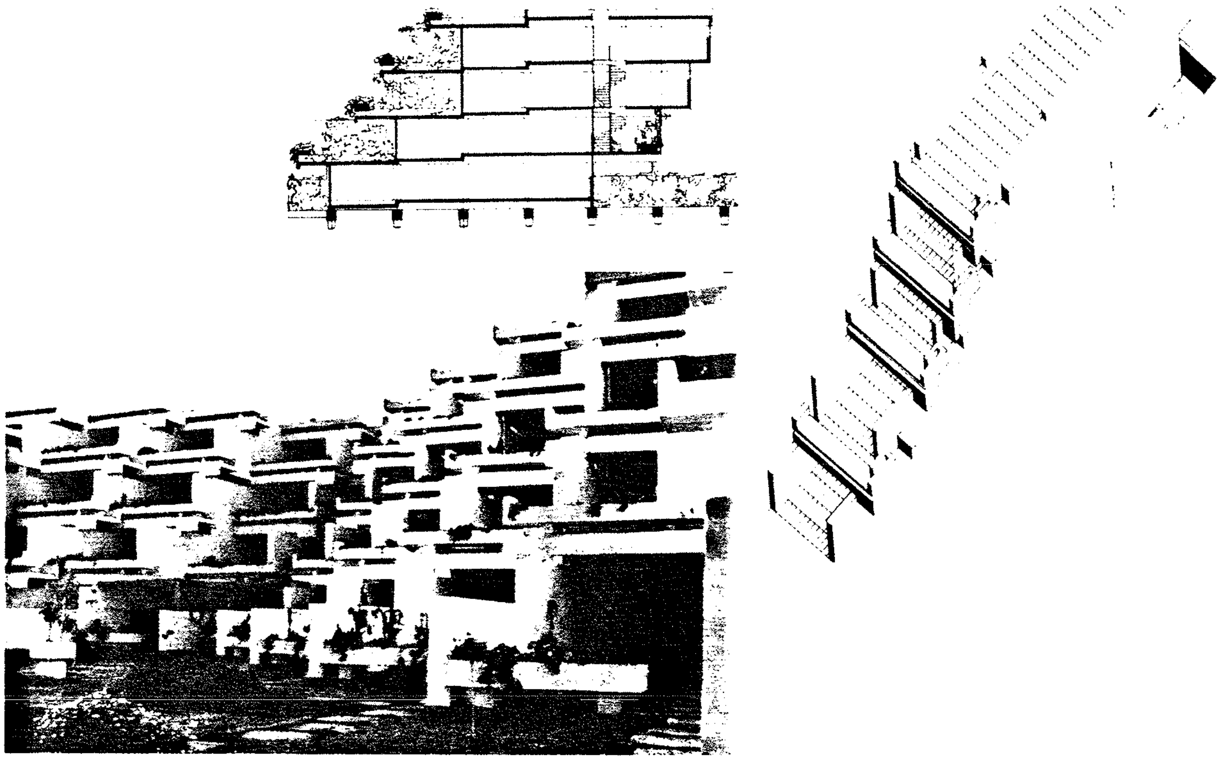


Figure 62: Ciudad Blanca in Alcudia, Mallorca (From Gollwitzer and Wirsing, 1971.)

top unit provided additional private or public garden space.

Perhaps the greatest exponent of the cascading type of apartment building today is Moshe Safdie. His proposals for Habitat 67 in Montreal (see figure 63), Habitat New York, Habitat Puerto Richo, Habitat Israel, and Habitat Rochester all involved a system of arranging separate and vaired units so as to provide a roof garden or roof terrace for each unit. Writing about Habitat 67, Safdie stated:

> The fact that you have a terrace outside makes a 1200-square-foot house in Habitat feel twice that size. The fact that you can go from indoors to outdoors makes the difference between feeling fairly self-sufficient in that environment or feeling locked into an apartment where you must leave the building just to get some fresh air. I could easily spend a whole day in Habitat without leaving home, because of the choice of being in or out of doors. (Safdie, 1974, p.46.)

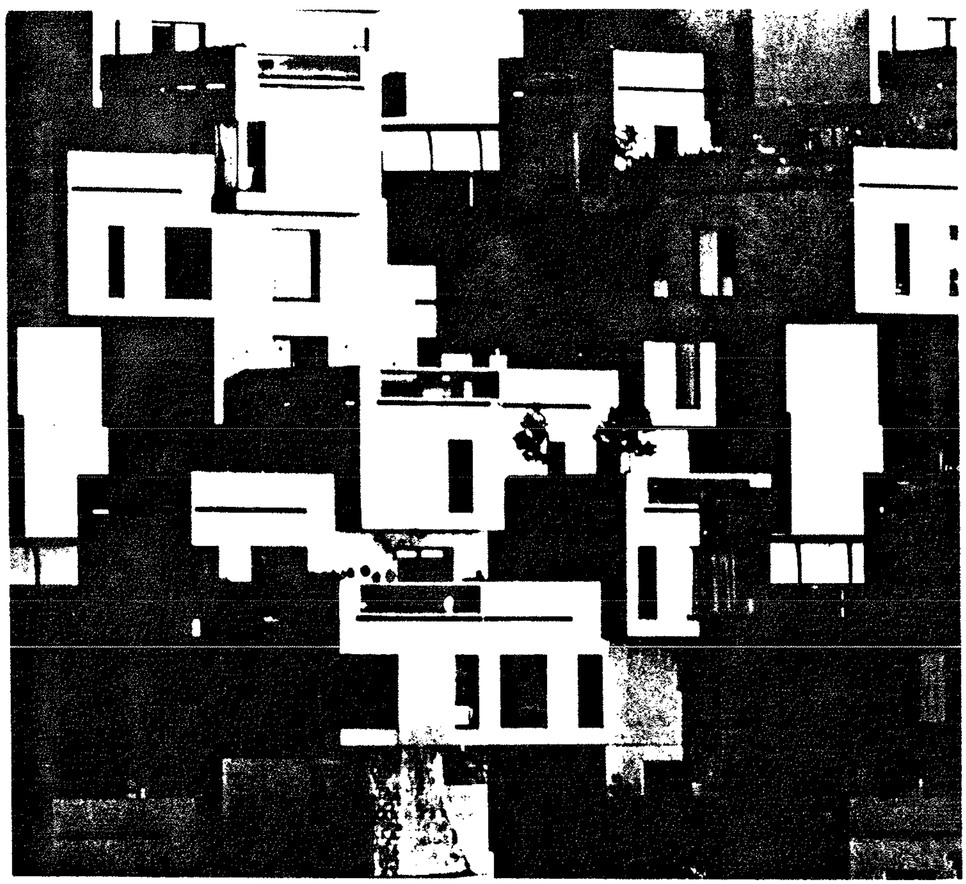


Figure 63: Habitat 67, Montreal (From Safdie, 1974.)

One of the most unusual schemes for a cascading type of apartment complex was the metabolist proposal by Richard J.

Dietrich, which he called the 'Metastadt-Bausystem' or 'Metacity Building System' (see figure 64). This infinitely expandable city structure was judged especially successful because of the way the small, lightweight, adaptable units (3.6 by 3.6 by 3.6 metres) could be plugged into the highly regular framework or building system. All the roof terraces were equiped with lightweight planter units which doubled as parapets. As in Safdie's Habitat 67, the pyramidal shape produced by the double stepped slopes created a semi-public environment within, which was niether exterior space nor interior space, but something in between.

One recent housing development which does not fit into either the cascading or the block form was the imaginative project dubbed "The Spaces of Abraxas" by its architects: Ricardo Bofill and Taller de Arquitectura (1978-1982). The concept behind this three-building development, built in the Marne-la-Vallé suburb of Paris, was to add drama to and increase the density of suburban housing. The three buildings were named "The Theatre," "The Palace," and "The Arch." Together they were designed to act as a monumental entry gate to the new suburb. As grand and eccentric as any design by Ledoux or Boulée, this post-modern colossus grew up out of the French soil as a thundering parody of the often namby-pamby French classicism which shapped so much of Parisian architecture. Thoroughly original, pretentious, authoritarian, often witty, and always interesting, but never subtle,

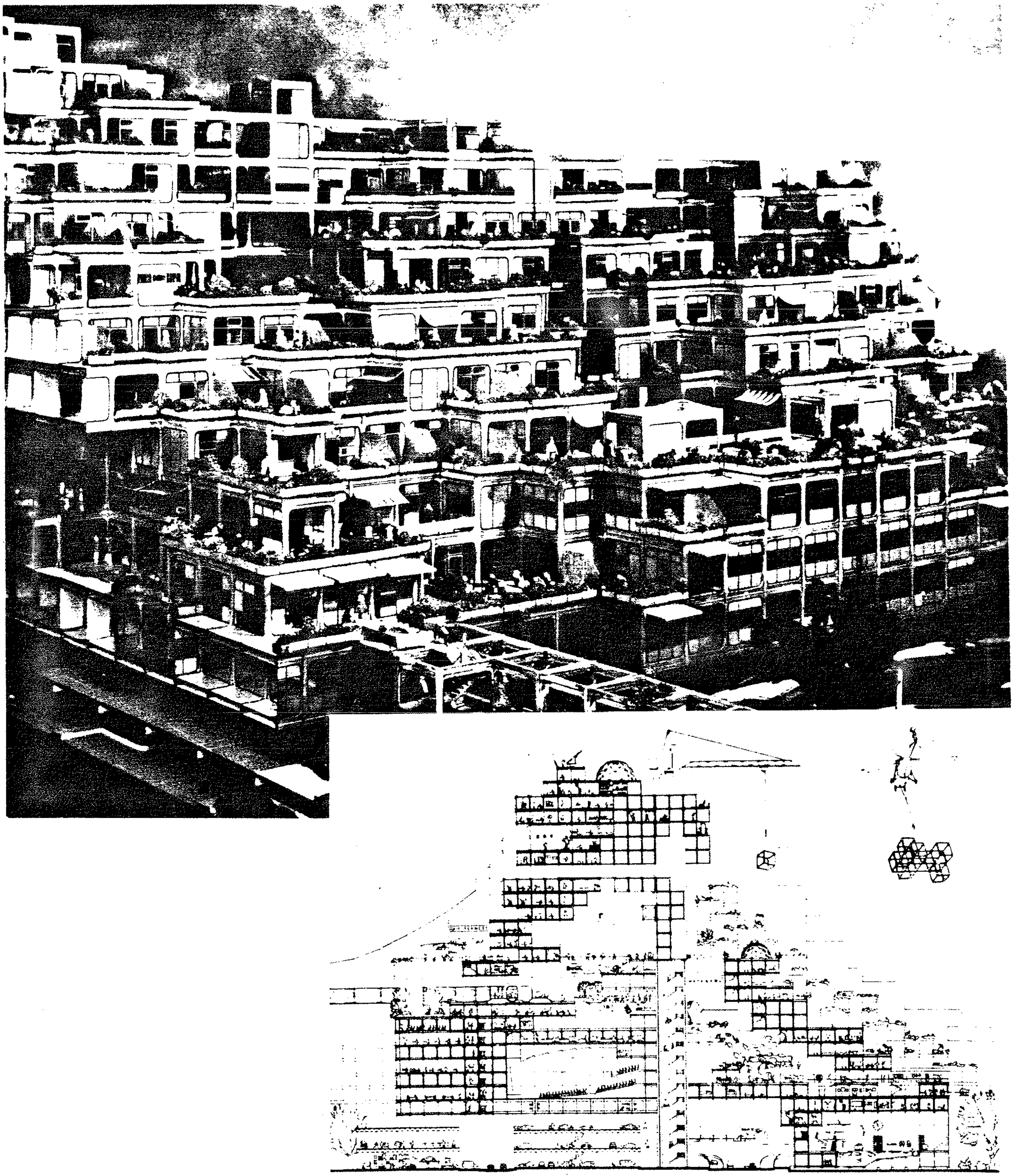


Figure 64: Metacity Building System Proposal by R.J. Dietrich (From Gollwitzer and Wirsing, 1971.)

the design for The Spaces of Abraxas was conceived as a theatre set, in which 584 apartments happened to be located. Bofill himself called The Arch a "stage curtain that shelters exhibitionists" (as quoted in Bergdoll, 1982, p. 74). The semi-circular Theatre and The Arch were covered with what must be called roof gardens. (See figure 65) Reminiscent of Taller's Arcades-du-lac complex, the ten-storey Theatre was capped with a roof less than 12 metres wide but over 165 metres long. The proportions, plus the curvalinear shape rather limited the way in which the roof garden could be developed. As a result, the lawn-covered, cypress-bedecked roof became non-accessible green space with one long trench-like walkway running along the full length of the building inside the building's 'cornice.' The roof gardens of the Theatre and The Arch, were designed to serve primarily as a foreground for the view out to the Marne Valley as enjoyed by the residents of the upper floors of the 19-storey Palace. Because of the way the cypress trees were planted directly above each one of the glass-faceted columns, the building, when viewed from the amphitheatre side, appears as a continuous row of ten-storey high planters.

3.2.2.3 Commercial and Public Buildings

Late in his career, Le Corbusier designed the Cultural Centre in Ahmedabad, India (1953-57). (See figure 66). Like his buildings in Chandrigarh, and most of his other post-Ronchamp buildings, it had a heavy, chuncky appearance. The

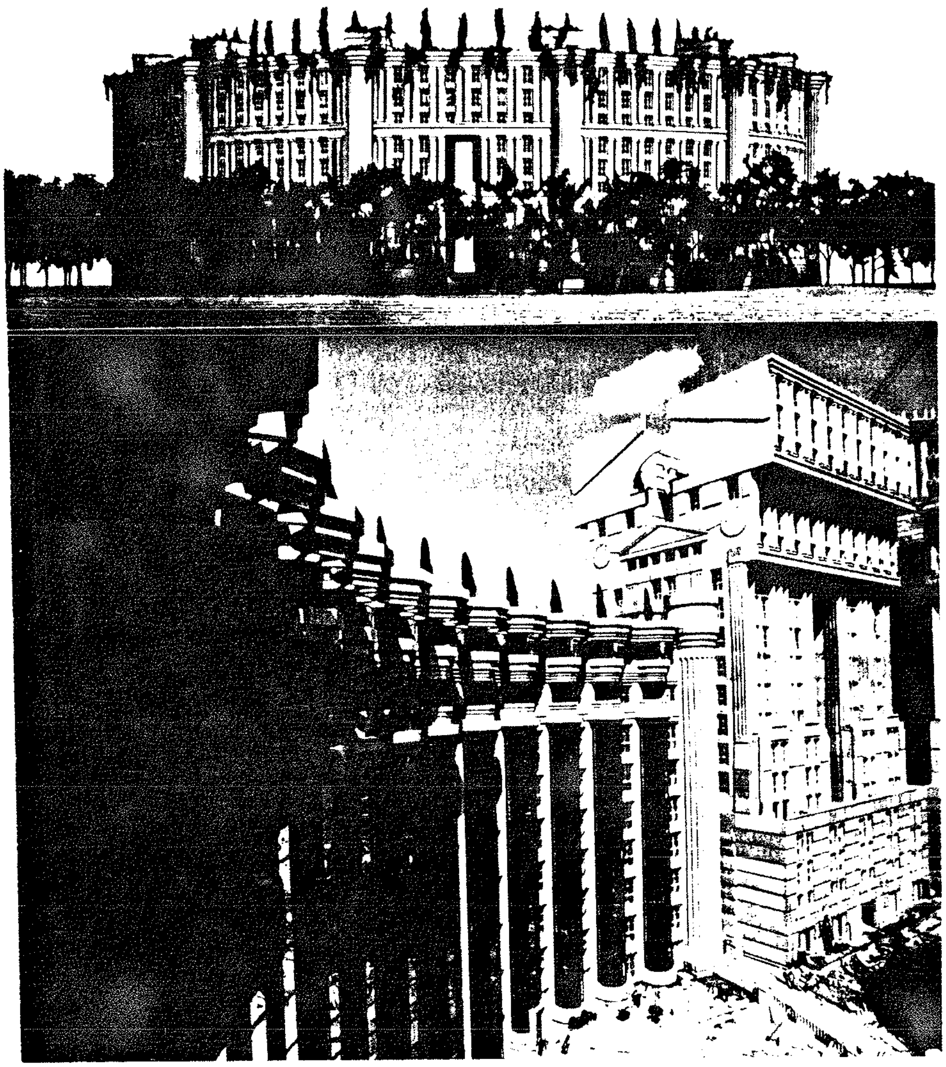


Figure 65: 'The Spaces of Abraxas' by Bofill and Taller, near Paris (From Bergdoll, 1982.)

massive square structure rested on small pilotis. A planter girdled the buildings at the point where the pilotis met the building (see section, figure 66). From this planter climbing plants were trained up the walls where they acted as a screen to protect the building and its inhabitatns from the hot Indian sun. On the roof Le Corbusier installed 45 large basins each containing about 20 cubic metres of water. The still water reflected the sun's rays away from the building, helped keep the building cool, provided a habitat for a lush growth of aquatic plants, and cooled the visitors who strolled through it on a system of raised walkways and

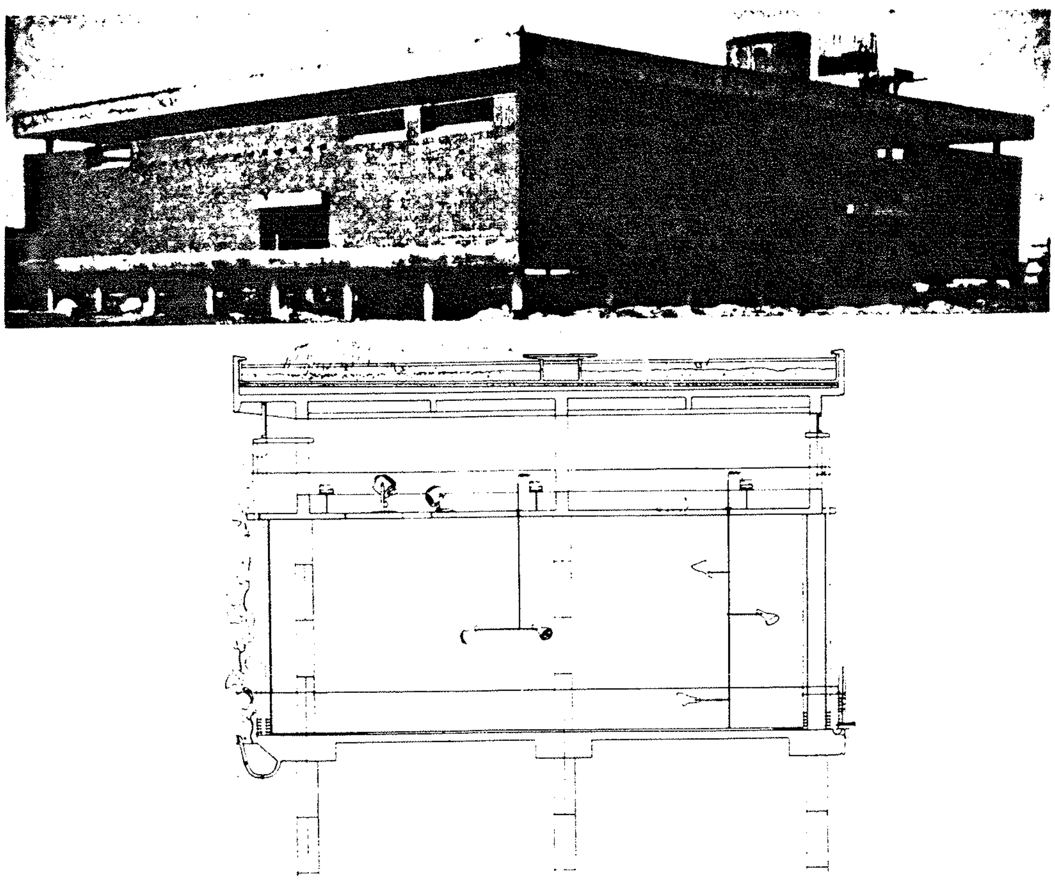


Figure 66: Cultural Centre, Ahmedabad, India (From Gollwitzer and Wirsing, 1962.)

bridges.

During the 1950's high land values and lack of space made the development and unhaltered construction of the high-rise inevitable. As the highrise became the rule, the podium or open area at the base of the high-rise, developed as a corollary to this rule. Sometimes the podium was built over an underground car park or service area, such as that of the Kaiser Center in Oakland (see below), the First National Plaza in Chicago (landscaped by Novak, Carlson, and Associates), Mellon Square Park in Pittsburg (landscaped by J.O. Simonds), Constitution Plaza in Hartford (by Sasaki, Dawson, DeMay Associates), the Seagram Building in New York (by Mies van der Rohe and Philip Johnson, landscaped by Middeler and Linn), and Equitable Plaza in Pittsburgh (landscaped by Collins, Simonds, and Simonds).

Other times the podium roof gardens were built over one or more levels of offices or shops, as in Arudel Great Court London (by F. Gibberd and Partners), or Pacific Telephone and Telegraph Building in Sacramento (see below). These podium spaces provided building owners with sites which they could either develop for the use of their own employees, or dedicate to the general public and thereby receive recognition as civic benefactors.

In 1956 architect Kenzo Tange designed the Tokyo Art Centre. The podium over the underground auditorium and classrooms provided him with the opportunity to create a multipurpose garden which was both functional and graphically interesting when viewed from the air (see figure 67). The garden served as foyer for the auditorium, as a sculpture garden, and as an outdoor theatre. The roof of the building proper provided a more private garden space and an ideal

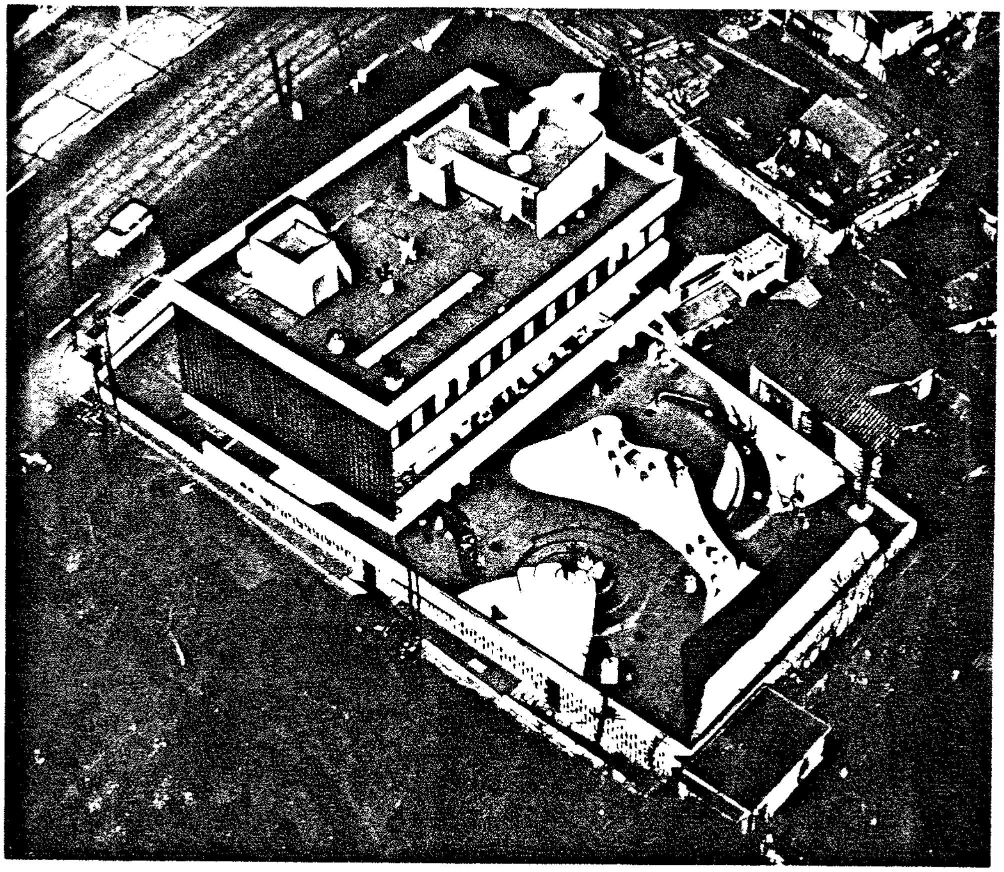


Figure 67: Tokyo Art Centre (From Gollwitzer and Wirsing, 1971.)

place from which to view the podium garden.

Architects J. and P. Genard discovered in 1958-59, when they designed a five-storey car park in central Toulouse, that a rooftop with a minimum amount of amenities can sometimes be the best solution to the needs of the public (see figure 68). The space on which the large car park was built was originally an open air marketplace, but the city of Toulouse decided to sacrifice the Marketplace in order to ameliorate the parking problem in this densly populated city. Because there was no other open space to which the marketplace could be moved, it was relocated on the roof of the newly constructed car park. By prohibiting the construction of any permanent partitons, seating areas, kiosks, or planting beds, on the roof, the roof became a large multipurpose area: it was used for additional parking when needed, it was used as a market place, as a heliport, and as a park for special events like concerts or carnivals. Special pedestrian access was provided in the hubs of the ramp turrets. Lamp standards were installed to provide for the opportunity of night time use, but other than this, no permanent fixtures or features were included in the design.

G.A. Jellicoe and Partners took the opposite approach when they designed the roof garden on Harvey's Store in downtown Guildford, Surrey, in 1958-59. Every square centimetre of the rooftop garden was carefully designed and utilized. The roof garden, as viewed from the adjacent cafeteria resembled an urbanized Japanese garden in its use of a water body, irregular islands, bridges, stepping stones, and screens to block wind and undesirable views (see figure 69).

The wind would have quickly dried out the shallow soil (which varied from 15 to 45 centimetres), but small weepholes in the curbs containing the soil allowed water to seep from the pool into the beds. The pool, in effect, acted as an automatic irrigation system. The pond was only 15 centi-

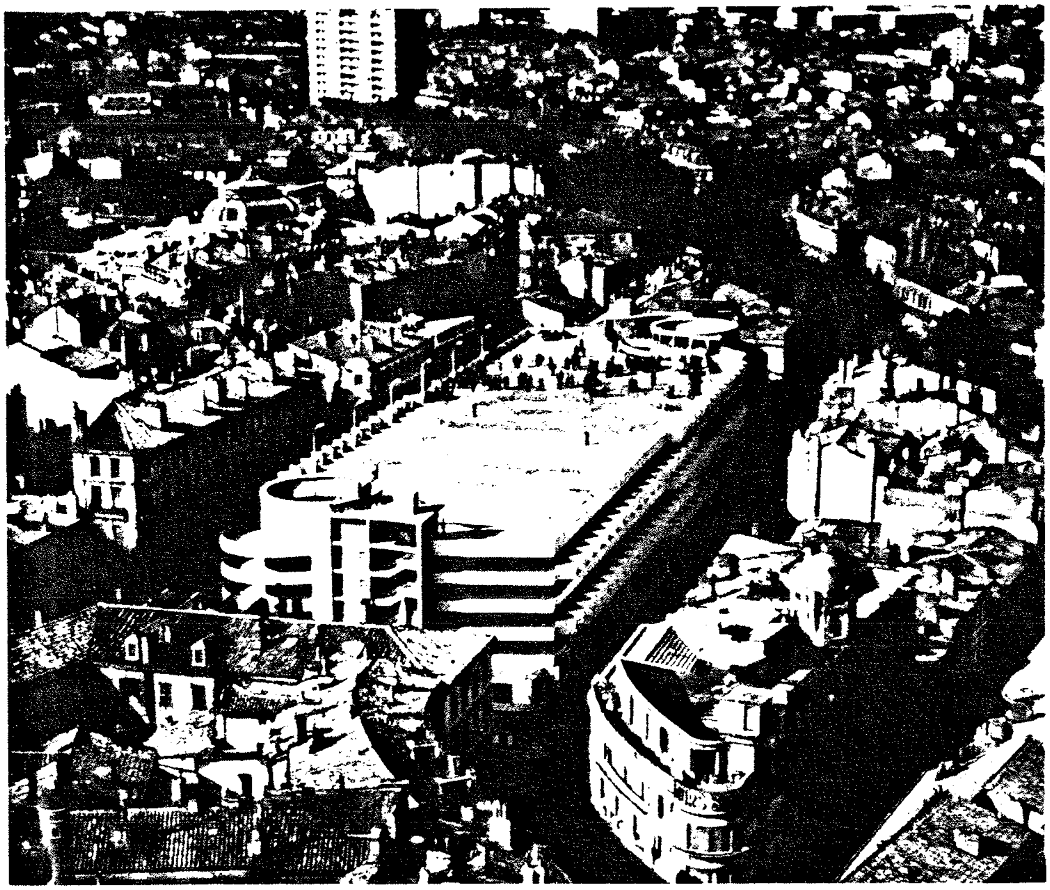


Figure 68: Car Park in Toulouse (From Gollwitzer and Wirsing, 1962.)

metres deep but, by covering the bottom with different shades of coloured gravel, the illusion of varying depths was achieved.

As in the case of Derry and Toms Departmental Store, this roof garden was an afterthought, built after the building was complete. But while the Derry and Toms roof surface was enormous and its loading capacity almost limitless, the roof over Harvey's was small and could support only a very limited load. Jellicoe maximized the garden's potential by locating the heavier elements (such as the tree-tubs) over the structural piers, by using winding contours and screens to give the impression that the space was actually larger than it was, and by filling the space there was with interesting details and constantly changing plants. All the plants chosen for the design were native to wetland environments (willows, irises, azaleas, spireas, ferns, etc.).

The roof was closed to the public in 1972 when vandalism became a problem. (Groups of children began dropping objects from the roof and the management was unable to absorb the cost of a higher parapet or the policing required to prevent the vandalism.) The only maintenance the garden received since then was the topping up of the pool to ensure the survival of the fish. But, although the beds are now overgrown with weeds, all the major planting is still thriving after more than a decade of neglect (Scrivens, 1982.)

In 1959 Richard Neutra was commissioned to design the Lincoln Memorial in Gettysburg, Pennsylvania. Again he incorporated a water roof, this time more for aesthetic and symbolic reasons than for environmental reasons (see figure 70). Here the long calm reflecting pool, located above the administrative offices and flanking the walkway/viewing platform, heightened the dramatic view of the battlefield beyond. The water provided a foreground in which were reflected the gigantic cylindrical museum, the surrounding forest, the sky and the clouds. At sunset, as the water caught the red glow of the sun, the roof became an enormous

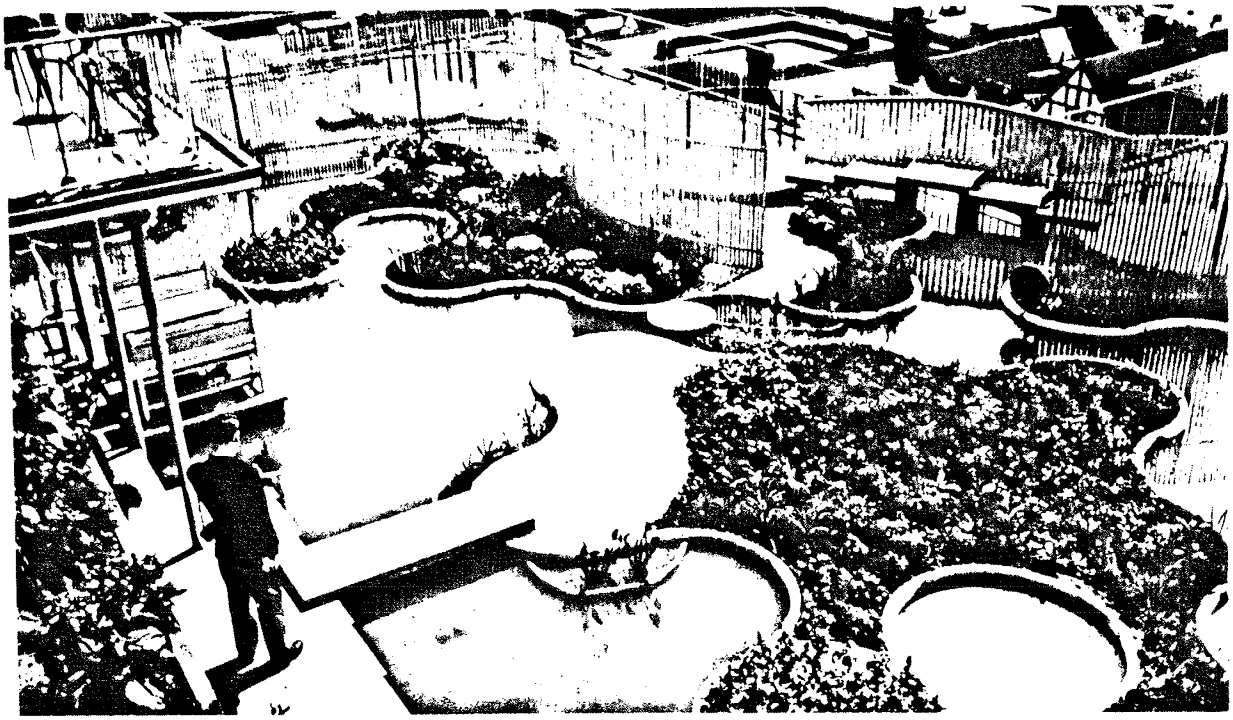


Figure 69: Roof Garden over Harvey's Store, Guildford, Surrey (From Clay, 1962.)

pool of blood reminding visitors of the 30,000 lives that were lost on the battlefield before them.

In the same year (1959), one of the most publicized roof gardens was constructed on the multi-storey car park of the Kaiser Center in Oakland, California. The roofscape was designed by Theodore Osmundson and Staley of San Francisco. It was built as both a leisure space and a visual amenity for the employees of the adjacent office tower, and for the general public during the hours in which the rooftop department store was open (see figure 71 and 72). The use of curvalinear forms created a park-like atmosphere at eye level and an attractive composition when viewed from the 28-storey tower. The 1.4 hectare garden was the largest in the coun-

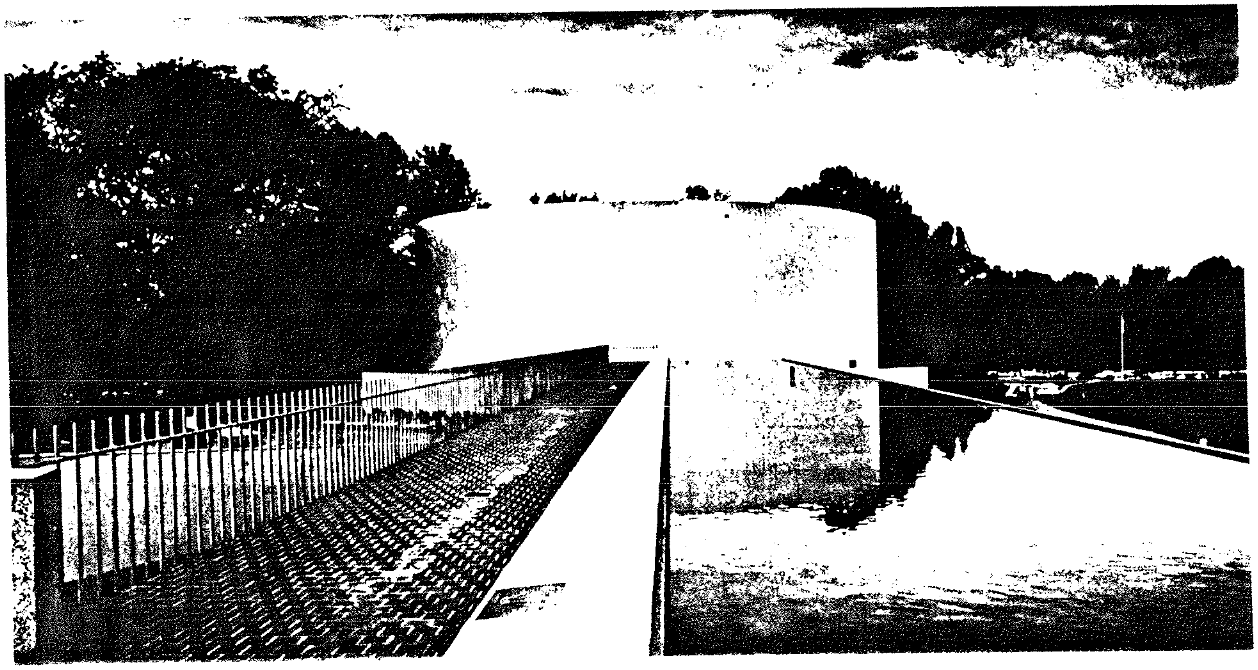


Figure 70: Lincoln Memorial, Gettysburg, Pennsylvania (From Exner and Neutra, 1974.)

try when built (and only slightly smaller than the Derry and Toms roof garden in Britain).

While 90 percent of the site on which the Kaiser Center was built was covered by buildings, 60 percent of the site was covered with roof garden, proving that "high density need not rule out the aesthetics of landscape architecture" (Osmundson, 1962, p.15).

The garden featured a large free-form pond containing 40 centimetres of water and a black bottom to give the impression of depth, an automatic irrigation system which varies with the amount of soil and type of plants surrounding it, 42 specimen trees (some over six metres tall), grassed areas, lush planting beds, a paved area, and an automatic lighting system to provide dramatic night time illumination. The water in the pond was kept in motion by jets around the preimeter and by underwater jets with filters.

To minimize the weight problems, lightweight concrete was used throughout, pumice stone boulders and lightweight soil mixes were used, and the areas of deepest soil depths were centred over structural piers. The soil varies from 15 to 80 centimetres. Large trees (mostly Olive because because of their fibrous root systems) were left in their wooden containers and the earth bermed up around them. In this way no extra guying was necessary and once the wood decomposed the root systems were sufficiently extended to ensure stability (see figure 73).

The garden was drained with a 10 centimetre porous, lightweight crushed rock sublayer underlying the entire site. The water flowed through the sublayer towards the drainage pipes which ran down the five-storey structural columns, and into the storm sewer in the basement.

Between 1960 and 1964 the city of Bern, Switzerland, undertook the development of a 1.1 hectare municipal park on the roof of an extensive complex containing a railway station, a mulit-level car park, offices, and shops. The roof park, landscaped by W. Liechti, featured a promenade, playground, sunny and shady sitting areas, water features, treed areas, and a large expanse of lawn (see figure 74).

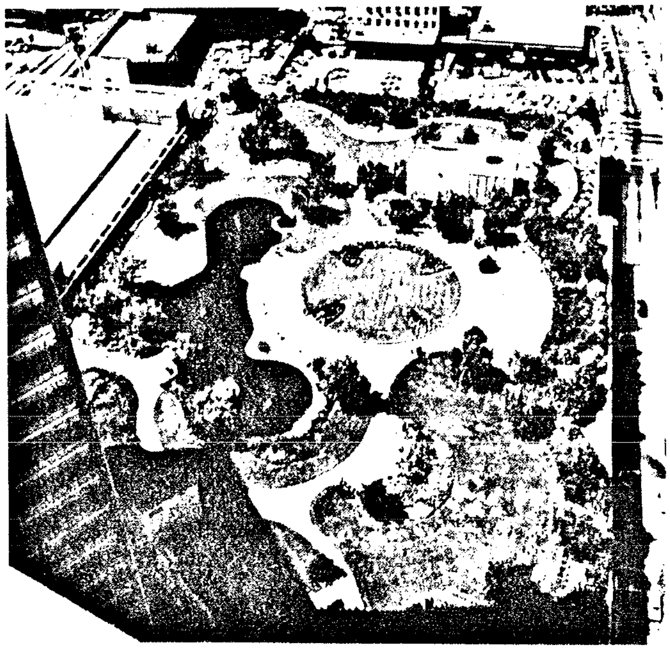


Figure 71: Kaiser Center Roof Garden, Oakland, California (From Whalley, 1978.)

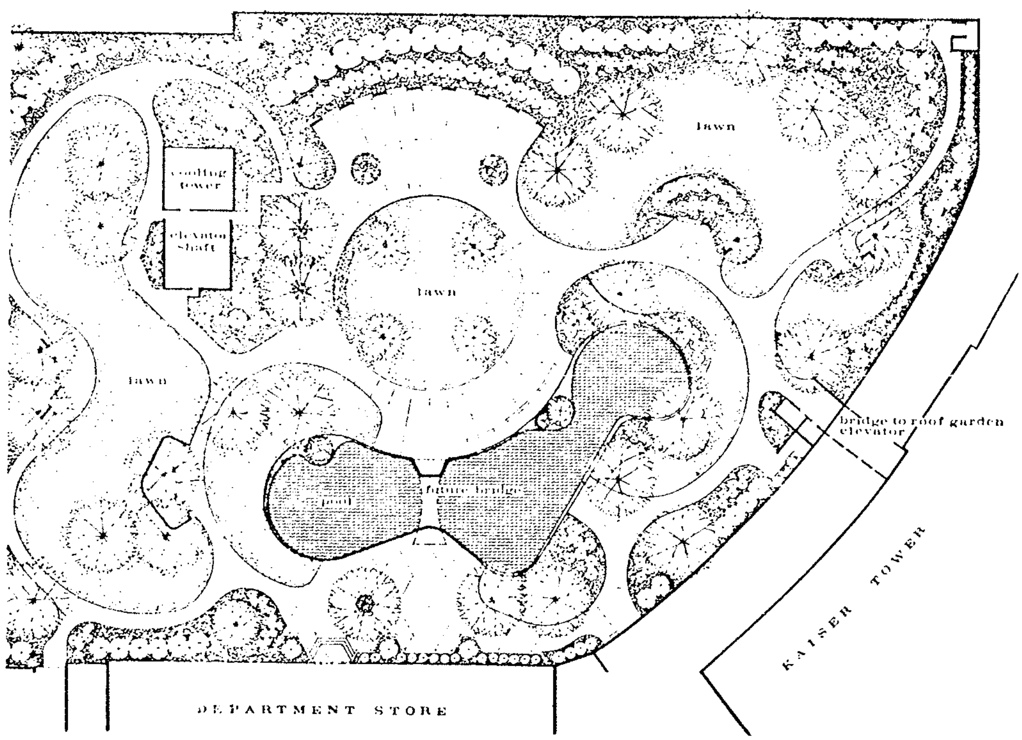


Figure 72: Plan of Kaiser Center Roof Garden (From "The View From Above," 1964.)

Because the complex was built on the site of an existing

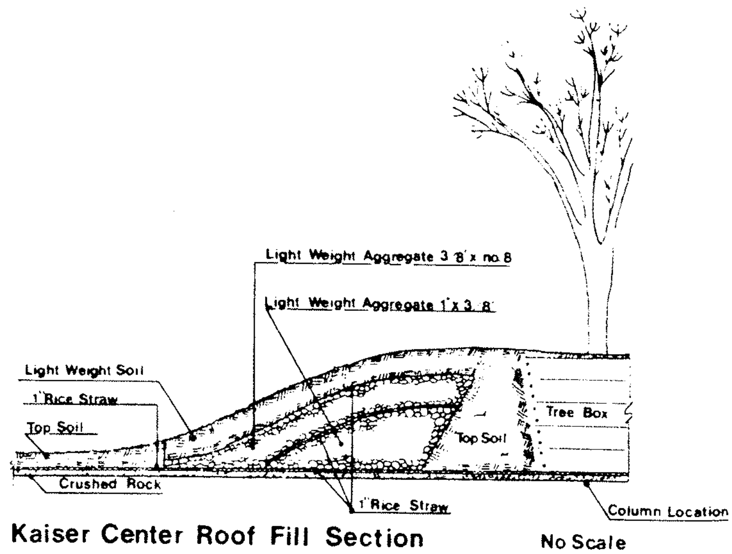
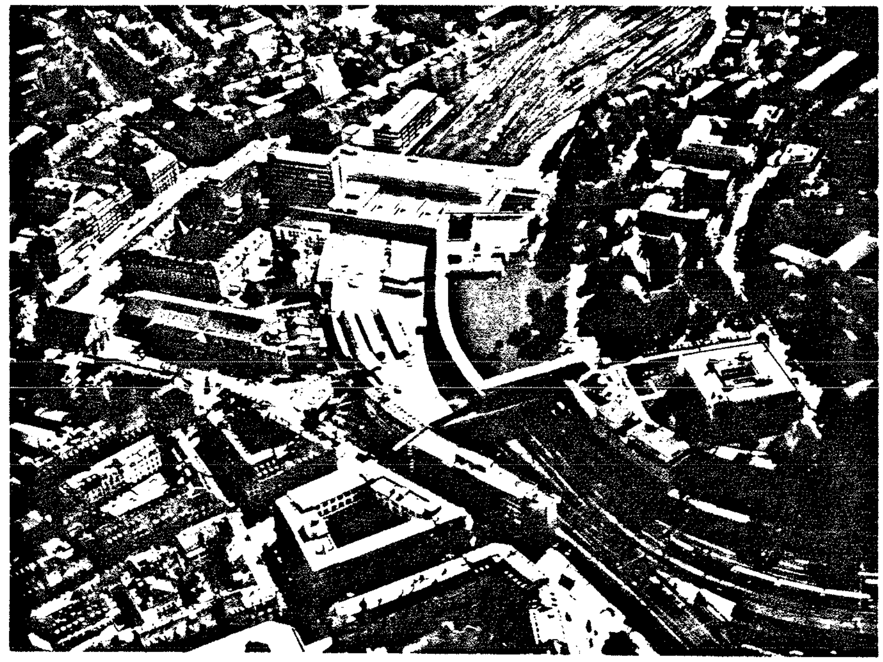
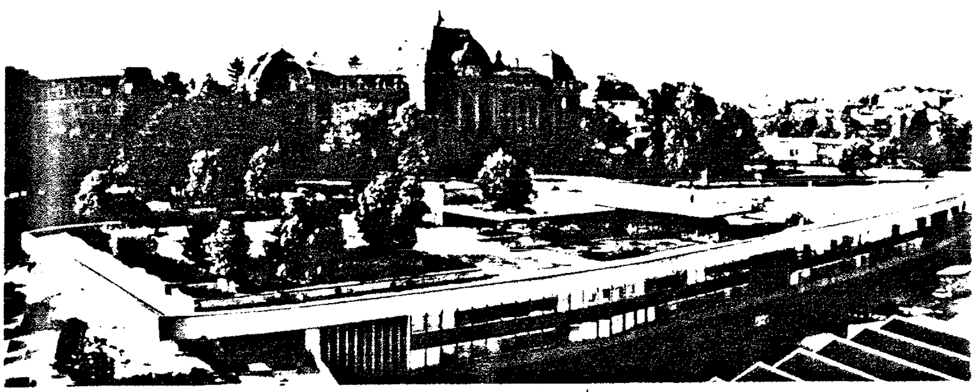


Figure 73: Kaiser Center Roof Fill Section (From Osmundson, 1979.)

public park, permission for its construction was granted only after the developers agreed to replace the lost park with a public open green space on the roof of the complex. Built into the hillside, the roof park can be approached from street level on the North, but is about five storeys above grade on the South. It was for this reason that the park was named "Grosse Schanze Park" or "Great Barrier Wall Park." The much used park was designed as a quiet haven with a view out over the busy city surrounding it, and the Alps on the horizon.

In 1961 the German architect Fred Angerer designed a roof garden for the fifth storey atrium of a bank in Munich. Recognizing the attractive qualities of the 'water roofs' of Le Corbusier, Jellicoe, and Neutra, Angerer decided to try his hand at designing one (see figure 75). Instead of a





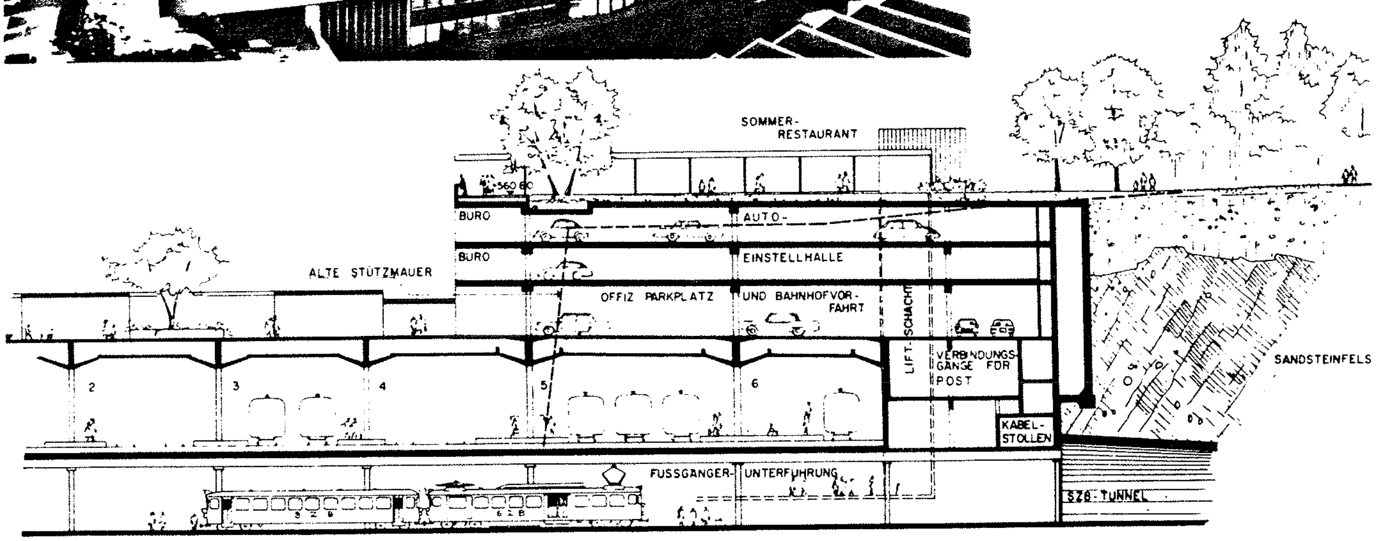


Figure 74: Grosse Schanze Park, Bern (From Gollwitzer and Wirsing, 1971.)

still reflecting pool, Angerer wanted an animated one. Five jets of water, shooting two to three metres above the shallow pool, added a dimension of life through movement, sound, and sparkling mist-laden breezes which cooled the air and the employees strolling in the surrounding covered walkway. Plexiglass domes were placed between the jets to allow daylight to penetrate down into the large banking hall below. Water falling from the jets onto the surface of the domes created shimmering patterns of light in the hall below. A few planters around the perimeter of the pool added a touch

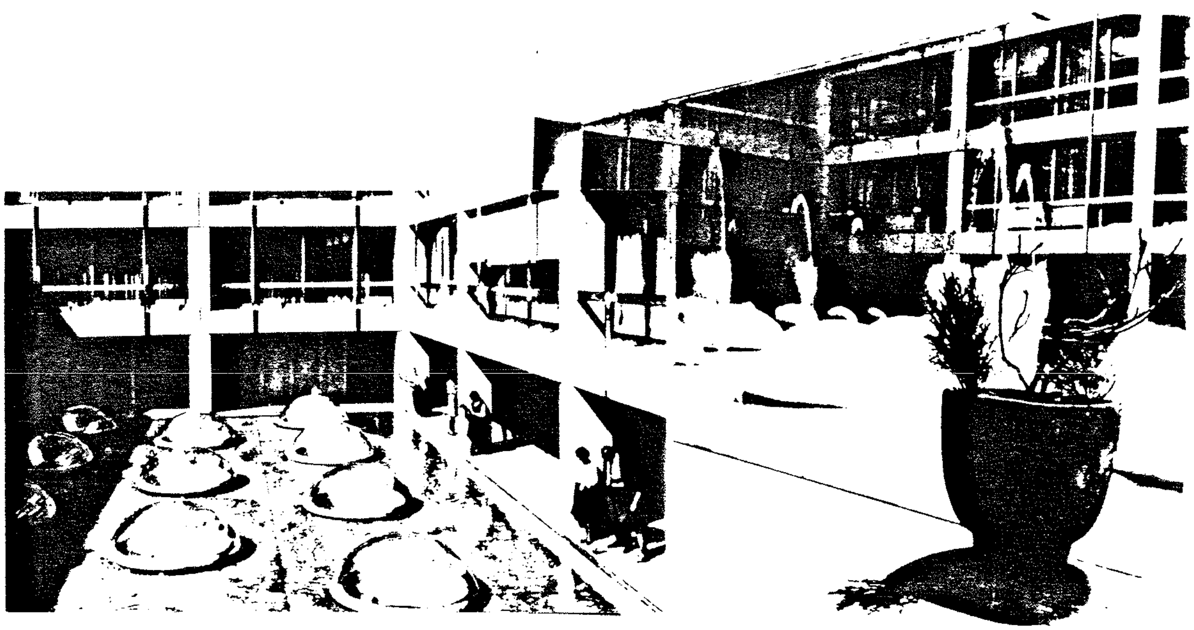


Figure 75: Water Roof Garden over a Bank in Munich, Germany (From Gollwitzer and Wirsing 1971.)

of colour to the otherwise plantless atrium garden.

Another courtyard roof garden built strictly for the building employees was the Pacific Telephone and Telegraph

Building in North Sacramento (1962) (see figure 76). Landscaped by Osmundson and Staley (three years after they designed the Kaiser Center Gardens), this garden was designed to provide employees with a lunch hour retreat as well as amenity space for office parties and other special events.

Because the floor below contained millions of dollars worth of computers in a carefully climate controlled environment, it was essential that the roof be 100 percent leakproof. Osmundson and Staley therefore used the same system they used in the Kaiser Center (see figure 73) but added a five millimeter thick layer of fiberglass insulation between the soil and the crushed rock drainage layer to speed up runoff (see figure 76).

The only criticism of the garden reported by the occupants of the building was that the four walls surrounding the garden restricted air circulation.

In 1964 the Swiss firm of Burkhardt and Schonhotzer built an attractive roof garden over the Ciba-Geigy Administrative Centre in Basel (see figure 77). Above a four-storey, underground car park, was built a large pond and garden terrace. In the centre of this pond a one-storey circular structure was built to house the company canteen. Since the plaza surrounding the pool area provided ample outdoor space for the employees to stroll through, or sit and rest in, during their lunch hours, there was no need to make the roof

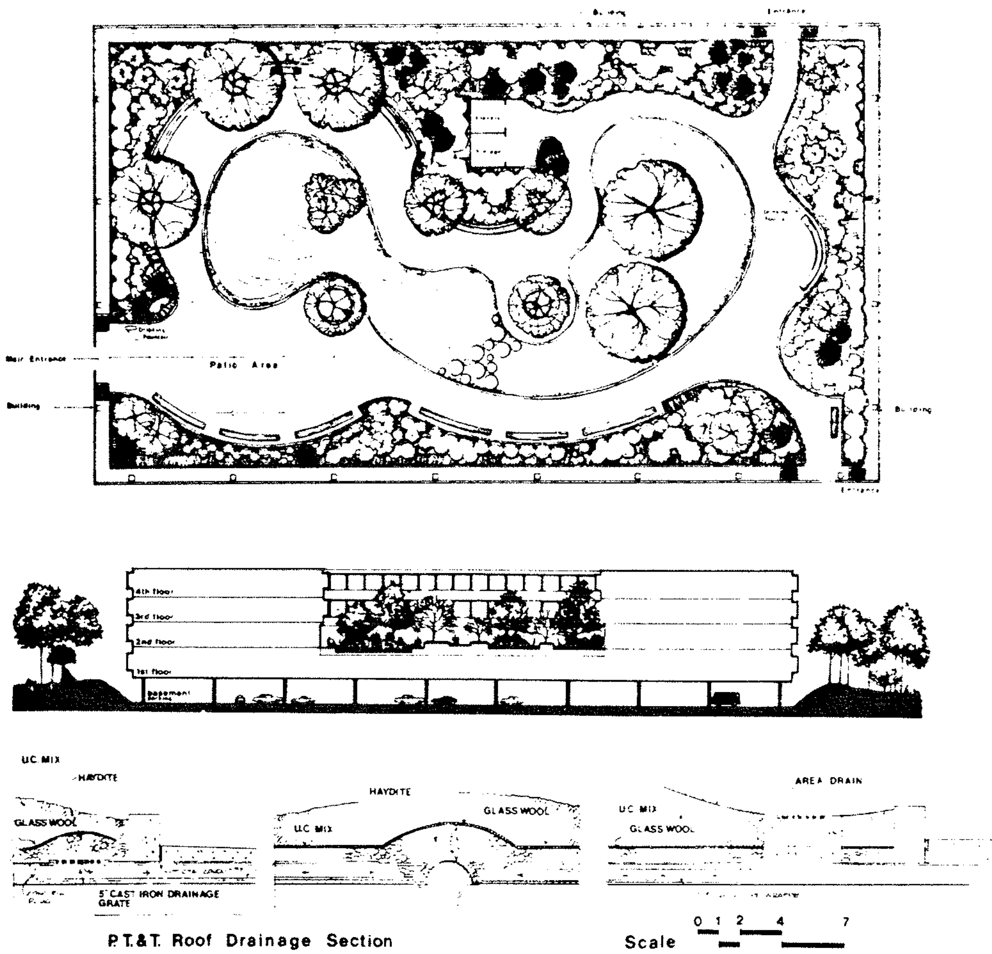


Figure 76: Pacific Telephone and Telegraph Co. Roof Garden, Sacramento, California (From Osmundson, 1979.)

of the canteen accessible. But, because the circular canteen roof was very visible from the adjacent office tower, the architects decided to turn it into an attractive green space. The roof was covered with 15 centimetres of humus and planted with a mottled carpet of various ground covers, grasses, and low shrubs. Vines were planted around the perimeter of the roof and allowed to cascade over the edge. Small, square, concrete island-planters containing tall grasses and other water-loving plants were placed in the pond around the canteen.

While roof gardens such as those of the Ciba-Geigy Centre, the Kaiser Center, and Tokyo Art Centre were designed as much, or more, for viewing from above as for viewing from eye level, the Hotel Bonaventure roof garden in Montreal (built in 1966-67) was designed as an interior courtyard to be viewed only from within. The rooftop of this ten-storey hotel/convention centre/commercial complex, designed by architects Affleck, Desbarats, Dimakopoulos, Lebensold, and Sise, is over two hectare in area. The roof garden itself, however, designed by Sasaki, Dawson, DeMay and Associates, covers only about .8 hectares and is in the shape of a square doughnut (see figure 78). A lobby and administration offices were built as a unit in the centre of the roof. The linear roof garden was layed out around this centre unit and the garden was encircled by 400 hotel units, about half of which had views out into the garden.

The garden was divided up into four sections, each designed to reflect the function of the core unit to which it was adjacent (restaurant, lobby, etc.). But the four sections were made to read as one linear space through the use of a continuous water course and winding paths. The water course, which cascaded through a series of pools, channels, and waterfalls, was designed to be as interesting in winter when drained as when filled with water. The water course

Figure 77: Ciba-Geigy Roof Garden, Basel (Gollwitzer and Wirsing, 1971.)

was kept light by keeping the water depth to between 25 and 50 millimeters and installing pumps along the channels to keep the water moving.

The overall character of the garden was designed to be distinctly Canadian. Plants native to the Boreal Forests were chosen to both create a Canadian identity, and to ensure winter survival. Large boulders were incorporated into the landscape, making sure that they were located directly above the structural columns supporting the roof. Careful consideration was given to the garden's visual potential in winter when covered with snow.

The severe weight restrictions which were imposed by an underdesigned roof structure, and the awkwardness of the linear space interrupted by corners and enclosed corridors, made this an extremely difficult roofscaping problem. But, despite this, or perhaps because of this, the landscape architects created one of the most exciting and successful roof gardens built to date.

Around the same time (1967) another very successful, and now very famous, roof garden was begun. The Oakland Museum in Oakland, California, was designed by Kevin Roche, John Dinkeloo, and Associates, and landscaped by Dan Kiley. It was completed in 1970. The Museum of art, history, and natural sciences, was designed as a three-storey structure, with each floor smaller than the one below so as to create a

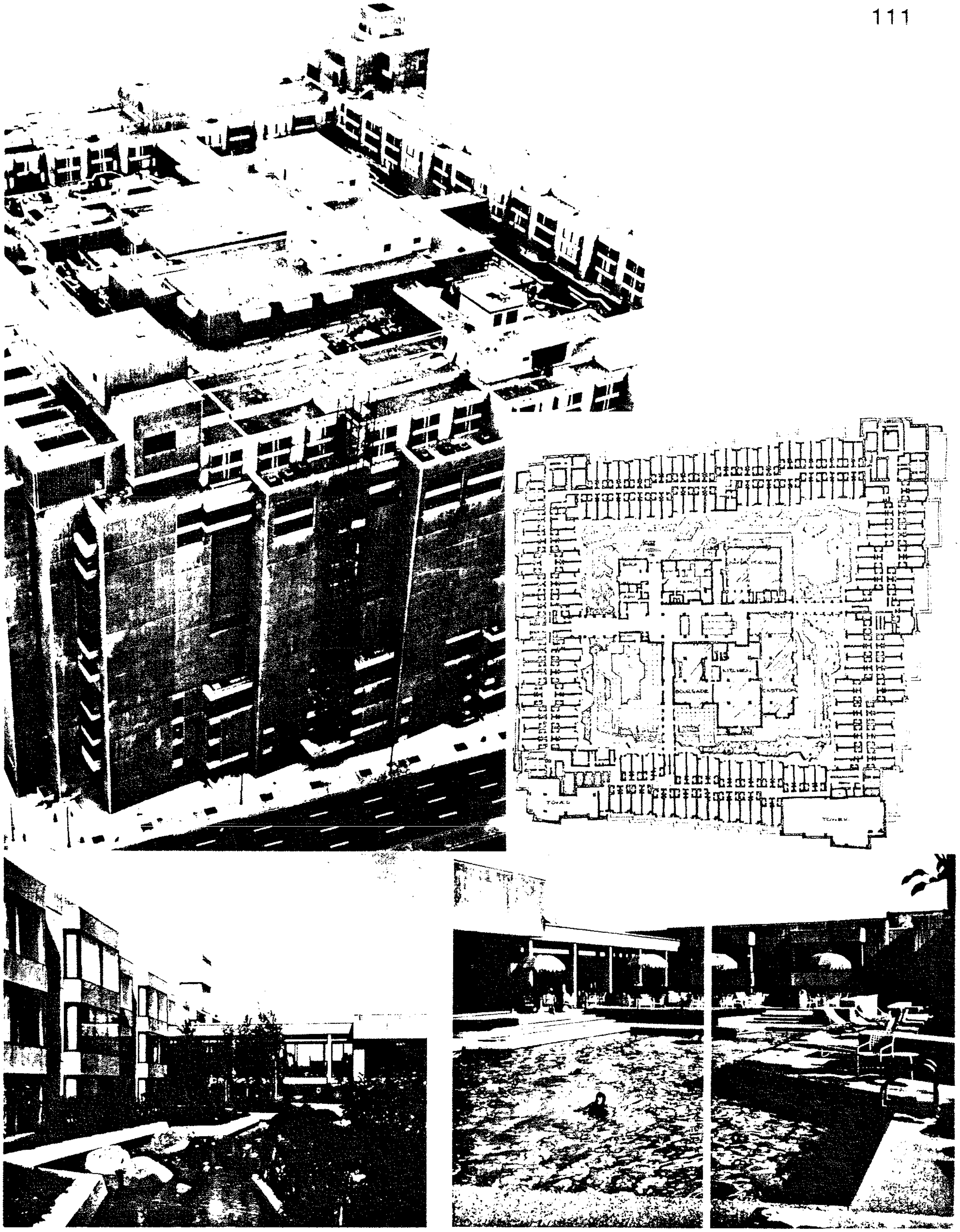


Figure 78: Hotel Bonaventure, Montreal (From Gollwitzer and Wirsing, 1971.)

series of terraces (see figure 79). The entire site, including all roof surfaces, was landscaped to create a 2.8 hectare public park. Twelve of the original cedars and redwoods were retained on the lowest level of the courtyard, thereby giving an "immediate sense of permanence and scale to the scheme" (Whalley, 1978, p.11). The site was also heavily planted with additional shrubs and trees. All planting beds were planted with quick growing ground covers to stabalize soil and provide a green cover while the trees and shrubs were maturing. An automatic sprinkler system was installed which not only supplied the plants with moisture, but also with liquid fertilizer at pre-set times.

Because the park was designed to be seen and directly accessed from almost any place in the museum, the park became an integral part of the museum's exhibition and circulation space. The massive planting involved in the design made it one of the most successful designs in terms of maximizing the aesthetic and environmental benefits outlined in Chapter II.

Considering that the roof garden is commonplace in the vernacular architecture of the Mediteranean, it was only natural that architects José Ma Martorell, Oriol Bohigas, and David Mackay, designated the roof an appropriate place for a playground when they designed Sant Jordi School in Pineda, Spain, in 1968-69 (see figure 80). Here numerous terraced levels were tied together with a series of stair-

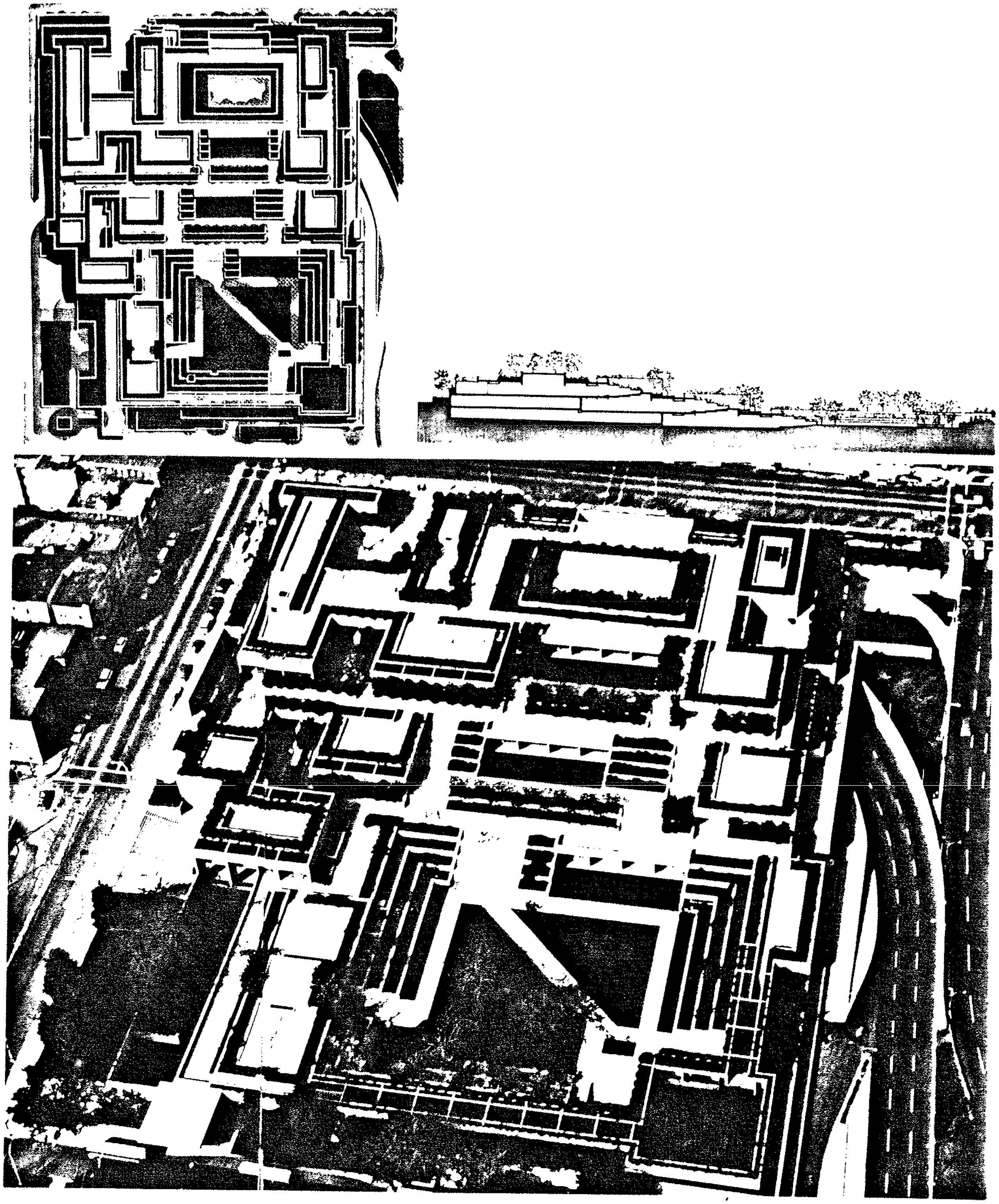


Figure 79: Oakland Museum, Oakland, California (From Gollwitzer and Wirsing, 1971.)

cases to make one large, but subdivided playground. The walls separating the different levels were designed to provide shade, while the open upper levels allowed the cooling winds to blow over them. The architects decided to keep

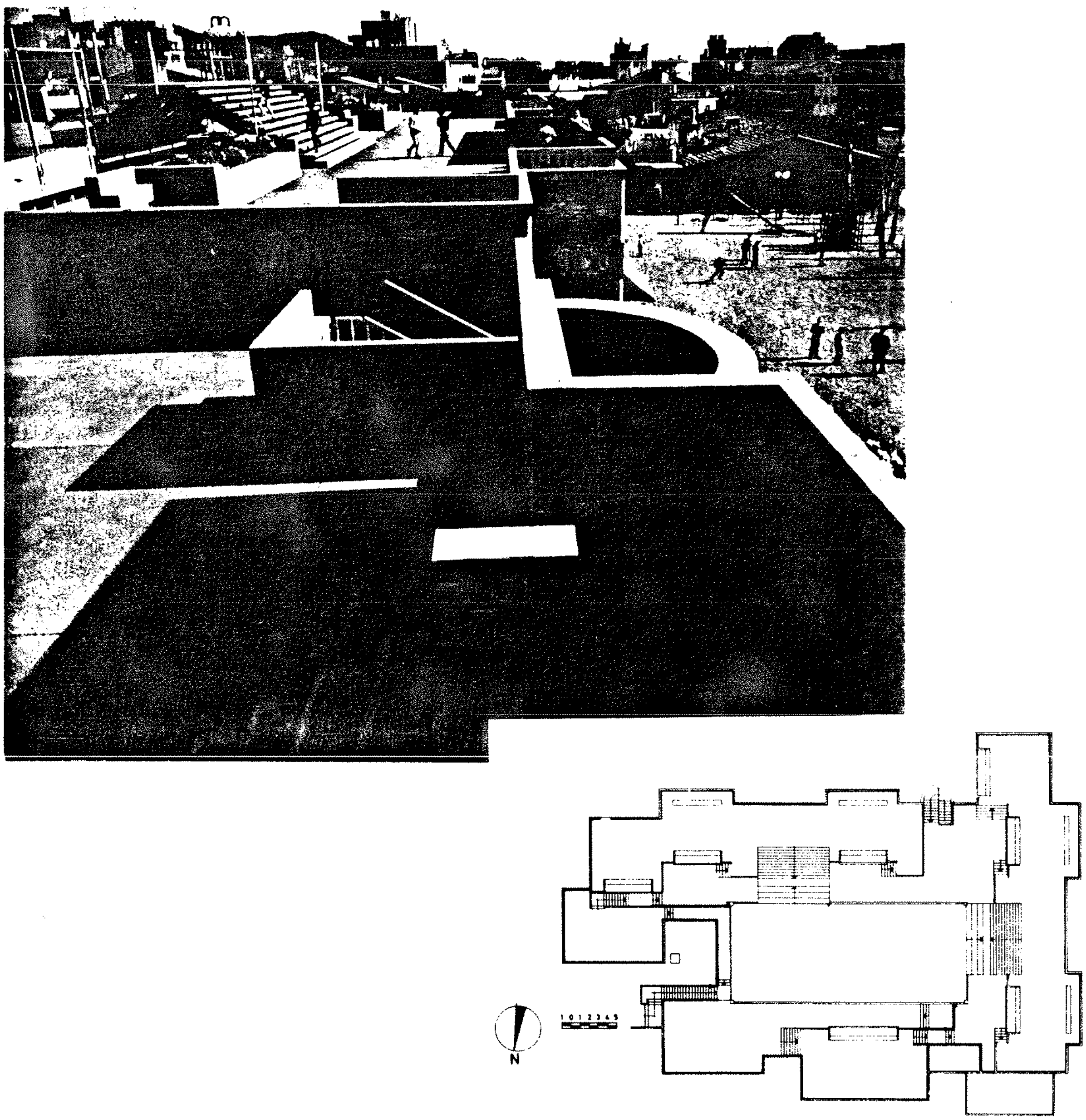
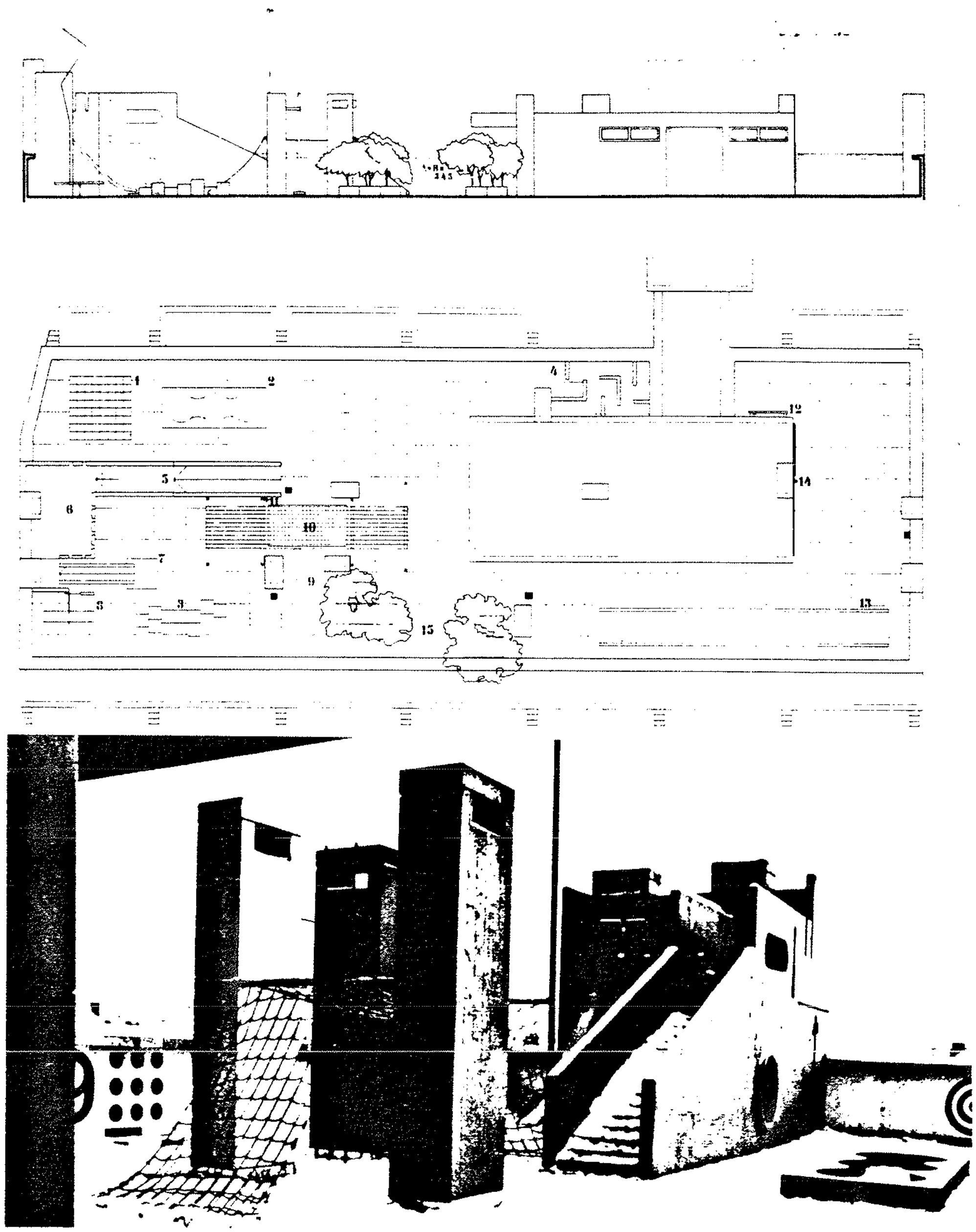


Figure 80: Sant Jordi School, Pineda, Spain (From Gollwitzer and Wirsing, 1971.)

planting to a minimum and maximize the open play space.

Another rooftop playground built about this time (1970) was the one above a six-storey firehall in Munich. Recognizing that particular neighbourhood's need for a playground, architects Kurt Ackermann and Peter Jaeger designed a play area for people of all ages (see figure 81). Incorporated into the roof playground were: a one lane bowling alley, labyrinth, a giant chessboard, a sandbox, ramps, slides, swings, and other play structures including a large 'play mountain' from the top of which the 'king of the castle' could rule the whole rooftop kingdom and surrounding cityscape. The design provided for a great variety of activites, and through a richness of forms and colours, actually stimulated activity. It, therefore, quickly became a gathering place for all people in the neighbourhood.

Around 1973 landscape architects Vrignaud and Brichet landscaped the roof garden of the offices of Saint Cloud Hill near Paris. Marcel Vrignaud, being a specialist in Japanese Chara floral art and garden art, decided to create, as much as possible, the feeling of a Japanese garden (see figure 82). The client stipulated that the garden must be a low-maintenance garden. Vrignaud therfore chose not to use any lawn, but rather carpet plants and carefully shaped beds of gravel and small stones. Irregular shaped water bodies were incorporated to animate the landscape.



1. Chess board
2. Sandbox
3. Wooden blocks
4. Labyrinth
5. Ramp
6. Architectural mountain
7. Slide
8. Swing
9. Climbing Pole
10. Rope bridge
11. Flag pole
12. Ballet bar
13. Bowling alley
14. Wind pin-wheel
15. Shade trees

Figure 81: Playground over a Firehall in Munich (From Gollwitzer and Wirsing, 1971.)

Because spacial limitations are very often a major factor in roofscape design, the use of many of the Japanese principles of garden design can be very beneficial in many cases. The use of these principles may, or may not, result in a garden with an oriental appearance. It is not the material or actual techniques that are important, but rather the basic principles behind them, the principles which have been developed over the centuries by the master gardners of the

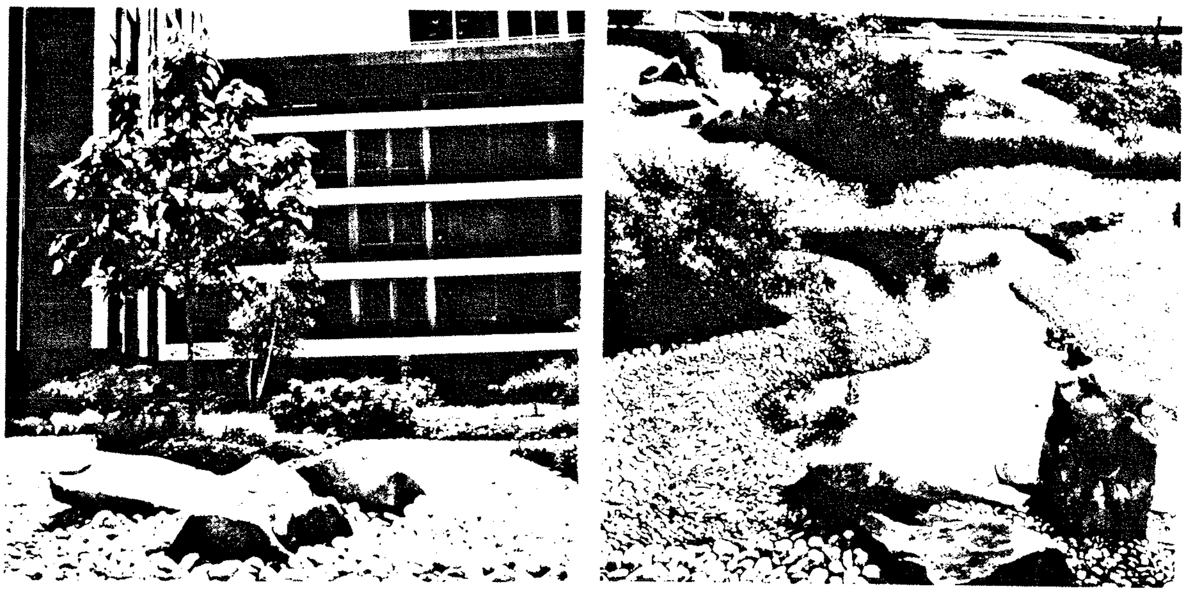


Figure 82: Hanging Gardens on the Offices of St. Cloud Hill near Paris (From "Hanging Gardens," 1974.)

Orient.

In 1974 Alexander Calder designed the roof painting of the Kent County Administration Building in Grand Rapids, Michigan (see figure 83). Calder complimented the roof painting with his sculpture "La Vitesse," also loacted on the Calder Plaza. The roof painting, like his airplane painting, was done with specially formulated paint. The roof vents were made almost invisible because they were painted the same colour as their background. The roof painting added nothing to the weight of the roof, did not impede drainage in any way, and yet it transformed an ordi-

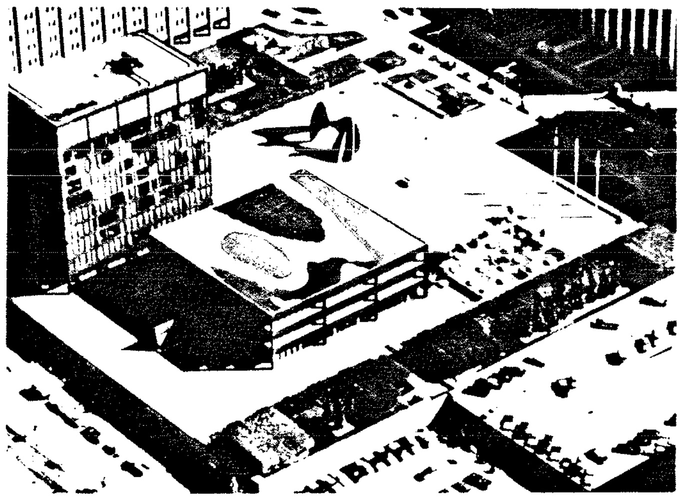


Figure 83: Roof Painting by A. Calder, Grand Rapids, Michigan (From Lipman, 1976.)

nary, non-descript rooftop into a visual delight.

One of the most innovative roof gardens built during the 1970's was not over a building at all, but over a freeway. Lawrence Halprin's Freeway Park in Seattle, Washington took eight years to design and build. But, when completed, in 1976, the two hectare park over the Interstate 5 in downtown Seattle provided the city with a much needed green network of gardens and play spaces (see figure 84). The park was only one part of a 24 million dollar project which also included an office tower, two garages, and the bridge spanning the I5 on which the park was built. Only 3.5 of the 24 million dollars went towards the construction of the park.

The design reclaimed the otherwise lost airspace above the freeway and converted it into attractive, usable, environmentally beneficial, green space. One critic described the park as:

> a huge concrete and steel machine complete with piping systems to deliver irrigation waters and nutrients to plants, to pump and recirculate fountain waters, to drain away rainwater and at the same time to provide numerous other services including parking for 813 cars. ("Halprin Down Under," 1982, p.30.)

The most interesting view of the park is from the freeway itself (see figure 85). Going north drivers can see the massive hanging gardens, waterfalls, and concrete canyons 18 meters wide and 10 meters high. At night, dramatic underwater lights illuminate the fountains, and other lighting fixtures sprinkled throughout the park turn the roof park into a fantasy land.

Probably the most ambitious rooftop development undertaken since the Rockerfeller Center development was the 139 million dollar Robson Square/Law Courts complex in Vancouver. Begun in 1972, after the New Deomocratic Party selected Erickson as the architect for the job, the project took approximately eight years to complete. When finally finished, however, the complex included a seven-storey law courts building, government offices, a public plaza, and a rennovation of the old courthouse which was retained on the site (see figure 86).

Figure 84: Plan of Freeway Park, Seattle (From "5.4-Acre Park Saddles Downtown Seattle Freeway," 1976.)

All of the roof space of the complex was developed as public open space, except for the glass-roofed law courts building. The entire scheme covers three city blocks without cutting off any of the street traffic: the government offices were built over top of Smithe Street like a large bridge, and the open air, sub-grade plaza links the site underneath Robson Street traffic (see figure 87). The landscaped rooftops form a series of terraces linked by

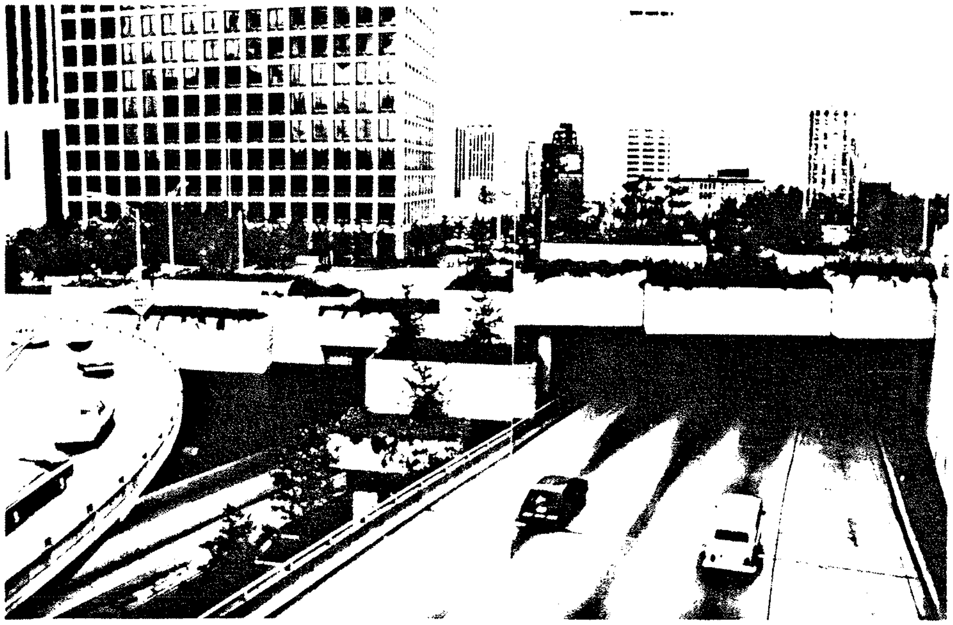


Figure 85: Freeway Park Hanging Gardens, Seattle (From "Halprin Down Under," 1982.)

'stramps' and an extensive water feature. The roof of the government offices was covered with an 85 metre long pond that stepped down via three waterfalls towards the plaza. Some of the office walls and ceilings were made of glass so that employees looked up or out through sheets of falling water. Although the roof park is characterized by a formal, angular, architectural appearance, over 50,000 plants help soften the edges and add colour to the grey concrete surfaces.

The plaza features an international food fair, skating rink, media centre, and shops. Even this plaza level, which is two storeys below street level was technically a roof garden since it is built above an underground truck tunnel system used to service the park without disturbing the people above.

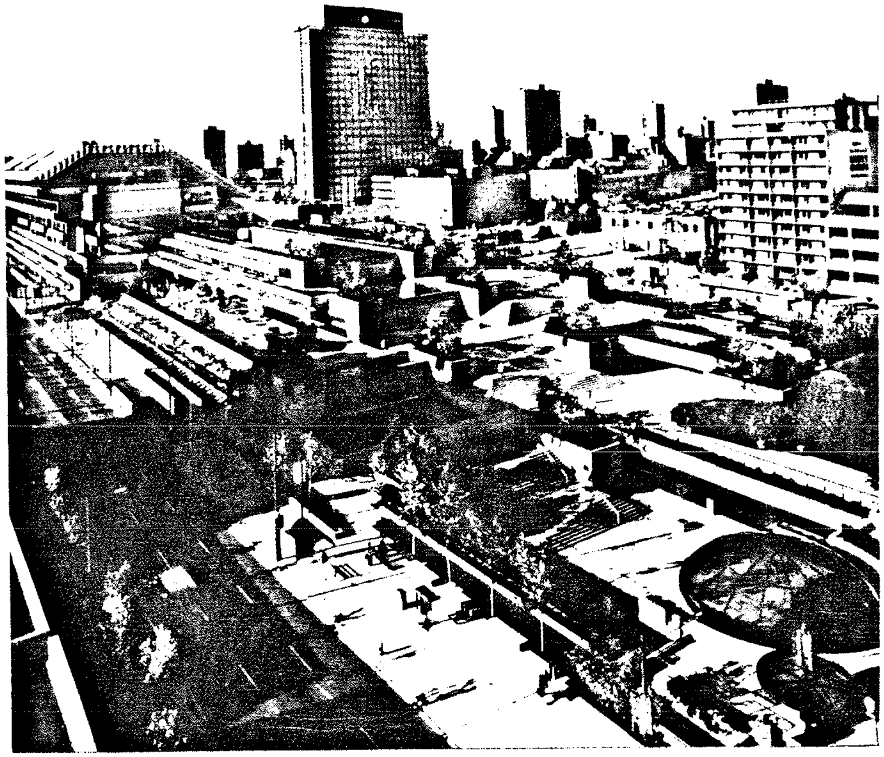


Figure 86: Robson Square, Vancouver (From "Vancouver's Robson Square," 1980.)

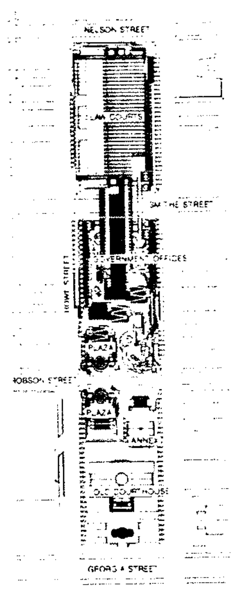


Figure 87: Plan of Robson Square, Vancouver (From "Law Courts/Robson Square Vancouver," 1981.)

Another large scale public building complex built during the 1970's with a landscaped rooftop was the Police Headquarters in Jacksonville, Florida. The design chosen was the winner of an AIA sponsored competition. It was chosen because of the way the structure/roofscape broke "down the barriers of isolation, unpleasantness, and resentment that have recently become attached to the image of law enforcement" (Hoyte, 1978, p.117). The structure, designed by William Morgan, was completet in 1977.

Nearly the entire rooftop was landscaped and opened to the public as open park space (see figure 88). The roof park features a very large water fountain, 27 street trees and numerous shrubs and vines. Although the park is attractive from a sculptural point of view, the expansiveness of the concrete surfaces and openness of the design do not make it a particularly inviting roof park.

In the fall of 1977 Edgar F. Kaiser Jr. decided to construct a roof garden on the 18th floor setback of the Kaiser Resources Company's new offices in Crown Life Place, Vancouver. He hired Osmundson to do the landscape design -- the same architect his father had hired to landscape the Oakland Kaiser Center 20 years earlier. Unlike the huge car park roof in Oakland, the Crown Life Building had not been designed to support a garden. It was only 9.5 by 45.7 metres, and was made of a large 28 centimetre thick concrete slab, supported only at the edges. This meant that the garden

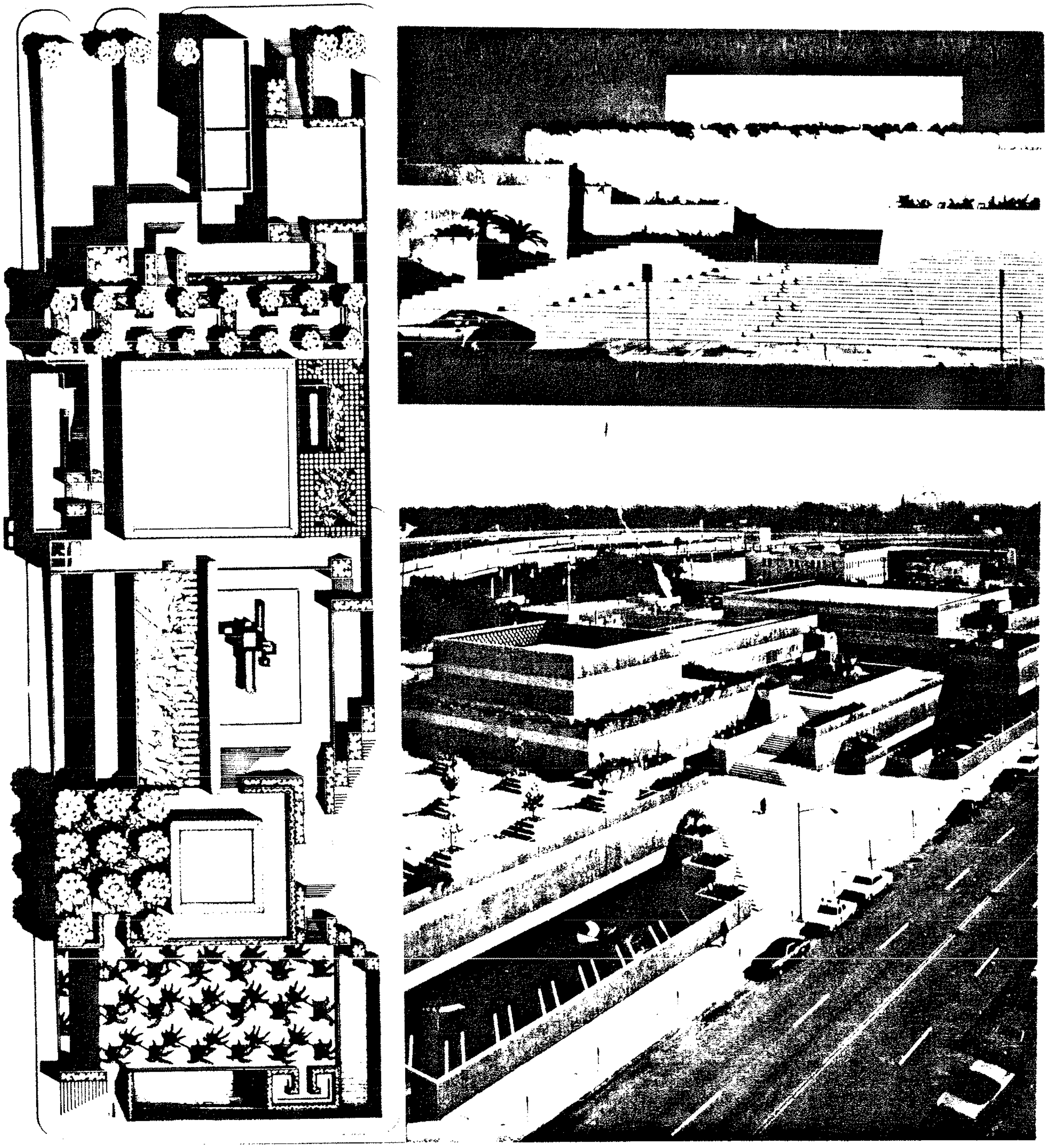


Figure 88: Police Headquarters, Jacksonville, Florida (From Hoyte, 1978.)

load could not exceed 332 kilograms per square metre. Also, the interior floor of the adjacent 18th floor offices was at the same elevation as the roof slab, and therefore did not allow for the required depth of soil, paving, drainage layer, etc. The design also had to accommodate the storage and operation of the large window washing machine used for the 18 floors below.

Osmundson was able to overcome all of the limitations in his design (see figure 89). The resulting garden was a 'natural garden' with enough flat open space to accommodate parties and daily use by the employees. As Osmundson wrote:

> We rejected the austere, vacuous, 'urban open space' approach so overworked in public landscape design. The design agreed upon was what I like to call a 'combination of Japanese garden, California patio, and the Trevi Fountain.' (Osmundson, 1979, p.501)

The elevation problem was overcome by building a low platform inside the offices at the point of entry and by raising the door sill accordingly. The weight limitations were overcome by using a new "high strength plastic hexagonal celled honeycomb-shaped material, called Grass-Cell, designed for turfed parking lots" (Osmundson, 1979, p.502). The Grass-Cell covered with a sheet of fiberglass batting provided a shallow lightweight but strong drainage layer below the layer of light weight Metro-Media soil mix. Virtually every element in the garden was constructed out of lightweight material: light weight concrete, plastic tubs, a plastic irriagtion system, spun aluminium lighting fixtures, and aluminium fencing. The pond depth was kept to ten centimetres.

One other special product used was the collection of lightweight fabricated rocks by de Giacomo of Burbank, California. They were "made by casting hollow cement and fiberglass copies of rocks from nature [which,] by the use of latex impressions, were carefully stained to duplicate the native stone of the area" (Osmundson, 1979, pp.303-4). As the photo shows (see figure 89) the product was exceptionally realistic. Troubled at first by the dishonesty of using artificial rock, Osmundson finally decided that "a natural garden 18 floors above the street is an illusion in itself and anything used which would enhance that illusion, without being offensive, was acceptable" (Osmundson, 1979, p.503).

In 1980 the city of Bonn, West Germany, developed a modular building system for roof gardens over public open space. The Plaza in front of the main train station was a busy connecting point for trains, transit buses, coaches, and automobiles. Some sort of covered walkway was required for travellers and the owners of the various kiosks in the plaza, so a system of tubular steel frames containing planters was developed (see figure 90). The system proved to be light, quickly and easily erected and dismantled, in need of no extra structural supports, capable of being assembled in virtually any configuration, and able to support a lush covering of verdure. The system provided travellers with shade and at least some protection from the rain. Lighting and electronic communication equipment could also be easily integrated into this type of system.

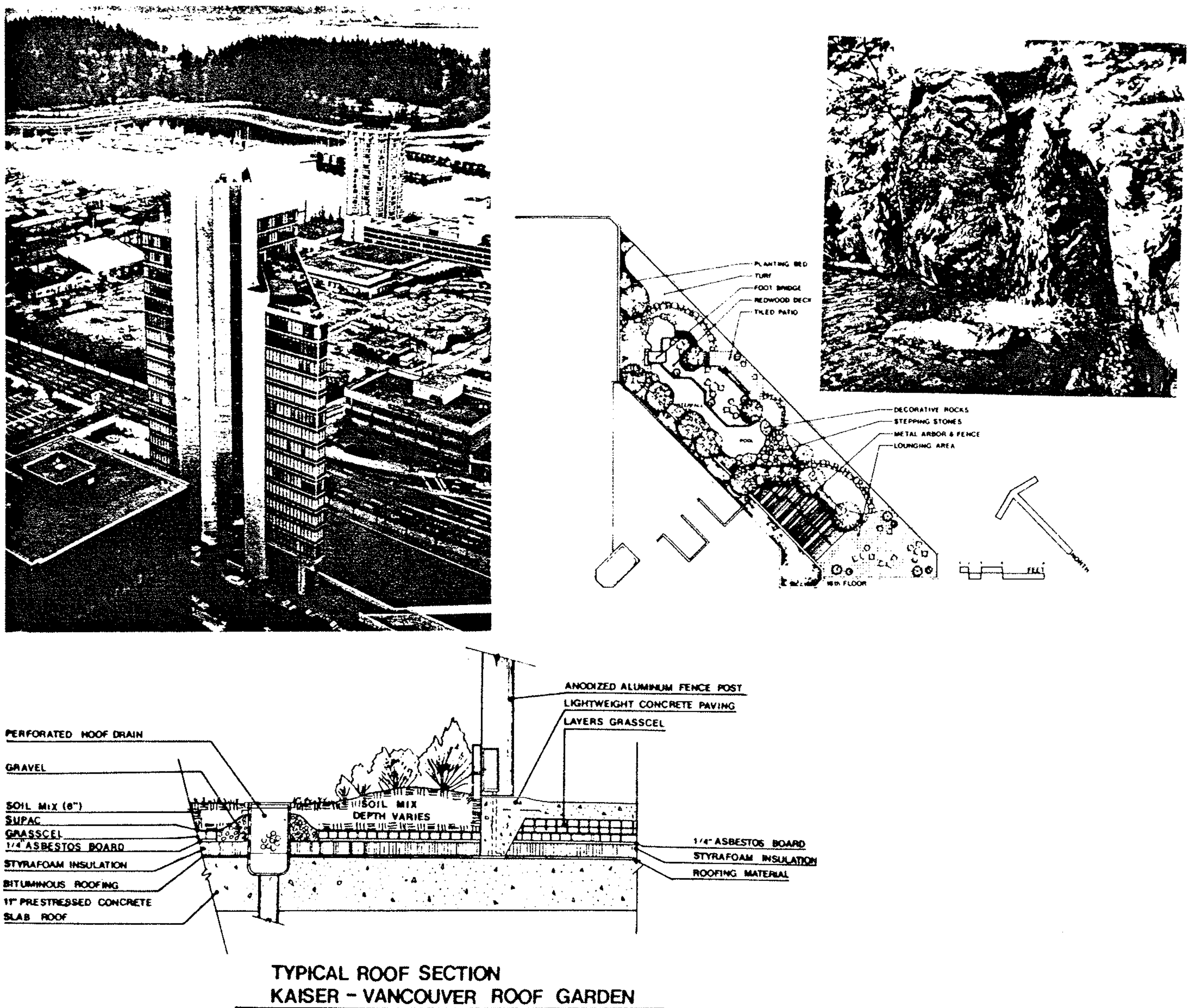


Figure 89: Kaiser Resources Roof Garden, Crown Life Place, Vancouver (From Osmundons, 1979.)

A similar but more sophisticated system was proposed by Vladimir Sitta (in Landscape Australia, November,1983). This scheme involved an automatic hydroponic system to en-

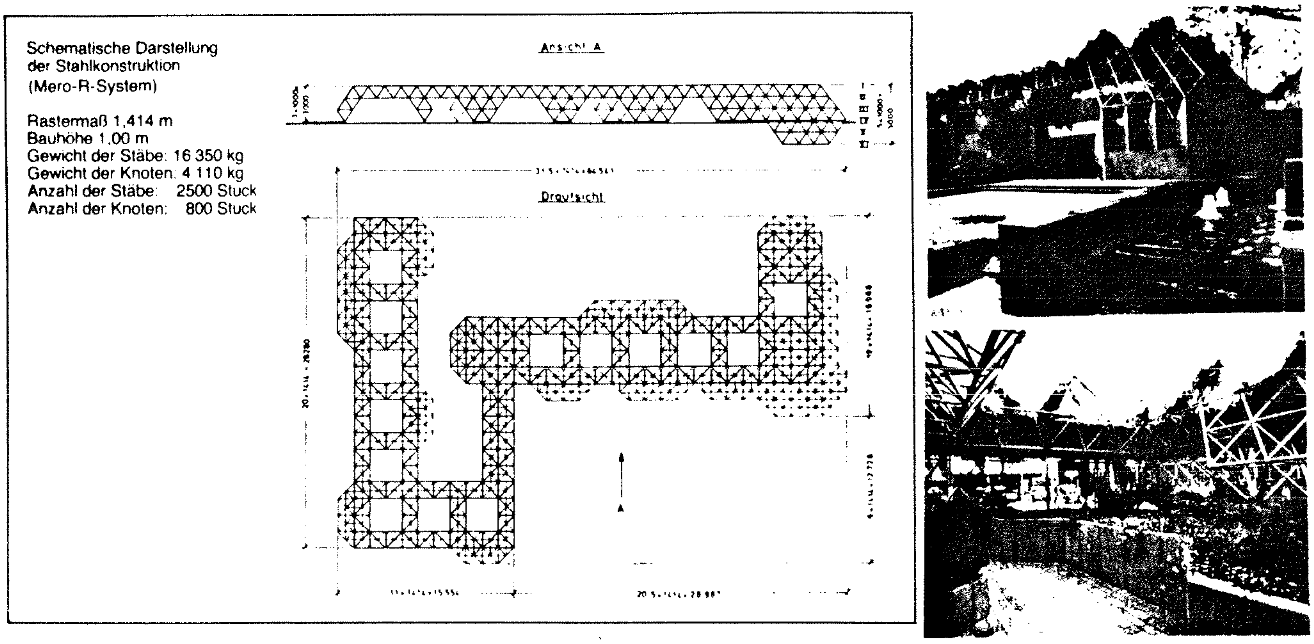


Figure 90: 'Hanging Gardens' of Bonn (From "'Hängenden Gärten' von Bonn," 1980.)

sure maximum plant growth (see figure 91). The system could be taken down and reassembled like the Bonn system, but it also incorporated 'clip on' street furnishings and street signs. It was also designed to carry phone lines, power lines, and other services. Its purpose was to provide all these amenities without destroying the scale of the street.

Sitta, in the same article, advocated the greening of not only roofs but also of façades by such systems as the 'Green Tile System (see figure 92).

The future of roofscaping is difficult to predict. As long as people become more and more environment conscious, roofscaping will continue to grow in importance and roof

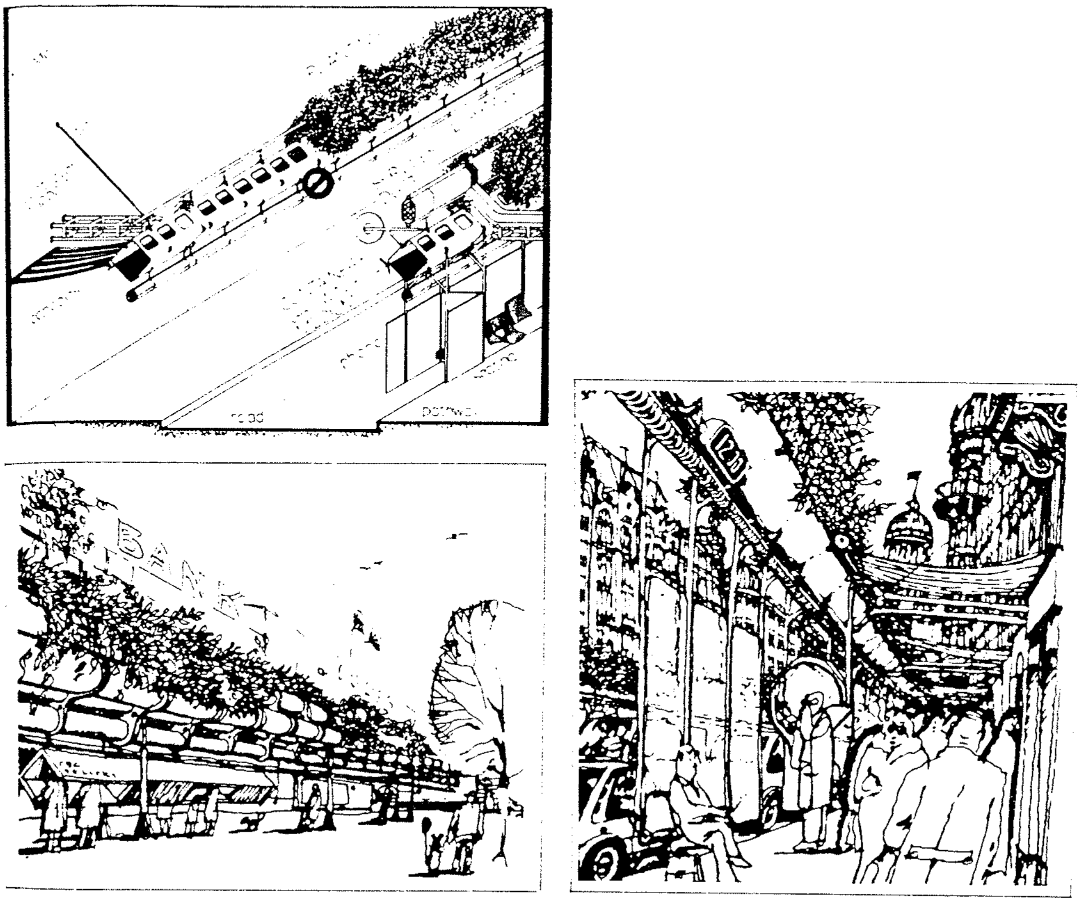


Figure 91: Hydroponic 'Street Roofs' (From Sitta, 1983.)

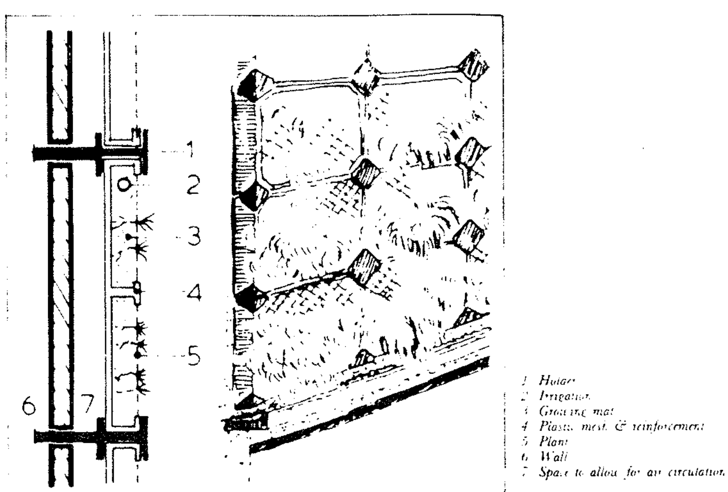


Figure 92: Green Tile System for Greening up Façades (From Sitta, 1983.)

gardens will play a greater and greater part in day-to-day urban living. Technoligical advances have had a great deal of impact on the direction and success of roofscaping in recent years, and the degree to which it is being accpeted today. The history of roofscaping may be 4,000 years long but it is only during the past 35 years that it has been taken seriously in North American cities. Technological advances have made it possible to overcome nearly any structural or constructional limitations, it is now time to turn our attention toward overcoming the limitations of our design creativity. New ways of utilizing our rooftops must be envisioned and explored: new ways of improving the ecology, appearance, and enjoyment of our urban centres. One brave new vision is that of Ferri's "romantic landscape of urban mountains" -- a proposed skyscraper for Madison Square, New York, shaped like a stylized mountain and complete with waterfalls (see figure 93).

Figure 93: Ferri's Proposed Skyscraper for Madison Square, New York (From Sitta, 1983.)

Chapter IV

THE DEVELOPMENT OF ROOF GARDENS IN WINNIPEG

> Happy is the [building] manager in a city where the code allows roof access doors to be locked against tenant prowlers. The urge to investigate roofs is so strong that one finds a locked cage in front of a locked door to prevent damage.
>
> -- Elizabeth Coit

North American cities are years behind most central European cities in terms of roofscaping. Moreover, Winnipeg's rooftop developments are extremely limited compared to many other North American cities, especially the west coast cities. Winnipeg's climate is partly responsible for this: the long cold winters, hot summers, and frequent high-speed winds, can make Winnipeg rooftops rather hostile environments.

The state of rooftop developments over apartment buildings is particularly bad in Winnipeg. The need for outdoor recreational space is greater in high-rise developments than in any other part of the urban environment, and the benefits of rooftop amenities are more immediately realized than anywhere else. And yet, the overall attitude of Winnipeg developers, building mangers, and caretakers, towards apartment building roof gardens is a very negative one. Of 69 realty agencies contacted, which manage apartment blocks and condominiums, only three stated that they manage buildings with roof gardens or roof decks. The mere mention of roof decks brought very negative reactions from many of the building managers interviewed. The many 'tar beaches,' which were almost a standard feature of apartment blocks built during the 1950's and 1960's, have nearly all been closed off. Most of them have been closed because the pitch or tar sealants cracked, allowing moisture to leak into top floor suites, and the roofing companies who retar the roofs refuse to guarantee their work if any type of traffic is allowed on the roof surface. A few of these roof decks have also been closed because of problems with people throwing things over the edge, or because roof parties kept getting out of hand. Even some of Winnipeg's more elaborate roof decks with swimming pools have been, or are in danger of being, closed down because of maintenance problems.

33 Hargrave Place (a 22-storey high-rise apartment block) had an expensive recreational centre on its roof, until the building managers closed it down; Pinewood Place (2510 Portage Avenue) had a multilevel roof deck with three large concrete pergolas; Drury Manor (1833-39 Pembina Highway) had a sun deck and barbecuing facilities; Sek On Toi (a Chinese senior citizens home built by Manitoba Housing at 289 Pacific Avenue) once had a roof deck with flower beds; and Birch-

wood Terrace (2400 Portage Avenue), 21 Mayfair Place, Univillage College Housing (22 Dalhousie Drive), Thunderbird Apartments (2150 Portage Avenue), Billingsley Manor (2515 Portage Avenue), plus many more blocks, all have roof decks which were closed down.

The reason all of these roof decks failed was because they were poorly designed: the needs and tendencies of the people using them were not well enough understood, waterproofing techniques were not yet sophisticated enough, and the special needs of plants at roof level were not yet fully understood. Unfortunately, these failures left building developers and managers with very ill feelings about rooftop developments (not to mention some expensive repair bills). As a result, only a handfull of apartment blocks built within the past fifteen years have any sort of rooftop development, even though technological advances have now made it possible to overcome all the problems which led to the failure of earlier roof gardens.

Fortunately, Winnipeg developers have not been as reluctant to landscape the roof of apartment building garages, especially the subgrade garages. Examples of these types of roofscapes are a bit more plentiful in Winnipeg.

Examples of Winnipeg's rooftop developments over apartment buildings, their garages, and their podiums, are discussed in the first section of this chapter. In the second section Winnipeg's few public rooftop developments are discussed.

4.1 APARTMENT BUILDINGS

Winnipeg's first roof garden was built in 1931. It was built above the three-storey Gainsborough Apartments located at 508 Sherbrook Street. The March, 1931 Western Canada Contractor and Builder described the block:

> An apartment block costing $150,000 is now under construction by S.A. Sigurdson and is located on the west side of Sherbrook Street between Ellice and Sargent Avenues. Rising three storeys over the basement, the building will provide accommodation for 32 suites.
>
> A feature is the fact that the block will have a roof garden laid out by a specialist. The idea is that each tenant will be able to read his newspaper and do her sewing, as the case may be, in the open air above the city's din. In area the garden will approximate the dimesions of the block, namely 65 by 124 feet.
>
> To what extent roof play-grounds will keep children off the street remains to be seen. The one planned by Mr. Sigurdson will operate summer and winter and will be provided with sand boxes, swings, and teeter-totters. In winter, it will be enclosed with window. Around the roof will be a parapet surmounted with an ornamental railing.

The playground planned by Mr. Sigurdson was either very short-lived, or never actually built. At present the roof garden offers nothing except for a tar and gravel surface and six ornate, cast-iron lamp standards which no longer function as lights but are strung with clothes lines (see figure 94). The original attractive, brick and wrought-iron parapet surrounding the roof is still intact.

1931 also saw the construction of another apartment block with a roof garden. Like the Gainsborough Apartments, the Ladywood Apartments, located at 170 Edmonton, has a roof garden which is accessed through the top floor locker and laundry rooms. The same sort of brick and wrought-iron parapet that surrounds the Gainsborough Apartments also surrounds the roof of the Ladywood Apartments. The roof is currently unused and in bad repair; its surface is bare tar

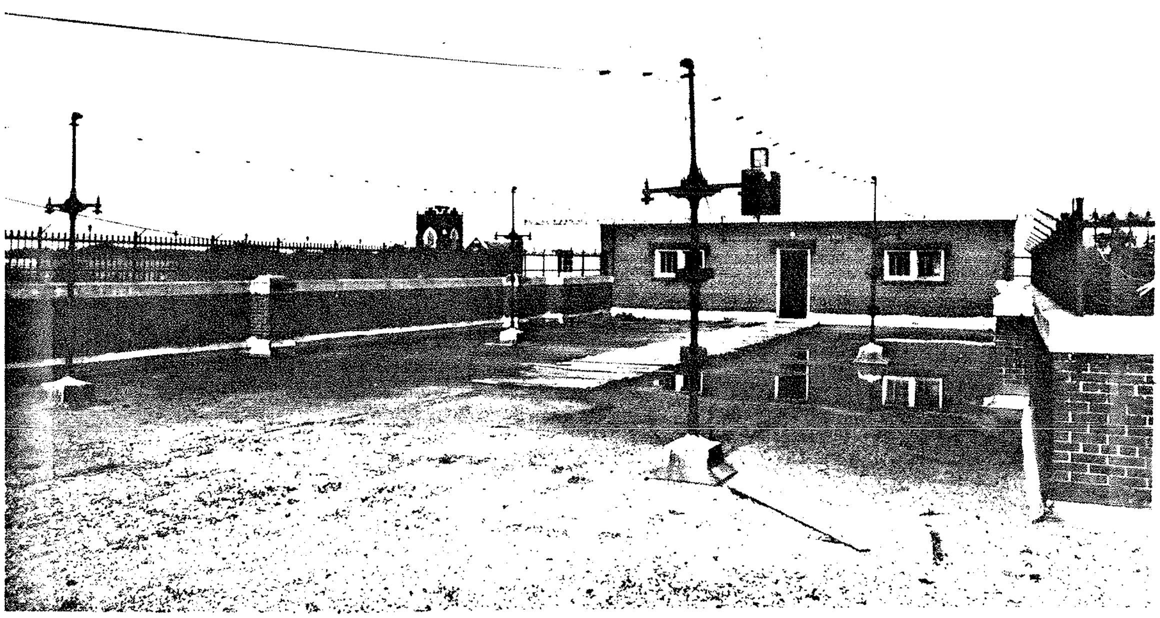


Figure 94: Gainsborough Apartments, 508 Sherbrook Street

and gravel, and it is strewn with litter (see figure 95).

Virtually no blocks with roof decks seem to have been built for the next 20 years. The in the 1950's the 'tar beach' roof decks began to appear. They generally consisted

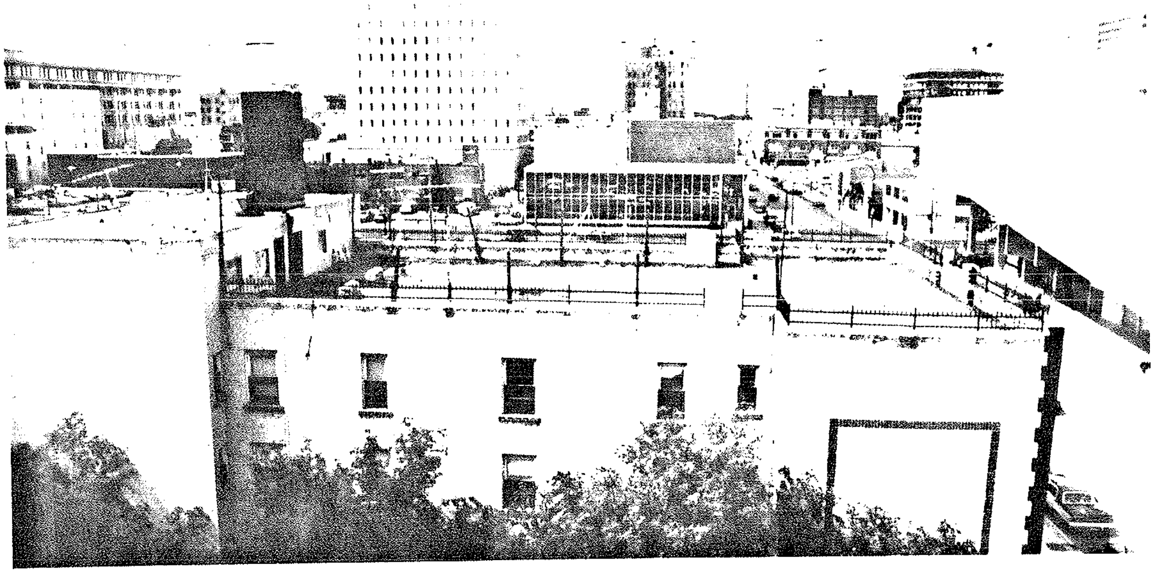


Figure 95: Ladywood Apartments, 170 Edmonton Street

of duck-board flooring over a tar and gravel roof, a 1.5 metre high chain-link fence running around the roof's perimeter, and a small out building built over the top of the building's stairwell through which the roof was accessed.

In 1961 what was probably Winnipeg's first rooftop swimming pool was built on the roof of St. James Place (2345 Portage Avenue). Although the building's laundry facilities are located adjacent to the pool and sun deck, and although there have been no problems with leakage, vandalism, theft, or with people throwing things over the edge, the pool area is little used today and would be closed down if the current building manager had his way.

In 1965 a slightly more successfull roof pool was designed for the roof of Sussex House (230 Roslyn Road) (see figure 96). Here the pool and the surrounding deck are sunk, not into the roof of the block itself, but into the roof of a one-storey penthouse structure on the roof. Inside this structure are located washrooms and a small evelator lobby.

Access to this pool area is via a long, narrow, metal staircase running up the side of this penthouse structure. The structure is the only part of the roof which is developed and actually makes up much less than half of the entire roof surface. The pool area is surrounded by a 1.75 metre high brick wall with small observation holes in it. Although the pool area is kept exceptionally clean, and the view of the surrounding cityscape is spectacular, and although the perimeter wall blocks out most of the wind, the building caretaker feels that the amount of use the roof receives does not warrant the 15 hours per week of maintenance required.

Probably Winnipeg's most successfully designed apartment rooftop garden is the one above the Fort Rouge Ecumenical Apartments, located at 400 Stradbrook Avenue (see figure 97). This 14-storey building, constructed in 1972-73, contains 146 government subsidized units for the elderly. There are actually two roof gardens: one over the second floor setback, and one on the top floor of the building.

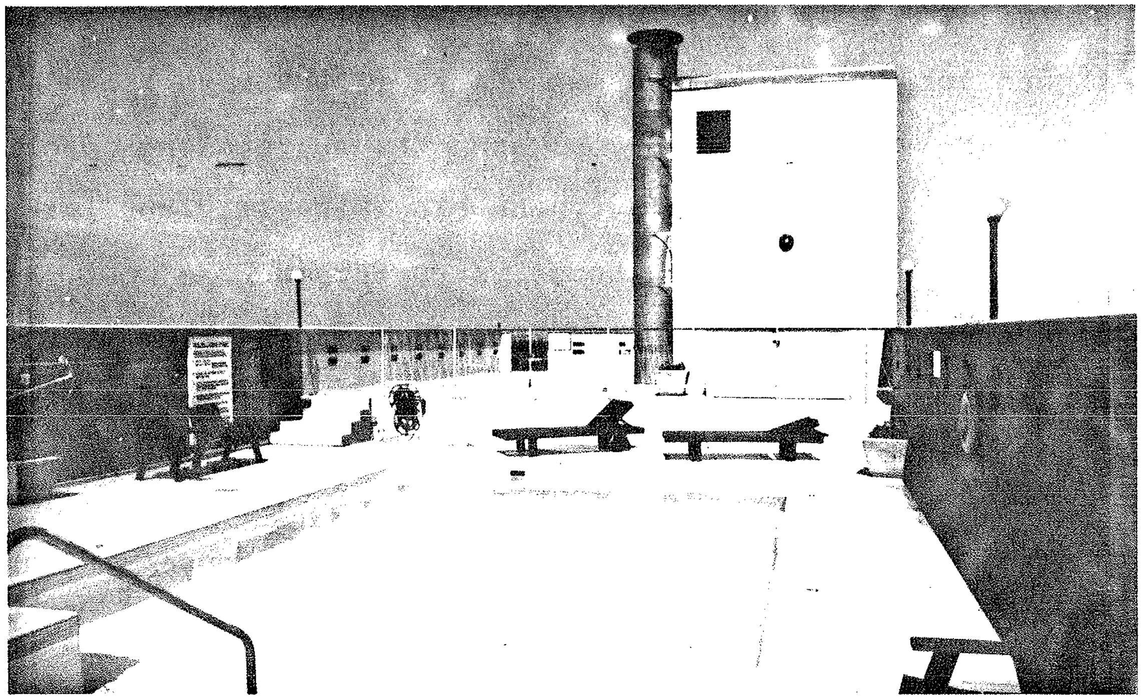


Figure 96: Sussex House, 230 Roslyn Road

The second floor deck is nothing more than a shady, quiet, sitting area with a few pieces of wooden patio furniture. The 14th floor garden, on the other hand, provides the building's residents with a communal vegetable/flower bed, planters, sunny and shaded sitting areas, a spectacular view of the city, and a cozy solarium. The success of this roof garden depends to a great degree upon the inclusion of the solarium in the design. The solarium is located just off the elevator lobby. It provides a transition point between the interior and exterior spaces. Because the solarium is easily accessed and used during any sort of weather, the residents are much more conscious of the roof garden's existence, and therefore more likely to use it during good weather. The roof garden is therefore used visually, if not physically, in winter as well as summer. The existence of suites on the same level as the roof garden also helps to make the roof garden feel like an integral part of the building, rather than something tacked onto the top. These suites do not look out onto the roof garden but are adjacent to it and therefore aid in surveillance of the garden and control of its use without actually infringing on the priva-

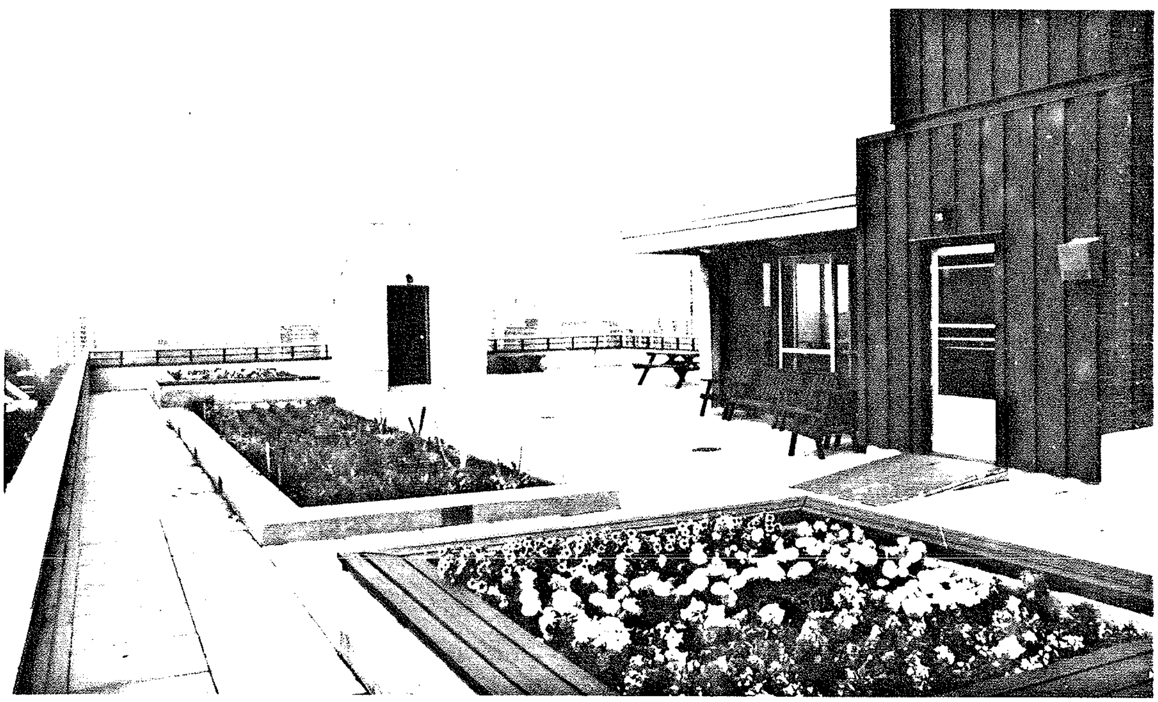


Figure 97: Fort Rouge Ecumenical Apartments, 400 Stradbrook Avenue

cy of its users.

Another reasonably successful rooftop development in the city is the one above the Holiday Tower North. The twin Holiday Towers, located at 170 Hargrave Street, are Lakeview Property luxury apartment developments (see figure 98). The towers are both 27 storeys high and together they contain 510 suites. The towers are connected both underground and via a skywalk on the 26th floor. They are also adjacent to, and physically connected to, the Holiday Inn, the Lakeview Square office tower and shopping plaza, and through it, to the Winnipeg Convention Centre. The tenants of the Holiday Towers have free use of all the recreational facilities of the Holiday Inn, including an indoor and an outdoor pool (the latter being located on the roof of the hotel's car park).

Only the north tower presently has a roof deck. The south tower used to have a jogging track but it was closed because the traffic created moisture problems and noise problems in the top floor suites.

The north tower recreational area includes washrooms and changerooms on the 27th floor. Three steps up from the finished floor level of the 27th floor is a fairly large sun deck surrounded by a three metre high concrete wall with built in wooden seating. This deck makes up about a quarter of the total roof surface. The pool level is a full storey above this this level and is accessible only by stairs. The pool area is surrounded by a 1.5 metre high concrete parapet. Both levels are covered by an artificial-turf-type carpeting.

The roof deck provides nothing more than a place to swim, sun tan, and view the surrounding cityscape during the summer months; there is very little protection from the wind at the pool level, very limited seating space, no planting, and no provisions for activities other than swimming and sunning. All maintenance is done by the lifeguard while on duty. The management estimates that about ten per cent of the tenants use the pool area, but the management is very

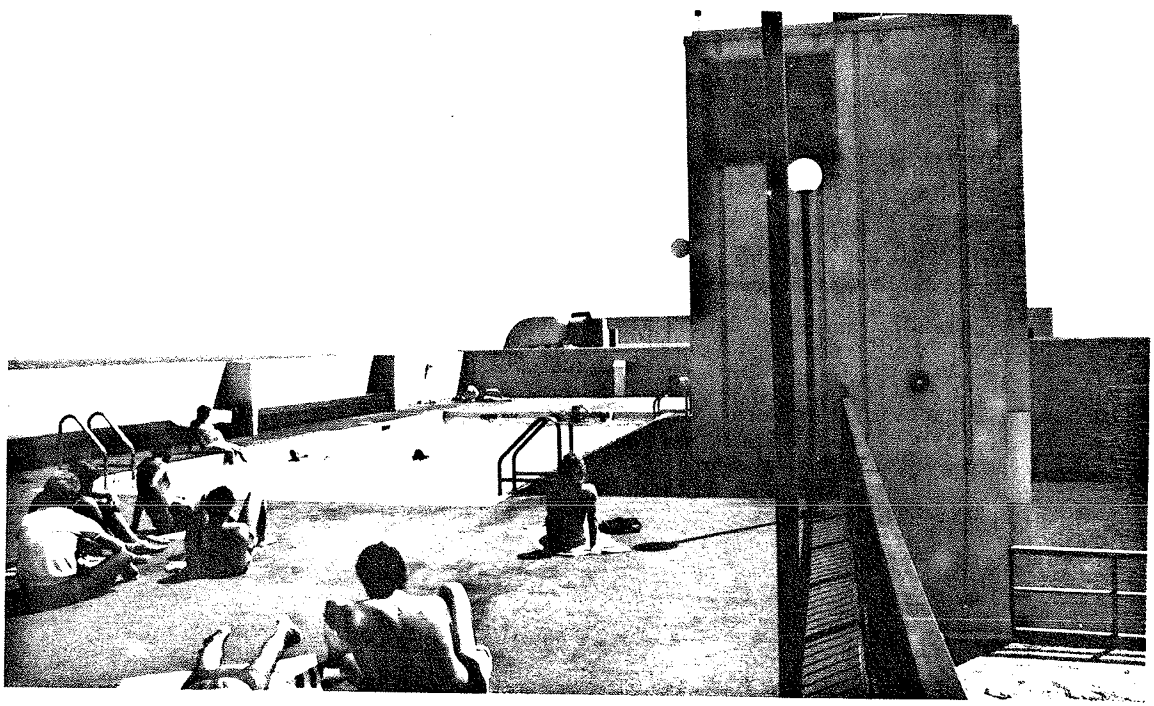


Figure 98: Holiday Tower North, 170 Hargrave Street

satisfied with its use and operation.

Colony Square, located between Portage and St. Mary's Avenues and between Colony and Balmoral Streets, is another Lakeview Property development. This development consists of two apartment towers (16 and 17 storeys high) with a common entrace facing St. Mary's Avenue, a six-storey office tower on Portage Avenue with retail shops on the main floor, an underground car park, and a roof podium linking the second floors of the apartment towers and office block (see figures 99 and 100). The project was designed by Smith Carter and Partners, and Peter Wreglesworth. The roof podium was landscaped by Hilderman, Feir, Witty, and Associates in 1980.

The roof podium provides the apartment tenants and office employees with an amenity space. It features a swimming pool, sun deck, a large flower/shrub bed, a number of shade trees, and planter/seating units. The planting beds are raised above finished grade rather than sunk down into it. Since there is no irrigation system , all plants are hand watered (Lee, 1982).

The two proposed tennis courts, shown in figure 100, were never built. Consequently, there is a large dead space where they were to be. Those roof edges not closed off by building façades are closed by 2.5 to 3 metre high brick walls, thereby making the podium roof a large courtyard garden.

The podium garden is well maintained and well used, a plant rental company ensures that the plants stay healthy, and there are no moisture or structural problems with the podium roof. The only complaints with the design, voiced by the tenants, are the limited amount of sunlight the podium receives, and the high noise level (sound originating in the pool area echoes between the three towers and the expansive

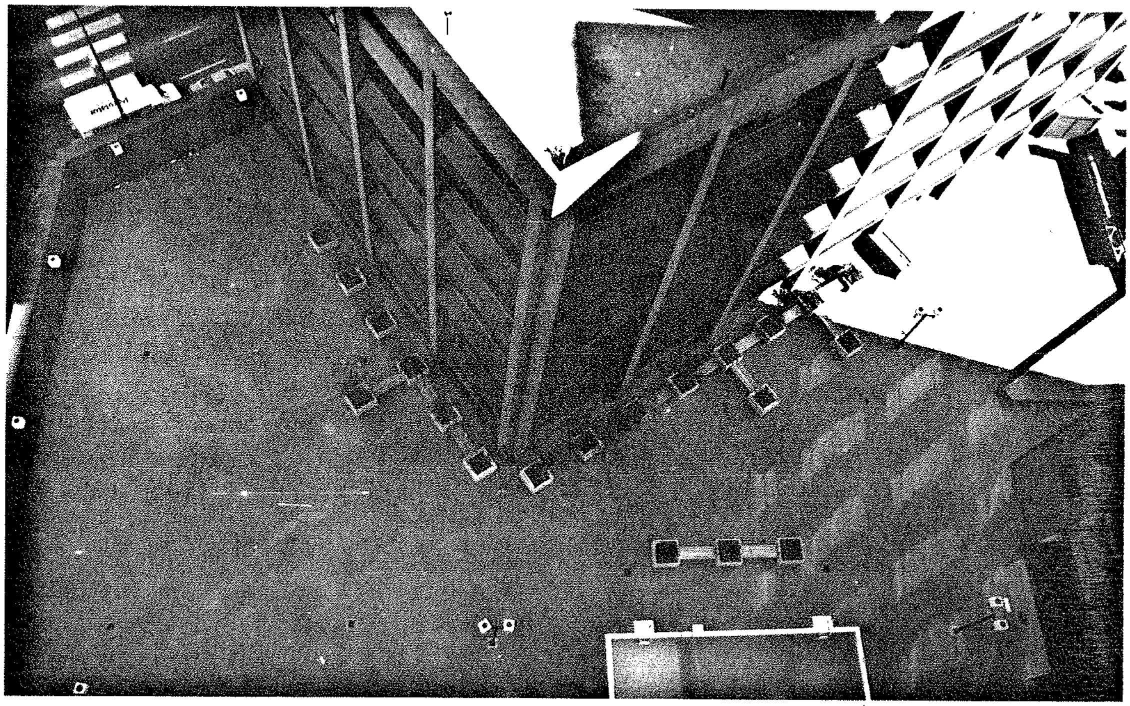


Figure 99: Colony Square, Portage at Balmoral

brick surfaces of the podium).

Another apartment block with a rooftop recreation space is the Plaza by the Riverside (70 Garry Street). Above the four level car park, directly adjacent to the 21-storey tower, is a 1,338-square-metre garden (see figure 101). This split-level garden includes patches of lawn, trees in box planters, a playground with sandbox and climbing structure, a small arbour seat, picnic tables, and paved walkways. Tenants are allowed to barbecue on the gravel-surfaced areas.

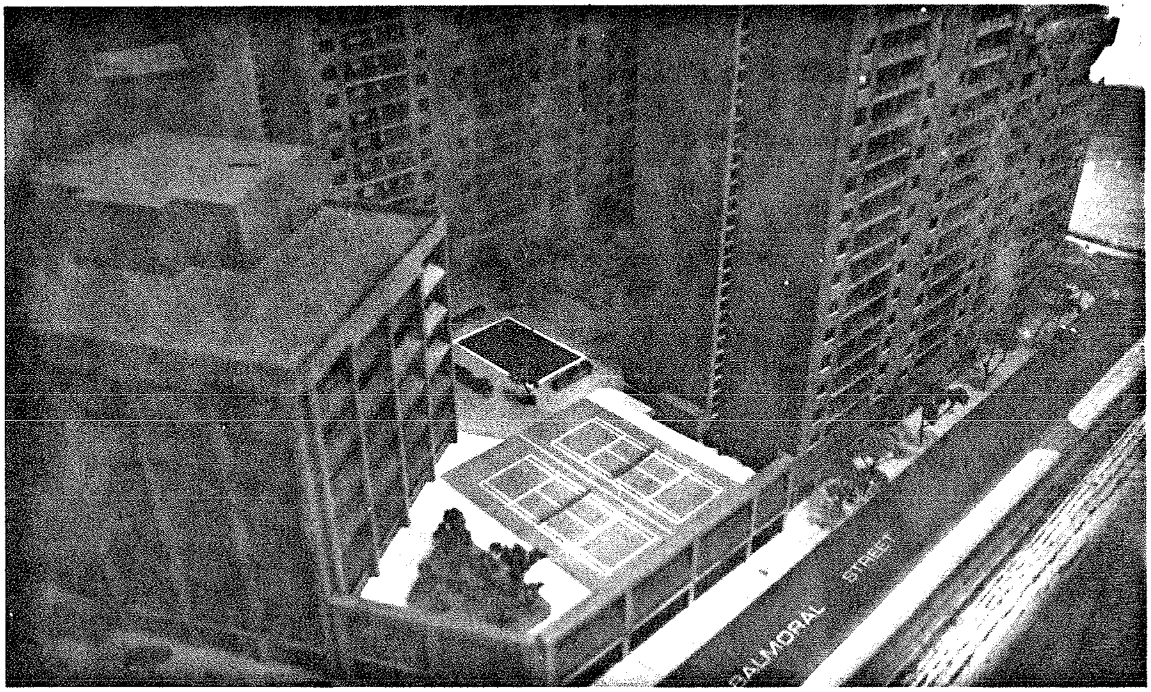


Figure 100: Model of Colony Square

Access is gained either through the car park stairwell or though the building itself via an entrance of the end of the the fourth floor corridor. The garden itself is relatively well used and maintained, but considering its size, it is rather underdeveloped.

Two more projects currently being constructed in Winnipeg which will offer roof gardens are Villa Cabrini (433 River Avenue), and Broadview Manor (Broadway at Donald Street). Villa Cabrini is an eight-storey senior citizens residence designed by LM Architectural Group. It will feature a roof garden over a second floor set back overlooking River Avenue. Broadview Manor is an apartment/commercial complex designed by Cooper Rankin. Around the base of the apartment

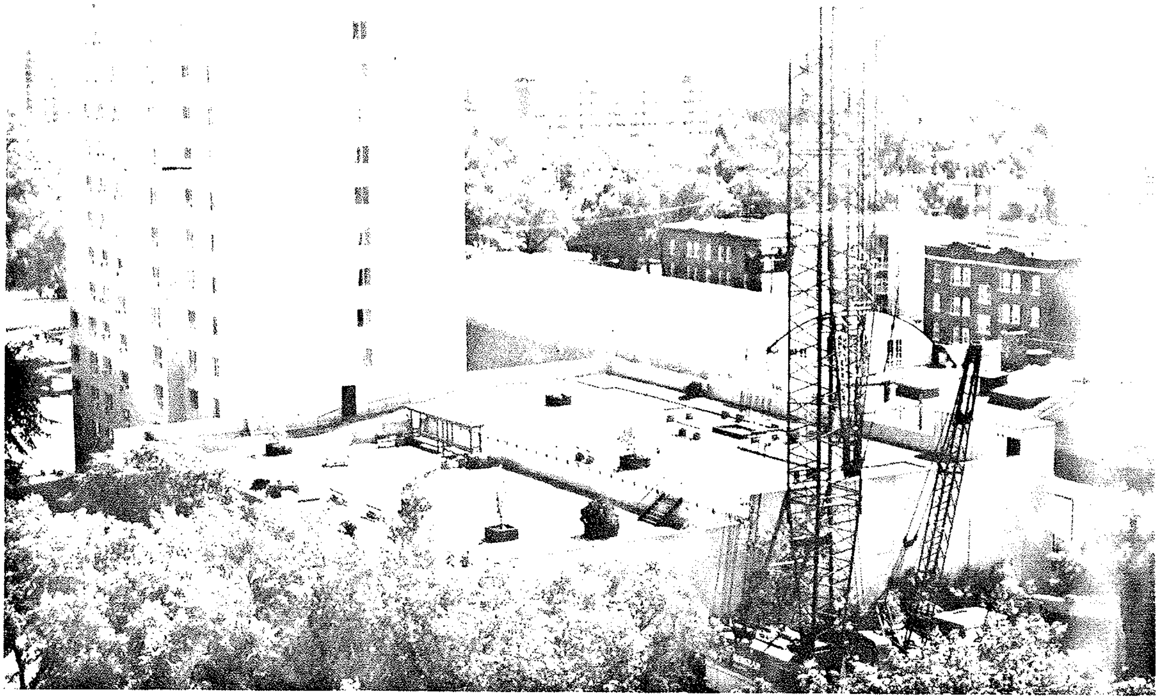


Figure 101: Plaza by the Riverside, 70 Garry St.

tower is a four-storey car park/commercial complex. The roof of this car park will be landscaped by Hilderman, Witty, Crosby, Hana, and Associates.

Examples of car park roof gardens are much more common in Winnipeg than building top roof gardens. One of the earliest good examples is the Southwood Green Condominium complex (Snow Street at Pembina Highway). Completed in 1967, the project won the 1969 Canadian Housing Design Council Award. It was designed by The LM Architectural Group and landscaped by Dennis Wilkinson (see figure 102).

By placing most of the parking underground, all the area between the 98 units was freed up for use as park space and pedestrian walkways. There are therefore no car-pedestrian conflicts within the site. A large fountain and numerous pieces of sculpture provide focal points along the network of pathways. Because of the sense of unity in the design, it is difficult to tell which parts of the site are built over the car park roofs and which are built on firm ground. The trees above the underground parking areas are planted in mounds of earth up to 1.5 metres high, contained within 20 centimetre high curbs. All the mounds are grass covered (see figure 103).

In addition to the car park roofscaping, most of the units also have private roof terraces on the second floor.

A number of other Winnipeg apartment building/condominium complexes have greened up the roofs of their underground parking facilities. The Courts of St. James, (2727 Portage Avenue), for example, have lawn and small shrubs covering the roof of both the indoor swimming pool and the underground car park, and large Spruce trees grow up out of the berms around the edges of the car park (see figure 104). Number Seven Evergree Place has a large but uninteresting expanse of lawn over its parking facilities with a single straight row of alternating Spruce trees and lampposts (see figure 105).

Ikoy partners took a more architectural approach when they designed the garage roof of the Wellington Arms in 1979. The development, located at 277 Wellington Crescent,

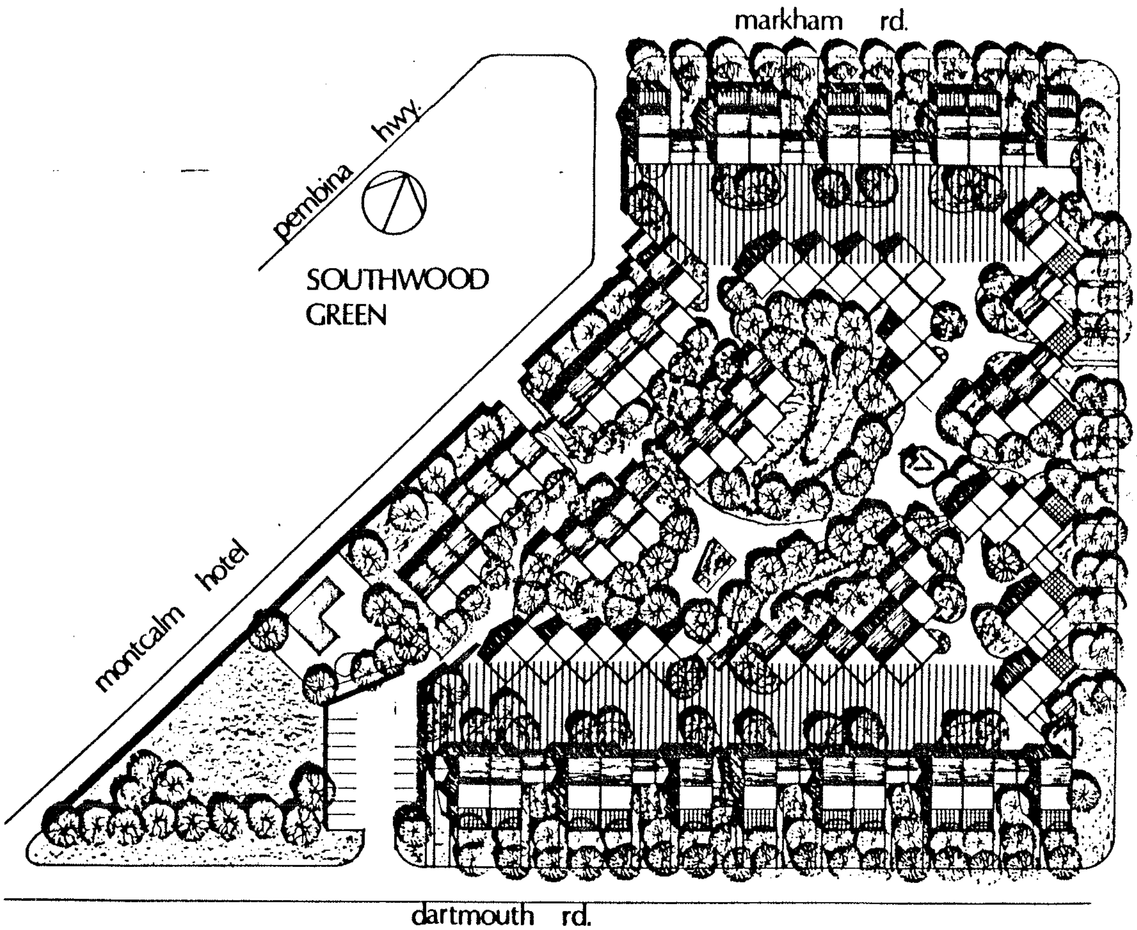


Figure 102: Plan of Southwood Green Condominiums, 19 Snow Street (From Simon, 1982.)

consists of a 17-storey apartment tower and a parallel row of two-storey town house units. Between the two is a one-storey garage, the roof of which forms a terrace linking the tower with the second floor patios of the town house units. A swimming pool, located at ground level, is linked to the terrace with a stairway. The huge roof terrace, unfortunately, offers the residents nothing more than a large painted concrete surface and expansive, 'plant-less' pergola which provides neither shade nor spacial organization (see figure 106).

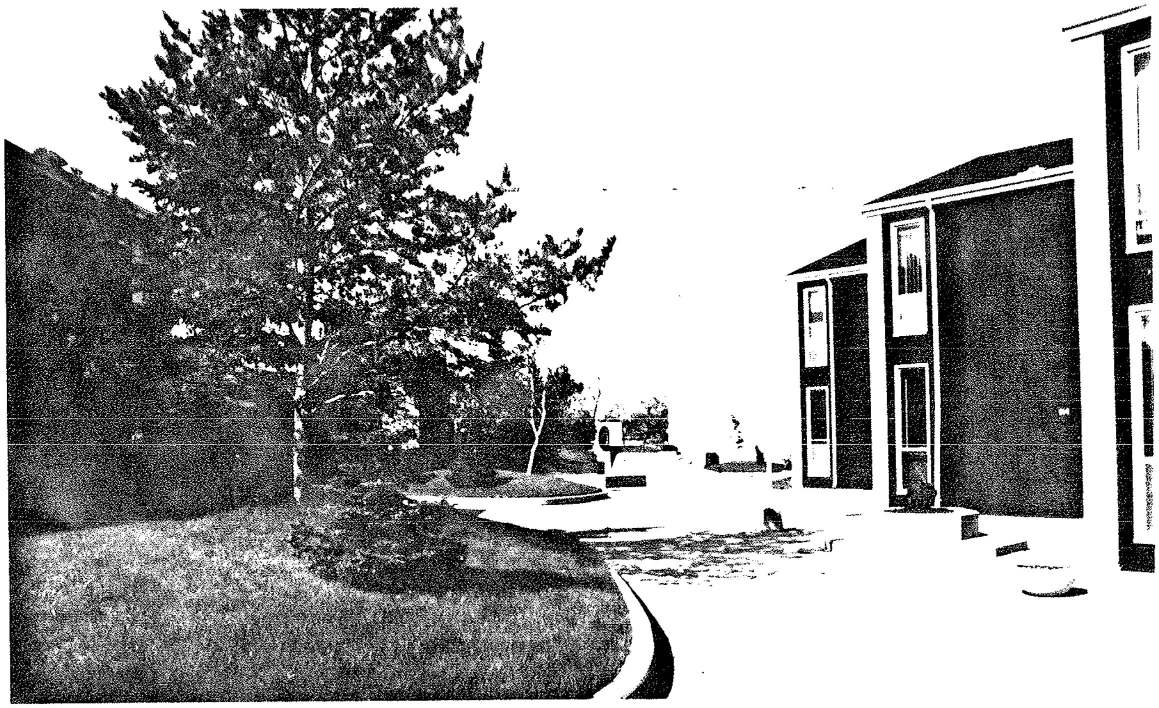


Figure 103: Southwood Green Condominiums

Figure 104: The Courts of St. James, 1717 Portage Avenue

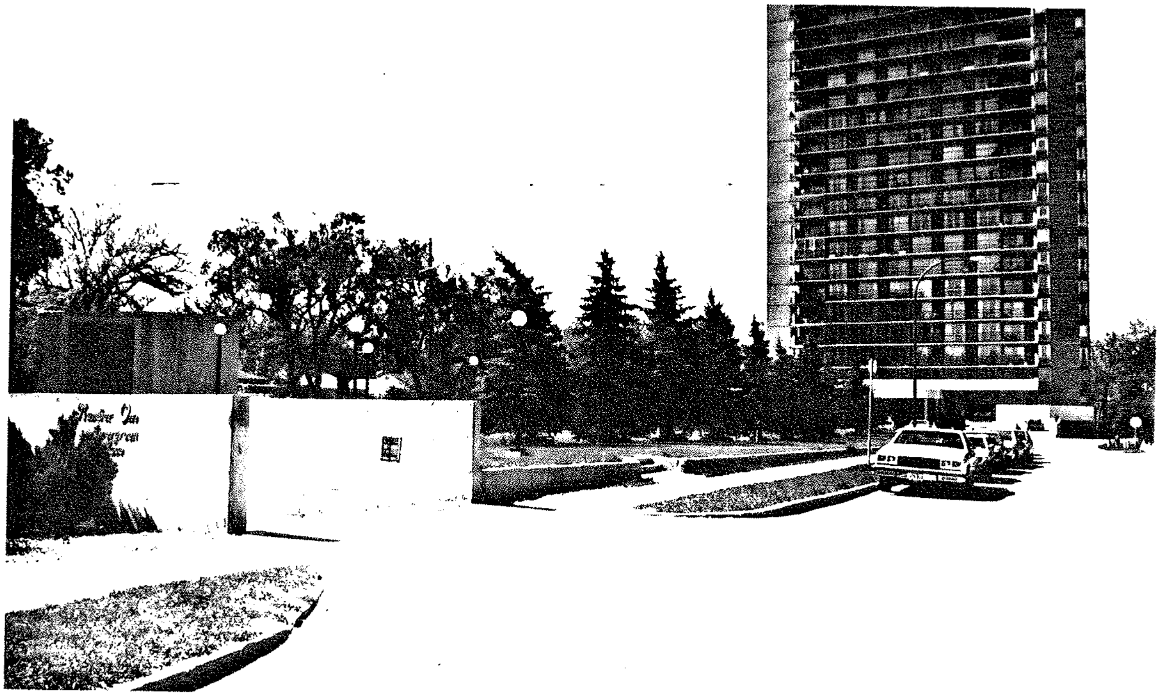


Figure 105: Number Seven Evergreen Place

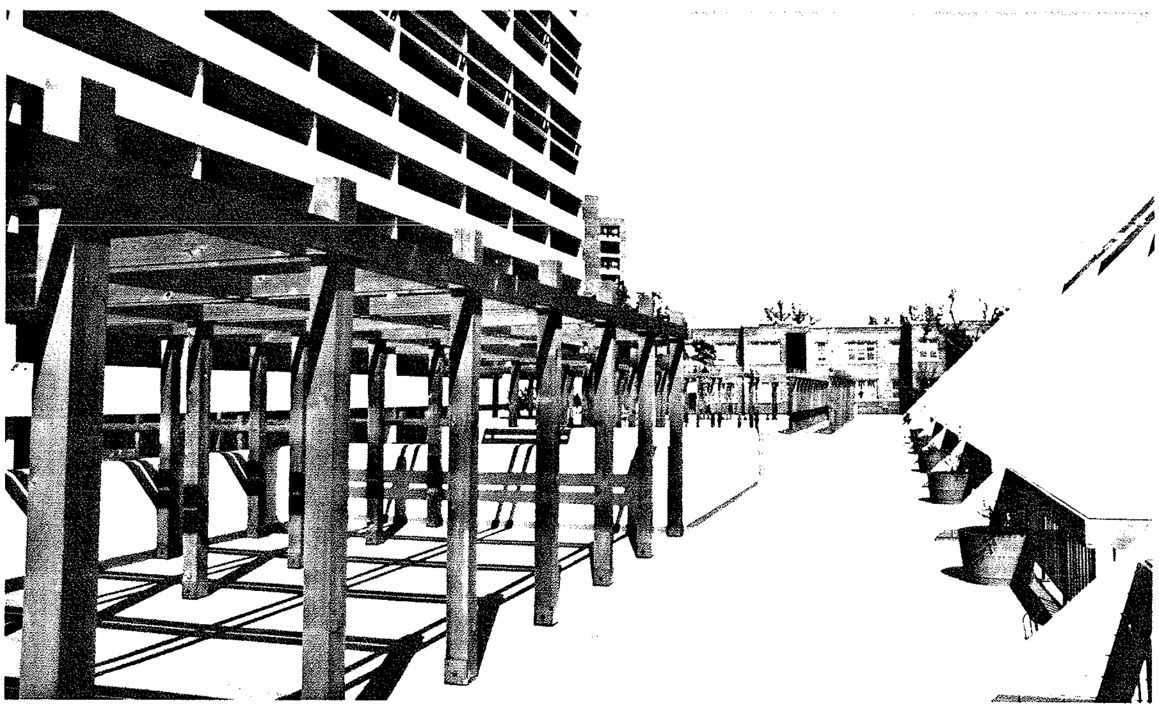


Figure 106: Wellington Arms, 277 Wellington Crescent

4.2 PUBLIC BUILDINGS

Examples of commercial (non-residential) roof gardens are virtually non-existent in Winnipeg (except for the grassed area above the new unerground cafeteria and tunnel complex linking the old and new Great West Life Insurance Buildings on Osborne Street), and examples of public roof gardens are very rare. There are, however, three very successful public rooftop gardens in Winnipeg which are both aesthetically pleasing and environmentally beneficial. They are: The University Centre plaza at the University of Manitoba, the Winnipeg Art Gallery roof garden, and the Winnipeg Centennial Library gardens.

The University Centre building at the University of Manitoba is a large complex housing the offices of the Student's Union and a great number of other facilities (see figure 107). Bearing a striking resemblance to the Boston Civic Centre, this building was designed by a host of architects including Waisman, Ross, Blankstein, Coop, Gillmor, Hanna, Roy, Sellors, Carl Nelson Jr., and Claude DeForest. The roof gardens were landscaped by the firm of Man, Taylor, Muret. The building was opened in 1970.

The two large atriums on the fifth floor of the building are undeveloped and unused, but do provide light and fresh air for the interior offices. The third floor roof deck serves mainly as a promenade deck, (especially now since the recent addition of the Microcomputer Centre onto the west end of the third floor, has effectively eliminated the west portion of the deck). All of the large plaza area to the south is built over the roof of the sub-grade first floor. The original reason for sinking part of the structure below grade was to provide an unobstructed view of the Administration Building from Chancellor Matheson Drive. Because the south wall of the second floor is entirely glazed, the outdoor roof plaza becomes a visual extension of the interior space. The plaza is also a major pedestrian circulation route. For these reasons the roof plaza is always well used.

The roof plaza provides its many users with shade trees, patches of green lawn, brightly coloured flower beds in summer, and numerous niches and nooks with built-in seating. All the planting beds and planters are built above the finished grade level (rather than sunk down into it). In this way all the planter edges double as seating surfaces.

An 'inverted roof system' was used wherby paving bricks were set on five centimetres of sand, over top of five centimetres of ridgid insulation, with a gravel drainage course between the insulation and the 20-centimetre-thick sealed concrete slab roof (Lee, 1982). There have never been any leakage problems.

The plaza is sloped to drain towards the centre through verticle pipes in the structural columns. The original irrigation system proved unsatisfactory, so it has been replaced by hand watering. Poor maintenance resulted in the loss of some of the original plant material, but the existing material is now mature and provides an ample amount of greenery to couterbalance the large areas of brick and concrete. The Mugho Pines growing immediatley outside the second floor glass walls provide year-round greenery, and the heat rising from the building below the plaza causes the roof lawns to turn green in early spring while most other lawns are still snow covered (see figure 108).

The success of this development results, to a great extent, from the fact that the garden is seen from inside and therefore becomes an ever present extension of the interior space, and because of its central location along a major pedestrian thoroughfare.

There are two other roof plazas on the University of Manitoba campus; one small one built in 1970, and one very large one built two years later. The smaller one is located in front of the Duff Roblin Building (see figure 109). The plaza is built over a sitting area and underground tunnel system. It acts as a node along a pedestrian circulation route and offers a seating area along part of its perimeter. Planting beds are also integrated into the south retaining wall.

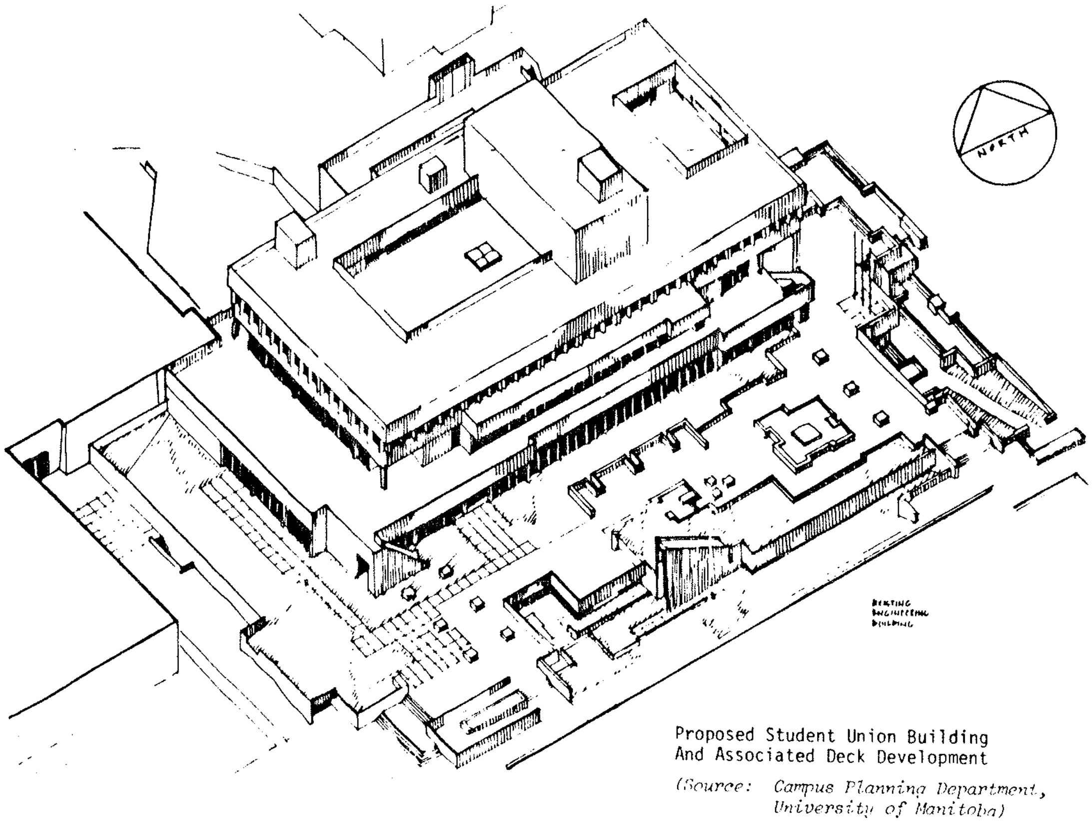


Figure 107: University Centre, University of Manitoba (From Lee, 1982.)

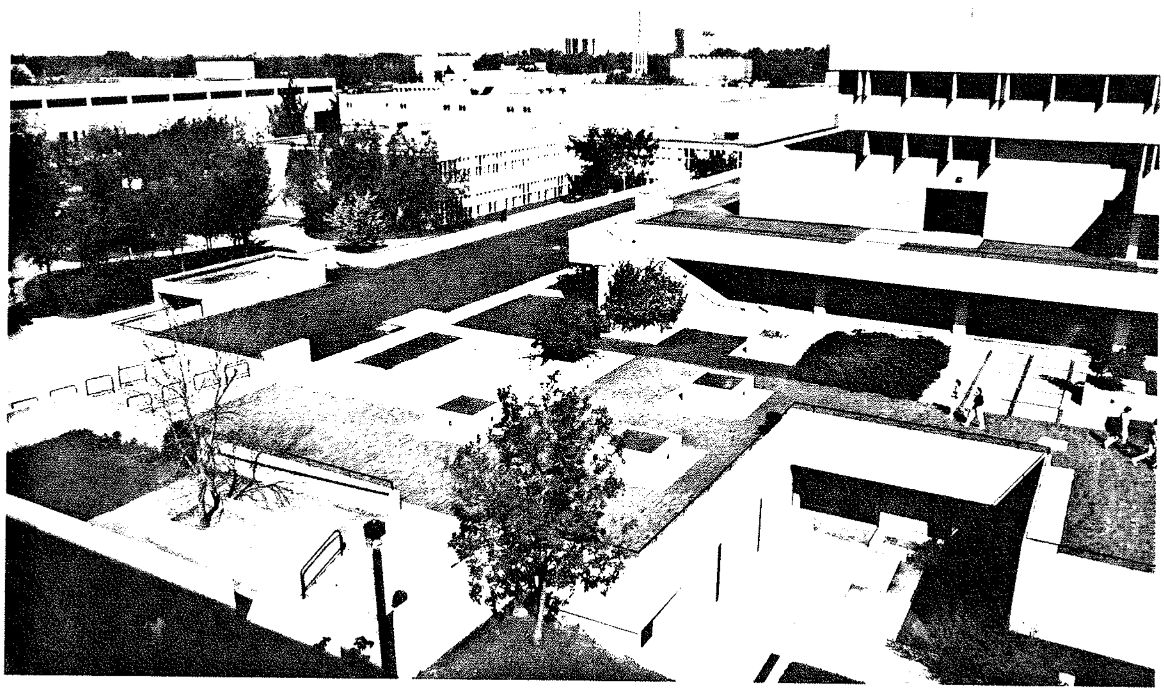


Figure 108: University Centre, University of Manitoba

The other roof plaza on the University of Manitoba campus is on the roof of the Frank Kennedy/Administrative Studies Building, and is undoubtedly one of the worst wastes of roof space in the city (see figure 110). Like University Centre, part of this building was built underground so as not to obstruct the view of the Administration Building from Chancellor Matheson Drive. Unlike University Centre, the rooftop of this building was not developed at all. This enormous roof is tied into several circulation routes by way of stairs and even a large 'bridge' on the northwest corner. However, it is rarely used by anyone because of its forbidding appearrance. A narrow, patio-block walkway linking the fire exits with the stairways, is the only attempt made at

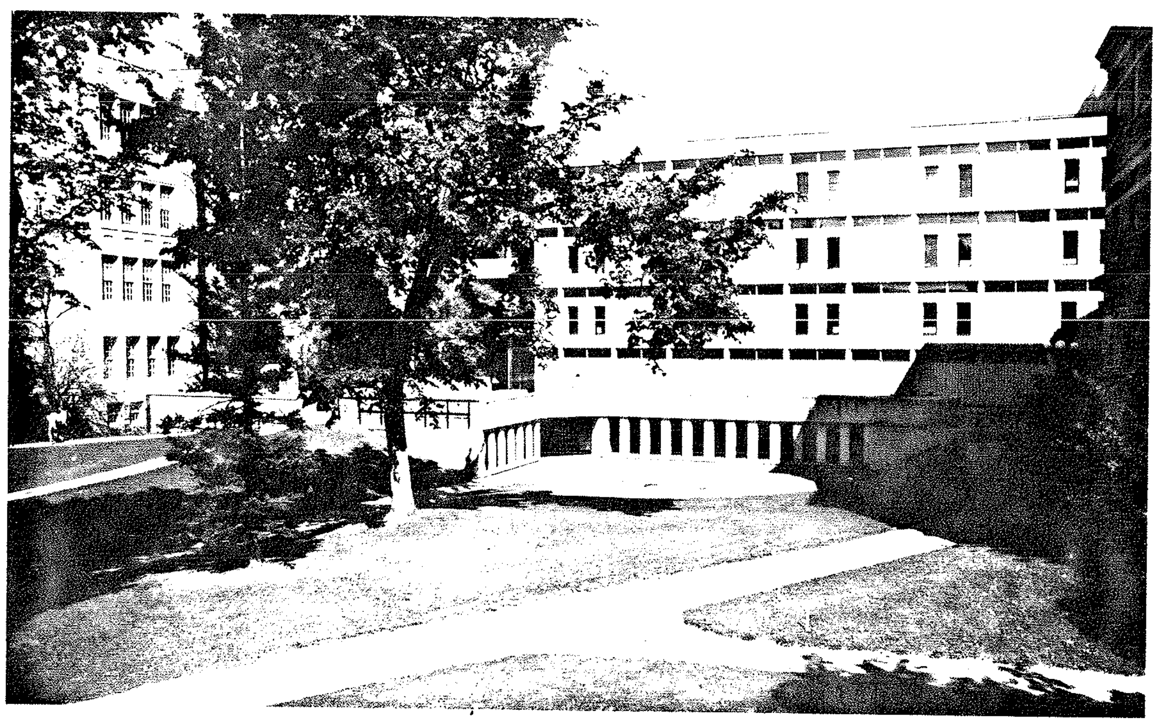


Figure 109: Duff Roblin Building Roof Plaza, University of Manitoba

Figure 110: Frank Kennedy/Administration Studies Building Roof, University of Manitoba

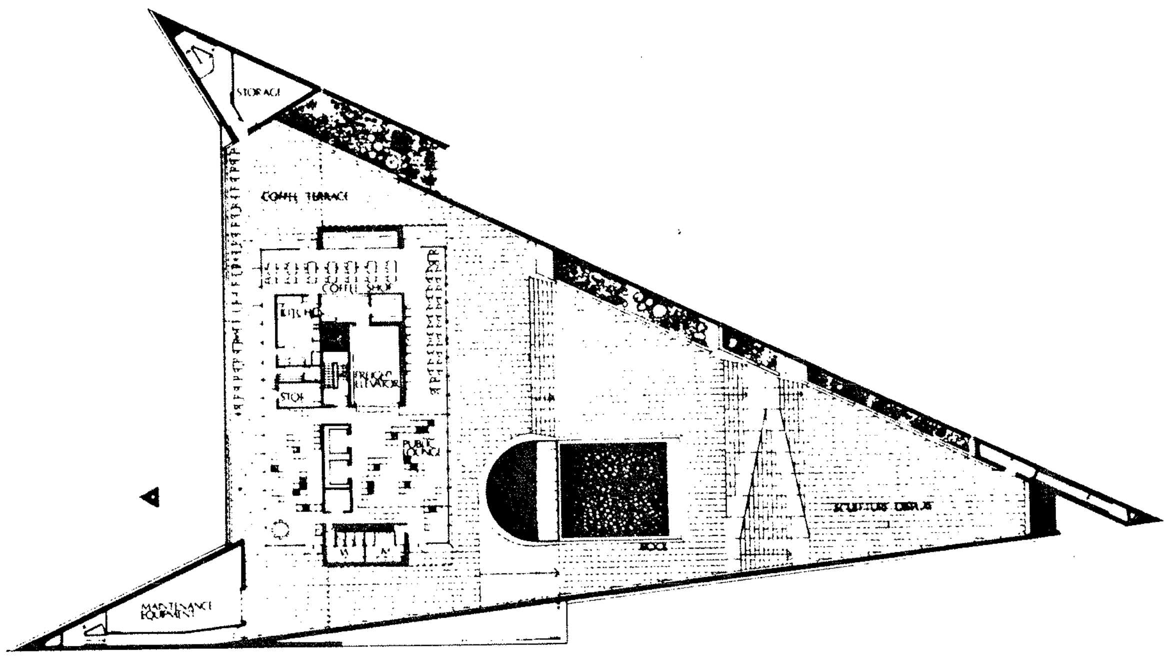
developing this potentially exciting rooftop.

In 1970, the same year that University Centre was completed, another of Winnipeg's three public roof gardens was being constructed. The design for the Winnipeg Art Gallery, by Gustavo da Roza and The Number Ten Architectural Group was selected from 109 entries in a national competition held in 1968 (Lee, 1982). The roof garden on the penthouse level was designed as an integral and important part of the building. The triangular roof plan features a restaurant/coffee shop and tri-level garden. The glass walls of the restaurant offer patrons a view south to the Legislative Building and north into the walled roof garden (see figure 111). Because entrance to the garden is gained through the restaurant elevator lobby, and because the lobby and restaurant walls are all transparent, the garden acts an extension of the interior space. In summer it is used for concerts and special events, and in winter as a viewing garden. The garden also serves as a sculpture courtyard, thus making it an integral part of the gallery's exhibition space.

White Tyndall stone pavers are used throughout the three levels and for the steps, ramp, 'stramp,' planters, and pool walls. The hard architectural edges give the courtyard itself a sculptural quality, but the overall hardness is softened by the use of a considerable amount of planting. Wooden box-planters and seating units also help soften the hardness of the many polished stone surfaces. A large black-bottomed pool with one-metre-high jets of water animates the garden with sound and movement, and helps to cool (at least psycholgically) the often hot rooftop atmosphere (see figure 112).

The Art Gallery roofgarden is a handsome, well designed, and well used rooftop development. Because it is on the fourth floor, rather than at street level, it is usually the first roof garden which springs to mind for most Winnipeggers. Its success depends, to a great extent, on the way in which the restaurant draws visitors up from the building below to the roof level. Also, the fact that the restaurant roof is the highest part of the development and not the roof garden itself, adds a psycholgical comfort to the space.

The high parapet wall around the garden makes it invisible from street level, so the view as the elevator door opens out into the lobby and garden beyond is therefore a pleasant



ROOF LEVEL PLAN

Figure 111: Plan of Winnipeg Art Gallery Roof Garden (From Lee, 1982.)

surprise for most visitors.

The Winnipeg Centennial Library roof garden is a street level garden built over a two-storey, underground, public car park. It was commissioned in 1974 by the City of Winnipeg, and completed in 1977. The complex as designed by architects McDonald, Cockburn, McFeetors, and Tergeson, and the 1.1 hectare garden was landscaped by The Lombard North Group.

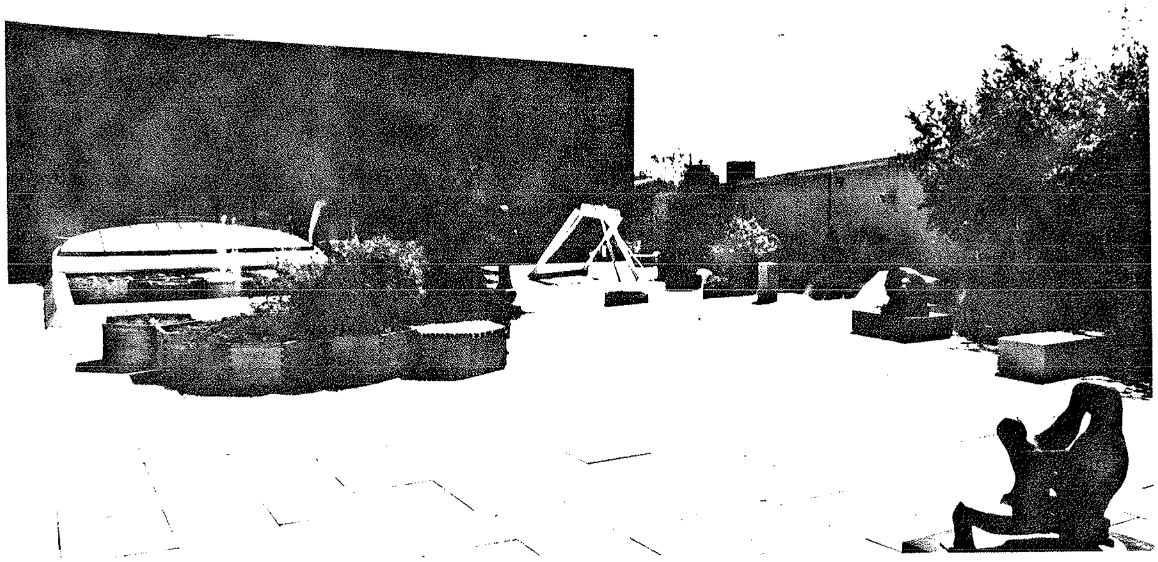


Figure 112: Winnipeg Art Gallery Roof Garden

Located between Donald and Smith Streets and between St. Mary's and Graham Avenues, the public garden takes up most of the south half of the block, while the library building makes up the north half. A small portion of the garden is fenced off and accessed only through the library building and is overlooked by a second floor roof terrace.

The garden is designed to accommodate a number of different activities. Most of the garden is subdivided into smaller units for passive activities: it is a popular place for downtown employees, shopper, and residents, to eat lunch, read, or just sit and rest in the shade of a tree. The garden is also an integral part of the pedestrian circulation system in the area. Sidewalks on the east and west edges of the block lead into the garden itself, so as to allow vehicular ramps to and from the car park to run directly off the street without crossing pedestrian routes. By bringing the public sidewalks directly into the garden, rather than around the perimeter of the garden, the public use and awareness of the garden is increased considerably. The large reflecting pool in the east half of the garden is used as a skating rink in winter, making winter activity in the garden more active than passive. (The design and planning of active use of a garden in winter is a highly desirable, sometimes essential, criterium for ensuring the success of any park or garden in a climate such as Winnipeg's.) The garden is also used as a viewing garden by people inside the library, and the surrounding buildings (see figure 113).

Of the three major public roof gardens in Winnipeg, the library garden has the greatest amount of planting. All of the planting beds, as well as lawn areas and pool, are raised above the paving level (rather than sunk down into the roof) and are contained by low concrete walls. This provides an almost unlimited amount of seating area. Along the east and west edges of the garden, the height of these walls increases to about two metres, thereby helping to block out street noise, adding interest to the topography of the garden, and denoting garden boundaries. Shubert Chokecherry trees and groves of Linden trees account for most of the large plant material, but there is also a large variety of blooming shrubs, groundcovers, and perennial flowers incorporated into the design. The planting beds are maintained by the City of Winnipeg Parks and Recreation Department. An irrigation system is incorporated into all the planting beds, but some hand watering is required (see figure 114).

Other than some minor cracks which have appeared in the base of the pool, there are no structural problems with the roof garden. The plants are thriving with no more than routine maintenance, and the garden is well used by the general

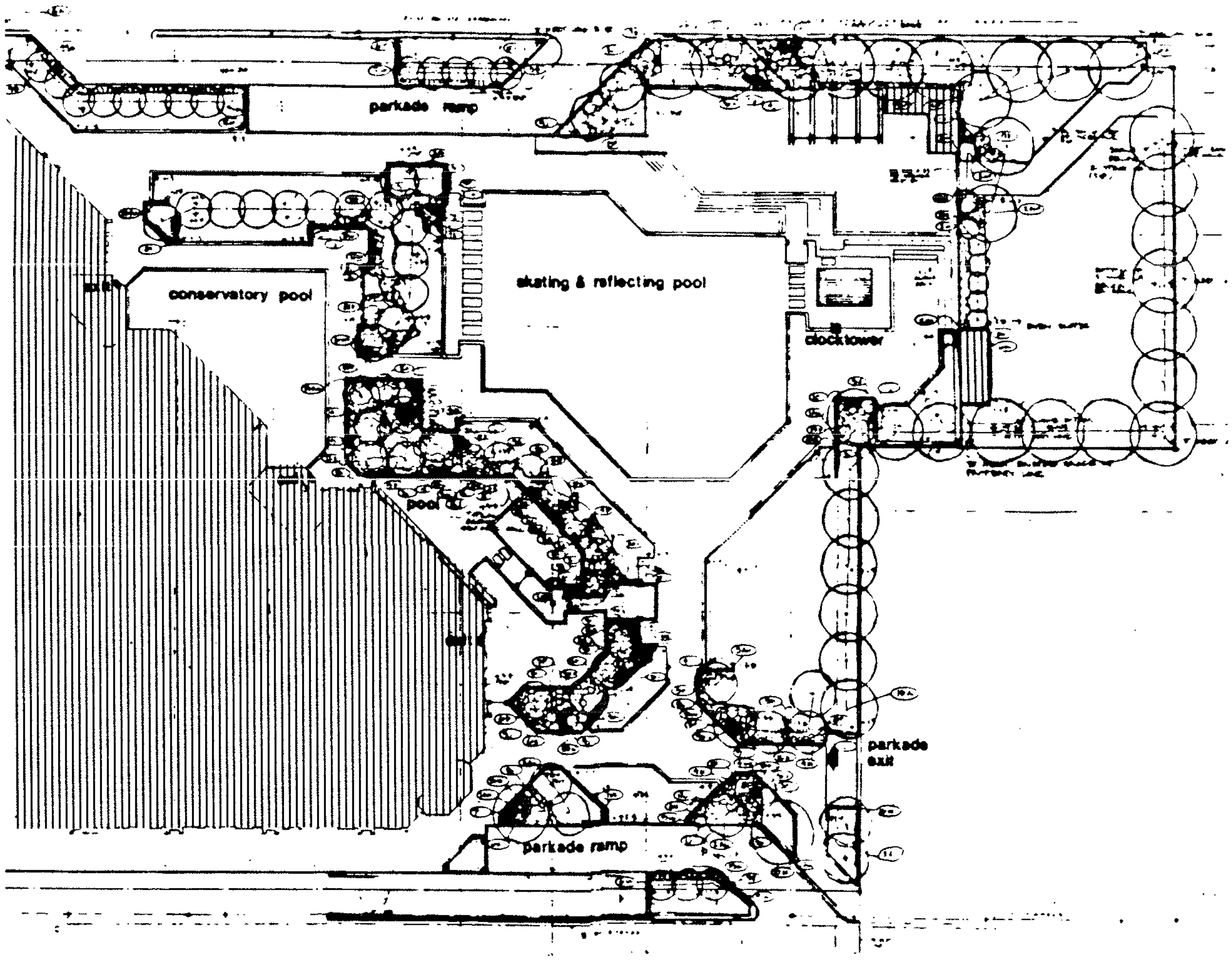


Figure 113: Plan of Winnipeg Centennial Library Roof Garden (From Lee, 1982.)

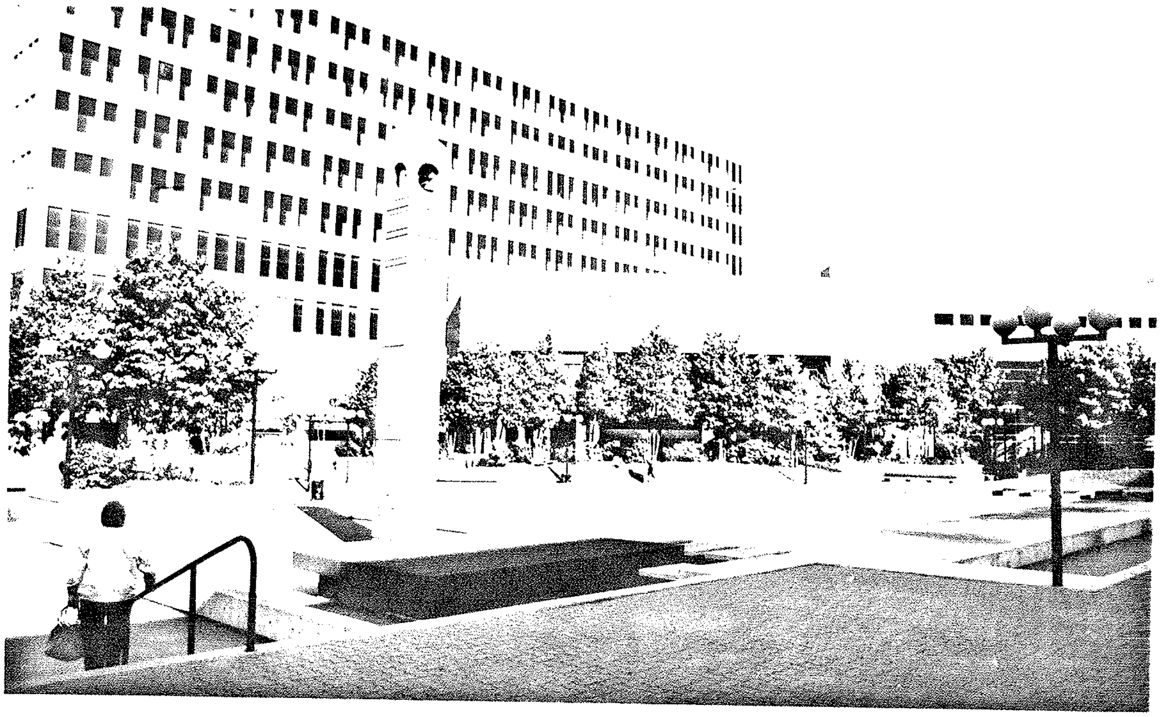


Figure 114: Winnipeg Centennial Library Roof Garden

public.

4.3 <u>SUMMARY OF WINNIPEG ROOF GARDENS</u>

The number of roof gardens in Winnipeg is very limited. In general, only a few of the apartment block roof gardens in the city can be considered 'successful' designs, and even those which are 'successful' could have been made very much more successful by capitalizing more on the special benefits and opportunities which only rooftops can afford. The few public roof gardens in Winnipeg, on the other hand, are quite successful but are still somewhat limited in size and scope. This is perhaps understandable considering Winnipeg's past economic conditions, its rather lack-lustre architecture, and its citizens' preference for interior spaces where climate can be controlled.

However, conditions may be changing. The construction of numerous pocket parks (temporary albeit) in the 1970's and the sudden appearance of a good number of outdoor cafés and street vendors during the past two or three years, seems to suggest that Winnipegers are more eager to spend their lunch hours, coffee breaks, and even evenings out of doors. The present multi-million dollar North Portage Project, the Core Area Initiative programs, and several recent large-scale buildings (such as the Air Canada Terminal, and the Great West Life Assurance Building) indicate an increase in architectural construction (even if not an improvement of architectural design). Now, while architectural activity is on the increase, is the time to push for a rooftop development scheme.

Chapter V

BENEFITS AND LIMITATONS OF DEVELOPED ROOFSPACES

> Rooftops give a dimension to modern city living which is impossible on the ground. Up high on the roof there are views over other buildings, sunsets to see, a relaxing freedom from cars and other traffic, a privacy and intimacy which no other city facility can bring and all of which are difficult to achieve at street level.
>
> -- Lawrence Halprin

> Even on a Babylonian scale . . . a roof garden can never replace a ground-level garden where taproots sink deep and trees grow tall.
>
> -- Grady Clay

Throughout the 4,000 year history of roofscaping there have been three major reasons for developing roof space: 1) for environmental benefits, 2) for economic benefits, and 3) to create either visual or physically accessible amenity space. The last reason is the oldest and by far the most important of the three reasons. The second reason is relatively recent; the first time roof gardens were promoted for economic reasons was in the late 19th century when Carl Rabitz published his treatise (see section 3.1). The first reason listed is the most recent of the three but may become the most important one in the near future. As the population of our urban centres continues to become denser and our open green space becomes scarcer, the environmental benefits become more and more important. Any rooftop development can, of course, be built for more than one reason, and ideally is built for all three reasons.

This chapter breaks down the many benefits and limitations, associated with the development of rooftops, into the above three catagories, examining them as they apply to urban centres in general. The final chapter then examines these benefits and limitations as they apply to Winnipeg's specific climate, architectural composition, environmental quality, density, and economic conditions.

5.1 ENVIRONMENTAL BENEFITS AND LIMITATIONS

Although there are many types of plantless rooftop developments which can produce considerable economic benefits and very desirable recreation or amenity spaces, the roof garden which contains plant material usually produces the greatest number of environmental benefits to the building occupants, and community at large. A few isolated roof gardens will not, of course, have any measurable effect upon the environmental quality of a city; but when roof planting is done on a grand scale, as in some European cities, the long-term environmental benefits can be considerable. This section looks at the ways in which greening up our rooftops on a large scale, could improve the environmental quality of our modern urban centres.

5.1.1 Benefits to the Urban Micro-Climate

When rooftop planting is done on a grand scale, the urban micro-climate is improved in a number of ways. First, the evapotranspiration of the plants will increase the humidity of the air. Cities generally have much lower humidity levels than rural areas because in the urban environment all rainwater immediately runs off the omnipresent hard surfaces. In fact, the humidity levels of the dry, overheated urban air masses often equal those of desert air (Kienele, n.d.). In rural areas, on the other hand, the abundance of soil and plant covered surfaces retain and slowly release moisture into the air through the process of evapotranspiration, thus increasing humidity levels.

Secondly, plants can help to purify the air. Plants help to trap the dust particles which abound in the urban air mass (Kienle, n.d.). The ubiquitous hard surfaces provide an endless source of dust particles as abrasive winds are channelled through the concrete canyons. The cleaner air also allows more ultraviolet rays to penetrate into the urban air mass and kill disease-causing pathogens. Hare and Thomas (1974) report that urban areas receive 5 to 30 percent less ultraviolet radiation than rural areas.

Plants also convert water into oxygen and release it into the air at night, thus increasing the oxygen level of the carbon monoxide-polluted air mass.

Thirdly, plants reduce radiant heat in summer. The bare roof surfaces absorb solar heat and re-radiate it into the air. Roofs covered by plants are shaded and therefore do not re-radiate as much heat (Kienle, n.d.). Plants, unlike hard surfaces, are able to utilize this solar radiation by converting it into energy and using the energy for photosynthesis.

Fourthly, plants absorb some of the high level urban noise (Kienle, n.d.). The sound of jet engines, large trucks, trains, car horns, and so on, simply bounce off hard surfaces and re-echo between buildings. Planted surfaces, on the other hand, absorb some of these harsh sounds, especially high frequency noises, and help reduce the high noise level of urban centres. The noise level of most busy streets averages around 90 decibels, which is 16 times louder than the top end of the comfort range for outdoor recreation (which is, 45 to 55 decibels) (Road and Rail Noise, 1977). Also, the noise level of even unplanted rooftops is usually lower than that of street level, because at roof level the traffic noises are muted by distance and by the effects of wind.

Fifthly, plants can help ameliorate the effects of wind. A dense planting of shurbs or trees can redirect and reduce the force of winds, which are always much stronger above the urban rooftop than they are down in the sheltered streets. In winter plantings used as wind breaks or 'wind sponges' can also trap snow which would otherwise be scoured away. This extra snow will increase the 'live load' on the structural elements, but it will also provide added insulation for the smaller roof plants in winter and extra melt-water for them in spring. (see figure 115).

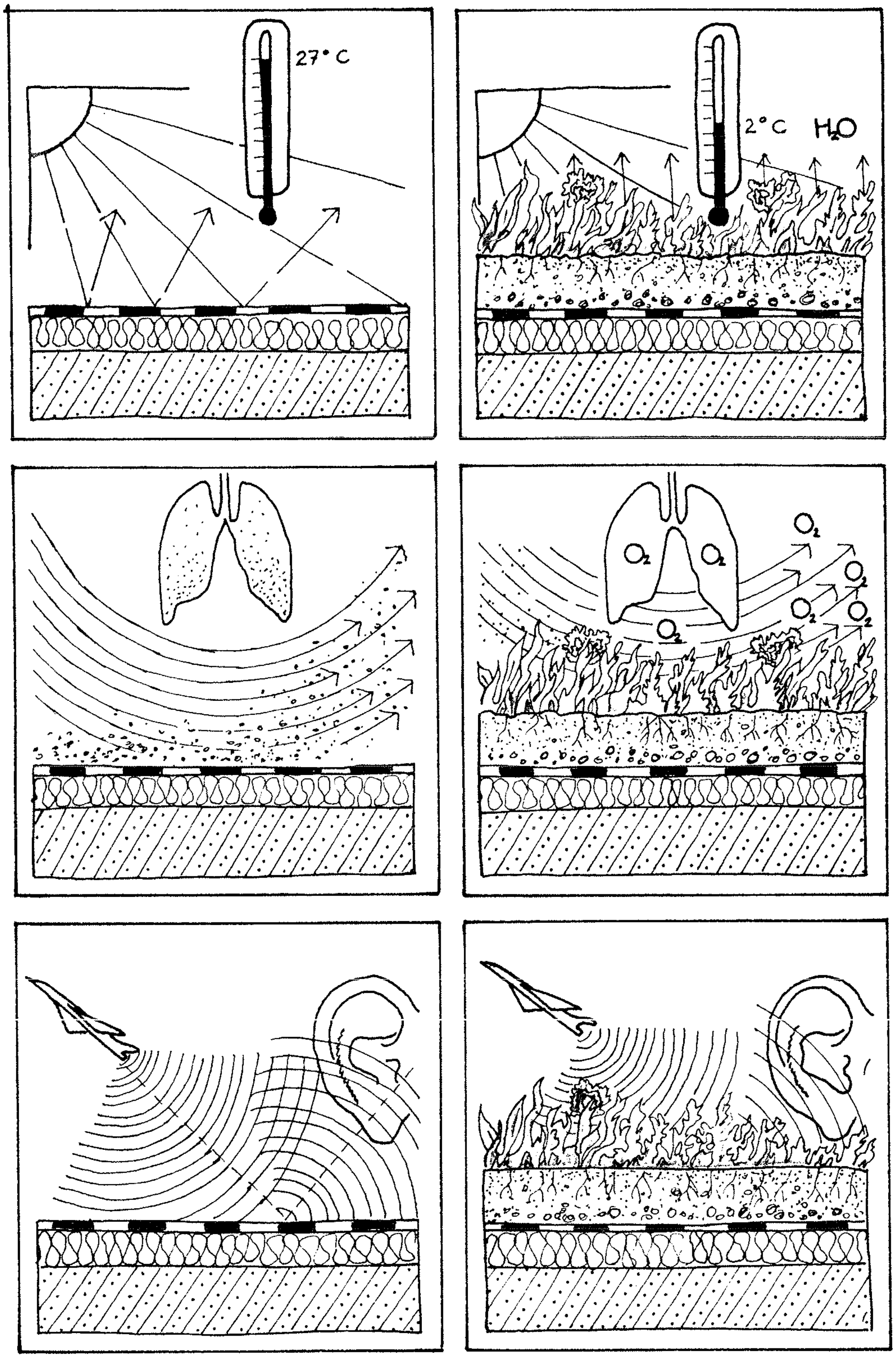


Figure 115: Benefits to the Urban Micro-Climate (Reduced solar re-radiation and increased humidity, cleaner air, and increased noise absorbtion. After diagrams in Kienle, n.d.)

5.1.2 Benefits to the Hydrographic Equilibrium

In an undisturbed natural environment a natural cycle exits in which the total annual precipitation of an area is eventually returned to the atmosphere. Solar radiation provides the energy whereby half the total precipitation is returned to the atmosphere through evapotranspiration, and half is returned through surface evaporation from lakes, rivers and streams (see figure 116). More than one-third of the urban environment is made up of roof surfaces where the runoff is 100 percent. Also, studies have shown that runoff rates escalate faster than urban expansion rates: a three-fold increase in built urban surface results in a five-fold increase in rainwater runoff. In urban areas this runoff is channelled directly into the rivers, thus polluting the rivers with the debris it carries with it. The sudden increase in the amount and speed of water in the rivers also causes accelerated erosion of the riverbanks (Kienle, n.d.).

An environment built of hard surfaces is as dry just minutes after a rain as it was before the rain started. A green surface acts as a sponge and remains moist for hours or even days after a rain. In a green environment much of the solar energy is used up in the condensation-precipitation-evaporation cycle rather than in the generation of radiant heat. By greening up our flat urban rooftops we can slow down runoff, reduce river pollution, slow down riverbank erosion, allow more water to seep down into the water table, and allow more water to evaporate into the dry urban

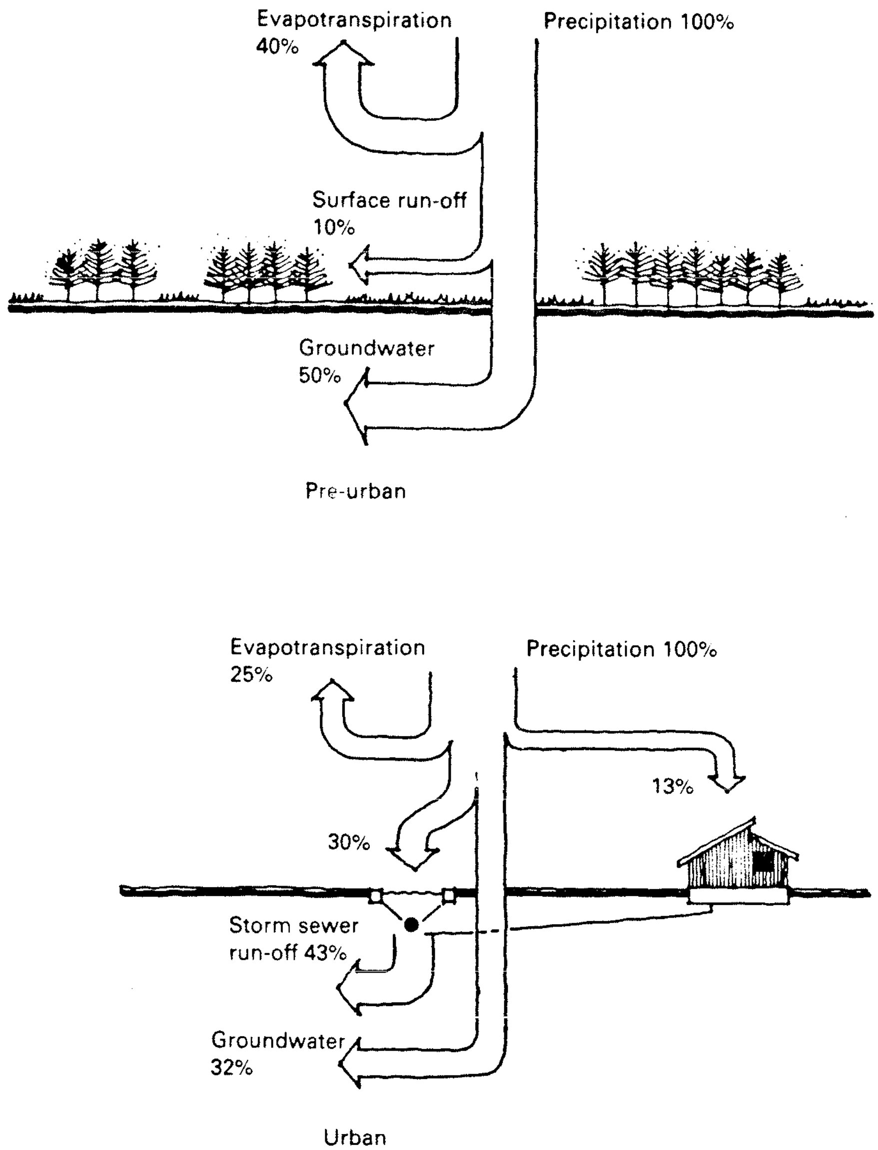


Figure 116: Natural and Urban Water Cycles (From Hough, 1984.)

air mass.

5.1.3 Wildlife Benefits

Major rooftop planting could greatly increase the number and variety of birds in urban centres. A tree-covered rooftop would actually be a more attractive place for some birds to nest than a rural forest because most rooftops would be free of natural predators. Bird watchers would not have to leave the city to observe and photograph birds which would not ordinarily be spotted in urban areas. The general urban public would become more cognizant of the variety and habits of birds. Many species of birds would return the favour to man by feeding on our mosquitoes and other bothersome insects, thus reducing the need to spray our environment with pesticides.

Our rooftops could also become home to several other types of wildlife such as rabbits, squirrels, and racoons. These rootops would, however, have to be very carefully designed and maintained because it is unlikely that a natural and continuous food web could be established on a rooftop, and because spacial limitations and water limitations would very easily become a problem for the animals.

5.1.4 Climatological and Ecological Limitations

Unfortunately, automobiles and factories are much more efficient at polluting the environment than trees are at cleaning it. Green areas have long been considered the 'lungs of the city,' and yet the recent research tends to negate the effectiveness of trees as oxygen-producers. Erich Kuhn argues that the effectiveness of green space to convert the carbon dioxide produced by urban living is not worth calculating. To support his argument he uses calculations by Camillo Sitte, who figured that it would take three acres (1.2 hectares) of green space to absorb as much carbon dioxide as four urban people would produce in a day. He also cites the figures of Martin Wagner, who stated that it would take 3,000,000 acres (1,214,000 hectares) of green space to make a noticeable improvement to the air of Berlin. (Kuhn, 1959).

Winds are several times stronger at altitudes above ten or fifteen storeys than they are at street level. The air is therefore generally fresher, but is is also often more uncomfortable. Winds can easily tear large trees from their necessarily shallow planting beds unless they are securely anchored. Structures such as arbours and brise-soleils are equally subject to wind damage. Trees, especially evergreens, can be quickly desiccated by these winds, if unprotected.

In most cities the amount of rain falling on rooftops is not enough to support most plant life. At ground level plants can draw moisture, and a number of important nutrients, from ground water. Roof plants cannot, and must therefore be irrigated and fertilized. It is unlikely that a natural, totally self-maintaining ecosystem could be created on a rooftop. Much of the bacteria and fauna found in natural ecosystems may not be able to survive in a man-made environment where the soil is shallow and the water chlorinated. As attractive as the idea may sound, we can never give back to Nature on our rooftops, exactly what we took from her on the ground. What we can do, however, is create a controlled, man-made environment which offers some of the attractions and benefits of a natural environment.

5.2 ECONOMIC BENEFITS AND LIMITATIONS

Today in North America the roof garden is usually considered a "nice idea" but is always the first thing to get "red pencilled" when the cost estimates come in. Developers would probably be less eager to scrap these proposed roof gardens if they were aware of all the many economic benefits which roof gardens can produce.

Cost is, however, always the ultimate constraint in any sort of architectural or landscape development. Monetary benefits and losses are also the most difficult aspects of roofscaping to discuss in general terms because the variables are so numerous and have such dramatic effects. The cost benefits of any rooftop design depends upon regional variations in material and constructional costs, the size and nature of the design, climatic conditions, the structural composition of the buildings, the financial assistance and tax benefits available, and so on. This section points out the very general economic benefits which roof gardens can generate, regardless of whether or not these benefits can justify the cost in specific situations. The next chapter examines the benefits in terms of the Winnipeg situation.

In addition to the following list of economic benefits, there are those benefits which are impossible to quanitfy. For example, the creation of an extensive network of open green spaces and recreational spaces in any urban centre would have a favourable affect upon the physical and psychological health of its citizens (see section 5.3). This improved health would result in reduced medical expenses. However, trying to calculate the actual number of dollars saved in reduced medical expenditures due to the extra amount of recreational space would be impossible.

5.2.1 Structural Benefits

A covering of soil and plants provides supplementary insulation for the building. This means a reduction of the extreme diurnal and seasonal temperature changes of the roof surface (see figure 117). Since this temperature change generates considerable stress on the building, a covering of soil and plants actually increases the life of the building by reducing the stress caused by continual expansion and contraction of structural members. This would reduce or eliminate maintenance and repair costs for roof sealants, fittings, and joints. An increase in a building's longevity automatically increases its realty value.

However, it must be remembered that while a roof garden can reduce structural stress due to exapansion and contraction, the weight of its soil, trees, paving stones, pools, etc., also create a tremendous amount of stress on the building below. (At Arundel Great Court, London, where the soil profile is two metres deep, the load is over two tonnes per square metre (Scrivens, Mar. 1982).) The benefits of decreased expansion/contraction stress is therefore valid only if the structure can withstand the stress created by the weight of the garden.

Average Diurnal Temperature Changes in Summer and Winter of an Unplanted and a Planted Rooftop in Switzerland. (Temperature extremes would be even greater in Winnipeg.)

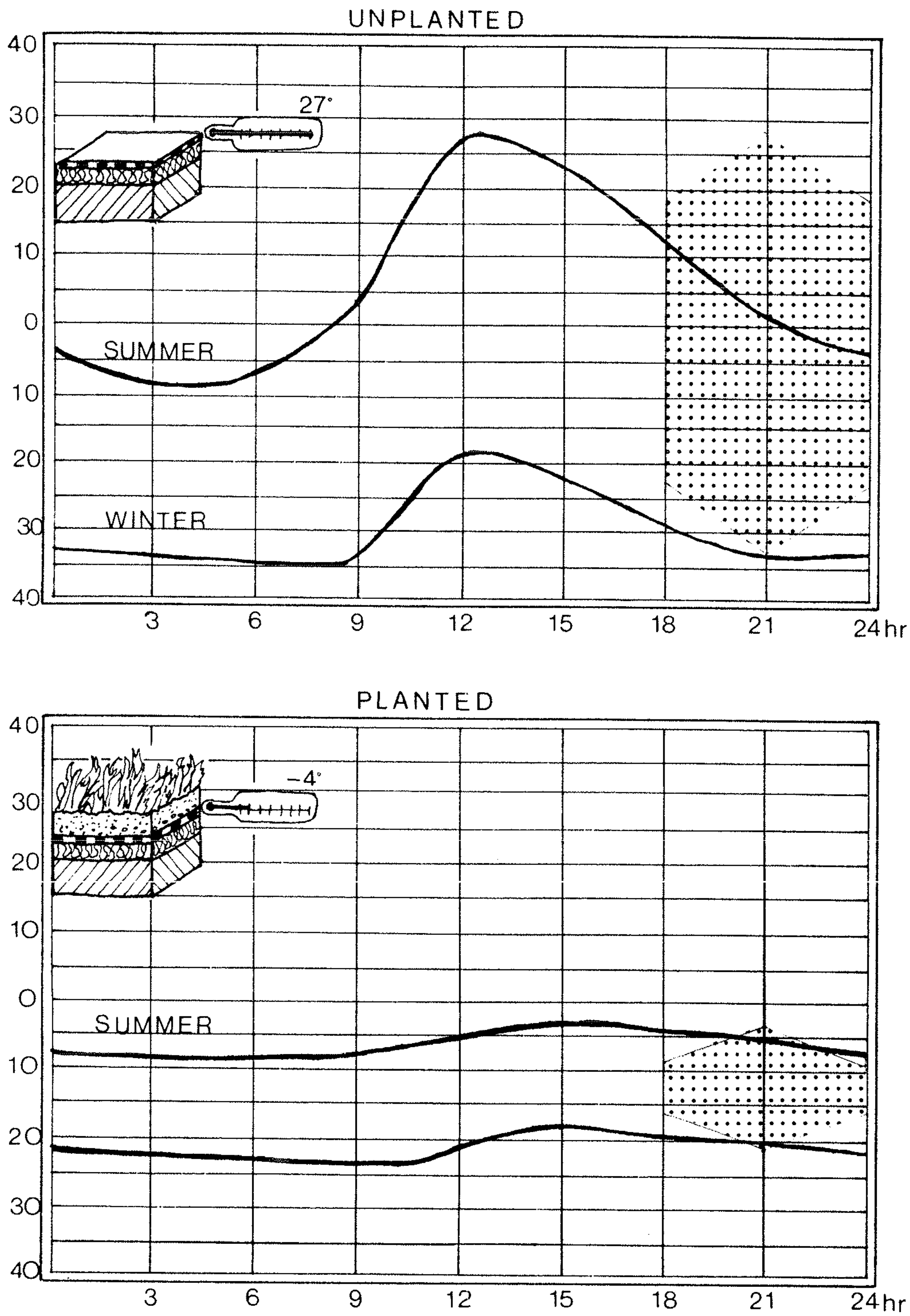


Figure 117: Roof Surface Temperature Changes (After graphs in Kienle, n.d.)

5.2.2 Thermal Insulation Benefits

A layer of soil and plants not only reduces structural stress but also ameliorates temperature changes inside the building below, thus reducing energy costs of heating and cooling the interior by as much as 30 percent (Sitta, 1983). It must be noted that the insulation value of soil can vary greatly: 30 centimetres of soil can have an 'R-value' of anywhere from .5 to 5, depending upon the soil composition and moisture content (Wampler, 1978).

The increased energy efficiency makes the building a more valuable piece of realty, and at the same time helps reduce fossil fuel consumption and the amount of air pollutions generated by converting these fuels into energy.

5.2.3 Benefits to the City Drainage System

As was discussed in section 5.1.2, roof gardens can reduce the total amount of runoff in urban areas. Runoff from impermeable surfaces is not only harmful to the rivers but also to the city sewer systems. Urban drainage systems are usually designed for a five to ten year rainfall and are therefore underdesigned for heavy rainstorms and overdesigned for more normal rains. By routing as much runoff as possible into natural drainage channels and by planting up roof surfaces, the stress on city sewer systems could be greatly reduced. This would result in reduced costs to the city for drainage system repairs (Kienle, n.d.). It would also reduce costs arising from structural and property damage incurred through flooding and sewer 'back-ups.'

5.2.4 Constructional Cost Limitations

The economic benefits of a roof garden are generally more extensive for buildings where the roof garden is part of the original design, than for buildings where the roof garden is added on as an afterthough. There are several reasons for this. First, it is less expensive to build the extra load bearing capacity into the structure during the initial construction, than it is to complete the structure and then call in a specialist to figure out a way to reinforce the existing structural members or design an additional roof structure to fit on top of the existing one. Secondly, it is less expensive to hoiste the plant and building materials up onto the roof while the cranes used to construct the building are still in place, than it is to hire another crane, winch system, or helicopter, to lift materials and equipment up to the roof of a completed building. Thirdly, when retrofitting an existing building much of the exisiting roofing material will have to be removed and roof vents, fans, compressors, and possibly even drainage systems will have to be re-arranged or redesigned. All this does not, of course, necessarily negate the possible economic benefits of a well designed retrofitted roof garden. Many of the most celebrated roof gardens have been added to exisiting buildings; Derry and Toms', and Harvey's Departmental Store roof gardens, are but two notable examples.

Whether added to the top of a completed building, or built as an integral part of the original design, roof gardens are more expensive to build than their generic equivalents at grade level. There is the cost of the added structural strength needed to support it, lightweight materials are often much more expensive than ordinary materials, roof garden mecahnical systems (irrigation, drainage, etc.) are often more sophisticated and more expensive, and the installation of these systems may require higher skilled (and therefore higher paid) workmen.

Just how much more roof gardens cost compared to the same development at grade level is impossible to say unless the particulars are known. Rogers (1975, p.11) quotes the average cost of roof gardens as being $5-$10 per square foot ($54-$108 per square metre) for roof gardens which are largely paved with inexpensive materials, and up to $40-$60 per square foot ($430-$645 per square metre) for gardens with elaborate planting systems, expensive paving materials, fountains, etc. In today's market those price ranges would be closer to $70-$140 and $560-$840 per square metre.

5.2.5 Cost-Return Limitations

One of the financial problems with rooftop developments is that some of the financial benefits derived from a planted rooftop are not enjoyed by the building owner who, presumably, payed for the cost of its construction. The building owner will enjoy the benefits of decreased heating and cooling bills and an increased resale value of the building, and possibly reduced roofing maintenance costs, but some of the benefits bypass the owner and go directly to the community. For example, if the roof development is a non-accessible green roof above the top floor, the owner/occupants will not be able to derive any visual benefits from it. If the development is designed to aid in the reduction of runoff, the owner of the building will be paying the costs of retaining the extra water and supporting its weight, while the city reaps the benefits of reduced repair and upgrading costs to the city drainage system. Few corporations or building owners are philanthropic enough to spend thousands of dollars on roofscaping unless the cost can be recouped though direct personal savings and tax reductions.

Clearly, different types of rooftop developments will produce different amounts of economic benefits. A large department store may be able to justify the cost of an elaborate park on its rooftop by the increase in sales resulting from added customers drawn to the store by the roof park. The owner of an office block might be able to justify the cost of a small roof garden by the economic benefits of increased employee satisfaction (higher productivity, decreased turn-over rate, etc.). The most financially successful rooftop developments are usually commercial service-oriented businesses. Restaurants, cafés, nightclubs, health spas, and recreation complexes built on rooftops can all be financially viable operations. Unfortunately, most of these businesses require large amounts of paved and roofed surfaces, rather than planted areas, and therefore do not help much to improve the environmental quality of the city. The roofs of public buildings, on the other hand, where direct economic return on the cost of investment is not essential (hospitals, schools, civic centres, law courts, public art galleries, bus and train stations, etc.), can be ideal locations for environmentally benefitial green space.

5.3 BENEFITS AND LIMITATIONS OF AMENITY SPACE

The third, and most important, reason for developing urban rooftops is for the sake of increased amenity space. This amenity space may be private, as in the case of Habitat 67 in Montreal, or the Villa Savoye near Poissy, it may be semi-private, as in the case of Unité d'Habitation at Marseille or Hotel Bonaventure in Montreal, or it may be public, as in the cases of Robson Square in Vancouver, and Gross Schanze Park in Bern. This amenity space may also be physically accessible, as in the Kaiser Centre in Oakland, or non-accessible as in The Spaces of Abraxas outside Paris. The purpose of amenity space is to improve the quality of life through increased active and passive recreational opportunities, increased contact with nature, and though the creation of more aesthetically pleasing environments. It stands to reason, then, that there are many overlaps between the reasons and benefits of roofscaping for the sake of ecological or environmental reasons and for the sake of creating amenity space.

A rooftop amenity space has some advantages over a grade level space, some disadvantages, and many similarities. The major benefits and limitations or constraints of developing rooftop amenity spaces are discussed below.

5.3.1 Benefits to the Physical Health of the Citizens

Because air circulates better at roof level than it does between the buildings down at street level, the air exchange rate is much higher on rooftops and the carbon monoxide levels are therefore much lower. Also, as has already been pointed out, rooftop planting on a large scale would decrease the amount of dust particles in the air, increase the humidity level, and increase the amount of oxygen in the air. This cleaner air would mean less problems with resperatory diseases. It would also mean that more of the sun's blue and ultraviolet rays would penetrate the urban air mass and destroy the disease-causing pathogens in the air (Kienle, n.d.).

If the rooftops provide opportunities for physical recreation like jogging, tennis, swimming, and so on, they can provide a very direct physical fitness benefit for those who use them. Rooftops also receive more sunshine and are less likely to be plagued by mosquitoes than street level gardens and parks.

5.3.2 Benefits to the Psychological Health of the Citizens

Rooftop gardens can help improve the psychological health of those who work and live in urban centres in a number of ways. First of all, they can reduce the feeling of isolation which often develops among people who work and live in the upper floors of tall buildings. The crowds of people moving through the streets below are hidden from view in upper floor apartments and offices. Instead, the view out the window of an upper storey office or apartment is likely to be that of a static, unchanging series of building façades and roofs, animated only by the the occasional flag fluttering in the wind. A view of a rooftop animated by people and growing, changing plants could re-establish that contact with the outside world which is usually missed by those living and working in the upper floors of tall buildings.

Secondly, roof gardens can contribute to the psychological health of citizens by increasing their contact and awareness of nature. The need for a closer contact with nature is expressed by high-rise dwellers in a number of ways; for example it is interesting to note how the window sills of tall apartment blocks are filled with house plants as if the occupants were trying to compensate for the absence of greenery outside their windows. Even if roof gardens are not physically accessible, the view out onto them would heighten peoples awareness of the change of season and weather. Planted roof gardens might attract birds, and could possibly provide homes for some other wildlife such as squirrels, racoons, and rabbits, if designed to do so. A network of green rooftops would help a great deal in softening the hard grey cityscape.

Thirdly, green spaces appear to be larger than built up spaces of the same dimensions, and therefore reduce the feeling of being hemmed-in (kienle, n.d.). Roof gardens, especially quiet green gardens or parks, provide the opportunity for their users to escape some of the noise and stress of urban living. An abundance of green parks also reduces the need of most residents to leave the city on weekends, thus reducing fuel consumption, exhaust fumes, and traffic jams on weekends.

5.3.3 Safety Benefits

Roof gardens, when properly designed, can actually be safer than street level gardens for a number of reasons: 1) because access is usually limited they are easier to patrol and control than street level parks; 2) there are no pedestrian-vehicle conflicts which often create very serious problems at street level, especially for children; and 3) surveillance is likely to be easier in a small roof garden than in a large street level park.

5.3.4 Aesthetic Benefits

Roof gardens affect the cityscape in two ways: 1) they provide unique places from which to view the city , and 2) when designed with an artistic eye they improve the visual quality of the city. Views of the horizon, of sunsets and sunrises, and of the stars at night are lost at street level but can be spectacular at roof level. Plants and water features at roof level would help soften the yang-dominated cityscape and add a unique character to the skyline.

5.3.5 Spacial Limitations

Roof gardens or parks in urban centres can rarely be as large as the average ground level park. Even the most extensive system of linked rooftops could never equal the size of an urban park like New York's Central Park, London's Hyde Park, or Vancouver's Stanley Park. Roof gardens or linked roof parks should never be considered an alternative to large city centre parks. They can suppliment ground level parks and provide some extra attractions which ground level parks cannot, but they can never replace the need for ground level parks. It is difficult to conceive of a roof garden above street level where horseback riding, baseball, or row boating, could occur.

5.3.6 Accessibility Constraints

For people living and working in the upper floors of high-rises, roof gardens are often more easily accessed than street level gardens, but for those living and working in lower floors they are often less accessible. Roof gardens are usually invisible from street level and a place which is out-of-sight is also often out-of-mind. People at street level, and even those immediately below the roof, are not likely to remember to take advantage of these roof gardens unless special 'indicators' or 'reminders' of their existence are integrated into the surrounding environment.

Ease of access can also be a problem. If the garden is intended for public use, some sort of mechanical lift is essential even if the garden is only one or two stories above street level. Special lifts may be necessary to transport people to public parks above private buildings. These lifts may have to be located outside of, or on the façades of, buildings if it is undesirable to have the general public use the lifts and facilities intended for the building occupants. Accessing a public park or rooftop café on top of an office tower after office hours when doors are normally locked, for example, could create security and maintenance problems.

5.3.7 Psycho-Social Constraints

Some of the same qualities of roof spaces which are so attractive to some (such as altitude and view) cause serious anxiety in others. Acrophobia (the fear of heights) is the single most common phobia (Adler,1984). Perceived, as well as actual, safety is an important design issue which must be dealt with.

The roof garden is still a relatively novel idea for North Americans. Because they are not a part of the urban tradition, and because many of the roof gardens built earlier in the century were unsuccessful, the public has a general mistrust of roof gardens and developers have an aversion to spending money on them. This general attitude will have to change before large-scale roofscaping will occur.

5.3.8 Building Type and Context Constraints

Obviously, not every flat-roofed building in urban centres warrants a rooftop development. Many buildings such as churches and synagogues, cinemas, and small shops, do not require accessible roof gardens (although most could still benefit from the added insulation of a non-accessible planted roof. In many cases it is the general community, rather than the building owners or occupants which benefit from the aesthetic and ecological advantages of rooftop developments. This, of course, seriously reduces the incentive of building owners to develop their own rooftops.

A building's context and location can also affect the validity of rooftop development. The many old and cheaply-built buildings which are destined for destruction do not warrant the monetary investment involved in the construction of roof gardens. The many flat-topped warehouses, heating plants, service shops, and so on, found in core area railway yards and industrial areas, would probably also not warrant the expense of rooftop developments.

Rooftops which are in constant shade may not be suitable places for roof gardens, or suitable only for certain types such as moss gardens.

Buildings for which future verticle additions are planned would also not be suitable sites for development.

Many highly refined architectural forms would suffer aesthetically if saddled with a roof garden: Philip Johnson's Glass House, Mies van der Rohe's Crown Hall, E.D. Stone's U.S. Embassy in new Dehli, or Yamasaki's Northwestern National Life Insurance Company Building in Minneapolis, for example all have flat roofs but would suffer aesthetically if their roof spaces were developed.

Roof gardens may also be inappropirate over certain historic buildings. A building tagged for preservation, conservation, or restoration, would not be an appropriate site for a roof garden unless the building originally supported one. (Many historic buildings being rehabilitated,[1] however, could benefit from the addition of a roof garden.)

The many buildings roofed with glass panels, with fabric supported by air pressure, or with a number or other roofing systems would obviously also not be suitable sites for roof gardens.

5.4 SUMMATION

In short, the possible benefits of developing urban roof space are substantial, especially if done on a mass scale. The greater the amount of vegetation used in the development, the greater the environmental benefits. Unfortunately, the possible constraints or obstacles limiting rooftop development are also great. The greatest constraint is, of course, cost. Whether the degree of benefit to the quality of life is significant enough to justify the cost, depends upon the specific situation and location. In urban centres where grade-level open green space is sufficiently abundant and the environmental quality (of the air, the rivers, etc.) is within acceptable limits, the cost of a mass roofscaping scheme would probably outweigh the benefits. On the other hand, in the many dense urban centres where virtually every square metre of ground is covered with asphalt or high-rise

[1] The term "rehabilitated" refers to projects where a building or site is upgraded to modern standards while recognizing and retaining its historical character. The terms "preservation," "conservation," and "restoration," refer to projects where a higher degree of historical accuracy is desired.

buildings, the development of roof space could not only provide the much needed amenity space and improve the environmental quality, but also produce an economic benefit for both the building owners and the community at large.

Because grade level green spaces are less expensive to create than rooftop green spaces, and because grade level green spaces provide most of the benefits which rooftop green spaces cannot, it is preferable to build the needed green amenity spaces at grade level. However, it is now too late for most cities; there is simply no room left at grade level on which to build these green spaces. We have therefore now reached the point at which we either pay the added costs of developing our rooftops, or do without the much needed recreation and green spaces, and suffer the consequences.

There is another issue involved here also. Even if the cost constraints outweigh the environmental benefits, even if there is ample amenity space, what then do we do with the many unsightly rooftops which are so glaringly obvious to us today. Even if architects somehow all miraculously decided to pay more attention to the appearance of the rooftops of future buildings, there is still the problem of how to improve the appearance of all the exisiting rooftops.

The problem is clearly an urban planning problem. Our rooftops make up a large part of the urban fabric (anywhere between 35 and 75 percent); a part which has so far been saddly neglected. Architects, landscape architects, and urban planners, must all come to recognize the potential benefits of developing our heretofore neglected roofscape if we are to improve the quality of life in urban centres.

What follows is a summary of the benefits and constraints of developed roof space. The environmental benefits are:

1. Purer air (reduced amount of suspended particulate matter and higher oxygen level).
2. Increased humidity levels (due to evapotranspiration).
3. Reduced radiant heat in summer (building surfaces covered with vegetation utilize solar energy for photosynthesis rather than re-radiate it back into the environment in the form of heat).
4. Reduced noise level (vegetation absorbs some of the higher frequency noises and reduces the amount of sound waves bouncing back and forth between hard building surfaces).
5. Increased moisture and snow retention, which allows more of the moisture to return to the atmosphere (rather than run off into the city drainage system).
6. Reduced river water pollution and riverbank erosion (due to reduced storm water runoff rates).
7. Increased wildlife (especially birds) and reduced need for insecticide spraying (due to increased number of insect-eating birds).

All of the above environmental benefits apply to planted rooftops only, and only when rooftop planting is done on a large scale. The following economic benefits apply to planted and/or unplanted developments, and to individual buildings or to the community at large.

1. Decreased heating/cooling costs (due to the added insulation value of soil and plants).
2. Increased life expectancy of buildings (due to reduced structural stress caused by expansion and contraction).
3. Reduced roofing material maintenance and repair costs.
4. Reduced repair and upgrading costs of city drainage system (due to reduced storm water runoff rates).
5. Increased resale value of building.
6. Increased revenue from rental of roof space (to service-oriented businesses such as amusement centres, restaurants, nightclubs, health spas, recreation centres, etc.), and to private citizens or commercial enterprises for use as greenhouse space, allotment gardens, private gardens, etc.).
7. Increased tenant or employee satisfaction (increased productivity and reduced turn-over rate due to better working conditions in office buildings and factories, and reduced turn-over rate for apartment building tenants due to developed recreation space).

8. Decreased medical expenses due to more recreational facilities, cleaner air, and more pleasant living conditions.

In addition to the above environmental and economic benefits, are the more general benefits derived from the creation of rooftop amentiy space:

1. Improved appearance of city roofscape, a more interesting skyline, and a softer, more human character for the city.
2. Improved opportunities for viewing the cityscape, horizon, sunsets and sunrises, and night skies.
3. Improved opportunities to get away form the hustle and noise of the street below.
4. Decreased feeling of isolation among those who work and life in the upper floors of tall buildings.
5. Increased contact with nature and awareness of seasonal changes.
6. Increased amount of sunlight and clean air (cleaner air causes fewer resperatory problems and allows more ultraviolet rays to penetrate the urban air mass and kill disease-causing pathogens).
7. Increased opportunites for recreational activities.
8. Reduced need to leave the city on evenings and weekends (and therefore less fuel consumption, air pollution, and weekend traffic jams).

9. Increased attraction for suburbanites who work in the city centre to move to the downtown area, and thus reduce the diurnal influx and exodus of suburban commuters.
10. Improved safety factors, especially for children (because of the absence of car-pedestrian conflicts, and because of the ease of controlling and patrolling smaller roof gardens.

Working against these benefits are the following constraints and limitations. The environmental constraints are:

1. Environmental benefits are appreciable only if rooftop planting is done on a grand scale.
2. Winds are much stronger on rooftops, making rooftops more uncomfortable, making the desiccation of plants more severe, and the anchorage of trees and built structures more difficult.
3. Any rooftop planting (except for some ground covers) requires irrigation and fertilizing because there is no water table from which to draw the required moisture and minerals.
4. Soil profiles are necessarily shallow, and the recreation of a natural ecosystem would be difficult or, more likely, impossible.

The major economic constraints are:

1. Increased cost of the structure to support the weight of the rooftop development.
2. Increased construction costs (cost of light-weight materials, cost of hoisting it up to roof level, cost of more sophisticated mechanical equipment and more skilled labour).
3. Maintenance costs of roof gardens are usually higher than the maintenance costs of regular roofing materials.
4. Possible property tax increases.
5. Many of the benefits of a roofgarden may not be directly appreciated by the building owner or the building occupants.

The major draw-backs of rooftop amenity space are:

1. Space is usually limited, making many types of recreation impossible.
2. Accessibility is often a serious problem.
3. Some types of developments might cause acrophobia in some users.
4. Some buildings cannot be fitted with roof gardens because of function, design, structural stability, or orientation.
5. Snow removal may be a problem in winter in some designs.
6. The present negative attitute of many building owners and developers would have to be overcome.

Chapter VI

RECOMMENDATIONS FOR ROOFSCAPING IN DOWNTOWN WINNIPEG

To the rapid traveler the number of elms in a town is the measure of its civility.

-- Thoreau ("A Yankee in Canada")

No shade tree? Blame not the sun but yourself.

-- Ancient Chinese Proverb

The benefits and limitations discussed in the last chapter are not necessarily universal. Their validity in Winnipeg depends upon a number of factors. One of the most important factors is the amount of roof space. As figure 118 demonstrates, the physical density (that is, the ratio of building to open space, both developed and undeveloped) is very low. Only 23 percent of the total area delineated in figure 118 is covered by roof space. The remaining 87 percent is composed of green space, pedestrian space, and space devoted to the automobile (streets, car parks, and car sale lots). The total amount of public and private amenity space is only

12 percent (see figure 119); 11 percent is public and 1 percent is private. The total amount of space devoted to the automobile is 61 percent (see figure 120). Only 14 percent of the total area is covered by green space (see figure 121), most of which is developed as public amenity space. About 1 percent of the total area is devoted to pedestrian space (sidewalks and entranceways). The final map (figure 122) shows the extent of the existing rooftop development in the downtown area.

The other factors affecting roofscaping in Winnipeg (such as climate, economic outlook, city drainage system, and environmental quality) are discussed as the come up in the following discussion.

Figure 118: Roof Space in Downtown Winnipeg (The total roof space equals about 23% of the total area.)

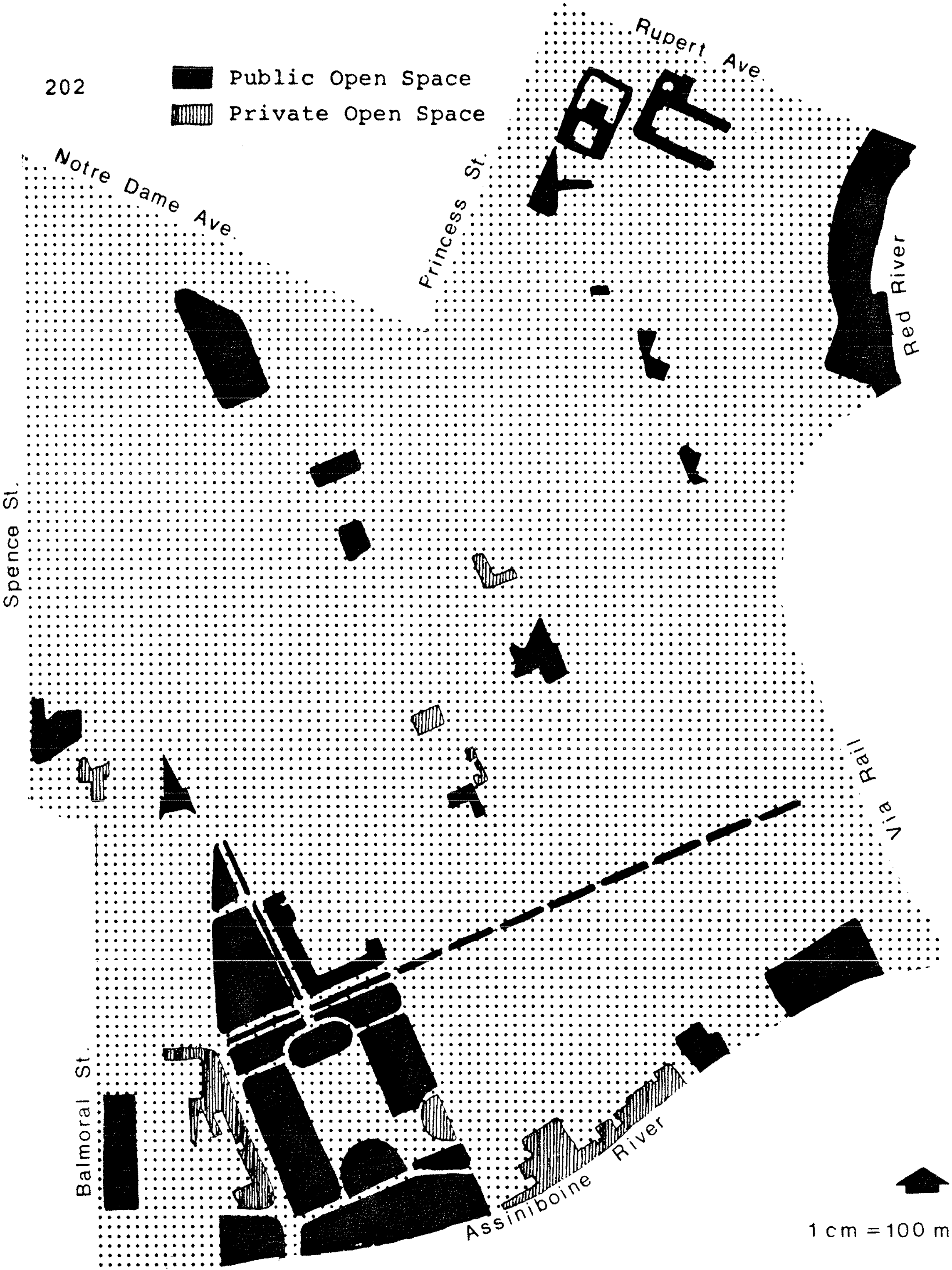


Figure 119: Private and Public Amenity Space in Downtown Winnipeg (The total hard and soft amenity space equals about 12% of the total area.)

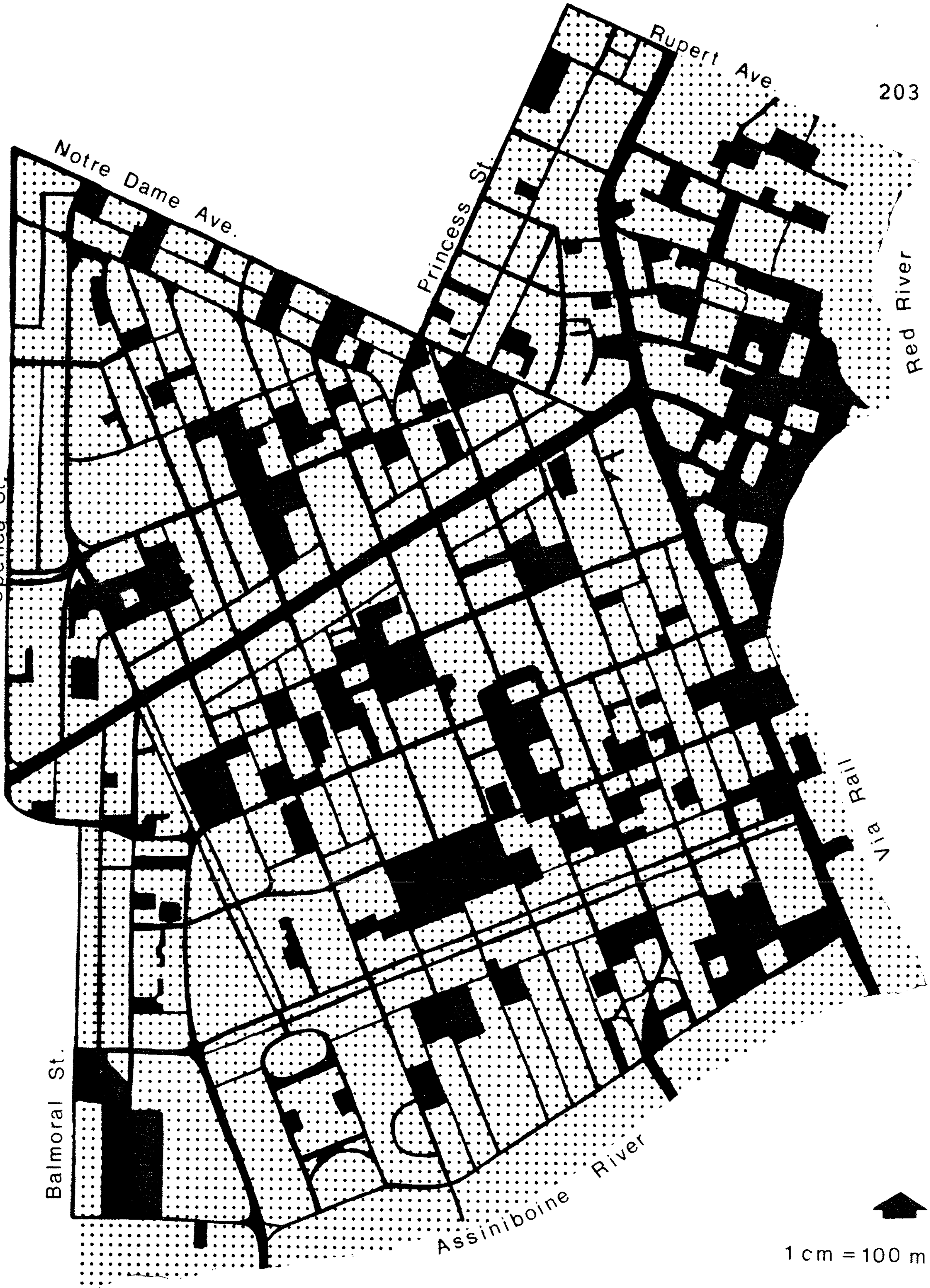


Figure 120: Space Devoted to the Automobile in Downtown Winnipeg (The total amount of paved road and parking space equals about 61% of the total area.)

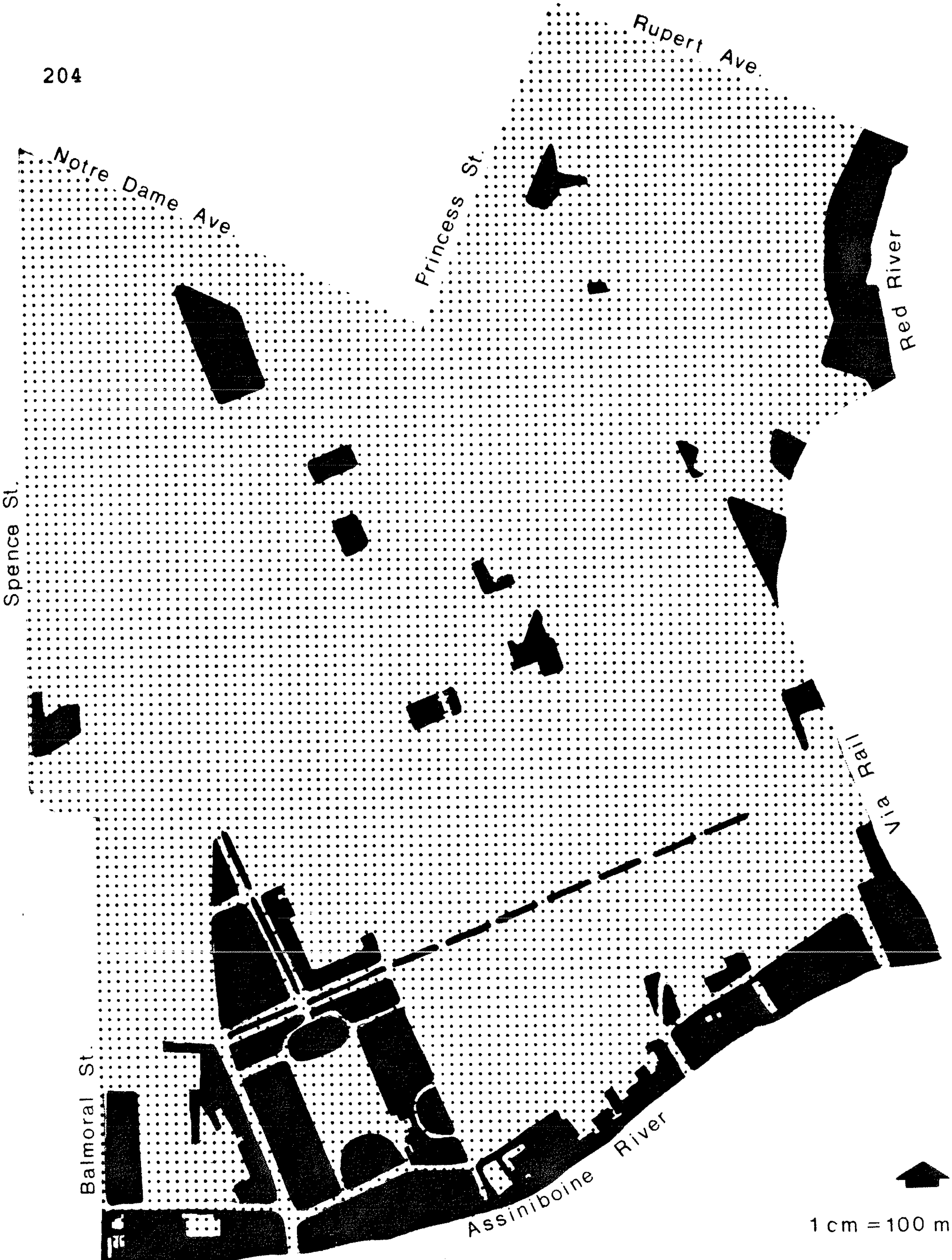


Figure 121: Green Space in Downtown Winnipeg (The total amount of green space equals about 14% of the total area.)

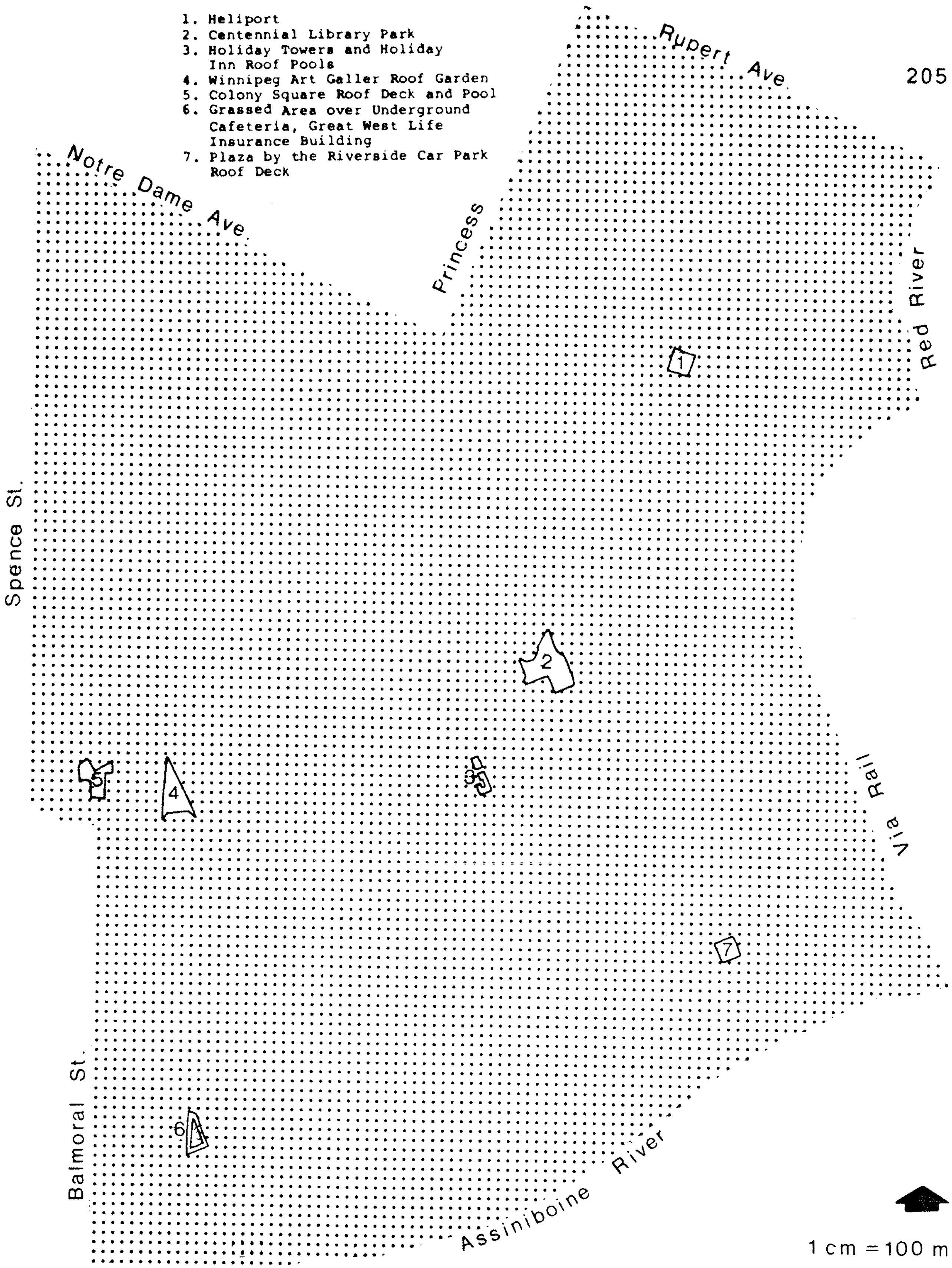


Figure 122: Present Rooftop Developments in Downtown Winnipeg

6.1 ENVIRONMENTAL BENEFITS AND LIMITATIONS IN WINNIPEG

The urban planners of today are slowly becoming more and more ecology minded as the remoteness of our urban developments from their ecological bases becomes more and more painfully obvious. The city of Frankfurt, Germany, is already considering new guidelines for urban development, which "include proposals for roofgardens and vegetative treatment of façades" (Sitta, 1983, p. 279). The chances of Winnipeg becoming the first Canadian city to develop a set of comprehensive guidelines seem, at present, rather remote.

6.1.1 River Water Pollution and Riverbank Erosion

As discussed above, one of the major environmental benefits of developed roof space is the potential for reduced river water pollution. In Winnipeg, because of high pollution levels, our rivers are "not safe for primary contact (swimming), nor . . . for secondary recreation (boating)" (Graham, 1984, p.108). Most of the pollutants picked up by rain water are not collected from the rooftops but from the streets (oil, gasoline, road salt, litter, animal droppings, etc.). It would therefore appear that a reduction in roof runoff would not reduce river water pollution. However, because of the nature of Winnipeg's separate and combined sewer systems, an increased amount of even clean water can increase the level of pollutants entering the rivers. Robert Graham explains in his practicum (1984):

> - - - there is, during wet weather, a significant overflow of untreated raw sewage from the combined

> and separate sewer systems into the Red and Assiniboine Rivers. This overflow occurs when stormwaters combining with the sanitary flow cause the water levels in sewer systems to overtop the wiers built into the underground system that, in dry weather, directs the flow to the interceptor sewers and thence to treatment . . . actual overflows can occur as often as once or twice a week during the summer months. During such storms events pollutant loadings are many times greater then [sic] the treatment plant affluent discharge. (pp. 107-108)

Any reduction in storm water runoff would therefore help reduce pollution levels in the Red and Assiniboine Rivers. This is an especially important benefit in Winnipeg because, despite the unacceptably high level of pollutants, the rivers are a major recreation resouce to many Winnipegers, and because the down-stream town of Selkirk derives its drinking water from the Red River.

Unfortunately, even though the mass planting of rooftops in the downtown area would help to reduce the level of pollutants entering the river after storms, the degree to which it could improve the actual pollution level of the rivers, is limited. Mass planting of existing downtown rooftops would result in only about an eight percent decrease in the total storm water runoff (see section 6.2.1 for an explanation of how the figure was derived). This small reduction would be rather ineffectual in reducing the amount of riverbank erosion in Winnipeg.

The reason why the benefits would be so slight in Winnipeg, is because of the city's low physical density. At present only about 23 percent of the total downtown area is covered with roof space. If this 23 percent were to increase to 35 percent (which would be much more in keeping with most other large North American cities), the runoff reduction would jump from the present 8 percent to 17 percent. A 17 percent reduction in runoff rates would make a difference in the pollution levels of Winnipeg's rivers and in the amount of riverbank erosion resulting from sudden increases in the amount of water entering the river.

6.1.2 Air Quality

Another environmental benefit of mass rooftop planting is improved air quality. According to the 1983 "Annual Summary" published by the National Air Pollution Surveillance department (NAPS) of Environment Canada, the amounts of sulfer dioxide, carbon monoxide, nitrogen dioxide, and combined sulfer dioxide and total suspended particulate matter, are all well below maximum desirable levels. Only the levels of oxidants (ozone), and suspended particulate matter exceed the maximum acceptable levels established by the government (see Table 1). The amount of vegetation in an area does not affect the level of oxidants present in the air, and mass rooftop planting would therefore not improve the Winnipeg ozone level. However, as discussed above, vegetation can reduce the amount of dust or suspended particulate matter in the air. According to Hare and Thomas (1974), the average urban dust particle load is ten times greater than the average rural load.

TABLE 1

Level of Air Pollutants in Winnipeg

(Readings taken at 65 Ellen Street.
Data from Environment Canada, NAPS.)

Sulfur Dioxide			Carbon Monoxide		Nitrogen Dioxide			Oxidants (Ozone)			Susp. Part.		Combination SO2/TSP
Ann	1H	24H	1H	8H	Ann	1H	24H	Ann	1H	24H	Ann	24H	24H
0	0	0	0	C	0	0	0	2	2	2	-	2	0

- Insufficient Data
0 Meets Desirable Objectives
1 Exceeds Desirable Limits
2 Exceeds Acceptable Limits
3 Exceeds Tolerable Limits

As Table 2 demonstrates, the amount of suspended particulate matter rises dramatically in spring when the snow cover disappears and then drops again in November when the snow cover returns. The need for dust particle absorbtion is greatest, then, during the spring, summer, and autumn -- the same time the plants are in leaf and have the greatest dust absorbtion capability.

Vegetation cover actually reduces suspended particulate matter in two ways: 1) as already stated, it traps the particles as they are blown by the wind, and 2) by covering rooftops (and walls, in the case of climbing and cascading vines), plant covers reduce the amount of hard surface from which the particles originate. A surface carpeted or draped with a green cover is protected from the abrasive winds

TABLE 2

Suspended Particulate Matter in Winnipeg Air

(Data from Environment Canada, NAPS.)

(micrograms/dubic metre)

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
18	37	42	147	-	-	78	81	95	73	38	32

which scour away and carry minute particles, which in turn, help to increase the abrasiveness of the wind. Because winds are stronger at roof level, vegetation covers would do the greatest amount of good when located on the rooftops and around the walls of the upper floors.

6.1.3 Humidity Levels

The average relative humidty, as measured at the Winnipeg International Airport, ranges from 61 percent (the monthly average for May), to 81 percent (the monthly average for December), making the annual average 73 percent (Environment Canada, 1983). This is slightly lower than the average relative humidity level of Toronto and much lower than that of Vancouver.

Although no figures are available for the average relative humidity levels in the downtown area of Winnipeg, Hare and Thomas (1974) state that the urban humidity levels are considerably lower than rural areas: the average relative humidity level in summer is eight percent lower, the winter average is two percent lower, and the annual average is six percent lower. That means that if the average annual relative humidity level at the airport is 73 percent, the average annual relative humidity level downtown would be only 67 percent.

Greening up two-thirds of the downtown rooftops would help bring the urban humidity levels up to the more natural levels found in rural environments. It would do this in several ways. First, the soil, and drainage layer below the soil, would hold rain and irrigation water and slowly release it into the air by evaporation. The water holding capacity of the roof garden would, of course, depend upon the type of design. Using the Swiss Optima system, a 23 centimetre layer of soil over a 12 centimetre layer of Hydoperl, will hold 170 litres of water per square metre.

Secondly, the plants themselves will transfer this stored water to the atmosphere through the process of transpiration. Trees have a much greater transpiration value than most shrubs and smaller plants because of the greater amount of leaf surface; an oak tree can release as much as 125 litres of water per day into the atmosphere (Sullivan, 1977). An increase in the amout of water returned to the atmosphere does two things: 1) it increases the relative humidity, and 2) it increases the chance of precipitation. S.F. Phillips

(1976) reports that *Phragmites communis* has been shown to almost double the effective precipitation. Increasing the chances of precipitation also increases the chance that more of the evapotranspirated water will find its way to the water table.

Thirdly, the greening of the downtown rooftops would increase humidity levels by trapping extra snow on the rooftops and increasing the amount of melt water in spring. Shrub and trees, especially coniferous species, would trap much more snow than ground covers, grasses and other low-growing plants.

It is difficult to project exactly how much the humidity would increase in downtown Winnipeg if two-thirds of the existing rooftops were greened up. If the average relative humidity level in summer is eight percent lower downtown than at the airport, an increase in green space of 15 percent (due to mass roof planting) would likely increase the humidity level by one or two percent.

6.1.4 Radiant Heat

Approximately 86 percent of the total downtown area of Winnipeg is covered with asphalt, concrete, and other heat-absorbing material. In addition to this, there are the huge expanses of brick, stone, and concrete building exteriors which also absorb heat. When one considers the amount of heat-absorbing surfaces, plus the facts that Winnipeg temperatures often reach 30° Celcius or more, and that Winnipeg receives an average of 2,330 hours of bright sunlight per year (Hare, 1974), it becomes easy to understand why temperatures are always higher in the downtown area. According to a study by Labelle (1966) temperatures downtown average 6° Fahrenheit (3.3° Celcius) higher than temperatures at the same time taken at the airport. (The difference could well be more than that on sunny days because the temperature difference is based on the average of both sunny and cloudy days, and the difference would be greater on sunny days, when the concrete surfaces absorb and re-radiate the solar heat.)

The mass planting of Winnipeg's rooftops could help reduce this temperature difference. According to data collected in Arizona (cited in Laurie, 1975), when air temperatures reached 42° Celcius, the temperature over the roof of a house was 71° Celcius (!), the temperature of asphalt in full sun was 51° Celcius, the temperature of grass in full sun was 35° Celcius, and grass in the shade was 32° Celcius (see figure 123). That means that there was a 29° Celcius difference between air temperature in the shade and air temperature just over a roof surface in full sun. There was also a difference of 11° Celcius between a concrete surface in full sun and a green surface in shade. Since Winnipeg temperatures are not as extreme, the temperature differences would not be as dramatic. Nevertheless, plants have a remarkable capability for reducing surface temperatures by converting solar energy into photosynthetic energy rather than heat energy), and by shading other surfaces from solar

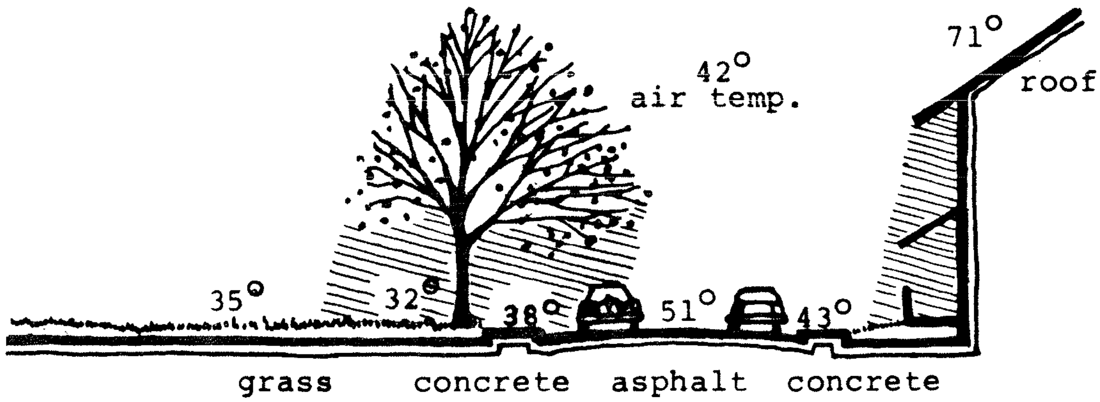


Figure 123: The Effects of Solar Radiation on Different Surfaces (After data in Laurie, 1975.)

radiation.

It is difficult to say exactly how many degrees difference the mass planting of Winnipeg's rooftops would make. If two-thirds of the existing downtown rooftops were planted up, so that at least 75 percent of each of those roofs was covered with vegetation, the amount of green space would increase from the present 14 percent to 29 percent. This doubling of the total amount of green space would most surely have a measurable affect on temperatures in the downtown area. It must be remembered, however, that the greatest benefits would be on the rooftops themselves and the spaces immediately below them, not at street level.

6.1.5 Noise Level

As already stated, the noise level of busy urban streets (such as Portage and Main Streets) average around 90 decibels, which is 16 times greater than the maximum comfort level for outdoor recreation (Road and Rail Noise, 1977). Plants do have the ability to reduce noise levels, but only to a limited extent. They are effective only when in leaf, they absorb only the high frequency noises, and large masses of vegetation are required near the source of the noise before the noise reduction is significant (Moore Friba, 1966).

In Winnipeg the effect on noise level that greening up two-thirds of the existing rooftops would probably be neglegible. Most of the noise is generated at street level and only those green rooftops at or near street level would have any effect. The only places in the downtown area where the noise level would be significantly lower would be on the tops of tall buildings. This reduced noise would be due more to the effect of distance and wind than to the presence of vegetation on the roof.

6.1.6 Wildlife

The amount of wildlife attraction which a massive roof planting scheme would bring about is largely dependent upon the type of vegetation used. Because any rooftop more than one or two floors above grade level is totally isolated from the surrounding environment in terms of animal access, the only truly 'wild' life which rooftops can attract are those animals which can fly; that is, birds, insects, and possibly bats. Any other animals would have to be brought in and cared for in the same way zoo animals have to be cared for.

According to Robert Nero, Winnipeg ornithologist for the Department of Mines and Resources, the mass greening up of downtown rooftops would have only a very limited value in terms of attracting birds, even if the roofs were covered with large, mature trees. A number of migratory birds would use these rooftops as resting places along their routes, but the many overhead wires and glass or mirrored building façades in the downtown area would result in the loss of a large portion of these numbers. Also, Poulin Exterminators are currently using strychnine-laced bird feed to reduce the pigeon population. This would create an added urban hazard for the birds (not to mention the cats and dogs that tried eating the dead birds). The increased greenery of a large-scale roof-planting scheme would not increase the present pigeon problem because pigeons are cliff-dwellers and prefer bare, flat rooftops. Unfortunately, the extra green space would also not attract falcons -- the natural predator of the pigeon -- because they too are cliff dwellers.

Also, although some migratory birds might use these roof spaces as resting places, very few, if any, of the native species would actually nest on rooftops. Those possible exceptions are the purple martin (which, contrary to popular opinion are not very helpful in reducing mosquito populations), and the tree swallow (which, like the martin, would require bird houses). Two other possible species would be the Nighthawk (which is an excellent mosquito eater), and the sparrow hawk or kestrel (which feeds on sparrows). Most species which are common in the Winnipeg suburbs would not be attracted to downtown rooftops as long as there were other habitats available.

Very little, if any, research has been done on the effects that roof planting would have on the attraction of birds native to this area. Any increase in bird population (except perhaps the pigeon) would of course be desirable. However, judging by the remarks of Robert Nero, the affect on the urban bird population would be very limited at best.

6.1.7 Summation of Environmental Benefits

As Table 3 demonstrates, the environmental benefits of greening up two-thirds of the downtown rooftops would be rather limited. The question must be asked: are the environmental benefits by themselves (that is, the reduction of urban temperature by one degree celcius, the increase of relative humidity by two percent, a slight reduction in suspended particulate matter, and a very slight improvement in our badly polluted rivers) ample justification for spending millions of dollars on a large-scale roof-greening program? Given the present state of the economy, a major roof-greening project for the sole purpose of improved urban ecology would not be practical in Winnipeg at the present time. However, as Winnipeg's physical density increases and approaches that of other large urban centres, the pollution levels and density factors may reach a state where large-scale roof-greening would be justifyable for ecological reasons alone.

At present, the environmental benefits should be considered very welcome 'bonus benefits' of a roofscaping project, if roofscaping can be justified for economic reasons or for the sake of creating extra amenity space. In other words, because Winnipeg's present environmental quality is acceptable and its physical density rate in the downtown area is so low, environmental benefits should not be seen as the primary goal of a roofscaping scheme, but effort should still be made to maximize the environmental benefits of as many rooftops designs as possible because they are important and will become more important as the city grows.

TABLE 3

Environmental Benefits of Roofscaping in Winnipeg

	At Present Physical Density Rate of 23%	At Future Physical Density Rate of 35%
River water quality improvement	1	3
Riverback erosion reduction	0	2
Air quality improvement		
SO_2, CO, NO_2, O_3,	0	0
Suspended particulate matter	2	3
Oxygen/Carbon Dioxide ratio	0	0
Humidity level increase	2	3
Radiant heat reduction	2	3
Noise level reduction	0	1
Wildlife increase	1	1

0 - Neglegible
1 - Minimal
2 - Appreciable
3 - Significant
4 - Considerable

6.2 ECONOMIC BENEFITS AND LIMITATIONS IN WINNIPEG

One of the greatest enemies of sound ecological planning has traditionally been economics. Property developers and civic administrators are accustomed to dealing in dollars and cents, in costs and returns. They are less accustomed to dealing with matters where the costs are measured in dollars, but the returns are measured in things like improved appearance, personal appreciation of the environment, and respect for the natural energy cycle. Many a tree has fallen in the city to be replaced by a parking spot because a parking spot generates direct economic revenue, a tree does not.

Sometimes, however, urban ecology can generate direct economic benefit. Roofscaping (at least certain aspects of it) is a case in point. These economic benefits of green roofgardens are discussed in the following section. If Winnipeg is ever to see an upsurge in rooftop development, these economic benefits must be played up as much as possible.

6.2.1 City Drainage System

As figure 118 shows, only 23 percent of the downtown area of Winnipeg is covered with rooftops. About one-third of these rooftops would probably be unsuitable for any type of roof planting (because of their low property value, structural instability, or location). If the remaining two-thirds of this 23 percent were roofscaped, and if 75 percent of every one of those rooftops was coverd with vegetation (thus allowing 25 percent for mechanical systems, service areas, etc.), the green space in the downtown area would be doubled (see Table 4).

If the rainwater runoff rate of the present total green space (that is, 14 percent of the total area) is assumed to be 35 percent, and the runoff rate of the remaining 86 percent of the total area is assumed to be 95 percent, then the average runoff rate for the whole downtown area must be about 87 percent.

If two-thirds of the existing rooftops were greened up, the runoff rate of 7.7 percent of the total area would remain at 95 percent (that is, one-third of 23 percent). The runoff rate of 15.3 percent (two-thirds of 23 percent) of the total area would be reduced by the addition of the vegetation. If 25 percent of these rooftops are left as hard surface with a runoff rate of 95 percent, and 75 percent of these rooftops are covered with a green surface which has a runoff rate of 25 percent, then the new runoff rate of the greened up rooftop would be 43 percent. This reduced runoff rate would result in a new average runoff rate for the whole downtown area. The reduced rate would be 79 percent. In short, mass rooftop planting in the downtown area would result in an eight percent decrease in the total runoff rate.

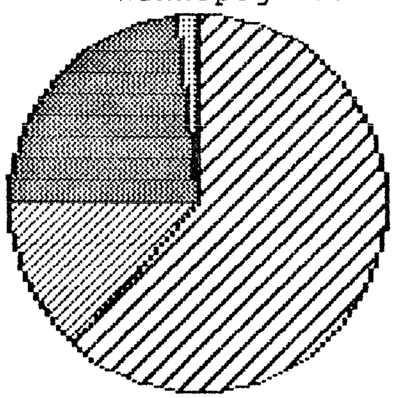
According to Ed Sharp, drainage engineer for the City of Winnipeg Waterworks, Waste, and Disposal Department, the downtown city drainage systems have recently been upgraded to a ten year flood capacity, and that an eight percent decrease would have no effect upon the maintenance and repair costs of the drainage system.

Again, it is the low physical density of the downtown area which makes roofscaping ineffectual in terms of reducing runoff. If the amount of roof space increased from the present 23 to 35 percent (as it may well do in the future), the effect of developing two-thirds of the rooftops would reduce the runoff rates from 87 to 70 percent. This 17 per-

TABLE 4

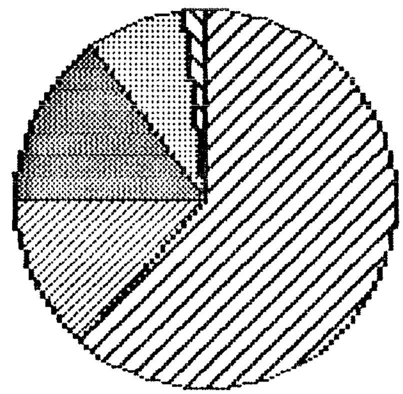
Runoff Rates Before and After Roofscaping

(Greening up two-thirds of the rooftops in downtown Winnipeg would reduce runoff by 8%.)



PRESENT SITUATION
(Total Runoff = 87%)

- 61% Automobile Space
- 14% Green Space
- 23% Roof Space
- 2% Pedestrian Space



AFTER MASS ROOF PLANTING
(Total Runoff = 79%)

- 61% Automobile Space
- 41% Green Space
- 15.3% Green Roof Space
- 7.7% Unplanted Roof Space
- 2% Pedestrian Space

cent reduction would then be enough to make a significant difference to the operations and maintenance costs of the city drainage system.

All new buildings with flat roofs now require storm water drain regulators on their rooftops. These regulators limit the volume of water which can enter the city storm drainage systems. If the amount of rain falling onto the roof exceeds the amount which the regulator allows to pass into the city drainage system, then the flat rooftop must serve as a retention reservoir, holding the surplus water until the city system can handle it. Even if mass roofscaping in Winnipeg today could reduce the operating costs of the city drainage system, it could still be argued that, economically, it would be more practical to retrofit the existing rooftops with drainage regulators than with roof gardens.

6.2.2 Thermal Insulation

As was mentioned in the last chapter, it takes at least 300 millimetres of soil to equal the thermal insualtion value of only 25 millimetres of Styrofoam SM rigid insulation. One square metre of soil, 300 millimetres deep, weighs between 435 and 525 kilograms (although a lightweight mix may weigh as little as 250 kilograms). One square metre of Styrofoam insulation, 25 millimetres thick, weighs only 1.2 kilograms. Soil would have to be taken up to the rooftop with cranes and spread with wheel barrows and shovels. The Styrofoam insulation could be brought up to the rooftop either by normal passenger elevator or window washing machine. One square metre of soil, 300 millimetres deep, would cost about \$2.70; but, if it was to support plant life, the cost of a drainage bed, a root barrier membrane, a roof protection membrane, a layer of mulch, and the plants themselves, would bring the cost up to about \$35.00 per square metre. (The cost of an irrigation system and drainage hardware would probably also have to be added to the cost.) One square metre of Styrofoam insulation, 25 millimetres thick, costs about $4.00, or $6.50 installed. But most importantly, the cost of increasing the load bearing capacity of the building with the Styrofoam insulation would be zero because it is almost weightless. The cost of increasing the load bearing capacity of the building with the roof garden providing the same insulation value, could easily be $100.00 per square metre or more. (The amount would vary dramatically depending upon the type of structural system used.)

In addition to reducing the heating and cooling costs for a building, a roof garden can also reduce the maintenance costs of repairing roof sealants, flashings, fittings, and so on. For example, because of the thick layer of soil and vegetation protecting the mastic asphalt sealant on the roof of Derry and Toms Departmental Store, the roofing is "still in perfect condition after 40 years" (Scrivens, 17 March 1982, p. 75). A layer of ridgid insulation capped with asphalt-impregnated felts, or bitumen sealant and gravel, cannot provide this type of protection. This saving in maintenance cost is, however, negated by the higher costs of maintaining the layer of plants and soil.

Clearly, the cost of increasing the thermal insulation of a rooftop by means of traditional ridgid insulation is only a fraction of the cost of using soil and plants, even though the energy savings would be the same. The added insulation value of a roofgarden, then, can be seen as a fortunate bonus of roofscaping, but not a prime reason for roofscaping.

6.2.3 Costs of Roof Garden Construction

As Table 5 indicates, the costs of different types of vegetative covers can affect the cost of the garden in a dramatic way. The cost of the garden itself, that is, everything above the waterproofing layer, could cost as little as $15.00 per square metre for a thin layer of soil and turf, or as much as $345.00 per square metre for a one metre deep soil profile and medium sized trees. (It should be noted that most of the price difference between the roof garden containing only shurbs, and the one containing trees, is due mainly to the cost of mature trees, and that the entire roof garden would not likely be covered with trees.) Added to the above figures must be the costs of irrigation systems, drainage hardware, retaining walls, lighting and electrical work, furniture, built structures, and the cost of extending the stairwells and elevators an extra storey.

Another very important factor determining the cost of roof garden construction is the cost of the roof structure required to support the weight of the garden (see Table 6). The weight of a traditional tarred felt and gravel roof is only about 226 kilograms per square metre, and costs about $26.50 per square metre. The weight of even the lightest type of roof garden being built in North America today, plus

TABLE 5

The Cost and Weight of Various Roof Garden Types
(Prices based on 1985 quotes from various Winnipeg suppliers.)

	Component	Weight (k/m^2)	Cost ($\$/m^2$)
Paving	paving stone	150 k/m^2	\$ 45.00 m^2
	5 cm sand base	30 k/m^2	\$ 1.00 m^2
	10 cm aggregate subbase	160 k/m^2	\$ 2.50 m^2
	Total	290 k/m^2	\$ 48.50 m^2
Grass	turf	5 k/m^2	\$ 1.70 m^2
	10 cm lightweight soil	85 k/m^2	\$ .90 m^2
	10 cm aggregate	160 k/m^2	\$ 2.50 m^2
	3 mm protection membrane	—	\$ 10.25 m^2
	Total	250 k/m^2	\$ 15.35 m^2
Ground Covers	plants	—	\$ 20.00 m^2
	25 cm lightweight soil	210 k/m^2	\$ 2.20 m^2
	10 cm aggregate	160 k/m^2	\$ 2.50 m^2
	3 mm protection membrane	—	\$ 10.25 m^2
	Total	370 k/m^2	\$ 34.95 m^2
Shrubs	plants	—	\$ 25.00 m^2
	60 cm lightweight soil	510 k/m^2	\$ 5.30 m^2
	10 cm aggregate	160 k/m^2	\$ 2.50 m^2
	3 mm protection membrane	—	\$ 10.25 m^2
	Total	670 k/m^2	\$ 43.05 m^2
Trees	tree (6 cm caliper)	385 k/m^2	\$300.00 m^2
	ground cover	—	\$ 20.00 m^2
	100 cm lightweight soil	850 k/m^2	\$ 8.80 m^2
	15 cm aggregate	240 k/m^2	\$ 3.70 m^2
	3 mm protection membrane	—	\$ 10.25 m^2
	Total	1475 k/m^2	\$342.75 m^2

the roof structure required to support it, is over three times as much, and costs more than twice as much. The weight of a roof garden containing trees, plus the roof structure required to support it, is nine times as much, and costs at least 15 times as much.

TABLE 6

The Cost and Weight of Various Roof Structures Plus Roof Gardens

(Prices based on 1985 quotes from various Winnipeg suppliers.)

Snow load for Winnipeg	176 k/m^2	$ — /m^2
16 gage steel roof deck (38mm)	20	12.00
51 mm Polystyrene insulation	3	7.75
3-ply asphalt-impregnated asbestos felt vapour barrier and gravel roofing	27	6.75
TOTAL	226 k/m^2	$26.50/$m^2$
Snow load for Winnipeg	176 k/m^2	$ — /m^2
204 mm thick Dy-Core lightweight hollow core concrete slab *	283	37.70
51 mm Polystyrene insulation	3	7.75
Asphalt-impregnated felt vapour barrier	—	1.75
Roof garden (paving only)	290	48.50
TOTAL	752 k/m^2	$95.70/$m^2$
Snow load for Winnipeg	176 k/m^2	$ — /m^2
204 mm thick Dy-Core lightweight hollow core conrete slab *	283	37.70
51 mm Polystyrene insulation	3	7.75
Asphalt-impregnated felt vapour barrier	—	1.75
Roof garden (grass only)	250	15.35
TOTAL	712 k/m^2	$62.55/$m^2$
Snow load for Winnipeg	176 k/m^2	$ — /m^2
204 mm thick Dy-Core lightweight hollow core conrete slab *	283	37.70
51 mm Polystyrene insulation	3	7.75
Asphalt-impregnated felt vapour barrier	—	1.75
Roof garden (ground covers only)	370	82.15
TOTAL	832 k/m^2	$82.15/$m^2$
Snow load for Winnipeg	176 k/m^2	$ — /m^2
204 mm thick Dy-Core lightweight hollow core conrete slab *	283	37.70
51 mm Polystyrene insulation	3	7.75
Asphalt-impregnated felt vapour barrier	—	1.75
Roof garden (shrubs only)	670	43.05
TOTAL	1132 k/m^2	$90.25/$m^2$
Snow load for Winnipeg	176 k/m^2	$ — /m^2
305 mm thick Dy-Core lightweight hollow core conrete slab *	391	45.75
51 mm Polystyrene insulation	3	7.75
Asphalt-impregnated felt vapour barrier	—	1.75
Roof garden (medium size trees)	1475	342.75
TOTAL	2045 k/m^2	$398.00/$m^2$

* Based on a maximum span of 6 metres

Table 6 takes into account only the cost of the garden and the roof structure itself. It does not take into account the cost of footings, columns and roof beams required to support the roof structure.

The best way to control the structural load of the heaviest elements used in roofscaping, is to place these elements (trees, rocks, etc.) directly over the structural columns

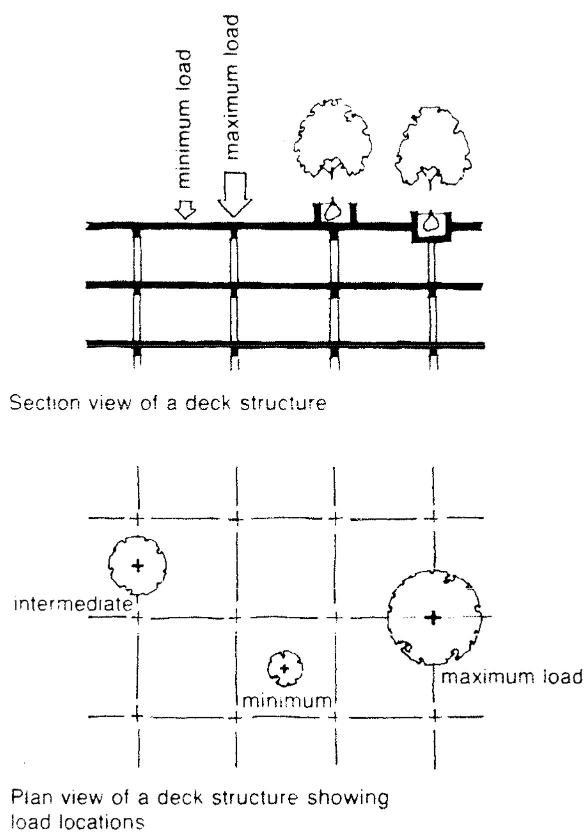


Figure 124: Locating Concentrated Loads over Structural Supports (From "Roof Decks Design Guidelines," 1979.)

(see figure 124).

Clearly, roof gardens are expensive propositions in Winnipeg. There are a number of European prefabricated roof garden systems (such as Brecht, Technoflor, Zinco, Frankische, and Optima) which are substantially lighter than any of the traditional systems. The Brecht system provides a ground cover system weighing only 150 kilograms per square metre. These systems can be fitted onto the rooftops of most buildings without having to do any sort of structural alterations. Unfortunately, these systems are not yet available in Canada. If they were tested here, and proved successful in our severe climate, they could be either manufactured here or imported from Europe. This could significantly reduce the cost of roof planting, possibly even making it an economically feasible alternative to rigid insulation.

One other system which is not yet available here, but which could make rooftop planting economically feasible on just about any building, is the "AGRO-Grün" system manufactured by AGRO-Foam-International GMBH (Kaiser, 1981). Instead of soil, it uses a seed mat on top of a polystrol substrate. The system creates a load of only 25 to 30 kiograms per square metre when wet. Within one year of installation the seed mat is covered with a thick carpet of sedum which, being a succulent, does not require any irrigation. The thermal tests done (using two idential roofs, one covered with "AGRO-Grün," the other not) showed that the system kept the room termperature of the spaces directly below the roof an average of 4° Celcius cooler in summer and up to 7° Celcius warmer in winter.

6.2.4 Revenue Generating Rooftop Developments

There are three basic ways in which rooftop developments could generate revenue and stimulate the economy in Winnipeg. The first way would be to start up a roofscaping industry which manufactured prefabricated systems. This could create jobs here in Winnipeg, and because there are no competetors elsewhere in Canada, could also bring in money from outside the province, or outside the country.

The second way in which rooftop developments could generate revenue in Winnipeg would be through the rental, or even sale, of rooftop realty. At present, not a single building owner in the downtown area makes a single cent from their rooftops. If buildings owners and realtors began leasing roof space the way they lease interior space, they would benefit from the added income. The developers, in turn, could construct service-based enterprises which generate user fees on these rooftops. The number and variety of such businesses which could occur on rooftops in Winnipeg is limited only by the imagination. Some of the more obvious ones would be: garden restaurants, nightclubs with outdoor dance floors, outdoor theatres and cinemas, miniature golf courses, tennis courts, roller rinks, ice rinks, daycare centres, 'totlands,' amusement centres, and lawn bowling greens. Product-oriented businesses, such as florists and vegetable growers, could also lease roof space for gardens and greenhouses. Rooftops could also be leased to surrounding residents for allotment garden space. As well, the rooftops of office and warehouse buildings could be leased and developed as private garden penthouse suites (see subsection 6.3.4).

The third way in which rooftop developments can generate income, is by increasing the resale value of the building and surrounding property. Large public rooftop parks, such as those built above underground car parks, automatically increase the value of the property immediately surrounding the park. In this way, the view can actually be translated directly into dollars and cents. In Winnipeg the only added taxation for retrofitting an existing building with a roof garden is a minor tax increase on any structural improvements which might have to be made to increase the load bearing capacity.

6.2.5 Summation of Economic Benefits and Limitations

At present, economic benefits alone are not enough to justify the cost of constructing roof gardens, unless the roof garden itself if designed to generate money through user fees or rental fees. As was shown in subsection 6.2.1, planting up two-thirds of Winnipeg's present downtown rooftops would not reduce maintenance and repair costs for the city drainage system. Subsection 6.2.2 demonstrated that, economically, it is much more advantageous to decrease heating and cooling costs by insulating rooftops with rigid insulation than with soil and plants. This added thermal insualtion value can be promoted as a a benefit of roof gardens, but it is not reason enough to justify the cost.

The low-cost, lightweight, roof planting systems of Europe, on the other hand, may change all that if they are tested and marketed in Canada.

The cost of roofing a building with even the least expensive type of traditional roof garden is usually twice as much as roofing a building with a conventional steel deck and asphalt or bitumen roofing system, and can easily climb to nine or ten times the cost. The heavier the garden the greater the cost, not only for the roof structure itself, but also for the structural system supporting it.

The one type of rooftop development which can be justified on economic grounds alone, is that type which generates direct financial returns. This can be done by developing service-based (especially food- and recreation-based) businesses on rooftops for which user fees can be charged. This can also be done by leasing rooftops to those who wish to develop them as private garden penthouse suites, or to those who wish to use them as commercial gardens or community allotment gardens and greenhouses. Some might be leased as heliports or scientific research stations.

Most of the commercial uses of rooftops would not provide a great deal of environmental benefits because most of them require more paved areas than planted areas (commercial, community, and private penthouse gardens being, of course, the exceptions). The urban environment would still benefit aesthetically from these developments. Even though a miniature golf course or tennis court may not be as attractive as a garden, they would still be an improvement over the usual tar and gravel rooftops strewn with mechanical paraphernalia. The presence of human figures can, by itself, make rooftops more visually appealing.

6.3 OPEN SPACE BENEFITS, AND AESTHETIC BENEFITS IN WINNIPEG

As figure 119 demonstrates, the amount of private and public amenity space in the downtown area is rather limited and the public amenity space is spread out around the perifery of the area. As figure 120 demonstrates, there is a tremendous amount of space in the downtown area devoted to the automobile, especially in the way of open, grade-level parking lots. This has resulted in a very inefficient use of land and an unattractive cityscape. The following section discusses how roof gardens and roof parks, both at grade-level and on multi-storey rooftops, can help to improve the Winnipeg situation.

6.3.1 Public Open Space Requirements

Although the amount of open green space per person, or per hectare of total urban area, is not as important as the quality of the space, these quantity-based standards are still useful as general urban planning guidelines. Winnipeg's Works and Operations District 1, includes the downtown area, but extends as far west as St. James Street, as far north as Higgins Avenue, as far south as Harrow Street and Pembina Highway, and as far east as to include all of Churchill Park. District 1 has a population of 111,954 (1983 Cencus), and a total of 128.7 hectares of public open space. This amounts to 11.5 square metres of open space per person, or 1.1 hectares of open space for every 1,000 people. (A comparison between Winnipeg and somes other cities

TABLE 7

Open Space/Population Ratio Comparisons

City	Hectares of Open Space/ 1000 Persons	Population Density (persons/ hectare)	Percentage of City covered by Public Open Space
New York City	1.8	513	19.8
Chicago	.8	1287	4.8
St. Louis	1.5	620	2.3
Winnipeg (Dist. 1 only)	1.1	870	.05

is shown in Table 7) The comparison in Table 7 may not be totally accurate because the Winnipeg figures are for District 1 only and the figures for the other cities are for the entire metro areas. Nevertheless, it is interesting to note that District 1 has a lower amount of public open space per 1,000 persons than St. Louis, Chicago, or New York City. The most amazing comparison between the cities is the percentage of the entire area covered by public open space. New York City, which is one of the most densely populated centres in North America, has almost 20 percent of its total area covered with public open space. Winnipeg's District 1, a relatively sparcely populated area, has less than one-tenth of one percent of its total area covered by public open space. The difference is, New York's population is stacked vertically, and the city has a 341 hectare park in the centre of it; Winnipeg's population is spread horizontally and the largest park in District 1 is Churchill Park, which is around 32 hectares.

Canada Mortgage and Housing recommends that about one hectare of public open space be allotted for every 1,000 persons (Site Planning Criteria, 1978). Both District 1, and the downtown area by itself, fall within this recommended minimum. The United States National Recreation Association guideline for in-city public recreation space is four hectares per 1,000 persons (Gold, 1973). This recommendation appears to be rather optomistic considering the amount of open space available in most cities today, but it does not seem unreasonable when one considers that about 11.5 hectares of space is required for a community recreation area (with court and field sports, swimming pool, ice rink, theatre, parking, etc.) (Gold, 1973).

About 11 percent of the downtown area is covered by public amenity space. The large expanse of lawn surrounding the Legislative Building accounts for almost half of this 11 percent. The only significant public green spaces in the downtown area are Steven Juba Park in the extreme northeastern corner, Bonnycastle Park in the extreme southeastern corner, Memorial Park in the southwest corner and Central Park in the northwest corner (see figure 119). The only public green space in the central area is the Centennial Library Park, the meridian green space along Broadway Avenue, the small 'Window Park' on Portage Avenue, and the even smaller 'Japanese Garden' in Lakeview Square.

Given the problems of access, cost, and size restrictions, it is preferrable to develop public green space at street level rather than on rooftops several or many storeys up in the air. Winnipeg is still in the fortunate position of having large areas of street level space available which could be developed as green space. Nearly all this space is currently used for parking. If the parking is put in two- or three-level, underground car parks, the amount of parking spaces could actually be increased, and the street level rooftops could be covered with public green space. For example, the adjacent parking lots on York Avenue between Edmonton and Hargrave Streets could provide an additional public park larger than Bonnycastle Park or even Central Park, and still provide the same number, or more, parking spaces. The underground parking would keep the cars shaded in summer and heated in winter, and could be connected with tunnels to a half-dozen buildings, including the Convention Centre. Carlton Street would not have to be sealed off where it crosses the park; instead, the park could run underneath the street the way Robson Square runs underneath Robson Street in Vancouver.

It has long been known that the exodus of full-time residents from the city centre to the suburbs, must be halted or reversed if the city centre is to be saved from further decay. If this is ever to happen the downtown area must be made a more attractive environment. By moving the large expanses of unattractive, barren parking lots underground and covering them with green rooftop park space, the visual and environmental quality of the downtown area could be improved considerably.

6.3.2 Semi-Public Open Space Requirements

Most of the downtown development is made up of retail shops, office buildings, warehouses, and industrial buildings (garment manufacturers, and light industries). All of these buildings are occupied by employees, most of whom live outside the downton area but who spend seven to nine hours of every weekday in the area. In addition to all these 'part-time residents' are the many Winnipegers who come to the downton area to shop or do business during the day, and to visit theatres, cinemas, restaurants, and nightclubs, during the evenings. All of these people require a certain amount of outdoor open space.

The rooftops of office buildings, warehouses, and factories, could provide ideal outdoor amenity space for employees. If garden cafeterias were located on the rooftops of these buildings, employees would not have to leave the building during their breaks to find a sunny green space in which to eat or relax. If the outdoor portions of these garden cafeterias are visible from the indoor areas, the view of the roof garden, and surrounding cityscape, could still be enjoyed in winter and during rainy weather.

Office warehouses, and factory rooftops, could also provide ideal locations for employee recreation programs. Jogging tracks, ping pong tables, shuffleboard, saunas, even swimming pools and tennis courts, could be constructed on rooftops for the use of employees. These recreation facilities could be used for aerobic exercise breaks during the day, as well as for after work hour recreation and office parties during the evenings. These rooftop recreation centres would require both indoor and outdoor areas so that they could be used year round.

Rooftop developments on top of the large retail stores in downtown Winnipeg could provide green open space for the many Winnipegers who come downtown to shop. A cafeteria and playground with babysitting service on the roof of The Bay building, for instance, would attract extra customers, especially parents with children. The roof of the Eaton's building could be linked to the roof of the Somerset Building, and possibly also to the roof of Eaton Place, by skywalks, thus making one large roof garden. The roof garden could offer a daycare service for the many parents working in the surrounding buildings, as well as garden cafeteria, amusement centre, and park space. All of these things would attract additional shoppers, and the daycare service would allow parents to spend their lunch hours with their children because it would be within walking distance of their places of employment

The rooftops of many of the downtown buildings, especially those in the theatre district, could provide ideal locations for nightclubs and garden restaurants. The Chamber of Commerce Building, the Electric Railway Chambers Building, the old Bank of Nova Scotia Building on Portage, and the Curry Building across the street from it, are just a few of the buildings which could be crowned with restaurants with garden terraces, or nightclubs with outdoor tables, stages, and dancefloors. These places could offer spectacular views of the sunsets and city lights, plus a kind of novelty and privacy that could not be created at ground level.

6.3.3 Semi-Private Open Space Requirements

The type of building in the downtown area for which the development of roof space is most critical is the apartment building. The Canada Mortgage and Housing Corporation requires that housing units above ground have a minimum of four square metres of outdoor living area, the minimum dimension of which must not be less than two metres, and 50 percent of which must be enclosed by an exterior wall or screen (Outdoor Living Area Advisory Document, 1980). This is clearly a very limited amount of space, especially if it is provided in the form of private space (a balcony or terrace). If the four square metres of space required for every unit is pooled and combined to create a semi-private outdoor living area (a community garden), the amount of space available to every tenant is exponentially increased but the personal appreciation, and use, of that space decreases at almost the same rate. This decrease is due to the fact that community space is usually not immediately accessible, and visible, from the private indoor living space; because it is not as private; and because individuals cannot directly control the use of, or shape the appearance of these spaces.

As was discussed in subsection 6.3.1, the amount and allocation of public open space in the downtown area is poor. The amount of useable outdoor living space immediately surrounding the apartment blocks in the downtown area is either non-existant or severely limited. It is therefore essential that every bit of open space available around and above these apartment blocks be developed to their fullest potential. Community roof recreation centres or roof gardens cannot provide tenants with the kind of private outdoor living space which every suburbanite takes for granted, but they can offer some opportunites which even large private gardens cannot. For example, the community roof garden offers the opportunity to meet and socialize with other tenants, whereas the private garden does not; the community roof garden offers the best possible view from anywhere in the building, whereas the private balcony or private grade-level garden offers a view only in one direction and sunlight during only a certain part of the day; and, because community roof gardens and recreation centres are provided for the use of so many more people than the private garden, they can offer larger amounts of useable green space and many more recreational facilities.

As was stated in the last chapter, the present situation of apartment building roof gardens in Winnipeg is, at best, dismal. This situation is the result of a lack of understanding of user needs, a lack of recognizing the full potential of roof space, the result of poor waterpoofing techniques, and the manner in which roofgardens have been tacked onto the tops of buildings rather than made an integral part of them. Design guidelines for developing apartment building rooftop gardens (including roofgardens on adjoining car parks), are well laid out in the Canada Mortgage and Housing Corporation publication <u>Roof Decks Design Guidelines</u> (1979).

There are a few issues regarding apartment building roof gardens which are specific to Winnipeg. There are only 171 frost free days per year in Winnipeg, and only 122 days when the maximum temperature exceeds 18° Celcius. If you subtract from that number, the number of days that it rains, the number of days that temperatures are exceptionally high, and the number of days that winds are exceptionally strong, the number of days left in a year when lounging on a roof deck is comfortable, dwindles down to a very small proportion of the year. For this reason, it is absolutely essential that the roof garden include a climate-controlled indoor area which can be used year round. Indoor pools with adjacent outdoor sundecks make more sense than outdoor pools. Uninterrupted visual access to the outdoor garden area from the indoor area is also important if the garden is to be enjoyed year round the way a residential back garden is enjoyed. The more attractions in the indoor area (such as party rooms with kitchens, games rooms, exercise rooms, saunas, and so on), the greater the attraction to the roof. The more the indoor area is used, the greater the awareness, and thus the greater the use, of the outdoor area. Plants should be used which are attractive in both winter and summer. The opportunity for active outdoor winter activity is also highly desirable. Pools which can be used as ice rinks in winter, and play areas where children can build snowpeople, will help maximize the use of the roof in winter.

Another climatic condition which must be given special attention in Winnipeg is the wind velocity. The high wind speeds characteristic of this city are several times stronger at roof level than they are at street level. Both the plants and the people using these rooftops must be protected from these winds. A solid parapet around the roof perimeter usually creates troublesome turbulance on the leeward side. A barrier which allows some of the wind through is preferable. A louvred parapet with horizontal louvres pointed up will help direct the wind up and over the roof space (see

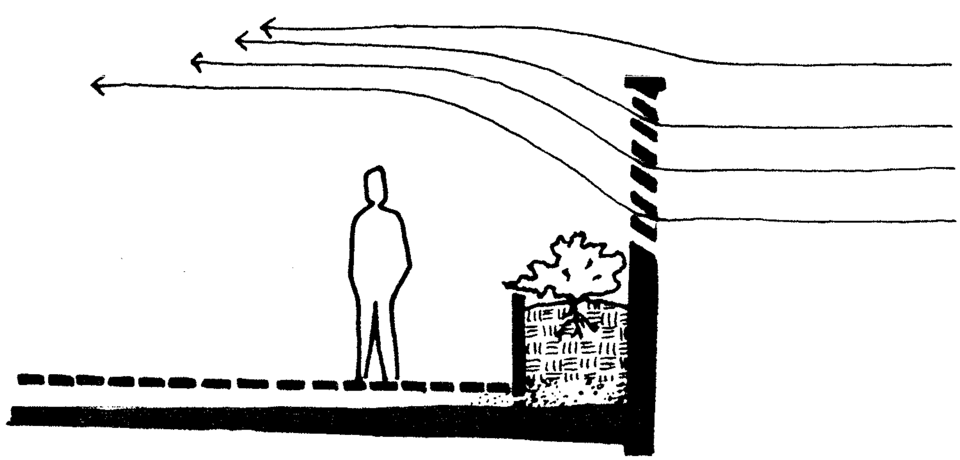


Figure 125: Louvred Parapet to Reduce Wind Effects

figure 125).

Several Winnipeg roof gardens were closed because tenants threw things over the edge (everything from beer bottles to shopping carts). The temptation for people to throw objects over the edge can be combated in several ways. One way is to ensure that the roof garden is constantly monitored by lifeguards, building security personnel, or maintenance staff (either by being on site or with closed-circuit cameras). Another way is to build parapets higher than eye level, or recess the parapet a metre from the roof edge. Most of the pleasure derived from throwing things over the edge comes from watching it fall and hit the ground. Since a tall or recessed parapet prevents anyone from watching this happen, most of the temptation is elliminated. These types of parapets also reduce the discomfort of those who suffer from vertigo.

Another type of semi-private open space which can be created on the roof of either apartment buildings, or almost any other type of building in the downtown area, is the community allotment garden. Residents of the downtown area have virtually no place in which to grow their own fruits and vegetables (except for those very few who live in houses south of Broadway and in the northwest corner). There are many sunny rooftops in the downtown area where allotment gardens could be built. For example, the two-storey Children's Aid Society building at 144 Garry Street, could be fitted with about 47 raised planting beds, each about 15 square metres. A locked stairwell could be added to the side of the building, thus making the plots more private and less subject to vandalism than street-level plots.

6.3.4 Private Open Space Requirements

Historically, the most interesting and imaginative roof gardens have been the private pleasure gardens. There are a number of reasons for this. As was discussed in section 2.1, one of the things that make roof spaces so attractive is the feeling of being above it all, of being removed from the noise, hustle, and chaos down in the streets. Private rooftops are places to escape to, quiet islands of retreat. The private penthouse garden is an environment which you, as owner, can shape and control. The penthouse garden is directly accessible from the indoor living area and acts as an extension of that space; there are no extra stairs to climb, and no elevators to ride to get from indoors to outdoors. The penthouse garden can be observed year round from the comfort of one's own living, dining, or bedroom. They are places where one can entertain guests without bothering neighbours. From the penthouse garden one can watch the sun come up, bask in the noonday sun, admire a fiery Winnipeg sunset, gaze at the glitter of city lights, and wonder at the star-strewn heavens. The sky is the most dominant feature of the prairie landscape, but there are precious few places in the city where its vastness and beauty can be appreciated the way it can be from a rooftop.

Penthouse suites with gardens often fetch two or even three times the rental rates, or sale price, of other suites in the same building. And yet they are very scarce in Winnipeg, and almost non-existent in the downtown area. Because open space is so limited around the downtown apartment buildings, it is preferable that the rooftops of these buildings be roofscaped as community gardens rather than as private penthouse suites. However, there is no reason why penthouse suites cannot be built on the rooftops of other types of buildings. Many office buildings would make excellent sites for one, two, or more penthouse suites grouped around a central rooftop foyer. This would mean that the elevator would have to be extended an extra floor, and that an extra security system would have to be designed to allow residents and guests to use the building elevators after office hours.

Obviously, the construction of garden penthouse suites would be expensive, and the rental rates or sale prices would therefore push them out of the reach of most people. But, the desirability of location would be enough to justify the extra cost for many people, and the construction of these garden penthouse suites would help to improve the appearance of our roofscape to the benefit of everyone.

6.3.5 Visual Improvement

The view of downtown Winnipeg from the air, or from any window above the fifth floor, is rather depressing (see figure 126). At present the need for a mass roofscaping scheme is more justifiable for aesthetic reasons than for environmental or economic reasons. Unfortunately, aesthetics is always last on the list of priorities when the economy is poor. A large-scale beautification program for downtown rooftops could actually create a lot of jobs, stimulate the economy of the construction industry, and improve economic conditions in the downtown area by attracting more full-time residents.

There are many ways of improving the appearance of rooftops in Winnipeg. The use of plant material is the most desirable way because of the environmental, thermal, building longevity, psychological, and physical health, benefits associated with increased amounts of vegetation. Plants help improve the overall appearance of the urban roofscape by softening the hard edges, by adding colour and textural variety, and by adding the element of change (daily, seasonal, and long-term change). Vegetation can animate an otherwise lifeless, static roofscape.

But there are other ways of improving the appearance of urban rooftops, many of them simpler and less expensive. One of the first steps in improving the appearance of either an existing rooftop or a rooftop still in the planning

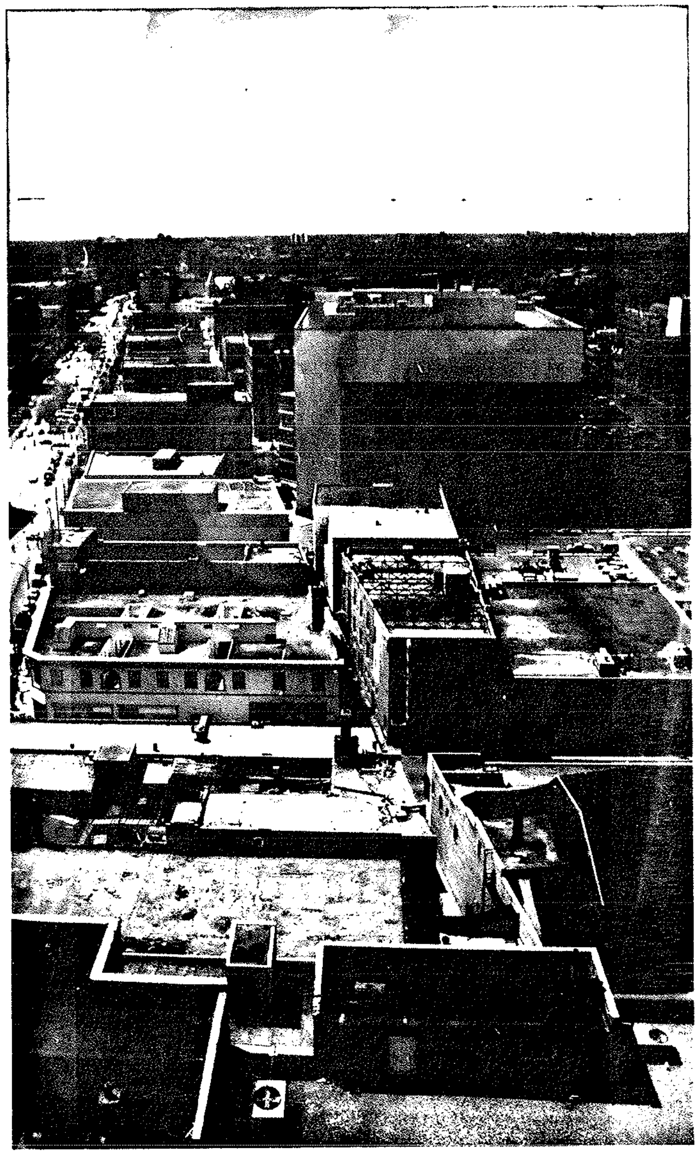


Figure 126: Typical View of Rooftops along Portage Avenue

stage, is to minimize the amount of rooftop paraphernalia. Air conditioner compressors, chillers, fans, vent hoods, lift housings, and satellite dishes, should all be made as compact as possible and grouped together. Often many of these things can be worked into the rooftop design and chamouflaged or disguised. Skylights can become attractive features when illuminated from below at night. Lift housings can be made of glass and flood lit to expose the works.

One alternative to plant material is water. Besides being attractive, water roofs will help cool the building below and the space around it in summer. They will help increase the humidity level of the dry urban air mass (especially if the water is aerated with fine jets). They can also act as storm water retention pools if designed to do so. The draw-backs are: they can be used only about five months of the year, maintenance requirements are often high, and the weight of the water can make expensive structural reinforcements to the building necessary.

Large, still reflecting pools, choreographed/computerised light and water fountains, and cascades tumbling down a series of descending roof levels, are only a few of the ways in which water can be used to create spectacular roofscapes. Sheets of water directed over glass skylights and down glass walls will add an ethereal quality to the light entering the building during the day, and during the night the interior lights will illuminate and colour the water. Mirror-fractured and gas-difussed laser lights could be integrated with fountains, or used as a substitute for water in winter. Neon sculptures and paintings, which are very much in vogue at present, could also be used to enliven rooftop space. In winter many of these lighting systems could still be used to 'paint' the snow.

Some rooftops could become accessible, or non-accessible, sculpture gardens. In winter, large wire-frame sculptures could be sprayed to create lightweight ice sculptures, illuminated from within.

Roof paintings such as the one done by Calder (see figure 83) are another way of improving the appearance of our rooftops. Roof paintings are inexpensive and effective. There are no environmental or thermal benefits, and their longevity is limited, but they are inexpensive enough to be periodically redone. Advertisements were once commonly painted on the blank walls of commercial buildings, especially in the warehouse district. More recently, the walls of a number of 'porta-parks' were painted with graphics, and the large wall facing the Main Street entrance to Market Square was covered with a mural. It would be unfortunate if our rooftops were all suddenly covered with huge advertisements, like huge horizontal billboards, but that would be one way of generating revenue from rooftops.

Even a fresh layer of white gravel and the removal of all unnecessary paraphernalia could improve the appearance of many rooftops. Small rooftops which are visible from the windows of surrounding buildings could be ideal sites for Zen stone gardens; raked gravel and carefully chosen and placed rocks, would be visible for contemplation but free from pedestrians and their footprints.

Patterned paving material is another way of making our rooftops more attractive. Paving material is generally lighter than most roof garden systems, and if it is laid on top of a grid of angle irons so that there is a few centimetre gap between the paving and the roof sealant where air can circulate, the paving can actually shade the roof surface and keep it cooler in summer. An attractive paving would give the rooftop a more finished appearance and possibly give the roof some functional uses as well.

Those rooftops which are in constant shade and where physical access is not desirable, could be covered with a carpet of moss. Six to seven square centimetre pieces of moss placed 15 centimetres apart will grown into a continuous carpet in four years. Moss will grow when moisture is present and 'hibernate' when it is not. A one or two centimetre layer of garden soil spread over a five centimetre layer of roof gravel is the only base that is required (Trillitsch, 1979).

The ways in which the appearance of Winnipeg's rooftops could be improved are limited only by our imaginations. Today rooftops are almost as visible as façades. It is essential that in the future architects give them the same attention as they give to the vertical surfaces.

6.3.6 Summation of Open Space Requirements and Visual Improvements

The present amount of public open space in the downtown area meets general Canada Mortgage and Housing Corporation requirements on a per capita basis, and on a land percentage basis; but, accessibility in the central part of the area is limited and the quality of the space leaves a lot of room for improvement. In order to attract more full-time residents to the downtown area, and improve the appearance and recreational opportunities for everyone, it is desirous that some of the huge parking lots be put underground and covered with street-level public roof parks.

Many of the office buildings, large retail stores, and warehouses could be fitted with roof gardens for the use of employees and shoppers. It is essential that these gardens include both outdoor and glazed indoor areas. Cafeterias, daycare centres, and baby-sitting services would increase the number of shoppers, increase employee job satisfaction and productivity, and increase the year round use of the roofscape. Many of the buildings could be fitted with garden restaurants, nightclubs, and health spas. all of which would increase the evening population levels of the downtown area.

Amenity spaces surrounding downtown apartment buildings are, at present, severely limited. Rooftop recreation centres with both indoor and planted outdoor areas are highly desirable. The needs and inclinations of tenants must be completely understood when designing these roof gardens if past failures are to be avoided.

Many office buildings and warehouse buildings in the downtown area could be fitted with private garden penthouses. The rental fees from these suites would provide extra income for the building owners, and improve the appearance of the urban roofscape.

The aesthetic blight from which the Winnipeg roofscape currently suffers could be greatly improved by the construction of roof gardens, water roofs, light sculptures/paintings, roof paintings, Zen stone gardens, patterned paving material, moss gardens, and a host of other types of cosmetic and environmentally beneficial developments.

6.4 RECOMMENDATIONS FOR FUTURE ROOFSCAPING IN WINNIPEG

The following list of recommendations is a condensation of all the issues discussed in the last two chapters. It is intended to serve as a general guideline for the direction and nature of future roofscaping in Winnipeg.

The process of sowing, watering, and nurturing our now barren rooftop deserts into productive oases, is a long, slow, and on-going labour. It will be years before our many rooftops are transformed, and many more years before they mature and reach their full potential. If the literature search and historical research presented in the first part of this study is seen as the gathering of 'rooftop seeds,' the final two chapters represent only the culling and preparation of that seed. The actual planting of these seeds is dependent upon the initiative of the architects, landscape architects, and developers, who ultimately determine the shape of our cities.

RECOMMENDATIONS

1. According to the findings of this investigation, and opinion of its author, the combined environmental, economic, recreational, and visual, benefits of developing roof space are more than enough to justify an extensive roofscaping program for the city of Winnipeg. This roofscaping program should be made an integral part of the long-term master plan for the development of the downtown area. A roofscaping program might also be added to the Core Area Initiative's present list of 13 programs.
2. Rooftop development could be promoted in Winnipeg through the creation of tax incentives, financial assistance, advertising, and educational programs.
3. Because rooftops are so very visible today, architects must be persuaded to pay as much attention to the design and detailing of rooftops as they do to the rest of the building exterior.
4. Existing and future roof space should be considered as valuable, leasable or salable realty. (The owner

of an building could legally sell the rooftop of the building to another who wished to develop it by filing for a "Condominium Declaration.")

5. At present, the main aim of a roofscaping program for the city should be the creation of aesthetically pleasing amenity space. The use of plant material should be strongly promoted in order to maximize the environmental benefits of roofscaping, but should not become the main goal of the program.
6. Planted roof gardens and 'water roofs' should be designed to retain as much water as possible, trap as much suspended particulate matter as possible, reduce solar heat absorbtion of surrounding building surfaces, and attract and shelter as much wildlife as possible.
7. Lightweight European roof garden systems (such as the Brecht, Optima, and AGRO-Grün, systems) should be tested in Winnipeg. If they prove successful, investigations should be made into the to economic feasibility of these systems being either manufactured here or being imported from Europe.
8. Some service-based businesses (such as daycare centres, restaurants, outdoor theatres and cinemas, and nightclubs) could be encouraged to lease and develop roof space.
9. Some product-based businesses (such as vegetable growers and florists) could be encouraged to lease and develop roof space.

10. Some recreation-based businesses (such as miniature golf, roller rinks, ice rinks, lawn bowling, amusement centres, and 'totlands') could be encouraged to lease and develop roof space.
11. Community allotment gardens could be constructed on the tops of some of the downtown buildings.
12. Some of the large street-level parking lots in the downtown area (especially the one on York between Edmonton and Hargrave) could be redeveloped as underground car parks with street-level public green spaces on their rooftops.
13. Garden cafeterias and babysitting services could be developed on the rooftops of the larger department stores (such as The Bay and Eaton's). It is essential that they be developed with both indoor and outdoor facilities, so as to insure year round operation.
14. Many office building and warehouse rooftops could be fitted with garden cafeterias and recreation facilities. It is essential that they ,too, be developed with both indoor and outdoor facilities.
15. Every opportunity should be taken to provide semi-private outdoor space for apartment dwellers in the downtown area, including the use of rooftops and adjacent car park rooftops. It is essential that rooftop recreation centres and gardens include an indoor area which is useable year round, and which is locat-

ed at, or just above, the level of the outdoor area. Indoor swimming pools are preferable to outdoor pools.

16. Some office and warehouse building rooftops could be developed as sites for private penthouse suites with garden terraces.

17. The rooftops of neighbouring buildings with compatible rooftop developments should be connected with skywalks, stairs, and lifts, whenever possible to increase the amount and ease of pedestrian circulation between rooftops.

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Appendix A

RECOMMENDED PLANT MATERIAL FOR ROOF GARDENS IN WINNIPEG, MANITOBA

Vines and Ground Covers

Allium flavum
Anemone
Antennaria rosea *
Arctostaphylos uva-ursi *
Clematis recta
Coronilla varia
Cytissus decumbens
Eriophyllum sp. *
Festuca spp. *
Fragaria vesca
Geranium sanguineum
Hemerocallis
Hosta
Mattiuccia strutheropteris
Parthenocissus quinquefolia
Paxistima canbyi
Potentilla verna
Sedum acre (Dragon's Blood, Running, Gold Moss) *
Sempervivium *
Sysirinchium bellum
S. montanum
Teucrium chamaedrys
Thymus spp.
Vinca minor
Vitis riparia

Coniferous Trees

Larix siberica
Picea glauca densata
P. pungens
Pinus cembra
P. mugo
P. sylvestris

Flowering Trees

Crataegus X 'Arnold'
C. X 'Snowbird'
Malus X 'Almey'

M. X 'Garry'
M. X 'Hopa'
M. X 'Selkirk'
Prunus maackii
P. pennsylvanica
Sorbus americana
Syringa reticulata

Shade Trees

Acer ginnala
Fraxinus nigra
F. nigra 'Fallgold'
F. pennsylvanica subintegerrima
F. pennsylvanica subintegerrima 'Patmore'
Populus tremula erecta
P. tremuloides
P. X 'Northwest'
Prunus virginiana melanocarpa
P. virginiana melanocarpa 'Shubert'
Salix alba 'Sericea'
S. alba 'Vitellina'
S. X 'Prairie Cascade'
Tilia americana
Ulmus pumila

* Suitable for no-maintenance rooftops