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# **ATRIA - THE INSIDE STORY**

**Liz Briggs**

**1989**

This dissertation has been submitted in partial fulfilment of the requirements for the Diploma in Landscape Architecture Lincoln College, University of Canterbury.

## **Acknowledgements**

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## APPENDICES

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## 1.1 Choice of topic

There seems to be a resurgence of interest in the use of atria in large scale commercial buildings. Several recent prestigious buildings such as the Hongkong and Shanghai Bank in Hongkong, the World Financial Centre in New York and the Park Royal Hotel in Christchurch have incorporated an atrium in their design. The use of indoor plants is often an important and integral part of the design. This dissertation therefore sets out to investigate the reasons behind the increase in popularity of this type of urban space, and the factors which contribute to the success or failure of both the planting and the space.

## 1.2 Objectives

This is expressed in the following objectives:

- \* To investigate the historic origins and subsequent development of the atrium space.
  
- \* To outline the main characteristics and design functions of atria.
  
- \* To examine the suitable planting and design of atria.

- \* To consider the ways in which atria can contribute to the future urban form in New Zealand.

### 1.3 Definition

Historically, an atrium was a term used to describe a cloistered courtyard at the centre of a Roman villa, which was open to the sky. However, today the term has become synonymous with a central enclosed and glazed space in a building.

For the purposes of this dissertation, a modern atrium will be defined as :

*"a centroidal interior daylit space which organises a building".<sup>1</sup>*

In order to meet this definition, an atrium must be:

- i) Centroidal : in its spatial role within a building. It need not be the geometric centre as long as the majority of other spaces in the building relate directly to it.

- ii) An interior space : a space enclosed and protected from the weather.
  
- iii) Daylit : some measure of direct natural lighting.
  
- iv) Within a single building.
  
- v) Capable of organising the building :  
this can be done in a variety of ways such as -
  - a place of orientation
  
  - a focal meeting place and public space
  
  - as a social, institutional or symbolic organiser
  
  - as a method of modifying, distributing and channelling the natural flow of energy.

## **2. Historical Development**

## 2.1 From circle to courtyard

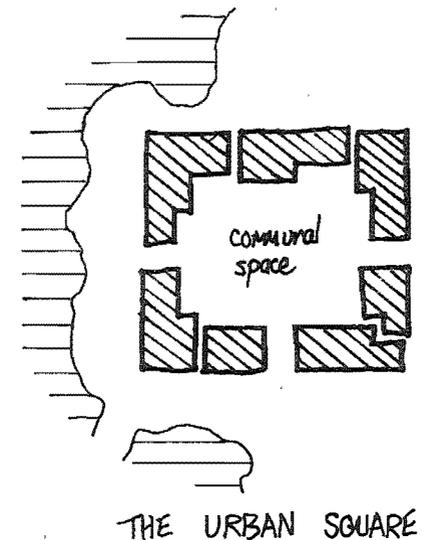
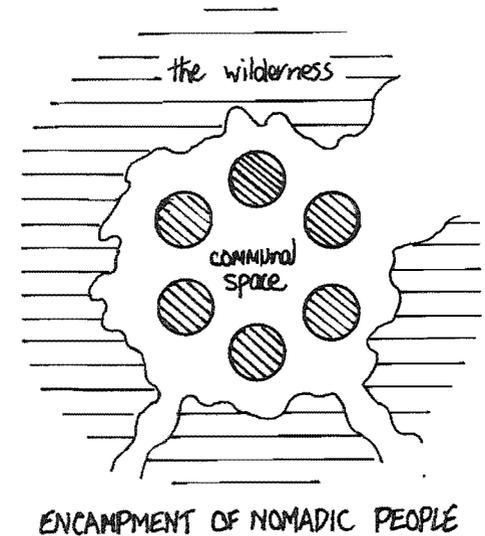
The atrium originated as the primary space in a Roman house. It was the central courtyard and communal space to which all other rooms related.

The courtyard concept evolved primarily from the encampment of nomadic people, where the tents were grouped in a circle to provide protection. With the emergence of urban settlements, the houses were traditionally grouped around an open space, forming a square. This afforded a high degree of control of the inner space, as well as facilitating a ready defence against external aggression by minimising the external surface area liable to attack.<sup>9</sup>

The courtyard house became a logical form, responding to the pressures of urbanisation, and the need to control the climate. Increasing densities were also resulting in the loss of individual privacy and limited exposure to communal open space.

The atrium plan met the need for individual privacy as well as providing a communal precinct away from the public gaze.

Climatic control was an equally important determinant.



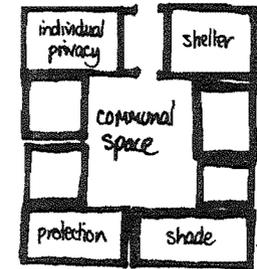
The atrium provided:

- \* a source of natural light and air
- \* protection from the wind
- \* a heat sink in the winter
- \* shade in the summer
- \* opportunities to use wind for ventilation
- \* private outdoor space

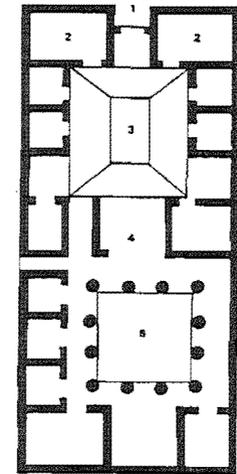
This kind of courtyard frequently came to bear a symbolic value and was therefore chosen as the model for the construction of numerous holy places such as the agora, forum, cloister and mosque.

## 2.2 The Roman atrium

The classical definition of the term atrium refers to a central court in a Roman house. It was the focus of the public part of the house, being surrounded by rooms used as shops or offices and connected to the street by a vestibule. It was usually linked to the inner court or peristyle by the living room, which gave access to the private part of the house. The atrium therefore became the privacy space in the plan, distributing light and air through a central opening in the roof, and giving direct visual and physical access to all the secondary spaces.<sup>3</sup>



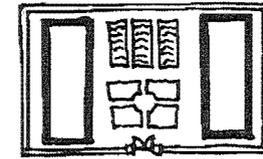
THE COURTYARD HOUSE



ROMAN HOUSE PLAN

1. Main entry
2. Shops
3. Atrium
4. Living room
5. Peristyle courtyard

This arrangement of rooms and space continued to be used as the traditional house plan in Rome until the 3rd century A.D.

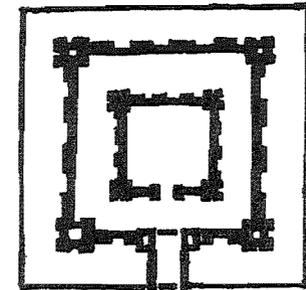


MONASTERY

With the invention of houses built around a central courtyard or atrium, this spatial pattern became a model for the future.



The multi-storeyed courtyard house, from the Middle Ages up to modern times, was the building type which acted as the starting point for monasteries, missions, castles and Renaissance and Baroque palaces.

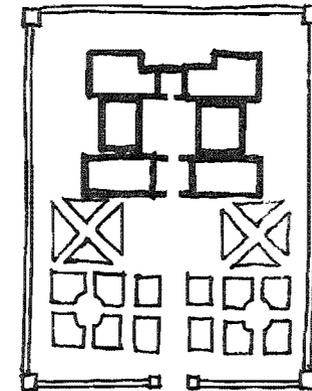


CASTLE



### 2.3 Enclosure of the courtyard

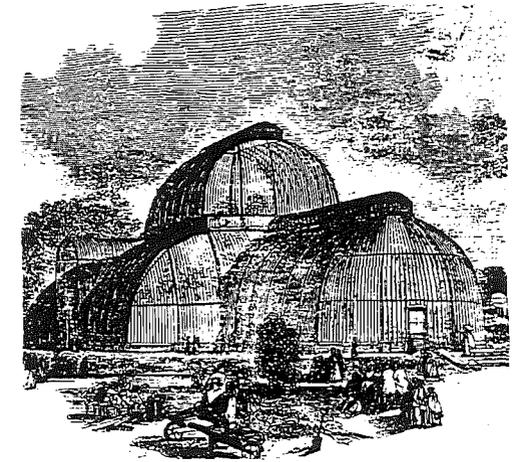
The enclosure of the courtyard became possible with advances in technology in the nineteenth century, which allowed greater structural spans of steel, and created larger panes of glass.



PALACE

A new style of architecture arose, where buildings were made entirely of iron and glass. Some of the most notable examples are :

- \* the conservatory or Palm House at Kew, London, by Richard Turner 1845
- \* Paddington Station in London, by Brunel and Wyatt 1853
- \* the "Gallerie des Machines" exhibition hall in Paris, by Dutert 1889.

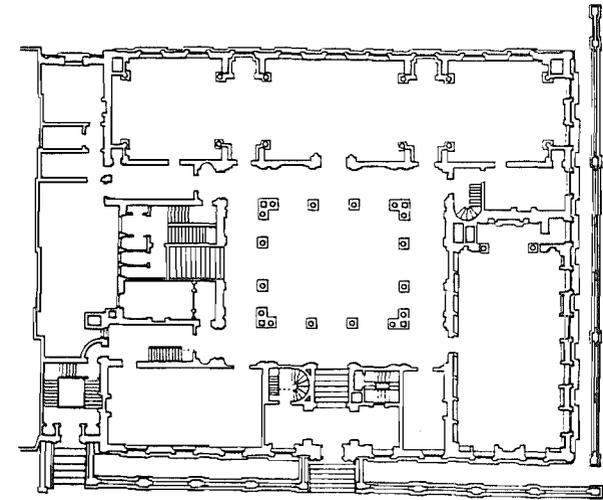


THE PALM HOUSE, KEW

The Crystal Palace in Hyde Park, London, designed by Joseph Paxton in 1851, was the culmination of this type of development in both sophistication and style. It was a completely transparent structure that was 1848 feet long by 456 feet wide, made entirely of prefabricated parts, and defined only by a matrix of structural iron members.

**2.4 Nineteenth century atria**

Concurrent with the development of the all glass-and-iron building, there were many explorations in combining this new technology with traditional masonry building forms. One of the first examples is the atrium in the Reform Club in London, designed by Sir Charles Barry in 1837. He used the Pallazzo Farnese as his model for the Club's building plan and form. He roofed the central court with a vaulted structure of metal, infilled

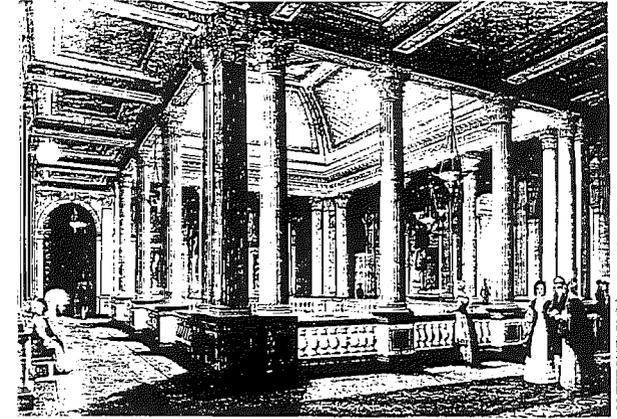


PLAN OF THE REFORM CLUB by Sir Charles Barry London 1837

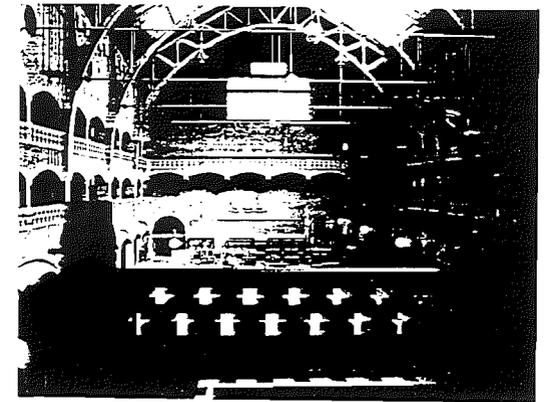
with glass. The central court then became an interior room, fully protected from the weather, but enjoying the light of an outdoor court.

Many atria were being built in France at this time, and known as "galleries". They were usually glass-roofed courts in the centre of large department stores. For example, the Bon Marche market designed by Boileau and Eiffel in 1876, had a skeletal iron structure and glass roof, and contained continuous subdivisible space and many light wells. The French continued to exploit the atrium spacial type and utilised it in many different kinds of buildings including hotels, offices, museums, apartments and libraries.

Probably the most influential European atrium building from this era was the Amsterdam Stock Exchange, designed by H.P. Berlage in 1898. Its influence upon the history of architecture was primarily for its Romanesque facades and the clearly visible architectural details and methods of construction, including the exposed iron structure of the three glass-roofed halls. The hall for the Commodity Exchange dominates the building, and is surrounded on three levels with galleries and offices. The roof structure is a



THE REFORM CLUB



THE AMSTERDAM STOCK EXCHANGE

triple articulated arched girder, with exposed tie bars supporting the glass roof. The remaining iron structure below the roof and arches is totally encased in brick and stone.

The popularity of this type of atrium space in Europe began to decline towards the end of the nineteenth century as architectural styles and forms began to change. Also, these atria were found to be a serious fire hazard because the iron or steel and glass structures of that time could not withstand the intense heat of urban fires. Many of the iron and glass buildings burnt and collapsed.

However, at the turn of the nineteenth century, there was a resurgence of popularity in the atrium space in the United States. The earlier European examples were often used as models, but in order to combat the fire problem, the buildings were predominantly masonry. Only the area defining the atrium utilised iron, steel and glass.

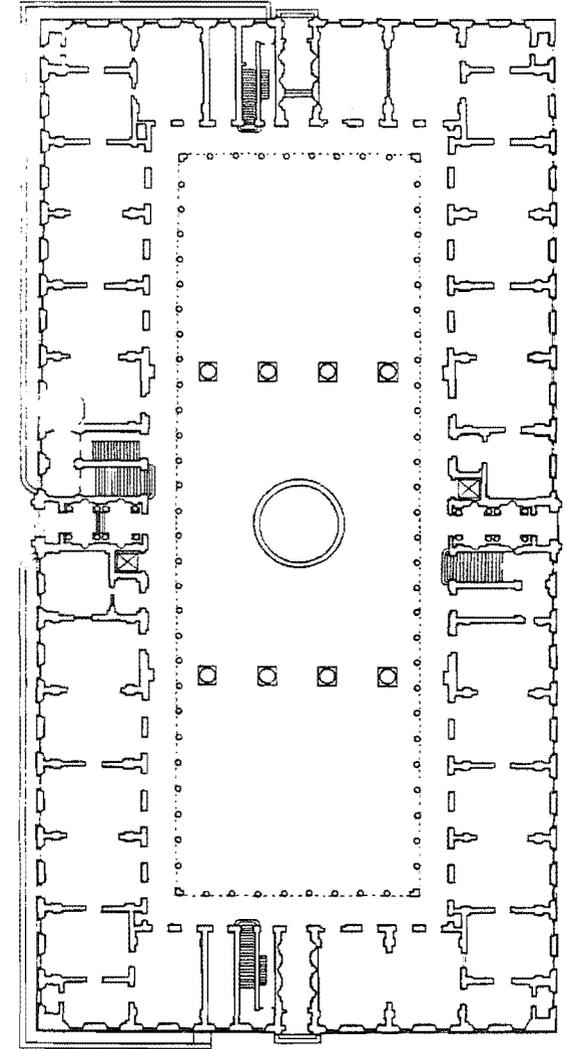
The most notable examples from this period are:

1882 The Pension Building, Washington D.C.  
designed by General Montgomery Meigs

This is one of the oldest and largest atrium buildings in the United States. It was constructed as a civic building to house the offices of the Pensioner Bureau and is currently home to the national Museum of Building Arts.

The atrium is vast, being approximately 89 x 28 metres in plan and 48.5 metres high. It is surrounded by four levels of offices, and punctuated by two sets of Corinthian columns which support the huge clerestory roof.

General Meigs claimed he was inspired by the Palazzos of Rome, especially the Palazzo Farnese. He introduced several energy-saving features, including the brick masonry to provide insulation and fire resistance, and a natural ventilation system. The ventilation works by :

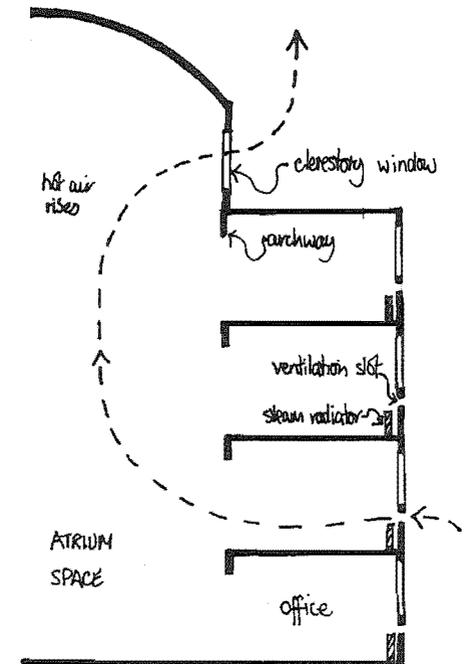


PLAN OF THE PENSION BUILDING

- \* allowing fresh air to enter through ventilation slots under each window
- \* the air is heated by steam radiation near the windows
- \* the heat flows through the archways from the offices into the atrium
- \* the hot air rises to the top of the atrium where it is released through movable clerestory windows.

This system ensured a continuous flow of fresh air through the offices.

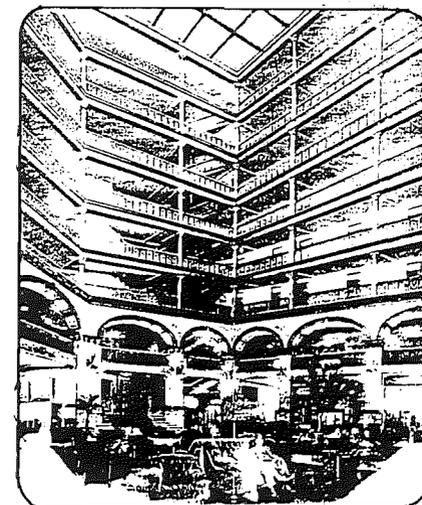
This building set a precedent for the inclusion of atria in public buildings, and because it contains one of the largest interior spaces in Washington D.C., has been used for several inaugural balls, including those for Presidents Nixon, Carter and Reagan.



VENTILATION IN THE  
PENSION BUILDING

1892 The Brown Palace Hotel, Denver,  
Colorado designed by Frank Edbrooke

This was the first hotel to incorporate an atrium as a central feature. The trapezoidal atrium is overlooked by ten floors of rooms and is enclosed by a square, double-domed skylight containing patterned and coloured glass. It serves as the hotel lobby, and has since become "the living room of Colorado", where people come to see and be seen. It is luxuriously furnished and equipped, with marble floors, oriental rugs and onyx finished piers and fireplaces.

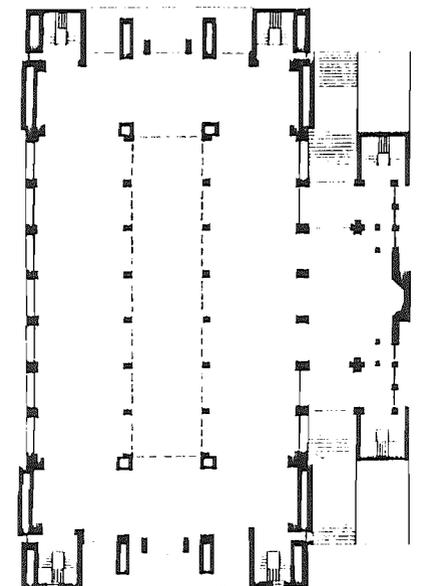


THE BROWN PALACE HOTEL

The idea of using an atrium as an hotel lobby and point of orientation has served as the inspiration for many of the more modern hotels, particularly the Hyatt hotels designed by John Portman.

1904 The Larkin Building, Buffalo,  
designed by Frank Lloyd Wright

This office building has since been demolished, but the atrium was designed to bring daylight into the surrounding five



PLAN OF THE LARKIN BUILDING

levels of offices, and to give the employees a sense of corporate identity and cohesion. The atrium floor was occupied by an open plan office which was overlooked from the other floors. Frank Lloyd Wright managed to create such a serene and peaceful space that the owners eventually installed an organ at one end of the atrium.

An atrium therefore has the potential for providing the point of orientation and organisation in a hotel as well as encouraging communication and corporate identity in an office block. It is also particularly suitable for use in monumental civic buildings such as courthouses and town halls because it can accommodate large crowds requiring a multitude of services.

An atrium has often played a central part in the renovation and restoration of historic buildings. In the States, the Landmark Centre in St Paul, Minnesota has been renovated to provide a public cultural centre, and the Old Post Office in Washington D.C. now houses federal offices and multiple use commercial space around its atrium. In England, the Barton Arcade in Manchester, Covent Garden in London and the Pantechicon in West



THE LARKIN BUILDING

Halkin Street, London are all examples of the refurbishment of historic buildings containing atria.

## 2.5 Emergence of the modern atrium

With increasing technological advances, fire and smoke control systems became more sophisticated and reliable, and improved air handling equipment resulted in the minimising of stratification and condensation in atria. Combined with an increasing awareness of the need to conserve energy resources and a continuing search for more dynamic and imaginative public spaces and built forms, the 'modern' atrium emerged as a popular concept in the States in the 1960s.

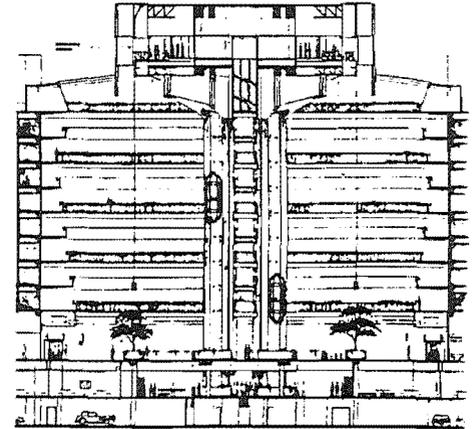
It was personified primarily by John Portman in his design for the Hyatt Regency Hotel in Atlanta, Georgia, in 1967. He was attempting to revolutionise the traditionally dull design of central city hotels, and to bring in light, space and a new visual experience. He is quoted as saying: <sup>2</sup>

*"I wanted to explode the hotel; to open it up; to create a grandeur of space, almost a resort, in the centre of the city. The whole idea was to open everything up; take the hotel*

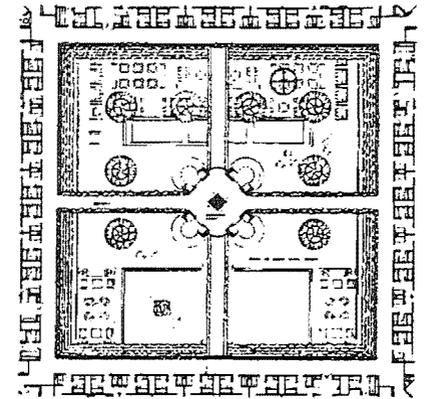
*from its closed, tight position and explode it; take the elevators and literally pull them out of the walls and let them become an experience within themselves, let them become a giant kinetic sculpture.."*

The resulting 23 storey hotel was an extravaganza of concrete, steel and glass set around a central atrium which rose the full height of the building. The lighted plexiglass elevator capsules travelled up through the atrium and skylight to a domed revolving restaurant with panoramic views. This concept has since been used repeatedly in international hotels throughout the world, and has become the trademark of the Hyatt Hotels, but it was a bold and innovative scheme in the sixties.

Another landmark in the evolution of the modern atrium was the construction of the Ford Foundation headquarters in New York in 1968. It was designed by Roche and Dinkeloo, and the planting in the atrium was carried out by Dan Kiley. It is historically important because it initiated the concept of including public space within a private modern building, and of incorporating a comprehensively designed indoor park within the



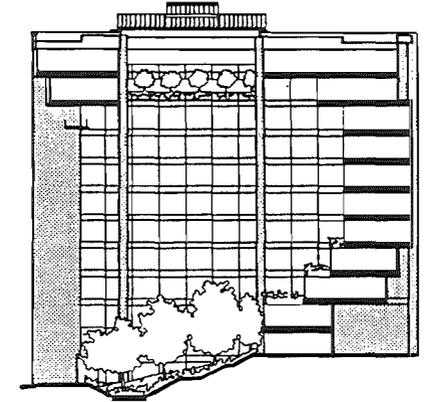
SECTION THROUGH THE HYATT HOTEL



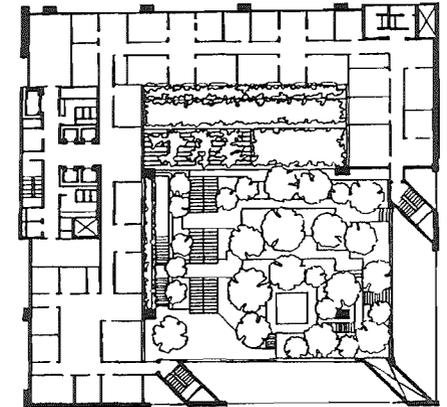
PLAN OF THE HYATT HOTEL

atrium space. The design and function of this example is discussed in more detail in the case studies, but it demonstrated the capacity for an atrium to simultaneously meet several functions such as :

- \* a transition space between the city outside and the private office space inside
- \* fostering a corporate image and feeling of common purpose
- \* creating a place for rest and relaxation
- \* providing an important public space and meeting place.



SECTION THROUGH THE FORD FOUNDATION



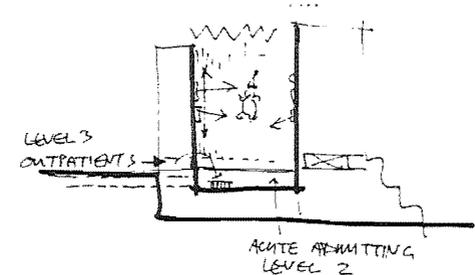
PLAN OF THE FORD FOUNDATION

### 3. Function and Form

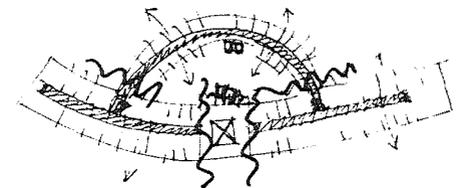
**3.1 Basic functions** An atrium has the capacity to simultaneously meet several functions, depending on the design and type of building. The main functions are listed below and are discussed in more detail in the following sections. The case studies highlight examples of specific atria functions in various building types and design.

Basic functions are :

- \* To utilise natural energy flows : (see section 3.4)  
Making use of natural daylight, passive cooling and heating, natural ventilation and the natural phenomena in atria.
- \* Climatic control :  
To provide a controlled passive indoor environment with shelter from wind, rain and extremes of temperature.
- \* As a place of orientation :  
A focal point or centre of gravity. Commonly used as a lobby or reception area, especially in hotels. A central atrium has the potential for improved surveillance and



CLIMATIC CONTROL



NATURAL VENTILATION

(from article on Auckland Childrens Hospital,  
Architecture New Zealand Sept./Oct. 88)



\* As a metaphor for the garden :

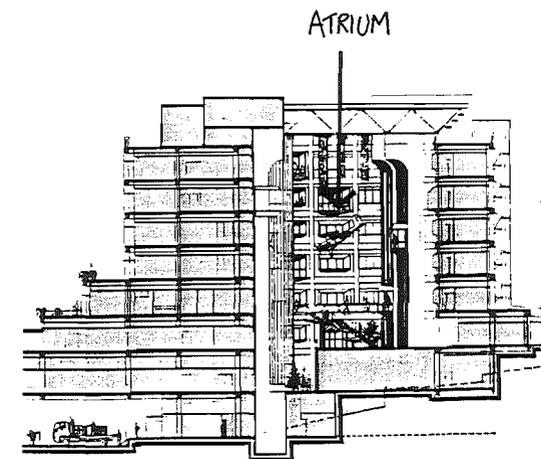
An imagined escape to a natural world, encouraging relaxation, daydreams and flights of imagination. Often employing a combination of plants, water and the play of light and shadow.

\* As an important meeting place and public space :

A social space, encouraging communication and interaction. An all-weather public gathering space. A communal space which may be particularly important to those people facing a time of alienation and loneliness. The new Auckland Children's Hospital, presently under construction, has a central atrium which serves as reception area, cafeteria and general meeting area.

\* Increased marketing potential :

The floorspace around an atrium commands a premium rental due to the attractive environment created.



SECTION - AUCKLAND CHILDREN'S HOSPITAL

\* Adaptation to the conservation of historic buildings :

Atria can be used to bring daylight into the centre of old buildings or to enclose open courtyards, and give a new lease of life to surrounding uses. Covent Garden in London is a well known example.

\* Multiple-use potential :

The atrium space can often be used for a variety of activities, either simultaneously or at different times. For example, a public plaza can be used for exhibitions, markets, cafeterias as well as an informal meeting place.

It is this capacity to simultaneously meet several functions which makes an atrium such an attractive proposition to many designers and architects.

### **3.2 Basic forms**

The basic shape or form of the atrium will depend on both client requirements and site constraints. However, there are several generic forms which have evolved. These can be classified as simple generic forms and complex generic forms.<sup>15</sup>

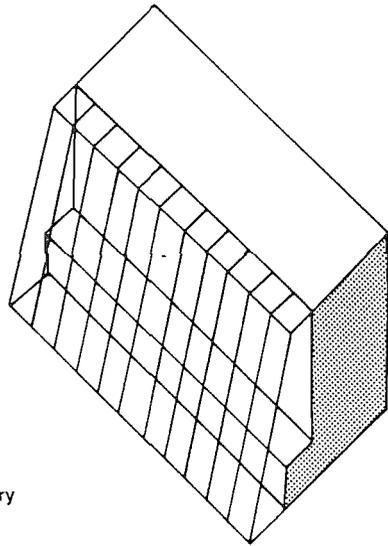
The simple forms include :

- \* a single-sided or conservatory atrium
- \* a two-sided atrium (two open sides)
- \* a three-sided atrium (one open side)
- \* a four-sided atrium (no open sides)
- \* a linear atrium (open ends)

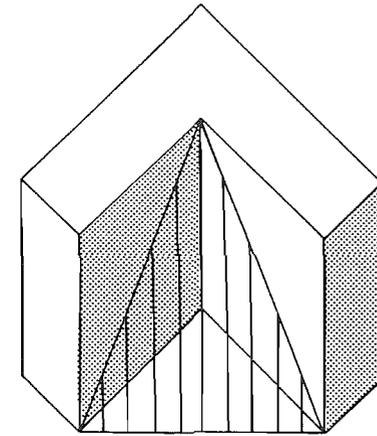
The complex forms include :

- \* a bridging atrium, between multiple buildings
- \* a podium atrium, at the base of a tower
- \* multiple lateral atria (any form)
- \* multiple vertical atria

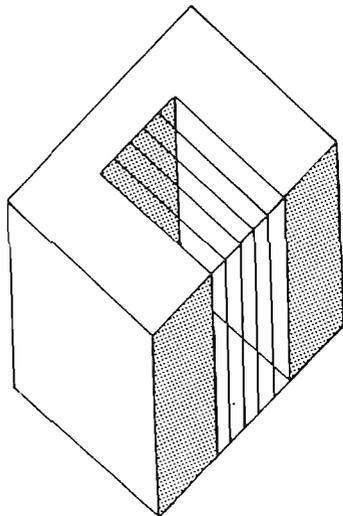
The simple or "pure" forms can be applied to small, single buildings as well as to large complexes. The complex forms are more appropriate for higher density, large scale development.



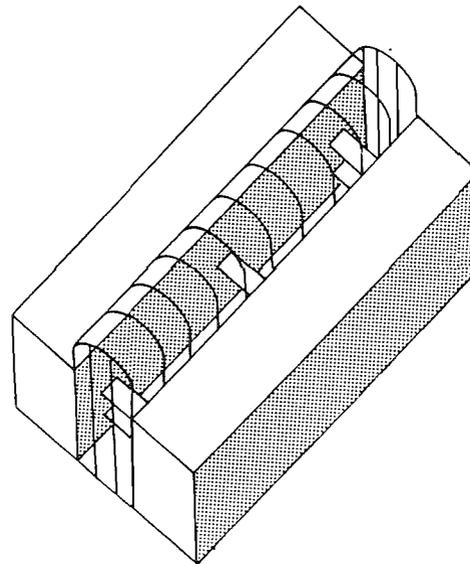
Single-sided or conservatory atrium



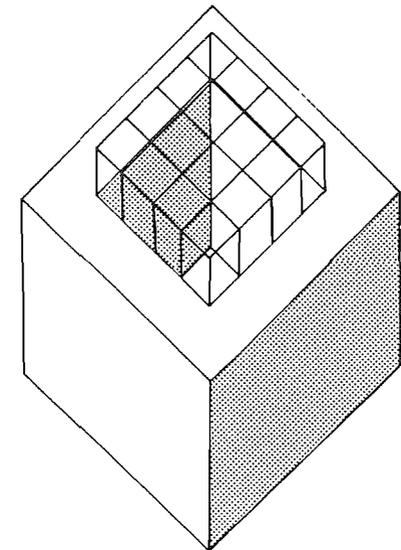
Two-sided atrium (two open sides)



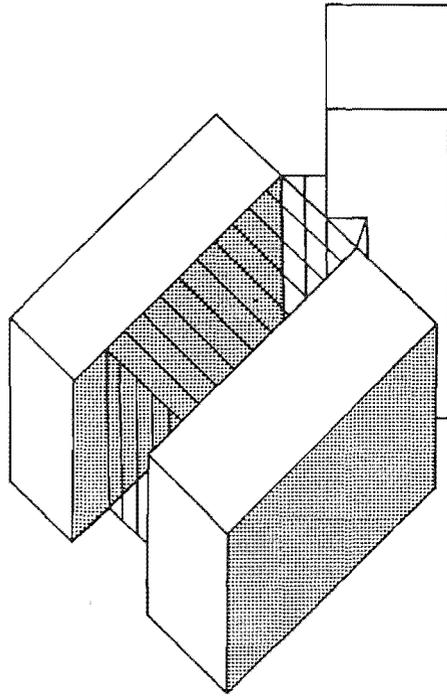
Three-sided atrium (one open side)



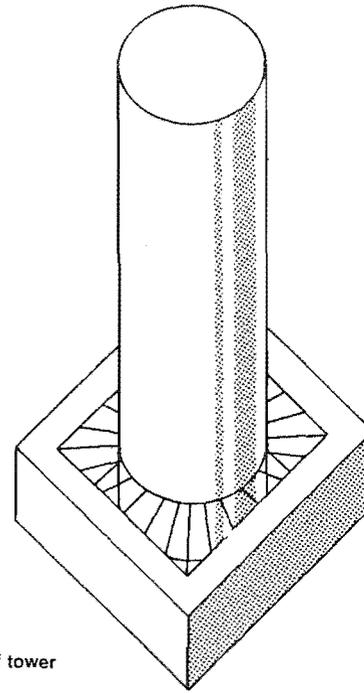
Linear atrium (open ends)



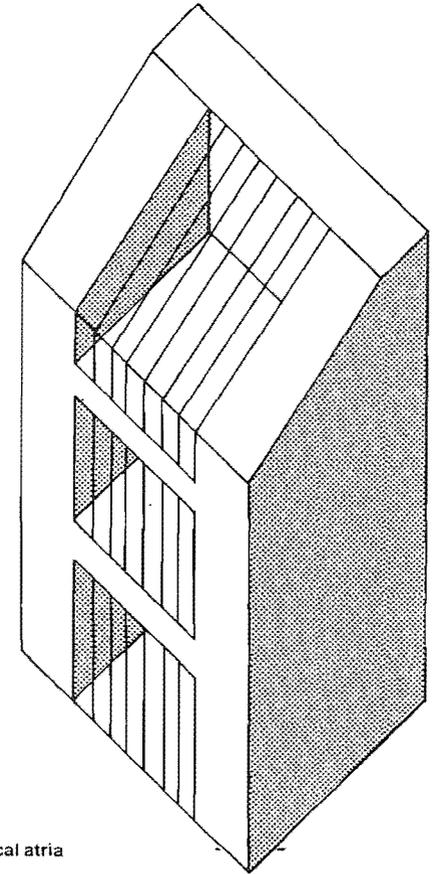
Four-sided atrium (no open sides)



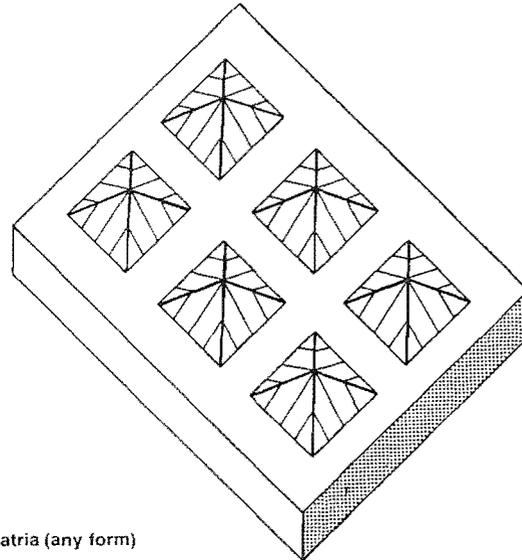
Bridging atrium, between multiple buildings



Podium atrium, at base of tower



Multiple vertical atria



Multiple lateral atria (any form)

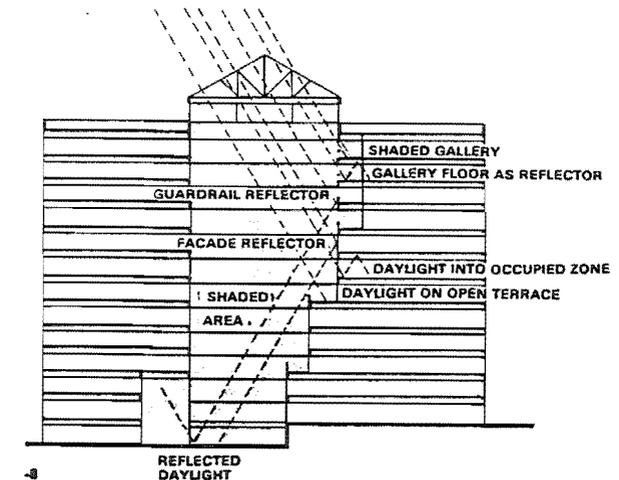
### 3.3 Natural phenomena

There are two natural phenomena which can work for or against the comfort in atria. These are the "greenhouse" and "stack" effects.

#### The greenhouse effect

This is caused by the fact that short-wave heat radiation from the sun will pass through glazing to warm interior surfaces.

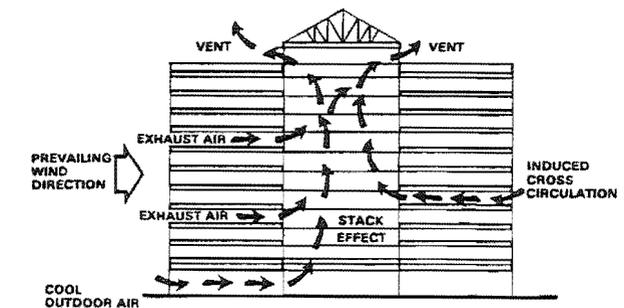
The re-radiated heat will then be at a longer wavelength and will not pass back through the glass. Solar heat is captured, with positive winter effects and often negative winter ones.



THE GREENHOUSE EFFECT

#### The stack effect

In any enclosed volume, air will always move from a lower opening to an upper one. The result of these pressure differences within altitude creates the "stack" effect. Any wind movement through openings will enhance the suction effect. Combined with the buoyancy of air warmed by the greenhouse effect, there will be a strong stratification of air by temperature in a tall closed volume, and an equally strong upward draught when openings are made.



THE STACK EFFECT

A natural ventilation cycle can be created, as long as fresh or cool air is introduced at the base, and the warm air is allowed to escape at

the top. The spaces surrounding the atrium can also be ventilated, as illustrated in the Pension Building in Washington DC (see page 11) The taller the building, the greater the stratification and therefore the higher the convection flow.

### 3.4 Energy performance

#### Utilisation of natural energy flows

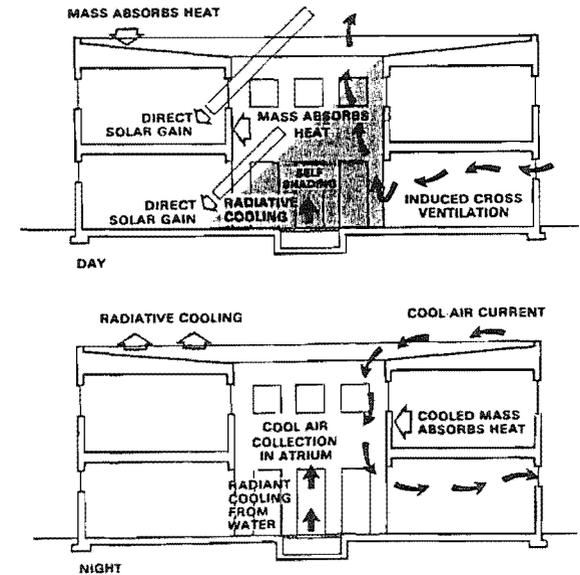
In order to be energy efficient, an atrium should make maximum use of natural energy flows. Only a small scale atrium located in a benign climate can be a candidate for a completely "natural" approach, but an atrium building can be "selective", using natural energy techniques suitable for the building purpose and location, supplemented by mechanical and electrical systems.

The ancient atrium house form, as described in section 2.1, used natural energy flows for ventilation, heating and cooling. This form has been adapted in other countries, as seen in the design of the Mediterranean courtyard house.

Here, the house is designed as a co-ordinated energy system which compensates diurnal and seasonal climatic variations by utilising natural energy flows.

- \* The masonry walls absorb heat from adjacent spaces during the daytime. The surfaces are cooled by the night air later in the day.
- \* During the day, natural ventilation is created by the rising of warm air out of the courtyard, and the subsequent drawing in of cool air through the windows.
- \* At night, the ventilation system is reversed. The cooling masonry absorbs the heat, and draws a cool air current down through the courtyard.
- \* Rainwater stored in a cistern provides additional evaporative and radiative cooling.
- \* The central courtyard, open to the sky, provides daylight to the surrounding rooms.

Not all of the features outlined in this house can be incorporated in the design of an enclosed



UTILIZATION OF NATURAL ENERGY FLOWS

atrium. However, the following natural energy systems should be taken into consideration, and incorporated wherever possible :

DAYLIGHT : The effective transmission and balanced distribution of natural light.

PASSIVE COOLING : Shading of the atrium from direct sun, and self-shading of interior surfaces.

VENTILATION : Cross-ventilation and vertical ventilation, making use of the "stack" and "greenhouse" effects.

PASSIVE HEATING : Heat storage in thermal mass along with direct gain from the "greenhouse" effect.

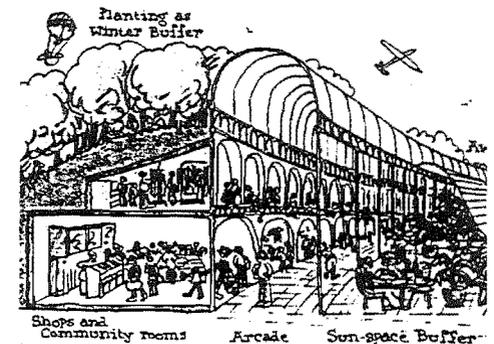
MICROCLIMATES : Effective use of plants and water features to provide cool, refreshing zones.

## Buffering

An atrium can be designed to act as a "buffer" space or intermediary zone between inside and outside. In this way, the full face of the external climate no longer falls on the membrane protecting the occupants of the building. The main force is dissipated on the buffer surface. However, the energy economy of buffer spaces is only fully achieved if no attempt is made to keep the spaces themselves comfortable all year round. They need to be colder in winter and hotter in summer than the comfort-conditioned spaces they protect.

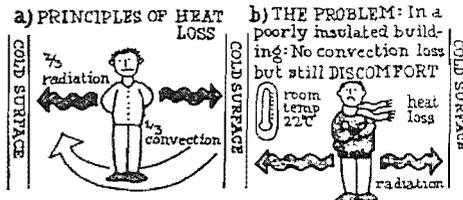
In 1980, Terry Farrell and Ralph Lebens produced a thesis called "buffer thinking".<sup>25</sup> It was the winning entry in a Guardian newspaper competition to describe the community of tomorrow. It showed several effective methods for "buffering", as illustrated on the following page. The basic principles were :

- \* buildings are orientated with long sides facing north and south

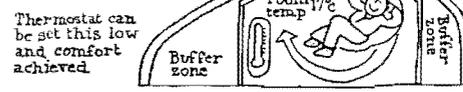


"BUFFER THINKING"

**1 | ENERGY CONSCIOUS DESIGN:** Should have as its starting point THERMAL COMFORT



**C) THE SOLUTION:** Ideal room temperature at 17°C with efficient insulation (using BUFFER ZONES) will provide a comfortable THERMAL ENVIRONMENT

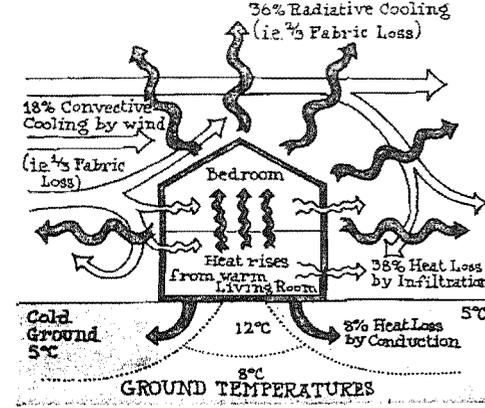


**2 | DESIGNING WITH THE CLIMATE MEANS** Maximizing the benefits of wind and sun



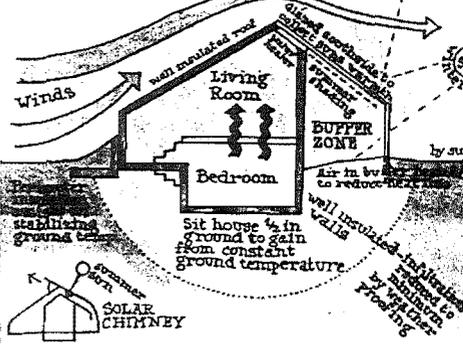
Use winter sun to heat house & domestic hot water  
Summer sun heats domestic water and creates solar chimney  
**BUFFER THINKING** means using shape of building, landscaping and trees to provide sheltered areas

**3 | THE INEFFICIENT HOUSE:** PATHS OF HEAT LOSS

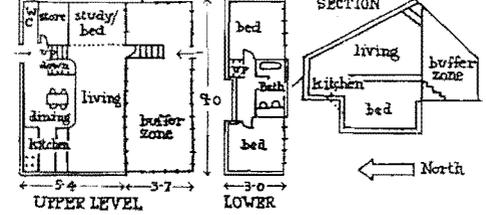


**4 | THE ENERGY EFFICIENT HOUSE**

**BUFFER THINKING** means: Trapping air and using its good insulating properties to reduce heat loss from building.

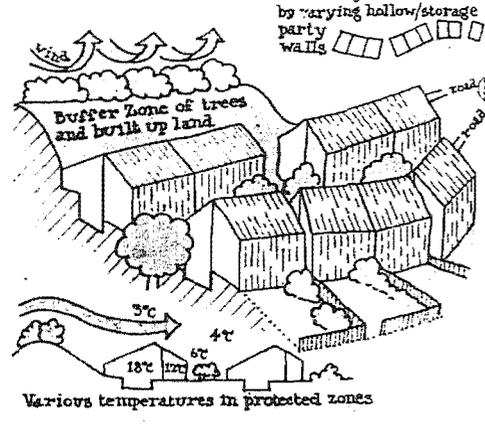


**5 | TYPICAL 5-PERSON HOUSE**



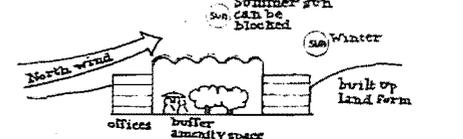
Developments in material science have produced the low cost twin-wall extruded polycarbonate which can be used to provide cheap buffer zone space. Enormous developments in glass technology to control heat losses and other improved properties.  
Saving allows a 35m<sup>2</sup> buffer zone & 20m<sup>2</sup> additional space

**6 | BUFFER HOUSING**

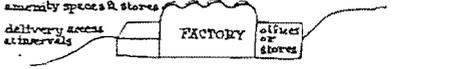


**7 | BUFFER THINKING TO DEVELOP WORK SPACES**

Broad views & access to surrounding countryside are not essential to work spaces, so they are partially sunken to increase visual amenities for housing and reduce heating & cooling loads on work areas.  
**OFFICE SPACES** where the buffer is the core space which also provides visual and leisure amenities.

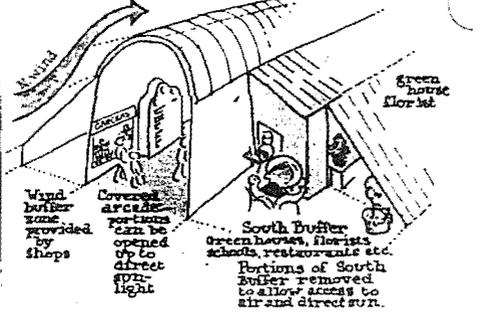


**MANUFACTURING SPACES** where the buffers are the ancillary offices stores and amenities



**8 | BUFFER THINKING TO DEVELOP NEW KINDS OF COMMUNITY SPACES**

Public capital is used to provide buffer zones between schools, shops and small offices. These would be covered over to produce an arcade and sheltered village squares.



(from "Buffer Thinking" by Forrell and Lohans)

- \* it is more cost-effective to have a buffer zone along the south side of the building in the northern hemisphere; planting is more effective along the north side
- \* polar sides are buried in earth or sheltered by planted mounds
- \* solar sides have conservatory buffer zones outside the fully habitable space.

Many recent buildings have used a complete double-wall concept as a buffer to modify the internal climate. Examples are :

- \* The Scottish Widows' Insurance Headquarters, Edinburgh by Sir Basil Spence.
- \* The Hooker Building, Niagara Falls, completed 1981, by Canon Design Inc.

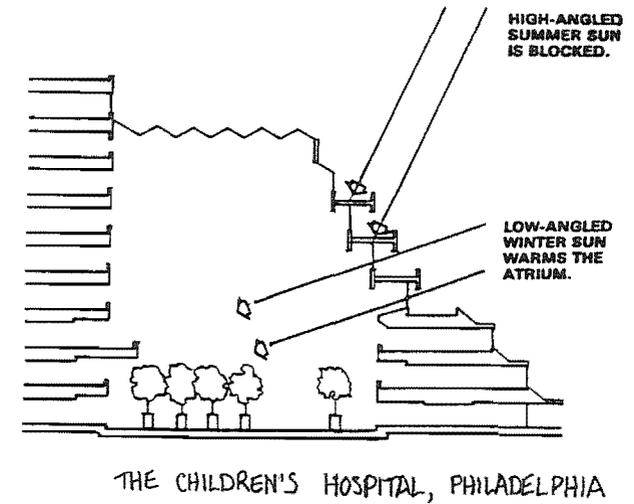
The atrium concept tries to use as little outer surface to buffer as much inner surface as possible. In a cube-shaped atrium with roof glazing, the roof area buffers four times as much

wall. The savings on wall insulation and waterproofing would probably pay for the roof.

## Orientation

Orientation is a significant design factor and will depend upon the energy strategy for the atrium. In general, north or south orientations are preferred, mainly because of the difficulty in controlling low-angled sun with east or west orientated walls. If the view is important, it is possible to install translucent sun shades to avoid glare. Also, the building can be designed to prevent high angled summer sun from entering the atrium, while allowing low angled winter sun to penetrate the space and warm the winter air. The Children's Hospital in Philadelphia has adopted this strategy, and uses open play decks as summer shading devices.

The solar orientation of the long axis of the plan and the height-to-depth ratio of the atrium will determine the extent to which parts of the atrium are in shade. A tall, deep atrium will not allow solar radiation to reach the floor or lower portions of interior facades. Each building will have an ideal orientation and ratio which will support the intended energy strategy. The main problem is the low insulation and shading value of glass, which causes both heat loss and gain.



## Daylighting

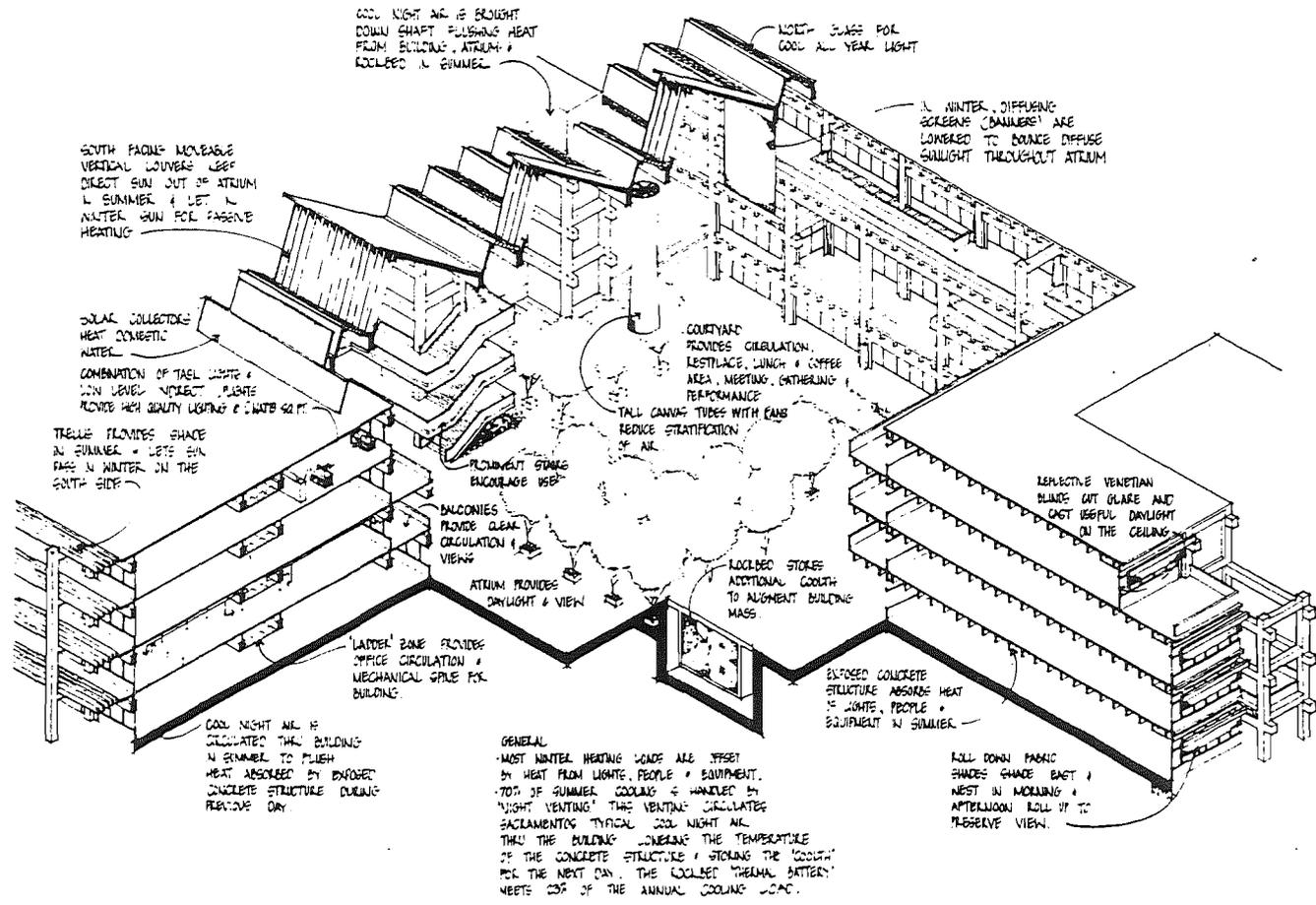
In view of the cost of providing artificial lighting, the problem of removing the heat released and the general poor quality of the light produced, the provision of natural daylight is a particularly important design consideration. Good daylighting means "lighting of the right quality delivered to the greatest plan-depth possible".<sup>16</sup> It is the quality of the light rather than the quantity which is important. The main problem is projecting sufficient ambient light deep into the occupied areas in the building.

The most appropriate design will depend on the climate of the site and the use of the building, but the following general principles apply to all designs:<sup>15</sup>

- \* admit light in a way which is compatible with the thermal strategy of the atrium
- \* convert sunlight to diffuse light for better distribution
- \* provide sufficient diffuse reflective surfaces in the atrium to transmit light downwards

- \* consider collecting light in rooms by means of a light shelf, and orientate the structure appropriately
  
- \* integrate artificial and natural light approaches by arrangement and control.

The design of the Geoffrey Bateman building in Sacramento, California in 1981 by the State Architect's Office is an example of a building that was consciously designed to utilise natural energy flows and to maximise energy performance. This is illustrated on the following page. It was designed around a central atrium and has comprehensive energy conscious design features such as orientation to the south, with moveable vertical louvres to keep the direct sun out of the atrium in summer and to admit winter sun for passive heating. Most of the summer cooling is handled by "night venting" which circulates the cool night air through the building, lowering the temperature. The exposed internal concrete structure absorbs the heat from lights, people and equipment in the summer. It is an example of a "tempered buffer" atrium as described in section 3.4.

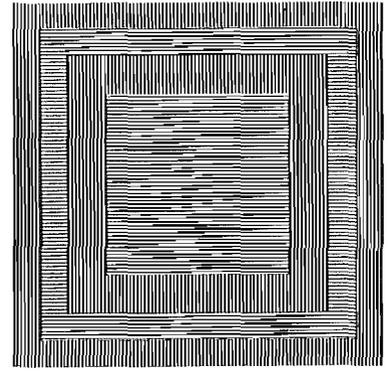


Geoffrey Bateman Building

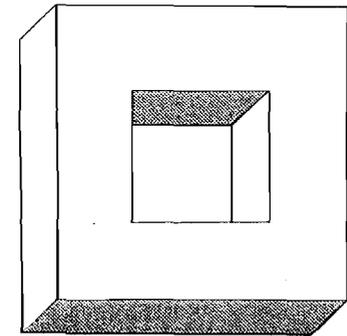
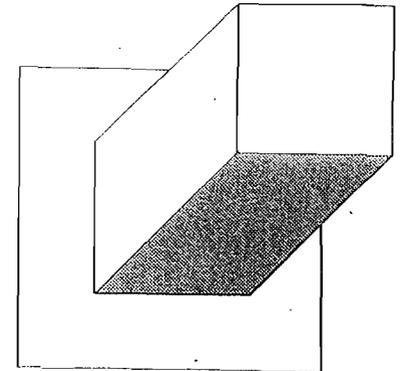
**3.5 Efficiency of  
land use**

**The courtyard  
versus  
the tower**

The relative efficiency of the courtyard form versus tower and slab forms was investigated in the 1960s by research undertaken by Prof. Sir Leslie Martin and Lionel March at Cambridge University. In April 1966 they published their findings in "Land Use and Built Form".<sup>10</sup> They used the example of a Fresnel square, where each ring is equal in area to the others, to make comparisons between the two forms. It is a fact of perception that the eye cannot read the rings on the square as being equal. Therefore the square in the centre seems to be larger in area than the ring around the perimeter. However, in their research, they showed that the same floor space could be delivered in relatively low buildings by arranging the buildings around the perimeter of a site, rather than constructing a tower in the centre. The question of western thought (the free-standing pavilion or tower) versus eastern thought (the hollow court) was resolved as a case of mathematical alternatives. Street following frontages could deliver space, sunlight and greenery as efficiently as the towers, and usually with less expense and discomfort. The results of this research helped to encourage reaction against the high-rise developments of the 60s, and several notable buildings were designed using the courtyard or atrium principle. Frederick



THE FRESNEL SQUARE



A TOWER AND COURTYARD WITH THE  
SAME BUILT VOLUME

Gibberd designed Arundel Great Court and the Coutts Building in London using these principles, and Richard MacCormac developed the multi-atrium office building concept as an urban design and energy-conservation device.

The following table summarises the costs and benefits of a courtyard development versus a tower block.

EXTRA COSTS	BENEFITS
<ul style="list-style-type: none"> <li>• Fire safety and smoke control systems.</li> <li>• Special transport required e.g. hydraulic lifts.</li> <li>• Atrium roof expensive.</li> <li>• Cost of planting and maintenance of plants.</li> <li>• May require a larger site area than tower equivalent.</li> <li>• May need to increase security because of public access to atrium.</li> </ul>	<ul style="list-style-type: none"> <li>• Heat loss and gain reduced.</li> <li>• Solar energy harnessed.</li> <li>• Daylighting simpler.</li> <li>• Provides shallow daylit space for perimeter offices, rather than the deep spaces of a tower block. More rooms with a view.</li> <li>• Provides premium floor space, attracting high rents.</li> <li>• Utilisation of natural energy flows. Energy saving.</li> <li>• Plan efficiency. Capacity to serve larger floor areas from a single core.</li> <li>• Lower energy use and therefore operating costs.</li> <li>• Vertical servicing more efficient than tower equivalent.</li> <li>• Provides public space for events, exhibitions, meetings.</li> </ul>

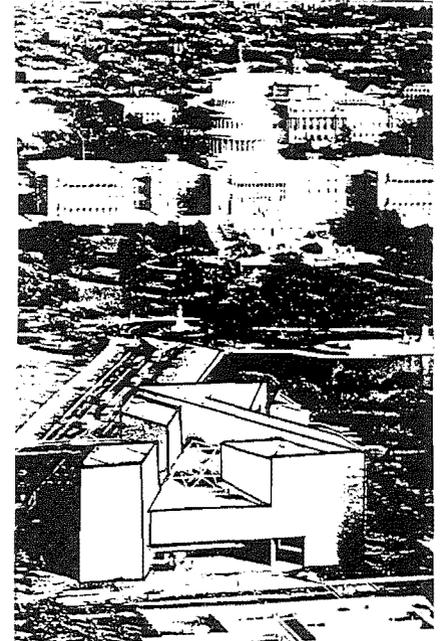
Table 1: Costs and benefits of the courtyard versus the tower

## Difficult sites

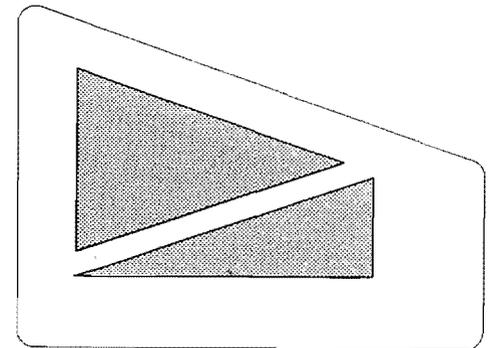
An atrium can be used as a design tool in the development of complex or unusual sites, where a traditional building form would be unsuitable or inappropriate. The design of the East Building for the National Gallery of Art in Washington D.C. provides a fine example. It was designed by the architect I.M. Pei and opened to the public in June 1978. Pei had to work within the constraints of :

- \* a trapezoidal site, wedged between the Mall, Pennsylvania Avenue and 4th Street
- \* a maximum height limit of 39.6m
- \* the need to relate the orientation, scale and appearance of the building to the existing adjacent West Building gallery
- \* the need to align the new building with the existing mall, which met the site at an angle.

Pei resolved the design problem by dividing the site into two triangles; an isosceles triangle and a right angled triangle. The former triangle aligned with the axis of the existing gallery, and the area



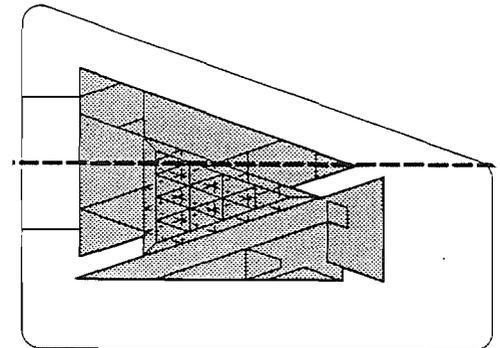
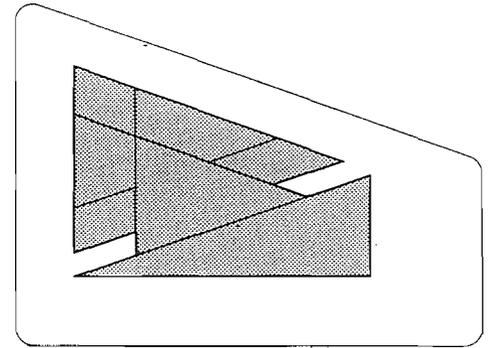
THE EAST BUILDING, WASHINGTON D.C.



between the two triangles reflected the angle of the existing mall.

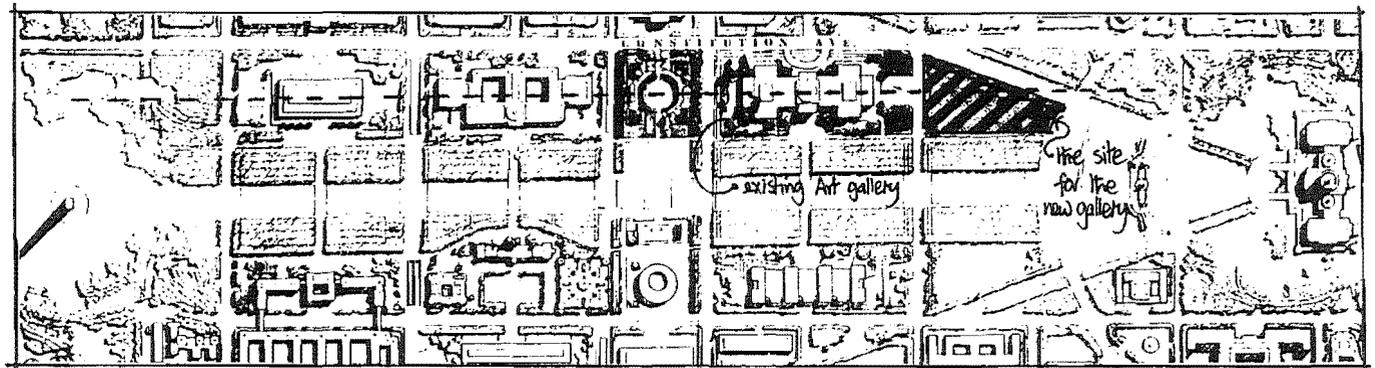
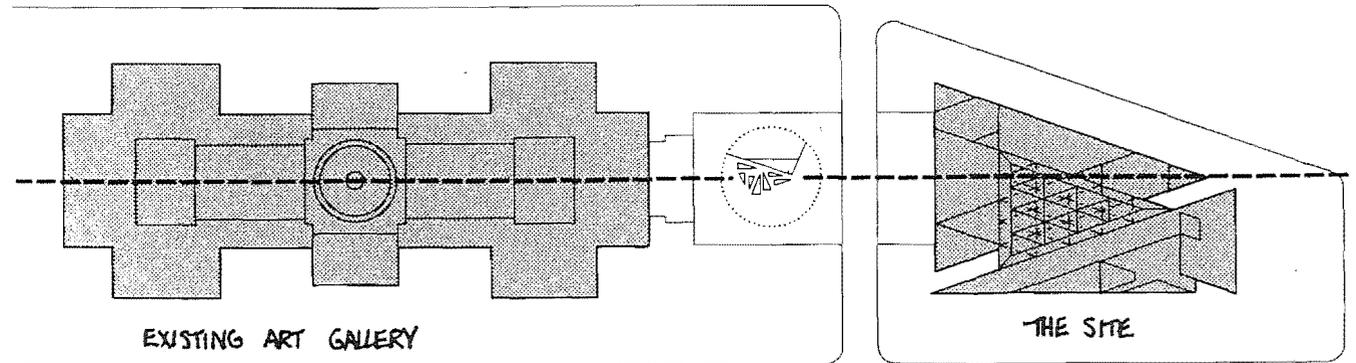
He used a third triangle, effectively the atrium roof, to cover the main circulation space and central court, and to tie the two primary elements together. The central atrium is roofed by a skylight which spans 1487sq.m. and is 24.4m above the concourse level. It is made of welded steel tetrahedrons and double-paned insulating safety glass, with ultraviolet and sunscreen filters to protect both visitors and works of art.

This roof "allows a play of light that makes the building refreshing and dynamic at any time of day"<sup>5</sup>, and the central space beneath helps both to organise the building and orientate the patrons. The atrium is entered through a progression of spaces, from a low, intimate scale at the entry on the concourse level, through a long tunnel to the lobby where "the space seems to explode overhead" as you enter the central court. This processional experience is a deliberate attempt by the architect, I.M. Pei, to provide drama and excitement in a way that will stimulate the senses and heighten awareness of the surroundings. He has also used the idea of the "hollowed court" rather than the



traditional "tower" design of the west to maximise development potential.

This may reflect the influence of his childhood in China and the design of the traditional Ming house with an interior courtyard. However, it reinforces the argument for the "courtyard" rather than the "tower" put forward in the previous chapter on efficiency of land use.



LOCATION MAP for THE NATIONAL GALLERY OF ART, WASHINGTON D.C.

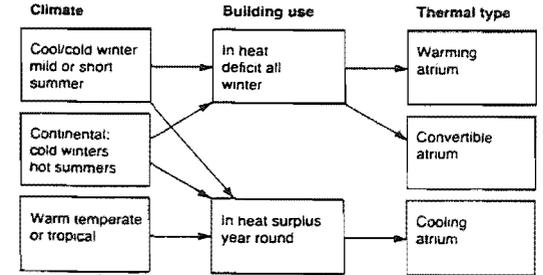
### 3.6 Design guidelines

**An energy strategy** The type of atrium required will depend primarily on the interaction of the climate and the proposed uses in the building, modified by site analysis factors. The design process is summarised in the diagram on the following page.

There are two basic considerations. One is the climate of the site, and the other is the thermal nature of the building.

From these investigations, a decision can be made as to whether a warming atrium (normally collects heat), a cooling atrium (normally rejects heat) or a convertible atrium (which attempts to do both at different seasons) is the most appropriate thermal type.

The degree of comfort required in the atrium will also affect the design. The basic "buffer" type will maximise energy saving but will not provide a comfortable and habitable year-round space. The "full comfort" atrium provides the most comfortable space but may be wasteful of natural energy flows.



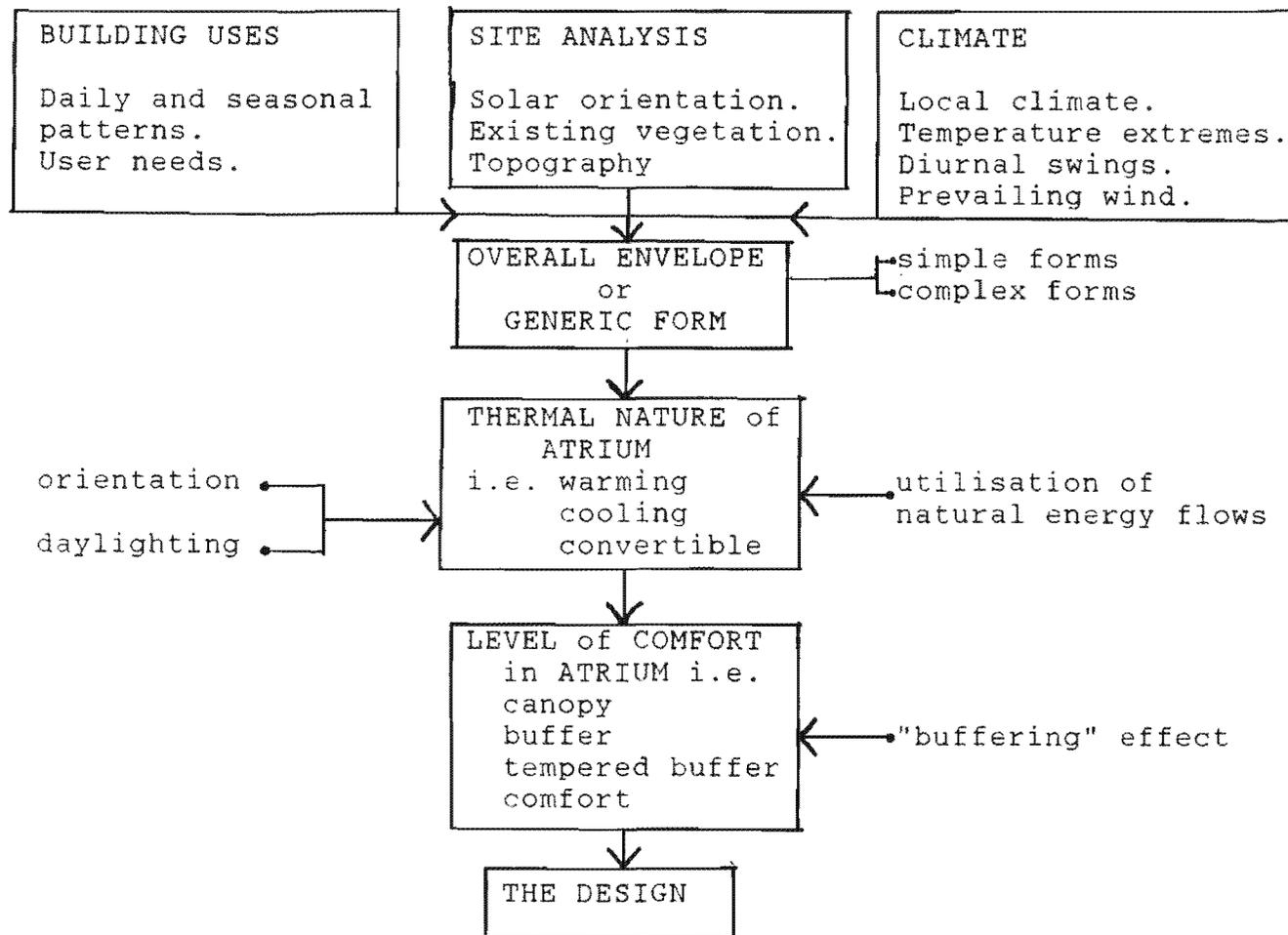
#### ATRIUM THERMAL TYPE SELECTION

Performance level	Comfort type	Examples
Shelter and shade no air containment	Canopy	Galleria, Milan Brunel Plaza, Swindon Antoine Graves houses, Atlanta
Winter air containment, shelter and shade. Summer natural ventilation no heating	Buffer	Trondheim University Swansea Quadrant Centre
Heating only to ensure minimum of 7°C or 13°C wide fluctuations	Tempered buffer	Atrium North, Toronto Children's Hospital of Philadelphia Gregory Bateson Building, Sacramento
Servicing to normal occupied space standard	Full comfort	Royal Bank, Toronto Courts Bank, London Hyatt Hotel, O'Hare, Chicago

#### ATRIUM COMFORT TYPE SELECTION

The final design will therefore evolve from a balanced consideration of all these factors, bearing in mind the variations in the local climate and the degree of comfort required in the atrium.

## The design process



## 4. The Living Atrium

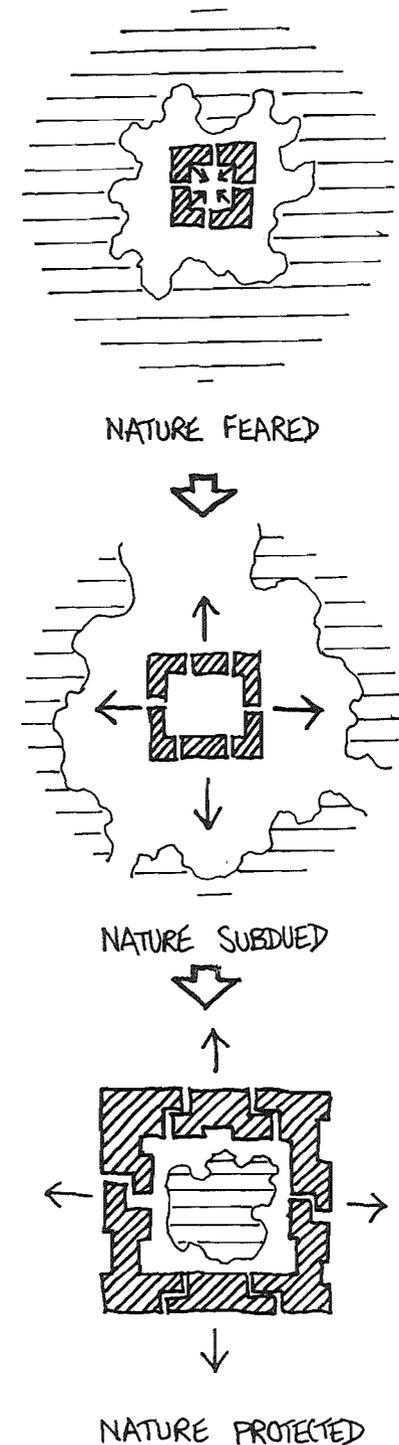
## 4.1 The importance of indoor planting

*"Indoor space is becoming the new landscape that provides eternal spring and summer, even in the extreme climates. We are moving into an age of Artemis.... where wild woods and bucolic nature are again becoming part of man's environment.... but now indoors".<sup>24</sup>*

This process can be seen as part of a continuum, originating in the antagonistic attitude of early settlers to the surrounding wilderness, the subsequent attempt to subdue, dominate and manage nature, and culminating in the present nurturing and protection of all things natural. Nature, once reviled, is now revered.

The present use of indoor plants also reflects several changes that have taken place in society, such as :

- \* An increase in leisure time, and in spending power, and a greater freedom of choice regarding leisure activities.
- \* A trade in activities which are structured and competitive for those which are passive,



individual, interpretive and highly selective. The quality of the environment and the impact on the senses becomes of paramount importance.

- \* The emergence of the ecological movement and an increased awareness of man's fragile relationship with nature.
- \* The psychological need to be in contact with nature, particularly as we are forced to live in increasingly controlled and artificial environments.

Indoor plants also have direct environmental benefits in that they :

- \* create more pleasant microclimates
- \* help to increase moisture levels in the air through evapotranspiration
- \* help to absorb air pollution and sound
- \* can be used for aesthetic reasons to add colour, form, texture, pattern or scale to the environment

- \* can be used to help screen unsightly objects or features
- \* can be located to direct traffic movement or to subdivide large areas
- \* provide scale relative to the human form and help to articulate spatial volume.

People are subconsciously aware of the natural and living aspect in a space when plants are used, as opposed to other means of spatial manipulation. Foliage plants are also symbolic of life and a denial of death which winter represents. However, in order to flourish and thrive, plants require certain environmental conditions. These are discussed in the following chapter.

## 4.2 The required environment

LIGHT

TEMPERATURE and HUMIDITY

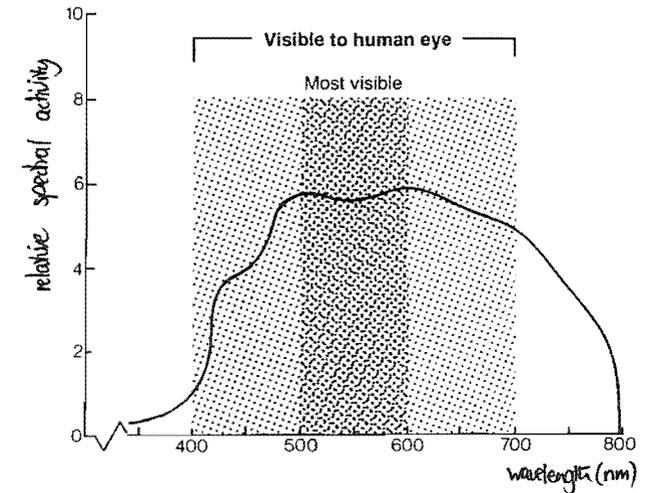
WATER

THE GROWING MEDIA

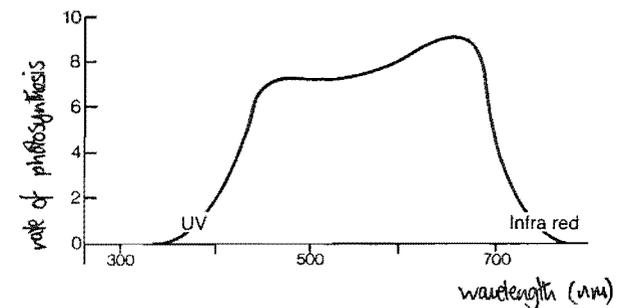
### Light

The level of light is one of the most crucial factors in determining the success of planting in atria. Without adequate light, the photosynthetic processes of plants are imbalanced, resulting in the inability to produce food for growth requirements and the exhaustion of stored energy. Light is also needed to regulate the shape of a plant and to give seasonal guidance.

Natural light is preferable to artificial light because it is more energy efficient, more likely to be evenly distributed and is pleasing to look at. The quality of the natural light will vary, depending on the aspect of orientation of the atrium; the angle and direction of the light; any filtering or shading from outside, particularly by trees, curtains or tinted glass; and the time of year, since the sun is at a lower angle during the winter than during the summer. An attempt should



SPECTRUM OF SUNLIGHT AT NOON

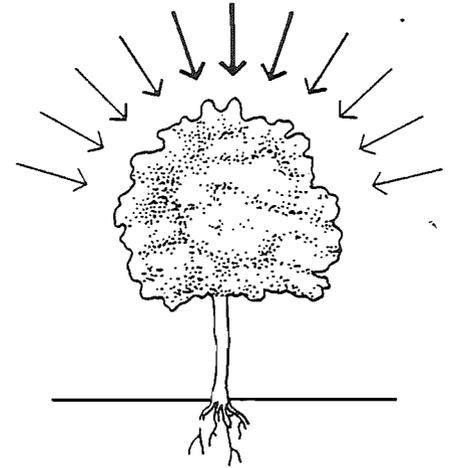


RATE OF PHOTOSYNTHESIS RELATIVE TO THE SPECTRUM

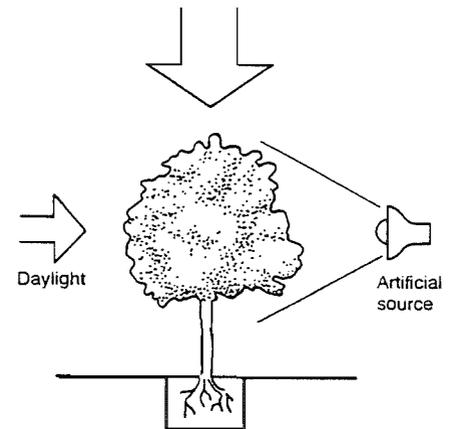
be made to distribute light evenly over the plants, preferably from an overhead source, and to ensure that ground cover below trees also obtains sufficient light.

In general, plants need a light level the equivalent of 700 to 1000 lux<sup>16</sup> for twelve hours a day. They also need a daily dark period to construct and distribute carbohydrates, therefore the use of continuous artificial light should be avoided. However, it is often necessary to use artificial light to provide compensating illumination. The recommended method<sup>1</sup> is by using high intensity discharge metal halide lamps in conjunction with high pressure sodium lamps in high bay luminaires. The metal halide lamps deliver strong full-spectrum light, have increased energy efficiency and a longer lamp life than other models.

Plants require light in the red/blue sections of the light spectrum, whereas optic light, which is absorbed by the human eye, is in the yellow/green frequency. When obtaining the light level, it is therefore necessary to make sure that the spectral distribution of the lamp includes an adequate red/blue output. To be sure of seeing plants in



A TREE'S SHAPE IS BASED ON NATURAL SKY BRIGHTNESS DISTRIBUTION



SUPPLEMENTARY ARTIFICIAL LIGHT CAN HELP MAINTAIN SHAPE

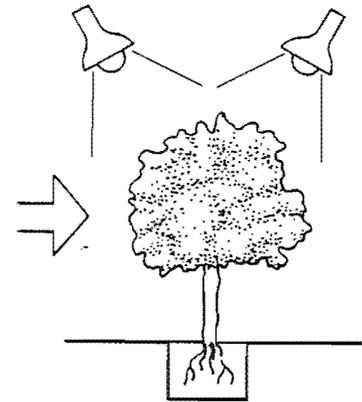
their true colours, lamps must have a high colour rendering index reading, in excess of 90 C.R.I.<sup>16</sup> The metal halide lamps meet these requirements.,

## Temperature and humidity

Plants have permissible air temperature regimes, based on their natural habitats, which should not be exceeded. The majority of foliage plants prefer a daytime air temperature of 21-24°C reducing to 15-18°C at night. The temperature should never drop below 13°C, especially for sub-tropical plants.

The main problem in selecting plants for atria is that the plants have to tolerate the temperature and humidity range selected for the comfort of the people using the atria. For this reason, sub-tropical planting is now found in most atria. Temperate plants were originally used at the Ford Foundation, but it became impractical to try to achieve the sustained low temperatures needed for winter rest.

The minimum temperatures and lighting levels should be maintained throughout the year, especially if the building is closed for holidays or at the weekend, and ventilation and heating systems would otherwise be closed down.



SEVERAL OFF-CENTRE LIGHTS ARE  
BETTER THAN ONE VERTICAL  
(from SANDY R. "Atrium Buildings")

Plants require a certain level of humidity to promote an efficient evapo-transpiration rate. They are normally grown in 64 to 90 per cent relative humidity, but can adjust to human conditions of 35 to 50 per cent relative humidity. The presence of a water feature will increase humidity levels, which should not be allowed to drop below a minimum of 30 per cent relative humidity.

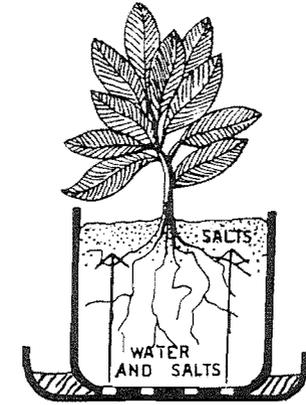
The air temperature increases with the height of the atrium, due to the combined effects of the "stack" and "greenhouse" processes. Tall plants, such as bamboo, may be damaged and scorched by the higher temperatures and intensified solar radiation near the roof, particularly in the summer. To avoid damage to their leaves, plants should not be located within a metre of the high intensity lamps. It is also preferable to keep plants away from cold draughts from doorways and ventilation systems, otherwise they will die back, particularly if the air movement is more than 1.5 metres per second.

**Water** Provided that light levels and temperatures are adequate, the biggest threat to plant health is from over-watering. It reduces air circulation,

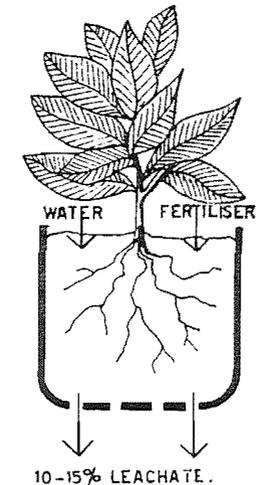
causing the roots to suffocate and eventually decay. The daily water loss by transpiration and evaporation is proportional to the amount of solar radiation the plants receive. Indoor plants generally receive a much lower level of radiation than those grown in their natural environment and, in theory, do not require as much water. However, they are growing in an artificial environment, without the benefits of rainfall, and require regular watering.

Watering can be done either manually or by an automatic system. The most appropriate method will depend on the size, type and number of plants and planters. The self-watering planters, which draw up water and fertiliser by capillary action from a reservoir in the base of the planter, are useful for free-standing planters, but are difficult to construct above a certain size. Also, they require greater care with supplementary feeding because nutrients may accumulate in the top layer of the compost and are not dispersed by leaching.

An automatic system, using piped irrigation with drip or spray emitters, can be used for more extensive projects. Di-electric detectors measure



WITH SUBIRRIGATION, SALTS ACCUMULATE  
IN THE TOP LAYER OF COMPOST



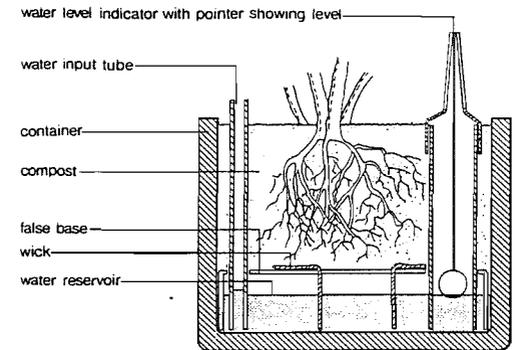
SURFACE IRRIGATION WITH 10-15%  
LEACHATE PREVENTS SALT BUILD-UP.

water content in the soil and activate solenoid valves to operate the system when moisture falls below a certain level. However, this type of system can be difficult and expensive to install, and may fail if there is a fault in the system or the power supply is discontinued.

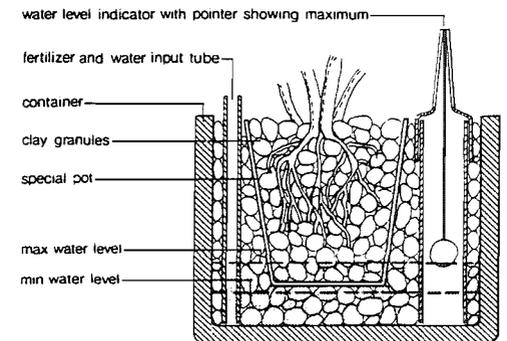
It is interesting to note that the most successful projects have all used manual watering and feeding methods. In this way, the individual requirements of each plant can be assessed and, at the same time, the plant can be checked for pests or disease or signs of stress. Also, the manual watering helps prevent the build-up of nutrients in the surface level, which is a problem with the self-watering techniques. This method may be labour-intensive, but the individual care and maintenance should result in much healthier plants and more luxurious growth.

### The growing media

The growing media must be lightweight and low density with large pore spaces in order to reduce the weight, yet allow for the drainage of water and aeration of the roots. In general, artificial mixes are preferred because they are light and easy to handle and have the right drainage and air-entrainment qualities. Sphagnum or sedge peats are



SELF-WATERING FREE STANDING PLANTER

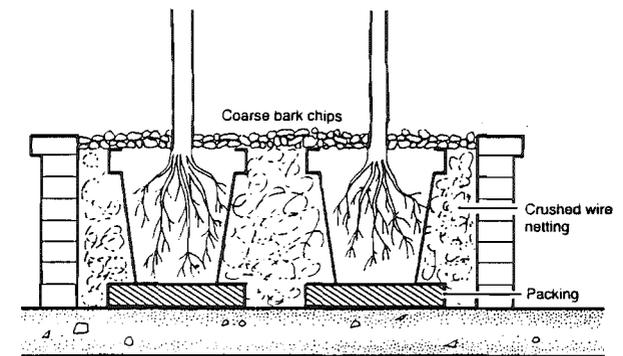


HYDROCULTURE

normally used, and improved to give the necessary air-filled porosity by the addition of inorganic materials such as sand, clay or loam or by synthetic materials such as perlite, foamed plastic, expanded vermiculite and leca (light expanded clay aggregate). The quality of materials required will depend on the quality of the peat, the type of plant and the local conditions.

The depth of the container is an important factor which interacts with the size of the pores in the compost. Shallow layers of medium will always be wetter than the same medium in deep containers because of the "perched water table" effect. For this reason it is essential that composts for shallow containers have enough large pores that drain quickly after saturation to give an adequate air filled porosity. This should be not less than ten per cent by volume of the medium. High air-filled porosity in the growing medium is essential for good root development.

The planter must also be deep enough for the compost or other medium to provide firm support for the plant as well as allowing for root development. Hydroculture can be used for smaller scattered plants in containers, but is difficult to adapt or



CONTAINERISED PLANTS WITHIN A PLANTER

design for large scale planting.

A disadvantage of peat based compost is that it contains very few plant nutrients, either macro elements or trace elements. It is therefore necessary to periodically add a slow-release fertiliser such as 'Osmocote' or 'Ficote', as a supplementary feed. The compost should be checked to ensure an optimum nutrient level before planting and a pH level of between 5.5 and 6.0.

### **Suitable plants**

Tropical plants are now almost universally used because it is impractical to achieve the sustained low temperatures needed for a winter rest by temperate species. (See Ford Foundation page 85).

The choice of individual species will depend upon :

- \* the environment created within the atrium in terms of the factors outlined in the previous chapter
- \* the visual and functional effects required
- \* the availability of suitable plants.

One of the major constraints in New Zealand is the

general shortage of sizeable species such as bamboo (Phyllostachys sp.) and Norfolk Pines (Araucaria heterophylla) which are often required in atria. (See Case Studies - Glaxo's, Palmerston North). Also, increasing demand for quality interior plants is placing a considerable strain upon many of the established channels of supply. It may be necessary to "grow on" suitable plants and to place an order with suppliers as far in advance of construction as possible. The plants may also need to be acclimatised prior to being placed in the atrium, in order to adjust to the changes in environment.

The lists in Appendices 4, 5 and 6 contain plants considered suitable for interior landscaping, and their required light levels. Those marked with an asterisk are not readily available in New Zealand, but are used widely overseas.

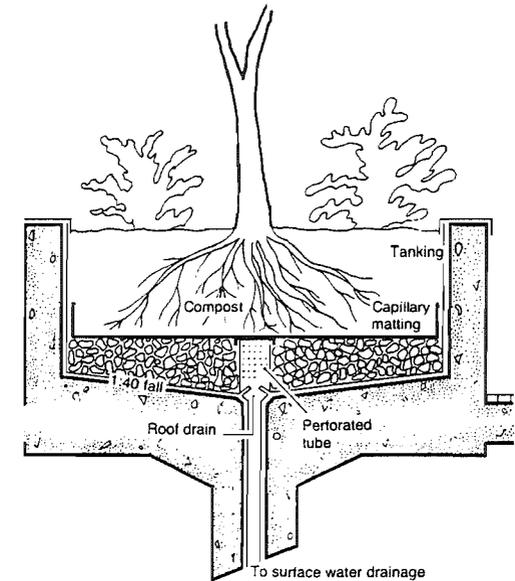
### **Suitable containers**

In general, the type of planter depends on the scale of planting. If smaller plants are kept in their production containers, they can be readily interchanged for seasonal variation or replaced if unhealthy. However, if large scale planting is envisaged, purpose designed planters are normally used. This allows for a suitable depth of compost

to accommodate the natural root spread of the plants as well as provision for drainage and irrigation. It also gives a more "natural" effect to the planting. The planter surface can be countersunk into the atrium floor, or raised above the ground level to provide a protective wall which can also be used as a basis for seating.

The planter base should be sloped towards a central drainage channel at a slope of 1 in 40. To assist the drainage a layer of 100 to 150mm of leca should be spread across the base. This should be covered by a layer of capillary matting to prevent the roots and compost from spreading into the drainage system. A peat based compost is then placed in the planter in preparation for the plants.

The materials used in the construction of the planter need to be watertight, non-toxic and non-inflammable. The inside of the planter can be waterproofed by the application of a coat of cold applied bitumen or acrylic emulsion. The planters must also be non-decomposable and resistant to the moisture and chemical conditions created by the soil. For these reasons, planters are normally constructed out of concrete, fibreglass or stainless steel. The weight of the planter must



BUILT-IN COMPOST PLANTER

also be considered in relation to the carrying capacity of the floor, particularly if it is to contain a large tree. In this case, the planter may need to be placed over a column in the floor or other structural support.

When the atrium floor is on natural ground, it may be assumed that planting can be done directly into the available soil. However, the existing soil is normally compacted by siteworks until it is too solid to permit good drainage or root penetration. A depth of new compost and suitable drainage facilities need to be provided and this is usually most effectively done with a purpose designed planter.

### Care and maintenance

To keep plant health at an optimum, it is necessary to ensure that the required environment is provided and that care and maintenance are carried out on a regular basis. Plants are organic and are therefore totally reliant upon their environment. With the high temperatures and low humidity often found in atria, many pests thrive. The person in charge of plant care must therefore be able to recognise and treat plant pests and diseases, as well as understand the symptoms of stress and nutritional deficiencies and their treatment.

It is possible to use biological control in the treatment of several pests, rather than using chemical sprays. The red spider mite is the most common pest, but this can be controlled by introducing Phytoscillus persimilis, an orange predatory mite from South America. This breeds twice as fast as the spider mite, but eventually declines due to starvation after the elimination of the infestation. Similarly, white fly can be controlled using a tiny wasp called Encarsia formosa, and mealy bug will be devoured by a ladybird named Cryptolaerus montrouzieri. However, the scale insect has no known predator and therefore needs to be discovered before infestation occurs.

Care and maintenance also involves watering, feeding, cleaning and replacing unhealthy plants. Plants can be cleaned and watered by spraying with soft clean water through a fine nozzle. It may also be necessary to clean the atrium roof and windows to ensure maximum daylight intensity and quality. If curtains or shades are used to filter light, they should also be cleaned regularly. It is probable that some plants, especially the smaller ones, will die and need to be replaced.

This should be done as soon as there are obvious signs of stress.

As the quality and intensity of light will not be uniform within the atrium it may be necessary to rotate smaller plants to ensure even growth. Also, the combined effect of the "greenhouse" and "stack" phenomena may result in tall plants such as bamboo being burnt by the higher temperatures and more intense radiation near the roof of the atrium. Plants may also be adversely affected by cold draughts from doors and ventilation shafts. It is for these reasons that the landscape architect should be familiar with the basic building technology and natural phenomena in atria, and should be able to select plants that will survive in the controlled environment.

The three most common causes of failure in indoor planting in atria result from:<sup>32</sup>

- \* insufficient design development and co-ordination
- \* a lack of technical knowledge
- \* poor on-site supervision.

It is essential that the design team work together from the beginning of the project. Plants must not merely be added as decoration to an unsuitable environment. The landscape architect needs to become familiar with the work of the other members of the design team and to have an understanding of the architectural concept behind the design. The list in Appendix 7 shows some typical professional services required in atria design, all of which should have some input from the landscape architect, and some of which will be their sole responsibility.

In order to ensure success, plant material must be chosen which is suitable for the atrium climate. However, the plants themselves also have minimum requirements regarding light, temperature, humidity, nutrients and the quality of the growing media. In effect, the landscape architect is working within an ecosystem where the plants are totally reliant on their environment.

There must be a commitment to plant maintenance and care from the time of installation. It must be regular and continuous and is therefore best considered as an extension of the installation contract. The establishment period is particularly

crucial and requires skilled care and regular inspection.

Appendices 1 and 2 contain checklists and a summary of requirements for the types of planters, the care and maintenance of the plants and the environmental conditions necessary to promote optimum growth.

## 5. Case Studies

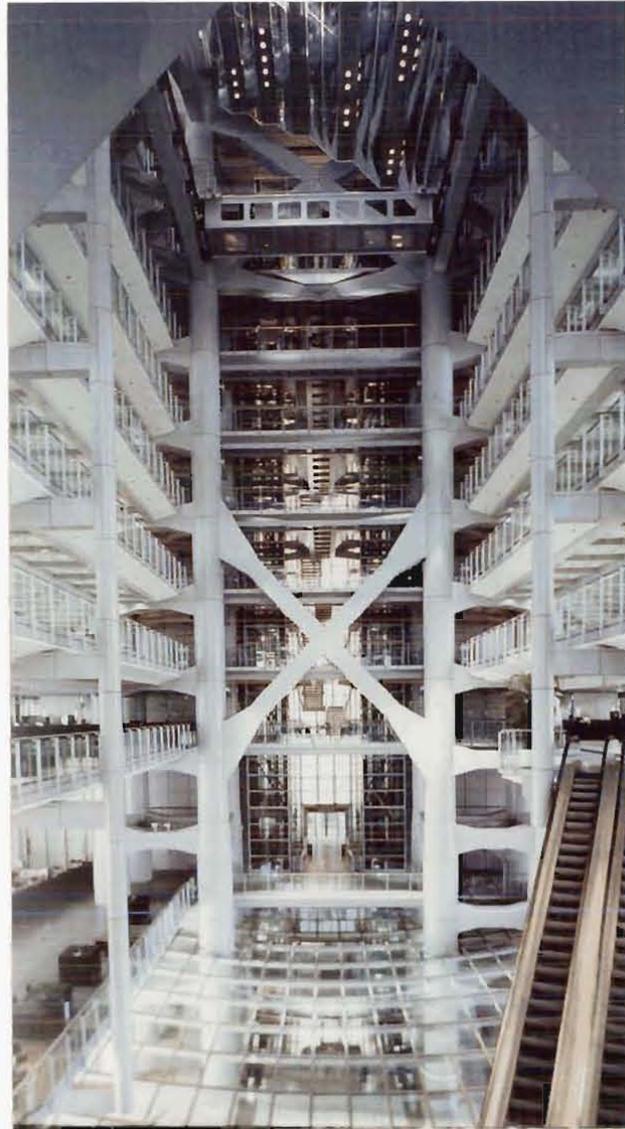
## 5.1 Types of planting design

In selecting the case studies, examples have been chosen which illustrate the various design functions of atria and also show different styles of planting. The planting style varies from the "sculptural" use of palms in the Winter Garden in Battery Park City, to the use of mass planting of tropical plants to create a "jungle" look at the Glaxo factory in Palmerston North. Each of the five case studies is examined individually then their design functions and styles are compared and contrasted in the table at the end of this section.

## EXAMPLES

## PLANTING DESIGN STYLE

- 1 Hongkong and Shanghai  
Bank, Hong Kong "Bare Essentials" - no planting.
  
- 2 The Winter Garden,  
Battery Park City,  
New York "Sculptural" - plants as a  
living sculpture.
  
- 3 The Parkroyal Hotel,  
Christchurch "Disguise" or "Decoration" -  
plants used to soften  
architectural forms, emphasise  
features or complement design.
  
- 4 The Ford Foundation,  
New York "A Metaphor for the Garden" -  
plants used to emulate natural  
conditions and encourage  
contemplation and relaxation.
  
- 5 Glaxo (NZ) Ltd.  
Palmerston North The "Jungle Look" - the use of  
mass planting with exuberant  
foliage and lush growth to  
create a tropical paradise.

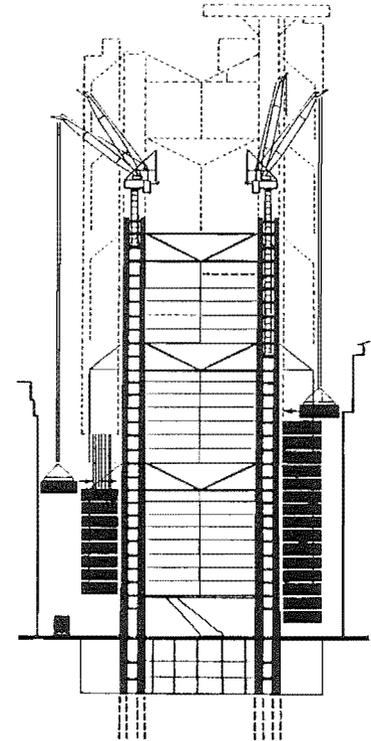


The Hongkong and Shanghai Bank

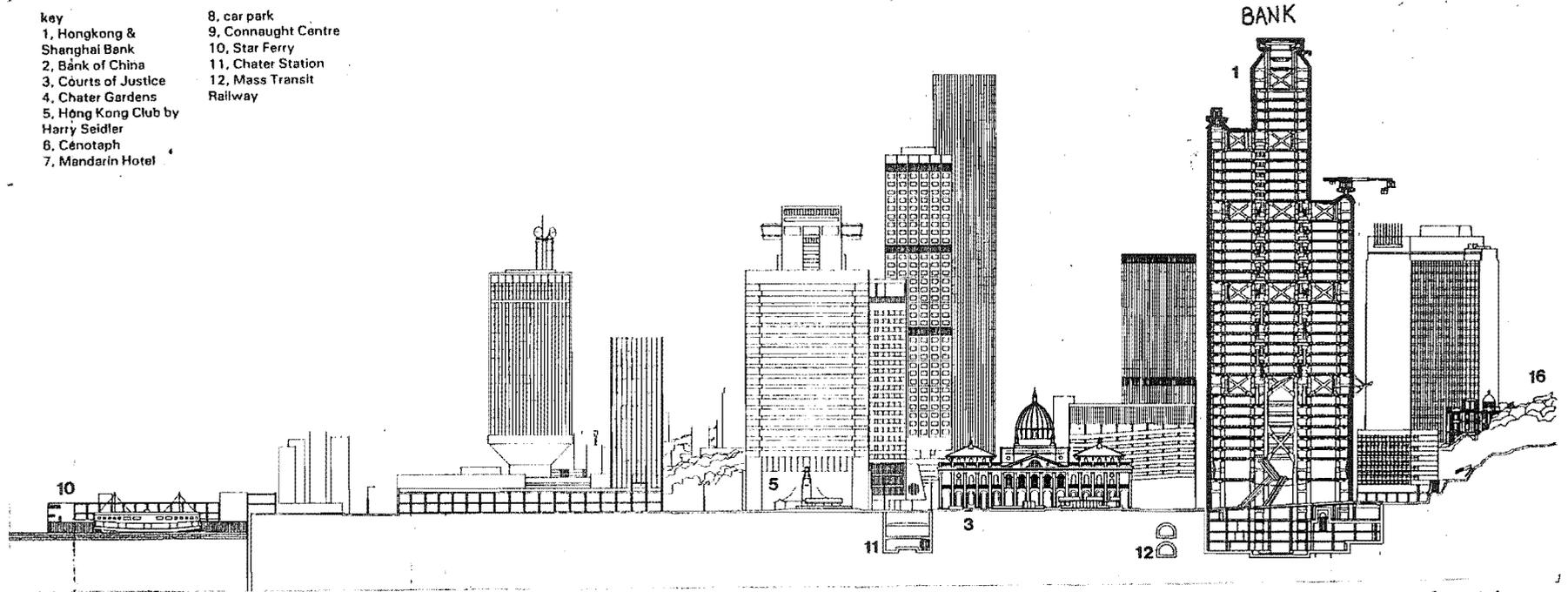
## THE HONGKONG AND SHANGHAI BANK

- LOCATION : Des Voeux Road, Hong Kong Island
- ARCHITECT : Norman Foster of Foster Associates
- THE DESIGN : The new multi-storey Hongkong and Shanghai Bank stands a long way back from the waterfront on Hong Kong Island but is distinctive from neighbouring tower blocks because of its method of construction. The steel suspension structure, exposed on the facade, is much lighter and more transparent than its neighbours and displays its construction details for all to see. The structure is suspended from eight massive masts and, in principle, behaves much like a series of stacked portal frames. Visually, it bears a marked resemblance to the stacked timber structures and overhangs that are typical of Chinese and Japanese Buddhist temples, and which Foster refers to as "source images".

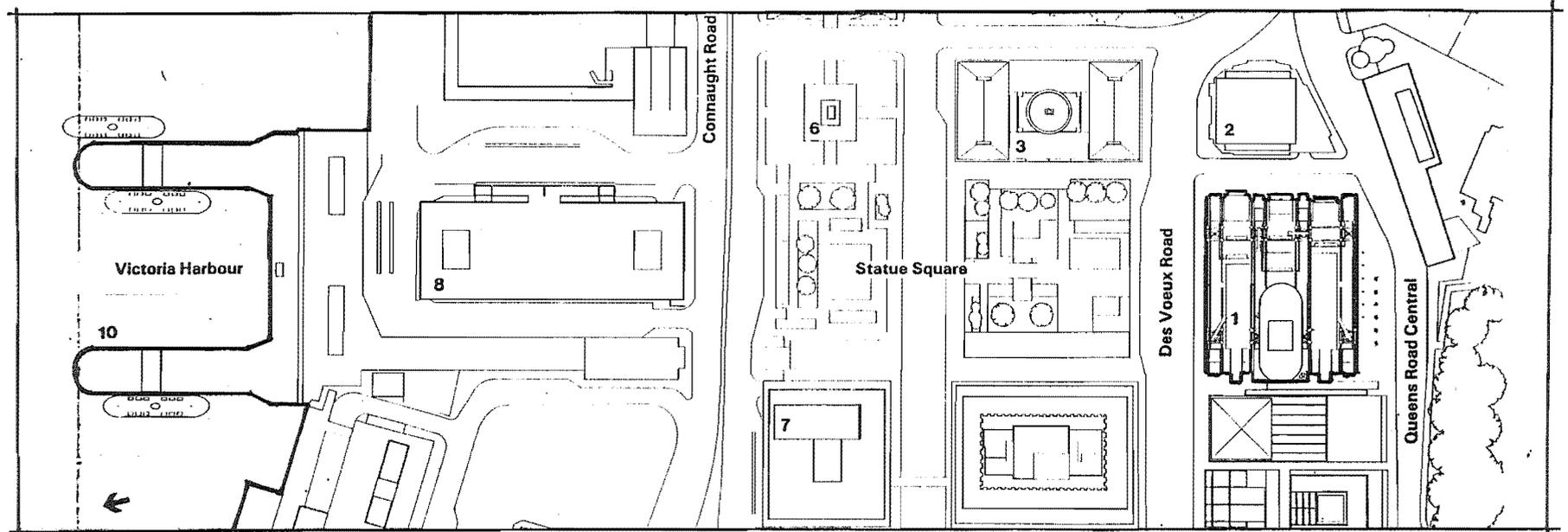
The building's centrepiece is the banking hall and atrium, which are a symbolic focus to replace the popular vaulted banking hall of the previous bank.



- key
- 1, Hongkong & Shanghai Bank
  - 2, Bank of China
  - 3, Courts of Justice
  - 4, Chater Gardens
  - 5, Hong Kong Club by Harry Seidler
  - 6, Cenotaph
  - 7, Mandarin Hotel
  - 8, car park
  - 9, Connaught Centre
  - 10, Star Ferry
  - 11, Chater Station
  - 12, Mass Transit Railway



SECTION

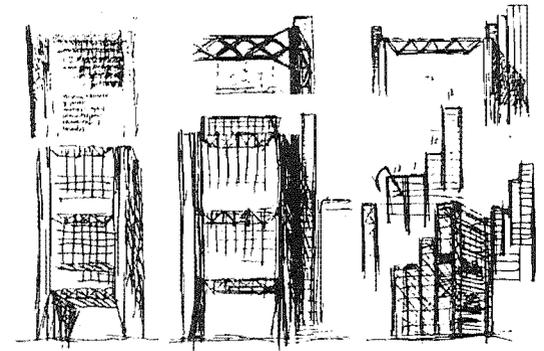


SITE PLAN

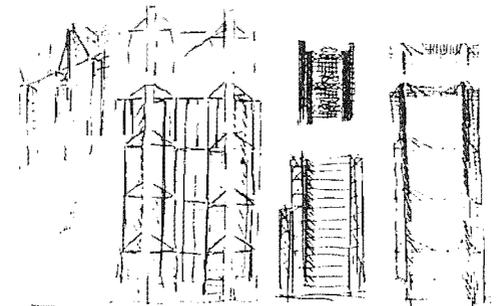
They also introduce natural light into the centre of the building with the help of the "sunscoop". This is a huge periscope composed of a bank of flat mirrors attached to the south side of the building at level 12, and a curved canopy of convex mirrors suspended over the atrium. It projects sunlight onto the banking halls and through the glazed underbelly to the public plaza beneath the building. The deflected sunlight casts shadows of passersby onto the granite of the plaza deep under the building.

The plaza is the bank's contribution to Hong Kong's urban spatial pattern and connects the busy thoroughfares of Queen's Road and Des Voeux Road, "pulling pedestrians down into the very bowels of the building". It is a sweeping space where two escalators span the full height from plaza floor to banking hall and atrium. Because of the transparent "underbelly" of the banking hall, people in the plaza have a clear sight 170ft straight up through the centre of the building :

*"If you do not know what is in store, the glance upwards from the plaza can knock you back... The immense void of the atrium affords the extraordinary*



FIRST STAGE - VARIATIONS OF CONCEPT - 1979



TRANSITION TO "EXISTENCE" OF FLOORS SUSPENDED FROM TOWER

THUMB NAIL SKETCHES BY FOSTER

dimension of complete north and south facing cross-sections through ten storeys. Standing at a point midway up the atrium, one looks from corner to corner through a whole street of transparent floors, with apparently precious little to hold them all up, apart from some slender 'sky hooks' hanging down the middle...<sup>21</sup>

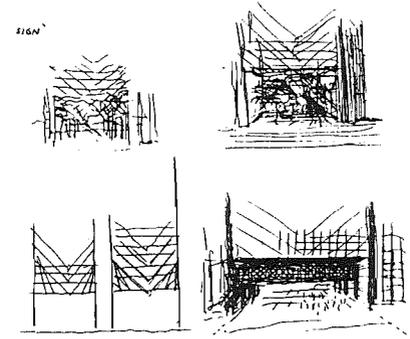
"Ioh Min Pei took a delegation from the Bank of China to look at the building and said afterwards that the atrium was the most impressive he had ever seen in his life".<sup>21</sup>

#### THE ATRIUM FUNCTIONS

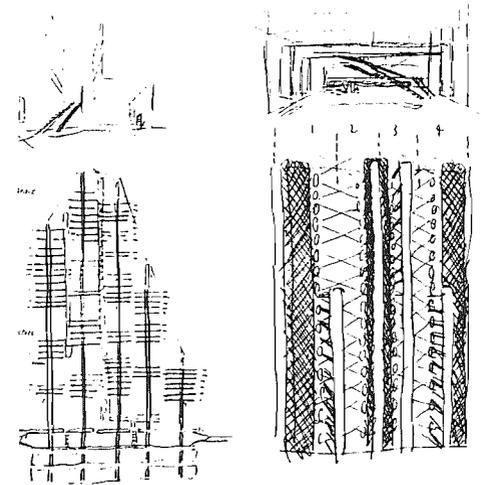
: The primary design functions of the atrium can be summarised as :

Utilization of natural energy; to bring daylight into the centre of the building and to provide a controlled indoor environment.

An impact on the senses; the journey upwards from plaza to office on a seemingly endless cascade of escalators through vast areas of almost unimpeded space is a dynamic spatial experience.



AN EXTENSION OF STATUE SQUARE BENEATH THE BUILDING



A GRID OF STRUCTURE & TOWERS FOR VERTICAL MOVEMENT & SERVICES

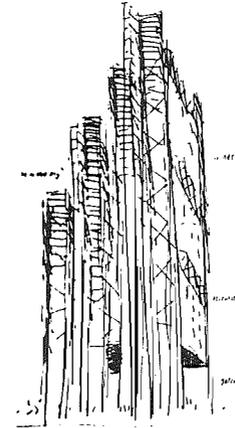
SKETCHES BY FOSTER

A place of orientation and organisation; a symbolic focus and important meeting place.

A transitional space. "The Bank provides an exhilarating journey from public to semi-public to semi-private and finally to private space".<sup>21</sup>

#### PLANTING

: This atrium is an example of the "bare essentials", where there is no formal planting to embellish the architecture or create atmosphere, but rather reliance on the sheer size and scale of the space, emphasised by the building's exposed structure, to create an impact on the senses.



ALMA MIX OF SPACES & ACTIVITIES

SKETCH BY FOSTER

THE WINTER GARDEN

- LOCATION : Battery Park City, New York
- DESIGNERS : Cesar Pelli, architect, Cesar Pelli and Associates  
Diana Balmori, landscape architect  
Paul Friedberg, landscape architect
- THE DESIGN : The atrium is a huge barred vault of glass connecting the four towers of the World Financial Centre. The floor is an intricate grid pattern of Mondragone, Rogo Aligante and Pior DiPesco marble. This contrasts with the stony pink granite and Botticino marble of the building's walls.

The planting design is striking and unusual and could be said to represent the inverse of tradition. The tall graceful palms have been used architecturally, spaced to emphasise their form and to reinforce the paving pattern, rather than massing greenery to soften the architecture. The palm grove embellishes and enlivens Pelli's distinctive architecture but does not impede the flow of pedestrian traffic through the plaza.



The Winter Garden

"Putting plants in air-conditioned and heated interior spaces is a troublesome issue for me", says Balmori. "Current practice uses plants for interiors as disposable items. It's very much like the old Victorian system of bedding out, which Robinson and Jekyll vehemently opposed and rightly so. I do not like to see plants put in for a short period of time and then be discarded; it is a lack of respect for living things. The alternative is to do much more research on plant material to see what can live under such extreme conditions. Adjustments and compromises will have to be made between what is comfortable for people and what plants need. The use of palms in the Winter Garden responds to this desert climate, and I have avoided any other kind of plant material in order to respond very tightly to the conditions".<sup>30</sup>

THE ATRIUM  
FUNCTIONS

: The Winter Garden is:

- \* a transition space between inside and outside.
- \* an important public space and meeting place.  
Moveable public seating can be adjusted around the perimeter of the space near the

restaurants and shops that line the walls of the plaza.

- \* a dynamic spatial experience with a strong visual impact.
- \* a controlled environment that can be used throughout the year.

THE PLANTING : Consists of sixteen Washingtonia robusta, a native American palm. They are tolerant of desert conditions and characterised by a narrow smooth grey/brown trunk and lush foliage. They were selected from Ellis Farms in Bonego Springs, California. The acclimatization of the palms took place in four stages:

- a) The trees were located and selected.
- b) 60 - 75 per cent of the root systems was pruned to encourage further root growth and give the palms time to adjust.
- c) They were transplanted into containers for a further 2 - 3 months.

- d) They were moved to a shade house for 6 months, where light levels were gradually reduced to approximately 1000 footcandles, equivalent to the level in the Winter Garden. The tinted glass allows 150 - 600 footcandles and this is supplemented by metal halide lights which supply over 650 footcandles.

Finally, the palms were transported in a closed truck to ensure proper temperature and humidity controls. The palms have been used as "a living sculpture" to embellish and enliven the distinctive architecture.



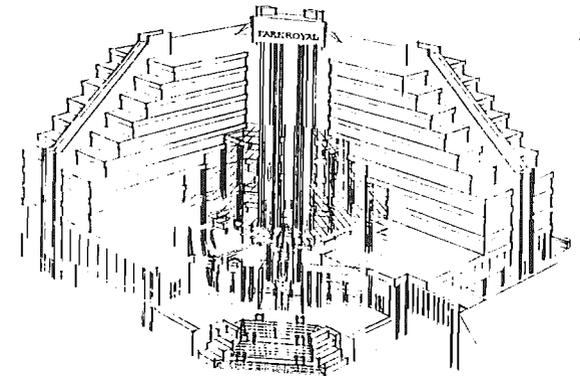
The Parkroyal Hotel

THE PARKROYAL HOTEL, CHRISTCHURCH

LOCATION : Corner of Durham and Kilmore Streets,  
Christchurch

ARCHITECT : Maurice Mahoney of Warren and Mahoney  
Architects Ltd

THE DESIGN : The new Parkroyal Hotel overlooks Victoria Square and sits astride the axis of Victoria Street, prematurely punctuating the end of this old radial route into the city. However, the axis has been retained as the main pedestrian thoroughfare through the hotel, although the visual continuity is broken by the change in level and blank wall facing onto Victoria Street at pedestrian level. The 45° angle of the old route has been used as a design theme throughout the building, as reflected in the octagonal columns and angled interior balconies.



THE PARKROYAL

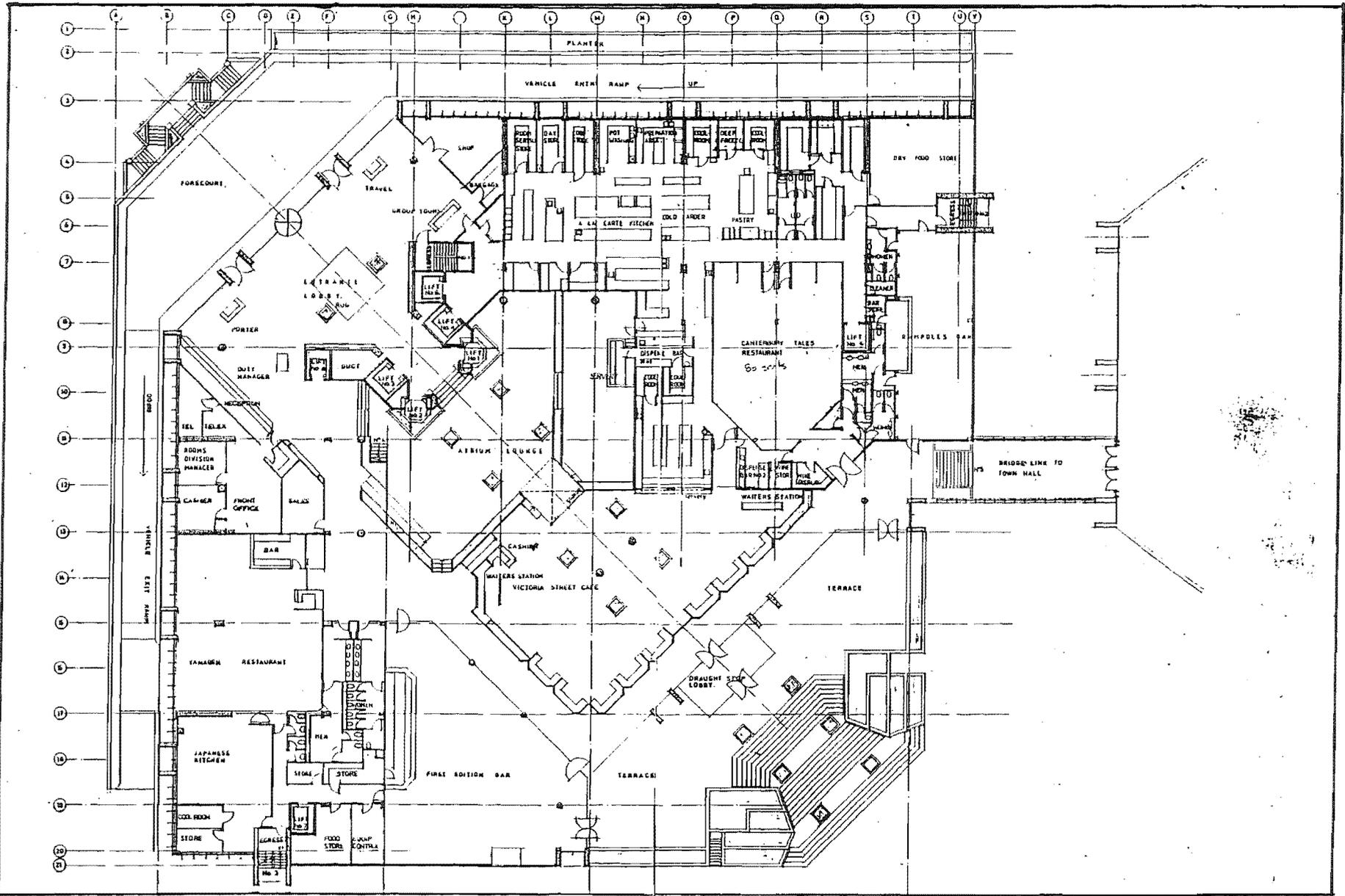
The central atrium sits on the south side of the building, between the two wings of guest rooms, which step upwards and backwards in a 14 storey

ziggurat form, on the "L"-shaped site. The stepped image of the exterior has been exploited internally to produce upper balconies and lounges at various levels overlooking the atrium. The glazed roof, gazebo and green foliage evoke the atmosphere of a conservatory, and give a light and spacious feel to the ground floor. According to the architect, Maurice Mahoney, the atrium was included primarily for visual and climatic reasons, to create an attractive indoor environment, sheltered from the weather and cool in the summer. However, the atrium also serves other functions as outlined below :

THE ATRIUM : As a place of organisation : the central atrium  
 FUNCTIONS creates inherent spatial order within the building,  
 with other rooms and functions leading from it.

As a place of orientation : a focal point in the  
 hotel, both visually and geometrically.

A meeting place and public space : the atrium  
 contains the main lounge and cafe, and has become a  
 popular meeting place for Christchurch residents as  
 well as hotel guests.



<p><b>Warren &amp; Mahoney Architects Ltd</b>          100-102, Victoria Street, Christchurch          Telephone: 342 1111</p>	<p><b>Holmes Wood Poole &amp; Johnstone Ltd</b>          100-102, Victoria Street, Christchurch          Telephone: 342 1111</p>	<p><b>PARKROYAL HOTEL</b>  <b>CHRISTCHURCH</b></p>	<p>1. REGISTERED TRADE MARK          2. TRADE MARK          3. TRADE MARK          4. TRADE MARK          5. TRADE MARK          6. TRADE MARK          7. TRADE MARK          8. TRADE MARK          9. TRADE MARK          10. TRADE MARK          11. TRADE MARK          12. TRADE MARK          13. TRADE MARK          14. TRADE MARK          15. TRADE MARK          16. TRADE MARK          17. TRADE MARK          18. TRADE MARK          19. TRADE MARK          20. TRADE MARK          21. TRADE MARK          22. TRADE MARK          23. TRADE MARK          24. TRADE MARK          25. TRADE MARK          26. TRADE MARK          27. TRADE MARK          28. TRADE MARK          29. TRADE MARK          30. TRADE MARK          31. TRADE MARK          32. TRADE MARK          33. TRADE MARK          34. TRADE MARK          35. TRADE MARK          36. TRADE MARK          37. TRADE MARK          38. TRADE MARK          39. TRADE MARK          40. TRADE MARK          41. TRADE MARK          42. TRADE MARK          43. TRADE MARK          44. TRADE MARK          45. TRADE MARK          46. TRADE MARK          47. TRADE MARK          48. TRADE MARK          49. TRADE MARK          50. TRADE MARK          51. TRADE MARK          52. TRADE MARK          53. TRADE MARK          54. TRADE MARK          55. TRADE MARK          56. TRADE MARK          57. TRADE MARK          58. TRADE MARK          59. TRADE MARK          60. TRADE MARK          61. TRADE MARK          62. TRADE MARK          63. TRADE MARK          64. TRADE MARK          65. TRADE MARK          66. TRADE MARK          67. TRADE MARK          68. TRADE MARK          69. TRADE MARK          70. TRADE MARK          71. TRADE MARK          72. TRADE MARK          73. TRADE MARK          74. TRADE MARK          75. TRADE MARK          76. TRADE MARK          77. TRADE MARK          78. TRADE MARK          79. TRADE MARK          80. TRADE MARK          81. TRADE MARK          82. TRADE MARK          83. TRADE MARK          84. TRADE MARK          85. TRADE MARK          86. TRADE MARK          87. TRADE MARK          88. TRADE MARK          89. TRADE MARK          90. TRADE MARK          91. TRADE MARK          92. TRADE MARK          93. TRADE MARK          94. TRADE MARK          95. TRADE MARK          96. TRADE MARK          97. TRADE MARK          98. TRADE MARK          99. TRADE MARK          100. TRADE MARK</p>	<p>1. CHINA          2. BRASS          3. STEEL          4. WOOD          5. GLASS          6. CEMENT          7. CONCRETE          8. BRICK          9. TILE          10. PAINT          11. GLUE          12. WIRE          13. NAILS          14. SCREWS          15. BOLTS          16. RIVETS          17. WELDS          18. SOLDER          19. GLASS          20. CERAMIC          21. PLASTER          22. GYPSUM          23. PUTTY          24. PAINT          25. GLUE          26. WIRE          27. NAILS          28. SCREWS          29. BOLTS          30. RIVETS          31. WELDS          32. SOLDER          33. GLASS          34. CERAMIC          35. PLASTER          36. GYPSUM          37. PUTTY          38. PAINT          39. GLUE          40. WIRE          41. NAILS          42. SCREWS          43. BOLTS          44. RIVETS          45. WELDS          46. SOLDER          47. GLASS          48. CERAMIC          49. PLASTER          50. GYPSUM          51. PUTTY          52. PAINT          53. GLUE          54. WIRE          55. NAILS          56. SCREWS          57. BOLTS          58. RIVETS          59. WELDS          60. SOLDER          61. GLASS          62. CERAMIC          63. PLASTER          64. GYPSUM          65. PUTTY          66. PAINT          67. GLUE          68. WIRE          69. NAILS          70. SCREWS          71. BOLTS          72. RIVETS          73. WELDS          74. SOLDER          75. GLASS          76. CERAMIC          77. PLASTER          78. GYPSUM          79. PUTTY          80. PAINT          81. GLUE          82. WIRE          83. NAILS          84. SCREWS          85. BOLTS          86. RIVETS          87. WELDS          88. SOLDER          89. GLASS          90. CERAMIC          91. PLASTER          92. GYPSUM          93. PUTTY          94. PAINT          95. GLUE          96. WIRE          97. NAILS          98. SCREWS          99. BOLTS          100. RIVETS</p>	<p><b>PLAN LEVEL 3</b></p> <p>1:200</p> <p>1/23</p>
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The Parkroyal Hotel

A transitional space : between Victoria Park outside and the hotel facilities inside. Also, between the public bars and restaurants, and the private guest rooms.

A dynamic spatial experience : the introduction of wall-climbing lifts which travel from the ground floor and burst through the atrium roof is an invigorating experience for most people, particularly at night when the lights of the city are suddenly revealed. Also, the atrium space is suddenly revealed in the progression from the main entrance lobby to the main lounge as visitors walk past the main lifts and into the lounge.

Multiple use : the atrium contains the Victoria Street Cafe, the main lounge and the Canterbury Tales Restaurant, all separated by the use of changes in level and raised planters.

Climatic control : to provide a controlled indoor environment, which also utilises natural energy flows.

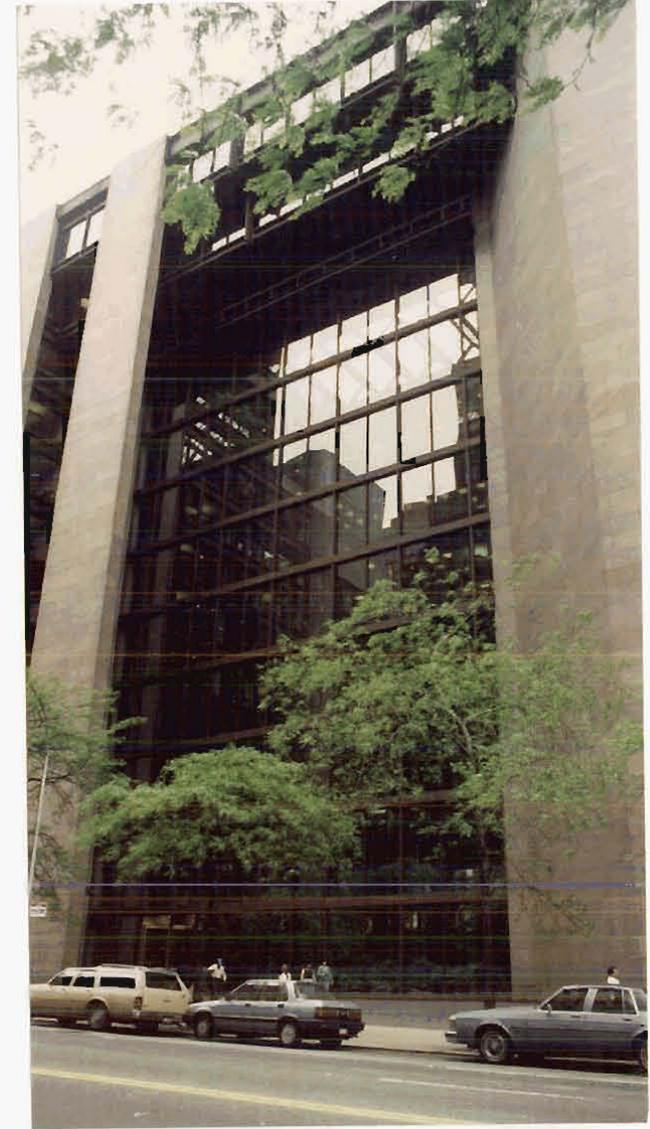
As a metaphor for the garden : to promote relaxation by creating a conservatory type of

atmosphere, complete with the constant tinkling from a grand piano.

THE PLANTING : The planting is all contained within raised planters of red granite or white marble, or in balcony planters along the edges of the ziggurat forms. The axis between Victoria Street and Victoria Park is highlighted by a row of approximately 3 metre high Ficus Benjamina in raised red granite planters. The edge of the main lounge is defined by raised planters containing mass planting of Spathyphyllum Walisii and Cissus, which also help to physically and visually separate this area from the cafe and general circulation space. The balconies overlooking the atrium are also planted with Spathyphyllum Walisii and Cissus, which trail over the edge of the planters and help soften the horizontal emphasis of the ziggurat form.

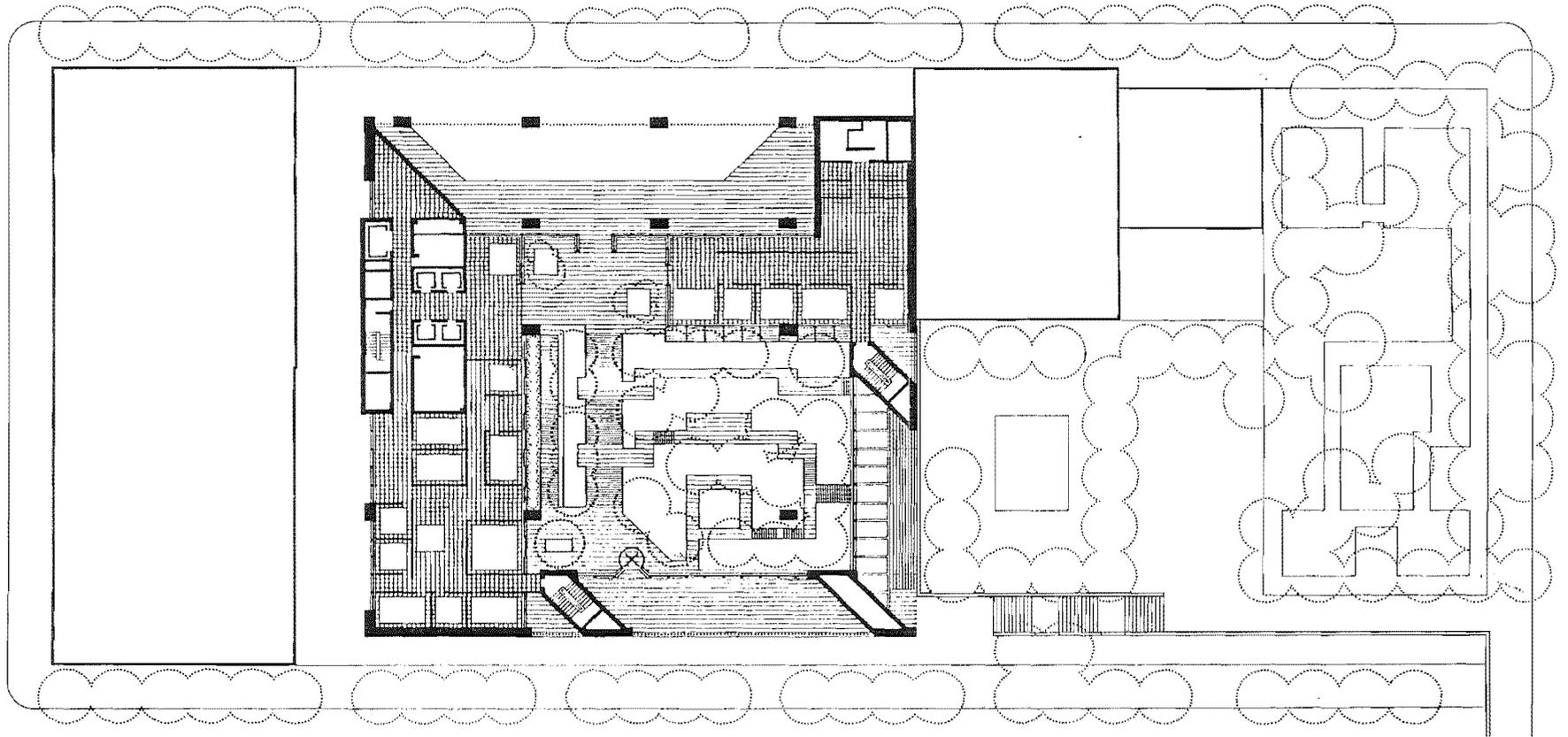
The planting has therefore been chosen to fulfil a decorative role in reating a "conservatory" atmosphere, a functional role in separating hotel activities, and as a form of disguise, to help

soften the architecture. The scheme is conventional rather than imaginative, but may be in keeping with the image that the hotel wishes to portray to the general public.



THE FORD FOUNDATION

- LOCATION : 42nd Street, New York City
- DESIGNERS : Dan Kiley, landscape architect  
Roche and Dinkelloo, architects
- THE DESIGN : The atrium is in the south-east corner of the building. It is ten storeys high and enclosed with steel framing and glass panes. The offices directly overlook the atrium through clear glass sliding windows and there are no intervening circulation galleries. It is approximately 8500 sq. ft in area, and 160 ft high.
- THE DESIGN CONCEPT : Dan Kiley created an indoor urban park in his design in 1967, using a series of terraces, steps and walkways under a canopy of temperate trees. The concept was historically important because it initiated the idea of including public space within a private modern building - it created a new kind of public urban space for use by both the general public and office occupants; a "downtown oasis" within the frenetic city.



*Entry level plan*

SITE PLAN

THE DESIGN : The following are the main design functions of the  
FUNCTIONS atrium:

Climatic control: the provision of a controlled indoor environment for use throughout the year.

A transitional space: between the public street outside and the private office space inside.

A "buffer" space: between the outside climate and the inside environment.

An important meeting place and public space: the atrium gives the Foundation a communal focal space that fosters a feeling of belonging and common purpose, and increases communication between the staff.

As a metaphor for the garden: the indoor park that has been created provides a haven for relaxation and contemplation of nature. The "woodland" effect can be experienced at ground level and viewed from the upper levels overlooking the atrium. It has been described as :

*"A tropical paradise that bespeaks the  
persian gardens' sense of retreat; the*

*Greek peristyle court as an  
indoor/outdoor extension; and Louis  
XIV's wealth and power....*"<sup>24</sup>

THE PLANTING : The original planting consisted of a palette of temperate plants, varying from southern magnolias and Eucalyptus for height, to Cryptomeria and evergreen pears for texture, Jacarandas as a canopy layer and a shrub layer of azaleas, fuchsias and camellias.

However, a large proportion of these plants failed to thrive or died in the first five years, because of insufficient daylight and the consistently high tropical temperatures. Also, the seasonal changes required by temperate plants could not be created without adversely affecting the human comfort range in the atrium.

Therefore, subsequent planting included species known to tolerate higher temperatures and indoor conditions, such as:

*Ficus benjamina*  
*Philodendron cordatum*  
*Chlorophytum*  
*Hedera*

*Rhoicissus rhomboidea*

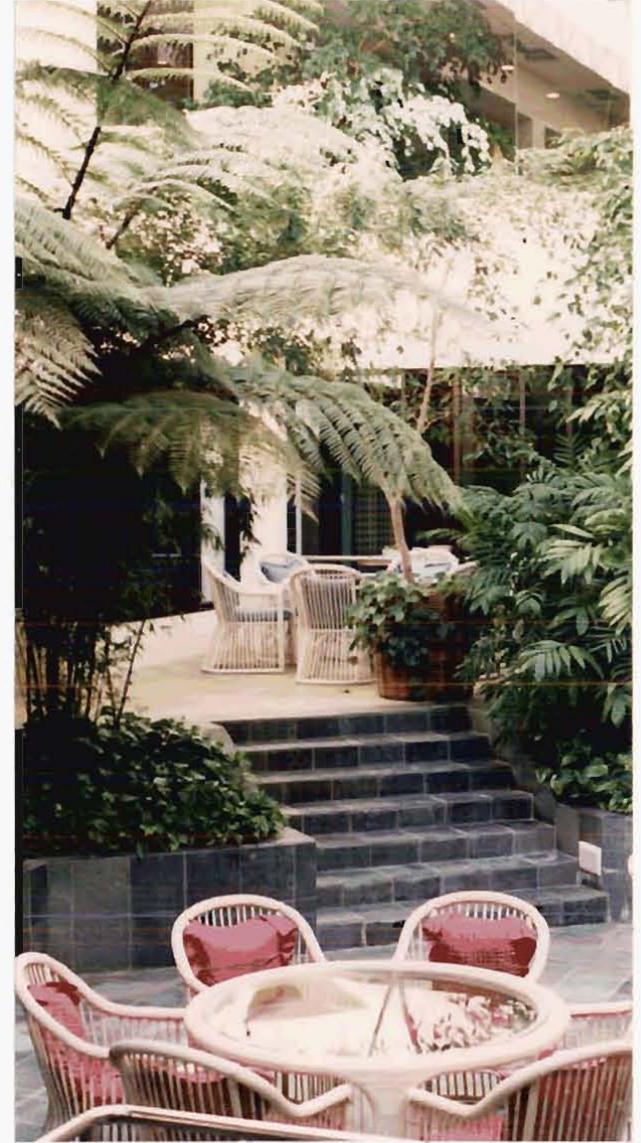
*Pittosporum*

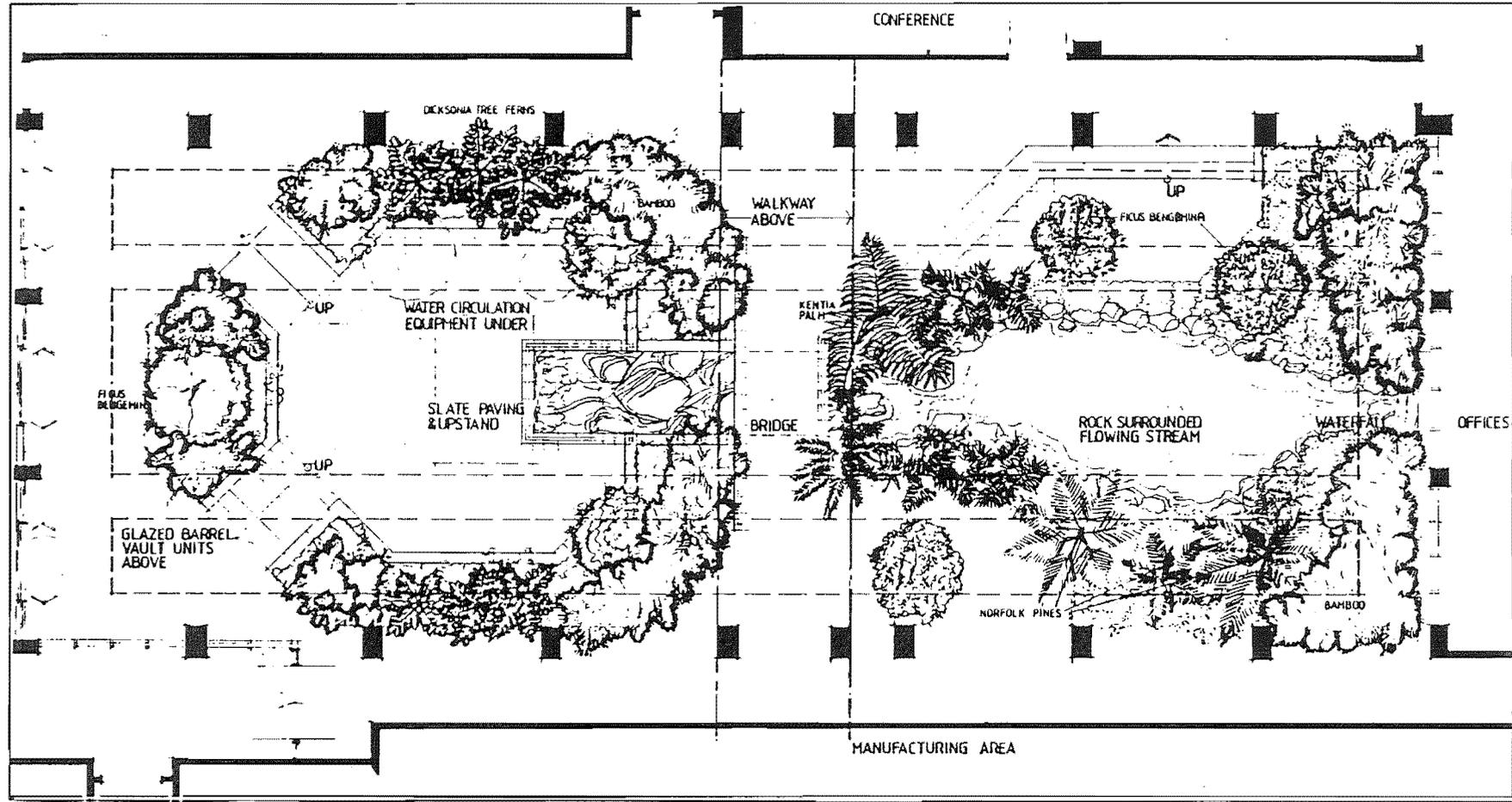
*Aglaonema*

These plants are proving more successful than the temperate palette originally planted, and have created an attractive "woodland" setting as shown in the following photographs.

GLAXOS

- LOCATION : Glaxo (NZ) Ltd, 142 Botanical Road, Palmerston North
- DESIGNERS : Bill Young, Chief Engineer, Glaxo (NZ) Ltd  
Steven Scrivens, landscape consultant,  
Technical Landscapes, UK
- THE DESIGN : The atrium was created in the space formerly occupied by a machine hall, in the centre of the main building. It was part of the refurbishment of the whole complex to portray a new corporate image. The central atrium now provides a valuable source of daylight to the surrounding offices which previously had to rely on artificial lighting. It has also created an "indoor oasis" complete with stream, native tree ferns, towering bamboo and Norfolk Island pines. The barrel-vaulted roof was constructed using aluminium framework glazed with "Plexiglass 233" clear acrylic material. The slate paved area has provided a formal seating area adjacent to the dining room and a more informal area near the stream. The two ends of the atrium are visually separated by a bridge which links the first floor of the building, but physically linked by the stream. This flows from north to south and





disappears under the seating area to be recirculated and pumped back to the top of the feature. The floor of the atrium had to be excavated to a depth of 2 metres to allow heavy concrete work to be carried out to restore the earthquake integrity of the building. The retaining walls for the planters were constructed on a concrete slab by lowering hollow concrete blocks over reinforcement and filling them with concrete.

The planting was finished on schedule in October 1987, and has flourished since then. This atrium has become of particular interest in New Zealand because of the success and scale of the planting and the general benefits that have resulted from this type of space within a commercial building.

THE ATRIUM  
FUNCTIONS

Climatic control: to provide a controlled indoor environment for use throughout the year.

As a place of orientation and organisation: it provides a focal point for the company and helps foster a corporate identity and common sense of purpose.

As an important meeting place: the seating area is used both as an extension to the staff dining room and as an informal meeting area.

Efficiency of land use: a conscious decision was made to refurbish the existing premises and to renovate the offices around the central courtyard or atrium, rather than rebuilt the office complex at a higher density.

As a metaphor for the garden: a tropical paradise and indoor oasis.

THE PLANTING : A list of plants used in the atrium is contained in Appendix 8. The selection of plant material was the personal responsibility of Bill Young, the Chief Engineer, with assistance from Stephen Scrivens, the UK consultant. In his article "Architecture in New Zealand"<sup>31</sup> Scrivens expresses his delight in the variety of types of bamboo grown externally and available for indoor use. However, he points out that there is a general shortage of available plant material in New Zealand, particularly of a reasonable size and in a healthy condition. He could not find any specimens of Ficus benjamina or Hawea fosteriana that were more

than 3 metres tall, and he had to have much of the ground cover grown especially for this project because it was not available in its ultimately required form. He states that there is a lack of firms with the necessary expertise to create intricate atrium landscapes, but that the most impressive aspect of this project was the way in which the local labour force adapted itself to create this atrium landscape with no previous experience.

Much of the success of the project is due to the care and attention to detail placed by Bill Young in the creation of the required environment for the plants. For example, the purpose designed planters contain a depth of 1.2 metres of high quality compost to which fertiliser and nutrients are added at regular intervals. Brewsters have been engaged on contract to water, clean and inspect the plants every other day and, to date, there have been no losses or replacements. The Norfolk Island pines are doing particularly well, but the bamboo is suffering slightly from the concentrated radiation from the sun near the roof of the atrium. However, the regular skilled maintenance and consistently high standards in the plant environment should ensure the continued success of this project.



GLAXO (N.Z.) LTD.

**5.3 Summary of  
design styles  
and  
atria functions**

As shown by the table on page 96 there were several design functions which were common to all of the case studies. All of the atria were designed to provide a protected and controlled indoor environment and they all acted as a focal point and important meeting place or public space. The provision of an atrium within the building also provided the opportunity for a dynamic spatial experience whether through the sheer scale of the space, as in the Hongkong and Shanghai Bank, or in the massing of luxuriant growth as at Glaxos. The latter example consciously chose to refurbish an old building, scooping a courtyard out of the old machine hall, rather than redeveloping on the site using the more traditional "tower" development. All of the examples used the atrium to bring natural daylight into the building, which in turn enabled a wide range of plants to survive and even thrive in some situations. The atrium at Glaxos would seem to be the most successful in terms of plant condition and growth, and the care and attention given to providing the required environment. However, on aesthetic grounds, the use of the palms in the Winter Garden to create a "living sculpture" is probably the most stunning. The key to its success is the understated elegance

of the *Washingtonia robusta*, which complement Pelli's architectural style while creating a rhythm and pattern of their own. There are no raised planters to impede pedestrian movement or attract rubbish, and the use of mature trees has minimised the chance of damage by vandalism. This example illustrates how simplicity in design can be much more effective than a haphazard massing of plants in an attempt to create a memorable design.

	HONGKONG and SHANGHAI BANK	THE WINTER GARDEN	PARKROYAL HOTEL	THE FORD FOUNDATION	GLAXOS
<b>DESIGN STYLE</b>	Bare essentials	Sculptural	Disguise or decoration	A metaphor for the garden	The Jungle look
<b>FUNCTION</b>					
CLIMATIC CONTROL - to provide a controlled indoor environment	●	●	●	●	●
UTILIZATION OF NATURAL ENERGY FLOWS - e.g. "greenhouse". "stack". "buffering" and "orientation" effects	●		●	●	
AS A PLACE OF ORIENTATION - a focal point, a centre of gravity or reference point	●	●	●	●	●
AS A PLACE OF ORGANISATION - to create inherent spatial order within buildings	●		●		●
AS A TRANSITIONAL SPACE - between public/private realms and indoor/outdoor	●	●	●	●	
AS AN IMPACT ON THE SENSES - a dynamic spatial experience; visual impact	●	●	●	●	●
AS A METAPHOR FOR THE GARDEN - to promote relaxation, fantasies, images of Arcadia			●	●	●
AS AN IMPORTANT MEETING PLACE AND PUBLIC SPACE - a social space encouraging communication	●	●	●	●	●
INCREASED MARKETING POTENTIAL - premium rental for space around atria		●			
EFFICIENCY OF LAND USE - the tower versus the courtyard					●
MULTIPLE USE POTENTIAL FOR VARIOUS ACTIVITIES - e.g. exhibitions/markets/restaurants		●	●		
TO REJUVENATE OR CONSERVE OLDER BUILDINGS					●

6. Summary– The place of atria in future urban design

## 6.1 Revival of popularity

In compiling this dissertation several important reasons have emerged which account for the current popularity of the atrium form in urban design. These can be attributed to :

- \* the re-emergence of the conditions of urbanism from which the form originated
- \* the potential for the "living atrium" to become a microcosm of nature within the urban fabric
- \* the need to consciously design and recreate public urban space in the "urban wilderness"
- \* the global energy crisis and the need to monitor the climate and utilise natural energy flows
- \* the return to the "hollowed court" as a design philosophy as opposed to the freestanding tower

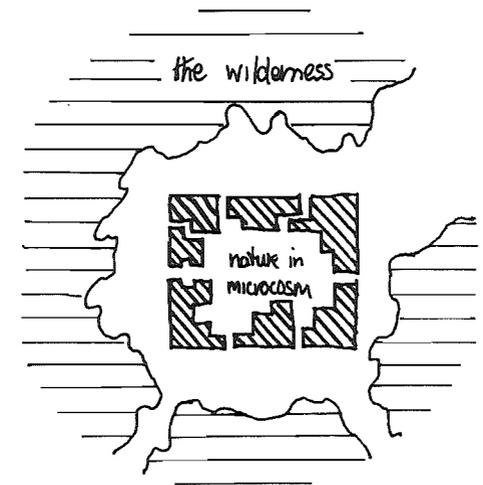
- \* the urban design potential of the atrium as a buffer or transitional space; a place of orientation or organisation and to provide a dynamic spatial experience.

The evolution of the Roman courtyard house and atrium was a direct response to the urban pressures now prevalent today such as limited land area, a limited exposure to communal space and a lack of privacy. In cultures both populous and hierarchic, the courtyard form fulfils the need for individual privacy while still remaining within familiar territory.<sup>13</sup>

## 6.2 Nature enclosed and protected

Early architecture set a domain under human control "against nature's unbounded immensity and merciless vagaries".<sup>22</sup> Whole cities were walled around with an outdoor public domain of only streets and squares, with their back turned towards the encroaching wilderness. Nature was not banished, but became a microcosm within protected walls.

Today, the natural wilderness has been banished to remote places, to be replaced by the urban "wilderness" or "jungle". The supreme irony is that, in conceiving of culture as natural, it is no



EARLY SETTLEMENTS

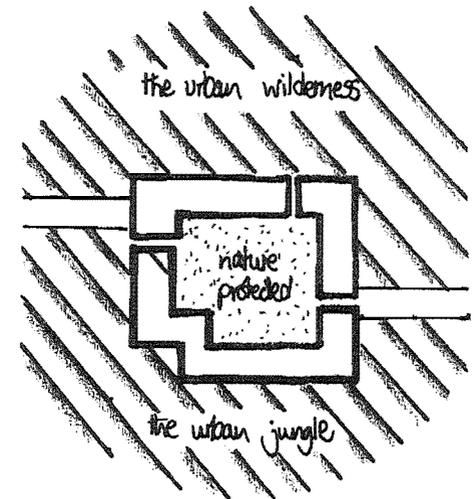
longer nature, but architecture and the city that are forbidding.<sup>22</sup> However, we have a psychological need to be in touch with nature and therefore create natural "pockets" within the urban fabric.

*"Our environment has changed so much in recent years. It has become so much more controlled. We live in such acclimatised surroundings, with covered areas, shopping malls, houses and cars all air-conditioned and heated for maximum comfort. But it cuts us off from the outside. It stifles our inherent love of the outdoors. So what do we do? We try to bring a little of the outside in. More than ever, we want something natural in our artificial environments".<sup>14</sup>*

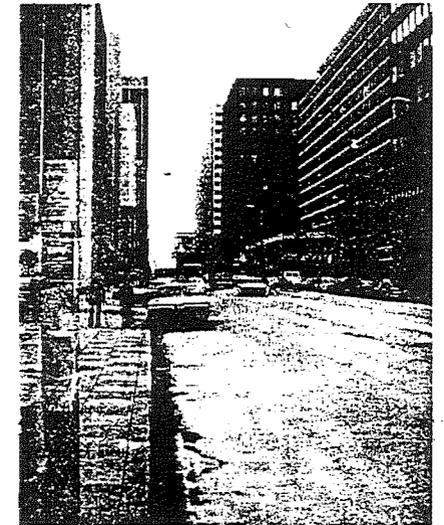
### 6.3 Failures of Functionalism and Modernism

There has also been much recent criticism of the Functionalism and Modernism that has resulted in cities dominated by corporate tower blocks and massive motorway systems:

*"Buildings shaped only by inner organic forces such as structure and circulation are freestanding in a void now as polluted as the chemical agriculture that has displaced the*



PRESENT CITIES



A MODERN CITYSCAPE

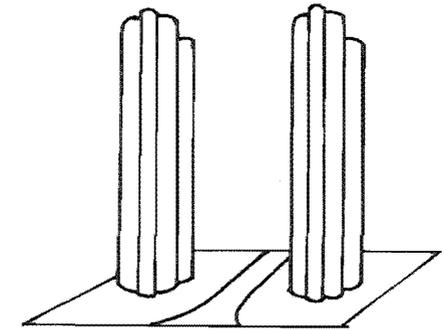
wilderness... Buildings no longer address the citizen or each other in the dialogue of the street that once made the city cohere and coherent....

"Streets are merely veins for traffic flow, not the theatre of daily life...."

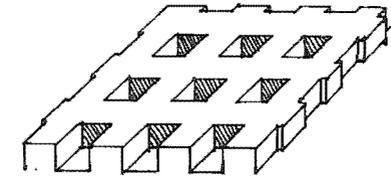
"Parks are merely lungs to clear the air and accommodate healthy exercise, not also realms for enriching fantasy...."

"For the citizen there is no centre, only this fluid void between fast flowing traffic and scaleless buildings..." 22

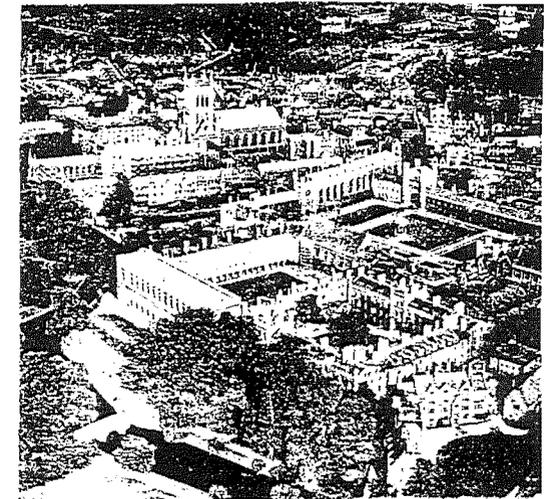
In contrast to the tower block, the courtyard form presents traditional urban scale and creates useful sheltered space within the site. By setting buildings against a notional party wall or site boundary, it provides the opportunity for communal open space between the buildings, while retaining the continuity of urban form from the street. This traditional pattern can be seen in many historic towns and villages, and is regaining favour in urban design.



THE FREESTANDING TOWER



THE COURTYARD ARRAY



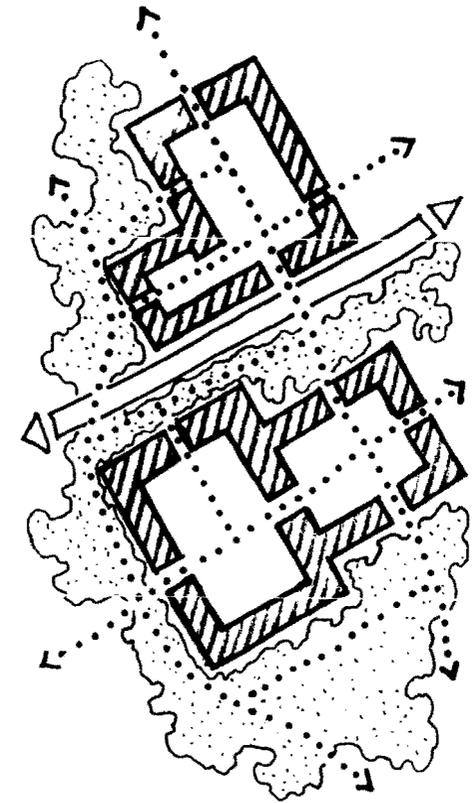
TRINITY COLLEGE, CAMBRIDGE  
- A COURTYARD DEVELOPMENT

## 6.4 Contributions to future urban form

The atrium space within the "hollowed court" can provide the city with a tranquil refuge that is part of an open space network weaving its way through the urban fabric. The ideal is a city with a web of hard public spaces and another of soft landscaping, interwoven to create a rich choice of routes, and a mix of different sorts of space for many kinds of activities.

The atrium provides the controlled indoor environment often required in adverse weather conditions and in dense urban development, where exposure to the elements is limited and land values high. It also utilises natural energy flows, a consideration which is becoming of increasing importance with the global energy crisis and associated "greenhouse" effect and ozone depletion in the atmosphere.

The atrium also fulfils design functions as a buffer or transitional space, or as a place of orientation and organisation. In all the case studies previously examined, it provided an important meeting place and public space in the centre of the building. It was also a dynamic spatial experience, creating an impact on the



A WEB OF HARD PUBLIC SPACES  
INTERWOVEN WITH SOFT LANDSCAPING

senses and triggering the imagination.

## 6.5 General design guidelines

The following are general design guidelines for atria which will ensure that they make a positive contribution to the future urban form in New Zealand:

1. Relate the atrium space to the context of the surrounding buildings, open space networks and pedestrian routes :
  - \* Integrate the building circulation with the urban movement pattern.
  - \* Match the activity in the atrium to the type of through traffic generated.
  - \* Connect the atrium to surrounding streets, plazas, courtyards, arcades and tunnels.
  
2. Maximise public access and use :
  - \* Make the entrance visible.

- \* Encourage public use by providing seating, services, planting, exhibitions and artwork.

3. Structure the spatial experience :

- \* Organise the sequence of spaces.
- \* Treat the entry as a transition.
- \* Use vertical lifts to exploit the space.
- \* Provide viewpoints from several vertical locations.

4. Give the atrium a function and encourage multiple use e.g.

- \* Reception area, lobby, dining, entertainment or informal public meeting place.

5. Design it to save energy :

- \* Maximise passive energy flows.
- \* Maximise daylight availability and distribution.
- \* Utilise the "stack" and "greenhouse" effects.
- \* Use it as an air plenum.
- \* Evaluate solar orientation for gain and shading.

6. Make the experience memorable :

- \* Define and articulate the space.
- \* Use daylight and planting to bring the space to life.
- \* Avoid visual clutter.
- \* Give it human scale by articulating floors, terraces and balconies.

7. Use planting in a creative and imaginative way :

- \* As a "living sculpture".
- \* As a "metaphor for the garden".
- \* As a "tropical paradise".
- \* To define sub-spaces and activities.
- \* To add texture, colour, line and form.

8. Ensure that any planting has the required environment in terms of :

- \* Temperature.
- \* Light.
- \* Water.
- \* Growing media.

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## THE REQUIRED ENVIRONMENT CHECKLIST

LIGHT	Intensity	:	700 to 1000 lux
	Duration	:	Min. 12 hrs a day & dark period
	Colour	:	Full spectrum preferred. Min. of red/blue.
	Natural	:	From roof, windows. Plants within 45° angle area of vertical window top.
	Artificial	:	No. and type of lamps. Ease of replacement.
	Dust level	:	Dust acts as a light filter or shade.
TEMPERATURE AND HUMIDITY	Day	:	21 - 24°C
	Night	:	15 - 18°C
	Holidays	:	As above, but absolute min. of 13°C.
	Location	:	Of hot and cold draughts and radiation.
WATER	Manual	:	Preferred for control and appearance.
	Automatic	:	
	Quality	:	Toxins, salts, pH.
	Pipe	:	Size and pressure, especially for automatic systems.
	Outlets	:	Location and proximity.

	Drainage	:	Location and direction of flow.
GROWING MEDIUM	Qualities	:	Need low-density, high porosity compost with water-holding capacity.
	Fertiliser	:	High ion exchange capacity or periodic addition of slow-release fertiliser.
	Decomposition	:	Slow rate of organic matter decomposition e.g. fibrous peatmoss.
	Nutrients	:	Check have optimum nutrient levels before planting; soil test or use packaged mix of known characteristics.
	pH	:	pH 5.5 - 6 before planting.
	Fire	:	Non-inflammable mix.
	Hydroculture	:	Requires nutrient solution without salt residue. Sufficient plant anchorage system : container depth, buoyancy of medium.



## CARE AND MAINTENANCE CHECKLIST

- ENSURE
- \* adequate access to POWER, WATER and DRAINAGE
  - \* skilled care is available, on a regular basis
  - \* available access to plants for general maintenance and cleaning
  - \* adequate storage areas for maintenance equipment, supplies and chemicals.

PLANTS SUITABLE FOR INTERIOR LANDSCAPING - S. Scriens

Plant Name	Common name	Family	Uses(a)	Minimum light Requirement		Tolerate 50° F temperature	Moisture	
				fc	Light Level(b)		Dry	Moist
Ananas comosus	Pineapple	Bromeliaceae	2,3	100	M		X	
Araucaria bidwilli	Monkey-puzzle	Araucariaceae	2,4,5	100	M	X		X
heterophylla	Norfolk Island pine		2,4,5	100	M	X		X
Ardisia crenulata	Coral berry	Myrsinaceae	1,3,4	75	M	X		X
Asparagus densiflorus 'Sprengeri'	Asparagus fern		1,2,3,8	100	M	X	X	
Aspidistra elatior	Cast iron plant	Liliaceae	3,4	50 <sup>c</sup>	L	X		X
Brassaia actinophylla	Schefflera, umbrella tree	Araliaceae	2,4,5	100 <sup>c</sup>	M		X	
Chamaedorea elegans	Parlor palm		1,2,4	50 <sup>c</sup>	L			X
erumpens	Bamboo palm		2,4,5	50	L			X
seifrizii	Reed Palm		4,5	50	L			X
Chamaerops humilis	Fan palm	Palmae	4,5	100	M	X		X
Chlorophytum comosum	Spider plant	Liliaceae	1,8	100	M	X		X
Cissampelos antartica	Kangaroo vine	Vitaceae	1,8	75	M	X		X
Codiaeum variegatum	Croton	Euphorbiaceae	1,2,4,5	100	M-H			X
Cordyline terminalis	Ti plant	Agavaceae	2,4,5	100	M			X
Grassula argentea	Jade plant	Crassulaceae	1,4	50 <sup>c</sup>	M	X		X
Dieffenbachia (all cultivars)	Dumbcane	Araceae	1,2,3,4,5	100 <sup>c</sup>	M			X
Dizyotheca elegantissima	False aralia	Araliaceae	2,4,5	100	M			X
Dracaena arborea	Tree dracaena	Agavaceae	4,5	100	M			X
deremensis 'Janet Craig'	Janet Craig Dracaena		1,2,3,4,5	75	M			X
deremensis	Striped dracaena		1,2,3,4,5	75 <sup>c</sup>	M			X
draco	Dragon tree		1,2,3,4,5	100	M			X
fragans	Corn plant		2,4,5	75	M			X
marginata	Madagascar dragon tree		2,4,5	75 <sup>c</sup>	M			X
reflexa	Malaysian dracaena		1,4	75	M			X
thalioides	Lance dracaena		1,4	75	M			X

PLANTS SUITABLE FOR INTERIOR LANDSCAPING

Plant Name	Common name	Family	Uses(a)	Minimum	Light	Tolerate	Moisture	
				light			50° F	Dry
				Requirement	Level(b)	temperature		
				fc				
Epipremnum aureum	Pothos	Araceae	1,6,7,8	75 <sup>c</sup>	M		X	
Fatsia japonica	Japanese aralia	Araliaceae	1,4,5	75	M	X		X
Ficus		Moraceae						
benjamina	Weeping fig		4,5	75	M	X		X
benjamina 'Exotica'	Java fig		4,5	75	M			X
elastica 'Decora'	Rubber plant		2,4,5	75 <sup>c</sup>	M			X
elastica 'Doescheri'	Variiegated rubber plant		2,4,5	75	M			X
lyrata	Fiddle-leaf fig		2,5	75	M			X
retusa nitida	Indian laurel		4,5	75	M			X
Hedera helix	English ivy	Araliaceae	1,8	50	L	X		X
Howea forsterana	Kentia palm	Palmae	4,5	50	L	X		X
Hoya carnosa	Wax plant	Asclepiadaceae	1,6	100	M		X	
Maranta leuconeura	Prayer plant	Marantaceae	1	75	M	X		X
kerchoveana								
Nephrolepis exaltata		Polypodiaceae						
'Bostonien is'	Boston fern		1,3,4	75	M	X		X
'Fluffy Ruffles'	Dwarf feather		1,3,4	75	M	X		X
'Rooseveltii'	Tall feather fern		1,4	75	M	X		X
'Whitmanii'	Feather fern		1,4	75	M	X		X
Philodendron								
bipennifolium	Fiddle-leaf		6,7	75	M			X
domesticum	Elephant's ear		3,6,7	75	M			X
pertusum	Split-leaf philodendron		2,6,7	75	M			X
scandens 'oxycardium'	Heart-leaf philodendron		1,6,7	75 <sup>c</sup>	M			X
selloum	Lacy-tree philodendron		5	75 <sup>c</sup>	L			X
Pittosporum tobira	Japanese Pittosporum	Pittosporaceae	4,5	75 <sup>c</sup>	M	X	X	
Polyscias		Araliaceae						
balfouriana	Dinner plate aralia		1,4,5	75	M			X
filicifolia	Fern-leaf aralia		1,4,5	75	M			X
fruticosa	Ming aralia		1,4,5	75 <sup>c</sup>	M			X

PLANTS SUITABLE FOR INTERIOR LANDSCAPING

Plant Name	Common name	Family	Uses(a)	Minimum light Requirement		Tolerate 50° F temperature	Moisture	
				fc	Light Level(b)		Dry	Moist
Rhapis excelsa	Lady palm	Palmae	4,5	50	M	X		X
Sansevieria trifasciata 'laurentii' all	Variegated snake plant	Agavaceae	1,4	50	L		X	
Spathiphyllum(cultivars)	White flat	Araceae	3,4	75 <sup>C</sup>	M		X	
Sygonium podophyllum	Nephthytis	Araceae	1,6,7	75	M			X
Veitchia merrillii	Christmas palm	Palmae	1,4,5	100 <sup>C</sup>	M			X
Yucca elephantipes	Joshua tree	Agavaceae	1,4,5	M	X	X		

a) Key to uses:

1. Small pot specimen for table or desk
2. Accent plant for planter.
3. Filler for planter.
4. Small specimen.
5. Large specimen.
6. Small totem pole (18 to 24 in.)
7. Large totem pole (36 to 48 in.)
8. Hanging basket.

b) L= 3W/m<sup>2</sup>; H=24 W/m<sup>2</sup>

c) Will tolerate light intensities of 20 to 25 fc.

NEW ZEALAND NATIVE PLANTS SUITABLE FOR INTERIOR LANDSCAPING

PLANTS SUITABLE FOR INTERIOR LANDSCAPING

Plant Name	Common name	Family	Uses(a)	Minimum light Requirement		Tolerate 50° F temperature	Moisture	
				fc	Light Level(b)		Dry	Moist
Cordyline Species	Cabbage tree	Liliaceae	4,5					
Cyathea medularis dealbata	Mamaku ponga	Cyatheaceae	5		°°	not documented	°°	
Dicksonia Fibrosa squarrosa	Wheki	Cyatheaceae	4,5			"	"	
Dracophyllum menziesii	Grass Tree	Epacridaceae	4,5			"	"	
Meryta sinclairii	Puka	Araliaceae	5			"	"	
Pseudopanax species		Araliaceae	4,5			"	"	
Rhopalostylis saphida	Nikau Palm	Palmaceae	4,5			"	"	
Schefflera digitata	N Z Patete	Araliaceae	4,5			"	"	

Key to Uses:

1. Small pot specimen for table or desk.
2. Accent plant for planter.
3. Filler for planter.
4. Small specimen.
5. Large specimen.
6. Small totem pole (18 to 24 in.)
7. Large totem pole (36 to 48 in.)
8. Hanging basket.

23 July 1986

Some Proven and Reliable Plants For Office Conditions

Species	Varieties & Similar species & Synonyms	Common Names	Plants sizes usually available*	Pot size	Max height achieved	Plant forms available	Light requirements (in lux)	
							'A' Minimum (Compensation level)	'B' Recommended
Aglaonema Crispum	A. pseudo bracteatum	—	250-400mm high × 150-300mm sp	9cm-18cm	400mm	Clump	400	750
Aspidistra elatior	A. variegata	Cast iron plant	300-600mm high × 200-300mm spread	13cm-23cm	600mm	Clump	400	600
Chamaedora elegans	Neanthe Bella	Parlour Palm	300mm-1m high × 300-500mm spread	9cm-23cm	1.2m	Single or multi-stem	600	1000
Dieffenbachia Amoena	D. Tropic Snow D. Exotica	Dumb Cane	450mm-1.0m high × 400mm-1.0m sp	13cm-30cm	1.0m	Single or multi-stem	750	1500
Dracaena fragrans	D.f. Lindenii D.f. Massangana	Corn Plant	300mm-1.5m high × 300m-1.0m sp	18cm-30cm	3.0m	Single or multi-stem	600	1000
Dracaena deremensis	D.d. 'Janet Craig' D.d. 'Warneckii' D.d. 'Bausei'	—	300mm-2.0m high × 300-750mm spread	13cm-35cm	3.0m	Single or multi-stem Single or multi-cane Branching cane	600	1000
Dracaena marginata	D.m Tricolor	Madagascar Dragon Tree	300mm-3.5m high × 300mm-1.5m sp	13cm-1.0m	5.0m	Ditto	750	1500
Ficus benjamina	F. reusa F. indica	Beniamme Fig Weeping Fig	300mm-7.0m high × 300mm-3.5m spread	13cm-1.0m	10.0m	Single or multi-stem Free form	1000	2000
Ficus pumila	—	—	25mm-1.5m high × 300-500mm sp	9cm-30cm	4.0m high × 4.0m spread	Ground Cover Climber	600	1000
Howea Fosteriana	—	Kenna Palm Palm Court Palm	600mm-3.5m high 400mm-1.5m sp	18cm-60cm	4.0m	Single or multi-stem	500	1250
Maranta tricolor	M. leuconeura M. massangana	—	75mm-300mm high 200-300mm spread	9cm-18cm	—	Ground Cover	750	1250
Philodendron erubescens	P. 'Red Emerald' P. burgundy P. emerald green (Queen)	—	300mm-2.0m high 300-750mm spread	13cm-30cm	3.0m	Single or multi-stem up pole	500	1000
Philodendron perisum	—	Cheese Plant	400mm-1.5m high 300-750mm sp	13cm-30cm	2.5m	ditto	750	1500
Philodendron scandens	P. oxycardium P. cordatum	—	300mm-2.5m high 300mm-1.0m trail	9cm-30cm	3.0m	Climber up frame or trailing	500	1000
Rhoicissus 'Ellen Danica'	R. rhomboidea	—	300mm-2.0m high 300mm-1.0m trail	9cm-30cm	2.5m	Ground Cover, Trailing, Climber up frame	400	1000
Schefflera actinophylla	Brassia actinophylla S. digitata S. arborescens Heptapleurum	Umbrella Tree	400mm-5.0m high 300mm-2.0m spread	13cm-1.0m	6.0m	Single or multi-stem	1000	2000
Scindapsus aureus	Epipremnum aureum Pothos	Marble Queen	100mm-2.0m high 300mm-1.0m trail	13cm-23cm	3.0m	Ground Cover, Trailing, Climber up frame	400	600
Spathiphyllum Wallisii	S. clevelandii	Spathiphyllum Peace Lily	300-400mm high 200-400mm spread	13cm-18cm	400mm	Clump	400	600
Syngonium Podophyllum	Nephtyis	White Butterfly	300-600mm high 300-600mm spread	13cm-25cm	600mm	Clump, semi-climber	500	1000
Yucca elephantipes	—	Yucca	500mm-2.0m high 400mm-1.0m spread	18cm-30cm	3.0m	Single cane, Multi-cane	1000	2000

Source: Temple P. "Plants and Planting Conditions" Landscape Design October 1985.

\* Height stated is above ground level. However, commercial growers quote heights as pot inclusive.

## LIGHT SPECIFICATIONS FOR INTERIOR PLANTS

Tolerant of low light (require at least 300-2400 footcandle hours/day) :

### Large plants (5-25 feet tall)

*Chamaedorea erumpens* - Bamboo Palm  
*Chamaedorea seifrizii*  
*Dracaena fragrans* 'Massangeana' - Corn Plant

### Intermediate-sized plants (3-5 feet tall)

*Brassaia arboricola* - Asian Umbrella Tree  
*Dracaena reflexa* - Malaysian Dracaena  
*Howea forsterana* - Forster Sentry Palm

### Small plants (1/2-3 feet tall)

*Aglaonema commutatum* 'Treubii' - Variegated Chinese Evergreen  
*Aglaonema modestum* - Chinese Evergreen  
*Aspidistra elatior* - Cast Iron Plant  
*Chamaedorea elegans* - Parlor Palm  
*Dracaena thalioides* - Lance Dracaena  
*Epipremnum aureum* - Golden Pothos  
*Philodendron scandens* (subsp. *oxycardium*) - Heart Leaf Philodendron  
*Sansevieria trifasciata* - Snake Plant

Tolerant of medium light (require at least 2400-6000 footcandle hours/day) :

Large plants (5-25 feet tall)

Araucaria heterophylla - Norfolk Island Palm  
Brassaia actinophylla - Australian Umbrella Tree  
Caryota mitis - Clustered Fishing Palm  
Chrysalidocarpus lutescens - Butterfly Palm, Areca Palm  
Ficus benjamina - Weeping Fig  
Ficus elastica - India Rubber Tree  
Ficus retusa - Indian Laurel  
Monstera deliciosa - Split Leaf Monsters  
Rhapsis excelsa - Slender Lady Palm

Intermediate-sized plants (3-5 feet tall)

Chamaerops humilis - European Fan Palm  
Cycas revoluta - Sago Palm  
Cyperus alternifolius - Umbrella Plant  
Dieffenbachia maculata - Spotted Dumb Cane  
Dizygotheca elegantissima - False Aralia  
Dracaena deremensis 'Janet Craig' - Janet Craig Dracaena  
Encephalartos ferox - Encephalartos  
Livistona chinensis - Chinese Fan Palm  
Pandanus veitchii - Veitch Screw Pine  
Philodendron domesticum - Spade Leaf Philodendron  
Philodendron selloum - Saddle Leaf Philodendron  
Phoenix roebelenii - Miniature Date Palm  
Pittosporum tobira - Japanese Pittosporum  
Polyscias balfouriana - Balfour Aralia  
Polyscias filicifolia - Fernleaf Aralia  
Polyscias fruticosa - Ming Aralia

Small plants (1/2-3 feet tall)

Aechmea spp. - Vase Plant  
Asparagus densiflorus 'Sprengeri' - Sprengeri Fern  
Chlorophytum comosum - Spider Plant  
Cissus antarctica - Kangaroo Vine  
Cissus rhombifolia - Grape Ivy  
Cordyline terminalis - Tree-of-Kings  
Cryptanthus spp. - Earth Star  
Dracaena surculosa - Gold-Dust Dracaena  
Episcia spp. - Flame Violet  
Fatsia japonica - Japanese Aralia  
Ficus pumila - Creeping Fig  
Maranta leuconeura (var. kerchoviana) - Rabbit's Tracks  
Pedilanthus tithymadloides - Devil's Backbone  
Peperomia obtusifolia - Pepper-Face  
Philodendron wendlandii - Wendland's Philodendron  
Pilea cadierei 'Minima' - Aluminium Plant  
Pilea depressa - English Baby's Tears  
Pilea serpyllacea - Artillery Plant  
Plectranthus australis - Swedish Ivy  
Rhoeo spathacea - Oyster Plant  
Senecio mikanoides - German Ivy  
Spathiphyllum clevelandii - White Peace Ivy  
Syngonium angustatum - Arrowhead Vine  
Tolmeia menziesii - Piggyback Plant  
Tradescantia albiflora - Great White Inch Plant  
Zebrina pendula - Inch Plant

Require high light (require at least 6000 footcandle hours/day)

Large plants (5-25 feet tall)

Beaucarnea recurvata (var. Intermedia) - Elephant Foot Tree  
Cereus peruvianus - Hedge Cactus  
Citrus limon 'Ponderosa' - Ponderosa Lemon  
Coffea arabica - Coffee Tree  
Epiphyllum oxypetalum - Night Blooming Cereus  
Grevillea robusta - Silky Oak  
Podocarpus macrophyllus (var. maki) - Buddhist Pine  
Tabernaemontana divaricata - Grape Jasmine

Intermediate-sized plants (3-5 feet tall)

Codiaeum variegatum (var. pictum) - Garden Croton  
Euphorbia lactea - Dragon Bones  
Euphorbia trigona - African Milk Tree  
X Fatshedera lizei - Pagoda Ivy

Small plants (1/2-3 feet tall)

Agave americana - Century Plant  
Aporocactus flagelliformis - Rattail Cactus  
X Citrofortunella mitis - Calamondin Orange  
Crassula argentea - Jade Plant  
Crassula lycopodioides (var. pseudolycopodioides) - Princess Pine  
Echinocactus grusonii - Barrel Cactus  
Echinopsis multiplex - Pink Easter-Lily Cactus  
Ferocactus acanthodes - Barrel Cactus  
Hedera helix - English Ivy  
Justicia brandegeana - Shrimp Plant  
Opuntia microdasys - Bunny Ears  
Pellionia daveauana - Trailing Watermelon  
Phalaenopsis spp. - Moth Orchid  
Sedum morganianum - Burro's Tail  
Streptocarpus x hybridus - Cape Primrose

## TYPICAL PROFESSIONAL SERVICES REQUIRED IN ATRIA DESIGN:<sup>1</sup>

- |                |  |
|----------------|--|
| ARCHITECTURAL  | * Modifications to building design to maximise planting effect.                            |
|                | * Changes in the character of spaces to provide themes for planting.                       |
|                | * Planter location and cladding details.   |
|                | * Volume articulation by provision of additional features such as lighting and sculptures. |
|                | * Space allocation between various floors based on activities.                             |
|                | * Modification of glazing proposals to maximise daylight.                                  |
| ENGINEERING    | * Providing loading requirements on the structure.   |
|                | * Installation procedures for large loads.   |
|                | * Planter loading and effect upon configuration.   |
|                | * Lighting details for plants in terms of lamps and luminaires.                            |
|                | * Irrigation system design.  |
|                | * Drainage system for planters.  |
| HARD LANDSCAPE | * Detailing water features.  |
|                | * Designing "natural" rock formations and "bridges" over water.                            |
|                | * Designing planters and paving details.   |
| SOFT LANDSCAPE | * Selection of suitable plants.  |
|                | * Checking the required environment.   |
|                | * Estimating water requirements for plants.  |
|                | * Estimating water requirements for plants to compensate for evapo-transpiration losses.   |

PLANT LIST - GLAXO (NZ) LTD

TYPE	BOTANICAL NAME	COMMON NAME	SIZE	NO.
TREES	<i>Araucaria heterophylla</i>	Norfolk Island Pine	4.0m	3
	<i>Dicksonia squarrosa</i>		1.5m	8
	<i>Ficus benjamina</i>		60cm	4
	<i>Honea forsteriana</i>	Kentia palm		1
	<i>Phoenix roebellini</i>			3
	<i>Phyllostachys</i> sp.	Bamboo		8
GROUND COVER AND CLIMBERS	<i>Aglaonema</i> 'Silver Queen'		20cm	20
	<i>Asparagus sprengeri</i>		15cm	40
	<i>Asplenium nidus</i>		18cm	20
	<i>Chamaedorea elegans</i>	Parlour palm	30cm	10
	<i>Chamaerops humilis</i>	European fan palm	40cm	3
	<i>Cissus rhombifolia</i>			
	<i>Davallia bullata</i>	Rabbit's foot	15cm	220
	<i>Dieffenbachia</i> 'Tropic Alex'		20cm	20
	<i>Ficus pumilla</i>	Creeping fig		20
	<i>Helixine solierei</i>	Baby tears	15cm	490
	<i>Jasmine polyanthemum</i>			7
	<i>Parsiflora caerulea</i>			6
	<i>Philodendron cordatum</i>	Sweetheart plant	20cm	180
	<i>Rhoicissus rhomboidea</i>	Grape ivy	20cm	20
	<i>Scindapsus aureus</i>	Devil's ivy	20cm	80
	<i>Selaginella martensii</i>	Spread clump moss		75 trays
	<i>Spathyphyllum wallissii</i>	Peace lily	15cm	154
<i>Stephanotis floribunda</i>			5	