



ADAPTABILITY IN ARCHITECTURE

Designing for Structural and Programmable Change

by Debbie Ann Ashbolt

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ADAPTABILITY IN ARCHITECTURE

Designing for Structural and Programmable Change

Design Research Project APG5058S

Submitted in partial fulfilment of the requirements for the degree Master of Architecture (Professional)

by

Debbie Ann Ashbolt

October 2011

University of Cape Town

DEDICATION

This thesis is dedicated to my family and to Pieter as huge thanks for their constant love, patience and support.



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CONTENTS



6 THESIS ABSTRACT

8 INTRODUCTION

10 ARCHITECTURAL INTERESTS AND INVESTIGATIONS

- Flexibility?
- The Evolution of the Office
- A Dutch housing Study
- Time-Based Layers Exploration

28 ADAPTABILITY IN ARCHITECTURE: REPLACING STATIC FORMS AND SINGLE USE BUILDINGS

34 INVESTIGATING A TIME-BASED ARCHITECTURAL APPROACH BY SEPARATING THE LAYERS

40 SITE INVESTIGATION

- Site Description
- Project Brief
- Interviews
- Rentable Area and Parking Schedules

52 ACCOMODATION AND PROGRAMME

- Residential Investigation
- Office Investigation
- Hotel/Student Residence Investigation

56 DESIGN DEVELOPMENT

- Sketch Ideas
- Site Study
- Layers Organisation
- Adaptability in Architecture...

82 REFERENCES


84 FIGURE REFERENCES

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THESIS ABSTRACT

"Change is the only constant."

- Heraclitus of Ephesus



The reality of architecture is the predominance of solitary, static forms and single-use buildings. The idea as an accepted norm prevents buildings from responding to changing needs. In the past, human behaviour was largely based on traditions and the rate of change took place at a much slower pace. These days, development in society is accelerating and there are many new technological and cultural challenges which need to be considered. Buildings must therefore be able to respond to these dynamically changing new conditions. Buildings can no longer be designed and built for one programme only, but should accommodate numerous options over generations. One way of achieving this is through the adaptability of buildings; if designed correctly, buildings can be re-programmed and re-inhabited without the threat of unnecessary demolition.

This thesis questions what it means to design for today's societal needs. Are programme specific buildings really the best solution for the problems of today or should we rather be thinking of what they need to be 50 years from now? What does it mean to design responsibly and how can the principles of Adaptability in Architecture achieve this?

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INTRODUCTION

"It is change, continuing change, inevitable change, that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be."

- Isaac Asimov

This quote is the foundation of my investigation; that the world is undergoing constant change and architecture needs to respond to this inevitable phenomenon.

Perhaps the most crucial problem in architecture today is its relationship with the culture of society as a whole. There is no way of designing for a collective society because there is no longer a stationary idea of society. I feel that architects need to recognize that it is no longer possible to foresee a society whose unity can be fully reflected in a static building. Society is diverse and ever-changing and so needs to be housed in buildings that are responsive and can adapt when necessary.

Analysing architecture as rigid and permanent is a misconception; *“The whole idea of architecture is permanence,”* and *“In wider use, the term ‘architecture’ always means “unchanging deep structure.”* (Brand, 1994: 2) This however, is not the condition of buildings. The term building is both a verb and noun, meaning that the object is not fixed but in a constant state of motion. New usages will always persist and so there will always be changes made to buildings.

The challenge is how one designs architecture that is not fixed to one situation in time, but manages to adjust to any new needs that may arise, either on a daily basis or more importantly during the structures lifespan. I would argue that the way in which this could be achieved is by using the term Adaptability as a focussing principle in architectural production.

Adaptability is a term that is often misused and abused when describing architecture. This is due to the belief that the rearrangement of interior walls is adaptable design. I would suggest that in order for a building to be described as adaptable it should meet and respond to all possible layouts, programmes and structural changes, not merely spatial rearrangements. Flexibility and adaptability is often implied in many modern buildings, however when actually investigating how this modification would be implemented, I have found that the buildings would have to undergo complete or partial demolition in order to meet the new requirements. This is both costly and unsustainable.


The world faces issues of resource scarcities, therefore the concern for the adaptability of buildings is of imperative importance; not only because it would address issues of sustainability, but also because buildings represent the largest cultural, physical and financial asset in the industrialised world. Sustainable development is not possible without considering how this resource can be managed and maintained.

The design proposal is to create a building that has the ability to accommodate many different programmes during the structure’s lifespan without major demolition to the building. There are two methods in which to deal with this design – the one would be to exploit space flexibility and the other would allow for variability by creating quick and cost effective refurbishment of the building layers. Adaptability in Architecture is about designing a site and building that can allow easy adaption of both the structure as well as programme changes, through the correct organisation of building systems and spatial configurations, using the least amount of effort and resources possible.

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ARCHITECTURAL INTERESTS AND INVESTIGATIONS





The following investigations were done in attempt to find a thesis issue and devise a proposal. They have shaped the brief and helped formulate ideas about designing using adaptability in architectural production.

- FLEXIBILITY?

- THE EVOLUTION OF THE OFFICE

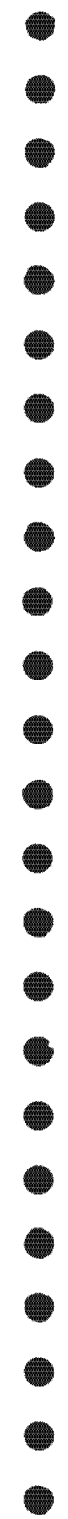
- A DUTCH HOUSING STUDY

- TIME-BASED LAYERS EXPLORATION

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FLEXIBILITY?

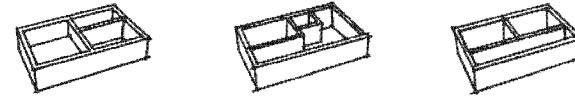
My initial interest was flexibility in architecture, and how one defines what that term means with regards to designing buildings.



I looked at various examples of flexible architecture and attempted to separate them into different categories to better understand their links.

I uncovered that it can be divided into 5 types; adaptable, universal, transformable, movable and responsive flexibility. There is a very fine line between these types; some buildings can contain characteristics of more than one, however I looked at the most predominant features when classifying.

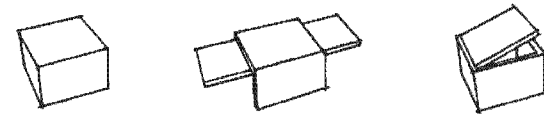
Adaptable Flexibility refers to the repositioning of partitions and other secondary building elements, changeable according to the user's needs. Example: *Rietveld Schroder House* by Gerrit Rietveld



Universal Flexibility has to do with the free plan; it is a building that is un-programmed, a universally flexible building. Example: *Eames House/Case Study No. 8* by Charles and Ray Eames



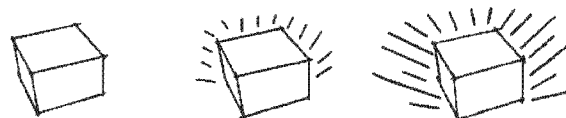
Transformable Flexibility is usually a building that has used modular design principles; it contains transformable parts that move. Example: *Wyly Theatre* by REX and the *Milwaukee Art Museum* by Santiago Calatrava



Movable Flexibility deal with re-locatable structures capable of being disassembled and reassembled elsewhere, usually made up of transportable elements. Example: *Puma City* by Lot-Ek



Responsive Flexibility deals with buildings that react to external stimuli, such as weather or people. Example: *Allianz Arena* by Herzog and de Meuron



THE EVOLUTION OF THE OFFICE

Adaptability has always been tested through office design, due to high levels of flexibility needed for this programme.

I have always had an interest in office or corporate commercial design. This interest lies in how office space is designed to both spatially accommodate the various user needs, as well as how tenants use architecture for the branding of their companies.

The timeline shows the evolution of office, completed in order to understand how principles of flexibility and adaptability have shaped office design.

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Palazzo degli Uffizi, Florence, Italy
Giorgio Vasari
"Uffizi" - Office - offices for the Florentine magistrates.



1540

Palazzo del Broletto, Como, Italy
[market house, no British examples before the 15th century] served as multi-function public space with rooms for discussing business.

These four buildings were examples of cellular offices that were either distributed along corridors OR centrally located offices flanked by two corridors (where the depth could then be increased to more than 15m).

1810 Westminster Fire Office, London
C.R. Cockrell

1832 Westminster Insurance Company, London

1850's
Offices were being developed by investors, who would rent a building to more than one company. These buildings had to be large flexible spaces, with mobile dividers for separation to be adaptable to the changing user needs.

Skyscrapers
It was in the 1880's in Chicago, that revolutionised the office building. After the fire of 1871, building construction switched from wrought iron columns to steel frameworks, therefore buildings could go higher.

Otis Lifts 1857

Home Insurance Building, Chicago
William L.V. Borom
It was the first building to use structural steel in its frame, but the majority of its structure was composed of cast and wrought iron.

1883



Monadnock Block, Chicago
Burnham & Root
Last building to use load-bearing masonry walls for main structure.

1891



1897 Schlesinger & Mayer Department Store, Chicago
Louis H. Sullivan
First building to have metal facade.

The Chrysler Building, New York City
William van Alen
Various architectural details and especially the building's gargoyles were modeled after Chrysler automobile products like the hood ornaments of the Plymouth; they exemplify the machine age in the 1920's.

The Empire State Building, New York City
Shreve, Lamb and Harmon
The Empire State Building was the first building to have more than 100 floors.

1930



1952 Lever Building, New York City
Skidmore, Owings and Merrill (based on Miles van der Rhee principles)
It was also the first fully computer-controlled, fixed-windowed office building in NYC. The top three floors, distinguishable on the facade, house technical installations and machinery.



1954 The Seagram Building, New York City
Mies van der Rhee - Less is More - One of the style's characteristic traits was to express or articulate the structure of buildings externally.



1964
"The Action Office" is a series of furniture designed by Robert Probst. Concept of the flexible, semi-enclosed workspace, now better known as the cubicle.



Palazzo della Regione, Vicenza, Italy
Andrea Palladio
Town Hall, private rooms and shops on ground floor.

1533



1818 County Fire Office, Regent Street, London
John Nash & Robert Adam

1818



1841 Sun Fire Assurance Office, London
C.R. Cockrell

1841

Harper's, New York City
James Borgardus
Cast-iron architecture



1854



10 storeys - Montauk Block, Chicago
Burnham & Root
First example of new 'skyscraper'.

1882



Burnham Reliance Building, Chicago
Daniel Burnham
Introduced the "Chicago Window."

1895



Larkin Building, New York City
Frank Lloyd Wright
It was revolutionary as it had a large central atrium. The atrium was central allowing light to enter through the interior and exterior. The offices were arranged around the large hall.

1904

Johnson's Wax Building, Wisconsin
Frank Lloyd Wright
The building was a horizontally-oriented space that looked towards the large open plan offices of the future.



1936

1961
There are 4 causes for changes internally:
- computerisation
- behaviourism (treating workers as an environment and not as a tool)
- The Quickborn Method 'Buro-landschaft', office space had to be flexible to different uses. Flexibility that deals with internal space and not the exterior of the building.

1945
There are 4 factors that began to change office design:
- shift from cellular design to open-plan ideas
- the invention of air-conditioning
- expanding volume of usable perimeter space
- new construction methods

Central Bell Office Building, Herman Hertzberg
"The basic requirements of an office building may well be simple enough in principle, but it was the need for adaptability that led to the complexity of the commission. Constant changes occur within the organization, therefore requiring frequent adjustments to the size of the different departments. The building must be capable of accommodating the internal forces, why the building whole must continue to function in every respect and in every way."

Source: Skidmore, Owings & Merrill

Sears Tower, Chicago
Skidmore, Owings and Merrill

The space was occupied by Sears' Merchandise Group, however the remaining floor space could be rented out to smaller firms and businesses until Sears could retake it. Therefore, those floor areas had to be designed to a smaller plate, with a high window-to-space to floor space ratio, to be attractive and marketable to prospective lessees.



1975

'Semi-office' group offices, where offices are placed at the periphery while the collective space is at the centre.

Broadgate, London
Arup Associates, Skidmore, Owings and Merrill

These offices rely on public spaces to facilitate flexibility of space.

Site begins to show identity in office architecture and business parks become more popular with the expansive landscapes.

SAS headquarters, Sweden

Henk Toop
Example of 'street' office building. Multi-programmed spaces.



Sharp, Japan
Shimizu Corporation
'the harmony of man and technology'
Column-free office floors provide flexibility of space and avoids the cubicle.

Vitra, Switzerland
Frank O Gehry
The modern forms are strikingly a skin, while the internal space is more rectangular to accommodate office functions. Square spaces are more flexible than organic.



Petronas Towers, Malaysia
Cesar Pelli

Skyscrapers are not seen as the icon symbol for office buildings. This building features tapering twin towers (connected by a sky bridge) share an Islamic-influenced geometrically polygonal plan.



Netherlands Embassy, The Netherlands
OMA

Inside the cube, the sense of security and stability required for an embassy is provided by a 200m path that zig-zags up through the eight stories, determining the arrangement of the building's spaces.



21st Century
The 21st Century office design is about innovation and technology/CAI advancements. Buildings have to accommodate a multitude of societal needs in a multi-culture generation.

The importance of a firm's image and new philosophies of spatial organisation give the role of architecture renewed importance and encourage diversity in configuration and arrangement of workspace.

An increasing number of companies are setting up in suburban areas, rural areas and fringes of the cities, as they can be freed of the urban constraints.

CEGB Building, Bristol
AARUP
A building designed to deal with climatic control, it was ahead of its time thinking about sustainability.



Lloyd's of London, London

Richard Rogers
The building was innovative in having its services such as staircases, lift, electrical power conduits and water pipes on the outside, leaving an uncluttered space inside.



ING headquarters, Amsterdam

Ton Alberts
The office is built horizontally rather than vertically, each office space is never deeper than two work stations.

Gruener & Jahr, Germany
Steinle & Kissler with Schweiger & Partners
Building design is based on internal streets, with short depths and plenty of light.



Chiat/Day, New York City
Giuseppe Penone / Perce
The space is filled to accommodate all types of working conditions, the interior is separate from the exterior allowing for easy admissible changes.



Steelcase, Michigan, USA
In-house
The building uses the open-plan layout and the space-plan can be changed as it needs to be.

20th Century
The 20th Century brought about new architectural types in office design, including buildings with lightweight structures, low thermal inertia and large glazed areas. Old buildings that had heavy structures lacking in sufficient natural light.



Horizontal Skyscraper - Vanke Centre
Shenzhen, China
Steven Hall Architects
Hovering over a tropical garden, this 'horizontal skyscraper' as long as the Empire State Building is tall.

Flexibility is a higher priority than ever, in terms of both work schedules and organisation of workspace.

There is not a single element that will not be affected. Except for one, the parameter that will remain the same throughout the life of the building, is it's location and the climate of the place.

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A DUTCH HOUSING STUDY

"Earlier than elsewhere, the Dutch discovered that houses need not be immovable, rock-solid and monolithic; they should accommodate the movements of life."

- (Fassbinder, 1990: 5)



Figure 1 - Maison Domino

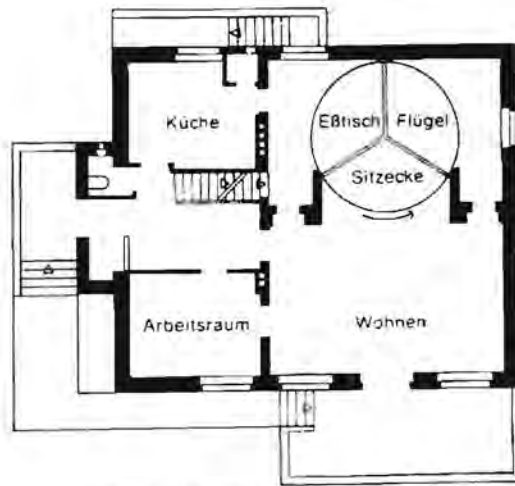


Figure 2 - Onkel Tom Stasse (1923) plan illustrating rotating platform



Figure 3 - Houses Am Weissenhof 14-20 (1927) plans showing adaptable floor layouts

Arguably the most extensive research into adaptable flexible design has been in the Dutch housing sector. This investigation started long before the rest of the world understood the need for flexibility in housing.

The design of flexible floor plan for domestic buildings have been studied since the early 1930's due to the understanding that flexibility is key to creating a happy society, and easy adaption of dwellings can provide residents with control over their personal space. I researched architects such as Rietveld, Van Doesburg, Van den Broek, Van Tijen, Habraken, Hertzberger and Van Eyck, all of whom attempted to address the issue in different ways.

Frank Lloyd Wright introduced Japanese housing ideas to modern Europe; expressing his appreciation of the sliding walls/screens and open multi-programmable rooms. In Berlin, in 1923, Mendelsohn built in *Onkel Tom Stasse* a house with a turning circle, that by turning an area in the floor, the program could be changed. Le Corbusier's *Maison Domino* in 1914 illustrated the possibilities for a load-bearing frame structure. Mies van der Rohe's contribution was a residential building with movable walls within the flats, which allowed the occupant to decide on the layout of space. Mostly they looked at the possibilities of having un-specified rooms, and load-bearing frames within completely variable free floor plans were possible. They investigated adaptable layouts and they looked how one might use the same bay spacing for different combinations of dwellings.

A significant event in the quest for better housing principles was the 2nd CIAM congress, focussed on '*minimum dwelling and flexibility*', held in Frankfurt in 1929. Various architects presented their ideas for housing strategies; Ernst May, Gerrit Rietveld and Le Corbusier were among these. This congress had different results on architecture in various countries. The Dutch architects, for instance, decided that it was not standardisation that would solve habitation crisis but looking at the passage of time of a dwelling and designing around a time-based architectural approach.

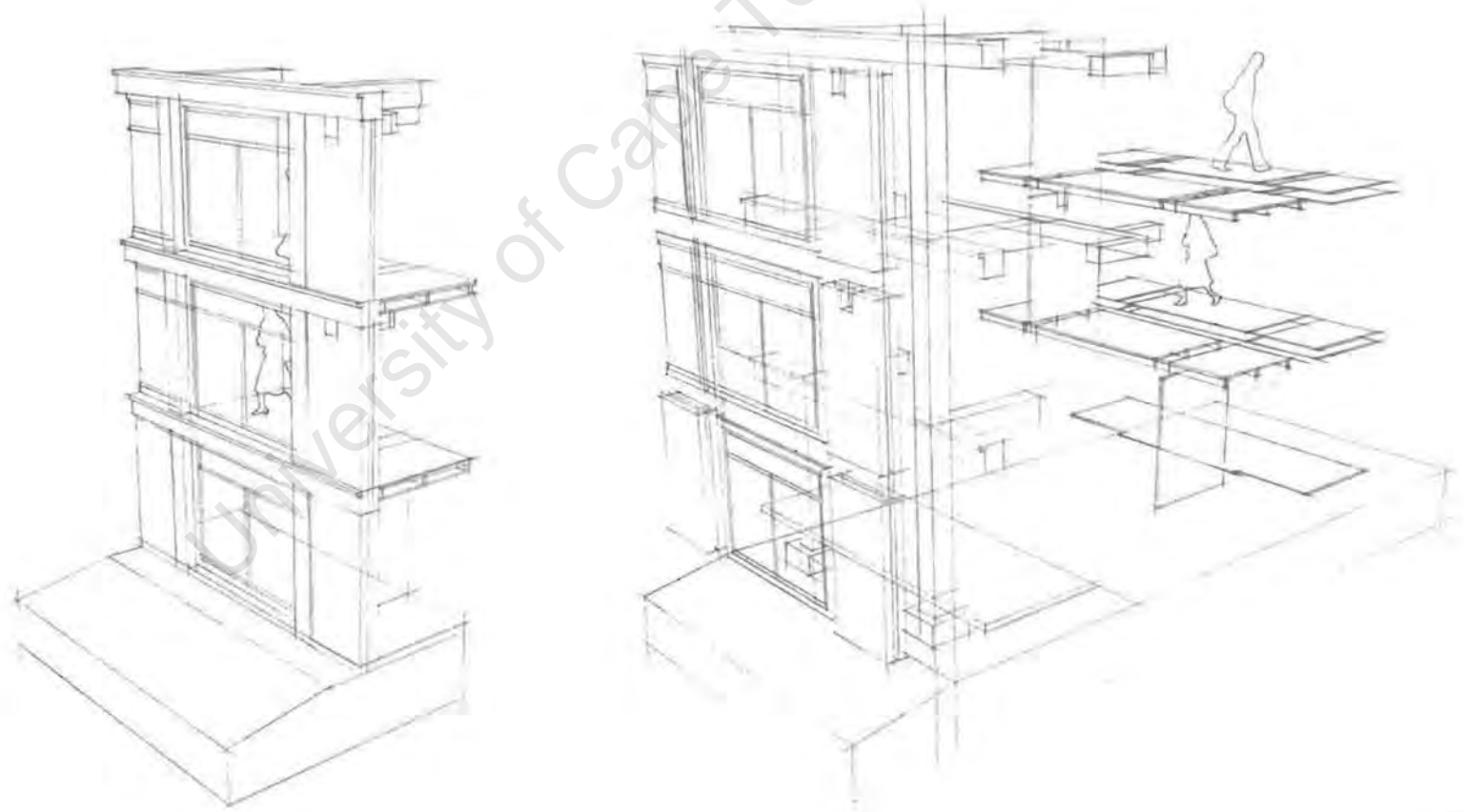
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TIME-BASED LAYERS EXPLORATION

These drawings were done after reading the book by Steward Brand, 'How Buildings Learn' (1994). The idea of separating a building into various layers intrigued me. In an attempt to understand these principles I did a series of 3D exploration sketches.

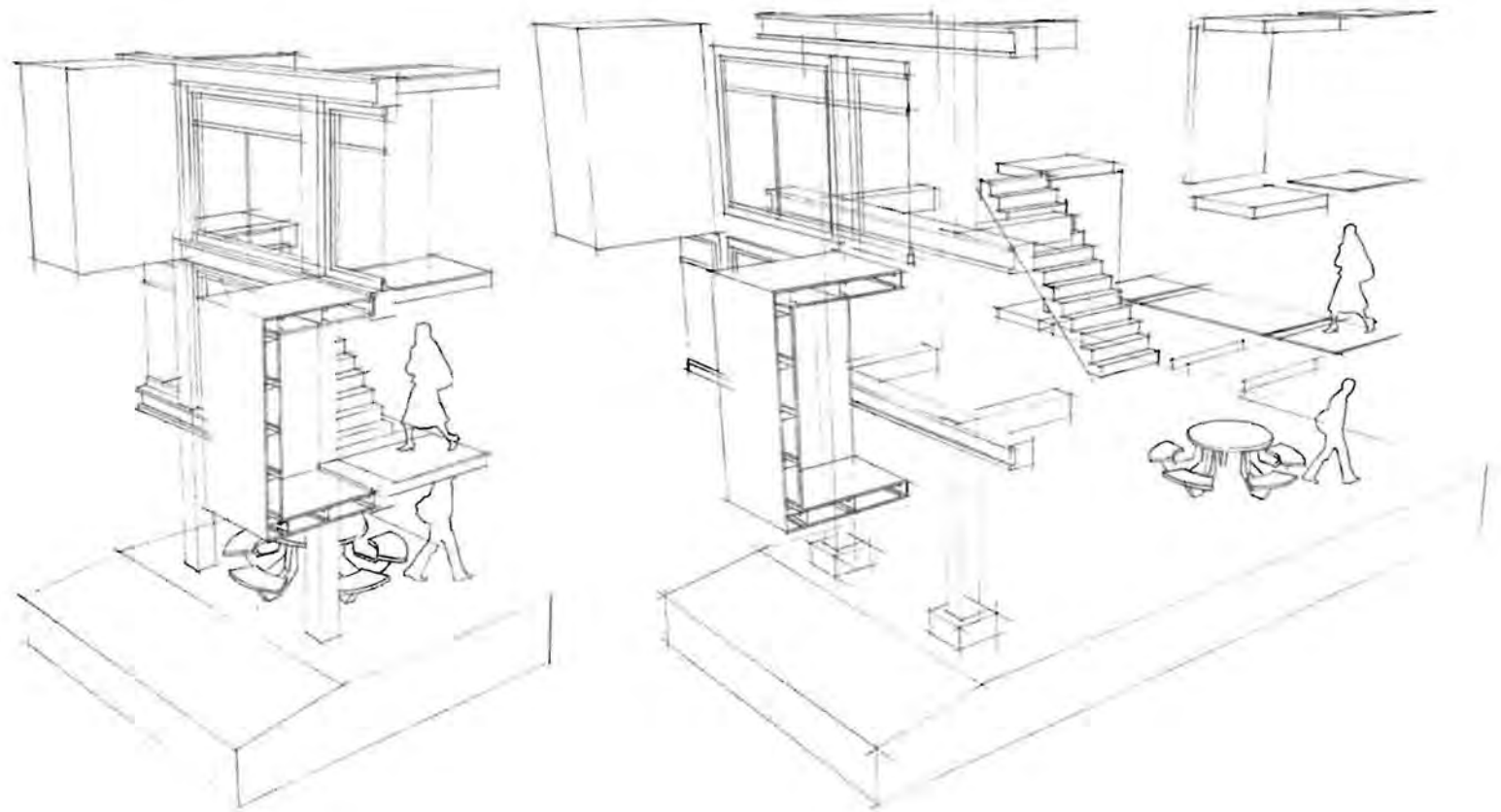
LAYERS EXPLOSION_1

A traditional layering of site, structure, skin, services, circulation, space plan and stuff. The layering is ordered according to their time-based rates of change. The stuff can be easily shifted; the space plan is secondary to the structure which allows for flexibility; the circulation is also secondary and determined by the plan; the services are exposed and accessible for adaption; the skin is in-filled, the structure is a basic load bearing concrete frame and the site conditions are carefully analysed, as once impacted upon it is changed forever.



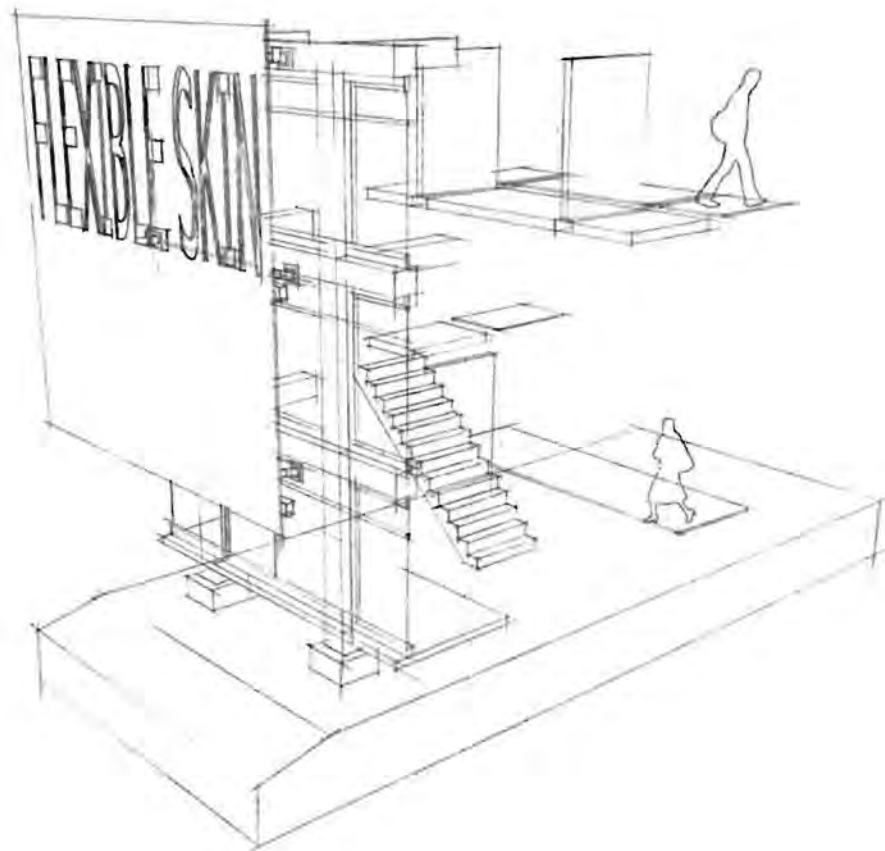
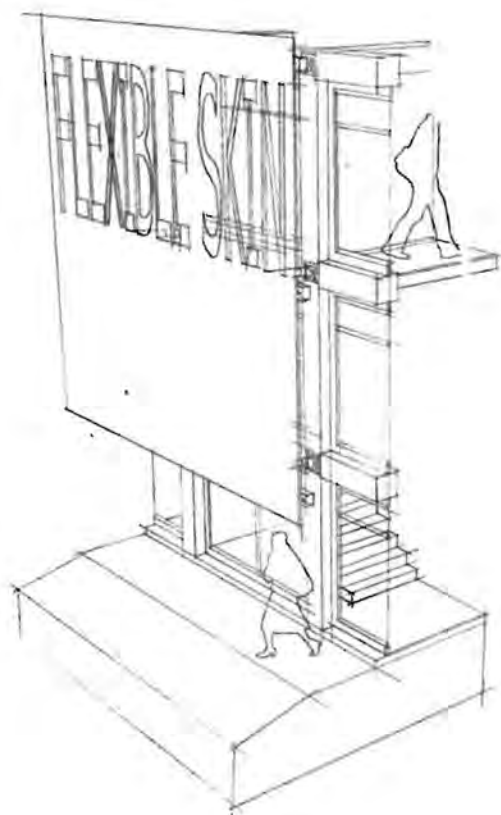
LAYERS EXPLOSION_2

The traditional layering is made more adaptable by adding clip-on elements. The clip-on additions are a secondary structural element often containing their own services, space plan and stuff. In order for a building to accommodate these additions, the structure must allow for fixings without compromising the structural integrity. All planning must be done at the beginning of the project to minimise major demolition.



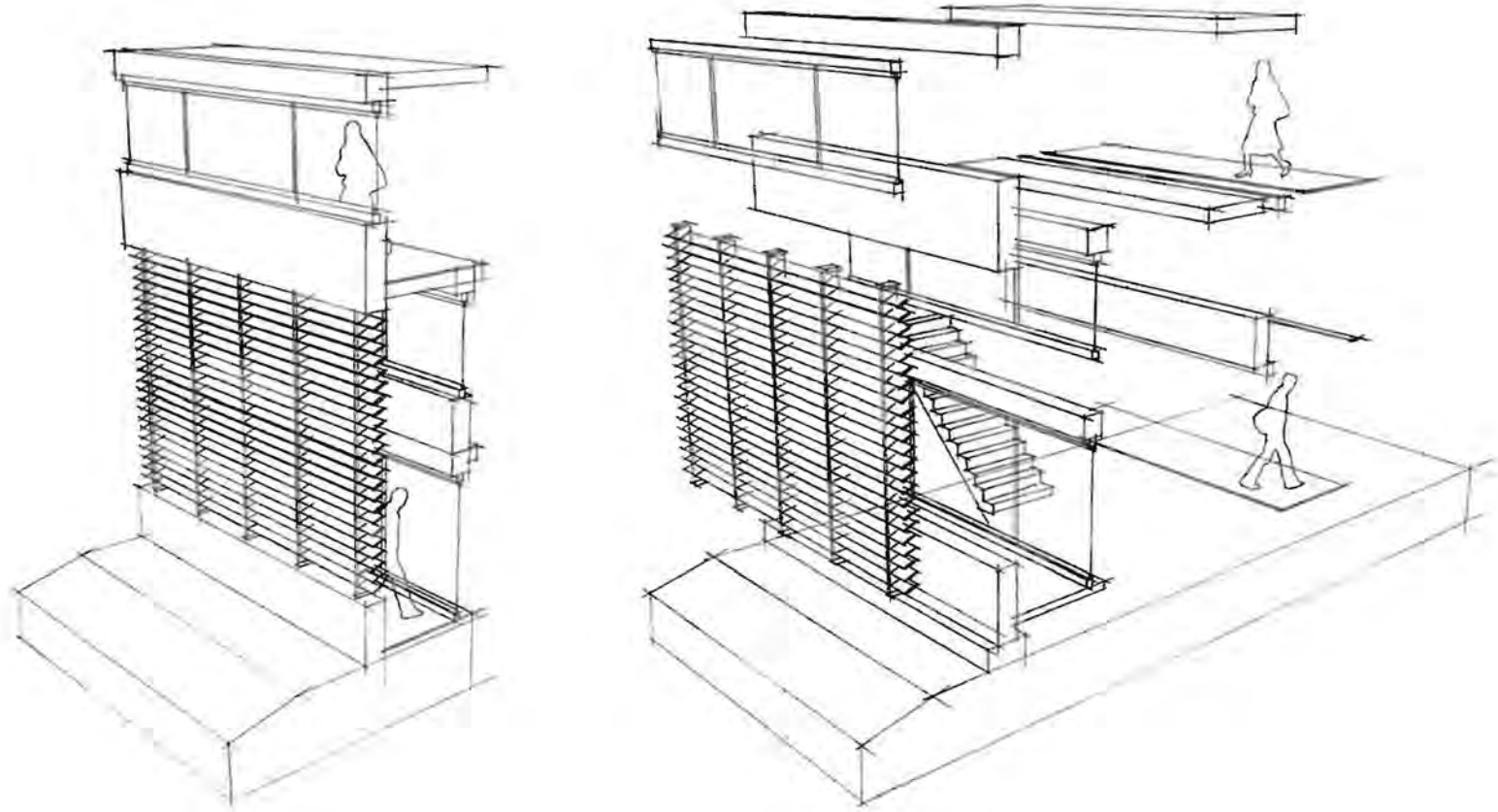
LAYERS EXPLOSION_3

In this investigation the skin is the most visible adaptable component. This building could have a very economical base structure and internal components, while the architectural language is expressed in the 'low-road' skin. This skin can be changed for a rebranding of the building. When a building tenant changes or the internal program changes, a rebranding of the building is sometimes necessary. This skin could have dual functions such as, solar shading or advertising.



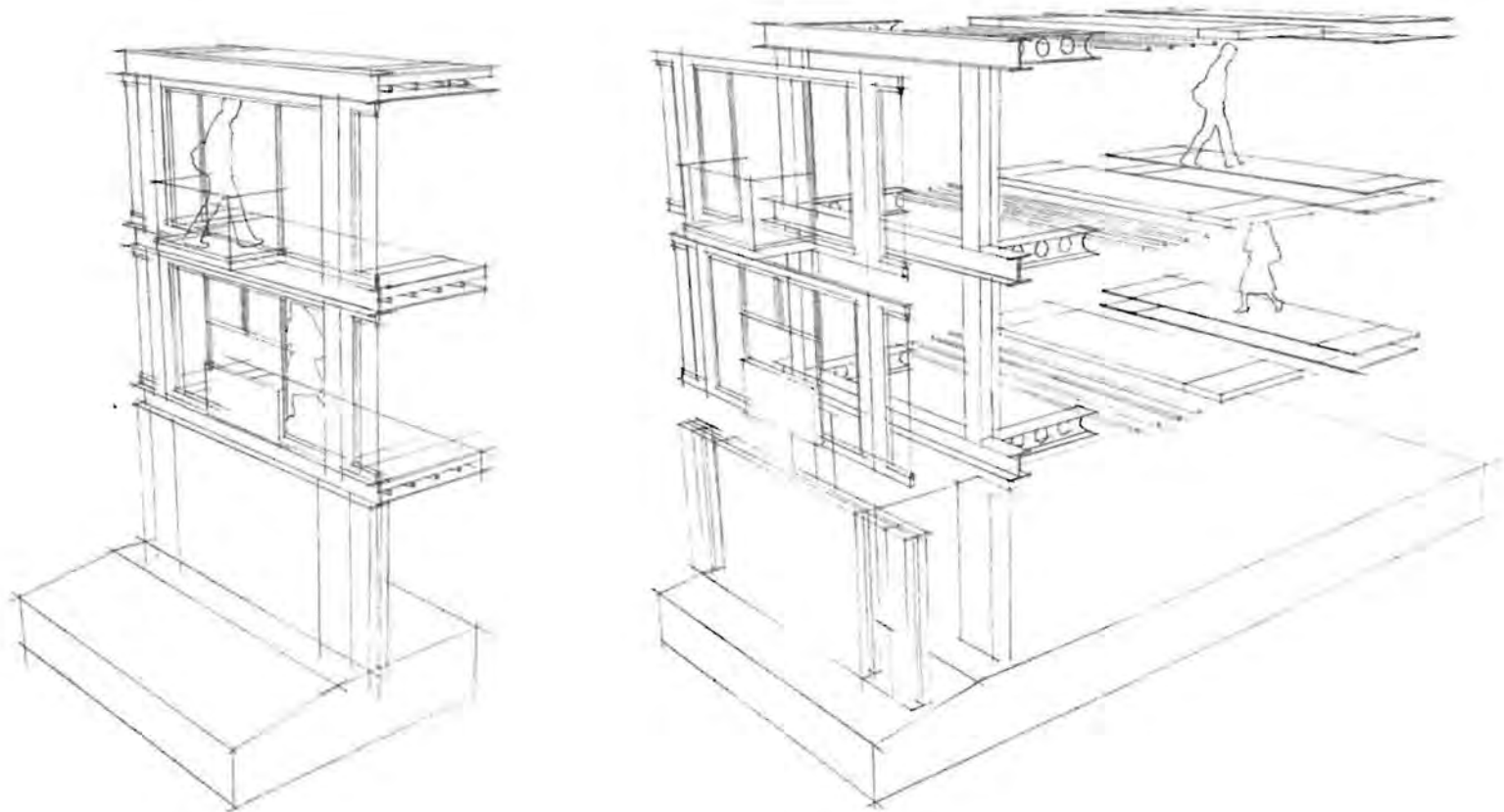
LAYERS EXPLOSION_4

In this investigation the components are mixed and not laid out in the traditional time-based manner. Here the circulation and skin becomes a public interface. The public private relationship is juxtaposed. The skin is not fully sealed but acts rather as a permeable layer (solar shading, rain restricting), while the sealed skin sits further back. The services, space plan and stuff are found behind the sealed skin.



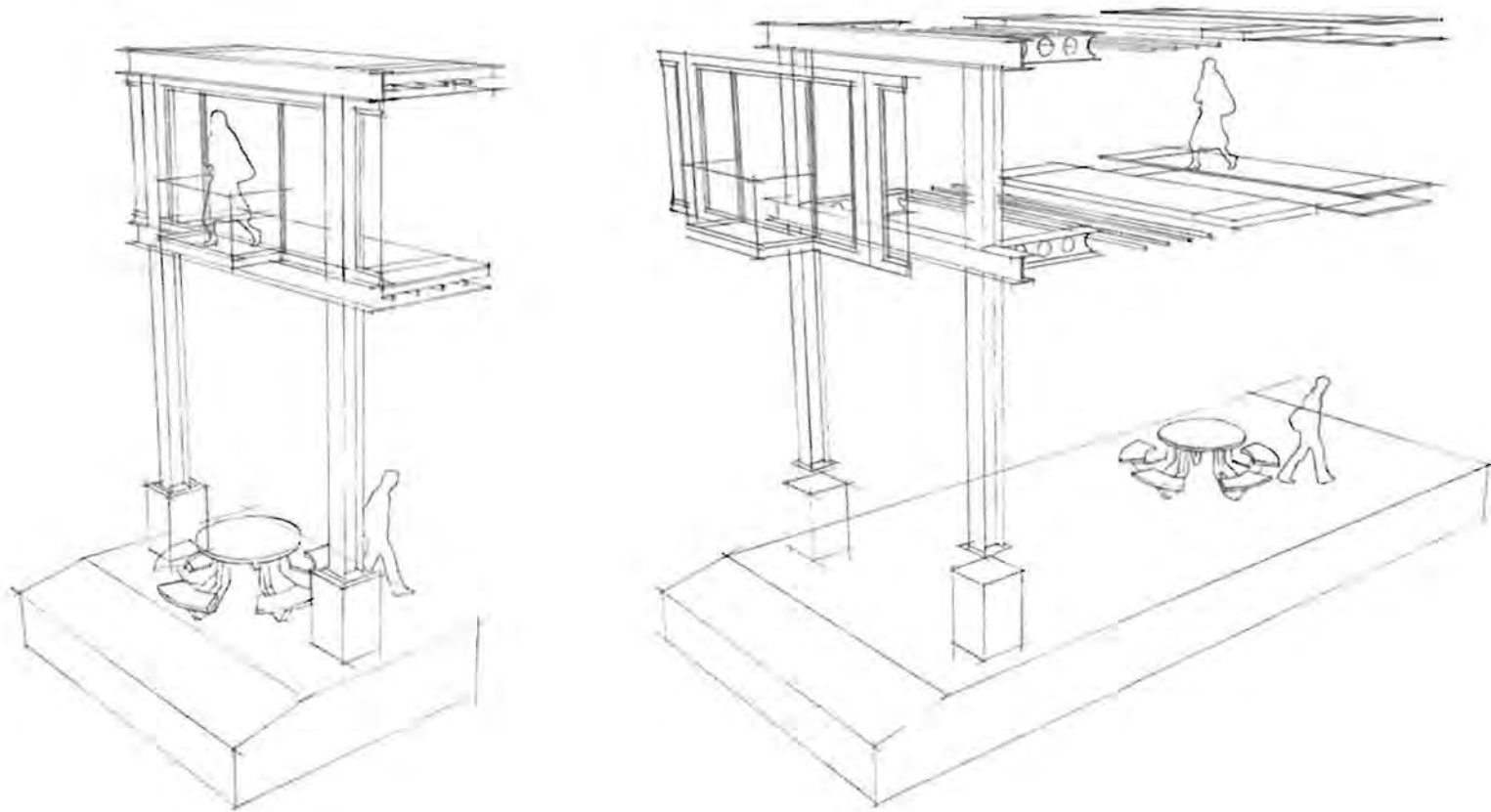
LAYERS EXPLOSION_5

This steel structure allows the services component to be hidden and easily accessed. This structure enables the skin and space plan to be changed and adapted as needed. The fold out window idea allows one to obey site boundaries, while giving flexible balcony space during the day. There are possibilities for a combination of 'high-road' and 'low-road' skins.



LAYERS EXPLOSION_6

This study looked at how one can use site as a tool for interaction between public and private. By lifting the skin, services, circulation, space plan and stuff off the site, the area below is sheltered and adaptable as public space. This space could also, at a later date, be in-filled and used for expansion, rather than the traditional expansion upwards. This process needs to be planned and a comprehensive site investigation is necessary to determine if it will be utilised and its program possibilities.



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ADAPTABILITY IN ARCHITECTURE: REPLACING STATIC FORMS AND SINGLE USE BUILDINGS

"Architecture has trapped itself by insisting it is 'the art of building.' It might be reborn if it redefined its job as 'the design-science of the life of buildings.' A shift that minor could transform the way civilisation manages its built environment – towards long-term responsibility and constant adaptivity."

- (Brand, 1994: 210)

In this theory investigation I looked at various definitions and types of adaptability with regards to buildings, exploring a range of opinions on how to achieve adaptability in architectural design and ultimately to determine the different responses' sustainable value.

Diverse and wide ranging concepts of adaptability have been in constant debate. Adaptability can be explained and differentiated in many different ways with interconnecting principles. Key words that surface time and again are flexibility, convertibility and expandability. **Flexibility** enables shifts in the space plan and layouts. **Convertibility** allows for changes in the program and uses of the building. Lastly, **expandability** refers to a buildings ability to facilitate additions or alternatively and less often, subtractions. These all can improve the performance of the building in a more efficient use of space, longevity and technological operations.

A theory that I found particularly interesting was the separation of adaptability into two different design approaches. In Ulrich Schroeder's book, *'Variable usable houses and apartment: Ground-plan, adapted to family size and life form'* (*Variabel nutzbare Hauser und Wohnungen: Grundrisslosungen, anpassbar an Familiengrosse und Lebensform*), he makes this distinction. The first is **'flexibility'**, when a building is capable of adaption without changing the building structure, but rather reorganising spatial layouts. The second is **'variability'**, when a building is capable of adaption by changing the actual building structure.

FLEXIBILITY

'Flexibility' the word is often interchanged with adaptability, due to their similar meaning. According to *Collins Online Dictionary*, the concept 'adaptability' refers to objects ability to change or be changed in order to suit new situations. 'Flexibility' refers to adaptability; in the case of a building, it is pliant and adaptable to new and changing situations. The 'flexible building' approach or 'multifunctional building' has been dealt with by many architects over many decades. Some of these ideas include work by Gerrit Rietveld, Ray and Charles Eames and extensive research by Robert Venturi and Denise Scott Brown.

Rietveld Schroder House (1924)

Utrecht, The Netherlands

Cedric Price

This example is perhaps the most important example of typological 'flexibility'. This building is and could only be a place for living; however the functional living requirements were designed with change in mind. This building's form is derived from the De Stijl movement; however the interior spatial layouts were based solely on the needs of the users; not just any person living in a home, but on the specific daily routine of Mrs. Truus Schroder Schrader. The *Rietveld Schroder House* was designed for Mrs. Truus Schroder Schrader and her three children, after the death of her husband. She lived there from construction in 1924 until her death in 1985. The house was designed to accommodate various types of living conditions and allow for future changes in requirements. The layout consists of two levels and a number of different screening devices and moving partitions; these secondary elements can be moved to create rooms when necessary. For both Rietveld and Schroder living in a home was a conscious act. The furnishing of the house reflects this belief. The resident has to perform an action for every activity. For example the bathroom is created by opening out a wall, while the sleeping areas could be screened off with sliding partitions. The house is literally a machine for living in.

Figure 4 - Rietveld Schroder House (1924) flexible plan layout options





Figure 5 - Eames House (1949) exterior view

Case Study House No. 8 (1949)

Los Angeles, California

Charles and Ray Eames

Another approach to flexibility is the container that accommodates any programme. *The Eames House* otherwise known as *Case Study House No. 8*, constructed in 1949 in Los Angeles by husband and wife pair, Charles and Ray Eames is an example of this. The International Style between the 1920's and 1930's was more concerned with the stylistic aspects of Modernism. Their attempts were at breaking away from architectural tradition by designing simple unornamented buildings. The Case Study Houses were an experiment in American residential buildings commissioned by *Arts and Architecture* magazine between 1945 until 1966. This project was to be built to test its functionality as a home and prove that universal space was the best way to design future buildings. The building is essentially a rectangular box with a geometric facade that is composed of coloured panels between thin steel columns and braces. The primary structure is kept separate from the internal layouts. This would allow the dwelling to be adapted according the user's needs or to hold a new program. This building was not designed simply as a home but as a structural and spatial experiment.

The 'Functional Bandwidth' Debate

In the book *Architecture as Signs & Symbols for a Mannerist Time* by Robert Venturi and Denise Scott Brown, they adapt the phrase *'form follow function'* (a phrase first coined by Louis Sullivan in 1896) and propose that it be replaced by *'form accommodates function.'* *"Here is architecture appropriate for our dynamic time, where form accommodates functions rather than form follows function, where form accommodates functions as a mitten rather than as a glove, to allow wiggle room for the varying fingers inside."* (Scott Brown, 2004: 37) This entails making buildings that are not based on basic typologies but allows a building to accommodate other unforeseen functions and perhaps even an entirely new program. However, one has to always be aware that not all functions can be completely flexible; some buildings need certain fixes in order to allow for easier adaption. *"A flex-building need not necessarily be able to take up every possible function. 'Functional bandwidth' is a current term: which functions are involved? You don't always need flexibility."* (van Zwol, 2005: 65) There is a risk that with too much flexibility the building can become featureless. *"The desire for flexibility led to programmatically neutral characterless buildings. Flexibility became synonymous with blandness and the word subsequently slipped from the architect's vocabulary."* (van Zwol, 2005: 9)

VARIABILITY

'Variability' according to the *Collins Online Dictionary* is when something is subject to variation; in this case it is the building which is subject to change. The idea of this type of adaptability deals with altering the physical building structure. There are many ways in which this could be done; through the ideas of Cedric Price, Frank Duffy and Stewart Brand, or 'Open Building' methods.

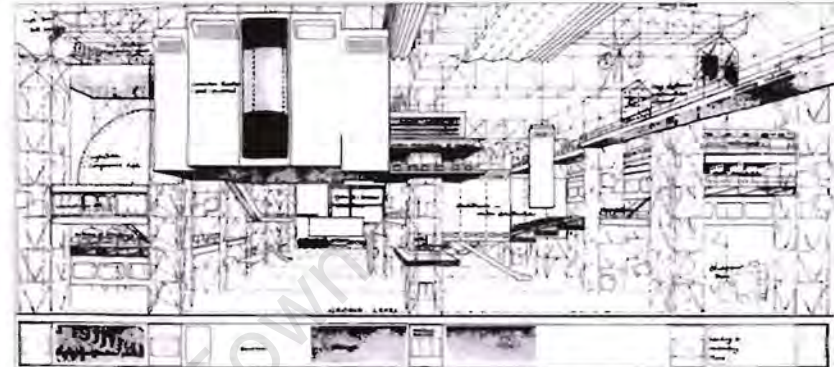


Figure 6 - Fun Palace (1961) conceptual image

Fun Palace (1961) Cedric Price

This was one of the most revolutionary uses of 'variability' in architectural history. The design was a mega-structure that was fully serviced by multiple travelling gantry cranes. The building was a kit of parts, pre-fabricated walls, platforms, floors and stairs that could be assembled and made by the cranes. All the pods could be moved allowing the occupants to decide on their position within the system and their programmatic use. He believed "...in allowing for change/flexibility, it is essential that the variation provided does not impose a discipline which may only be valid at the time of design." (Price, 1962) Unfortunately it was never built; however a smaller more modest version, the *Inter-Action Centre*, was built in 1976.

Figure 7 - Fun Palace (1961) conceptual image



The Medical Faculty (1970 -1976)

Leuven, Belgium

Lucien Kroll

Another way of uncovering 'variability' is within the framework of 'Open Building.' 'Open Building' is a term commonly used today, both by N. John Habraken and the International Council for Research and Innovation in Building and Construction Working Commission W104 '*Open Building Implementation*.' Both Habraken and Work Group W104 propose that there should be separation of base support building and the infill, as a way of making the occupants active in the design process. This entails separating the 'fit-out' from the other elements, of structure, skin and services. The 'fit-out' is what contributes to the particular use of the building but is not needed for the functioning of the building. This leads to more sustainable methods of construction; due to high levels of 'variability' in the structural layouts.

This is a built example of the principles. Lucien Kroll is a Belgium architect that always used vernacular style in his works, simple forms and truth to materials. He was well known for his methods of actively involving participation by the future users. He gave up his position as an expert during the design and building process. His most famous work is *The Medical Faculty*. The buildings within this complex campus that best illustrate user participation are the student housing. The basic structural layout was designed and then the users were consulted to 'fit-out' their individual internal space plans. The result is a complex collage of layouts and facades. Nothing was too precious to undergo change and adaption.

Figure 8 - The Medical Faculty (1970-1976) facade collage



In doing this research, I discovered that there are two very clear ways of designing adaptable buildings. Firstly, one could exploit space flexibility, whereby due to the correctly calculated layout designs and configurations could allow for multiple ways of occupancy. The second is variability of the actual building itself, creating quick and cost effective refurbishment of the buildings layers. Adaptable design holds the potential to reduce the risk of unsustainable building designs positioning them for realizations of possible greater value.

INVESTIGATING A TIME-BASED ARCHITECTURAL APPROACH BY SEPARATING THE LAYERS

"The unit of analysis for us isn't the building, it's the use of the building through time. Time is the essence of the real design problem."

- (Brand, 1994: 13)

In this Technology Investigation I wanted to understand how one could use time as a means of architectural production, therefore I researched various books and theories that dealt with this idea. I then looked at examples of buildings that have used time-based principles as the driving force of the designs. These buildings are all examples of the 'High-Tech' architectural style, as this style dealt with rapidly changing programmable needs and how buildings should adapt accordingly.

When buildings are designed today, their structures are built to last for 300 years and yet many never remain standing for that length of time. This is largely due to the way in which they are designed, for a very specific purpose at a single moment in time. Analysing a building in terms of its longevity is necessary in our current context because the rate of technological and culture evolutions are happening at an increasing pace. With these rapid shifts in culture, an architecture that is able to adapt and be flexible to new needs, is a way of creating some stability in the built environment and therefore in the societal environment.

Future buildings should participate in a time-based architectural approach, taking into consideration time and uncertainty. In the book

'Time-Based Architecture', "...there are three possible ways to deal with time and uncertainty: Make buildings polyvalent. Make buildings that are part permanent and part changeable. Make semi-permanent buildings, e.g. 'industrial, flexible and demountable' (IFD) buildings." (van Zwol, 2005: 13)

A **polyvalent building**, a term first brought into the architectural debate by architect Herman Hertzberger, is a building that is multipurpose and can be used for any function in different ways without the need to adjust the structure. The main factor for a polyvalent public building is the correct ratios and dimensions of space, while achieving polyvalence in a private dwelling, the appropriate spatial configuration is necessary.

Part permanent and part changeable buildings is a concept that has evolved through the years. It began as a support structure whereby the main structural frame is built and then individual space is in-filled; this was seen as the solution for public housing after WW1. Out of the support structure, the carcass structure idea developed, mainly for larger commercial buildings. This response enabled the occupant to retrofit the internal spaces. The last concept is the frame concept, where the frame is the most permanent component of the building and the other layers have a time limit. This time limit can involve the actual material life cycle, new technological requirements as well as cultural aspects – for example an identity revamp – resulting in these layers being replaced. The building layers are therefore variable over time and so one must design the most resilient base structure to support all the changes.

The last way to deal with time and uncertainty is through **semi-permanent buildings**. These buildings are generally movable or mobile buildings that can be disassembled and reassembled elsewhere. They are industrially made in the factory and the parts are easily transportable. These buildings are not always fully disassembling; sometimes it is only the skin that is replaced. This example is mostly used for the industrial factory programs.

The concept of 'part permanent and part changeable' buildings is further expanded in the literature of Stewart Brand and Frank Duffy, whereby buildings are split up into various components according to their rates of change. "Our basic argument is that there isn't such a thing as a building," says Duffy. "A building properly conceived is several layers of longevity of built components." (Brand, 1994: 12)

Frank Duffy distinguishes all buildings into four layers, the Shell, Service, Scenery and the Set. However, Stewart Brand extends upon this idea, to create six layers. These layers are Site, Structure, Skin, Services, Space Plan and Stuff.

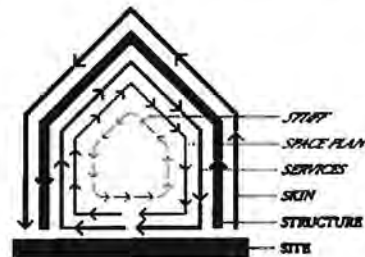


Figure 9 - Shearing Layers of Change

I have included in my thesis a seventh component to take into consideration, that of Circulation. I explored the 'part permanent and part changeable' buildings through a series of case studies.

The case studies that I chose all investigated flexibility and adaptability as the driving force in the design. There are many lessons to be learnt from these examples especially in our current technologically and culturally changing context, as it seems to be more necessary than ever to design for change and to separate buildings into time-based layers to make the adaption trouble-free.

SITE

The site refers to the geographical position of the building. This component is usually seen as separate from the building; however most decisions of the building are a direct result of the site conditions and context. Many aspects have to be taken into consideration when designing the site, its natural environmental processes as well as the social environment and the architectural surroundings. The site is responsible for the structural opportunities and therefore impacts the entire building.

The Sainsbury Centre (1977) & Crescent Wing (1991)
University of East Anglia, England
Norman Foster

The most interesting idea when studying this precedent was the two very different ways of addressing site within one project. The first building appears to sit on the site as an object, while the extension hides itself underground due to the natural topography of the site, sloping towards a lake. The first could be seen as an intrusion; however less destructive in the earth. The extension would rather express the landscape; however it makes a much bigger impact on the natural site.

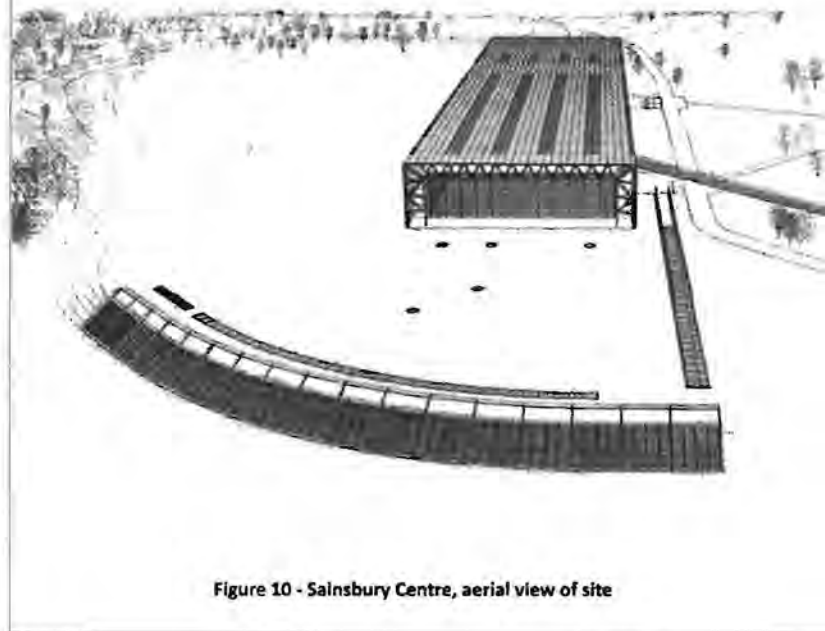


Figure 10 - Sainsbury Centre, aerial view of site

STRUCTURE

When referring to the structure layer of a building, it means the base structure; for example in a load bearing frame structure, it is the foundations, columns and beams. The structural system transfers the loads (live and dead) through interconnected structural members. The type of structural system to use can depend on various factors; the site conditions, the architectural intention, costs and appropriate materiality. These structures can be of any material but the most common are concrete and steel. In time-based adaptable building design, one must consider the changes through time, and the structure should be able to easily accommodate these changes without compromising the building. The structures of buildings are built to last between 30 and 300 years.

Inmos Microprocessor Factory (1987)

Newport, Wales

Richard Rogers

It is the prefabricated structure of this building that allows one to extend or remove parts of the building. This building structure was proven to be the perfect solution to a growing and changing factory. The solution, of a supporting spine structure, is a simple one and yet offers many possibilities. The wide spanning steel structure and top supported roof leaves a large amount of free floor space, which can then be space planned accordingly.

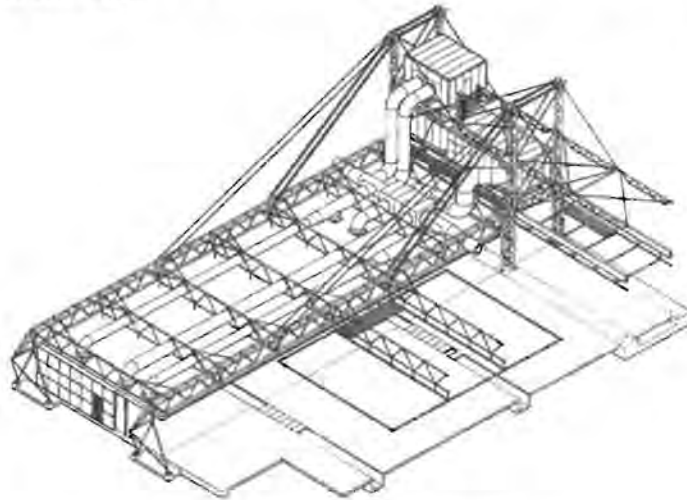


Figure 11 - Inmos Factory, structural system

SKIN

The skin is the layer that usually expresses the nature of the building. It can be purely a manifestation of the internal order of structure, it can illustrate the program internally, it may be a form of branding or it could be simply the best possible sustainable solution. *"The design and construction can fruitfully take either the High Road or Low Road, toward beloved permanence or toward beloved disposability."* (Brand, 1994: 193) An example of Low Road skin is a funky or high-tech LED walling system, which is no great loss to replace and adapt, while the 'high road' skin would be masonry or stone in-fill, which would be difficult to change. The skin usually lasts less than 20 years; however it is more frequently replaced in commercial buildings, which generally take the 'low road' solution.

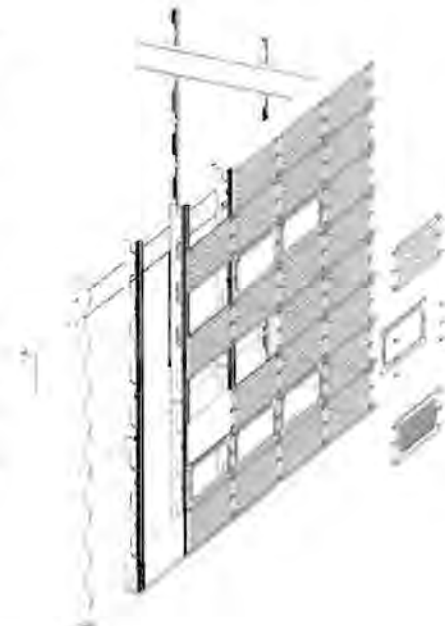
Igus Headquarters & Factory (1992)

Cologne, Germany

Nicholas Grimshaw & Partners

Figure 12 - Igus Factory, exploded drawing of cladding system

This skin has the ability to adapt to accommodate function and flexible programmatic requirements. It also reiterates the general function of the space internally. The facade uses one simple set of structure and connections but allows different types of openings and enclosures. This system of skin is borrowed from the flexible shelving solutions and then reinforced to enable it to be used structurally. This means that with the ease of adaptability, the building is not confined in its use. In the pursuit of a time-based architectural approach, this 'low road' skin can be disassembled and re-imagined.



SERVICES

Services are perhaps the most rapid advancing technology in the building environment, due to technological improvements and new sustainable methods. Services in the past have had a 7 to 15 year life span, however change is becoming more frequent and improvements can occur annually. Services can cover a wide range of components, but are mostly understood as the electrical and telephone fixtures, plumbing, ventilation strategies and lighting requirements. Sometimes the storage areas, plant rooms and restrooms are grouped with services. Stewart Brand would classify elevators, lifts and staircases into services, however for this study they are a separate layer.

The Centre Pompidou (1977)

Beaubourg, Paris
Su & Richard Rogers & Renzo Piano

The services are always the biggest challenge when designing a building that has to adapt for change. The placement of services have to be carefully designed, as they have to be serviced and under constant maintenance. In a long life building approach, where programme adapts, voids spaces and tolerances must be designed for possible scenarios. In this building the services are seen as a design tool to express the language of the architecture and illustrate this to the general public.

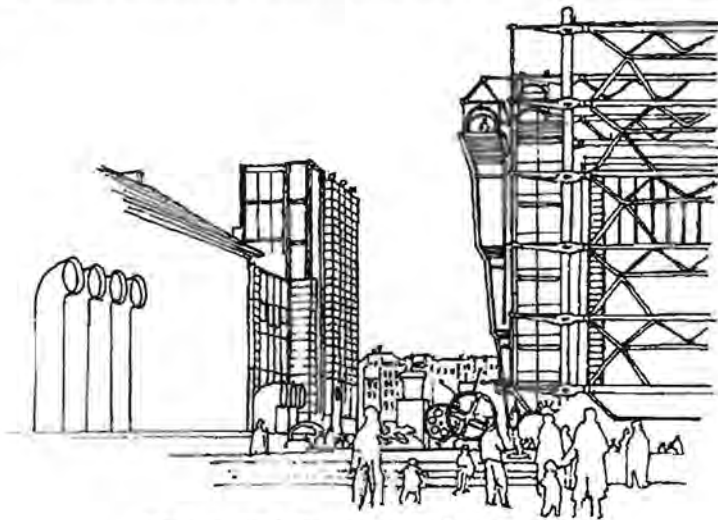


Figure 13 - Pompidou Centre, basic floor plan showing open space with services at the periphery

CIRCULATION

The circulation of a building refers to the way people move through and interact with a building. Elevators, escalators, and staircases are also considered circulation elements and must be positioned and designed to optimize the flows of people through a building. Frank Duffy and Stewart Brand do not recognise circulation as a separate component. However, in the pursuit for an adaptable programmable building, this layer must be designed independently so that it can accommodate for change. The rate of change for circulation would be dependent on new spatial layouts/divisions and changing council regulations.

Hartspring Business Park (1986)

Watford, England
Nicholas Grimshaw & Partners

This example is interesting because the circulation is the layer which is most expressed, due to the high flexibility and simplicity of the internal spaces. The circulation is structurally separate from the concrete frame and this is illustrated by the change in materiality from concrete to steel. The lightness of the staircases makes them appear to be temporary while in fact they are what hold the design aesthetic. Even the catwalk circulation help articulate an otherwise dull monotonous facade. Interestingly, the catwalk is connected to the solar shading devices. This gives the catwalk a dual-purpose, giving circulation that is used less often, a necessary function. This circulation pattern allows one to adapt the internal spaces for change without needing to redesign the flows of movement in the short term.

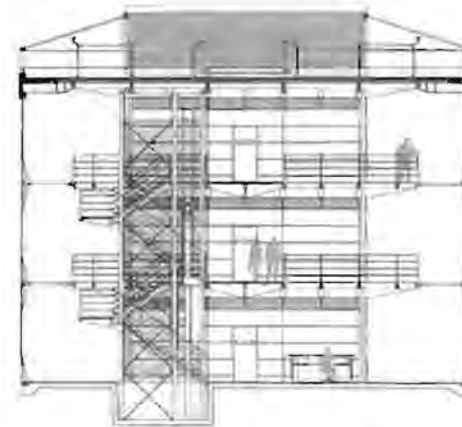


Figure 14 - Hartspring, section through circulation core

SPACE PLAN

The space plan of a building refers to its internal layout. The space plan includes the internal walls, dividers and ceilings. The space plan of a private dwelling is dependent on the occupants' daily needs and wants. These layouts can be highly flexible from day to day and hour to hour. In commercial office buildings the subject of space plan design has been widely researched in order to find the best possible work environment. The 1950's movement of *Bürolandschaft* (office landscaping), by the Quickborner Team in Germany, devoted endless time to office space planning in an effort to find the optimum proficiency of space. The space plan rate of change is very difficult to calculate as it depends on the programme of the building; however it generally lasts between 2 and 5 years in a commercial building and a possible 30 years in a private dwelling.

Schlumberger Research Centre (1985)

Cambridge, England
Michael Hopkins

This example of space planning illustrates how to design for many different programme requirements in one building; instead of separating the testing, research and office management, they are integrated and therefore work more productively. The space planning uses materiality and height changes to show function. In this building it was first and foremost the space plan that led to the design. This space plan offers a wide mixture of working conditions, which gives the employee a greater sense of freedom, which is most important for a creative workforce.

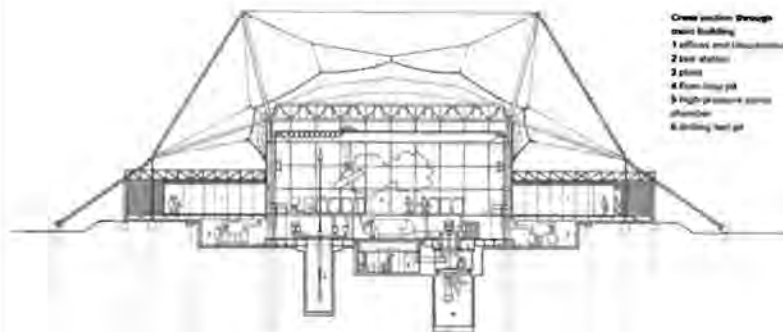


Figure 15 - Schlumberger Research Centre, section through width of building

STUFF

The stuff is all the movable elements of a building, described here as the furniture – tables, chairs and light fittings – as well as the human element, people. Stuff can move continually, and for furniture to move takes less than a year. In the field of architecture the stuff is left to those from other fields, like that of the space plan. The stuff is usually not considered until the building is complete. However, in a time-based approach to architecture, one has to imagine and predict change. This example shows how an architect can use industrial design as another method for expression of an architectural idea.

Tecno Nomos Desking System (1987)

Italy
Norman Foster

In stuff design architects can get quicker gratification of a final product. Furniture prototypes can be tested and many changes made without major costs or repercussions. This stuff is either commissioned by a furniture company or as integral part of an architectural project. Many times, the product needed for a project is not available and the architect has a vision that he then needs to resolve by manufacturing it himself. Most times the architect designs everything but the stuff, however in a time-based approach one must understand how over time different stuff could be accommodated and space plan for different scenarios.

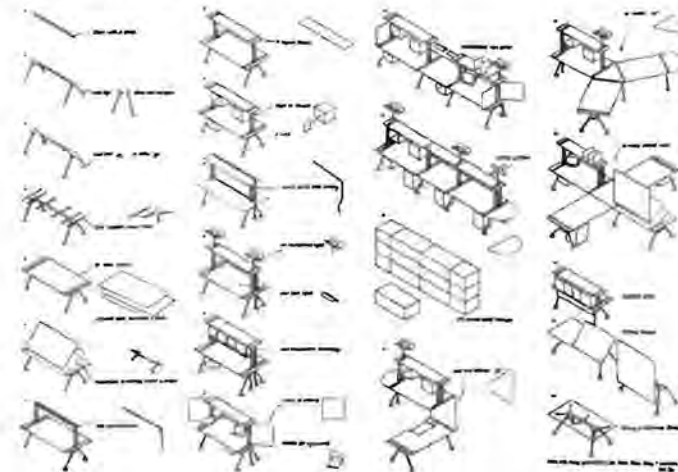


Figure 16 - Tecno Nomos Desking System, drawings showing possible flexible options

University of Cape Town

SITE INVESTIGATION

In order to investigate office space in Cape Town, I was advised to look at a recently built development in Cape Town. I chose to investigate The Boulevard Office Park Development. The master plan was designed by DHK Architects and the buildings were designed by both DHK Architects and Peerutin Architects. FairCape approached DHK Architects to develop the scheme on a consolidated site in Woodstock.

After some basic research into the development, I decided that I was going to use this location as my site and redesign the office park to make it more adaptable in its site organization, spatial layouts and structural capabilities. In order to get a better understanding of the planning decisions I met with DHK Architects, Derick Henstra and Peter Fehrsen as well as FairCape Leasing Agent, Samantha Du Plessis.

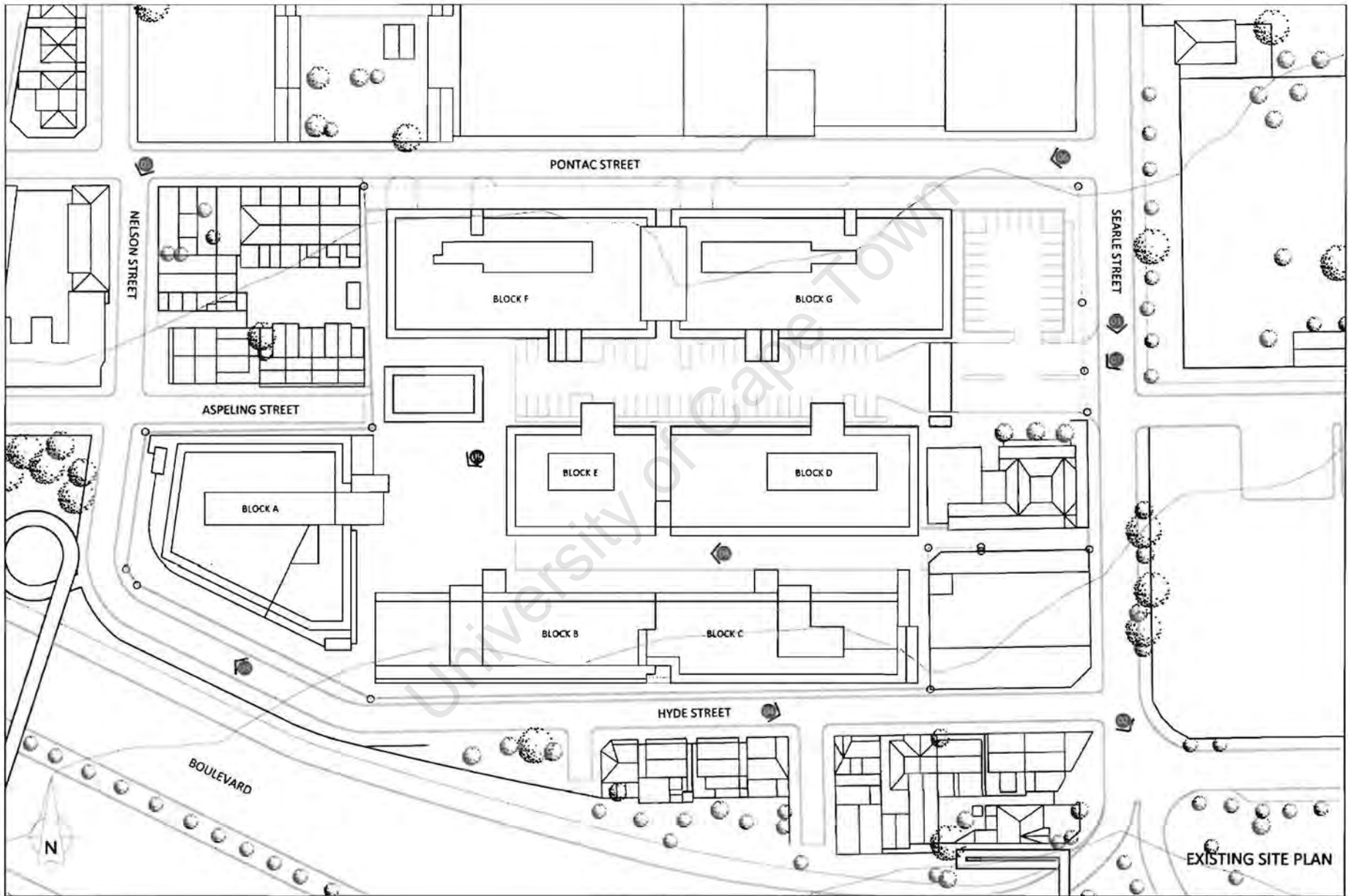




Figure 17 - Aerial view of site

SITE DESCRIPTION

The site is situated in Woodstock, Cape Town between Searle, Pontac, Nelson and Hyde Street, with Nelson Mandela Boulevard, previously named Eastern Boulevard in close proximity. It is surrounded by factories, retail and residential units, offering a diverse collection of building uses. The site has excellent views of both the mountain and the harbour.





PROJECT BRIEF

The initial design brief had no programme specifics, except to create a series of mixed-use buildings; possibly that of a hotel, retail complex, office park and residential development. However, later the market dictated that they move away from residential, hotel and retail property and develop a fully inclusive office park. As with most projects today this was completely economically driven and many compromises were made that affected the architectural result. The word flexible is often used to describe this development, however this is only appropriate to describe the office arrangements (large open floor plans/universal space) and not flexibility over time or for changes in programme.

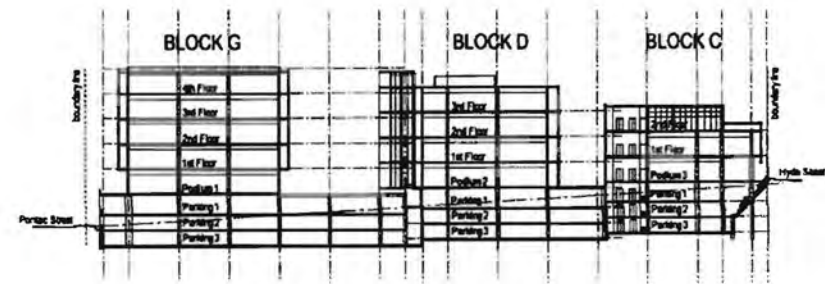


Figure 18 - Section received from DHK Architects

Interview with DHK Architects, Derick Henstra & Peter Fehrsen

Held on the 29 March 2011

How did the Boulevard Office Park Development come about?

Fair Cape approached DHK Architects to develop a scheme on an already chosen site in Woodstock. The initial design scheme had no programme specifics, except to create a series of mixed-use buildings, possibly that of a hotel, retail, office and residential. However, later the market dictated that they move away from residential property, as the market was in a slump, and develop a fully inclusive office park. This project, as with most projects today, was completely economically driven. The development is let at below standard rates to create interest, this and the market is in a very precarious place at the moment.

What were the limitations and positives of the site?

The site's limitations were the scale of the surrounding buildings, mostly housing and factories, offering a variety of height ranges. The site was also bordered by different speeds of roads. This meant that the park had to be carefully designed to respond to all edges. The advantages were obviously the fantastic views, making any type of development at this location viable and sort after. It is close to Cape Town, therefore there is minimal traffic congestion and the site could accommodate lots more parking for tenants than in the city. Woodstock is also an important area that needs to be looked at for expansion and development.

What was the brief and were there many specifics; leasable space, landscaped space, etc?

The brief was very broad. At first the scheme was designed for a multitude of programmes, however once the commercial programme was finalised, the developers wanted maximum coverage and maximum parking. The site was designed with a parking ratio of 4 spaces to every 100m². It is the only office complex, close to the city with this ratio. The buildings were designed to economic standards and rates, it is all very financial. But of course, aspects, such as natural light and sustainable design were important. The spatial layout was a direct result of the parking layout.

The office park has many social spaces and places of interaction. Was this a decision of the architects or a request from the developers?

This was the decision of the architects, as it was necessary to make sure there was human interaction in this commercial space. The Vida Cafe and square was about social interaction and connections, a breathing space. In the master plan this was a green space, but was unfortunately paved when built. Most of the office spaces also have balconies, mostly for access and circulation, but dual function as social space.

How did the architectural language come about, was it an economic decision, was there a certain branding identity? Did form follow function?

Block A is about speed and so the glass facade panels were meant to convey this. The black glass was chosen, however it was originally meant to have a certain lightness and opacity to it. The more articulated surfaces of Blocks B and C correspond to the smaller scale of the road and buildings alongside. Only Block A, B and C were designed by DHK Architects. Block D, E, F and G were designed by Peerutin Architects within a similar language.

The developers were looking for a similar look to that of their other projects, an architecture that was clearly modern, with sharp lines, one that would appeal to a number of different companies. The styles had to be universal in taste. Also students need to understand that a major cost is the designer facades, so finding ways to decrease the overall m² in necessary.

Mostly, the architecture is a result of the economics of the brief; however architects have to find clever ways of addressing design concerns within these financial limitations.

I have read the works of Stewart Brand and Frank Duffy, and their idea of the building being separated according to rates of change. Were any of these ideas used in this project?

This is possibly the simplest ways of introducing flexibility into architecture; the challenge is to do this while still retaining some sort of identity of the whole. In some ways the building elements are separate, although this was due to technology reasons and not with major flexibility in mind.

Obviously sustainability is a huge design necessity in building today. What are the sustainable solutions in this project?

All DHK Architects projects are concerned with sustainable practices, from passive technologies to a conscience use of materials. This building attempts to maximise the natural light (natural light is very important, especially in the design of offices; the buildings are usually 12 – 13m in width to accommodate this). The sustainability is mostly expressed through technologies used.

All descriptions of the office park mention flexible space; in what way is it flexible?

It is flexible in its versatility of office arrangements.

Are there various office landscaping options, for example open office spaces, hives or hubs?

This is purely dependant of the type of tenant and their needs. All the spaces have been designed as open-plan areas with access to the services in the centre. This was on request of the developer. The developer never wants his leasing options to be limited.

Was there any intention of program flexibility in the future? The structure is built to a high standard, with sustainable principles of natural lighting, could it in 50 years time be easily adapted?

Anything can be adaptable; it just depends on the financials and the costs of change. If buildings were designed according to ideas of cost free adaptability, then this transition is just easier. The question is the initial costs of building a universally flexible architecture. It is definitely something that should be considered as a potential solution to solve the reoccurrence of the single-use building. A thoughtfully designed space should be able to accommodate a range of programmes.

How do you feel about flexibility as an architectural proposition?

This project is very exciting as it is in the realm of sustainable practices. It could offer limitless opportunities for both developers and architects. The challenge is to find the architecture language that illustrates a fully flexible building.

Interview with Fair Cape Leasing Agent, Samantha Du Plessis

Held on the 01 April 2011

Why did Fair Cape decide on an office development in this location?

The market dictates the kind of program for development. At the time the residential property market was in a slump and the need for a secure office park environment was in high demand. Woodstock is undergoing urban renewal incentivised with an Urban Development Zone Allowance which enables any improvement to be written off over five years for tax purposes. This location offered great views of the mountain, which is an enormous leasing positive when advertising; as well as being close to the city centre.

Why the large amount of parking? Were 3 levels of parking necessary?

This park offers a ratio of 4 spaces to every 100m² and is the only office complex, close to the city with this ratio. Parking is always an issue within office complexes, especially a location that is surrounded by dense fabric with limited roadside spaces. This parking is a big advantage in advertising for an office park.

The KwikSpar is very successful in the area, why is there no retail activity within the park?

The complex is successful due to the high level of security which is actively controlled. This is why the tenants have set up offices at this particular site. If the complex was open and encouraged as a public space by a retail component; there would have to be increased security for the businesses at all entrance doors. Business m² is more valuable than retail leasing. Also business tenants are more reliable tenants.

In the early site plans the square is green landscaped, whose decision was it to pave it and why? Are the public spaces well utilised?

It is a maintenance issue and as a paved area it is more useful. It was decided that business people would not relax on the grass and so it would not be functional. This area has been rented for car commercials, film shoots and even held a marquee for work functions. The public spaces work very well, the Vida Cafe is always in use by the various employees. Some of the businesses cater for their own employees, these employees then use the other outdoor spaces to socialize. Fair Cape is fully responsible for the security, maintenance and construction.

Which buildings out of the 7 have been most desirable?

Each building offers a different opportunity; however it is mostly based on the m² rather than its position within the scheme. Although, the initial base tenant, Alexander Forbes, did request the corner Block A, as it allowed a greater opportunity for advertising to the Boulevard. Block A is really the statement iconic building of the site. All buildings have the same facilities and have similar finishes.

How are the offices split up within the blocks?

This is negotiated with the leasing agent, but most companies use the entire floor m². The leasing agents will pay up all costs before dividing floor plans. The central spaces are where the services are located, so the leasing agent has to take this into account.

Are the tenants allowed total freedom to retrofit their offices?

All companies generally want their own sense of branding and signature styling of their interiors. However, Fair Cape prefers that they use in-house contractors. All the companies have asked for different personal layouts, some go for the open plan layout; most have a mixture between hubs and open plan, whilst the older companies prefer cellular offices.

How do you feel about the look and architectural language of the office park?

A modern example such as this is needed in Woodstock. There needs to be more playfulness with architecture and the facades. If Woodstock is to change its reputation as a negative dangerous area, buildings like this office park need to be developed. It has the same look as the Ogilvy Building.

Do you think architecture can change the perception of an area?

Woodstock needs more office developments, improved residential blocks and further expanding on the already successful retail area. If this is achieved, especially if the buildings are modern, using new materials, the area will be uplifted and it will bring more tenants and more expensive residential options. This area is underused, and it is especially important due to its location to the centre of the city.

Have there been any complaints as of yet?

The only complaint has been the wind, which is not something that can be dealt with now. The only other complaint is that of sun shading, as the facades are all glass. The solutions offered are internal blinds at the companies' expense; however film is being placed within the elevator shafts to reflect the heat but still let in light.

Do you think this development could be adapting into housing at some point?

There are other places where housing developments could be built within Woodstock. What is needed at the moment is commercial space.

But what if office space of this size was no longer needed or requested, could this be used for another purpose?

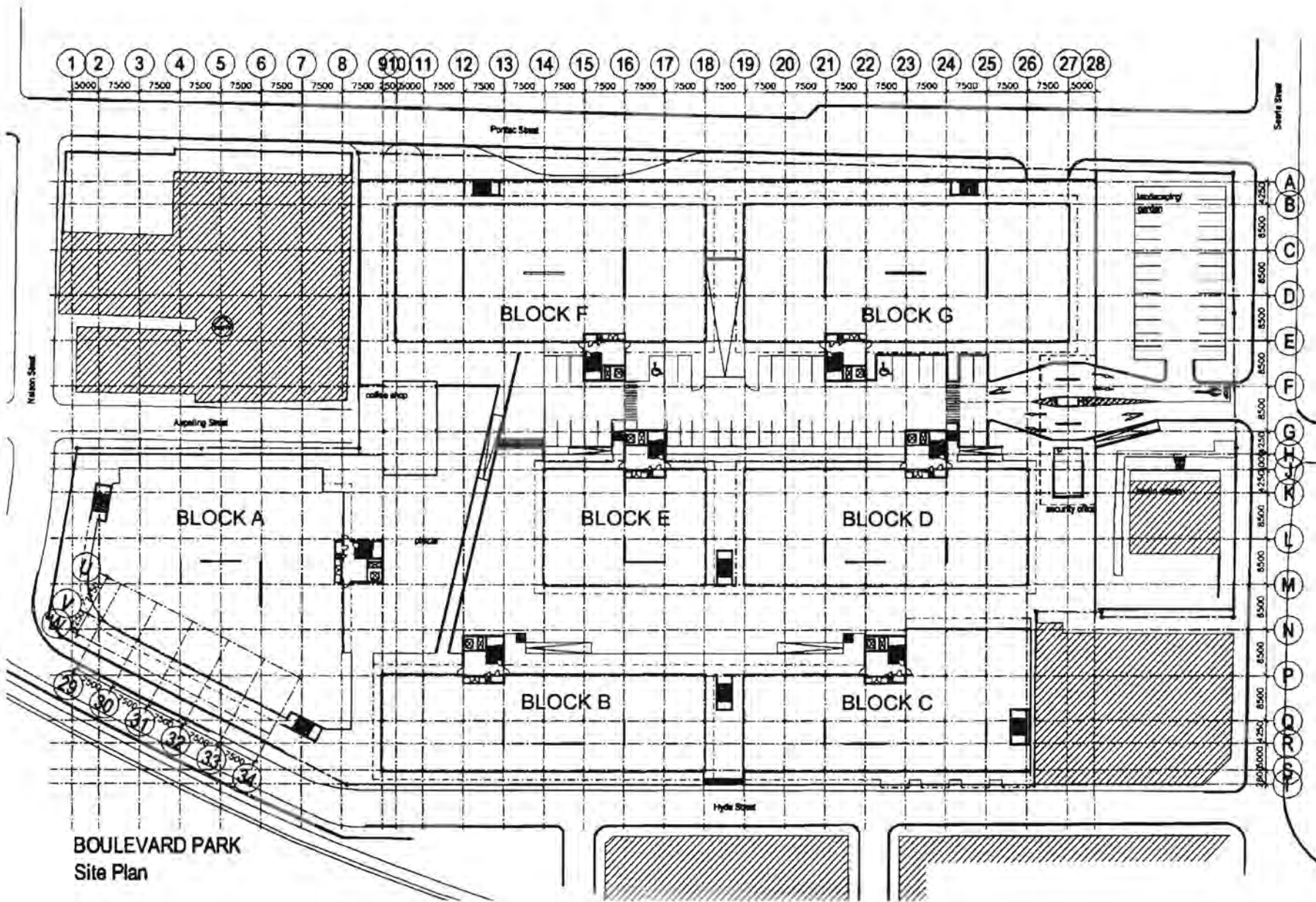
The parking is more than adequate; most residential blocks only have 1.5 parking bays for every 90m². The security would already be established. There may need to be more community functions, like a pool and laundry facilities, definitely larger green spaces. It is possible in terms of infrastructure, but it was not designed to change in that way, so it would be too expensive to do so.

RENTABLE AREA SCHEDULE

The table shows the calculations of each section of each office block. This information has helped me to understand what kind of square meterage is necessary in a big office park development. Each level is split up into office space, walkways and balconies. This separation helps to illustrate the percentages of rentable spaces versus the actual square meterage of the buildings in their entirety.

		Block A	Block B	Block C	Block D	Block E	Block F	Block G	Total
Podium	Office	1829 m ²	823 m ²	902 m ²	1174 m ²	685 m ²	1530 m ²	1595 m ²	8538 m ²
	Walkway	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²
	Balcony	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²	0 m ²
1st	Office	1708 m ²	1177 m ²	1324 m ²	1312 m ²	730 m ²	1710 m ²	1783 m ²	9744 m ²
	Walkway	86 m ²	200 m ²	49 m ²	80 m ²	106 m ²	86 m ²	86 m ²	693 m ²
	Balcony	161 m ²	0 m ²	16 m ²	0 m ²	0 m ²	0 m ²	0 m ²	177 m ²
2nd	Office	1708 m ²	1177 m ²	920 m ²	1313 m ²	730 m ²	1710 m ²	1783 m ²	9341 m ²
	Walkway	86 m ²	200 m ²	49 m ²	80 m ²	106 m ²	86 m ²	86 m ²	693 m ²
	Balcony	53 m ²	0 m ²	445 m ²	0 m ²	0 m ²	0 m ²	0 m ²	498 m ²
3rd	Office	364 m ²			1174 m ²	685 m ²	1494 m ²	1783 m ²	5500 m ²
	Walkway	0 m ²			217 m ²	151 m ²	86 m ²	86 m ²	540 m ²
	Balcony	282 m ²			0 m ²	0 m ²	216 m ²	0 m ²	498 m ²
4th	Office						1299 m ²	1493 m ²	2792 m ²
	Walkway						86 m ²	86 m ²	172 m ²
	Balcony						221 m ²	289 m ²	510 m ²
Basement	P1	14 m ²	17 m ²	17 m ²	18 m ²	18 m ²	17 m ²	17 m ²	118 m ²
	P2	14 m ²	17 m ²	17 m ²	18 m ²	18 m ²	17 m ²	17 m ²	118 m ²
	P3	14 m ²	17 m ²	17 m ²	18 m ²	18 m ²	17 m ²	17 m ²	118 m ²
	Lobbies	42 m ²	51 m ²	51 m ²	54 m ²	54 m ²	51 m ²	51 m ²	354 m ²
Total	RENTABLE	5609 m²	3177 m²	3146 m²	4973 m²	2830 m²	7743 m²	8437 m²	35915 m²
	Walkway	172 m ²	400 m ²	98 m ²	377 m ²	363 m ²	344 m ²	344 m ²	2098 m ²
	Balcony	496 m ²	0 m ²	461 m ²	0 m ²	0 m ²	437 m ²	289 m ²	1683 m ²

Figure 19 - Site Plan received from DHK Architects



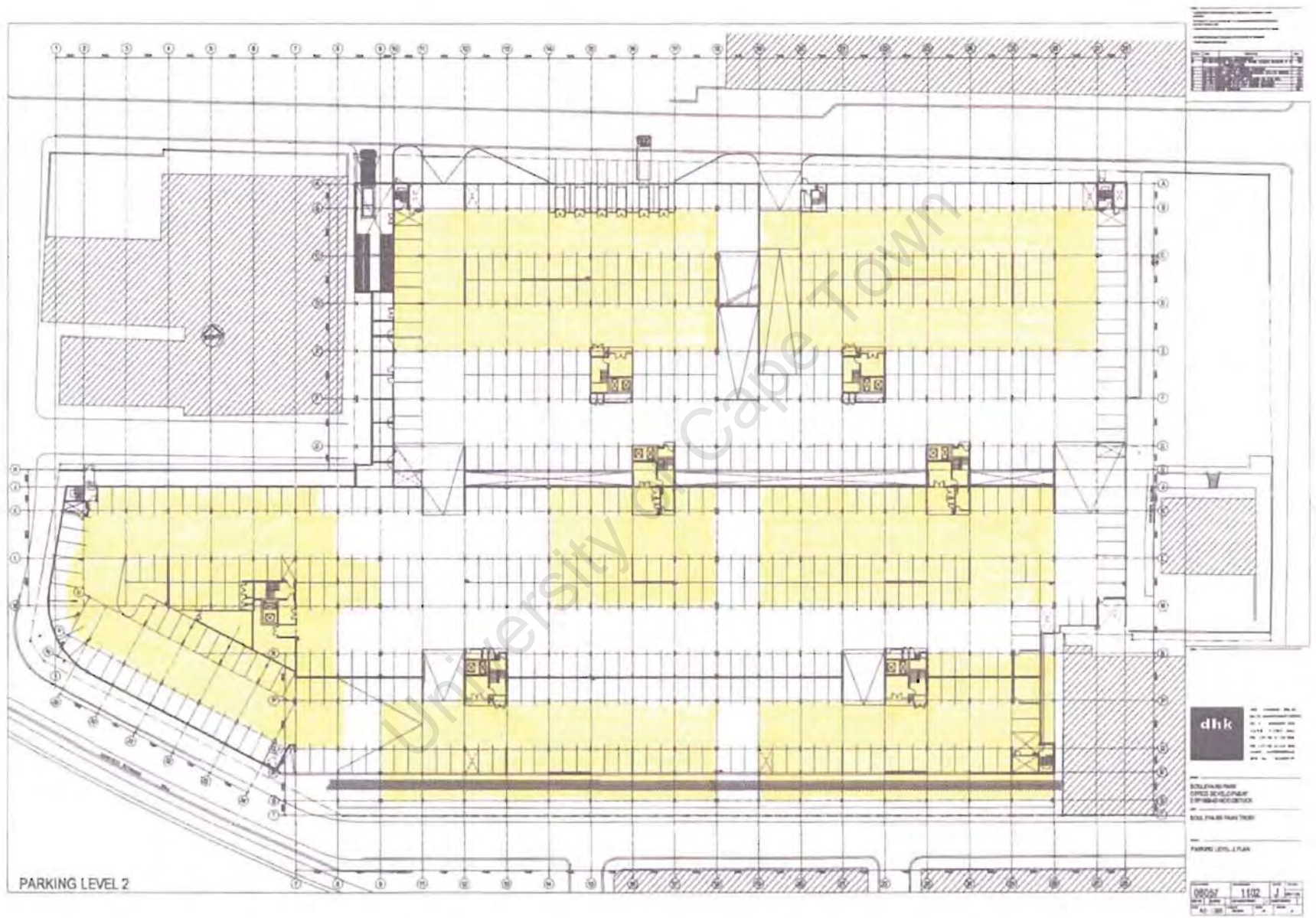
BOULEVARD PARK
Site Plan

PARKING SCHEDULE

The parking at the Boulevard Office Park Development is ± a ratio of 4 bays per every 100m². This is the only office park in Cape Town that offers this ratio. I believe this to be excessive, especially with regards to my thesis proposal. If this were to change to a residential development where the more realistic ratio is 1.5 bays per every 90m², much of this parking area would be underutilised, as underground parking is totally un-adaptable for residential purposes

PARKING	
Shop (visitors)	20 bays
Podium (visitors)	43 bays
Parking Level 1	603 bays
Parking Level 2	584 bays
Parking Level 3	602 bays
TOTAL	1852 bays
	- 200 bays
AVAILABLE	1652 bays

Figure 20 - Parking Level 2 received from DHK Architects

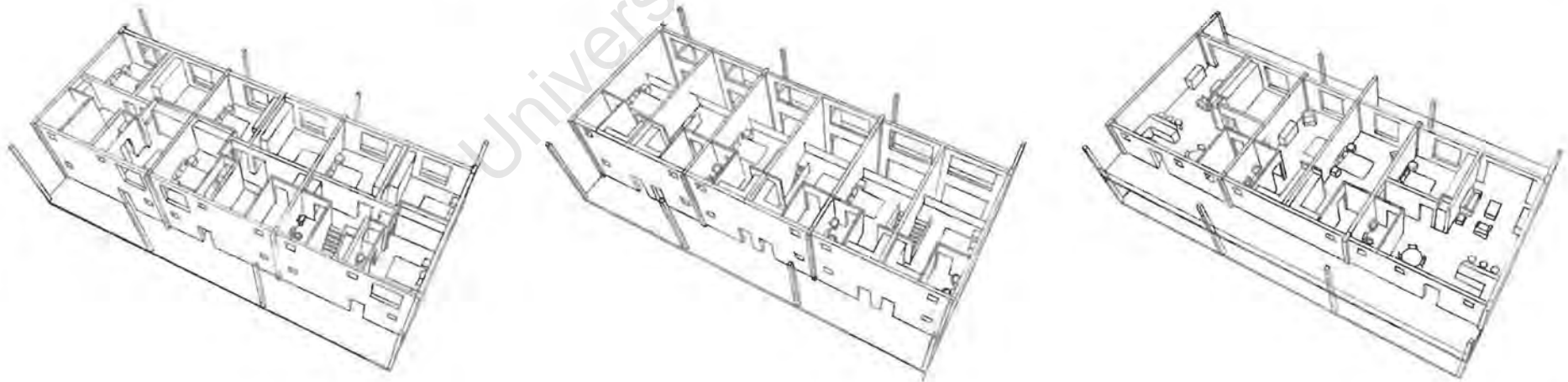


PROGRAMME AND ACCOMMODATION

The method for designing for different programmes was to break down the requirements for each programme and try to find the common links of spatial needs and layout dimensions.

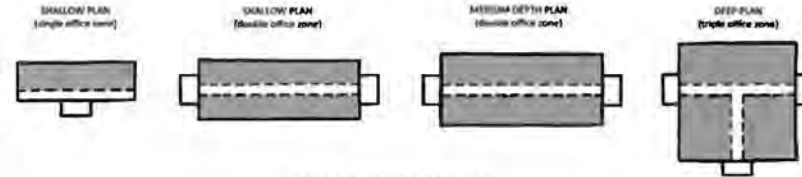
RESIDENTIAL INVESTIGATION

In the search for the perfect residential configuration and spatial sizing I had to explore various options of units, from studio apartments right up to four room apartments. I also did investigations into how one could create flexibility between units. This exploration was done in accordance with grid dimensions already decided through parking explorations.



OFFICE INVESTIGATION

Office layouts were a little easier to configure due to the amount of research I had done into office design. After looking at building layouts, I looked at 3 possible office layouts; the open plan office layout, the cellular office layout and the flexible office layout. I then organised these layout within the grid. In this programme the offices could possibly expand outwards taking over the balcony spaces for additional room.



OFFICE BUILDING LAYOUTS

FLEXIBLE OFFICE LAYOUT

The flexible office layout is a combination of open plan space, hubs and cells. This is the most popular type of office design due to the variety of spaces achieved. Often private functions and the senior employees are screened off or closed behind office doors, while the working masses are housed in the open plan space. The open plan space is also landscaped.



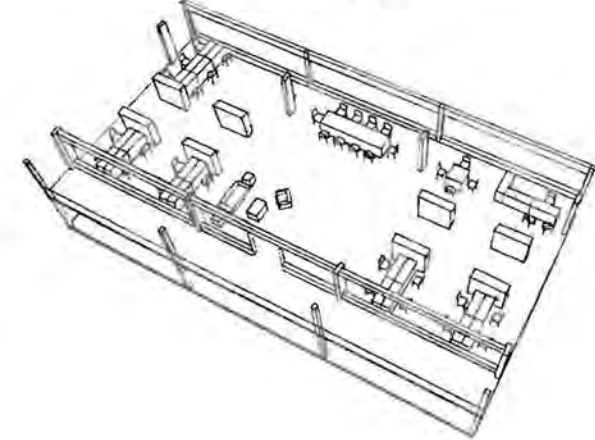
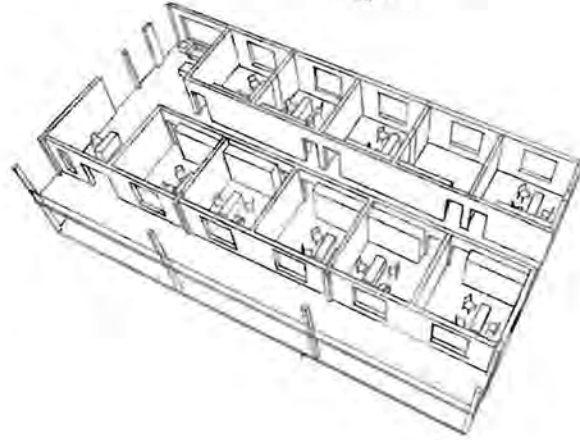
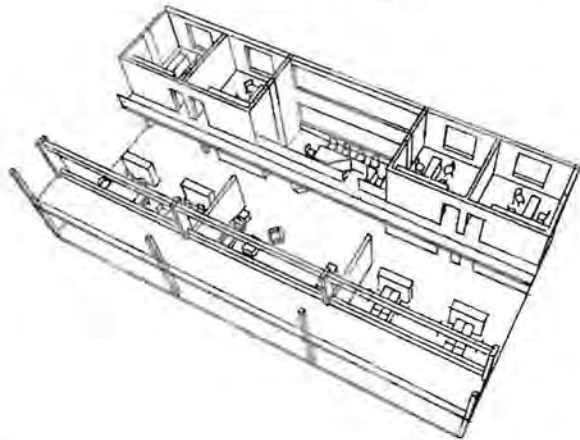
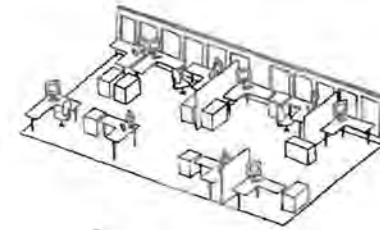
CELLULAR OFFICE LAYOUT

A cellular office is an office which has fixed walls and a door where a person would normally work on their own. Usually, one or two people work in a cellular office. It is furnished with traditional furniture, for example a desk and chair. The cells are grouped according to tasks and departments. Cells are a hierarchical way of organising office space.



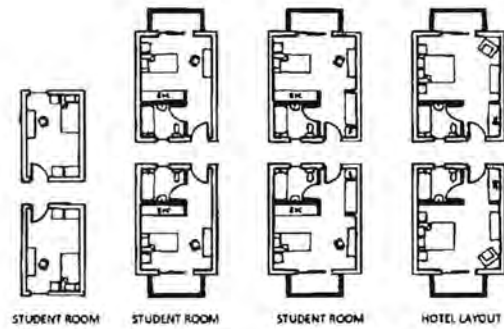
OPEN PLAN OFFICE LAYOUT

A large area where many employees work together, multiple work stations, usually designed around corresponding tasks. There are often screening devices used to separate areas of work. Sometimes temporary hubs are created for more private tasks. The term used to organise an open plan office is office landscaping.



HOTEL/STUDENT RESIDENCE INVESTIGATION

Lastly I looked at either a hotel or student residence configuration. This entailed looking up the minimum dimensions for these programmes and seeing whether it could fit into the grid I had established. I decided that I did not know enough about these programmes to include them in my thesis proposal; however I did determine that it could possibly work.



DIMENSION AND LAYOUT STUDIES

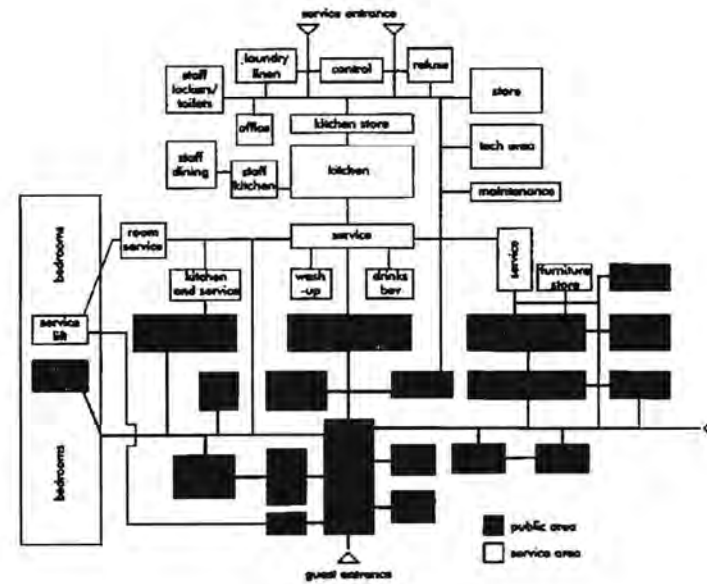
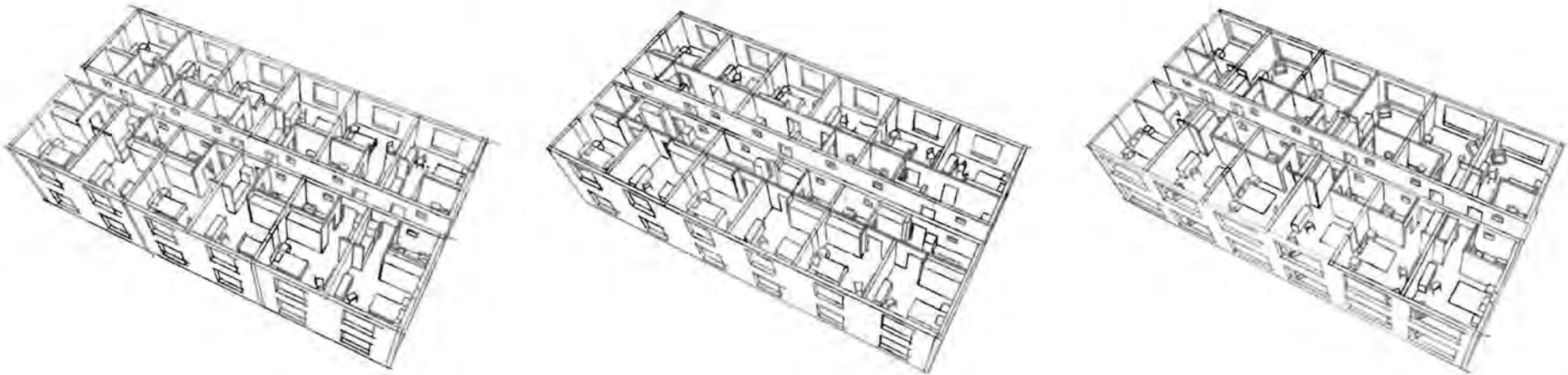


Figure 21 - Hotel Layout



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DESIGN DEVELOPMENT

The following section represents my thesis design and its development thus far.

Included in this section are early design sketches, site plan proposals, parking studies, developing ideas on the building layers and layout organisation, elevation studies and 3D model images.

The process of the design development was carried out as follows:

- Initial sketch ideas of site and social environment
- Site studies for positioning of series of buildings
- Building proximities, form and site massing
- Grid layouts (based on accommodation and programme requirements)
- Plan depth (based on accommodation and programme requirements)
- Structural design that could adapt over time according to programme layout options
- Vertical circulation, servicing and ramped parking additions
- Space plan layouts between programmes
- Cladding design that responds to different programme and solar needs

- SKETCHING IDEAS

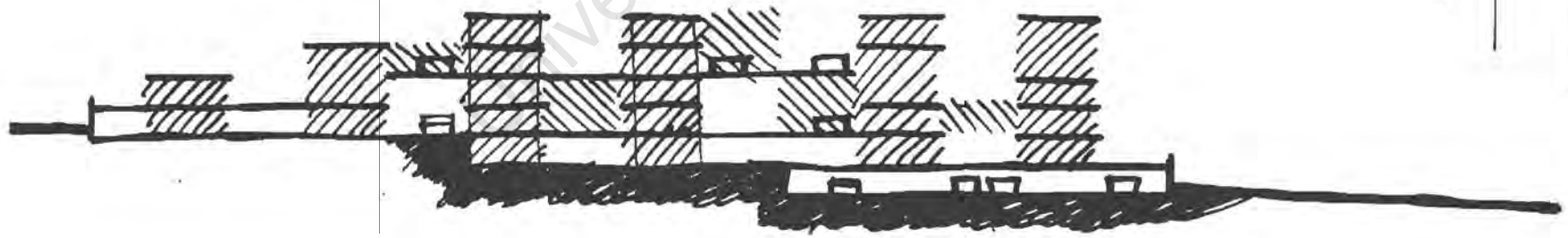
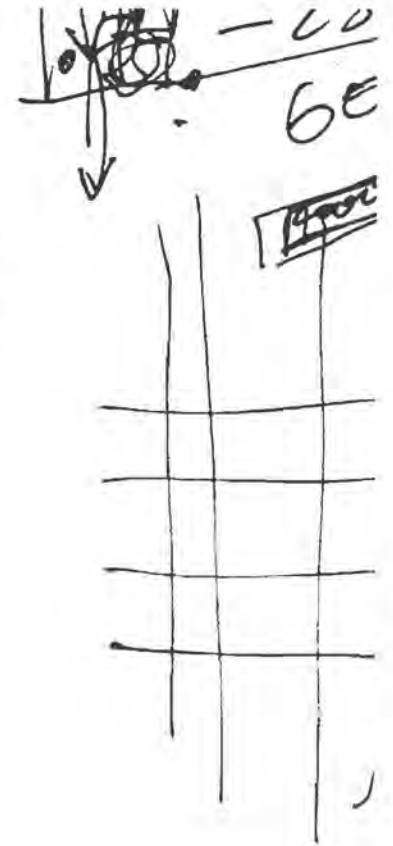
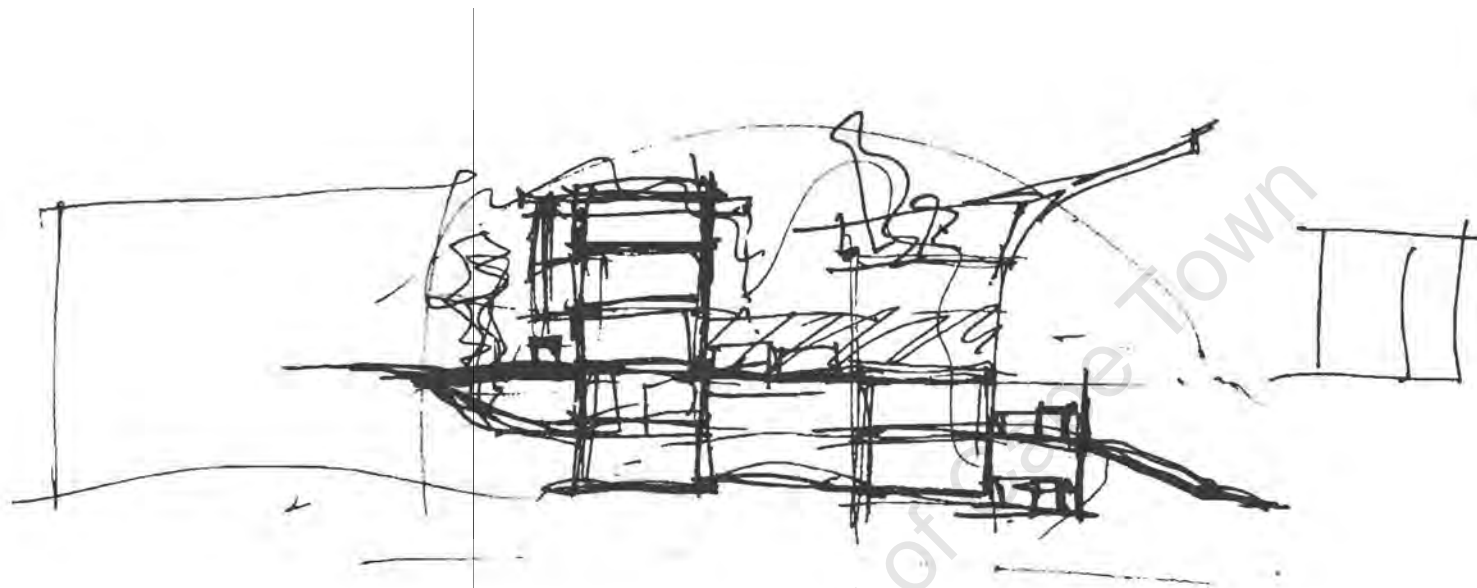
- SITE STUDY

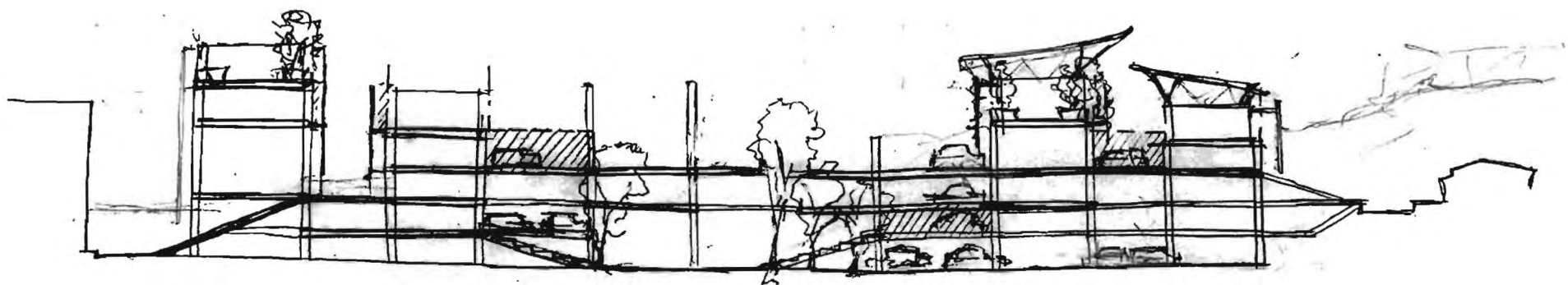
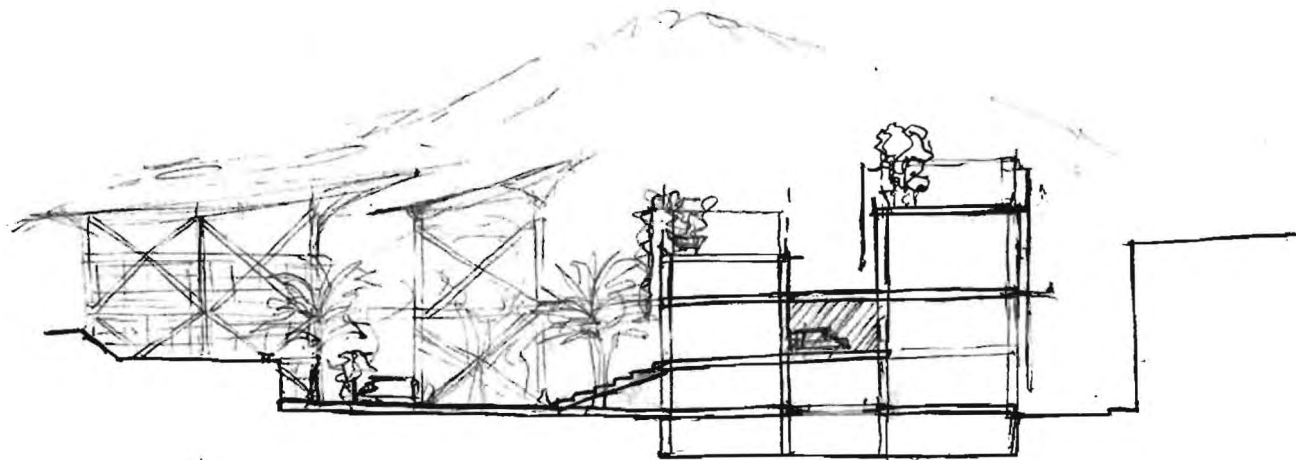
- LAYERS ORGANISATION

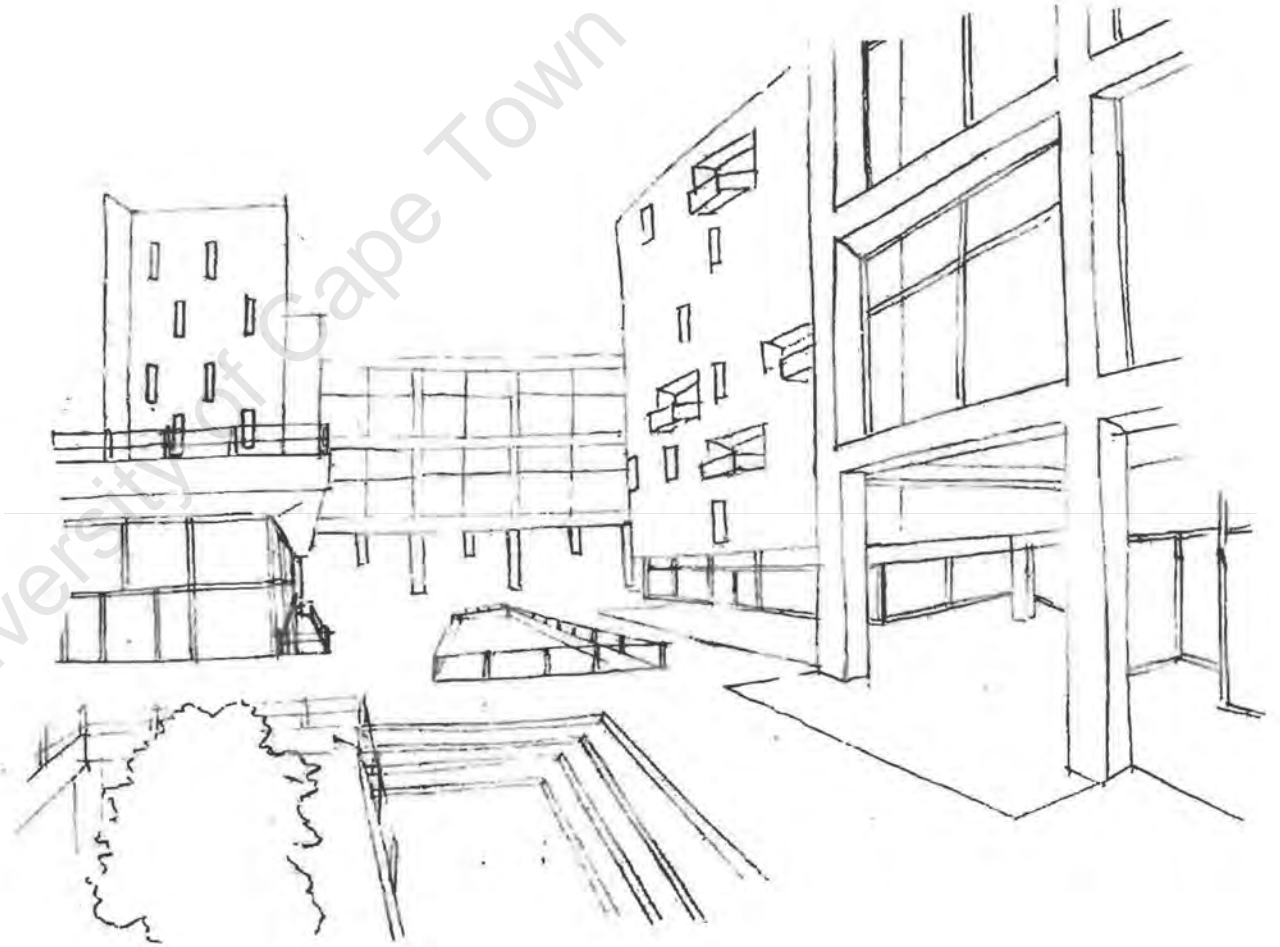
- ADAPTABLE ARCHITECTURE...

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SKETCHING IDEAS







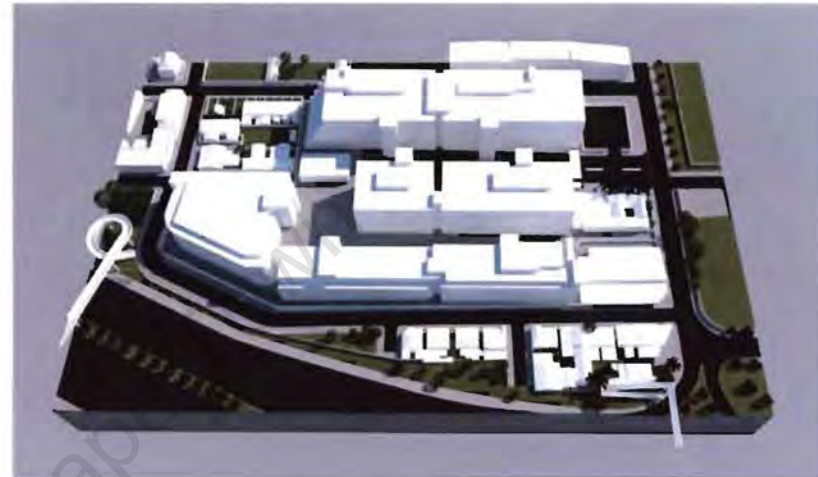
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SITE STUDY

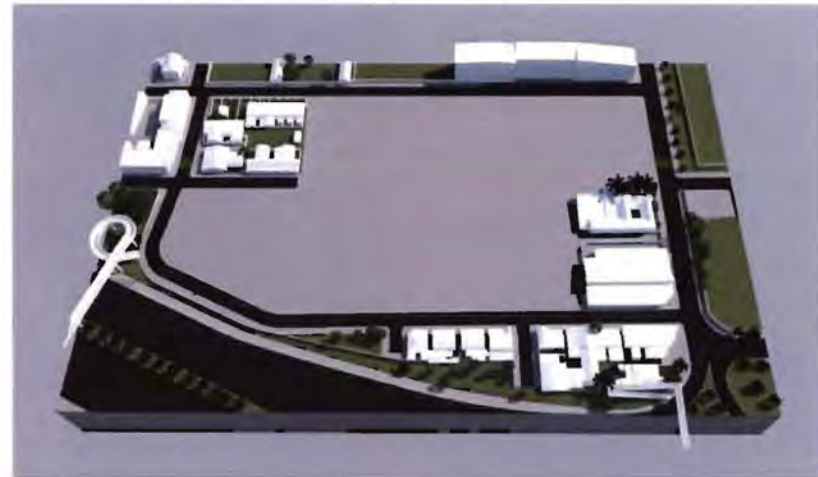
SITE LAYOUTS

The first task was to understand the site and its slope in two directions. This entailed doing a series of 3D site drawings and 3D computer modelling of the site as existing versus the site as it once was.

EXISTING SITE MODEL



SITE WITH CURRENT BUILDINGS REMOVED



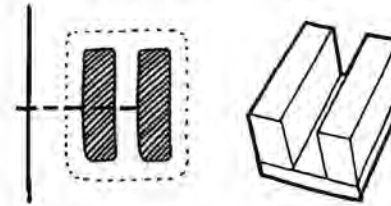
SITE LAYOUTS

There are many considerations that need to be taken into account when designing office parks, such as mixtures and sizes of units, amenity accommodation, access and control and parking spaces. Office park sites can be designed in a number of different schematic ways. These are just a few layout concepts that I used to organise the various buildings on site.

SCHEMATIC LAYOUTS

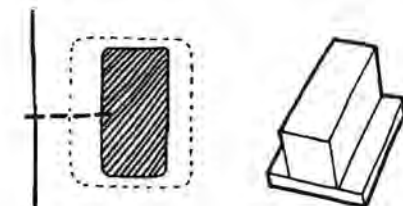
concept 1

6 - 8m wide buildings
corridor with offices on one side



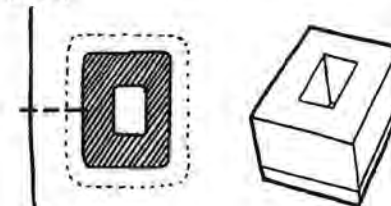
concept 2

13 - 14m wide building
corridor flanked with offices



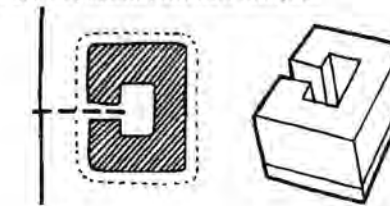
concept 3

6 - 8m wide circumference
corridor around courtyard/atrium with offices
on one side



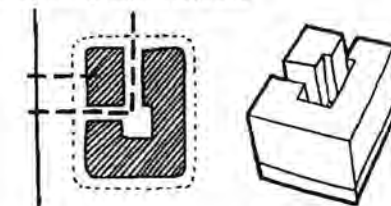
concept 4

6 - 8m wide circumference
corridor around courtyard/atrium with offices
on one side, publically accessible courtyard



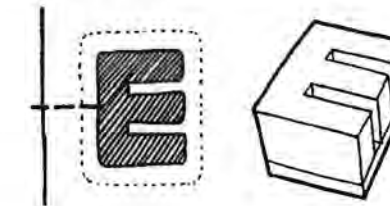
concept 5

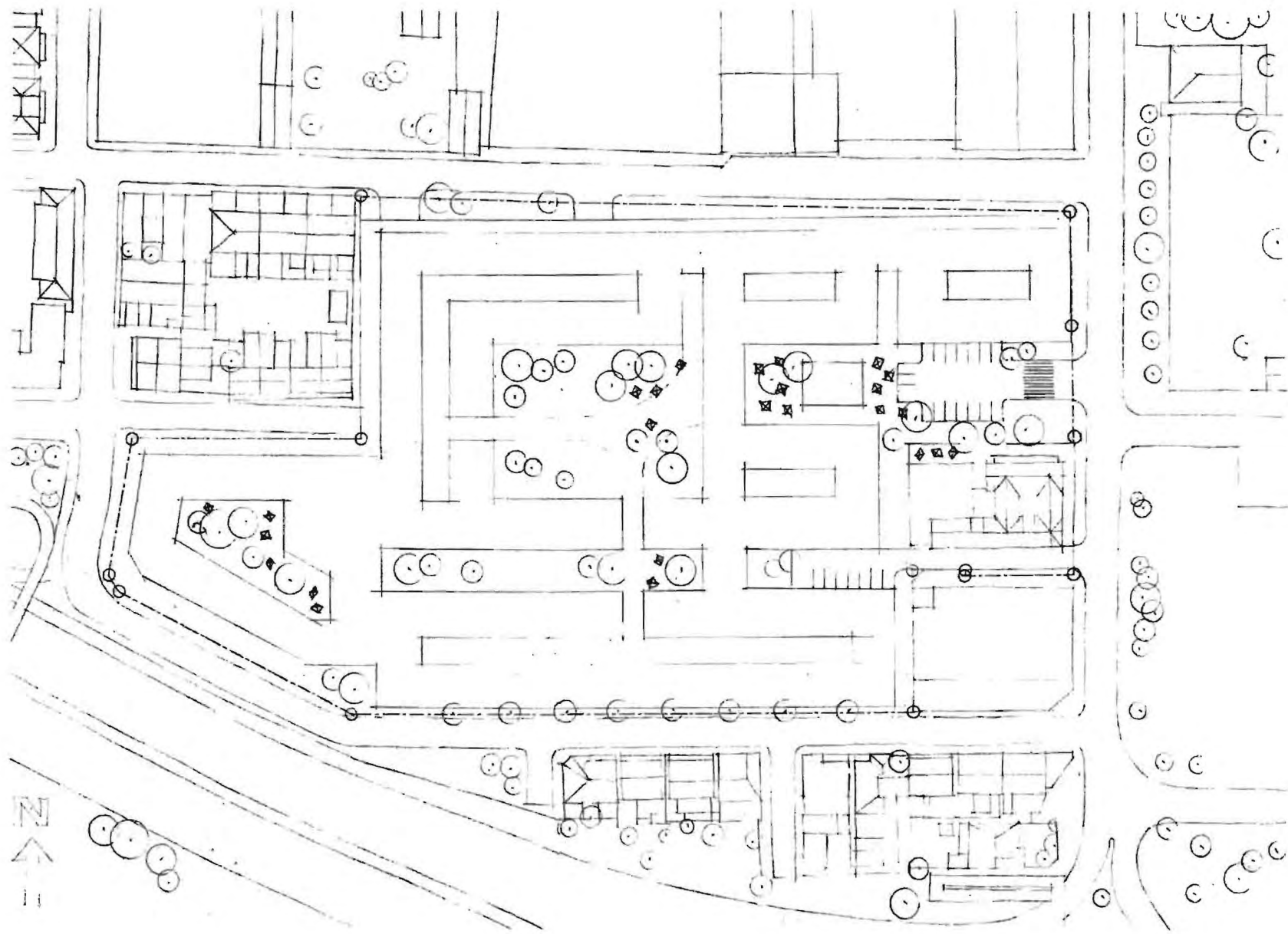
6 - 8m wide circumference
publically accessible courtyard, many access
points, buildings become separated



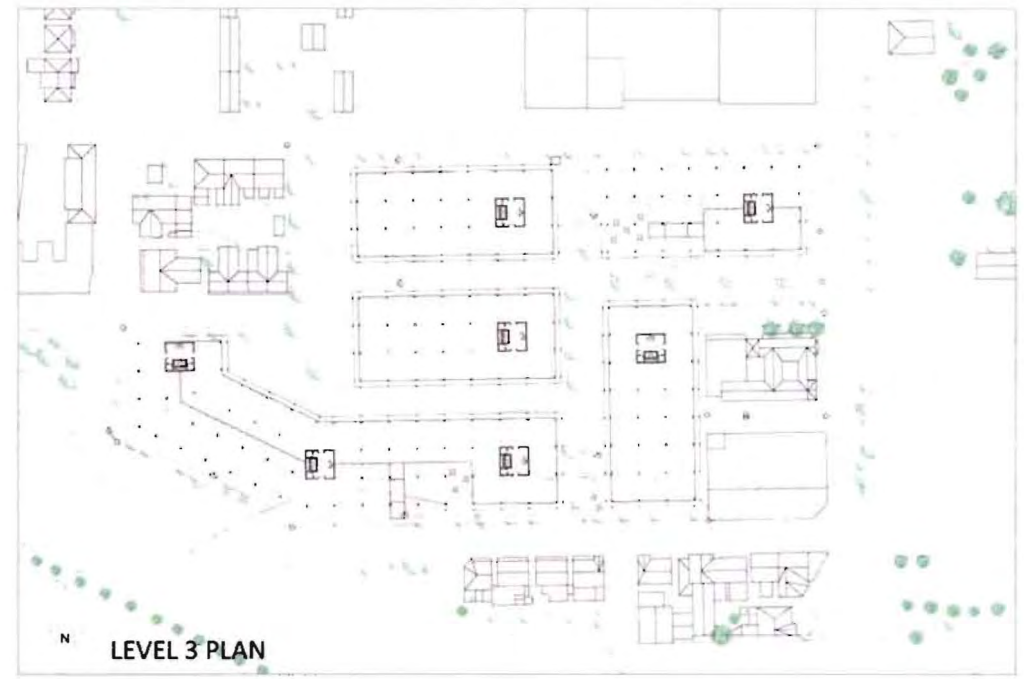
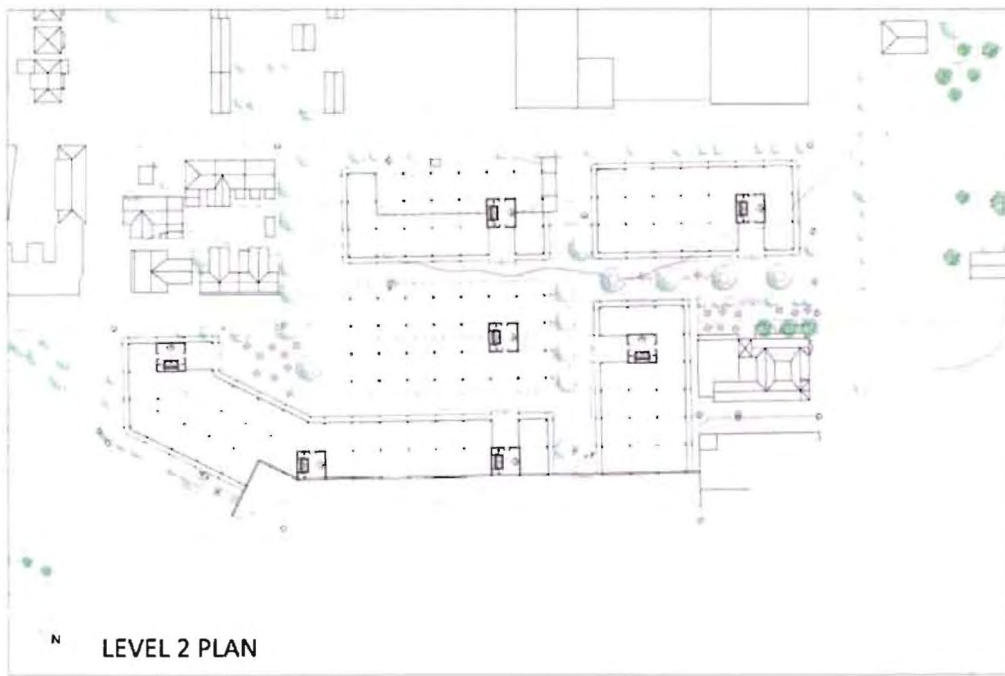
concept 6

6 - 8m wide buildings
office buildings that attach to a spine

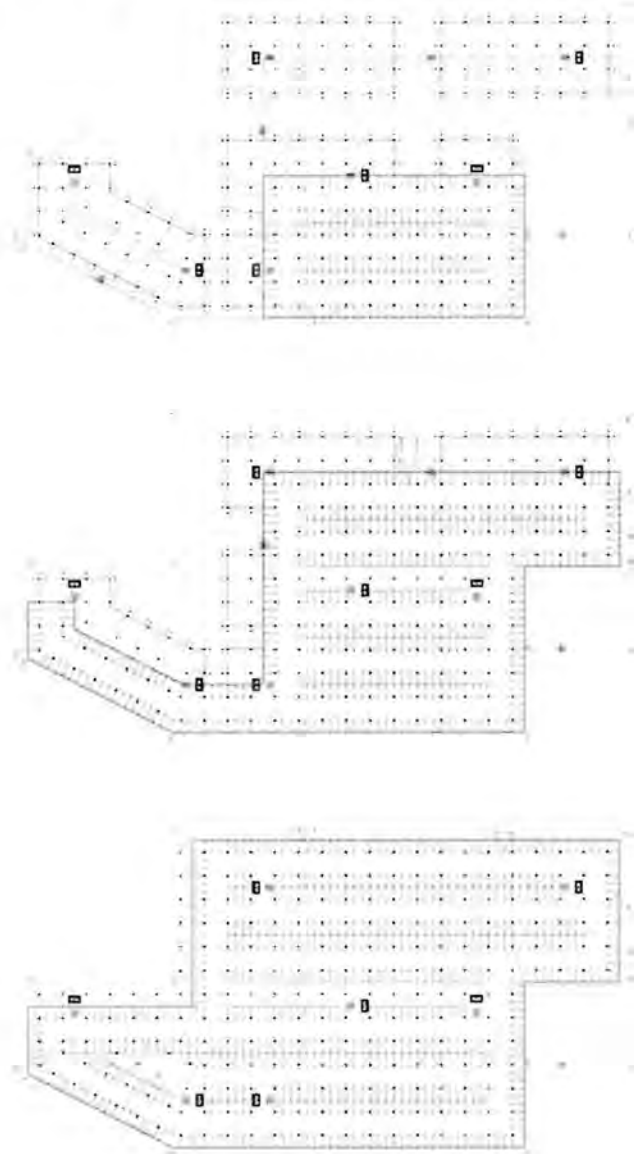






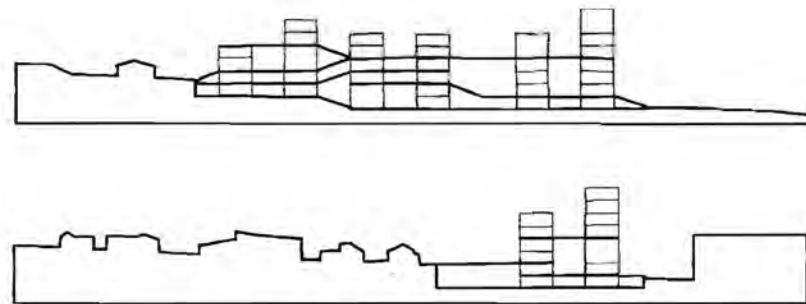


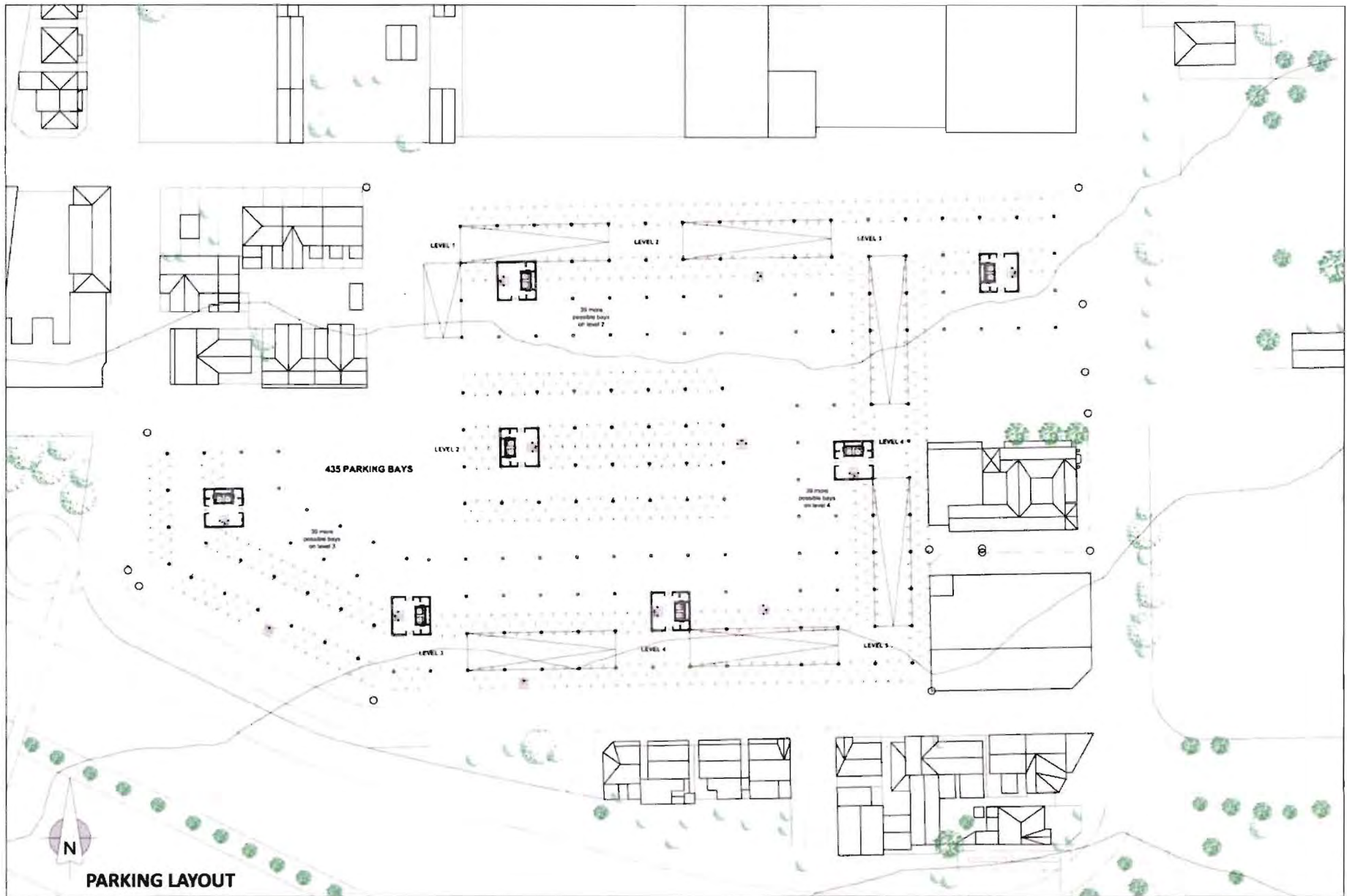
INITIAL PARKING LAYOUTS



PARKING

Parking became a real challenge because my thesis is about predicting future needs. At first I designed numerous parking levels to be able to accommodate the same number of existing bays, however I soon realised that this was not an expression of my thesis issue. In my opinion or hope, Cape Town's public transport system will become more frequently used and private vehicles used less and less, therefore large parking levels such as those at the Boulevard Office Park Development could become redundant. So how does one design parking for today that can be converted to feasible rentable space tomorrow, being re-programmed from vehicles to people? The obvious answer was that in order for parking to be fully adaptable, it must be above the ground. So I started to look at various ramping options that could possibly be removed as the need for parking bays gradually decreasing with the increased need for rentable space. This way meant that the parking became a temporary time-based layer and no longer dominated the design layout.



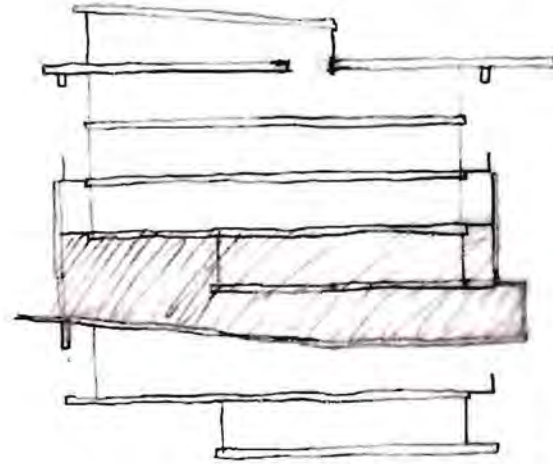


PARKING LAYOUT

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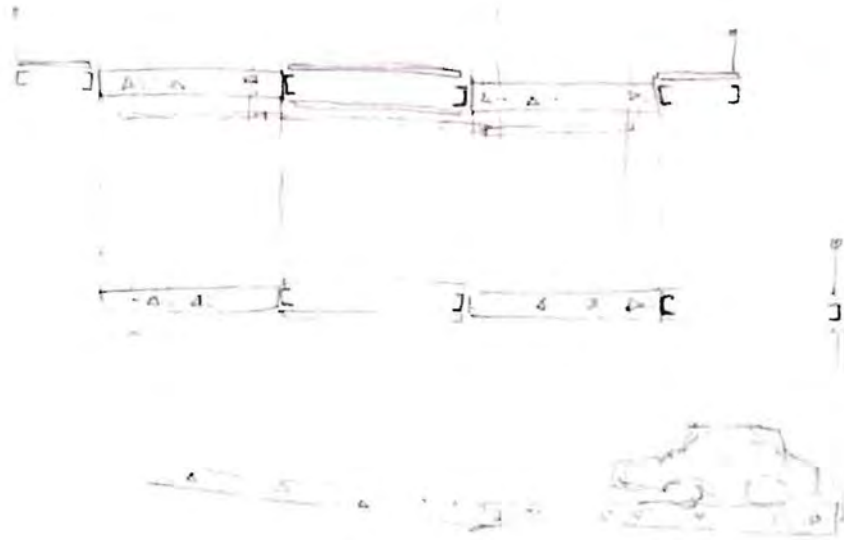
LAYERS ORGANISATION

After establishing the grid system on site, based on the correct parking dimensions and programme requirements, the next step was to develop the rest of the time-based layers of structure, services, circulation, skin, space plan and stuff.

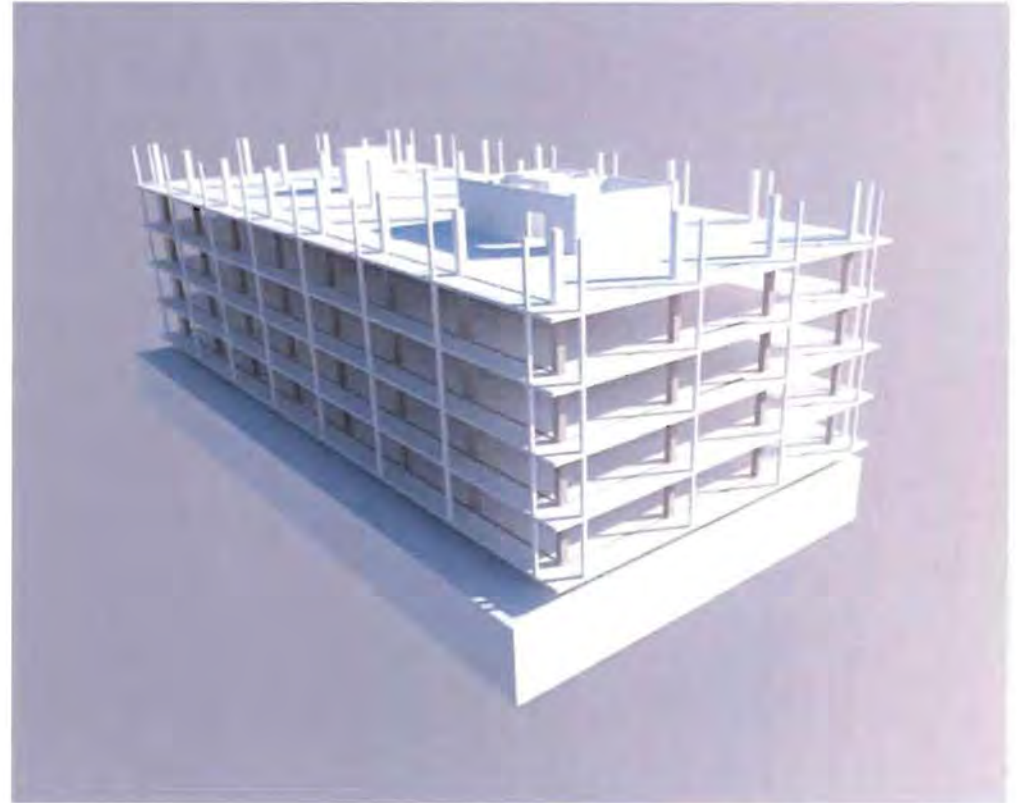


THE ADAPTABLE STRUCTURE

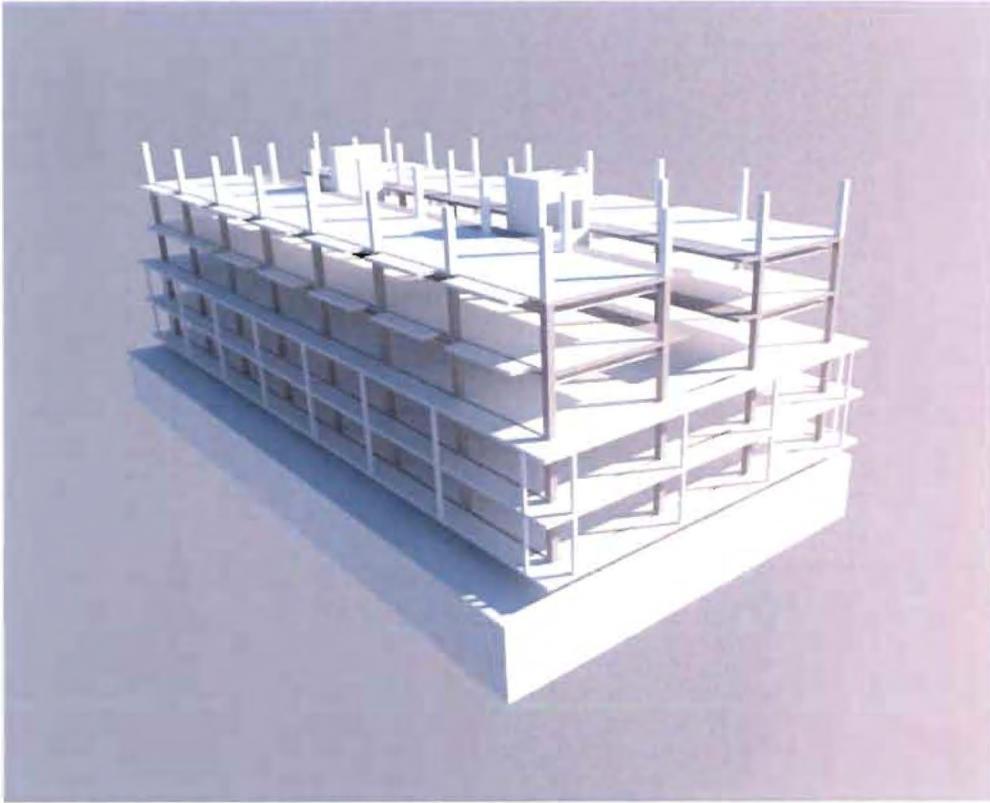
The structure has to be able to adapt easily from office space to residential units without demolition, therefore all circulation, services, skin and space plan needs must be in place and accommodate all requirements.



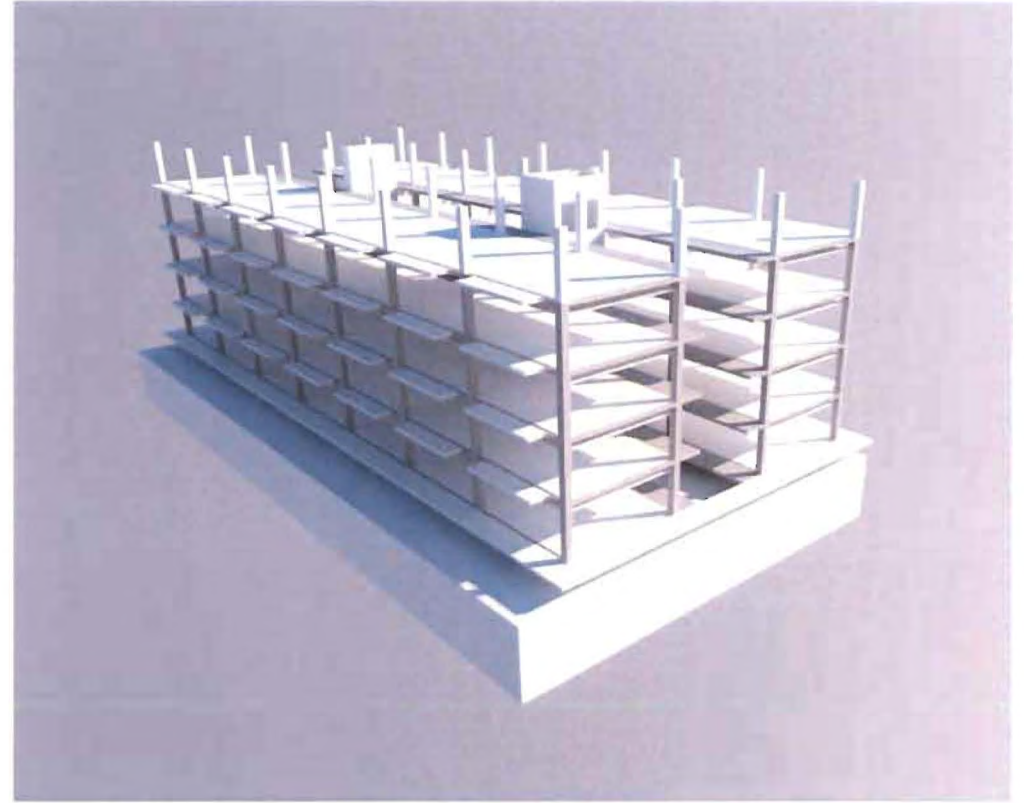
OFFICE PHASE



TRANSITIONAL PHASE



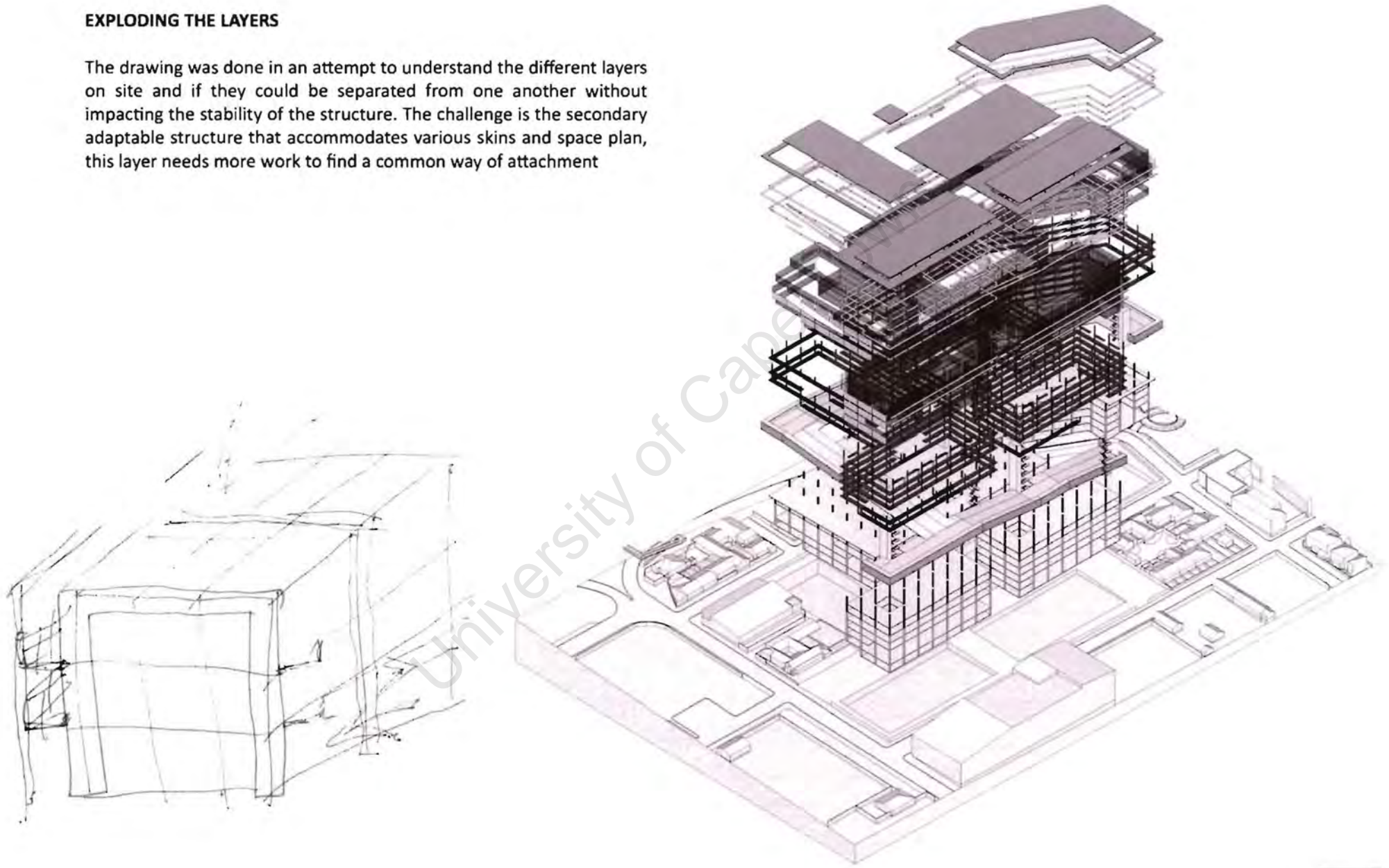
RESIDENTIAL PHASE

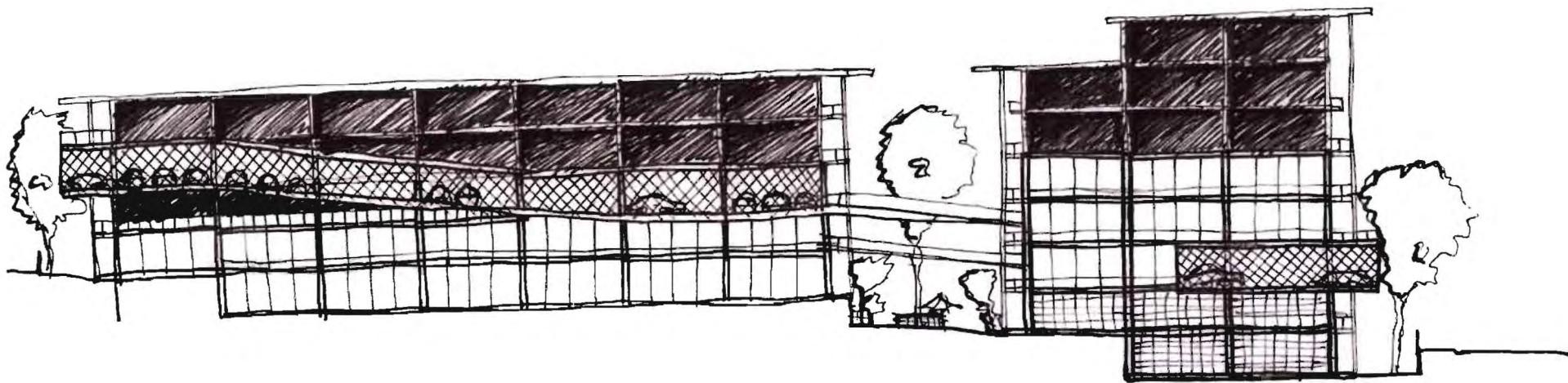
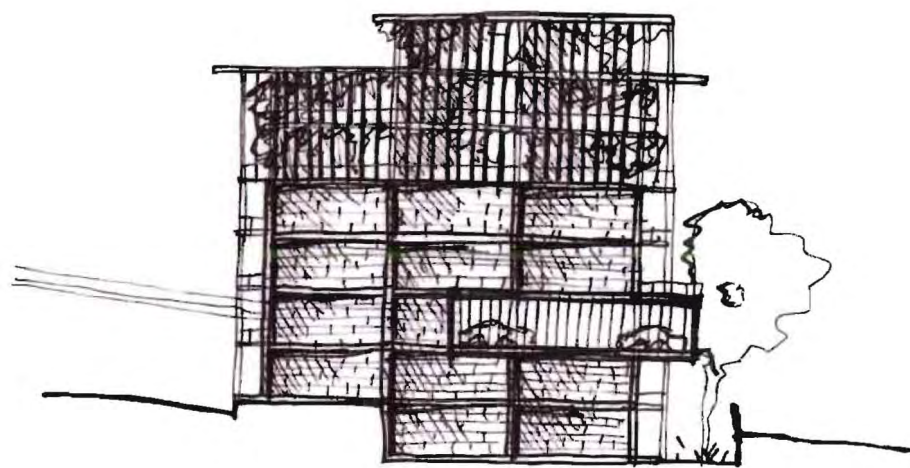
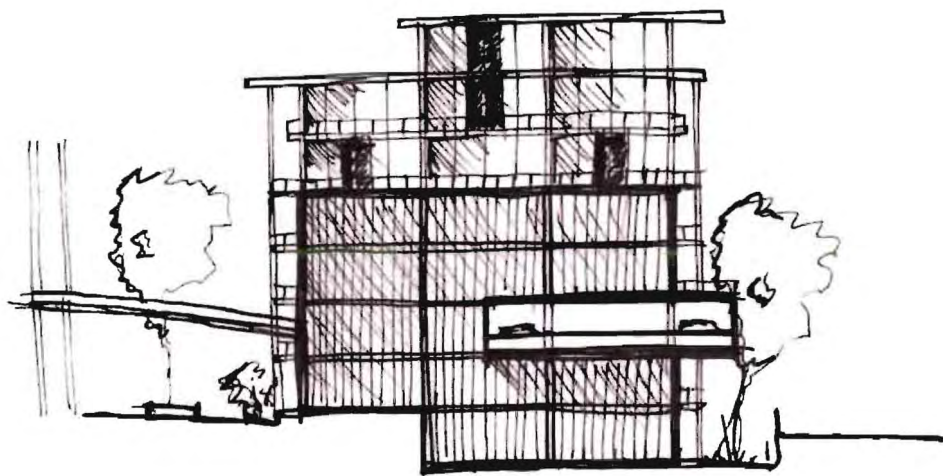


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EXPLODING THE LAYERS

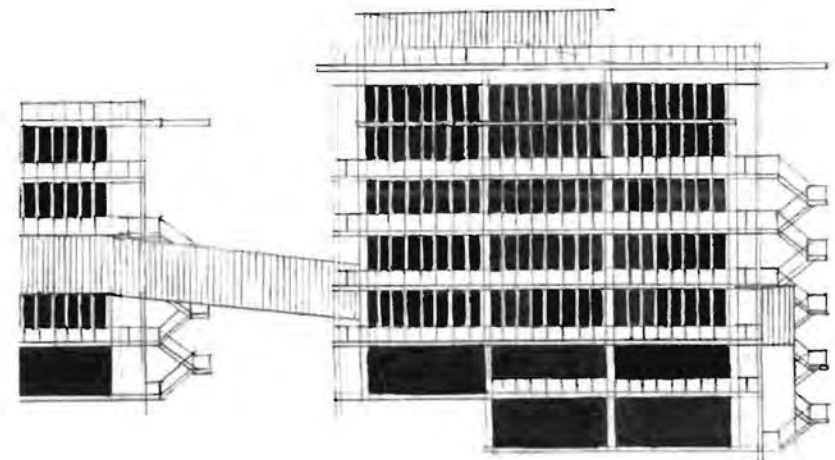
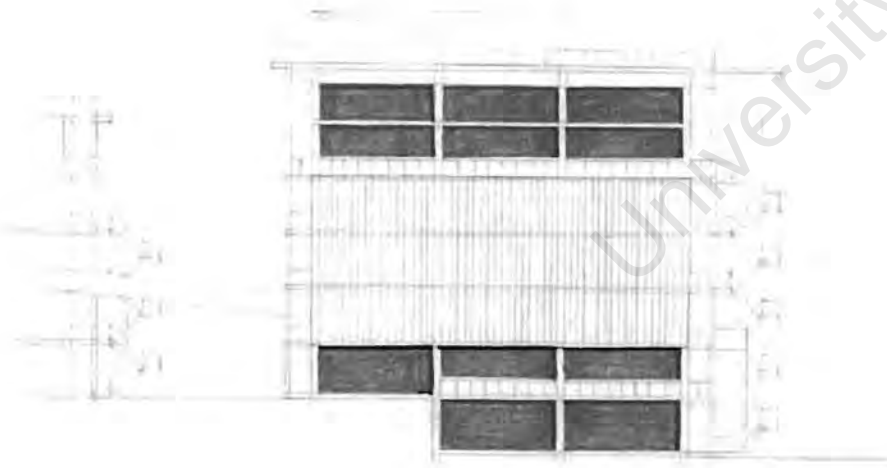
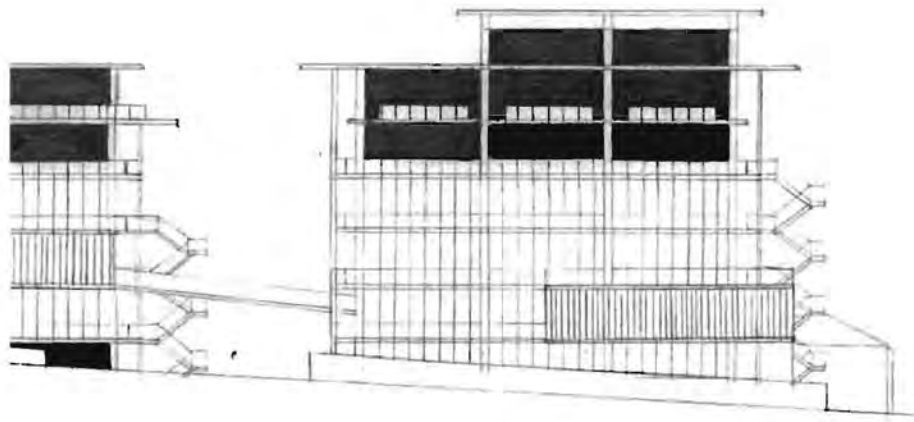
The drawing was done in an attempt to understand the different layers on site and if they could be separated from one another without impacting the stability of the structure. The challenge is the secondary adaptable structure that accommodates various skins and space plan, this layer needs more work to find a common way of attachment



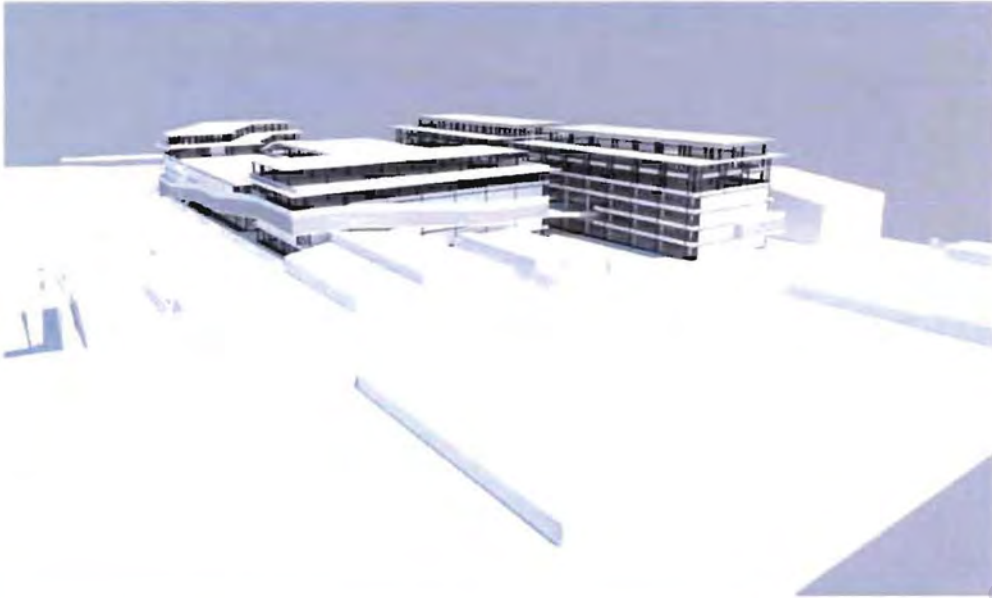


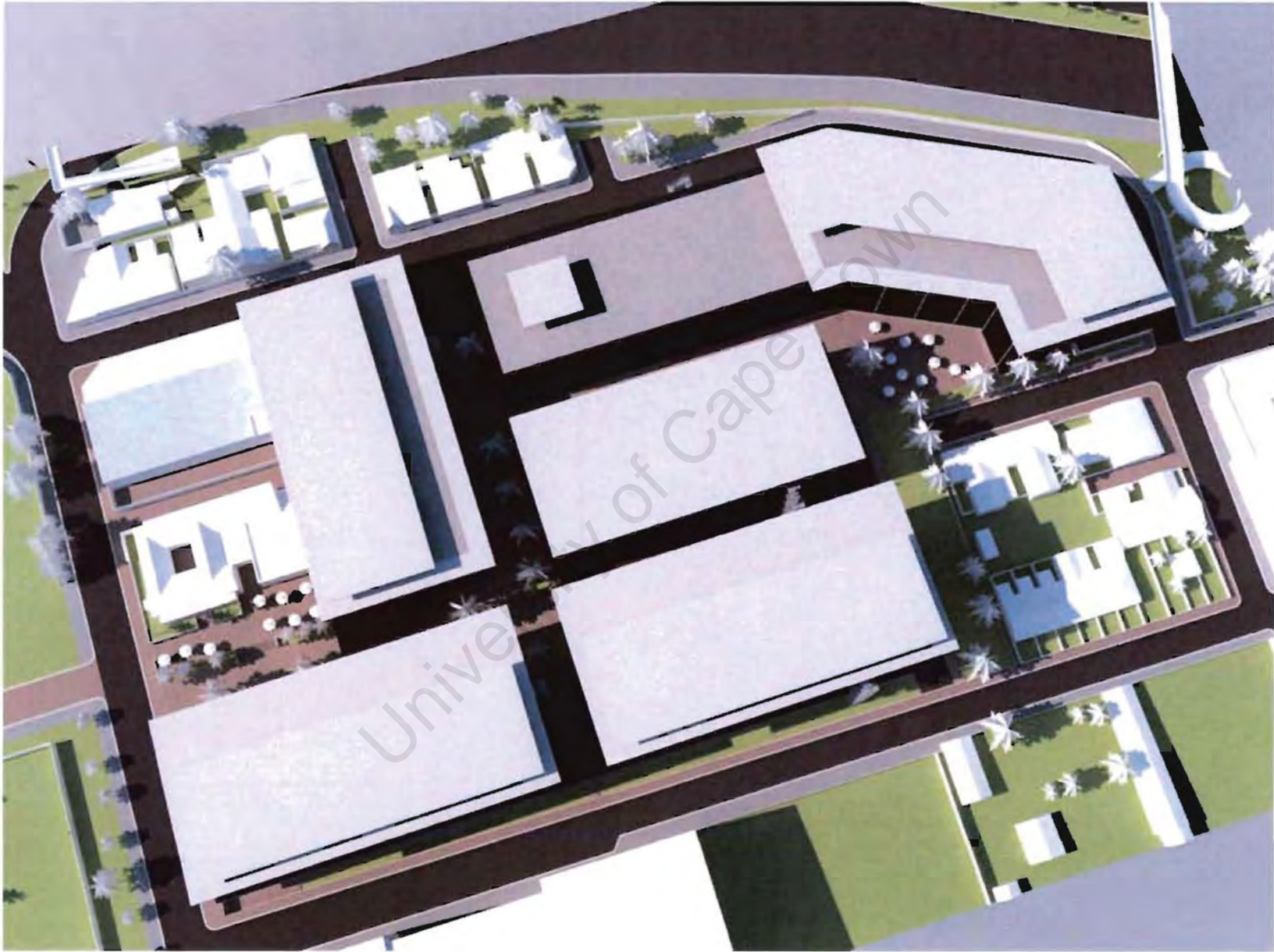
ELEVATION STUDIES

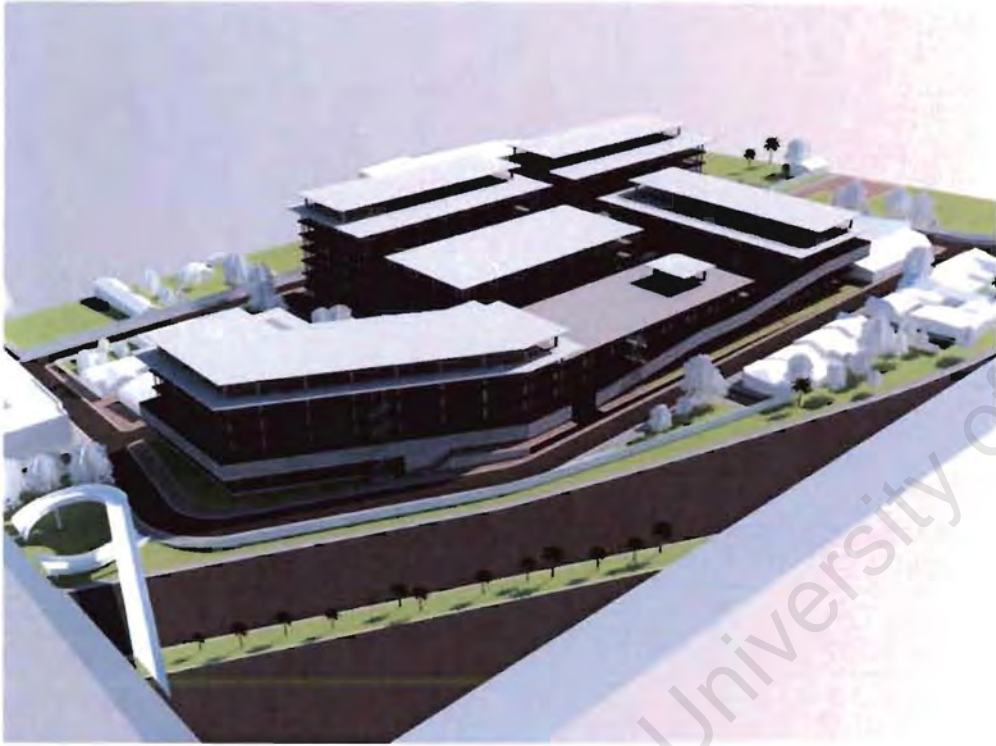
This is a series of elevation studies to illustrate the various ways in which the building could adapt and take on many different skins or solar shading devices.



ADAPTABLE ARCHITECTURE...







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REFERENCES

- Brand, S. 1994. *How Buildings Learn: what happens after they're built*. London: Penguin Books
- Duffy, F. 1966. *Office Landscaping*. London: Anbar Publication Ltd.
- Duffy, F. 1997. *The New Office*. London: Conrad Octopus Ltd.
- Fassbinder, H. & Van Eldonk, J. 1990. *Flexible Fixation*. Van Gorcum Assen Maastricht: Eindhoven University of Technology
- Price, C. 1962. *Activity and Change*. Archigram 2
- Schroeder, U. 1979. *Variabel nutzbare Hauser und Wohnungen, Grundrizzlosungen, anpaszbar an Familiengrosze und Lebensform*. Berlin: Wiesbaden Bauverlag
- Scott Brown, D & Venturi, R. 2004. *Architecture as Signs and Symbols: for a Mannerist Time*. London: Harvard University Press
- *The Square Book*. Cedric Price. New York: Wiley-Academy
- van Zwol, J. 2005. *Time-based Architecture*. Rotterdam: 010 Publishers
- Retrieved October 23, 2011, from www.collinslanguage.com
- Retrieved: October 23, 2011, from www.habraken.com/html/open_building.htm
- Retrieved: October 23, 2011, from www.open-building.org/ob/concepts.html

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FIGURE REFERENCES

- Figure 1: Fassbinder, H. & Van Eldonk, J. 1990. Flexible Fixation. Van Gorcum Assen / Maastricht Eindhoven University of Technology. p. 14
- Figure 2: Fassbinder, H. & Van Eldonk, J. 1990. Flexible Fixation. Van Gorcum Assen / Maastricht Eindhoven University of Technology. p. 16
- Figure 3: Fassbinder, H. & Van Eldonk, J. 1990. Flexible Fixation. Van Gorcum Assen / Maastricht Eindhoven University of Technology. p. 16
- Figure 4: Retrieved: October 25, 2011, from [www.radionetherlands.nl/features/cultureand history/rietveld001214.html](http://www.radionetherlands.nl/features/cultureand%20history/rietveld001214.html)
- Figure 5: Steele, J.2002. Eames House: Charles & Ray Eames. London: Phaidon. p. 30
- Figure 6: The Square Book. Cedric Price. New York: Wiley-Academy. p. 40
- Figure 7: The Square Book. Cedric Price. New York: Wiley-Academy. p. 60
- Figure 8: Kroll, L. 1988. Lucien Kroll: Buildings and Projects. London: Thames and Hudson Ltd. p. 47
- Figure 9: Brand, S. 1994. How Buildings Learn: what happens after they're built. London: Penguin Books. p. 13
- Figure 10: Jenkins, D (ed). 2007. Foster 40. New York: Prestel Publishing. p. 66
- Figure 11: Powell, K. 2006. Richards Rogers: Architecture of the Future. Italy: Birkhauser. p. 97
- Figure 12: Moore, R. 1993. Structure, Space and Skin: the work of Nicholas Grimshaw & Partners. Hong Kong: Phaidon Press Ltd. p. 167
- Figure 13: Powell, K. 2006. Richards Rogers: Architecture of the Future. Italy: Birkhauser. p. 244
- Figure 14: Moore, R. 1993. Structure, Space and Skin: the work of Nicholas Grimshaw & Partners. Hong Kong: Phaidon Press Ltd. p. 193
- Figure 15: The British Council & the authors. 1991. British Architecture Today, six protagonists. Milano: Electa. p. 97
- Figure 16: Lambot, I (ed) 1989. Norman Foster, Foster Associates, Buildings and Projects Vol. 3 1978 – 1985. Hong Kong: Watermark Publications. p. 44
- Figure 17: Retrieved: October 25, 2011, from www.googlemaps.co.za
- Figure 18: Retrieved: March 29, 2011, from DHK Architects
- Figure 19: Retrieved: March 29, 2011, from DHK Architects
- Figure 20: Retrieved: March 29, 2011, from DHK Architects
- Figure 21: Pickard, Q (ed). 2002. The Architects' Handbook. London: Blackwell Publishing. p. 143