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D E S I G N D E V E L O P M E N T

P R O J E C T O B J E C T I V E S

The establishment of functional and spatial networks through the city with the common nexus as the CUBE facility, remains the core objective of the project. The following networks have been identified in the design formulation and have been deemed suitable for implementation.

CBE and Council Headquarters
Built Environment Network
Future Development Plan Exhibition
University Student Partnerships
School Education Network
Construction Network
Research and Information Hub
Historical City Network

Through the following chapters these relationships will be developed into physical and functional form which will establish CUBE as the public interface with the city and the built environment.

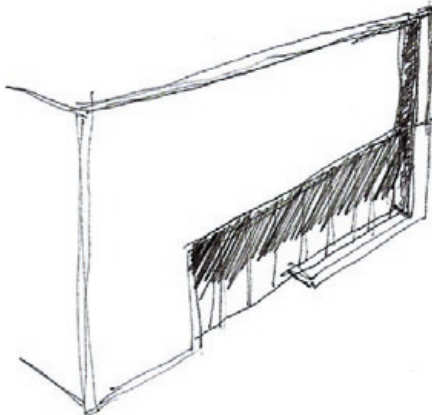


Fig.9_01.Concept mass sketch

D E S I G N C O N S I D E R A T I O N S

F U N C T I O N S

A R C A D E

- Width for adequate comfort and usage.

Preliminary provision for the full construction width of the arcade was taken at 5m. This includes the support and glazing systems used to contain and protect the arcade walkway.

The pattern Public Thoroughfare (Alexander, 1977) examines the psychological requirements for the users of arcades in respect of width.

“Since the likelihood of three people passing three people is not high, we consider as a maximum two people passing two people, or three people passing one person. Each person takes about two feet; there needs to be about one foot between two groups which pass...” Alexander, 1977

These estimates put the total width for a four person wide arcade at 11 feet or 3.3m. Further research into the width variations of existing arcade systems around the world range from 2.7m to over 4m. (Adler, 1999)

Thus a desired width for the arcade was taken initially at 3m internally, allowing a 1m distance for the structure and glazing of the arcade on each side.

- Structure

The column grid through the building became the main determining factor in the structural decisions regarding the arcade. Initially the entire site width was equally divided into a rectilinear grid of column supports, with columns running along the edge of the site boundary.

This approach was later rejected and altered to provide the same column spacing but shifted across to create a cantilevering slab edge. This would reduce the column count, provide a better bending

moment solution in the slab and eliminate possible problematic construction of structure near to existing buildings around the site.

From this last point, an alteration to the support structure of the arcade was required. Initially the arcade framework was to utilise the same structure as the rest of the facility. Since the problem of casting structural members so close to existing buildings was quite evident, it was decided that the arcade would need to obtain its support from the building framework, rather than support itself. This fell in line with a design objective to create a very transparent space between the facility and the adjacent building.

A steel framework box was designed to fix onto the one side of the load-bearing concrete structure of the facility, within which the arcade would be able to be contained, supported and served.

This solution serves to alleviate any costly construction techniques and continue the effect of cantilevering on the one side, aiding the bending moment through the slabs.

- Height

“...a comfortable distance between strangers is the distance at which you cannot distinguish facial features...this distance as being between 12 and 16 feet. Thus, the ceiling height in an indoor street should be at least in this range.” Alexander, 1977

Using this premise as the basis for an arcade height, an initial height of 4.8m was aimed for.

The ratio of width to height however in enclosed spaces is critical in determining the psychological and emotional feeling of the user within that space. The degree of visible enclosure also contributes to the experience of such a space.

“...the higher the ceiling, the more distant people seem from each other” Alexander, 1977

With this in mind, the design objective required as ‘sensitive a touch’ between the facility and the adjacent building. The arcade has the possibility of becoming extremely claustrophobic to the users so to combat this, the initial height of the arcade was increased to

6.5m. In so doing a width to height ratio of 1:2 was created which helps to alleviate any phobic sense within the space. With the main material identified as glass to aid the penetration of light, the degree of enclosure is somewhat hidden, further combating any sense of claustrophobia.

- Lighting

During the day, natural lighting will be the main source of illumination in the arcade. Due to the extensive use of glass work with lighting in mind, the only provision may need to be for shading devices to prevent direct penetration of solar radiation.

At night, illumination will be provided through floor lighting under the arcade walkway and luminaires built into the ceiling glass work of the arcade. Sand blasted polycarbonate sheeting will provide adequate ambient glow illumination of the walkway. The polycarbonate sheets will be secured with countersunk head bolts which can be removed to replace the luminaire bulbs once expired.

- Ventilation

As a public space with open air access at both ends of the arcade, natural ventilation will be the primary method of air circulation. With the additional height increase of the arcade creating a double volume through the arcades length, sufficient flow of air will be achieved.

The warmest air would be found at the central corner of the arcade. Heated air generates a low pressure through the expansion of air molecules which should create airflow into the arcade from a relatively cooler, higher air pressure state outside the arcade. This air inflow will require an outlet to achieve circulation.

The access route into the courtyard from the arcade will act as this outlet for air flow, enabling each arm of the arcade to act independently of each other.

- Access

A public arcade requires that it be open and accessible throughout the entire day and night. At present, some arcades in Pretoria are closed over weekends and after certain times during the day which restricts

pedestrian flow and the subsequent experience of the city.

The arcade has thus been designed to operate independently of the facility and remain accessible even when the building may not be. This goes directly to the success of the project as routes through the city require reliability in order to remain in use.

The arcade must remain accessible to all people including those with disabilities. Extremely low slopes allow for full accessibility and surface water drainage; walkway surfacing providing sufficient footing grip to pedestrians even when wet and sufficient lighting to light route to the partially sighted. Arcade width additionally allows for wheelchair usage and sizeable deliveries to the entrance of the adjacent building.

- Drainage

Public routes become polluted and dirty through use and provision for cleaning must be made especially with surface water runoff drainage required. Parts of the arcade near the entrances will also be exposed to external weather and will require sufficient drainage should it rain to prevent surfaces from becoming slippery or damaged through standing water pools.

- Fire safety/evacuation

High importance must be given to the fire behaviour of any structure should a fire be started within it.

The arcade, with the design emphasis being light and sensitive, has support members reduced to a minimum to give a maximum feeling of openness. This however negatively impacts on the ability of the structure to resist fire.

Steel and glass are the two materials used and both have limited resistance to fire. Thus additional measures will need to be taken to improve their performance in this regard.

Specified glass within the arcade to be of safety glass type, multi-layered for additional strength with epoxy bonding between panes to improve safety should the glass crack or break.

The supporting steelwork is to be painted with fire resistant paint. Critical supports and joints may need

to be encased in concrete or a more resistant material. Additionally the design of the support structure should be such that multiple paths are created to transfer load to supports in the event of member failure.

A sprinkler system will also be incorporated into the design of the arcade structure which will ensure a fire resistant surface as well as reduce temperatures and hence expansion of the steel and glass, increasing the time until failure if the fire is unable to be extinguished.

- Fire within building

In this scenario the arcade operates as a central escape route onto which all fire escape stairwells open in emergency.

- Fire within arcade

In the case of fire in the arcade, the central through route of the facility becomes the main escape path. In either case, the part of the structure unaffected by the fire becomes the main escape route to minimise the possibility of users unable to reach safety.

- Materials

To establish a continuity in materials throughout the construction of the arcade, glass will be used as the principle material for the roof, walls and floor.

Increased thicknesses of glass to be used in the roof construction to support additional loads such as rain and wind.

Glass wall panes up to a height of 1.6m to be of increased thickness and comply with class 2 safety glass for increased impact resistance.

The floor glass will be sandblasted to hide services running below the arcade. Adequate thickness and pane size to support users will also be of laminated safety glass. The sandblasting of the glass floor will increase friction over its surface and create a non-slip pedestrian walkway. Under floor lighting will permit good visibility at night with the diffusal of light through the sandblasted panes.

C O U R T Y A R D

- Access

Entrance into the courtyard is provided through both the CUBE building and the public arcade. Doorways allow pedestrians in the arcade to move into the courtyard and access the building indirectly. These doors can also be closed to limit access to the building or close the facility at night while still allowing public use of the arcade.

- Lighting

Sunlight will provide sufficient illumination during the daytime. At night, lighting will come from overhead luminaires suspended below the third floor connecting bridge. Upward facing spotlights positioned around the edges of the courtyard will reflect illumination off of the building walls, giving definition to the courtyard space.

- Floor surfacing

Adequate grip for pedestrian footing, a robust surface and drainage requirements must be considered in selection of a surfacing material. Adoption of a local material from the surrounds identified sandstone tiling as a suitable and complimentary material.

- Shading/Protection

Northern sunlight must be permitted to enter the courtyard for a certain amount of time during the day. However to combat possible heat problems that are generated through excessive exposure to sunlight, only a minor break in the building edge will be created. The third floor will also extend across the open air volume of the courtyard to protect the southern side of the courtyard and possible sunlight penetration into the arcade space.

- Drainage

Rainwater will drain away from the entrances facing the courtyard, towards the centre where drainage gratings will allow water to flow underground into suitable stormwater pipes which run beneath the arcade and connect with municipal drainage lines.

P U B L I C C I R C U L A T I O N S P A C E

- Lighting

Light will primarily be provided through roof skylights located along the length of the structure while the atriums will allow the natural daylight to filter down through the building. Additional light fixtures to be placed overhead main passage routes for additional lighting during low daylight levels. Emergency LED lights to be placed along all escape routes and stairwells and activated during a fire.

- Temperature requirement

User comfort requires the maintenance of the air temperature to be held around 20°-22°C. Cooled air from the office areas can be vented out into the larger circulation volume to aid in reducing temperature increase.

- Ventilation

Vertical movement of warm air provided through the atriums and expelled through vents located in the skylights. Mechanical extractor fans will be installed to provide additional air flow should the passive system not be sufficient during extreme weather.

- Fire resistance and escape routes

Fire escape stairwells provided at both ends and in the centre of the building will allow for vertical movement during a fire. The stairwells exit into both the building and the arcade to allow either to act as independent routes out in an emergency.

- Visibility and visual linkage

A connection between the internal circulation space of the building and the adjacent space of the arcade will be created by allowing the users of each space to observe the movements within the other. Visual links to the external city environment to also be created along the building length in order to protect against northern sunlight exposure. Creating transparent divisions in an east-west direction will permit a strong visual axis through the building.

O F F I C E D E S I G N

- Lighting

Controlled levels of lighting will be provided through overhead luminaires. Additional natural light however will be able to penetrate the office environment from both sides due to the central atrium spaces. The increased penetration of natural light will create a more pleasant working space.

- Ventilation

Mechanical ventilation is provided in these spaces and will supplement fresh, cool air whilst the warmer air is vented into the central atrium spaces. Heating will also be provided through this system during winter months.

- Servicing

A suspended ceiling system will be installed in all office areas to allow ease of servicing and installation of electrical conduiting.

- Storage and filing

Filing of records to be done within the enclosed offices provided in each office module for security reasons. Central server rooms will provide electronic storage of information and media which can be accessed through the building computer network systems.

- Workstation design

A large percentage of the members of the councils work on an intermittent basis. These members' working spaces will be incorporated into the open plan office areas. Utilising a hot desking system will allow usage of workstations based on requirement with access for visiting professionals and delegates to also be met.

- Fire routes

Central movement routes through the office areas will serve to convey the users out of their working spaces, onto the main circulation routes which provides access to the fire escape stairwells.

- Structural layout

The chosen structural grid of 5m-8m-5m allows the development of office space in the two 5m spaces

with the central 8m area acting as container for circulation and atrium spaces.

R E S T U R A N T D E S I G N

- Capacity

The restaurant is to be designed as a small, localised eatery which will serve the building users and additional members of the public during the day. A target of 20-40 customers will inform the design. Food served will be light meals with quick preparation times with possible self-service buffet area.

- Equipment storage

After business hours the courtyard tables and chairs will be stored within the internal restaurant area and secured behind the folding glass doors. Waitrons personal belongings must be stored in a separate lockers near the service entrance of the kitchen.

- Kitchen

Main cooking and preparation areas to be combined with separate area for cleaning and food storage. Access to external refuse removal.

- Ventilation

Overhead cooking hobs must ventilate the kitchen space to the outside with the implementation of mechanical ventilation to introduce fresh air.

- Smoking areas

No smoking regulations within buildings restricts the act of smoking to the outdoor courtyard area where the open air space will permit dispersion.

- Fire escape

The kitchen area should be located near to the building edge to allow quick exit to staff through the service entrance. People in the dining area will be able to move either through to the courtyard or return into the building and exit through the main entrance.

- Surfacing materials

All surfaces should be easily maintained and washable to retain an hygienic environment. Ceramic tiling and off-shutter concrete to be principle materials with all

clay brick wall surfaces to be plastered and painted.

B O O K S H O P

- Quantity of books

The book collection will be restricted to the available shelf space but specific works and larger volume orders can be placed through the bookshop directly to publishers. An initial estimate of 2500-3000 books will be able to be accommodated in the bookshop.

- Book storage

The majority of books will remain on the shelf available for purchase since large volumes of specialised material will not be sold quickly. Provision for minimal storage of books however will be made and alternative storage can be made in the library areas.

- Office requirements

A single multi-purpose room will suffice to serve the administrative needs of the bookshop.

- Capacity of shop

Due to the bookshops specialised nature of reading material available, a maximum of 10 people browsing the shelves was acceptable.

- Fire escape and prevention

Protection of the books in the case of fire will be through either powder chemical or carbon dioxide extinguishers. Automated dispersal systems will be linked to fire alarms with the provision of additional handheld extinguishers.

- Security

All books will receive magnetic strips and detectors placed at the entrance to the shop will detect unauthorised removal of material

L I B R A R Y

- Capacity

Estimate book numbers of between 5000-10000 as well as the storage of models and plans to be provided.

- Book storage

All books will be available on the shelves, minimising the need for additional storage. Books which can be lent out to the public will be stored in a librarian office during check-in prior to being replaced on the shelves to examine book condition. Books in need of repair will be kept aside until fixed.

- Office requirements

A preliminary of 4 staff librarians are required to maintain the collection. Offices will be usable by any of the staff members and used to store secure filing equipment.

- Security

All books will be fitted with magnetic detection strips and scanned upon lending. A security station near the entrance to the facility will allow a quick response to incidents of theft.

- Fire escape and prevention

Direct access to the ground floor is provided via the main staircase to the library which will facilitate rapid evacuation of people. An additional route through the nearby fire escape stairwell will serve this purpose should the way be blocked or unaccessible.

Dry powder and CO2 extinguishers will be linked to a fire alarm and activated to protect the books and other materials from fire damage.

- Restricted material

Drawings, plan, models and other material considered to be of a valuable or sensitive nature will be stored in the second floor laboratory for limited use. These additional collections will be mainly used by the students and designers utilising the lab area.

F I R E R E S P O N S E

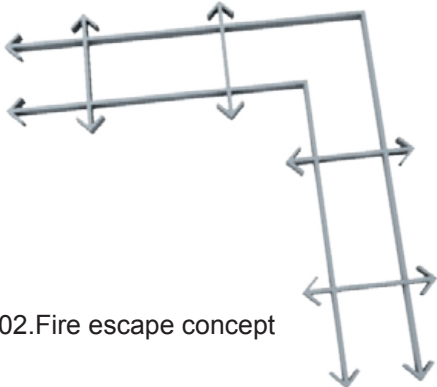


Fig.9_02.Fire escape concept

L I G H T I N G

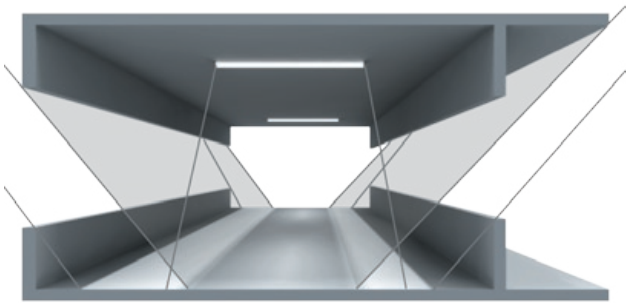
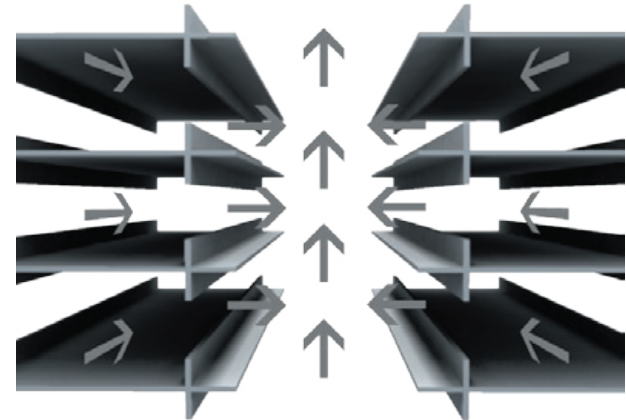


Fig.9_03.Light penetration principle

V E N T I L A T I O N



V E G E T A T I O N

Restricted space on site has meant that little natural vegetation could be incorporated into the design. In order to protect the northern edge of the courtyard however, several trees are planted to provide semi-shade to the courtyard. The trees will become a focal point in the courtyard and provide a pleasant atmosphere near the restaurant for dining.

S E R V I C E S

The following services are included in the main service spine located beneath the arcade. Positioning of the services in this manner was considered a cost effective and practical solution, allowing good access to the systems through access hatches and serving the building with the minimum distance of conduiting and piping.

- Waste management
- Water
- Electricity
- Drainage
- Telecommunications
- Refuse removal
- Servitude



Fig.9_04.Ventilation

Fig.9_05.Service spine

D E S I G N
O B J E C T I V E S
A R C A D E

An iconic form is required which will generate public interest and become synonymous with the CUBE facility. With glass as the principle material identified for use in the arcade, the formal design would need to capture the public interest since glass work is common in arcade design.

Spatial quality as an objective in the projects design requires translation into the arcade structure. Since the principle nature of an arcade is in its role as a movement space, the nature of the arcade's design should express movement.

Predominantly in arcade design there is a tendency to generate a constant cross-section that enhances continuity along the passage of movement. With such a focus on spatial expression as mentioned previously, the cross-sectional volume of the arcade will become variable in this design, expressing the movement of pedestrians through the city through fluctuations of arcade volume.

The functional nature of the arcade as a movement route will be expressed through the 'movement' of the form of the arcade.

The complicated construction envisioned to achieve this goal will require specialised workmanship. Training of skilled craftsmen will be implemented which will improve local construction quality once CUBE is complete. In addition the special nature of the design is hoped to inspire local designers and builders into tackling more intriguing and inspirational projects.

The technical design of the arcade must seek however to lower costs through possible standardisation of jointing, reduction of support members and ease of fabrication.

C U B E
B U I L D I N G

The CUBE facility itself must house all the necessary functional spaces to serve it's users and the intended role the facility will play in relation to the city.

The physical design of the building must speak on both mass and void and through this relationship, express to the viewer the variable role of space in any built object.

In order to impact a tangible sense of space in the design, permeability and continuity in space through the building will be created. The use of vertical atriums and circulation spaces, horizontal passages and the shifting between indoor and outdoor spaces will seek to manifest this.

Economy of structure and construction must be sought for but will not become a design generator in this project. Reinforced concrete as the identified material is robust, strong and easily erected and will provide the necessary framework to support an assemblage of differing spaces within the building.

The process of exploration and the development of perceptions over time are core design formulators. Response to this aspect of the design is through the progression of varying degrees of public and private use attached to the different spaces in the structure.

The ground and first floor will be designed together as the public realm within the structure with the second and third floors dedicated to the semi-private operations of the councils and it's users.

C O N C E P T U A L M O D E L S

T H E O R E T I C A L M O D E L

The development of various models identifying with the different stages of the design, epitomises the author's belief in the need for a method in which the translation of theoretical premises can be adapted to design ideas. This first stage sees the adaptation of theoretical ideas onto the physical context to generate a framework for a conceptual design.

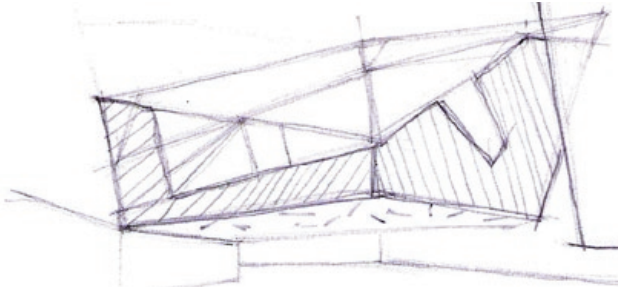


Fig.9_06. Concept sketch

Fig.9_07. Concept perspective

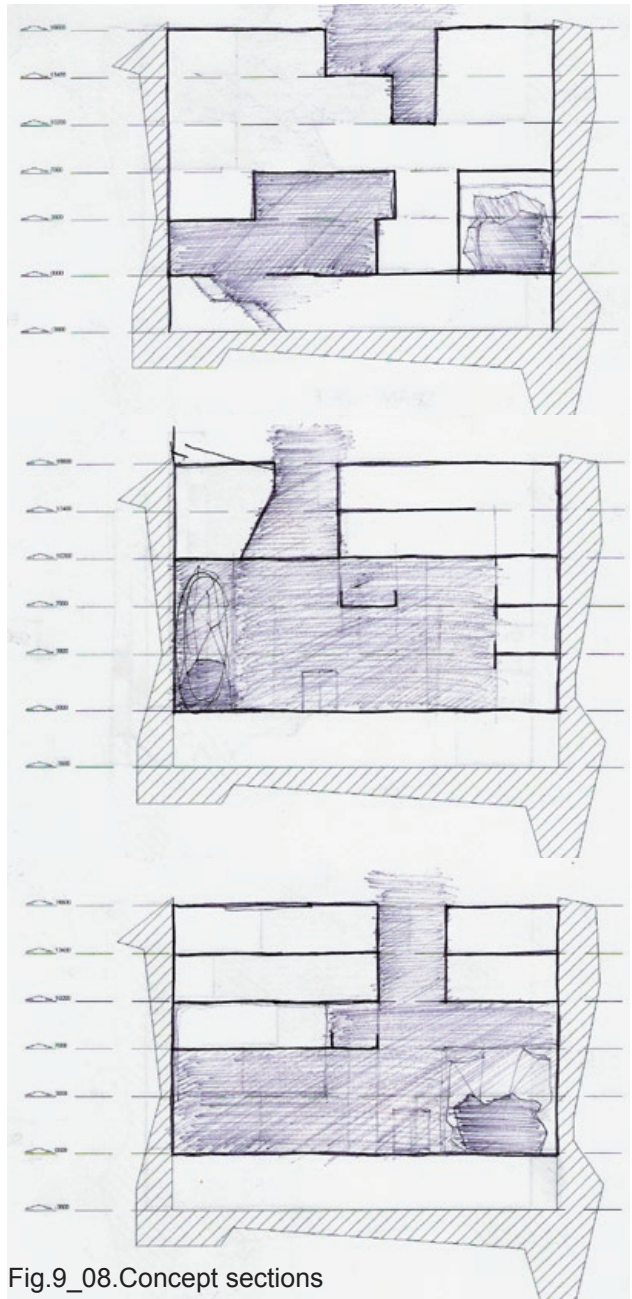
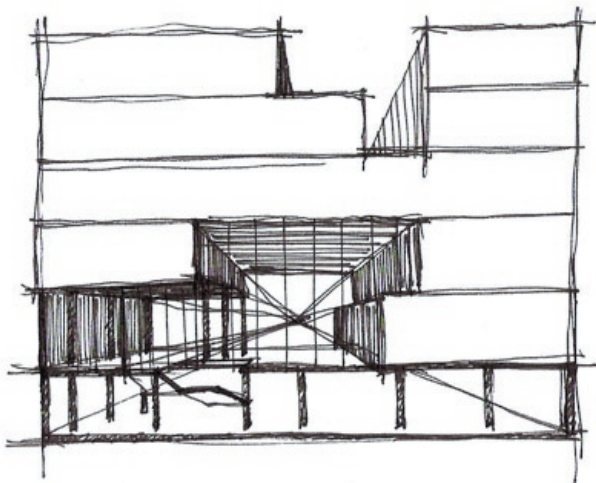


Fig.9_08. Concept sections

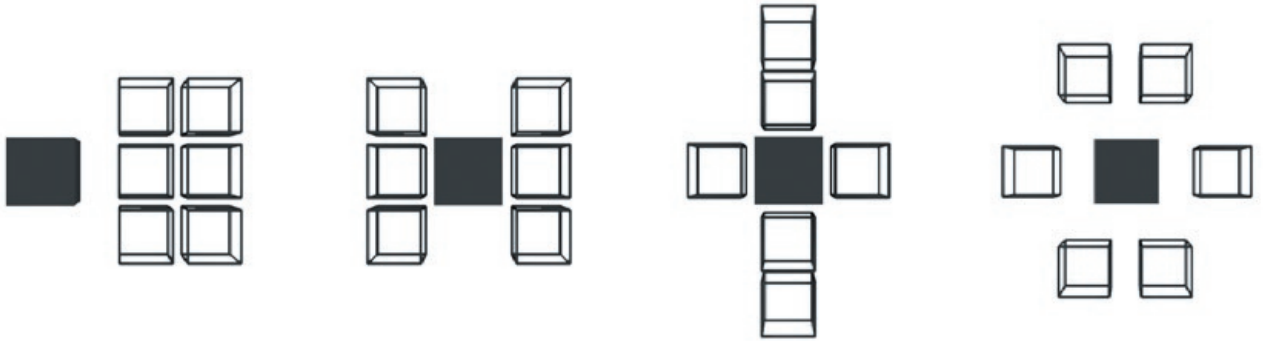


Fig.9_09.Spatial order ideas

the first order of organisation seeks to establish appropriate relationships between the main components in the design, in this case the CBE and six sub-council offices.

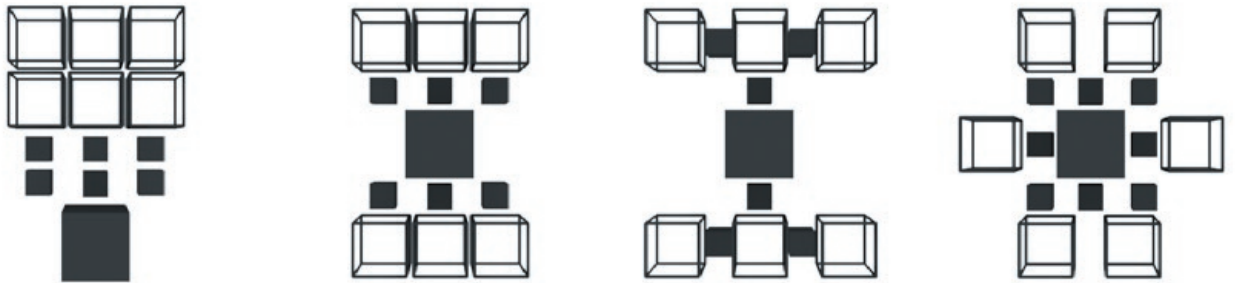


Fig.9_10.Spatial order ideas 2

the second layer of organisation examines the integration of the main building components with the lesser serving functional spaces. The spatial model seeks maximisation of access to all spaces and diversification of movement routes.



Fig.9_11.Site constrained order

the third layer of organisation stems from site constraints, in this case the limiting nature of site dimensions. In order to establish order and hierarchy through the project, site pathways and boundaries must be observed.

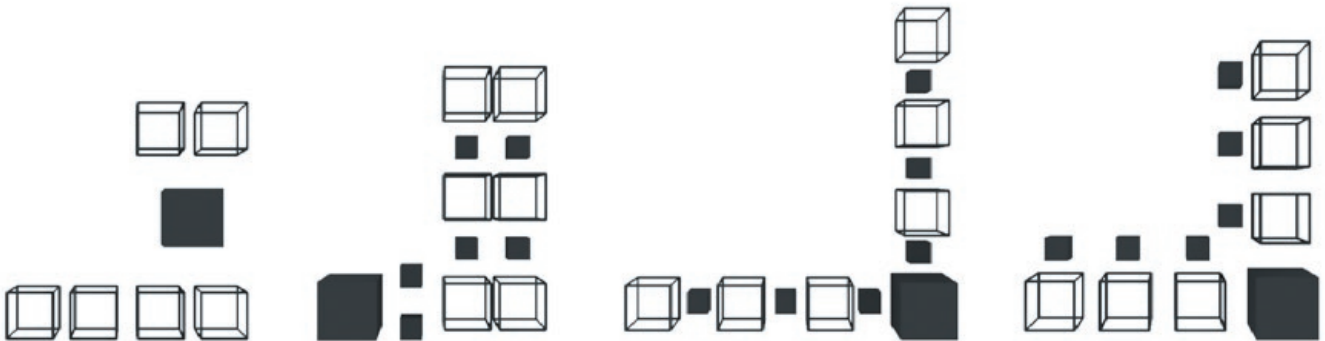


Fig.9_12.Site specific hierarchy

the fourth and final layer of organisation seeks to establish a medium between all three prior organisational layers, combined to facilitate maximum clarity of order and appropriate sequence of spaces.

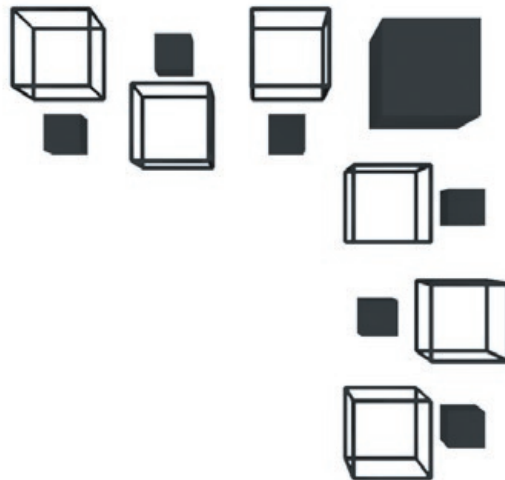


Fig.9_13.Final spatial layout

the final spatial model achieved at the end of this process reveals the ideal relationships between building components, establishing a readable order and spatial progression in accordance with hierarchy. Maximisation of access has generated a diversification of movement routes between spaces within the structure whilst remaining readable and functional.

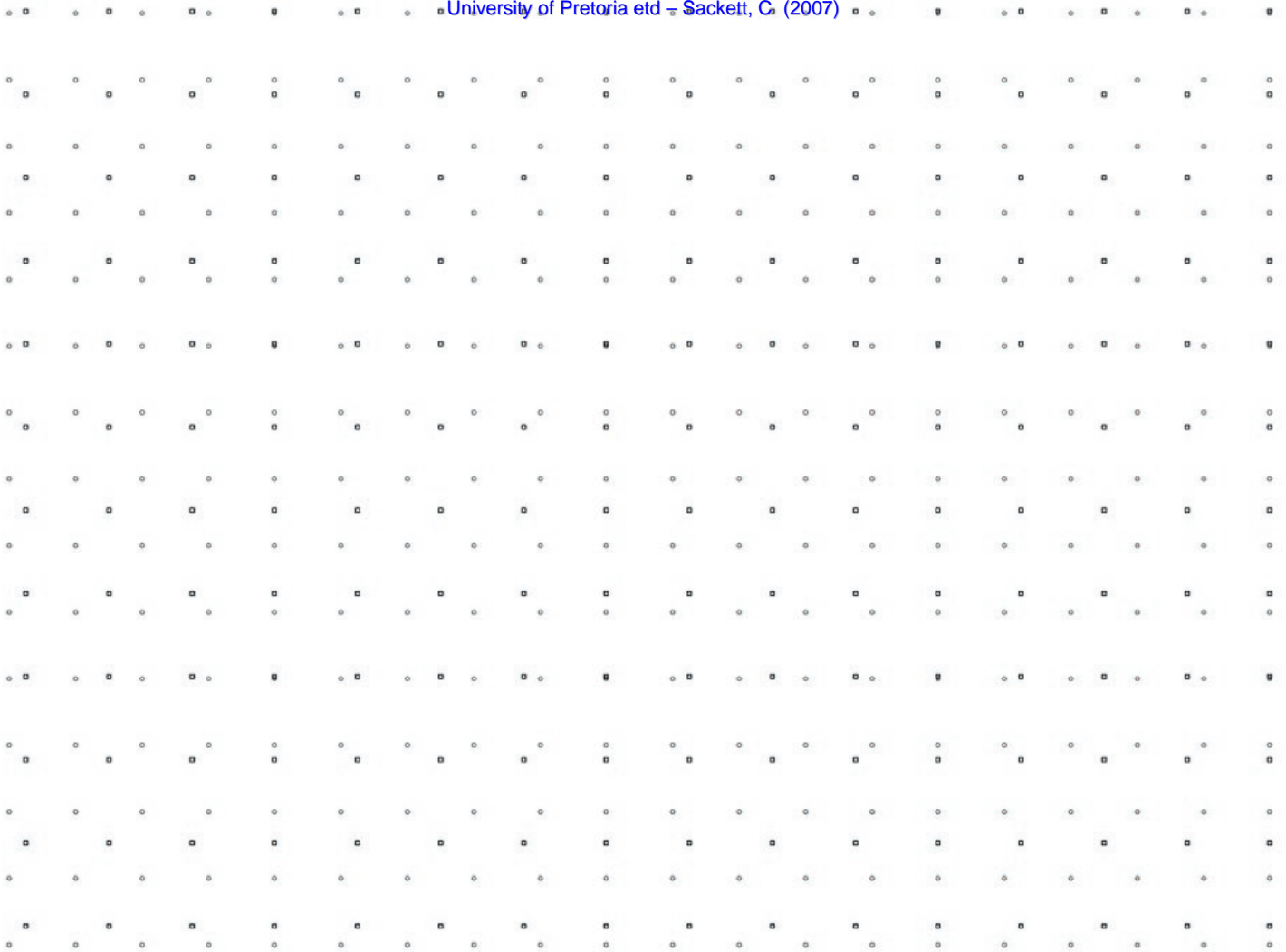


Fig.9_14. Grid overlays generating spatial quality

Generating spatial pathways through the structure required some form of connection between these two elements. By overlapping varying grids which suited the site dimensions, a variation in spatial fabric revealed itself. At certain distances the different grids would align, generating a very strong centre which seemed to 'expand' outwards. Conversely at the points of greatest divergence between the grids, a sense of 'compression' can be felt in the structural arrangement. This relationship between grids seemed able to communicate a sense of spatial quality related to structure. By connecting these spatial points together, a pathway can be generated through the structure that fluctuates in terms of its spatial expression; either motivating focus inward or outward.

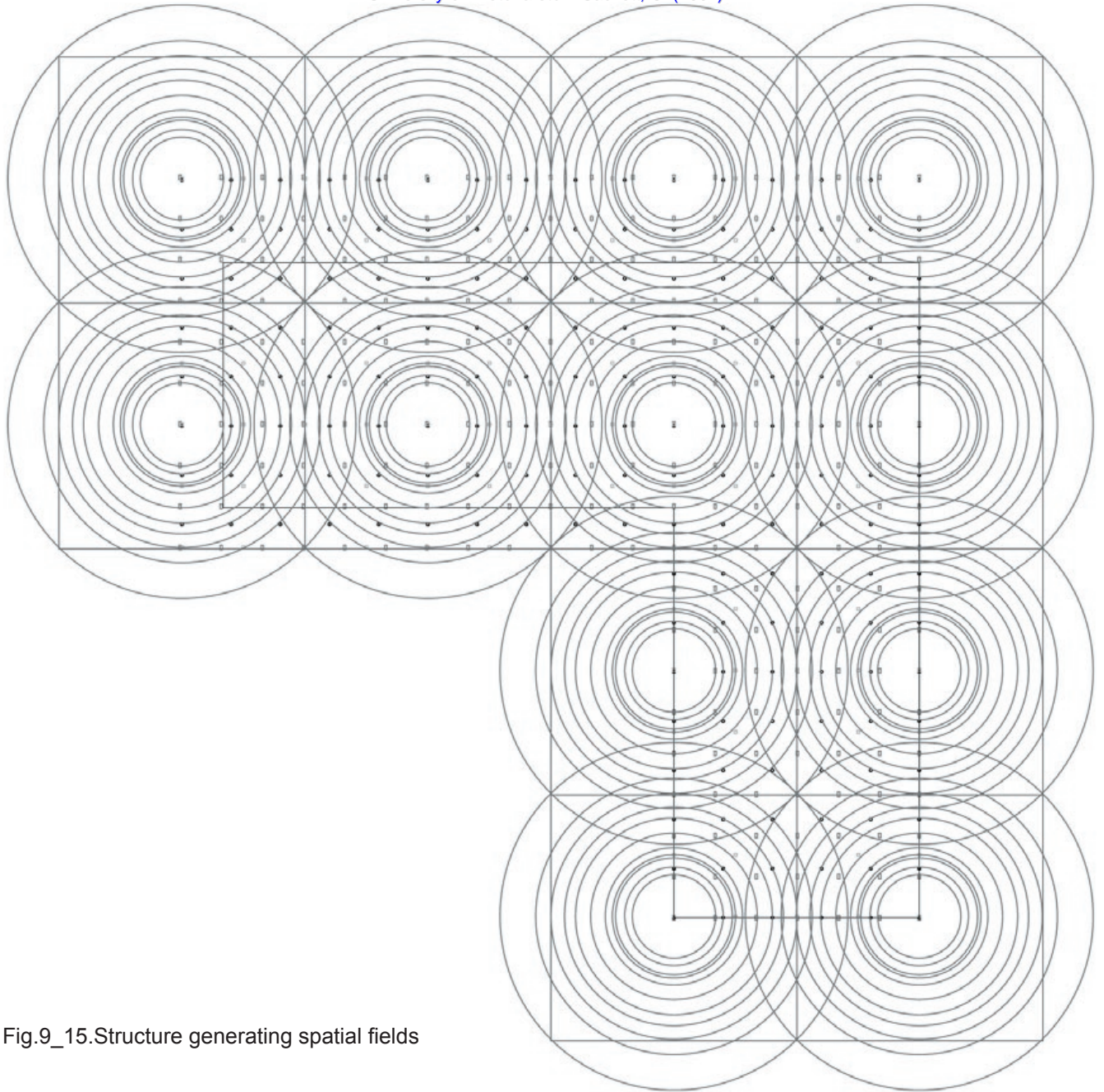


Fig.9_15.Structure generating spatial fields

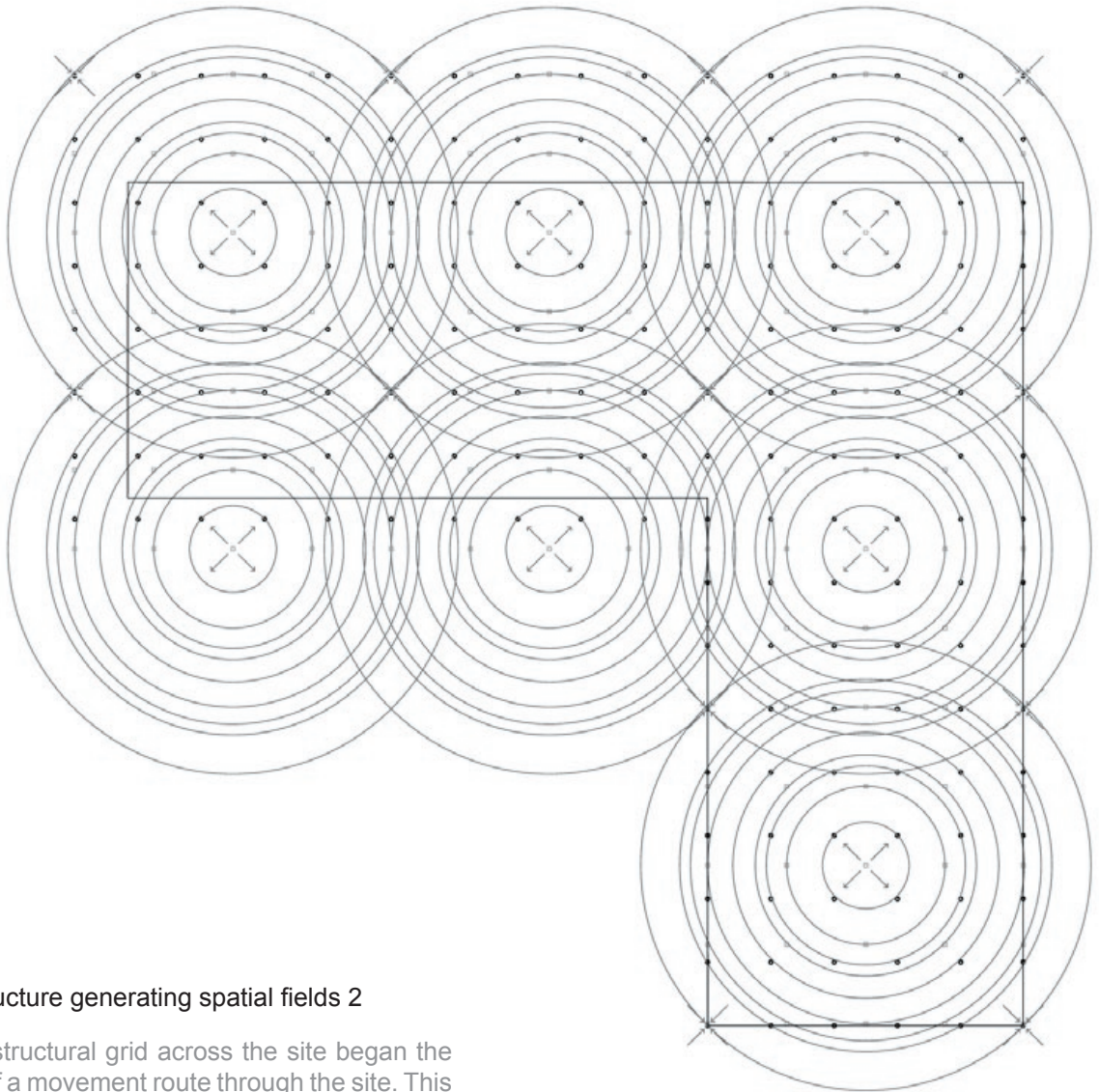


Fig.9_16.Structure generating spatial fields 2

Shifting the structural grid across the site began the positioning of a movement route through the site. This series of points will later become the building circulation areas which will move through spaces of varying spatial expression as sought for in the design.

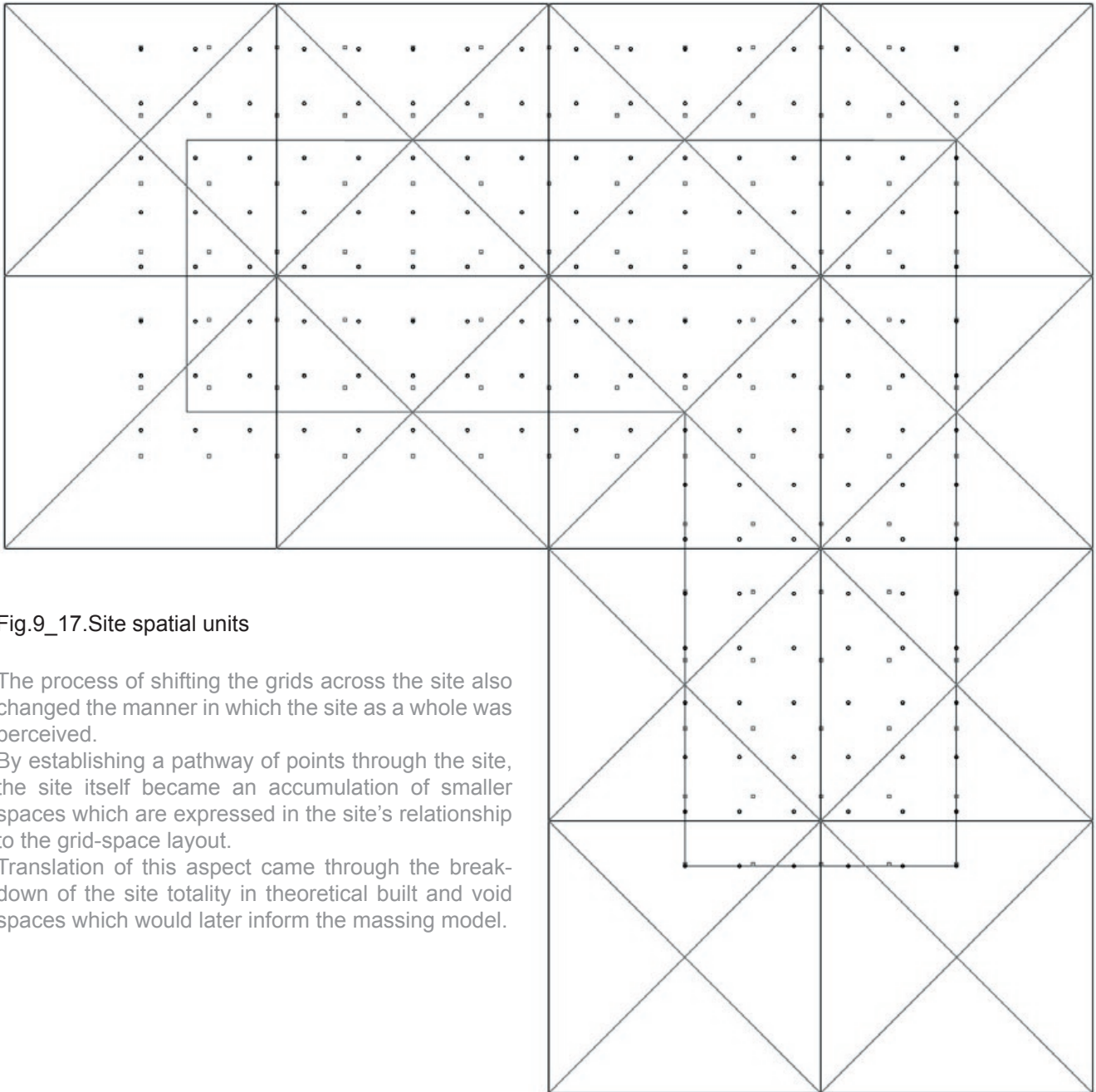


Fig.9_17.Site spatial units

The process of shifting the grids across the site also changed the manner in which the site as a whole was perceived.

By establishing a pathway of points through the site, the site itself became an accumulation of smaller spaces which are expressed in the site's relationship to the grid-space layout.

Translation of this aspect came through the breakdown of the site totality in theoretical built and void spaces which would later inform the massing model.

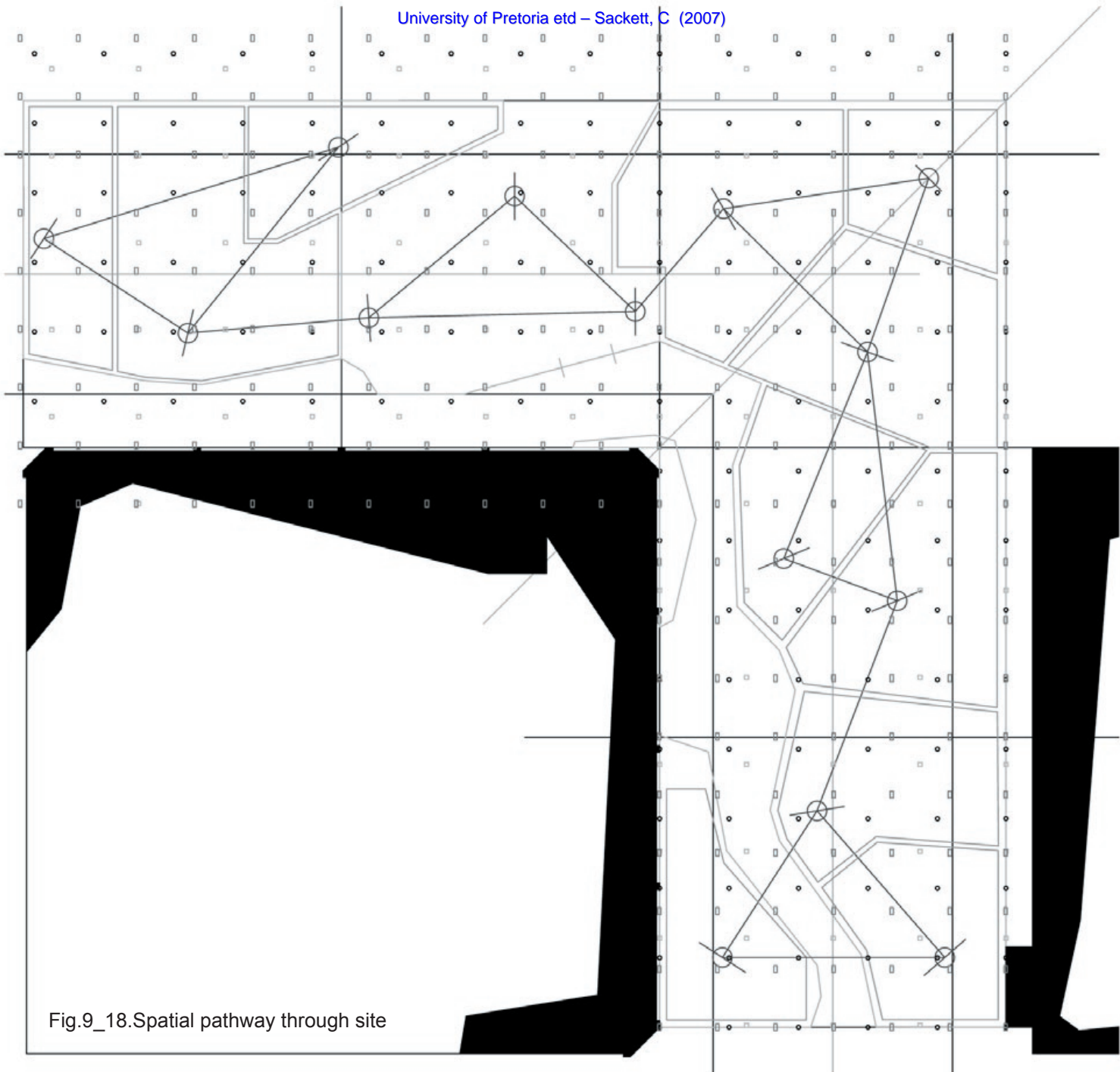


Fig.9_18.Spatial pathway through site

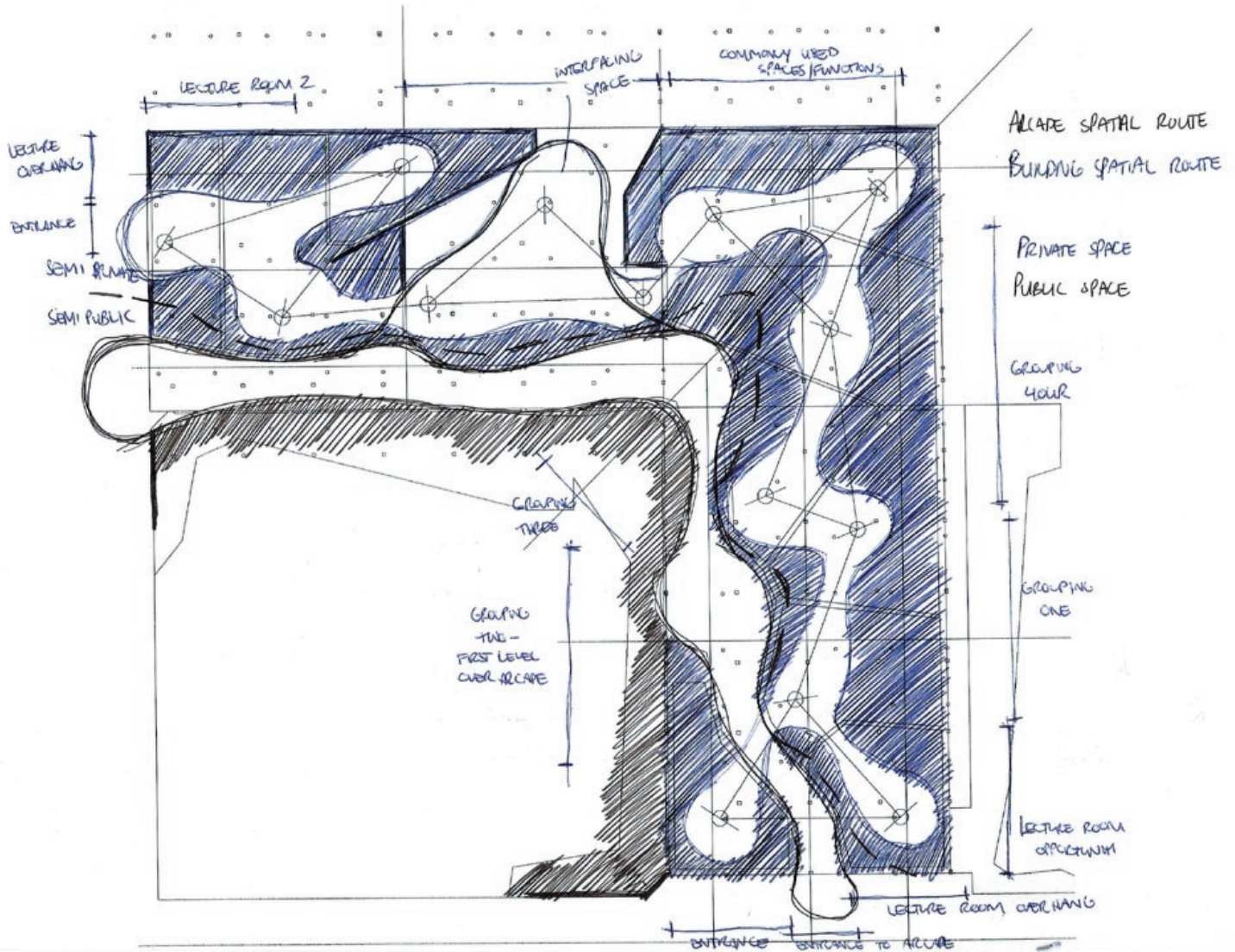


Fig.9_19.Public and built spatial pathways

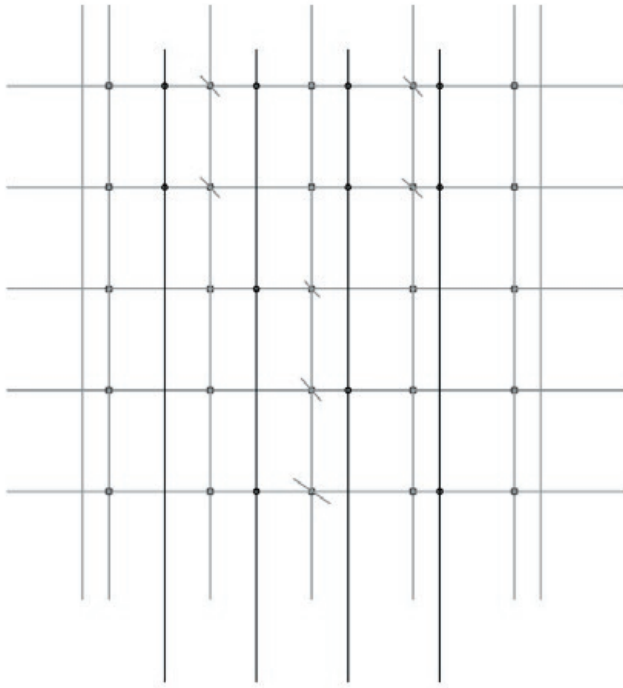
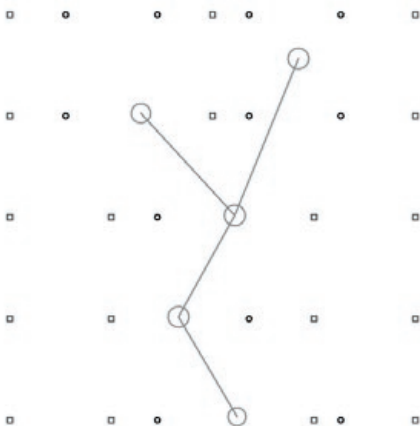
M A S S I N G

Fig.9_20.Developing paths through structure



Form-space play became the next focus in this project, utilising the general outlay developed through the theoretical stage.

The built mass thus began to be modelled around the pathways to separate the various realms within the building, both public and private, functional and spatial.

“To enclose a space is the object of building; when we build we do but detach a convenient quantity of space, seclude it and protect it, and all architecture springs from that necessity.”

Geoffrey Scott

Dictated by the varying spatial character required at each point along the path, the built mass was pulled and twisted, stretched and compressed to generate a final assemblage which conceptually resembled the building in relation to the site and the void space permeating it.

The final built mass model was then intersected with a purely functional model of a structure that could occupy the site. This stage was required in order to return the irregular design of the concept model into a representation of an economical and realistic structure.

The result of this intersection left behind the beginnings of the sketch plan phase into which the design was to proceed.

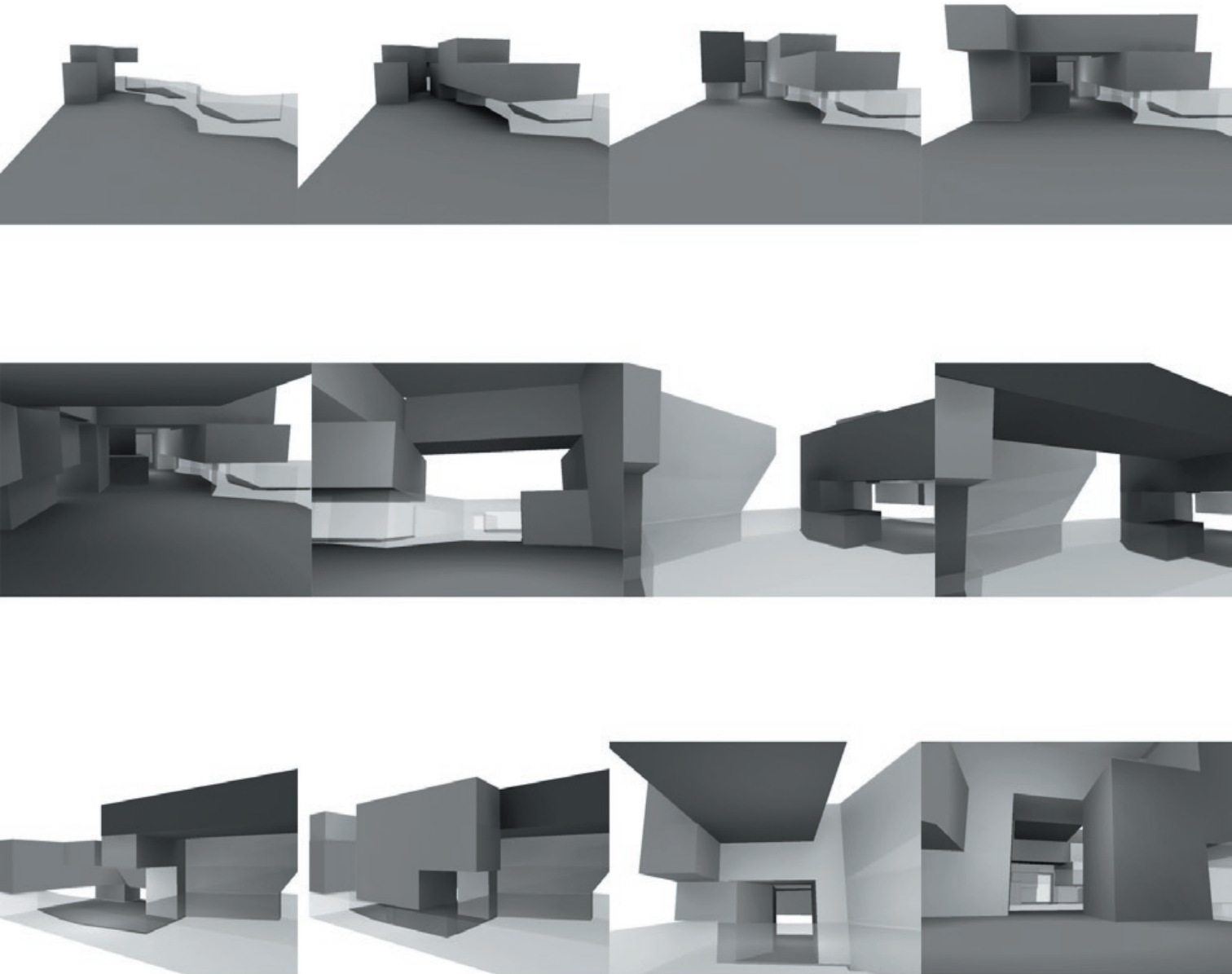


Fig.9_21.Built mass constructed around pathways

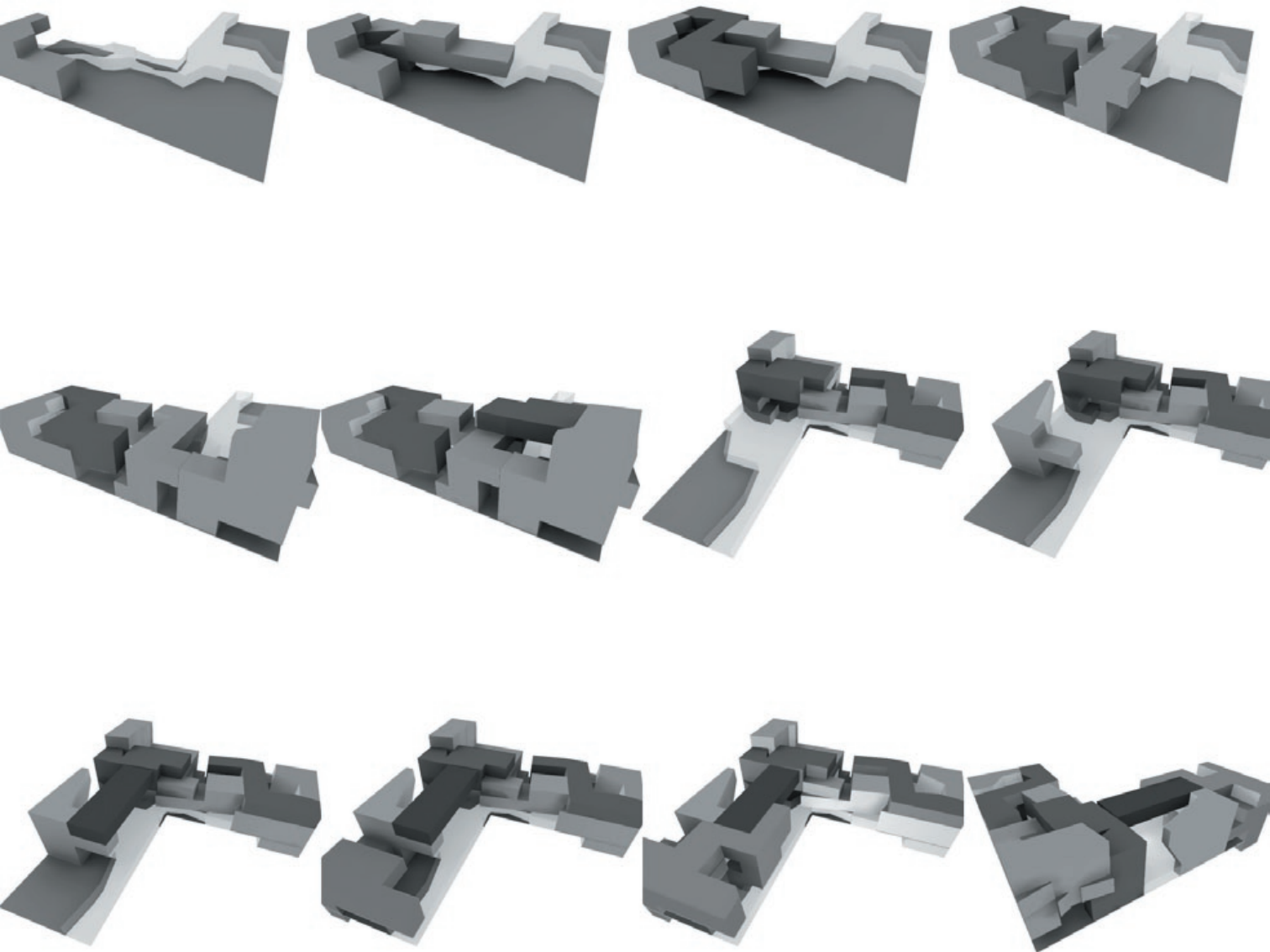


Fig.9_22.Built mass constructed around pathways 2



Fig.9_23.Final conceptual mass model

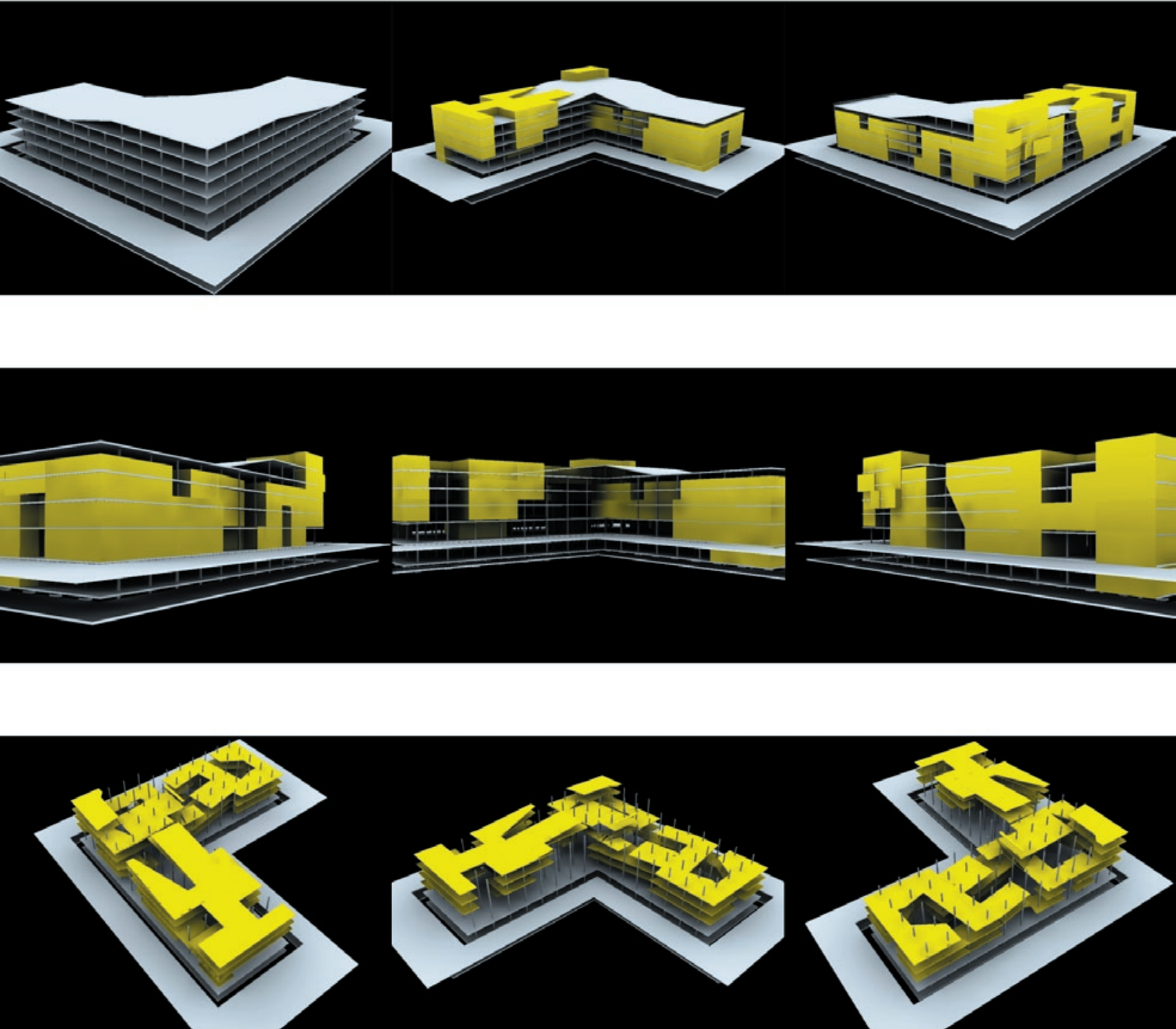


Fig.9_24.Combined models

S K E T C H M O D E L

The process of intersection resulted in the transformation of the built mass model into a semi-realistic arrangement of structure that if constructed would result in the massing model.

However the irregularities in the model required much refining and as such, the sketch design phase concentrated on this refinement process.

Returning to the design considerations mentioned previously, the functional aspects of the design and issues of construction and practical use, receive foremost attention in order to create a user friendly environment.

The spatial quality of the building remained throughout the refinement process as a result of two parts of the design process.

Firstly, the initial focus of the project stemming from the theoretical ideas of space and which in turn were connected with the basic structure, imbued the design heavily with the sought after spatial character.

Secondly through the process of 3D modelling of the space, a much greater sense of spatial connection through the building could be generated. Intricate form-space plays between the various levels in the structure were greatly enhanced through the modelling process which allowed the author remarkable communication with the design of the form. This process finds earlier echoes in the spatial clay modelling done by architects and designers in the middle of the last century.

“The architect models in space as a sculpture in clay. He designs his space as a work of art”

Geoffrey Scott

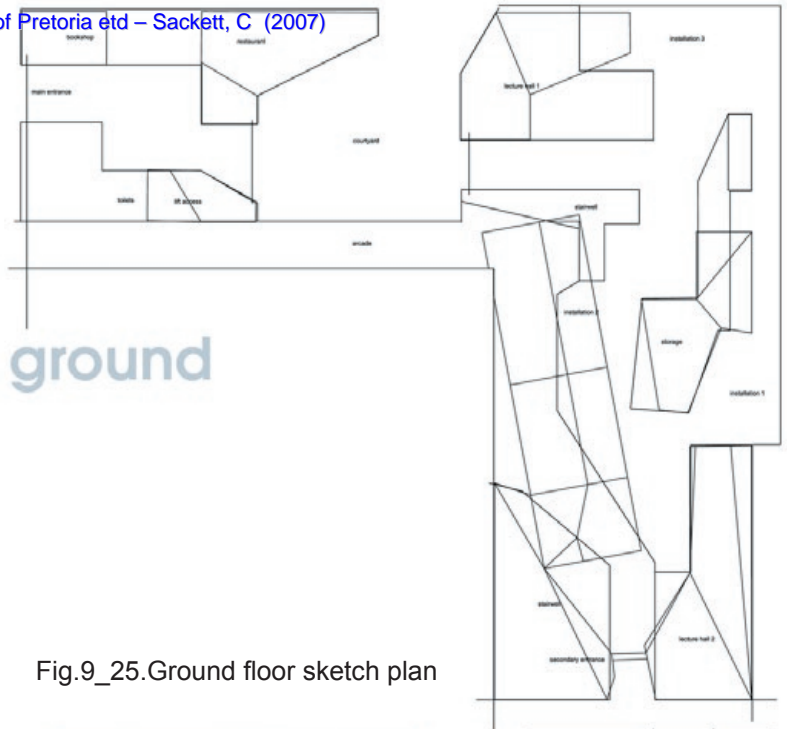


Fig.9_25.Ground floor sketch plan

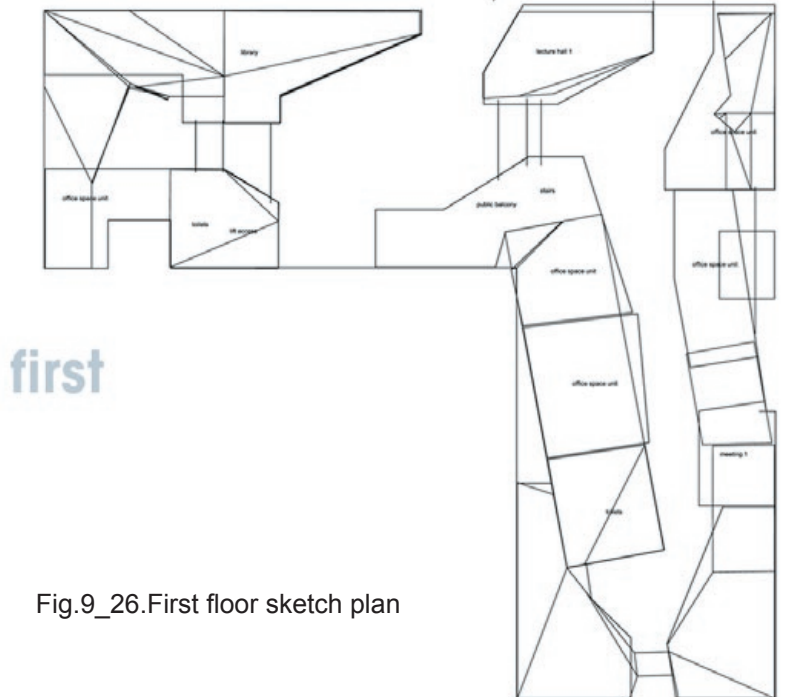


Fig.9_26.First floor sketch plan

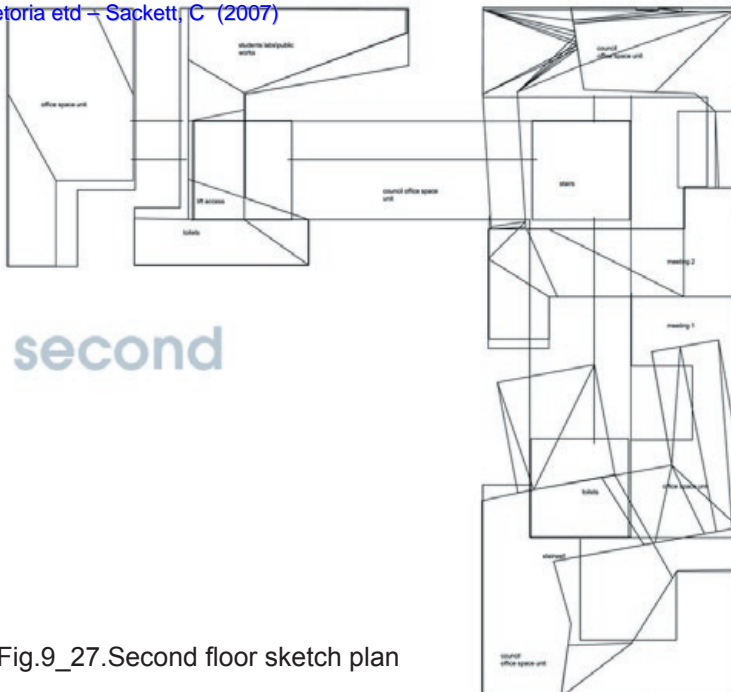


Fig.9_27. Second floor sketch plan

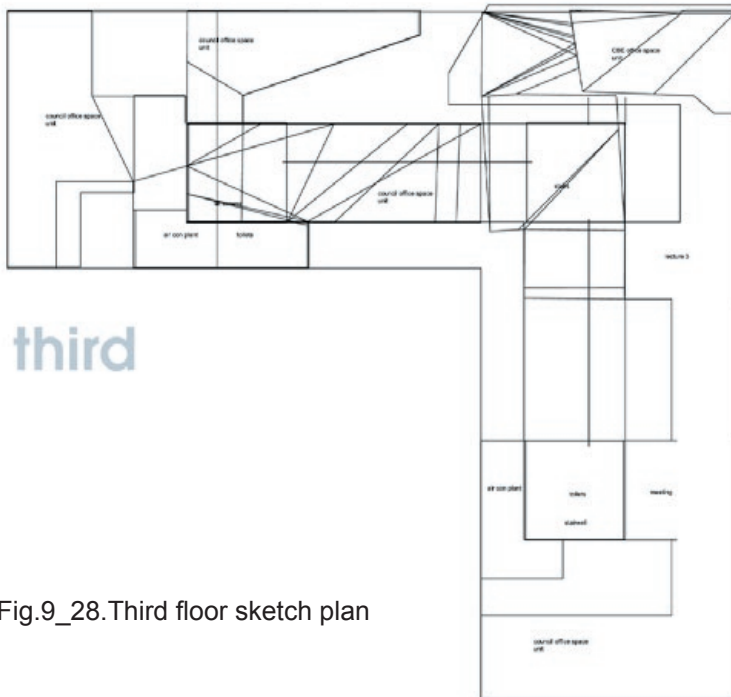


Fig.9_28. Third floor sketch plan

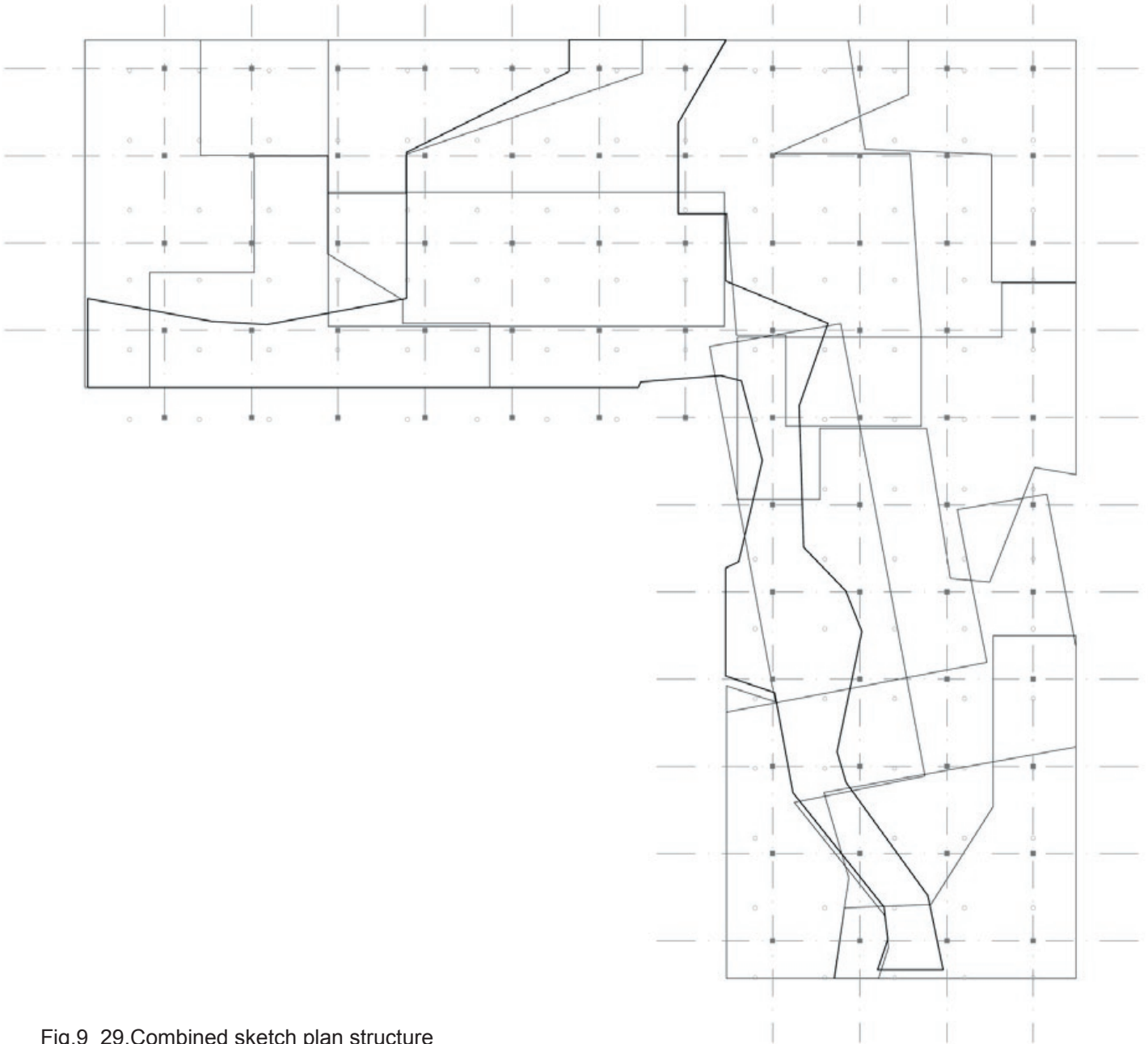


Fig.9_29.Combined sketch plan structure

C O N C E P T U A L
I M A G E S

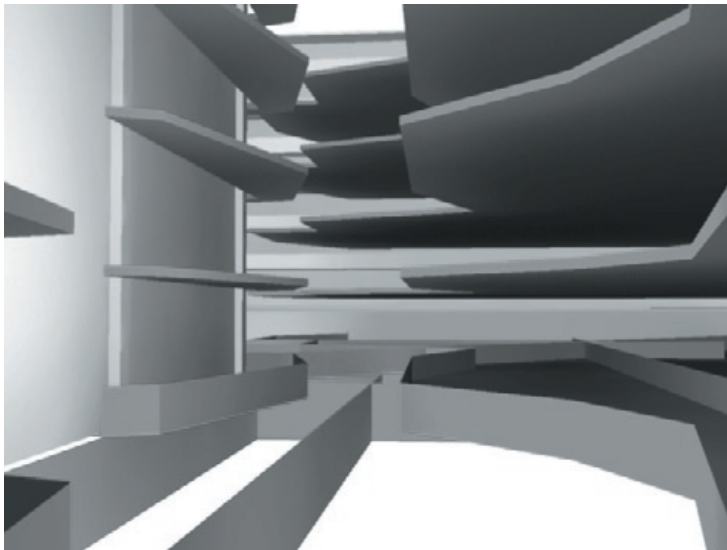
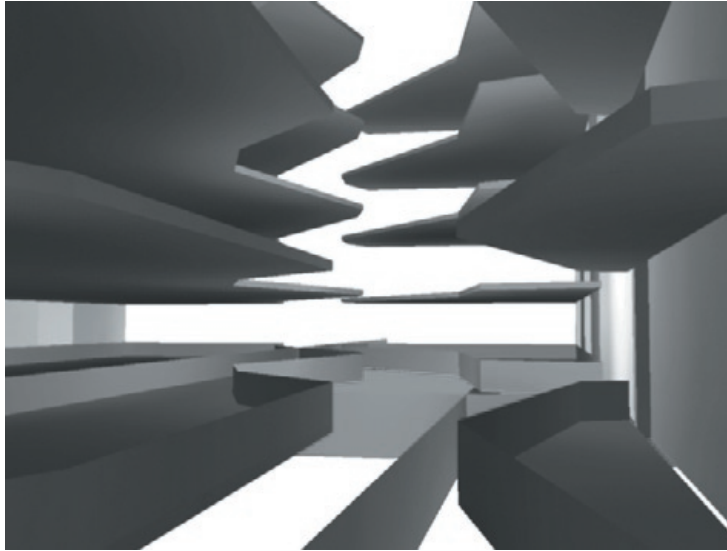


Fig.9_30.Exploration conceptual images

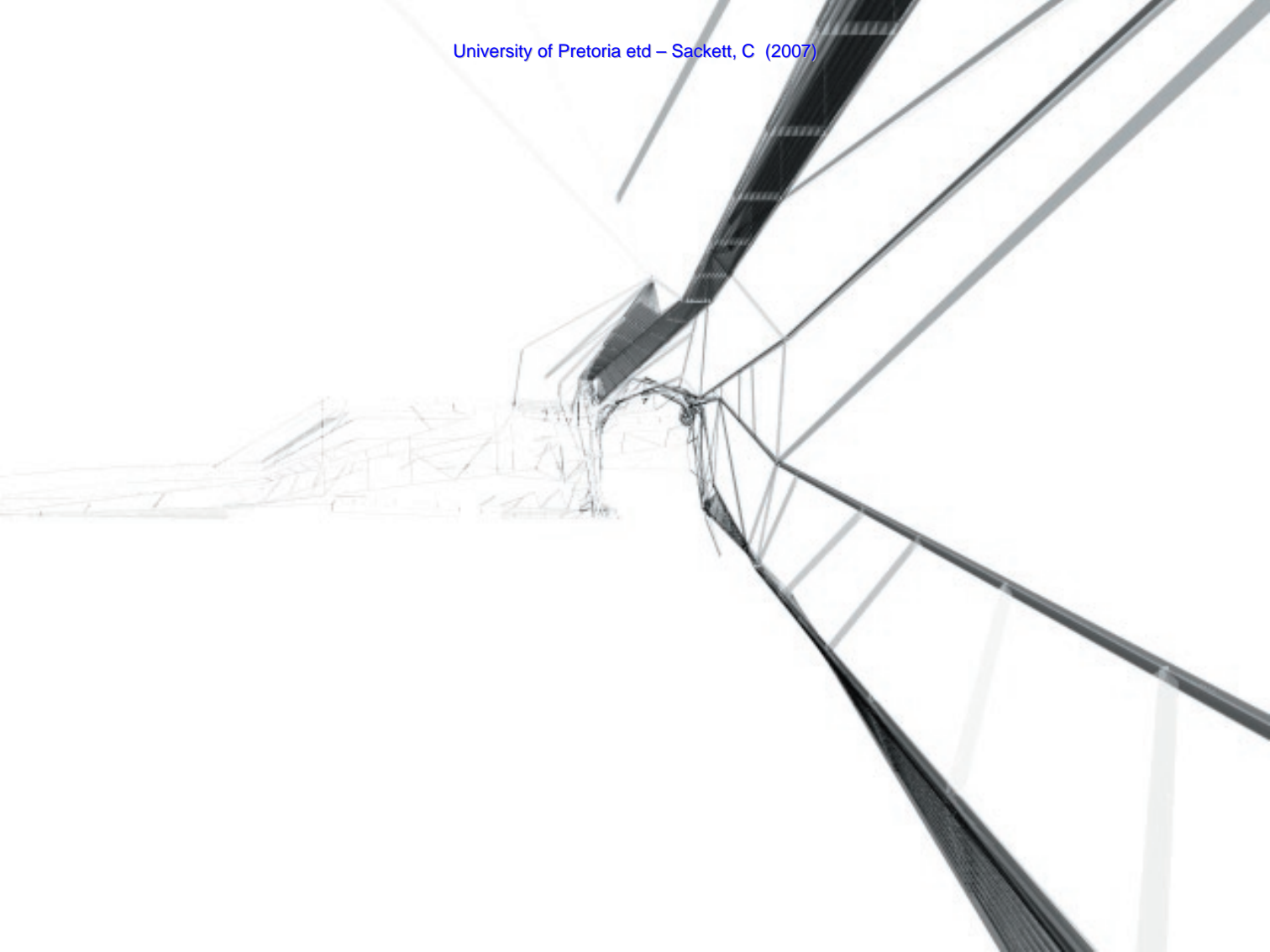


Fig.9_31.Arcade concept 1

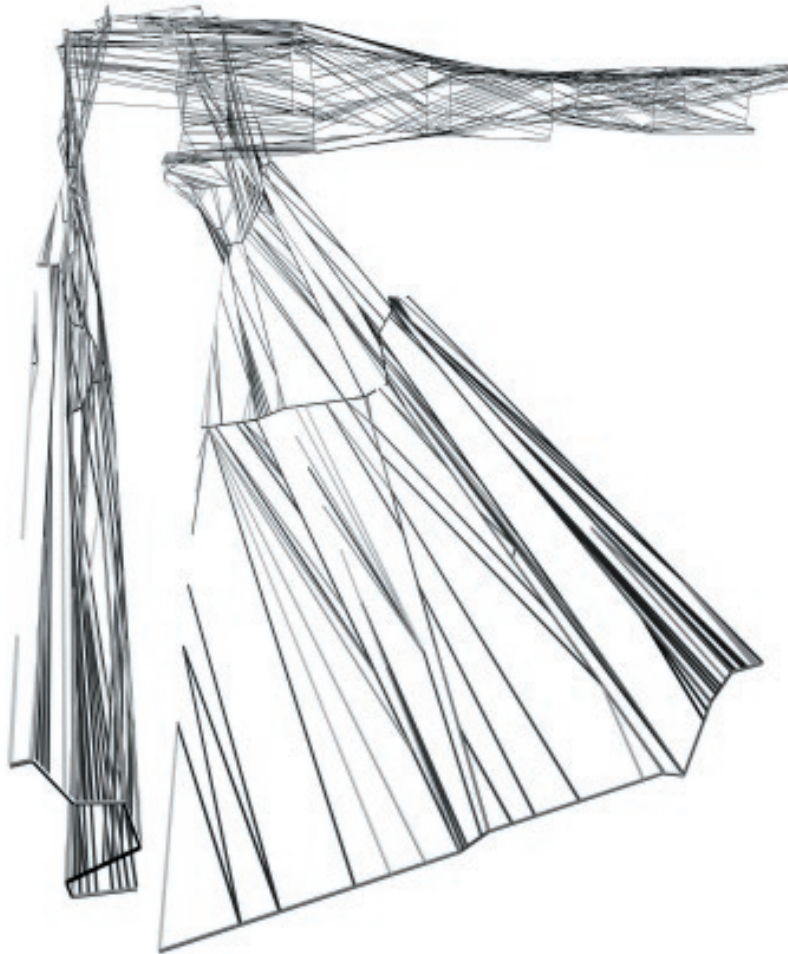
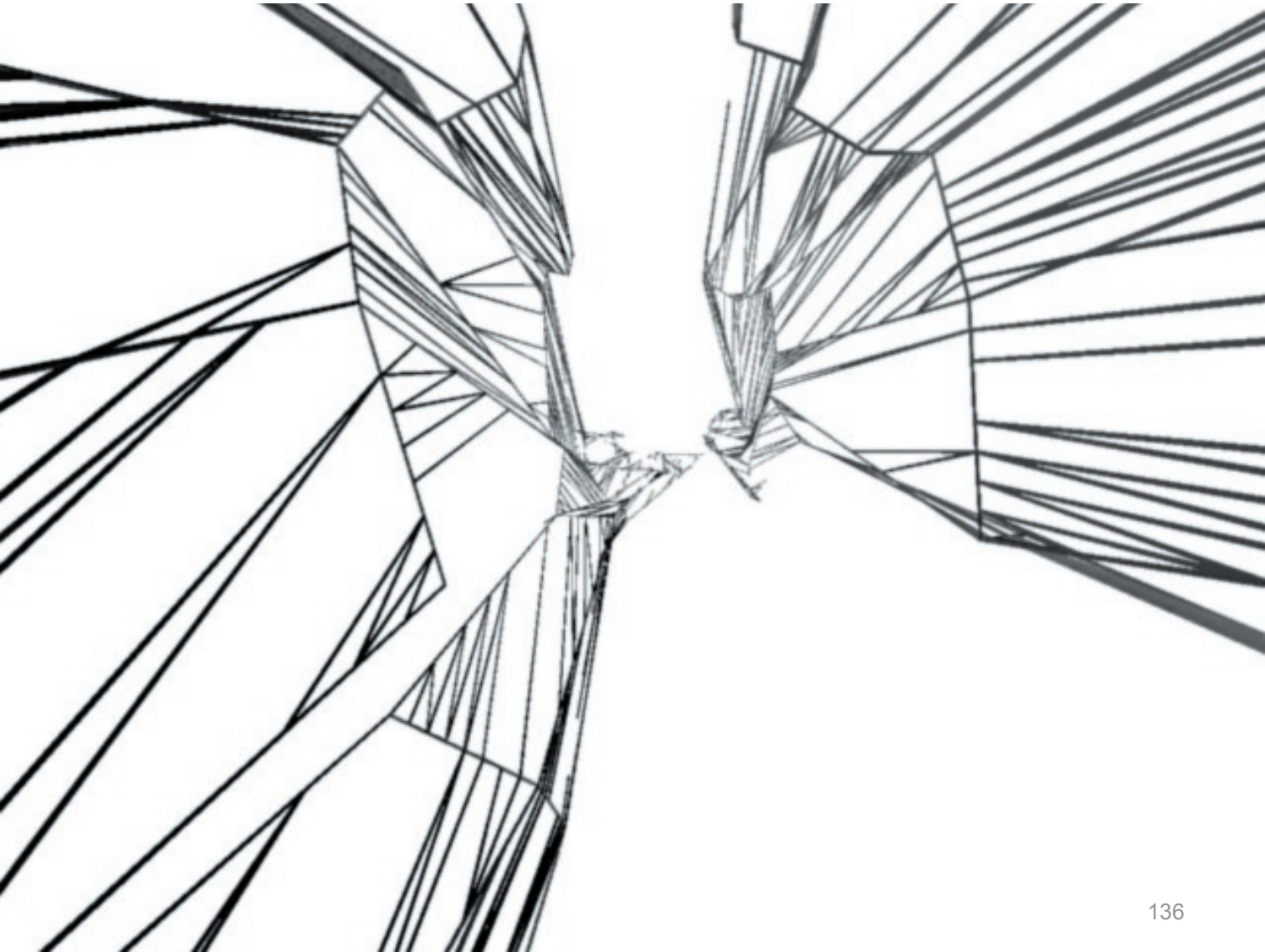


Fig.9_32.Arcade concept 2

Fig.9_33.Arcade concept 3



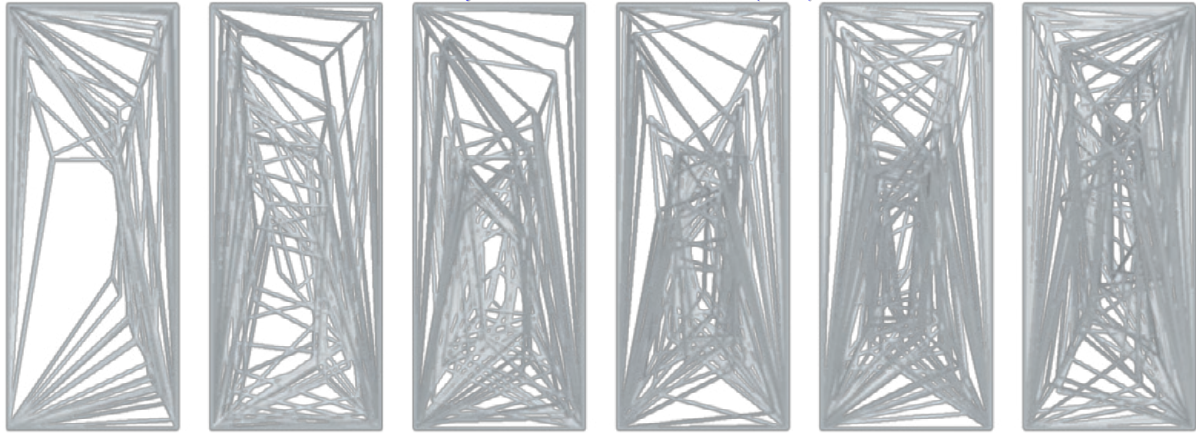


Fig.9_33.Reading space exploration

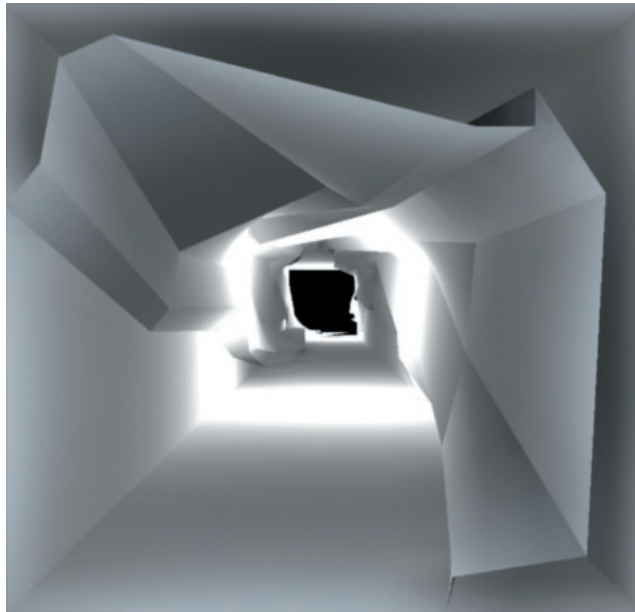


Fig.9_34.Arcade conceptual model 1



Fig.9_35.Arcade conceptual model 2

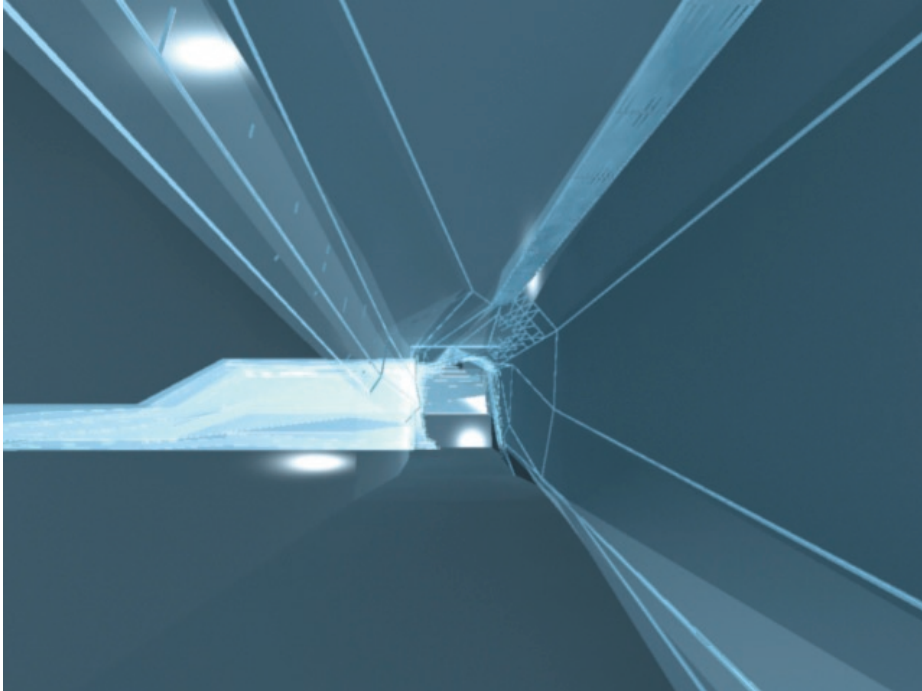


Fig.9_36.Arcade conceptual model 3