

# Prometheus Bound

The evolution of structure in relation to knowledge



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COVER SHEET

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## ESSAY WRITING REQUIREMENTS

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### Essay Structure

**Thesis:** No matter the purpose of the essay, you must have a thesis and build your paper so to explicate that thesis.

**Outline:** Your essay must have a clear and organized structure. Start by developing an outline. Break the essay down into the following categories:

**Introduction:** At least one paragraph which introduces the essay topic. It includes the thesis statement, usually as the last sentence in the first paragraph.

**Body:** Develop the themes and points that explicate your thesis in the body of the essay.

**Conclusion:** A final paragraph(s) that re-states your thesis and contextualizes or summarizes the body of the essay. Never add a new topic or point of explication in your conclusion.

**Paragraphs:** It is very important that you develop well-structured paragraphs. The rule-of-thumb is that each topic or theme is developed in a single paragraph. However, that rule may be modified if a paragraph becomes too long (which can be tiresome to read) or you have too many brief paragraphs (which are also tiresome). Include transitions at the end and beginning of paragraphs so that they flow together well.

**Writing style:** Your essay must be clear, concise, and flow smoothly. Academic essays require a certain degree of formality, but do not complicate the writing style or word choice unnecessarily. Utilize punctuation correctly! Check your grammar (pay particular attention that subject and verbs, pronouns and antecedent nouns agree)! Read your essay out loud to yourself to check for flow and clarity! **Proof-read and spell check!**

**For further reading or assistance, see:**

[http://startup.curtin.edu.au/study\\_skills/writing.html](http://startup.curtin.edu.au/study_skills/writing.html), or <http://www.lib.uct.ac.za/infolit/report.htm>, or The Humanities Library at UCT has a large collection of writing skills reference books, or visit The UCT Writing Centre (<http://www.ched.uct.ac.za/adp/writing/>), which offers writing assistance to all students.

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All academic writing requires you to cite all the sources that you have read and consulted in the preparation of your work. Not citing all of your sources is an act of plagiarism: essentially the stealing of others' words, thoughts and ideas, and is treated as fraud. Students found guilty could at best fail their course, at worst face expulsion. Every single instance of using phrases and ideas that are not your own must be acknowledged.

**Quoting:** When you quote someone's words directly, you *have to place these words in quotation marks*.

Longer quotations, which you should use sparingly, should be "blocked" to make them stand out clearly. This means indenting and single-spacing the entire quotation, also possibly using a smaller typeface.

**Referencing:** You must choose one method of referencing (or citation) and use it consistently throughout your essay: either the Harvard system or the footnote (Chicago or Oxford) system. No matter which system you choose to use, the information you must ascertain and include is:

- **Name** of the originator(s) of the document or the part of a document you are using as a source.
- **Date** of publication (some citation styles give the date immediately after the author; otherwise after the name of the publisher). For an electronic resource, look for the date on which the document was produced or updated.
- **Title** of the publication (and, if it is part of a larger work, e.g. an article in a journal, or one paper in an edited collection, also the **title of the whole** publication).
- For an electronic resource only, the **medium**, which may be given as "Online" or "CD-Rom" in square brackets, or you may use "Electronic" if you are not sure whether the source is online or networked CD-Rom.
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- Inclusive **page numbers** if the reference is to an item smaller than a whole book.
- For an electronic resource, the **date** on which the document was last **accessed**, often in square brackets.

### Harvard System

In the Harvard system, referencing is done by inserting the author surname and publication date in parenthesis within the main body of the text. For a complete guide to the Harvard system, see

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### Footnote System

In the footnote system, a reference in the text to another source is signalled by a numeral giving the number of the citation. This numeral corresponds to a numbered note at the bottom of the page (a footnote), or at the end of the paper. For a complete list and discussion of footnoting, see <http://www.lib.uct.ac.za/infolit/bibchicago.htm> or Turabian, K. 1996. *A manual for writers of research papers, theses and dissertations*. 6<sup>th</sup> ed. Revised by John Grossman and Alice Bennet. Chicago: University of Chicago Press.

University of Cape Town

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Prometheus Bound:  
The evolution of structure in relation to knowledge

Design Research Project APG5058S

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

By George Safi

17<sup>th</sup> - October - 2012

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This section deals with the focus of the thesis as well as a summary of preceding research done earlier in the year and some of the emotive attempts at creating space before and after the research was conducted. The early exploration was based on the stereotomic and tectonic (material and formal qualities) and was conducted with a generic hypothetical site in mind and only a loose idea of the buildings function

## Site & Program

25- 28

This section deals with site selection and program development. Both of these aspects were handled quite late in the year, however because the chosen site matched the hypothetical one quite closely the pre-developed abstract formal ideas applied readily to the site and were then tailored along with the development of the program to create a relevant building

## Design Exploration

29- 56

This section deals with the development of both the program of the building and its formal presence. Exploration was conducted mainly using drawings and models. The work is displayed in a roughly chronological order. The final building is not featured in this report as it is still a work in progress, but many of the ideas central to its creation are explored in this section

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# Preface

## Personal taste

The initial stages of my thesis inquiry began with an idea that was not purely architectural but was also a matter of personal taste. During a studio exercise early in the year we were asked to give an indication of the type of architecture that interested us. I responded by collecting images of hybrid and imagined buildings, created by artists not trained architects, that suggested qualities of both old and futuristic design.

The one thing that they had in common was that they all possessed very evocative forms and even those that were futuristic all seemed to have an underlying adherence to structure. I began to wonder for the first time in my architectural career what it was that drew me to certain forms and not to others. Throughout my studies in architecture, we had devoted so much time to analysis, economic and psychological investigation, social issues and the creation of 'relevant' buildings that I had never had the opportunity to fully realize (being a predominantly visually oriented person) what forms were most important to me and why.

I soon came to realize that the buildings with which I best identified were ones that very clearly displayed their structure and the way that structure works. Whether it is a heavy and solid temple of Roman or Greek origin, or a soaring and skeletal cathedral of Gothic design. The fact that I can imagine the physical forces being dealt with in these buildings and immediately appreciate the physical form that they take as a consequence was an indication to me of one of the aspects of the built environment which I find most important, intelligibility.

In terms of building technology the facet that interests me is not a particular area, but it's overall progression. I find it very interesting that much as natural organisms have evolved to become more efficient in dealing with their surroundings with the ultimate goal of survival, so too has this man made entity (technology) evolved to allow us to create more efficient buildings with the ultimate unchanging goals of "Utilitas, Venustas, Firmistas"

University of Cape Town



Archi01 - Speed painting depicting a futuristic observation point



Squad - Speed painting depicting a futuristic city

Wakeup - Speed painting depicting isolated settlement at a river crossing



# Preface

## The myth of Prometheus

Technology is a hallmark of human civilisation and has become a crutch on which we rely heavily. In the built environment, it allows us to subvert the elements and protect ourselves from a planet that does not always freely allow our inhabitation. With the focus of this project being on using technology to create spaces that are modern and yet connected to the user on a primal level, I felt that the story of the Prometheus was very applicable. Over the course of the year the project has evolved from a sculptural entity without program to become a user oriented scientific center. Personally I would identify the finished building as a modern day temple to Prometheus.

Prometheus is a Titan, culture hero, and trickster figure who in Greek mythology is credited with the creation of man from clay and the theft of fire for human use, an act that enabled progress and civilization. He is known for his intelligence, and as a champion of mankind.

Zeus, king of the Olympian gods, sentenced the Titan to eternal torment for his transgression. The immortal Prometheus was bound to a rock, where each day an eagle, the emblem of Zeus, was sent to feed on his liver, only to have it grow back to be eaten again the next day.

In the Western classical tradition, Prometheus became a figure who represented human striving, particularly the quest for scientific knowledge, and the risk of overreaching or unintended consequences. In particular, he was regarded in the Romantic era as embodying the lone genius whose efforts to improve human existence could also result in tragedy: Mary Shelley, for instance, gave *The Modern Prometheus* as the subtitle to her novel *Frankenstein* (1818).

Thy Godlike crime was to be kind,  
To render with thy precepts less  
The sum of human wretchedness,  
And strengthen Man with his own mind;  
But baffled as thou wert from high,  
Still in thy patient energy,  
In the endurance, and repulse  
Of thine impenetrable Spirit,  
Which Earth and Heaven could not convulse,  
A mighty lesson we inherit:  
Thou art a symbol and a sign  
To Mortals of their fate and force;  
Like thee, Man is in part divine,  
A troubled stream from a pure source;  
And Man in portions can foresee  
His own funereal destiny;  
His wretchedness, and his resistance,  
And his sad unallied existence:  
To which his Spirit may oppose  
Itself—and equal to all woes,  
And a firm will, and a deep sense,  
Which even in torture can descry  
Its own concenter'd recompense,  
Triumphant where it dares defy,  
And making Death a Victory.

Excerpt from the poem *Prometheus*  
by Lord Byron (George Gordon), 1816



# Thesis Inquiry

## Prometheus bound

The purpose of my thesis inquiry is the way in which materiality and structure have changed over time (while maintaining the same goals of stability and safety) to reflect our increasing understanding of the natural forces of our world (our level of technology). I have attempted to liken this to the way in which all things, especially living beings, have evolved to better deal with their circumstances, becoming more elegant and complex even if they seem to take on simpler more efficient forms.

In order to do this I have chosen four typologies, that represent to me, the pinnacles of the progression of architectural form from the heavy and solid (Stereotomic) to the light and open (Tectonic). These typologies are the Cave (or ground structure), the Greek Temple, the Gothic Cathedral and certain projects from the work of modern architects who rely heavily on advanced engineering (an example of which is Santiago Calatrava).

These typologies were chosen because they possess very powerful and evocative material presence and they are also large scale buildings of civic importance. A theoretical and technological investigation into these typologies was conducted to discern how these buildings are able to produce impressions on the user with which the user identifies very deeply. They revealed that one of the doctrines central to their design and construction is their respect and advancement of simple natural principles and the use of engineering (empirical and later calculated) to decode and apply these principles in interesting ways.

The theoretical and technological investigations were conducted using a comparison of Gothic Cathedrals and Calatrava's work. The Gothic Cathedrals were taken as a representation of the condensed knowledge of the ancient world into a way of making that began to reveal knowledge of structural principles beyond the empirical methods of the ancients (Greeks and Romans especially).

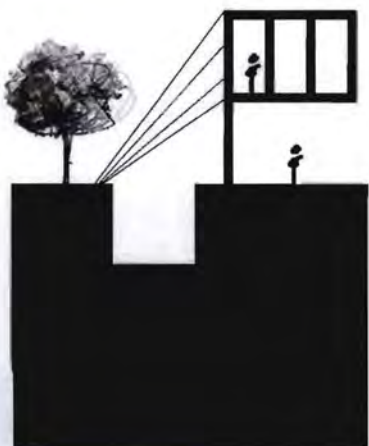
Some of the questions raised by this inquiry were:

How do we construct a building that allows a user (who has not been trained in architecture) to immediately identify why the building looks the way it does?

What spatial and material qualities would a building that encompassed aspects from each of the typologies be?

Is it possible to investigate older methods of building without introducing unnecessary inefficiency into a building?

Has the progression of knowledge simply given us more choice or has it impacted us in a way which is intrinsic to how we create built form?





The solidity and sculptural quality of caves, greek and Gothic architecture



The balance of stereotomic and tectonic within the structure as a whole and each component



A natural legibility that will allow the user to understand why his/her surroundings have taken such a form



A monasterial aspect that lends itself toward discovery and enlightenment

# Thesis Inquiry

## Qualities of space

While investigating the ways in which structure has been addressed from both a sculptural standpoint and that of pure engineering it is important to keep track of the qualities that each of these methods leads to, and discern what it is we wish to achieve with the use of either method.

For example, the work of Gothic architects and Santiago Calatrava have a remarkable similarity in their use of efficient skeletal forms, however Gothic cathedrals have an overwhelming visual aspect that is afforded to them by their ornate sculptural form (Grodecki p. 17). This is in contrast to the work of Calatrava whose complex calculation is usually hidden in the deceptive simplicity of the space created by his structures. The image below shows the Cathedral of Amiens completed in 1270 on the left and the Milwaukee Art Gallery completed in 2001 on the right.

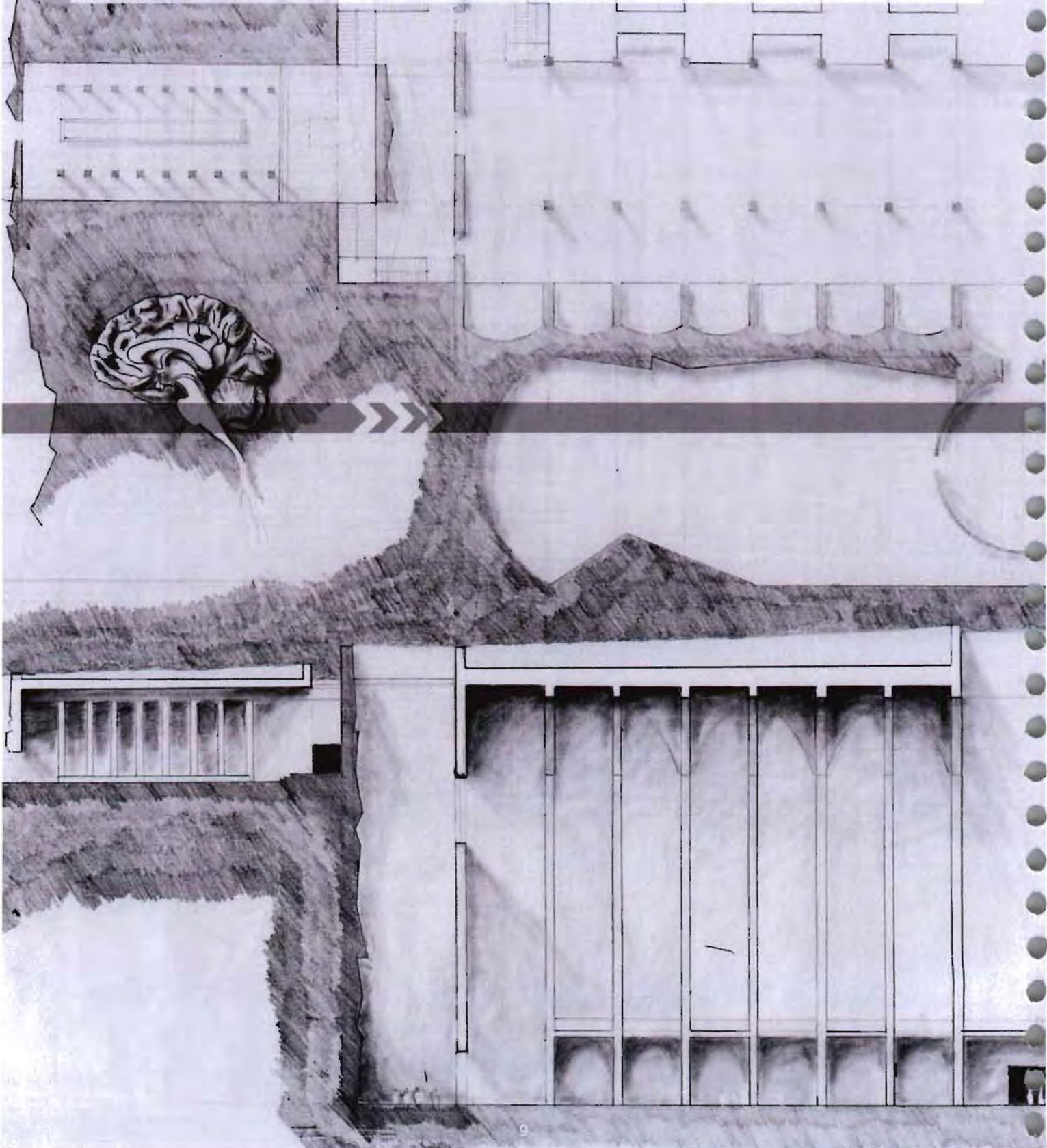


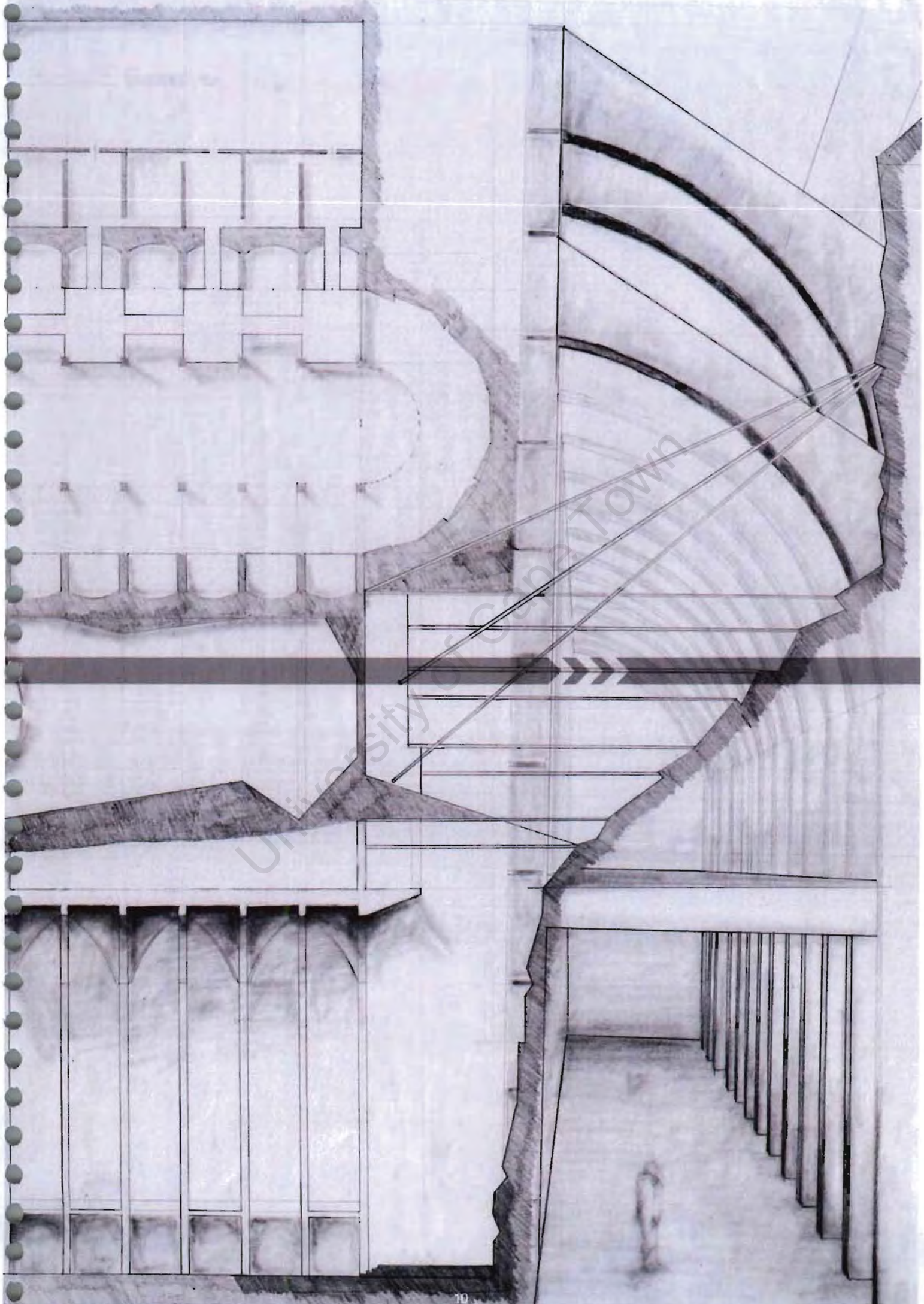
# Thesis Inquiry

## Emotive response

This images shows an emotive sketch created early in the year before site and program selection. The sketch shows the solid, carved out quality which I have attempted to retain throughout the project with the knowledge that in future it would be contrasted by a lighter section of the building. The goal would be to create a building that leads the user through a series of experiences that take them from the solid to the light and gives them an understanding of both.

It was also at this point that ideas about the function of the building started to develop. The idea of gaining knowledge, and the building having a monastic quality narrowed down the options for the program but it still remained open ended.





# Thesis Inquiry

## Emotive response

This rendered image shows one of the smaller spaces from the sketch plan on the previous page. This image was an attempt to depict the light quality and atmosphere I would want a user to experience as the beginning of their journey. This would be a heavy buried space with light from above leaving no doubt that they were in a space set into the earth.





# Thesis Inquiry

## Using Research to focus the project - the Gothic solution

*"In no other order of architecture do we find these ingenious and practical means of solving the numerous difficulties that surround the constructor living in the midst of a society whose needs are complicated in the excess. Gothic construction is not, like antique construction, immutable, absolute in its means; it is supple, free, and as inquiring as the modern spirit: its principles permit the use of all the materials given by nature or industry in virtue of their own qualities; it is never stopped by a difficulty; it is ingenious: this word tells all."*

Viollet-le-Duc, 1988

The work of architects such as Calatrava, whose projects almost always have a bias towards highly engineered construction solutions is what I believe to be an evolution of the Gothic era in architecture. The Gothic era was one in which master builders were beginning to analyze the structural solutions that came before them (from the Romanesque and Carolingian periods) and improve on them to create spaces that were highly efficient, and in this efficiency allowed the ecclesiastical goals of inspiring height and natural light to be achieved (Hearn p.174).

However unlike contemporary architect-engineers who are trained in engineering theory and calculation, the design of the Gothic Cathedrals was carried out in an empirical method by the master builders who used geometrical shapes that had availed them in the past. The major developments of this period that allowed for the creation of these lofty structures were three simple construction elements (Kurrer p. 200). The pointed arch, the ribbed vault and the flying buttress. These are depicted in their positions within the overall structure in the illustration to the right.

Both bodies of work depict an inherent and delicate balancing of the architects' artistic desires with the creation of efficient and functional structures within the technological and resource constraints of the time, and in most cases, the pushing of boundaries to adjust that balance. An inquiry into the technical aspects of their work yields a profound and enduring principle; the more a structure is able to imitate the natural state in which it would achieve such a form (the more efficient it is), the more likely it is to be understood and accepted based on its truth to nature.

As described by Frampton, the architect-engineer (specifically Calatrava) represents a creation of the "*Clinameri*" or turning point in the design of highly efficient and structurally advanced buildings that allows them to transcend the realm of pure engineering or art (Bloom p.14). He exists at the '*fulcro*' in the available spectrum of architectural and engineering practice. It is these qualities that arguably position Calatrava as one of the few contemporary architects who has been able to maintain a method of working, a theoretical view and a formal outcome that is eminently comparable to the master builders of the ancient times (Blaser p. 9). However because of the increase in engineering theory and the its critical application, unlike Gothic architects, Calatrava has been able to identify exactly what he feels it is that creates an evocative building and hone this into an ethos that he uses continuously throughout his work.

The three defining elements of the Gothic era of construction, the ribbed vault, flying buttress and pointed arch



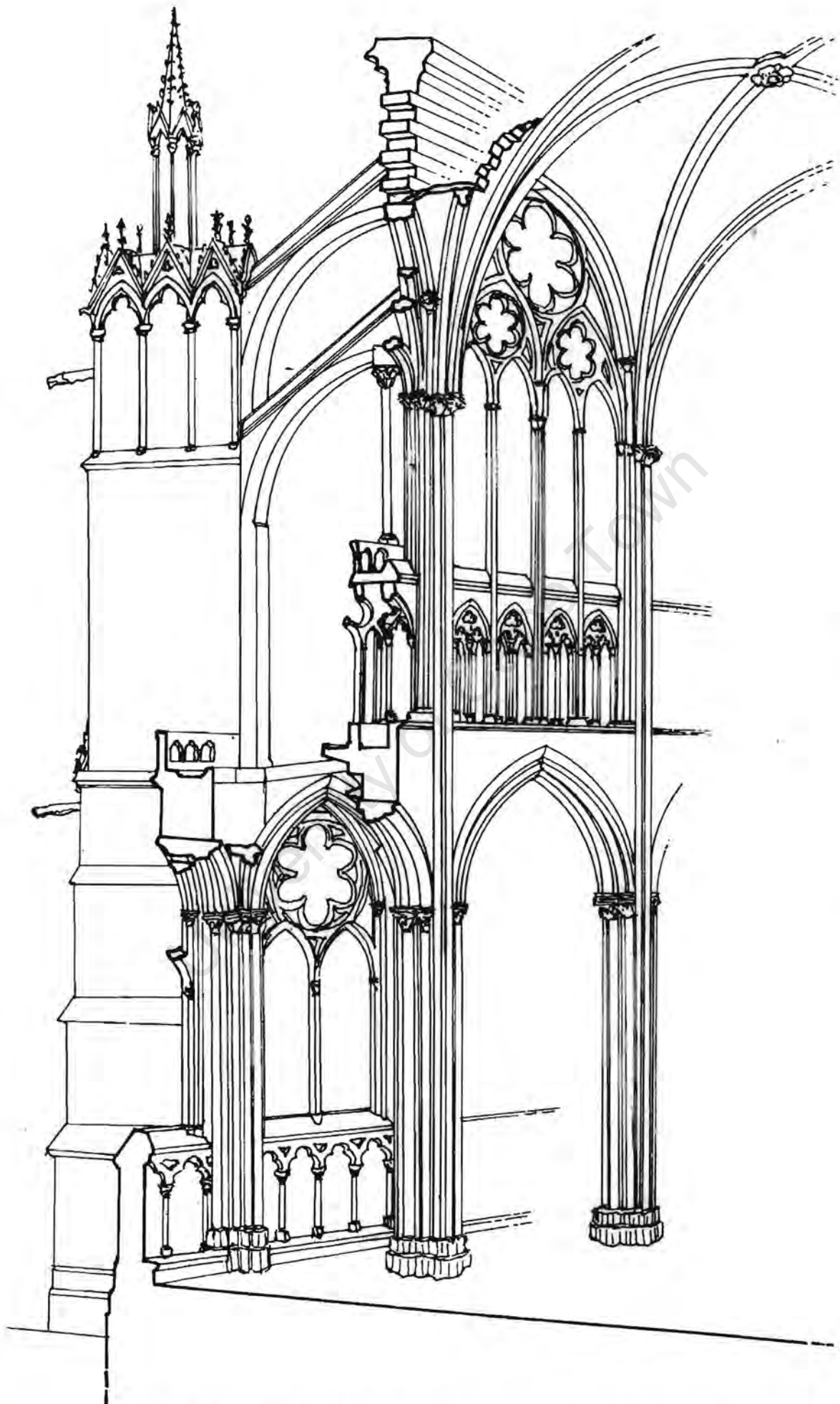


Diagram of Saint Denis Cathedral, the first Cathedral to display all three Gothic features construction completed 1144

# Thesis Inquiry

## Nature is both mother and teacher

*"Natura mater et magistra" - nature is both, mother and teacher. This motto has guided all my work. There are many lessons one can draw from nature, real guiding rules and metaphors from observing plants and animals"*

Santiago Calatrava, 1988

The principle that nature creates beauty in its efficient use of materials has a secondary aspect for an architect. Nature also presents a set of physical rules (forces) that has been laid before us. Architecture is both our interaction and shield from these forces. Therefore when this principle is applied to buildings, we create structures that are both efficient and engaging, because as human beings we are able to interface with the buildings on a primal level.

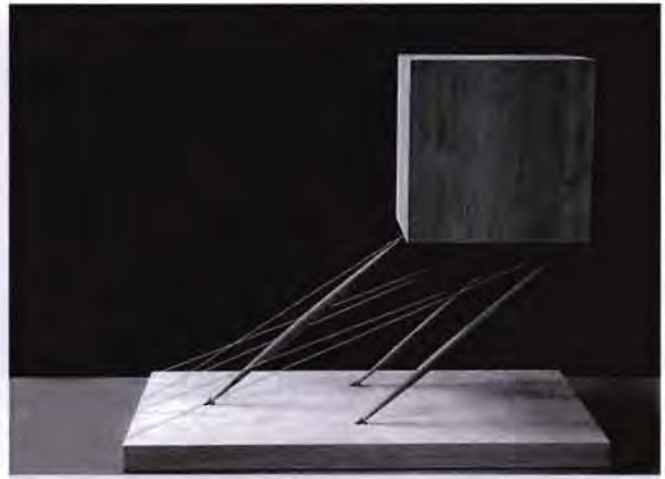
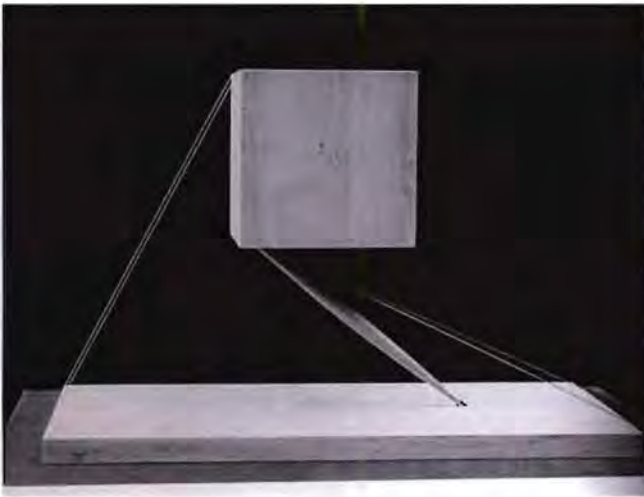
In his *Poetics* Aristotle writes "*e techne mimeitai ten phusin*" which translates to "*art imitates nature*". The significance of this is Aristotle's understanding of nature not purely as the physical world that surrounds us but the principles which govern the world and make it possible (Porphyrios, p. 29). Aristotle refers to this understanding of "*imitation*" or "*mimesis*" not as simple copying but as the cognitive practice that leads to knowledge about the world (Porphyrios p. 60). This concept is important as I believe it is central to understanding the key notion of Gothic and 'Calatravic' architecture

An examination of Calatrava's work reveals, in some instances, there is a direct abstraction of a natural shape in order to gain the benefits of its form for construction purposes, as shown in the sculpture below. The uniform reduction in size of the components hints at the increasing load created as the 'tentacle' extends outwards, thus diminishing the economy of the cantilevered portion. Simultaneously we understand that the base must be thicker because it carries the load of the entire extension. All of these principles are contained within a simple inert, abstract sculpture of steel and stone. However Calatrava does not stop at simple abstraction and imitation. He goes on to achieve true mimesis by understanding the forces governing the balance of the physical materials, and not just the materials themselves.

In the sculptures shown on the opposite page we see what seems to be a reversal of the adherence to natural laws shown in the Extension Sculpture. However, because the wooden cube is being kept aloft in a stable yet highly unusual manner, it is obvious that these sculptures represent not a violation, but a much deeper understanding of the forces at play within the arrangements displayed. Arrangements such as these lead to tension in all connotations of the word. This is one of the aspects of Calatrava's work that I find most fascinating and eminently applicable to architecture.

**Extension - Sculpture by Calatrava showing size diminishing with distance from base**





**Understanding Force - Series of sculptures by Calatrava showing interesting variations of force employed to keep a wooden block held aloft in a stable position**

Architecture is meant to be experienced, as such if a structure easily explains itself to a user then this may be considered a positive thing. However if the structure can force a user to think about their surroundings and how they work (even if it is by creating a feeling of uncertainty) then this is even better as it creates a deeper awareness and understanding of one's surroundings and experience of the built environment.

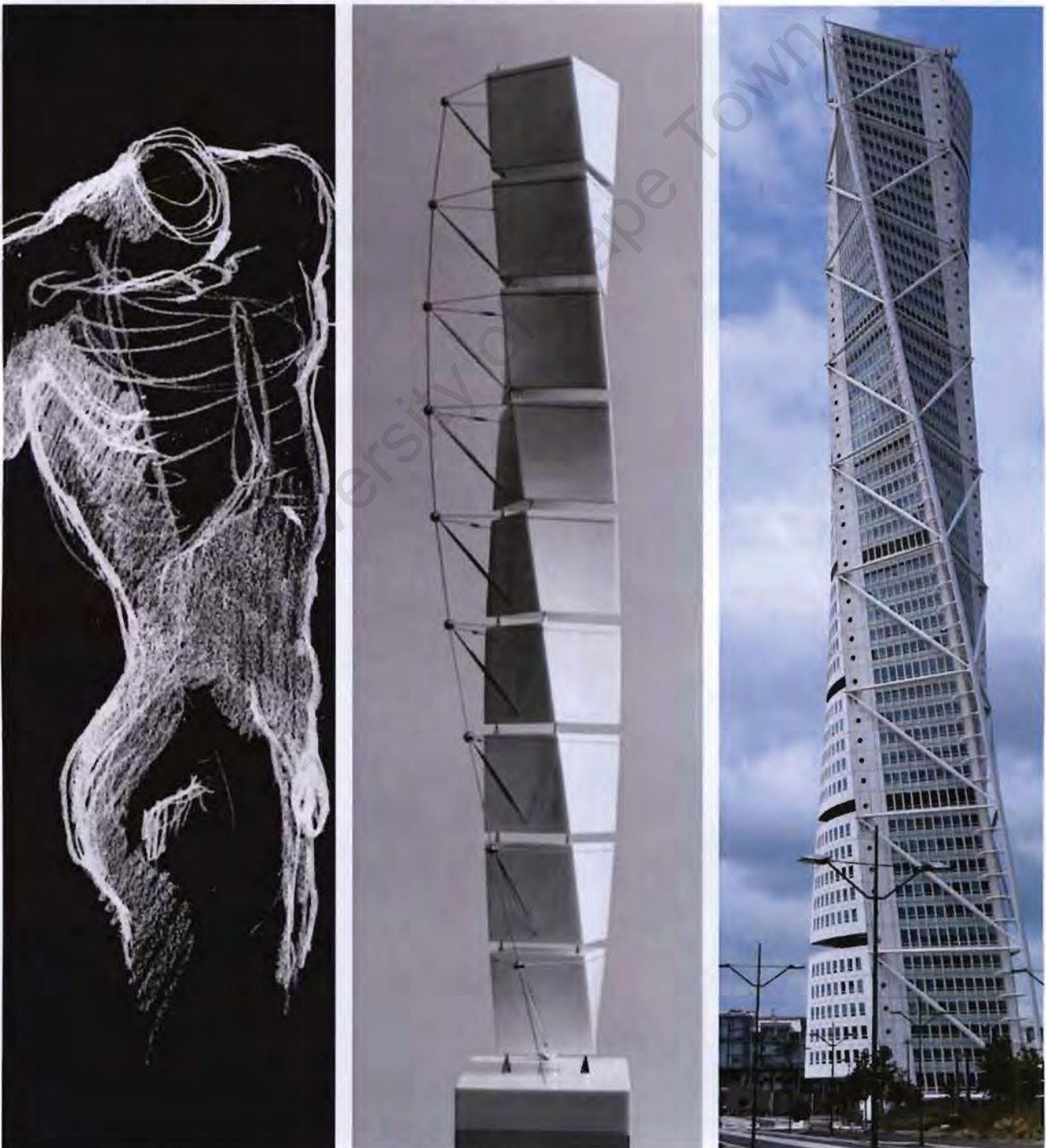
# Thesis Inquiry

## Application to buildings

Calatrava's buildings become a very fine balance between compression and tension, balancing the forces within the buildings as a whole as well as sculpting individual components to ensure efficiency and create shapes with visual interest. Two buildings that are of particular interest are The 'Twisting Torso' building in Malmo Sweden completed in 2001 and the proposal for the Cathedral of Saint John in New York put forth in 2000.

To me these projects best represent Calatrava's keen use of form and metaphor in a manner that bridges the gap between sculpture and architecture, making sculpture useful, and making architecture interesting.

Conceptual sketch, model and building of the 'twisting torso'





# Thesis Inquiry

## Exploration after research

This image shows another emotive response toward the creation of a building combined with some of the ideas gleaned from the investigations into the Gothic and Calatrava. Once again a large portion of the building is set into the ground, but this is contrasted by a lighter element that hangs and grows downward as a stalactite would. This represents a reversal of the usual order of heavy and light.

Lighter elements generally originate from a heavier base and move upwards. In this case there is the creation of a 'floating' heavy base from which a light crystalline structure emerges downwards to interact with the solidity of the earth.

Additionally ideas about program were beginning to move towards a repository of knowledge, archive or scientific research facility, with the earth acting as a metaphor for obtained knowledge (things of which we are certain) and the lighter built element acting as a 'laboratory' or a place where we create new knowledge of which we are uncertain, hence the tenuous suspension.

TENSILE

COMPRESSIVE

Town

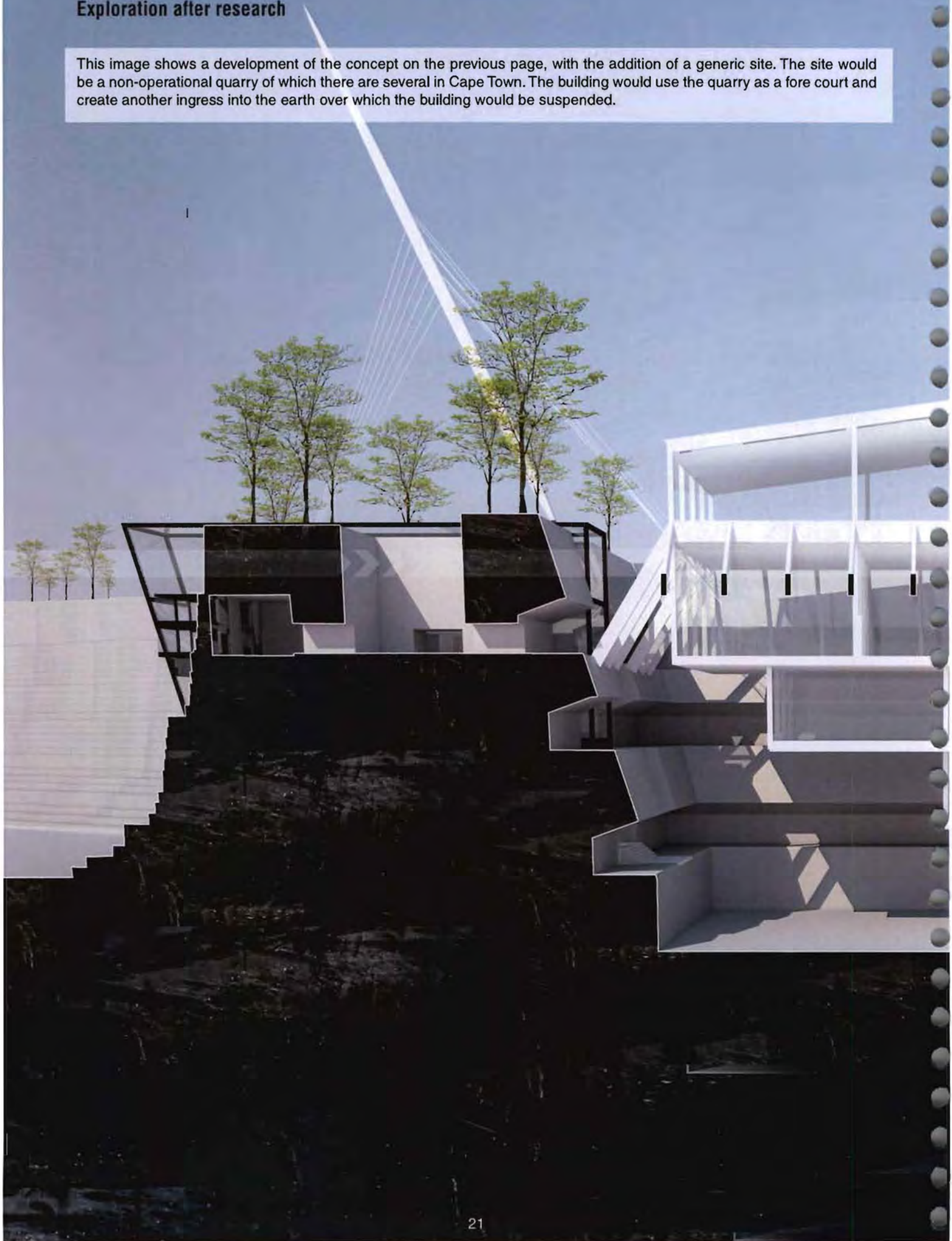


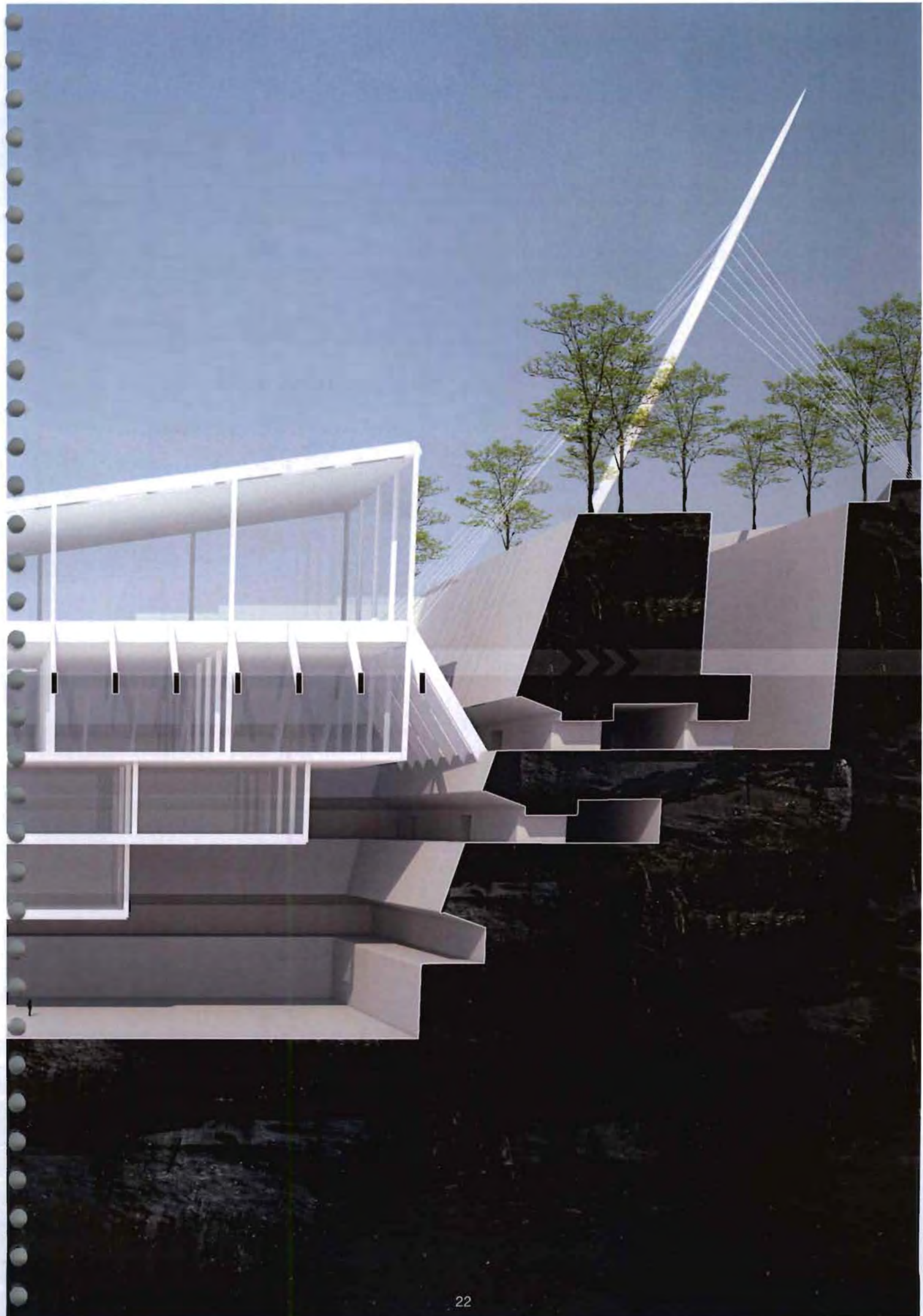
TECTONIC  
STEREOTOMIC

# Thesis Inquiry

## Exploration after research

This image shows a development of the concept on the previous page, with the addition of a generic site. The site would be a non-operational quarry of which there are several in Cape Town. The building would use the quarry as a fore court and create another ingress into the earth over which the building would be suspended.





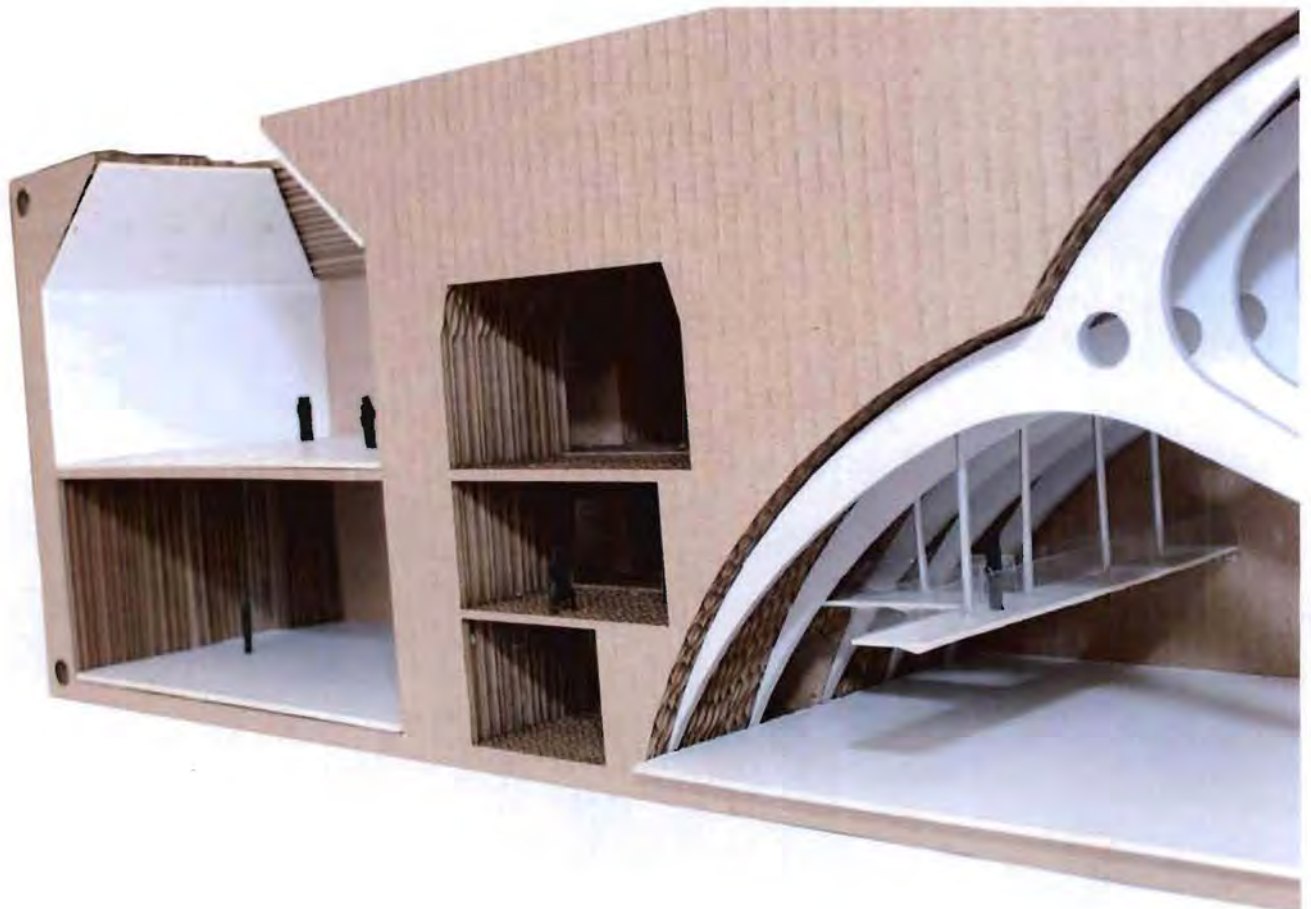
# Thesis Inquiry

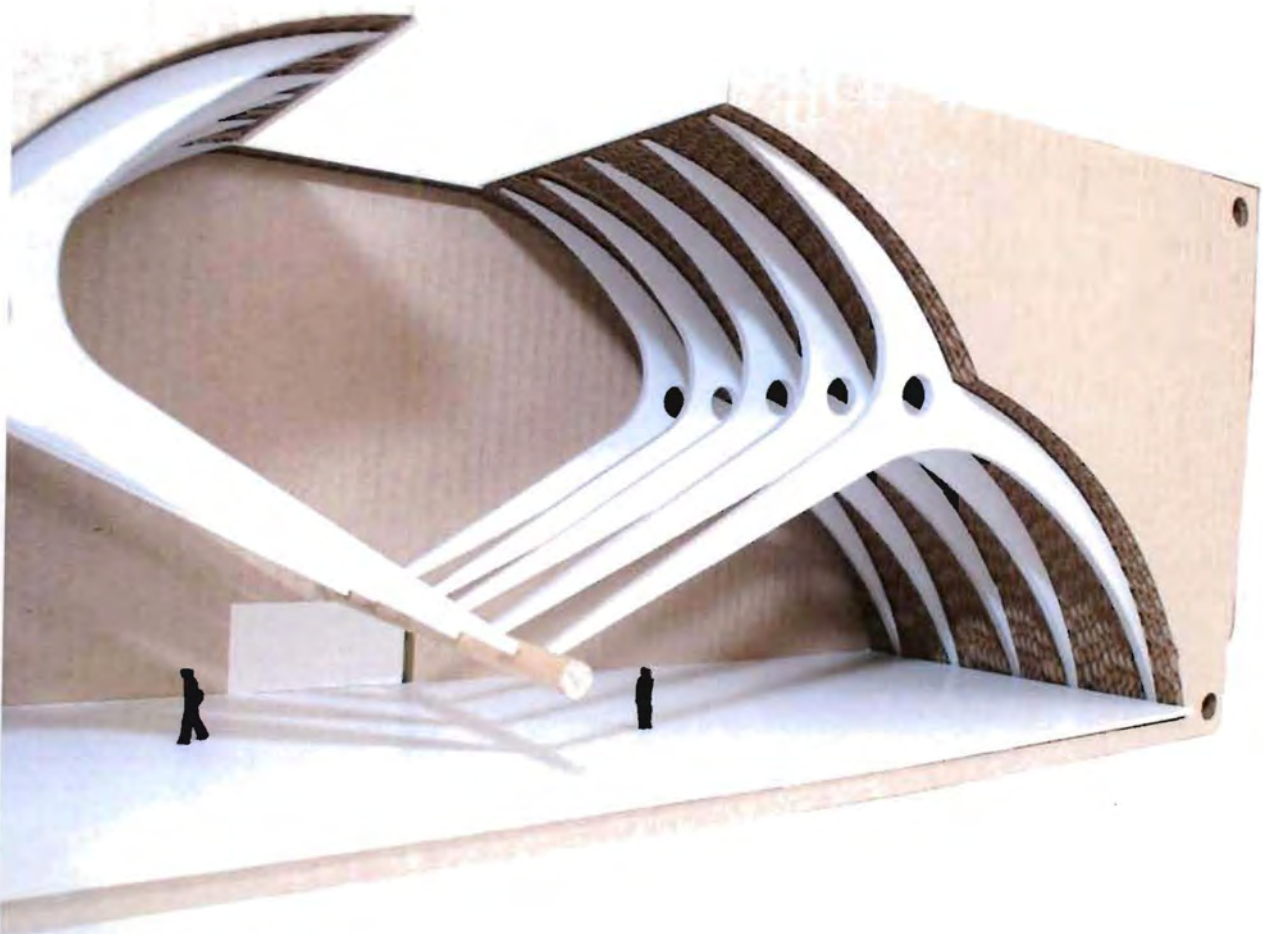
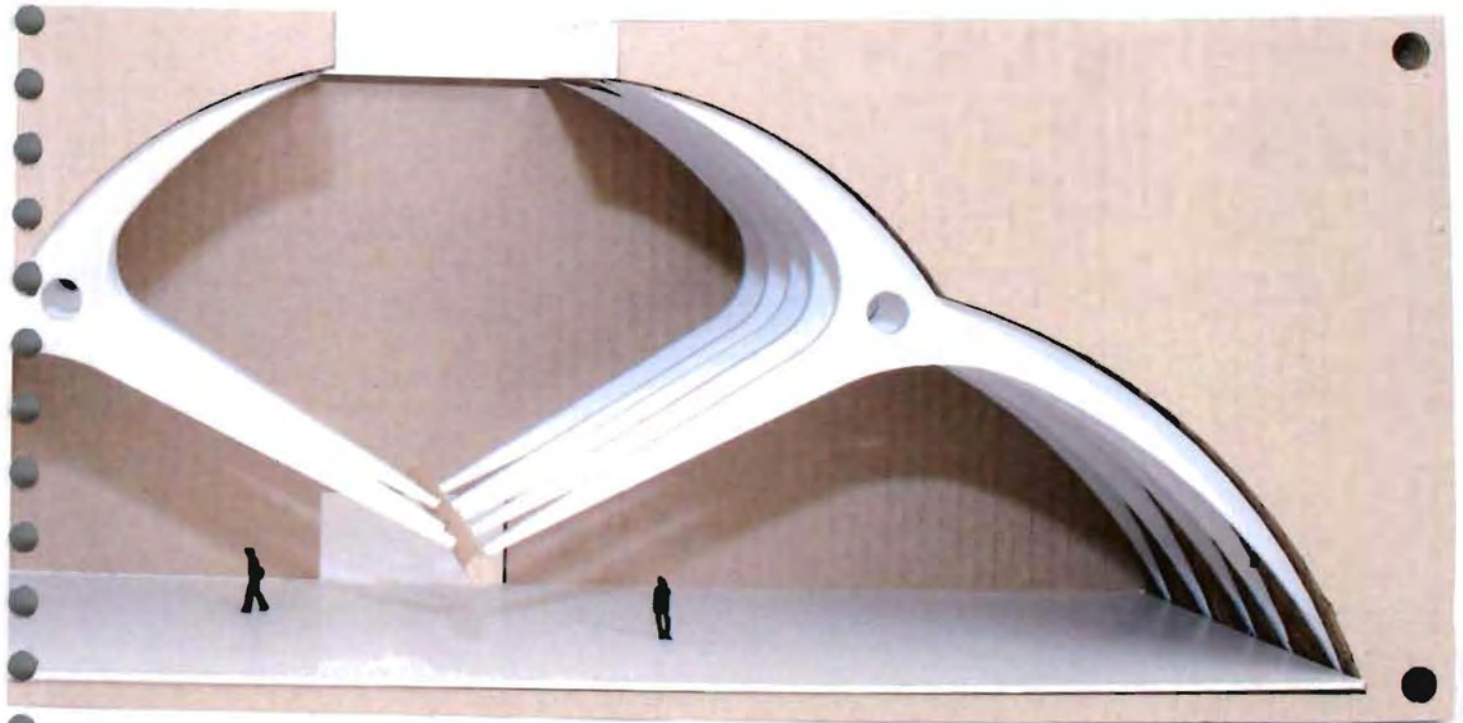
## Exploration after research

These images once again show a conceptual model of the types of spaces the building would contain. This time the entire building happens below ground level with solid carved out spaces. Some of the larger spaces would then have the opportunity to show the forces required to create that space by displaying the structural elements used to hold the earth in place.

One of the criticisms of the two previous conceptual models faced at the mid-year review, was that buildings such as those have been created before (such as Frei Otto's Munich Olympic Stadium) and that the separation between the compressive and tensile (heavy and light) was too abrupt.

This was a development from the previous models with regard to the interaction between the heavy and lighter elements. Instead of a complete separation they now have the opportunity to directly interact in their structural function and create more intelligible spaces which was one of the original goals of the project.





# Site

## Site Location and Choice

As mentioned previously it was decided that the site for this project would be a quarry. This was done for several reasons.

The quarry may be used to represent the first two 'pinnacles' of structural development mentioned previously, the cave (earth structure) and the megalithic civic building (greek temple)

A quarry is in itself a symbol of human endeavor, in terms of both physical labour and metaphorically in terms of us as a race digging to unearth knowledge (which takes us back to the story of Prometheus).

A stone quarry would provide an excellent base for the exploration of the stereotomic (heavy) and the tectonic (light) as it would readily provide the stereotomic material in the solidity of its mass.

With the program leaning toward a place to store and create knowledge, a quarry once again offers an effective metaphor as a storage space for the things that we are certain of and base our more tenuous knowledge upon.

The particular quarry that was chosen is located on the North side of Table mountain on De Waal drive which is one of the major transit routes between The University of Cape Town (UCT) and Cape Town City Center. The quarry face is composed of mostly sandstone with some slate deposits. It was operational till 1970, and since then has been taken over by the Cape Practical Pistol Club in 1976. It has been used as a gun range since then.

Given the location of this site, it would be highly beneficial for the facility to be linked to UCT. The site is already on a Jamie Shuttle Route (UCT's free student transportation service) that moves students between UCT upper campus and the Extended UCT Campus of the Michaelis School of Fine Art. This route is highlighted in blue.



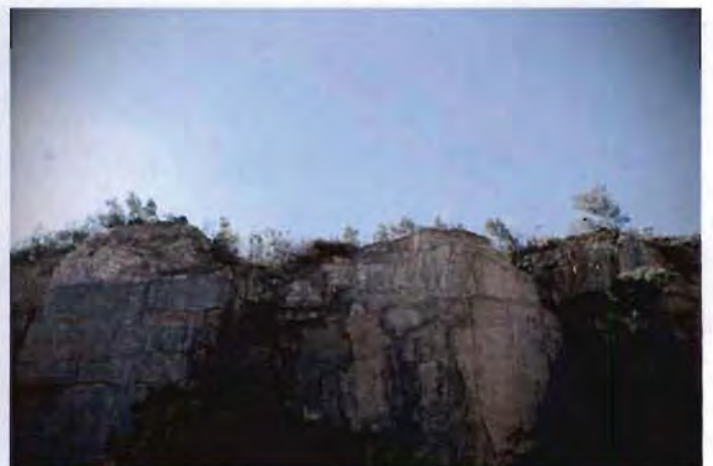


0 10 20 40 60 80 Meters

# Site

## Images of site and surrounds

Images of the site and views out over the city towards the harbour.





# Design Exploration

## Positioning of building and development of program

One of the initial ideas for the placement of the building was to leave the quarry face untouched and position the building within the cliff face as shown in the sketch plan on the opposite page. This would allow for the creation of carved out solid spaces that could then lead to lighter elements that clip onto the cliff face.

The idea behind this approach (given the abundance of rock mass at the site) was to obtain the 'monastic' and solid qualities of several ancient buildings that were constructed in this way, such as the rock city of Petra in Jordan or the Kailashnath Temple in Maharashtra, India. Both of these buildings deal with religious veneration and were places of introspection and focus. This takes us back to the original 'qualities of space' mentioned in the Thesis Inquiry. Using the solidity and monumentality of the earth to create a primal place.

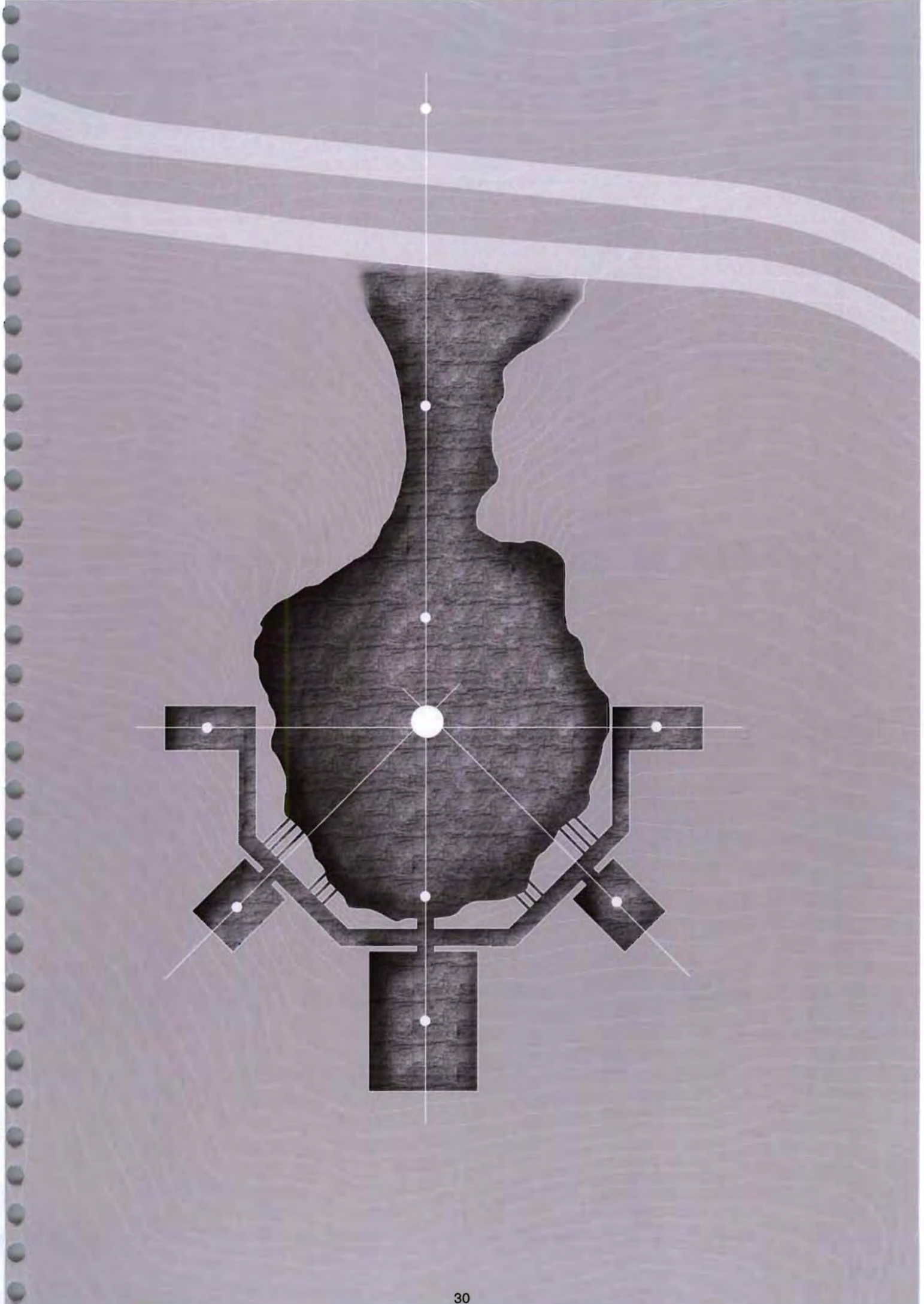
The idea of 'veneration' is also appropriate when applied to a building whose purpose is the furthering of knowledge. Unusually, the program for the building began to develop during the initial massing exercise. An emotive massing exercise led to a fragmented series of spaces that are then linked by a circulation route. In terms of knowledge, these different places could represent the three aspects of creation (or discovery), storage and dissemination.

City of Petra



Kailashnath Temple

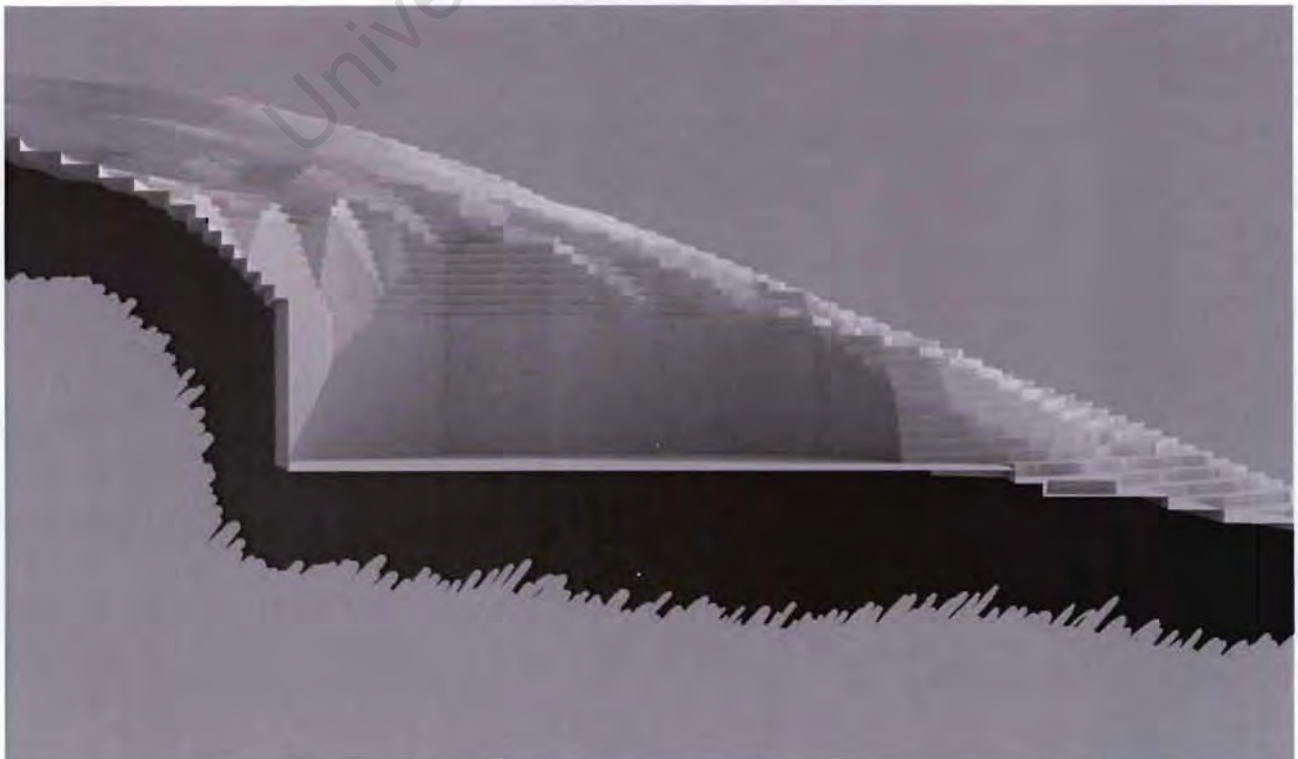
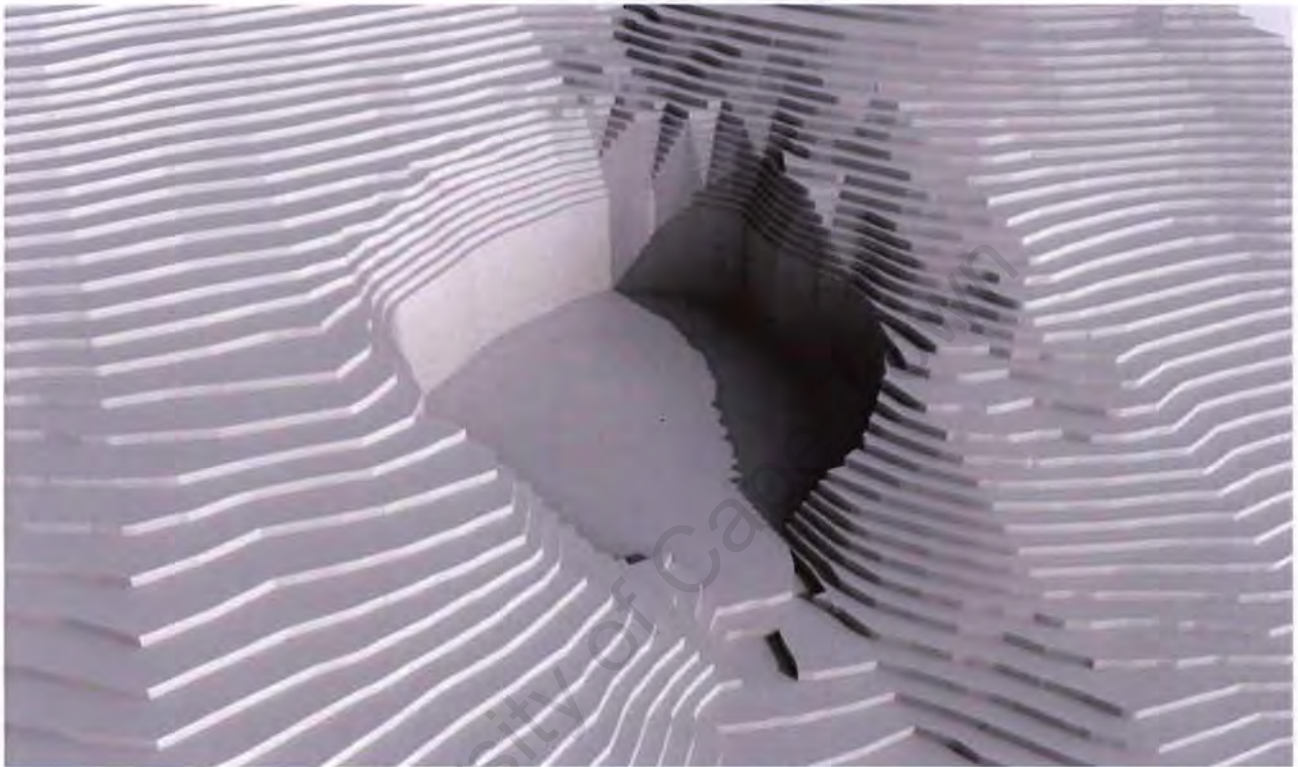




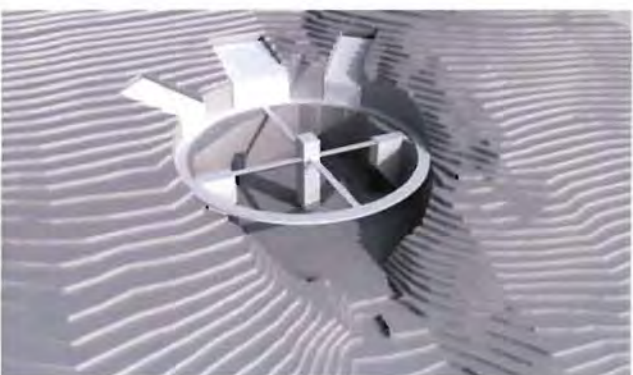
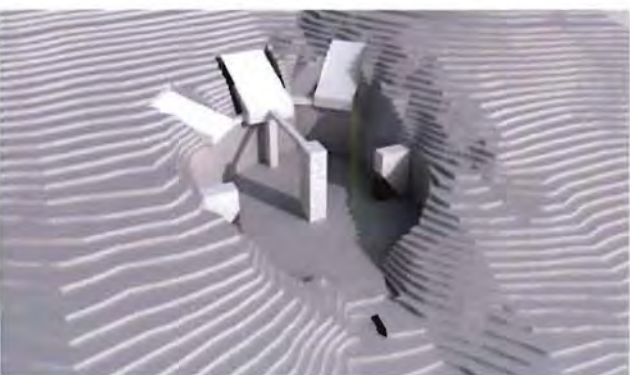
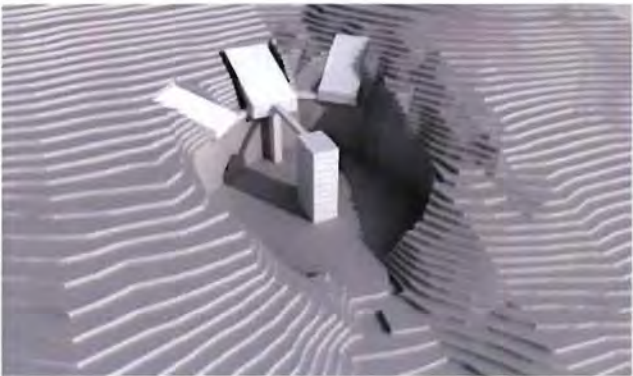
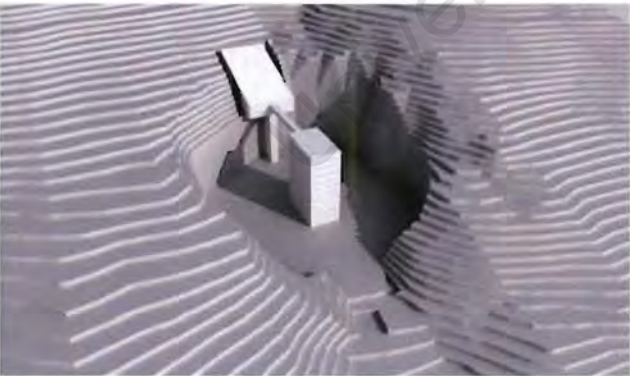
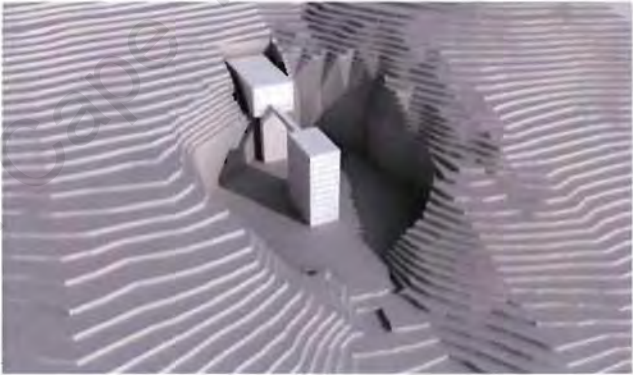
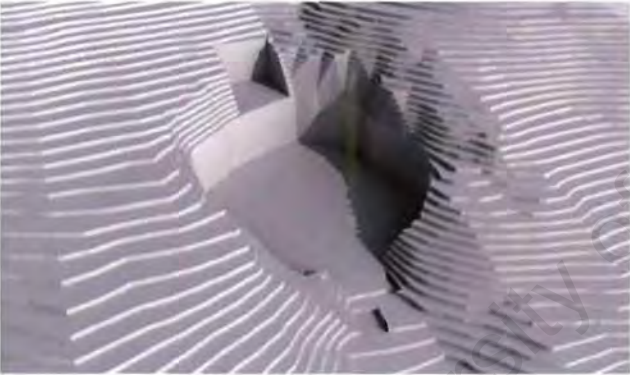
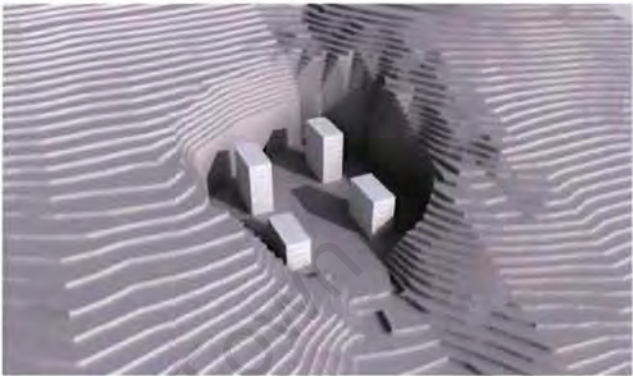
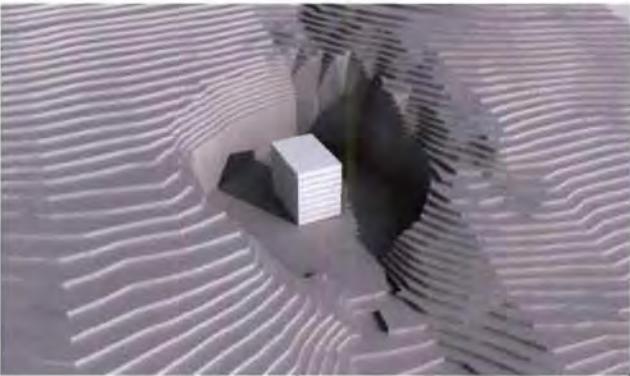
# Design Exploration

## Positioning of building and development of program

The positioning of the building became an interplay between incision into the cliff face as well as interaction with free standing and conjoined elements within the perimeter of the quarry itself. The positioning always kept the center of the quarry as a point of focus. And the entrance to the quarry was always kept clear. At this stage the building was very fragmented, with various parts of the still undetermined program splintered over the site to ensure that users would have a chance to experience the entire site.



As the program was clarified it was decided that the description that best fit this building was that of a scientific center. The requirements that began to develop, were for spaces such as a laboratory, library, and lecture and exhibition spaces. With this building being identified as a center of knowledge and its propagation, these types of spaces would satisfy the three important aspects of discovery (laboratory), storage (library) and dissemination (lecture theatre and exhibition).





Library within cliff face would  
represent 'obtained' knowledge

# Design Exploration

## Form and program interaction

Another early exploration, keeping in mind the clarified function of this building as a scientific center. This model shows a large portion of the building contained within the cliff face, with a 30 meter cantilevered volume protruding from the face.



Exhibition and lecture theater spaces would be cantilevered from the cliff face. Representing the tenuous nature of new knowledge

The cantilevered portion would create a pavilion of nothing in front of the building representing technology as a force of freedom, but also creating a sense of the danger should it (technology) fail

# Design Exploration

## Incorporating the human body into the project

As stated previously and expanded upon during the research phase of this project, one of the best places to look for interesting structural and formal solutions is in nature. Our bodies are an expression of physical 'appropriateness' and are a well adapted example of solid and light elements complementing each other that our high level of technology (as a species) has been unable to duplicate effectively.

The sketch shown on this page was an emotive image depicting the relation of the body to the solidity of the earth in this project, and using the body as an example of a very 'technologically' advanced entity that allows us to escape the rigid solidity and transcend the purely compressive structural systems that are used in almost all buildings.

However in order to draw on the body as a useful structural tool it is important to observe it doing work, or in conditions that are similar to those that we face in our built counterpart.

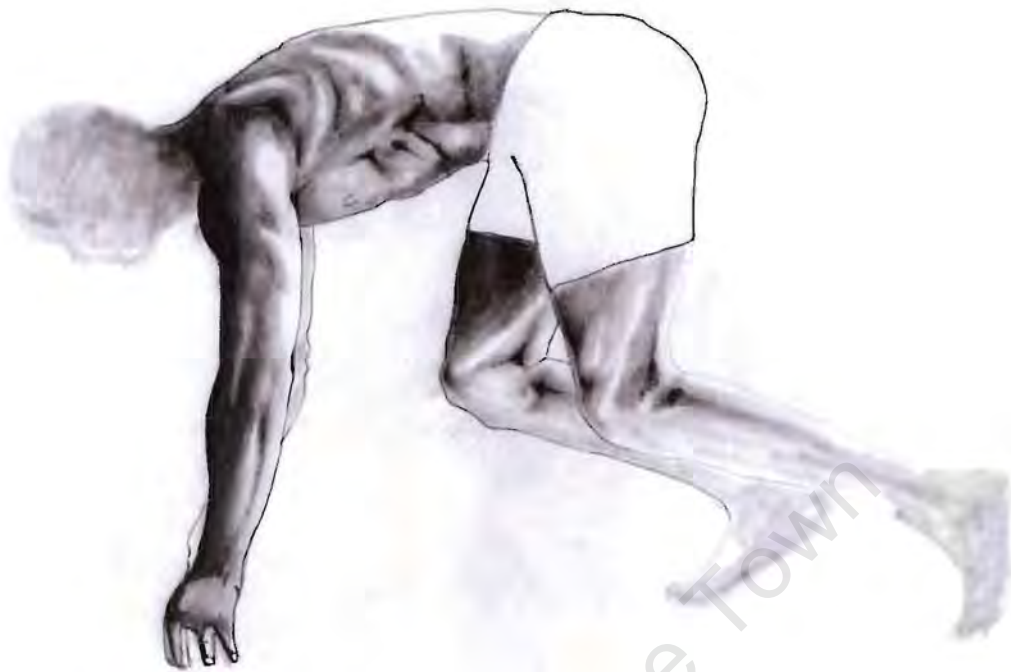




If we consider a runner in the starting position, his stance is one of compression and potential. Muscles tightened but hunched. This is comparable to a compressive structure, such as a wall or a column, some of the most common structural features. Using the analogy of the I began to think of more creative solutions to the question of structure. As this applies to the project the runner in this position represents the solidity, the cliff face and the ground, the compressive forces of the part of the building that resides within the rock.

# Design Exploration

Incorporating the human body into the project



Once the runner raises his body there is a shift from compression to tension, as he really tightens his muscles to make sure that he is ready to go. With the increase in tension there is also an increase in potential. What would a structure that represents this be? It is an evolution of the previous stage but still possesses some of the traits from before. In a frozen moment, the old and new work in concert to create something entirely different.



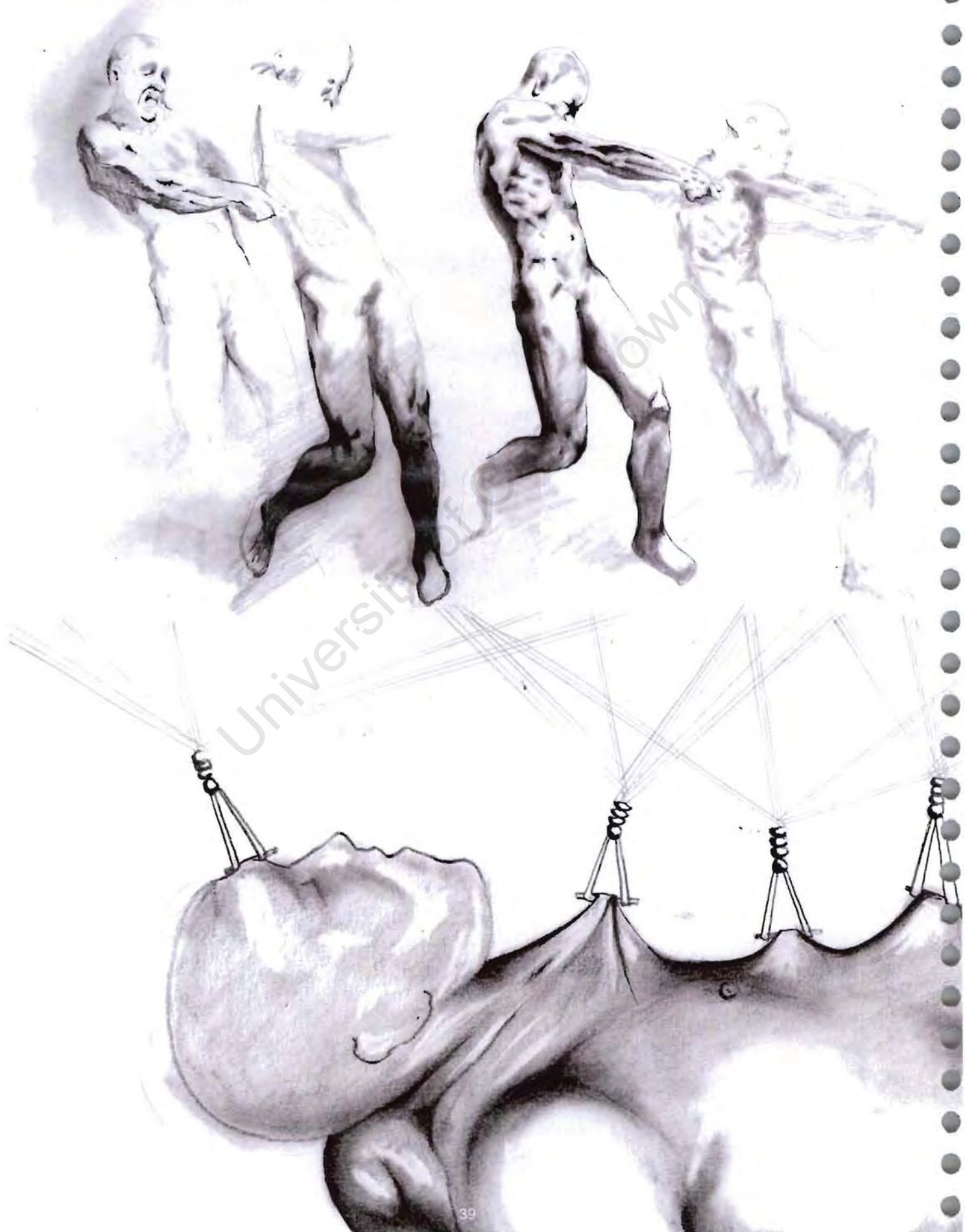
University of Cape Town

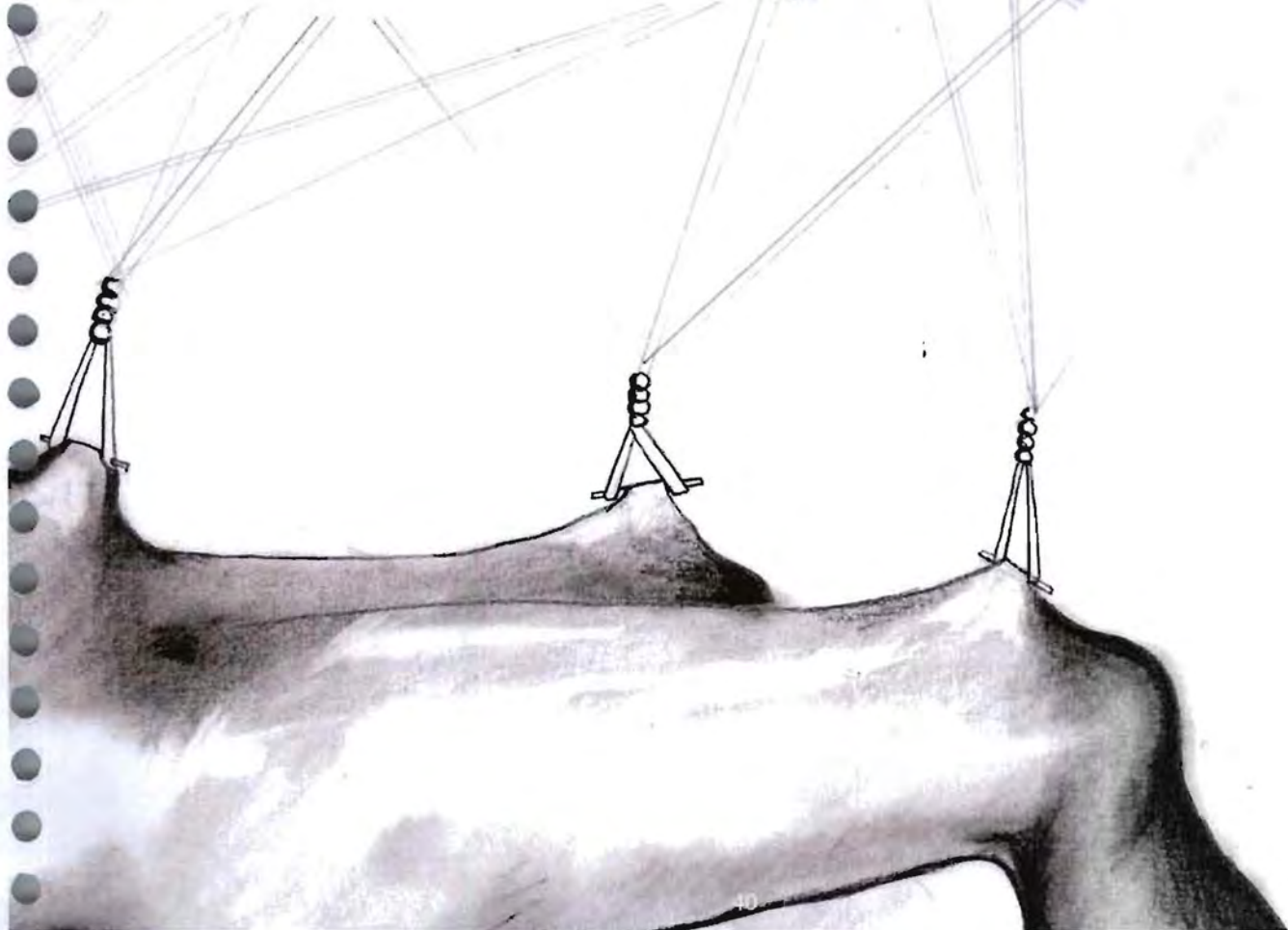
Finally the buildup of energy is released in a the mixture of compression and tension that is movement. This ultimate expression could be one of the reasons why many of Calatrava's buildings involve movement, both literally and metaphorically. Is movement the ultimate form of unison between tension and compression. Fluid organic movement is one of the things that we have been unable to mimic with even the latest forms of robotics. Is this possible in architecture?

# Design Exploration

## Incorporating the human body into the project

More sketch studies of the body exerting and taking force.



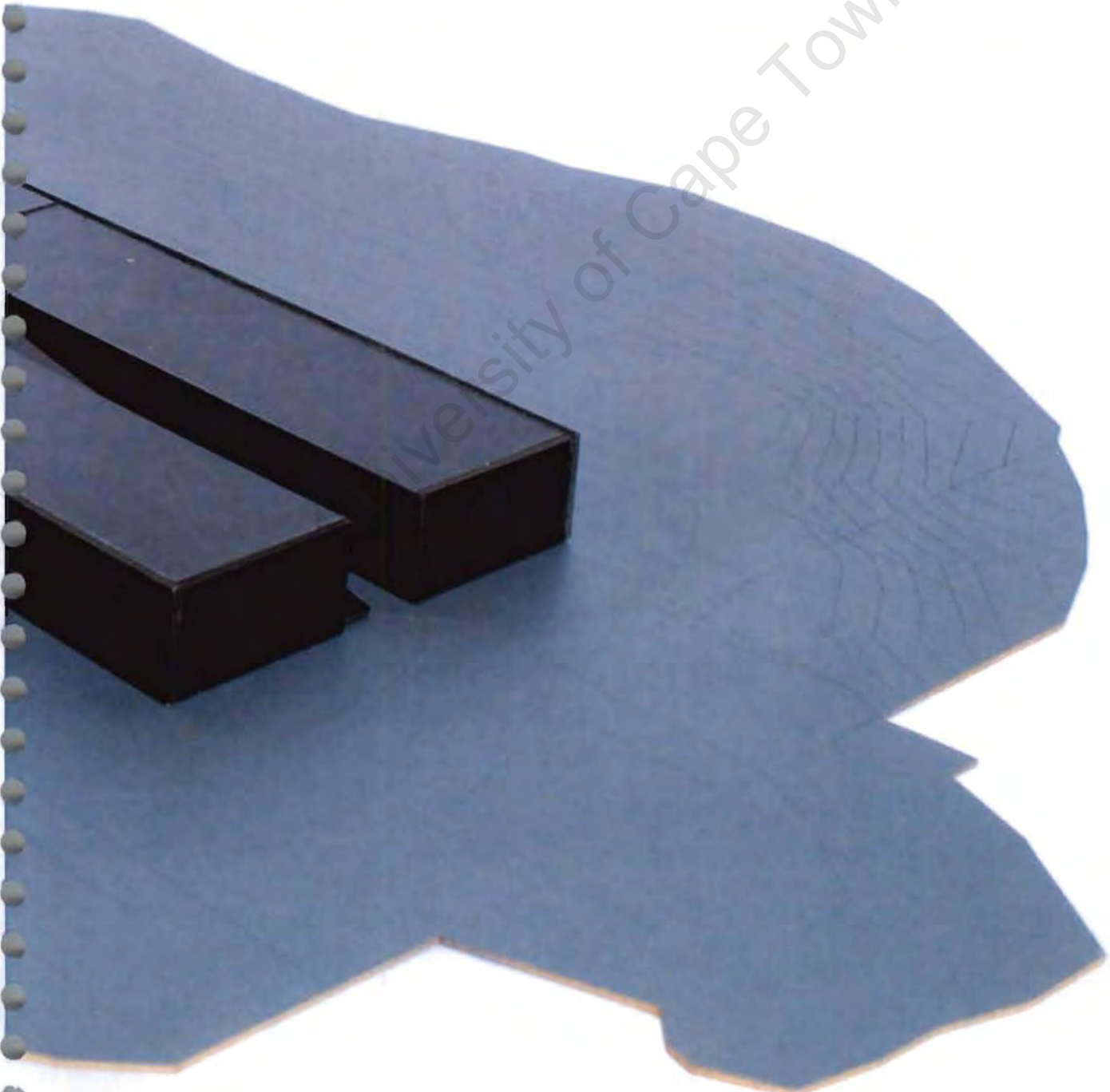
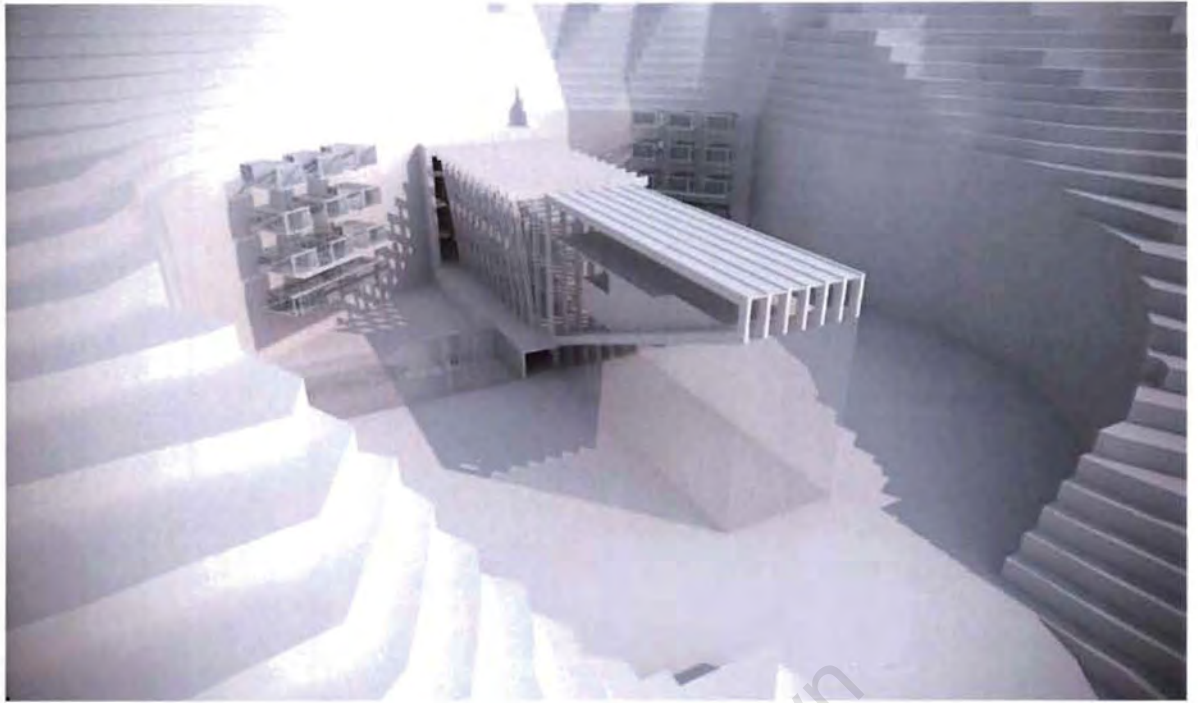


# Design Exploration

## Outcomes of human body exploration



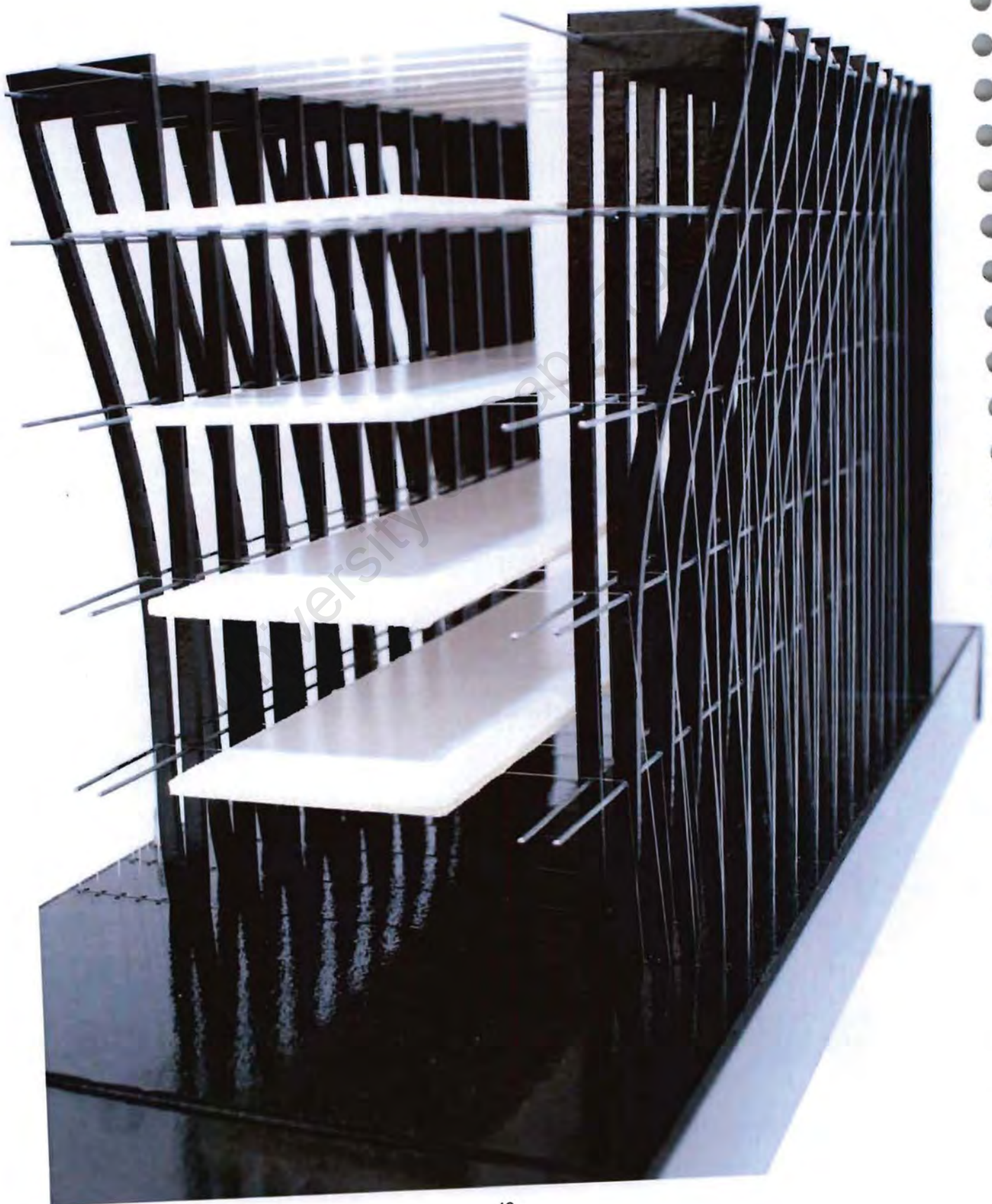
The building now consists of three 'phases. It begins anchored in the cliff as a heavy compressive structure, it then extends outward in a skeletal tension structure that acts in opposition to the compressive anchored portion. The final piece is a delicate balancing of a large concrete element to create a huge cantilever over an empty area that is the first space experienced when entering the quarry.

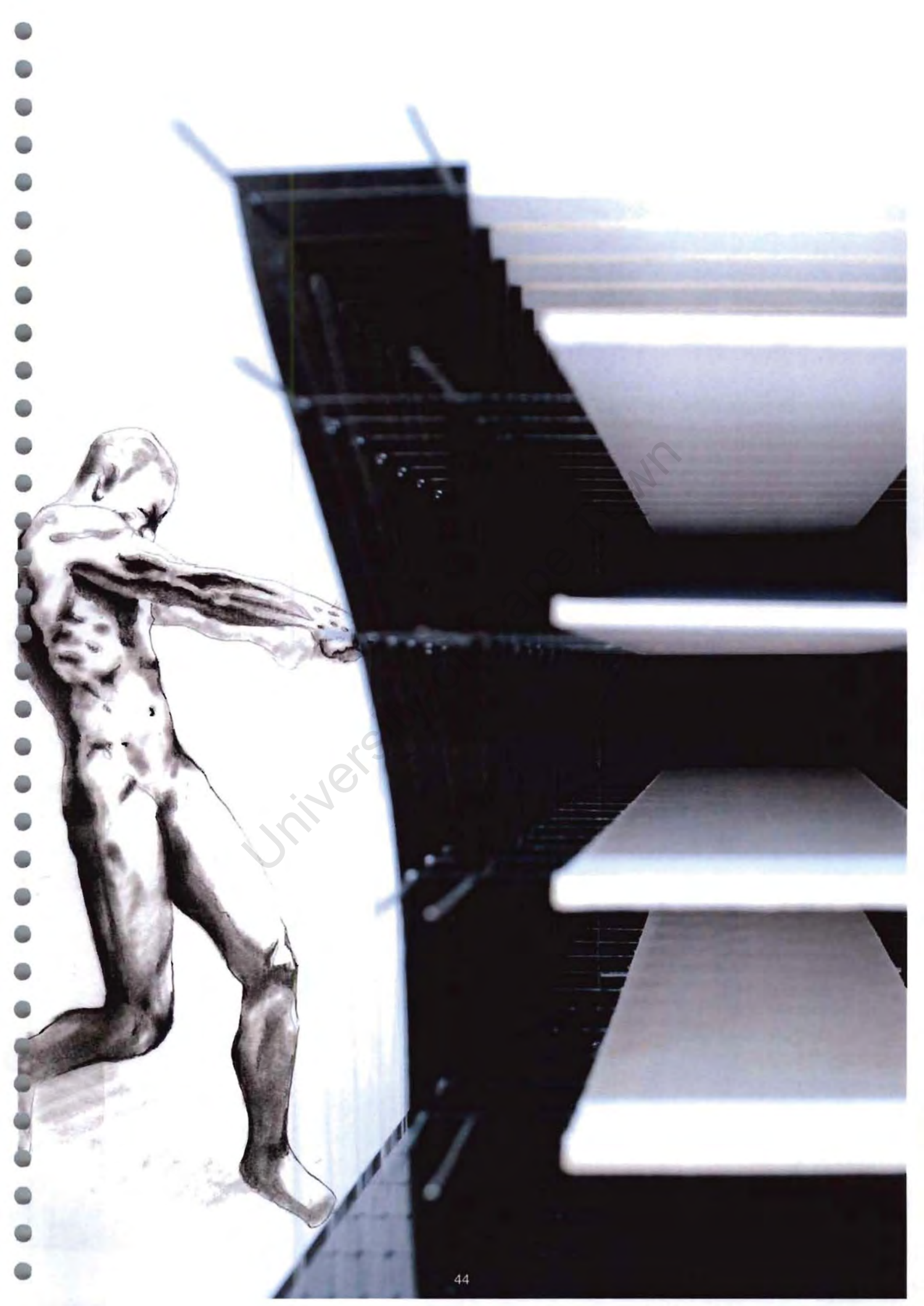


# Design Exploration

## Outcomes of human body exploration

Close up of model showing the mixture of tension and compression structures in the middle portion of the building. The 'floating' levels created could act as reading spaces for the library.



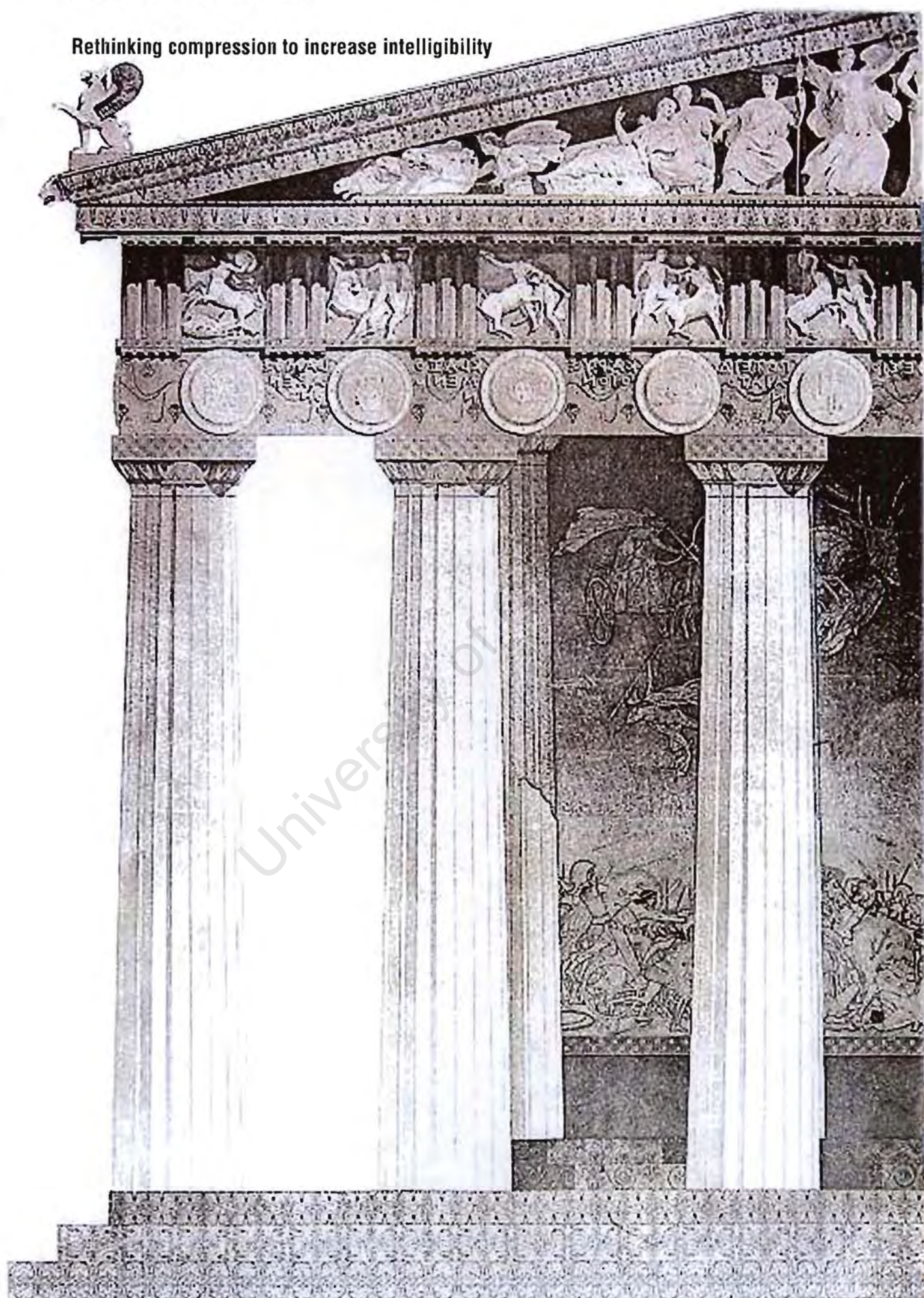


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## Design Exploration

Rethinking compression to increase intelligibility



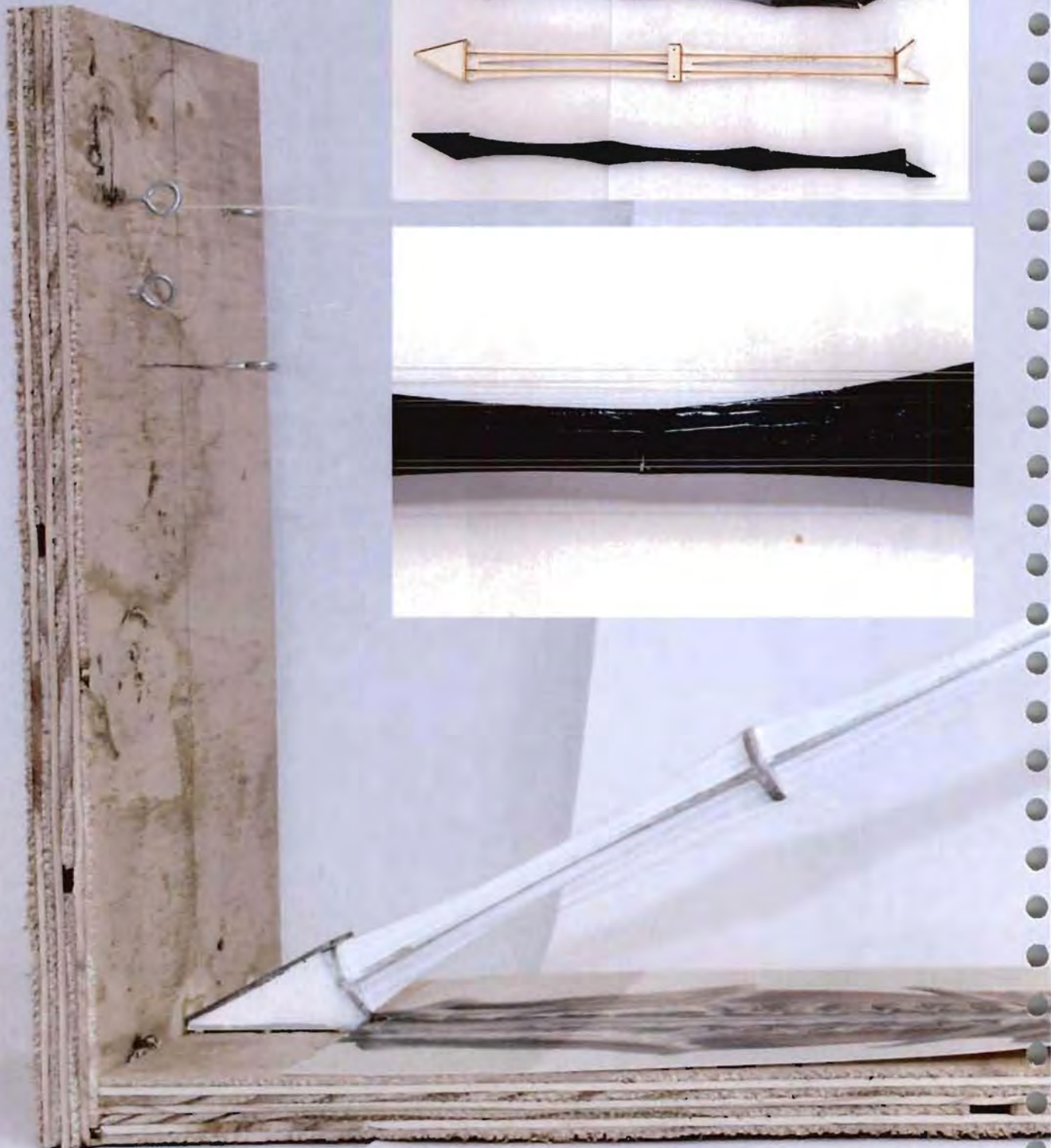
This was a separate exploration to the body studies. This model was about rethinking the column. A column's function is quite easy to understand and even untrained people know what they do, but we take for granted the amount of force that they keep held aloft. What if we redesigned a column using the play between compression and tension to create one that makes the force it is carrying much more apparent? The model below is made from card and uses fishing wire to keep the 'architrave' held aloft without it transferring direct compression to columns.

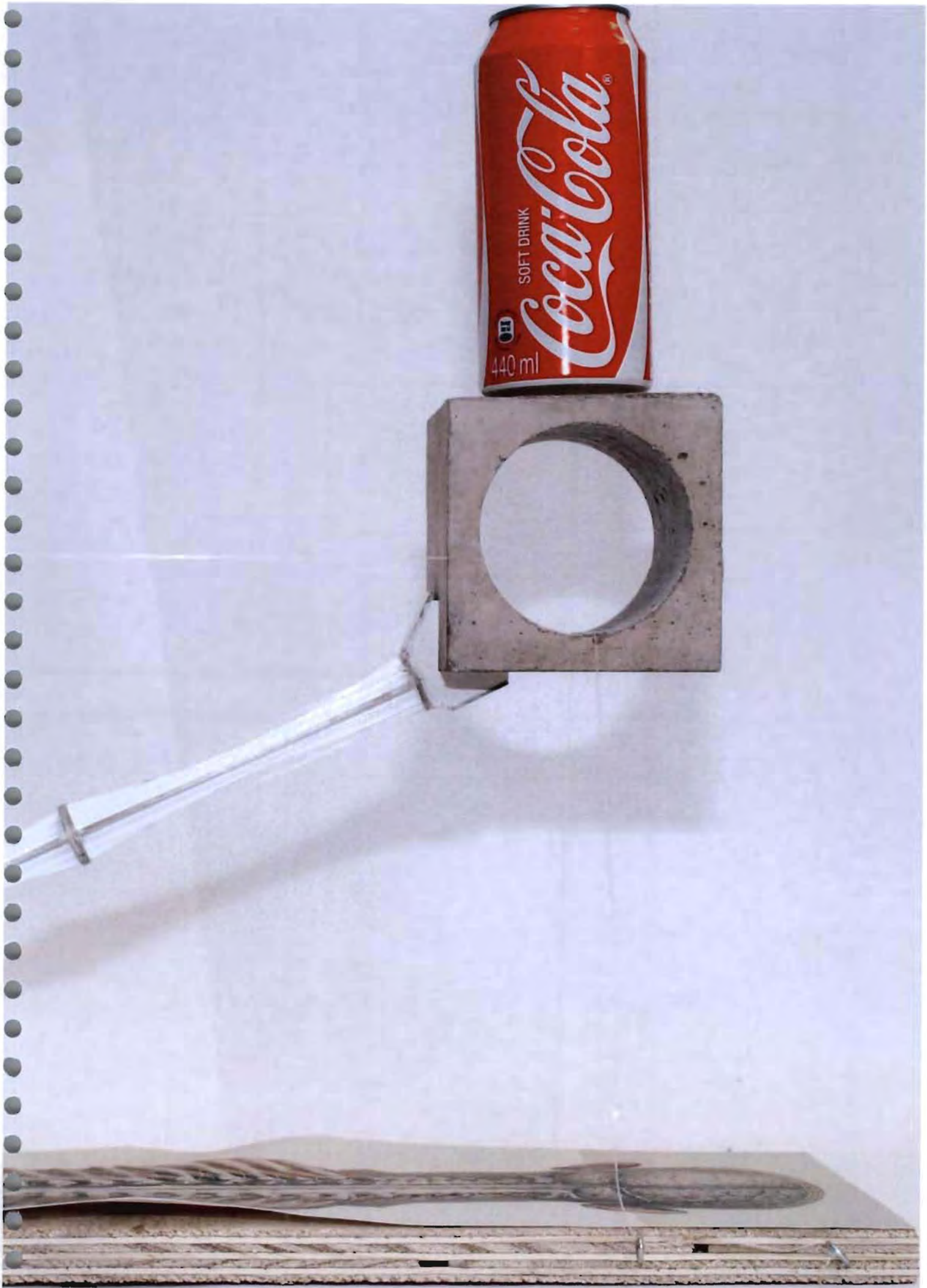


# Design Exploration

## Interplay of tension and compression increasing strength

This model was another separate exploration to the body studies. Here I was attempting to increase the strength of a relatively weak material by including tensional support. Much like bones and muscle. The first attempts failed in various ways, but eventually with the correct line of force I was able to support one concrete block and a can of coke on a strut made of triplex with a very thin cross sectional area. The slender strut is barely prevented from crushing by a sheathe of fishing gut running along its length. The density of concrete is  $2400\text{kg/m}^3$  which is 4 times that of triplex.

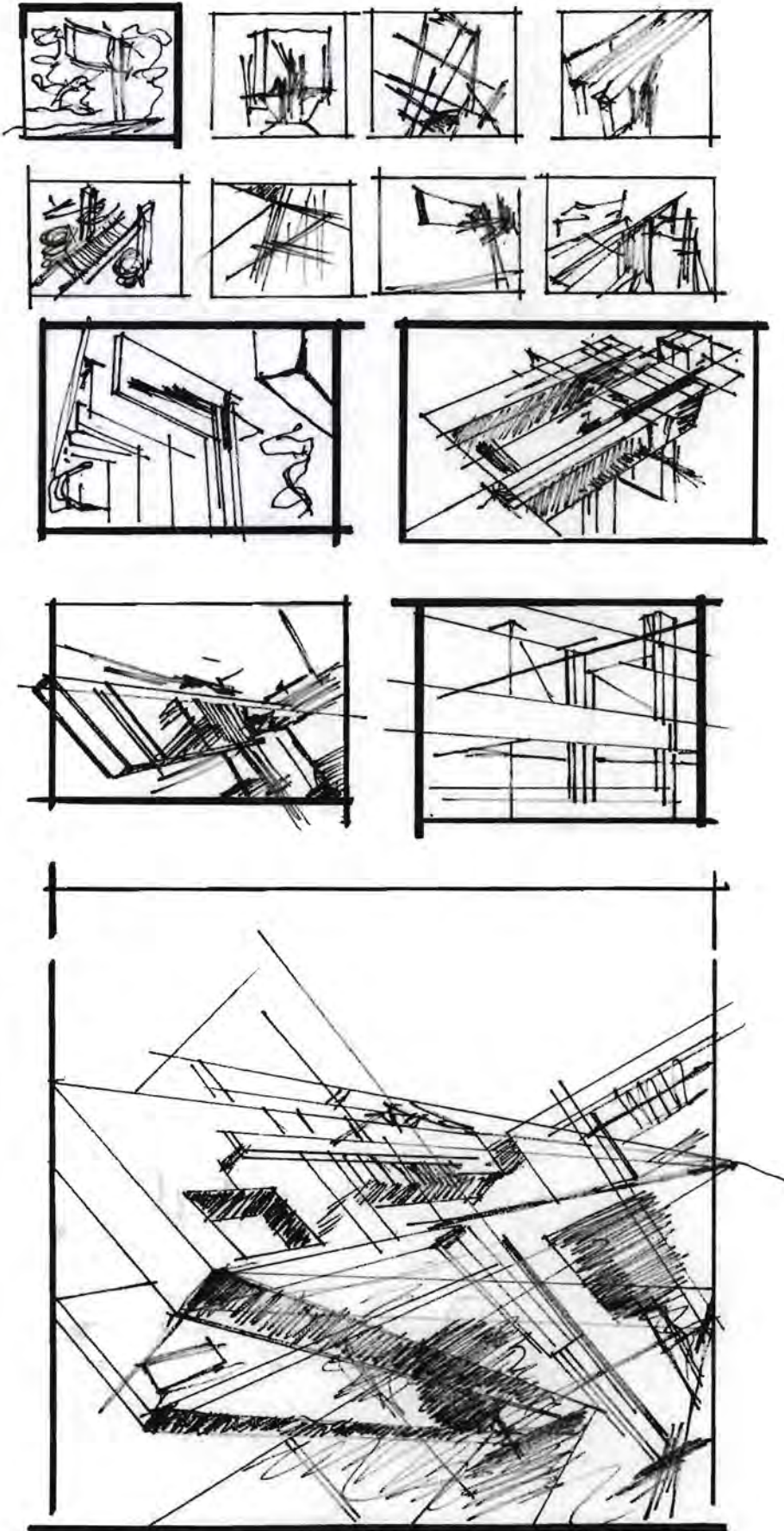


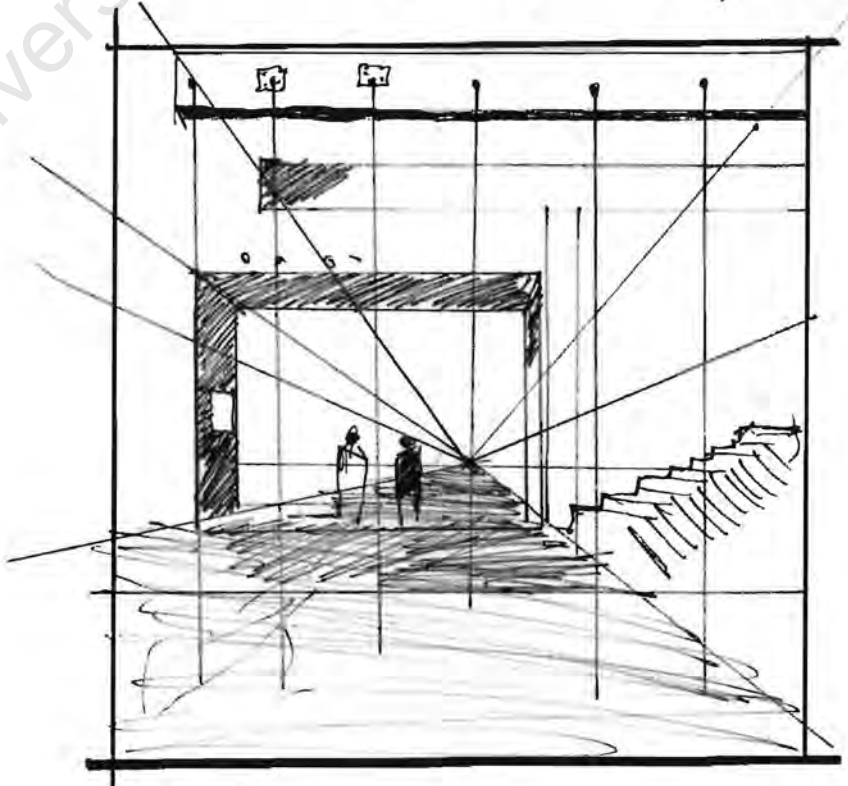
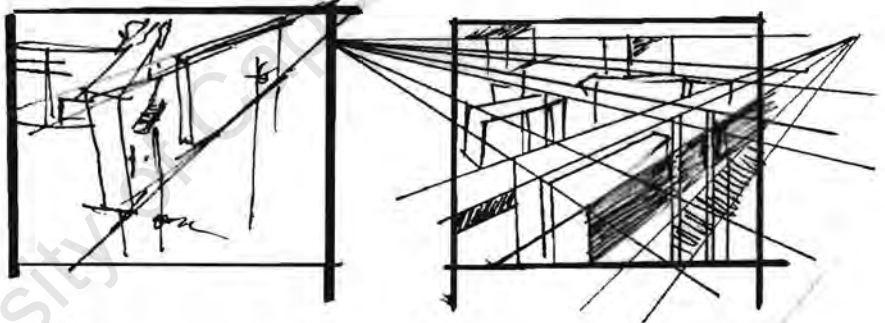
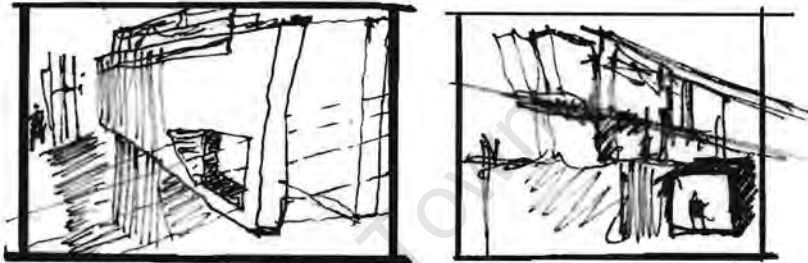
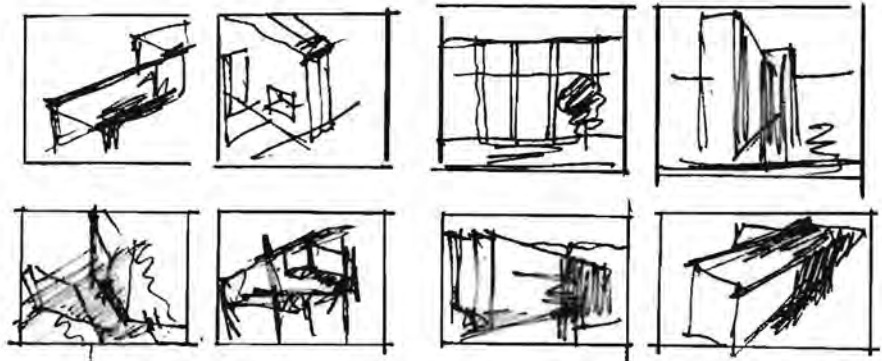


SOFT DRINK  
*Coca-Cola*<sup>®</sup>  
440 ml

# Design Exploration

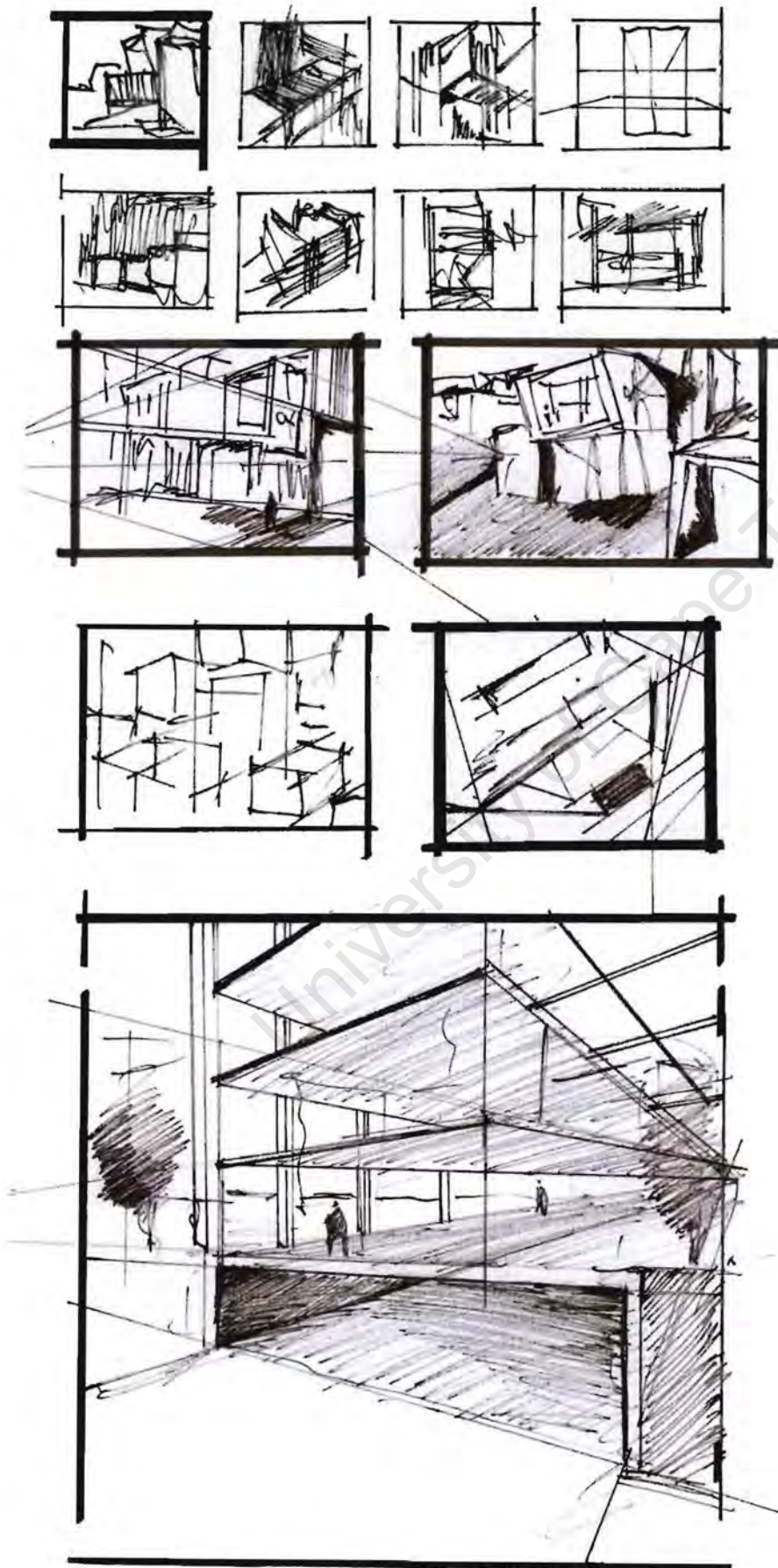
Sketching development of the building

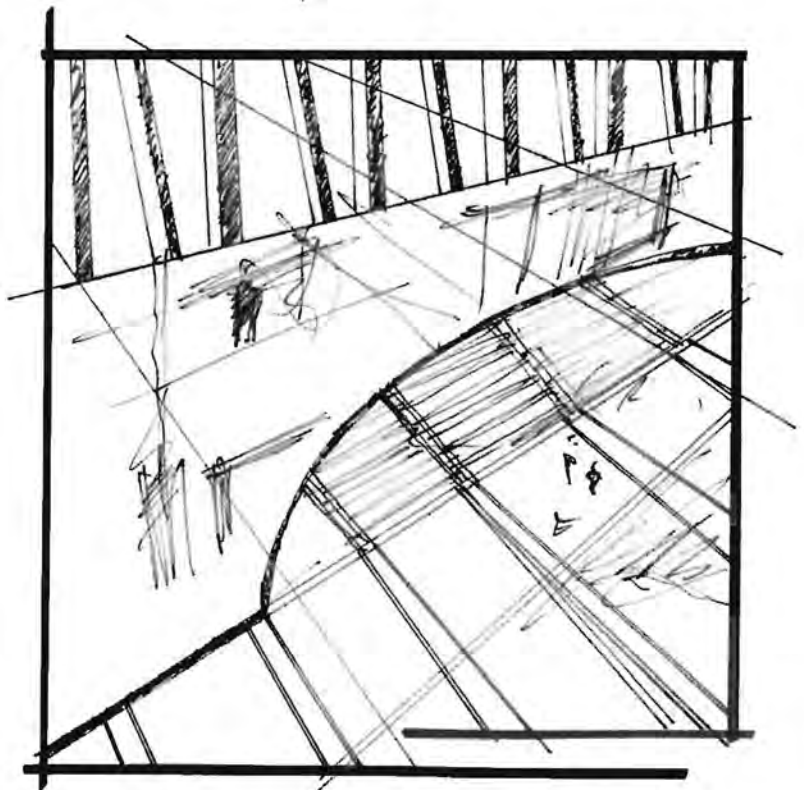
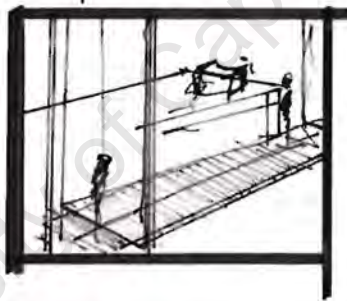
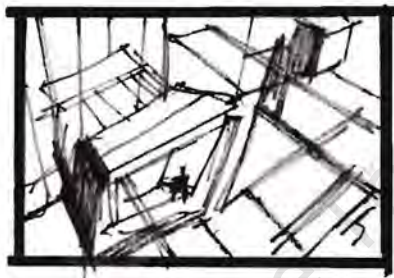
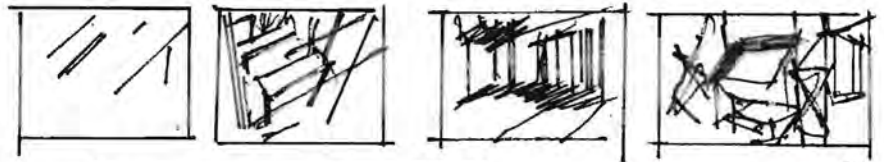
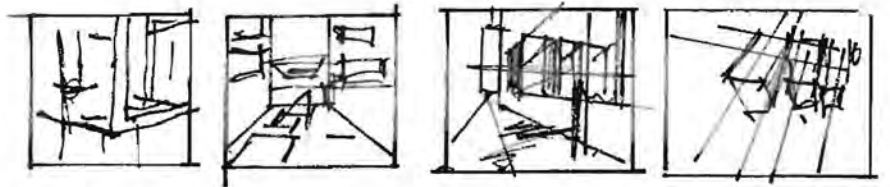




# Design Exploration

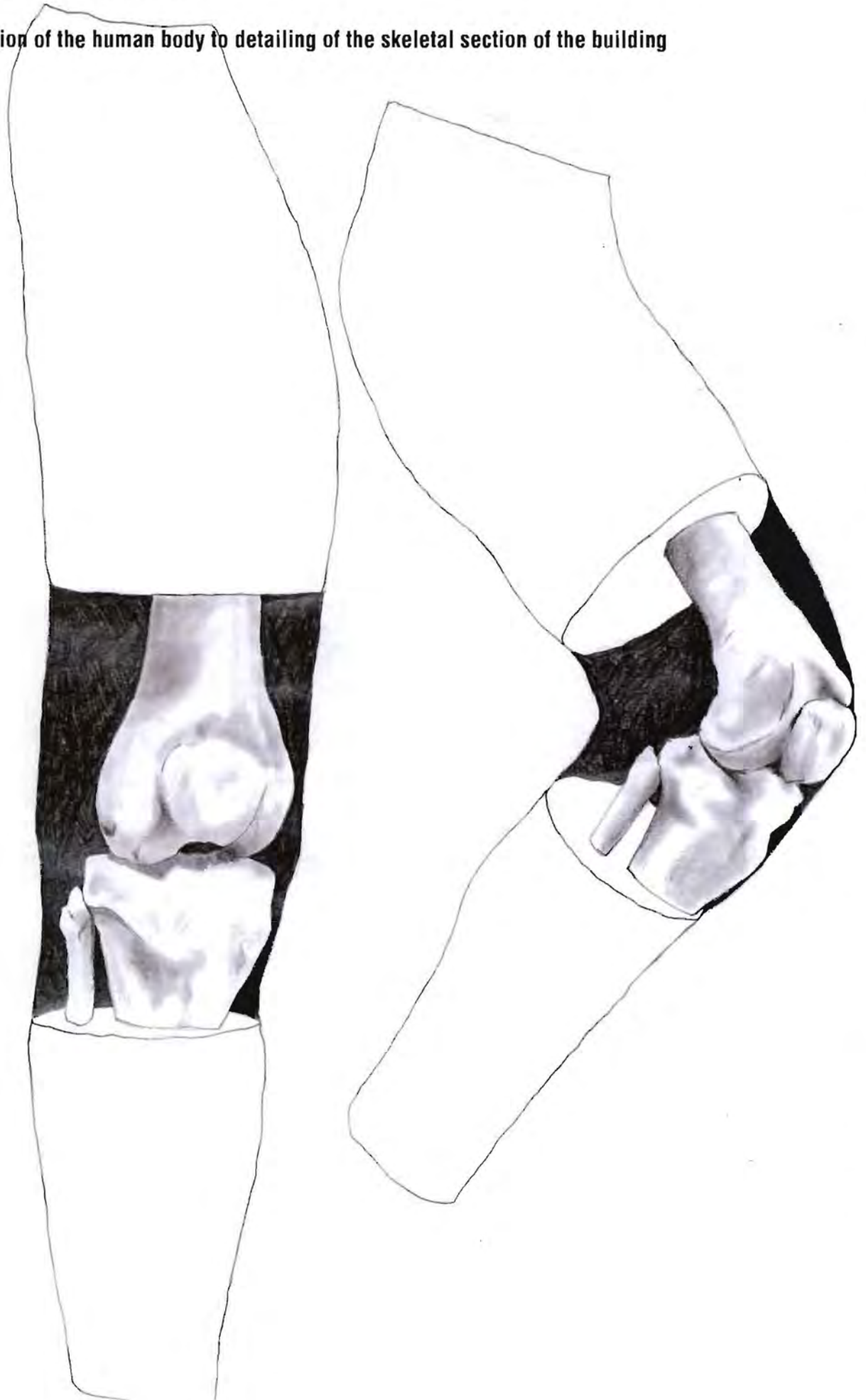
Sketching development of the building

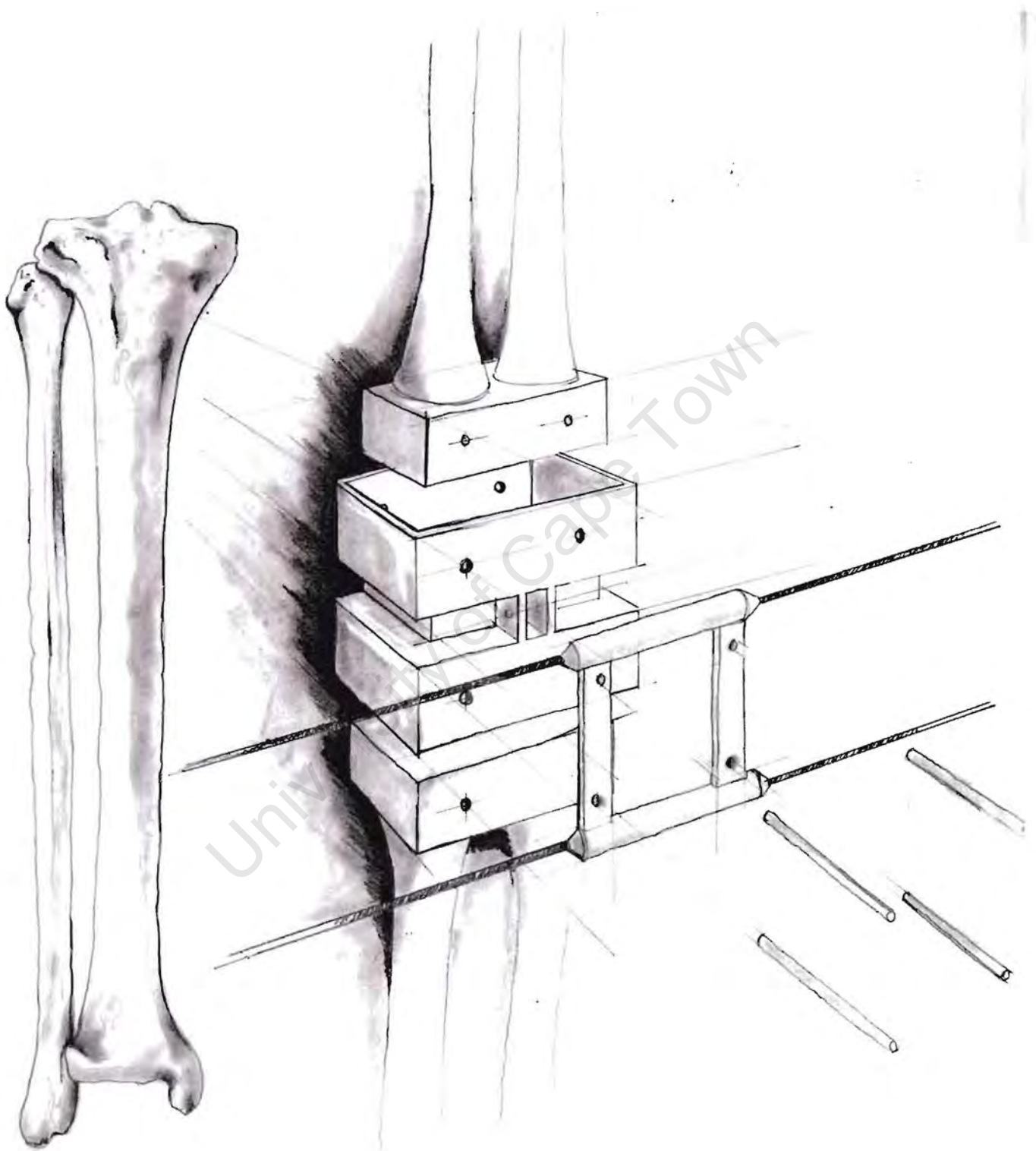




# Design Exploration

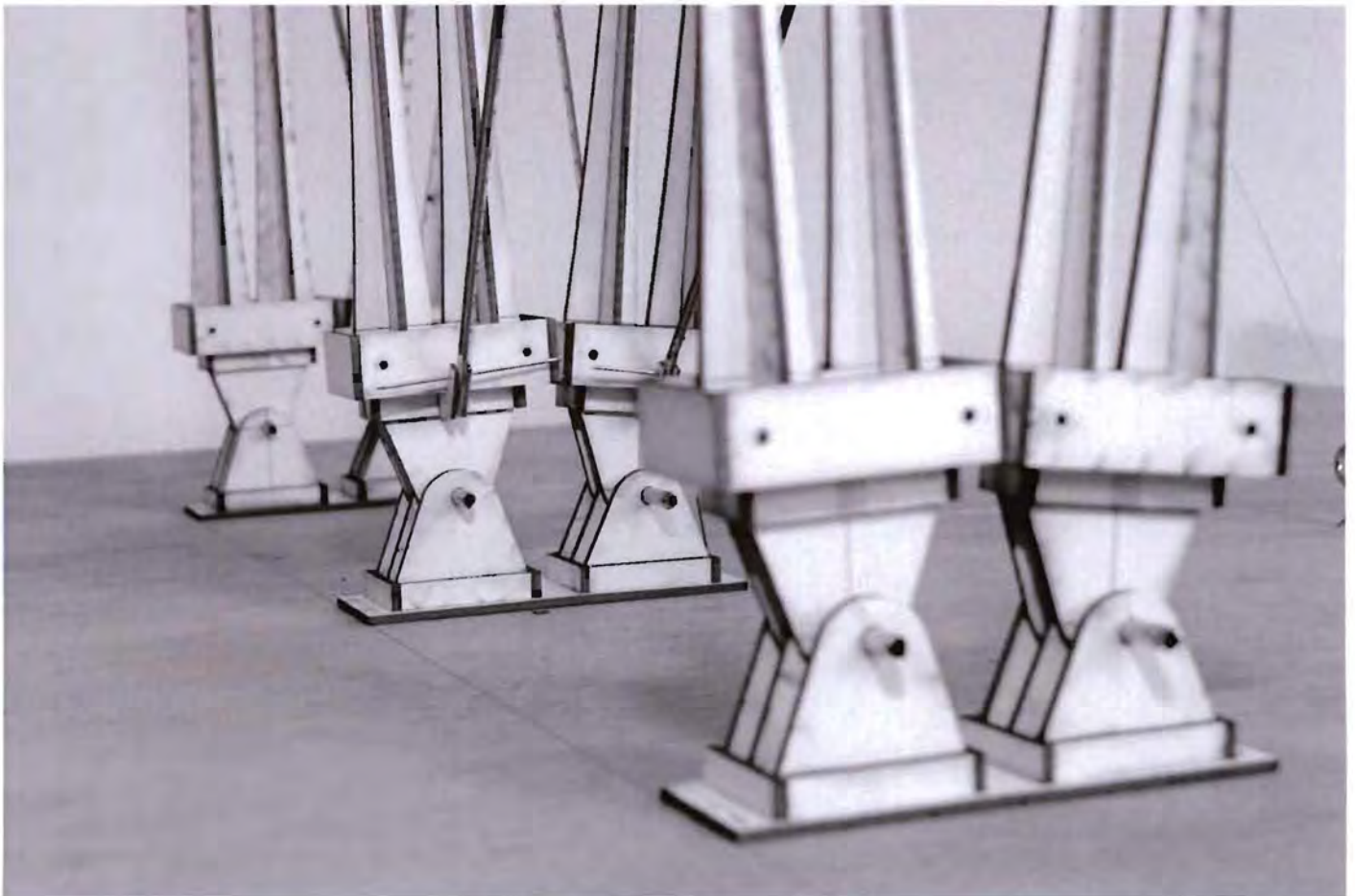
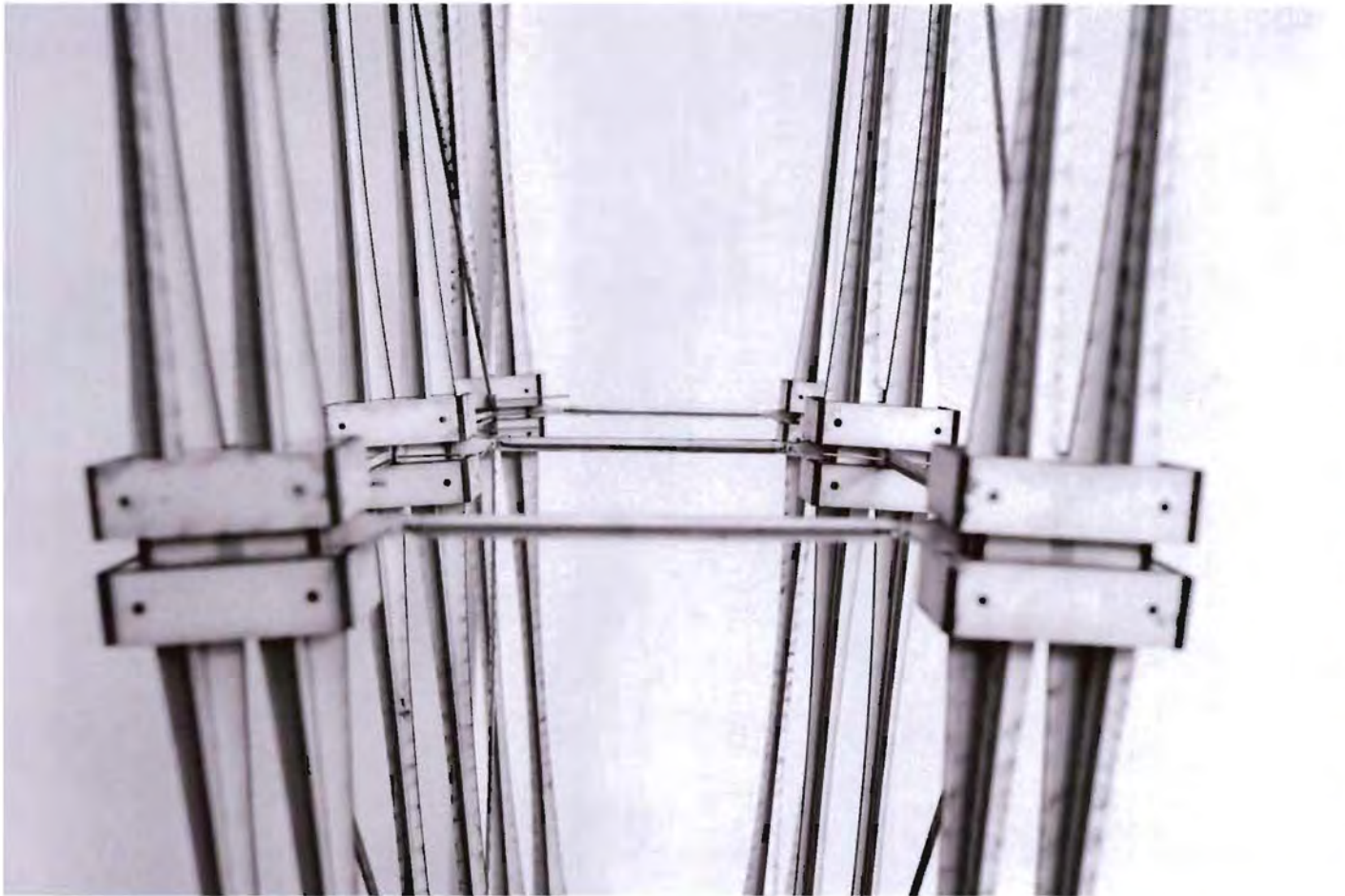
Application of the human body to detailing of the skeletal section of the building





# Design Exploration

Application of the human body to detailing of the skeletal section of the building





# Conclusion

## The design process

The design process for this project has been quite unusual. Beginning the project with only a notion of the qualities of spaces that were to be designed as opposed to the actual type of building that I wanted to create made the early stages of this project quite difficult. There was also the danger of the project becoming simply about a personal formal sculptural exploration.

However I feel that the choice of a site, program, and especially the research into Calatrava and the Gothic period helped to steer the project in a more relevant direction, where ideas could be explored that were architecturally useful. As shown slowly evolving in the design exploration section the building that has resulted from the process is a scientific center that is comprised of a laboratory, library, lecture theater and exhibition space. The building represents a progression from the heavy to the light and its materiality and spatial composition reflects this.

The final building is designed to cater to a small group of permanent staff as well as a large volume of students from UCT and visitors to the exhibition and lecture theater. Pictured on the opposite page is an exhibition niche from the basement level, which is one of the first spaces that is encountered in the final design. I feel that this space satisfies many of the qualities that I set out to achieve even in its simplicity. I hope to be able to achieve much more in all of the spaces within the final design.

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Utilitas, Venustas, Firmistas - Marcus Vitruvius Pollio

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## Image References

### All images other than those referenced below were created by the author

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Image of Reception With Open Brise-Solei obtained from <http://powicewobots.deviantart.com/favourites/#/d3akutz> at 12:25 AM on 2/11/2011

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