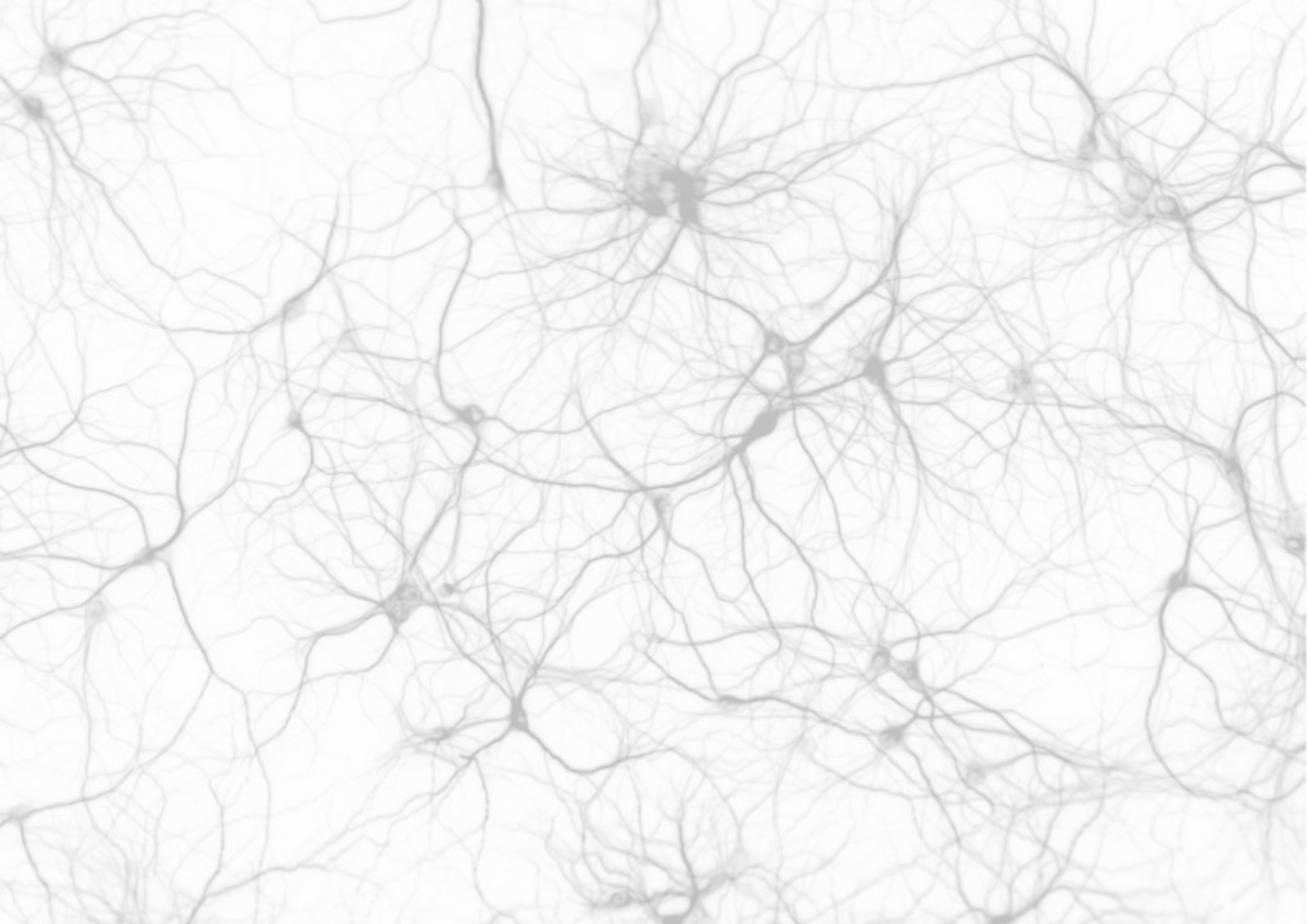
Head Space

An Exploration into Architecture and Neuroscience

Mariana Lamas
2011



Declaration

I, Mariana Lamas 0507376A, am a student registered for the course Master of Architecture [Professional] in the year 2011. I hereby declare the following:

I am aware that plagiarism [the use of someone else's work without permission and/or without acknowledging the original sources] is wrong. I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise. I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. For this purpose, I have referred to the Graduate School of Engineering and the Built Environment style guide. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

Mariana Lamas
09/12/2011

This document is submitted in partial fulfilment for the degree: Master of Architecture [Professional] at the University of the Witwatersrand, Johannesburg, South Africa, in the year 2011.

Acknowledgements

To my mother, I wish that you could be here to share in this. To my father, thank you for all the support and encouragement over the years.

Mike, you are my best friend and a constant source of inspiration. Thank you for your unconditional support, I couldn´t have done it without you.

To my supervisor, Dr. Randall Bird, thank you for embarking on this journey with me. Your time and input have been greatly appreciated.

To my architecture friends and especially CAMP, you guys made the hard times bearable and the good times awesome. Thanks for two awesome years and lots of memories.

Lastly, but certainly not least, thank you to all the people who were willing to speak to me and show me around various facilities. Your input was more valuable than you know.

Key Words

neuroscience; knowledge space; research institution; medical school; medical imaging facility; laboratory design; campus design

Preface

Mental, neurological and behavioural disorders have become more common than cancer, diabetes or heart disease and account for a significant portion of the burden of disease worldwide (ASHA 2011).

Mental health problems including depression, bipolar disorder, schizophrenia, substance abuse, and dementia account for nearly one-third of the disability in the world. These disorders have huge economic and social implications which are often overlooked or under-recognized. Mental disorders cost the United States more than $150 billion annually in treatment costs, social service costs, disability payments, loss of productivity and premature mortality (ASHA 2011).

A study carried out by the World Health Organization (WHO) in 2002 estimated that, 450 million people globally suffer from mental disorders. Of those, 154 million suffer from depression, 25 million from schizophrenia, 91 million from alcohol use disorder and 15 million from drug use disorder. Mental illnesses do not discriminate and can affect anyone regardless of gender, race, ethnicity or social status. It is estimated that 1 in every 4 people develops one or more mental disorder at some stage throughout their life (WHO).

While many mental illnesses can be successfully diagnosed, managed and even treated, many lack effective treatments or cures. Neurodegenerative disorders, such as Alzheimer's, Parkinson's, Huntington's, Multiple Sclerosis, and Lou Gehrig's disease, are chronic conditions characterized by progressive deterioration of the nervous system. There are currently no cures for these conditions.

Neuroscience research is key in order to attain a better understanding of the brain and the various disorders that affect it. It is only through research that we can hope to develop treatments and cures for these conditions, which cause suffering to so many people around the world.

Currently there are few sites in South Africa where competent neuroscience research can take place. This thesis is meant to culminate in the design of a facility which caters to this type of research.

Table of Contents

Introduction to the Thesis ____ 12

Section 1: Theory ____ **14**

Abstract ____ 16

The Architecture of Knowledge

Introduction ____ 17

Monasteries ____ 18

Universities ____ 24

Libraries ____ 30

Research Laboratories ____ 36

Knowledge in the Information Age ____ 42

Conclusion ____ 46

Linking Architecture and Neuroscience ____ 48

The Jonas Salk Story ____ 49

Can Architecture Benefit from Neuroscientific Research ____ 50

Architecture for the Mind: Some Principles from Neuroscience ____ 51

Precedent Studies ____ 52

The Salk Institute for Biological Studies ____ 54

The Monastery of Ste. Marie de La Tourette ____ 60

Neurosciences Institute ____ 64

Biovac Institute ____ 68

De Young Museum ____ 70

Guiding Principles ____ 72

Bibliography ____ 76

Image References ____ 80

Section 2: Site ____ **84**

Site Selection ____ 86

Introduction to the Area ____ 90

History of Johanesburg General Hospital ____ 98

Wits Future Development Plans and
Urban Design Framework ____ 100

Site Mapping ____ 110

Context ____ 112

Accessibility ____ 114

Walking Times ____ 116

Wits-Owned Land ____ 118

Building Heights ____ 120

Solar Studies ____ 122

Views and Surroundings ____ 124

Bibliography ____ 126

Image References ____ 128

Section 3: Design _____ **132**

Design Brief _____ 134

Design Concept _____ 136

Programme _____ 138

Design Development _____ 142

Construction Technology _____ 154

Final Response _____ 162

Introduction to the Thesis

This thesis aims to explore the relationship between architecture and neuroscience, focusing specifically on the mental faculty of knowledge.

The essay, which comprises the first portion of this thesis, investigates how knowledge has been dealt with and embodied in architecture throughout history. This is achieved by tracing the evolution of carefully selected examples of `knowledge spaces´ - a term employed to describe sites where knowledge has traditionally been produced, stored and disseminated - such as the monastery, the university, the library and the research laboratory.

Drawing on principles from neuroscience and aided by several precedent studies, this thesis is intended to culminate in the design of a 'knowledge space' of its own: a neuroscience research facility meant to further the study of neuroscience in South Africa.

This facility is to be located on the existing Wits University Health Sciences campus in Parktown, Johannesburg. The chosen site is immediately adjacent to the Wits Medical School and the Charlotte Maxeke Academic Hospital (previously known as the Johannesburg General Hospital).

As a neuroscience research facility, the affiliation with the aforementioned institutions forms an integral part of the scheme. Given its close proximity to both the hospital and the university, the chosen site is an ideal location for this type of facility.

1. Theory

Abstract

The mental capacity for knowledge production, storage and dissemination is one of the characteristics that makes us human. Throughout history humankind has built spaces to accommodate knowledge in its various forms: from medieval monasteries to state-of-the-art research laboratories. The evolution of these 'knowledge spaces' and their architectural character can tell us a lot about a society´s views and perceptions of knowledge. Using monasteries, universities, libraries and research laboratories as examples of 'knowledge spaces' this essay aims to explore the relationship between knowledge and architecture throughout history in order to understand where knowledge has traditionally been produced, stored and disseminated. Drawing on this information, the appropriateness of the historical typologies will be assessed with regards to today´s context where the nature of knowledge is rapidly changing as a result of the emergence of new technologies.

Introduction

The human brain is a remarkably intricate and complex organ which possesses more capabilities than any machine. Our brains are central to who we are, defining and controlling everything about us. The brain not only controls the processes that make life possible, such as breathing, heart rate, blood pressure and digestion, but it is also responsible for our personality, movements, and our sensory experience of the world around us. As the seat of consciousness, the brain is what makes us ultimately human, giving us capacity for memory, language, emotion, creativity, understanding and knowledge.

The brain, much like architecture, defines a realm or a space that is separate from the rest of the world. In the case of the brain it is the space that houses all our intangible mental faculties and capabilities. In the case of architecture, it is the physical space defined by design elements, such as walls, windows, doors or other thresholds, which houses specific programmes or functions. This essay seeks to explore the faculty of knowledge from an architectural point of view, by investigating how knowledge has been dealt with architecturally throughout history in what shall be referred to as ‘knowledge spaces’: spaces that accommodate knowledge in some form or another.

As knowledge resides in the brain, building for knowledge necessarily involves some element of building for the brain. Through the exploration of carefully selected examples of traditional knowledge spaces such as the monastery, the university, the library, and the research laboratory, this essay aims to explore the intricate relationship between knowledge and architecture throughout history in order to understand how we should be building for knowledge, and the brain, in today´s context.

Monasteries

Historically monasticism was one of the dominant forms of political, economic, and cultural power in the world. It arose from a desire of people devoted to the faith to live together in communities, in a life characterized by devotion to religion, learning and the arts (Goode 2009:617). Monastic complexes are comprised of several different buildings, all devoted to the accommodation of both the secular and sacred needs of the monks who inhabit them.

The first monasteries are believed to have emerged in rural settings and their architecture was appropriated mainly from existing secular typologies, such as villas and farmhouses (Popovic 2007:56). Over time, however, the architecture and planning of monasteries became increasingly formalized by rules which came to form the basis of monastic life. The rules devised by St. Benedict of Nursia, founder of the Benedictine Order, for his monastery at Monte Cassino, Italy (circa 529 CE) became amongst the most influential in the Western world (Goode 2009:617). Monasteries usually consist of a collection of buildings including the church, the cloister, the dormitories, the chapterhouse, the scriptorium and the refectory (Goode 2009:617). While the architectural character of monasteries can vary significantly, especially between different orders, they share many of the same typical features including the orthogonal plan, the cloister, and the enclosure wall.

The cloister was particularly significant in monastic life as a central communal space which accommodated a variety of secular and sacred activities (Meyvaert 1973:54). Architecturally the medieval cloister or claustrum was generally comprised of a large square or rectangular yard surrounded by a covered gallery or arcade (Horn 1973:13). The cloister represented the inner world of the monastery, and the physical architectural barrier surrounding it served to separate the monks from the serfs and workmen who existed outside the cloister (Horn 1973:13). In fact, the etymology of the word claustrum is related to the word clausum, which means `to shut´ (Meyvaert 1973:53). Not only was the cloister a multi-purpose space accommodating varying activities from reading and writing, to praying and meditation, but more importantly it symbolised the spiritual ideal of communal monastic life (Meyvaert 1973:54-56). As Calvo-Sotello (2001:186) put it “the cloister was the proper place in which absolute truth could be delivered, the faithful image of the theological philosophy of those times.”

The Plan of St. Gall

One of the most significant and impressive depictions of the architectural character of a monastic community is the Plan of St. Gall (Horn 1973:13). The Plan of St. Gall, which is preserved at the monastic library of St. Gall, Switzerland, was produced sometime in the ninth century by monks at the monastery of Reichenau (IATH 2011). It was the copy of an existing document which depicted an idealised architectural scheme for a Carolignian monastery (Horn 1973:13). It is known from an inscription on the plan that it was designed for Gozbert, the abbot of St. Gall. The exact purpose of the plan, however, remains unclear since the plan neither reflects the existing buildings at St. Gall, nor would it have fit onto the actual site (IATH 2011). As such, the plan has been interpreted as a representation of what an ideal European monastic community should or might look like.

The St. Gall plan (Figures 1.1 and 1.2) depict an arrangement with a square cloister located to the south of the main monastery church with an adjacent warming room. The refectory and its neighbouring kitchen are located on the southern side of the cloister, and the cellar on the west. The monk´s dormitory is located on the upper storey on the eastern side of the cloister, above the warming rooms (Goode 2009:618; Horne 1973:13). There is only one formal entrance or exit into the enclosure, through the parlour (Horne 1973:13). Reference to importance of the cloister to monastic life is made evident in the plans which depicts several buildings that can only be accessed through the covered arcades of the cloister.

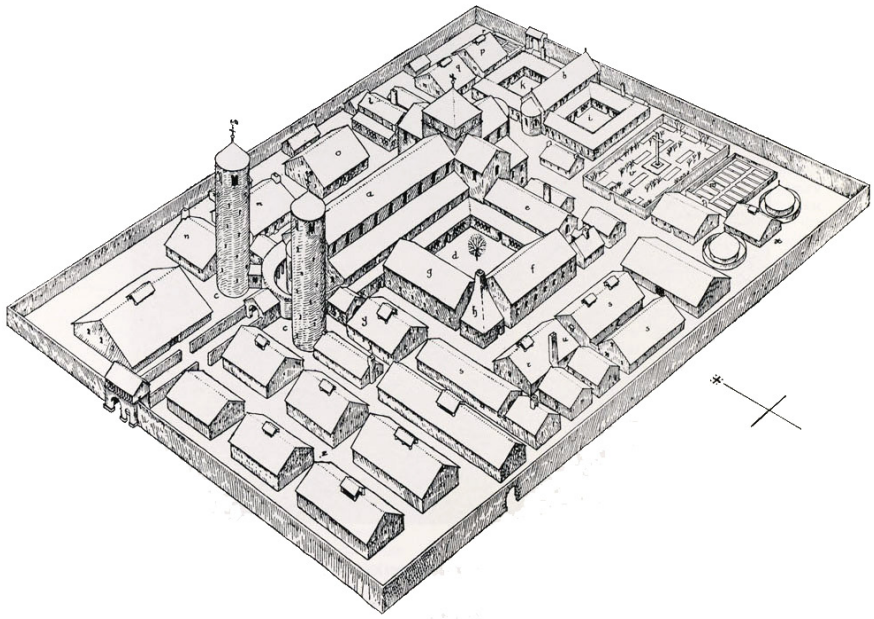


Figure 1.1. Artist impression of St. Gall Plan.

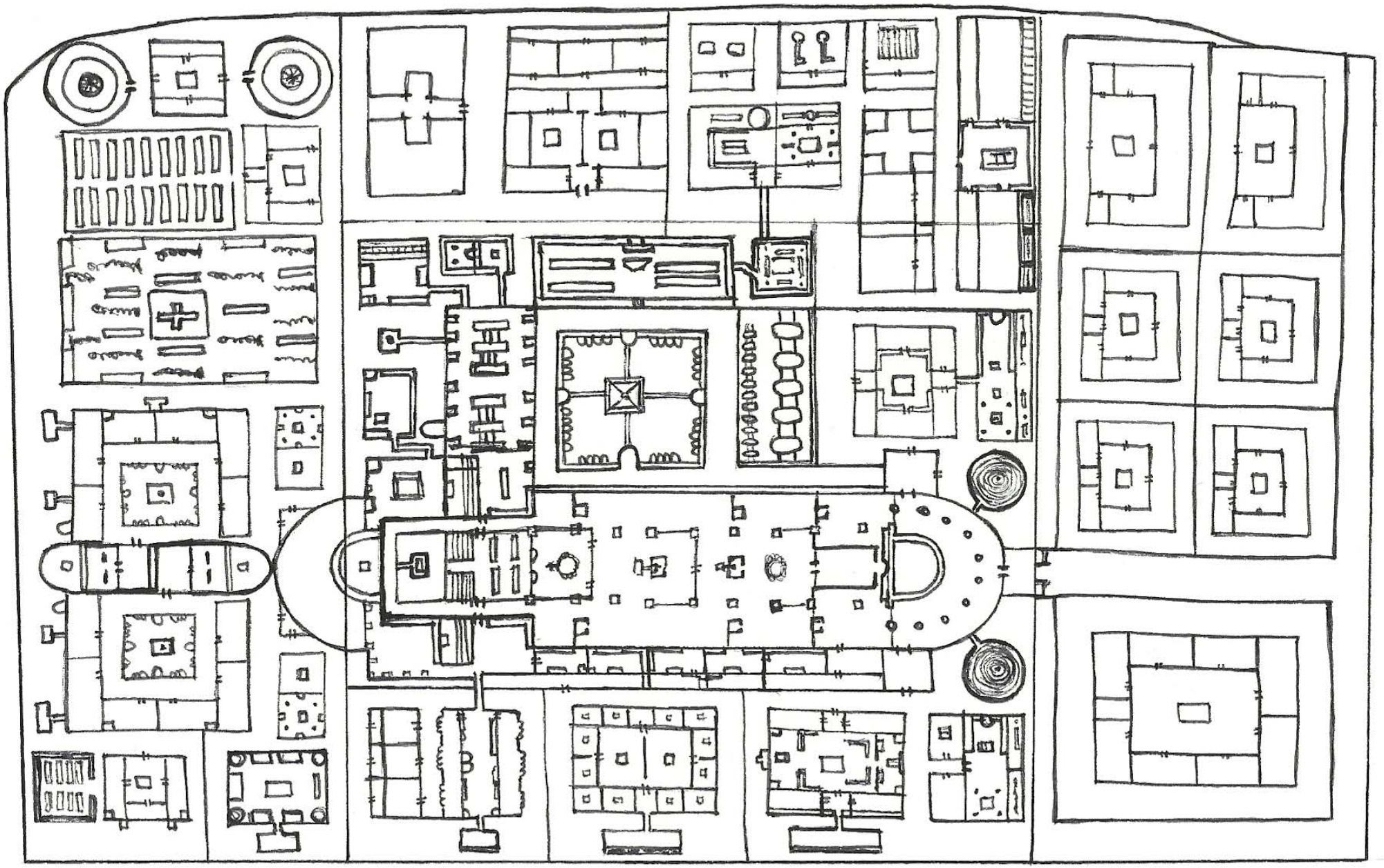


Figure 1.2. The Plan of St. Gall.

Knowledge within Monasteries

Originally, monastic schools served to train monastic members in theology, but over time they became bastions of knowledge, culture, and civilisation (McGrath 2007:214). Paul McGrath (2007:214), who has written several papers on knowledge within Medieval Irish monastic communities, argues that Irish monastic communities between the sixth and eighth centuries can be seen as an "elitist pre-modern knowledge society," who possessed a "peculiar mix of ecclesiastical and secular knowledge."

Knowledge in monastic communities was, for the most part, guarded and self contained, a fact which is evident in the architecture, itself enclosed and segregated from the outside world. While knowledge was shared more freely within monastic communities, its dissemination to the wider religious community was extremely selective. McGrath (2007:218) argues that it is through this selective sharing of knowledge that the Irish monks managed to establish themselves as an elite group and "elevate their symbolic role in society."

Later on in history, when monasteries became secularised they even served as the setting for scientific knowledge production, as in the case of the Benediktbeuern monastery in Germany (Figure 1.3). Benediktbeuern, located approximately 55 kilometers south of Munich, had been secularised by the Bavarian government in 1803 and subsequently bought to serve as a glass production house (Jackson in Galison 1999:151). Joseph von Fraunhofer, who is famous for his work in optics, particularly the discovery of the dark absorption lines that dissect the solar spectrum, did some of his most noteworthy work at the monastery. In his essay Myles Jackson (in Galison and Thompson 1999:141-163) argues that Fraunhofer "drew on the pre-existing architectural space and layout" of the monastery to manufacture his lenses, and that the architectural properties of the monastery were crucial to his work.

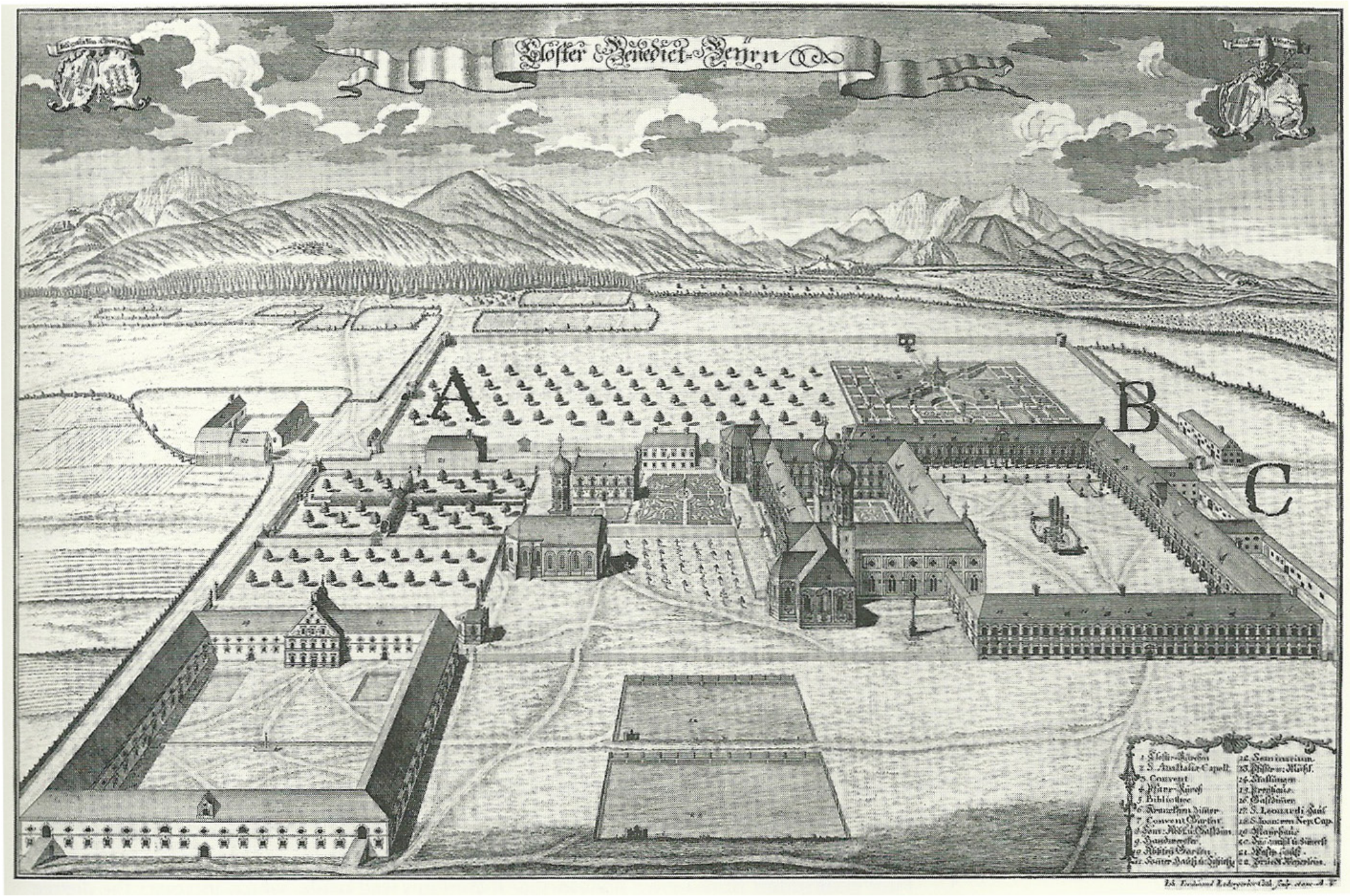


Figure 1.3. Copper engraving of Benediktbeuern monastery which served as a glass house from 1803 onwards.

Significance to Architecture

Architects too, have been inspired and drawn to the ideals embodied in monastic communities. Le Corbusier, for instance, was so deeply influenced by his visit to the Carthusian Monastery of Ema (Figure 1.4), near Florence, that he returned there several times throughout his career (Coleman 2005:129). The influence that monasticism had on Le Corbusier permeates through to his work, including the Maison Citrohan, the Immeubles Villas, and the monastery of Sainte-Marie de La Tourette (Serenyi 1967:277). Le Corbusier was fascinated by the enclosure of social life at varying scales that the monastery provided and saw in its architecture the "implications for the social life of institutions at all scales, from house to city" (Coleman 2005:136). For Le Corbusier, community life is embodied within the monastic ideal and he credits Ema with making him "conscious of the harmony which results from the interplay between individual and collective life when each reacts favourably upon the other."

As we have seen, the monastery has played a significant role as a knowledge space throughout history. It has served not only as a site for learning, devotion, and seclusion and but also inspiration. Much like Le Corbusier was influenced by monastic ideals, the emergence and evolution of other traditional knowledge spaces such as universities, libraries and in some cases even research laboratories owe a great deal to monastic typologies.



Figure 1.4. Le Corbusier´s sketch of the monastery of Ema.

Universities

Historically, universities have played a tremendous role in the creation and dissemination of knowledge, making them true knowledge spaces. The architecture of the university is the physical embodiment of a university's ideals, and as such has always been vital to the identity of the university. While archetypes and paradigms of university architecture are constantly changing, tracing their evolution helps to shed some light on the social and cultural attitudes towards knowledge production throughout history.

Universities began to establish themselves as vital institutions in Middle Ages, when the creation of knowledge abandoned the self contained cloisters of monastic communities and began to emerge into civil society (Calvo-Sotello 2001:186). In this way the monastery, as a knowledge space, can be seen as a precursor to the modern university. It is no surprise then that many early medieval universities, including Oxford and Cambridge, were based on monastic typologies (Goode 2009:964). (Figure 1.5)

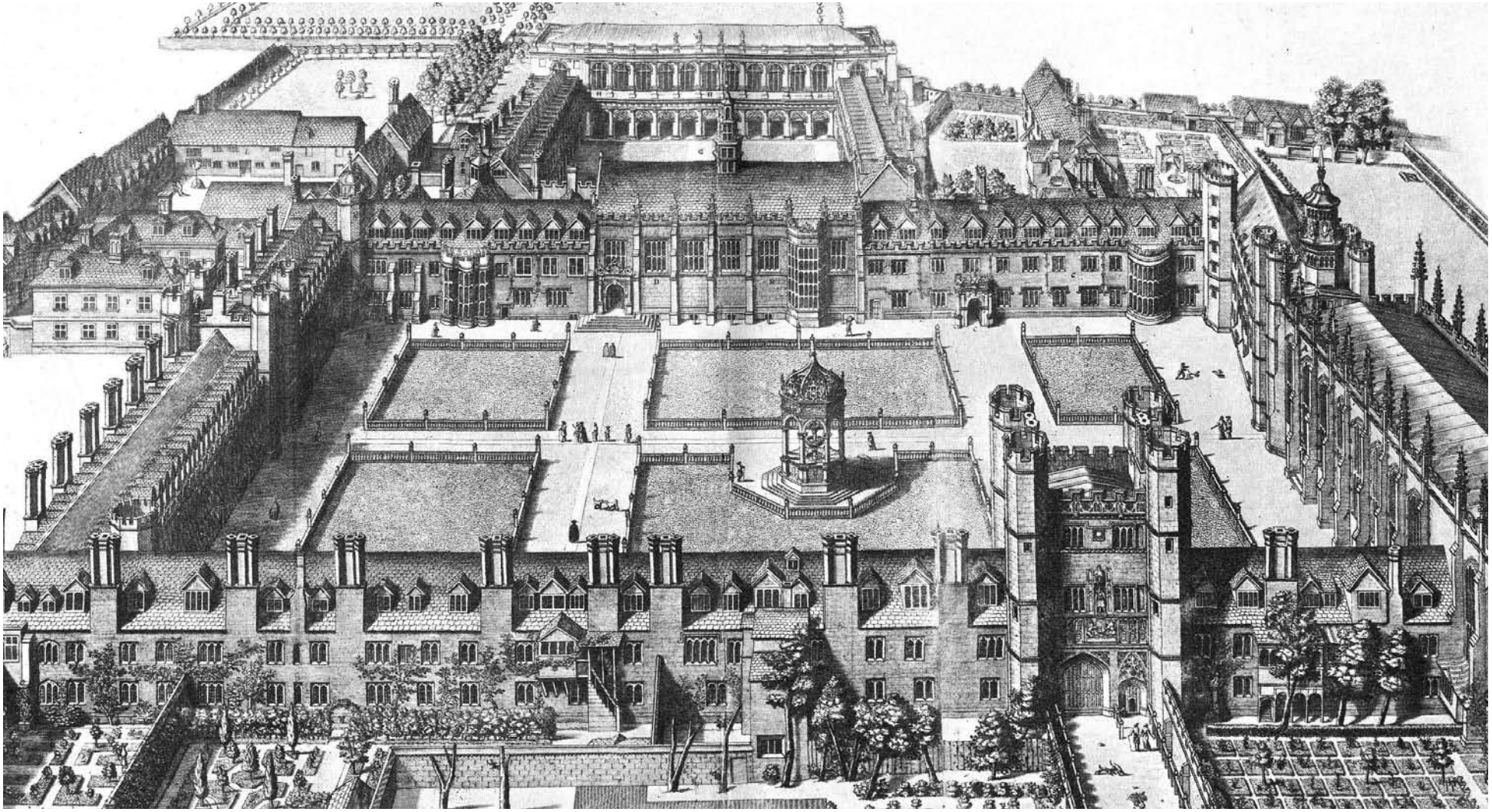


Figure 1.5. Engraving of Trinity College, Cambridge.

Oxford and Cambridge

The universities of Oxford and Cambridge are amongst the oldest institutions of their kind in Europe, and both continue to use buildings dating back to the thirteenth century (Goode 2009:192). Oxford claims to be the oldest university in the English-speaking world and although its exact date of foundation is unknown there is evidence that teaching has existed there in some form since 1096 CE (Oxford:2011).

The history of Cambridge University is inextricably linked with that of Oxford and starts in 1209 CE when scholars escaping troubles between the university and townspeople in Oxford fled to Cambridge. By 1226 CE, they had managed to organise themselves, electing the an official representative (the chancellor) and arranging a scheme of study fashioned after the one they had known in Oxford. In 1231 CE King Henry III took a step towards formalising the university by declaring that only those enrolled under a recognised master were allowed to remain in the town of Cambridge (Cambridge 2011).

Not only was the monastery a precursor to the university in terms of being a place of knowledge production, but the architecture of early universities often resembled that of monasteries or convents. Both the university and the monastery had to accommodate the daily needs of their users and as such consisted of many of the same facilities, including the chapel, refectory, kitchen, and dormitories, all linked by courts and passages (Goode 2009:192). The cloister, an important feature of monastic architecture, found its parallel in the university architecture in the quadrangle.

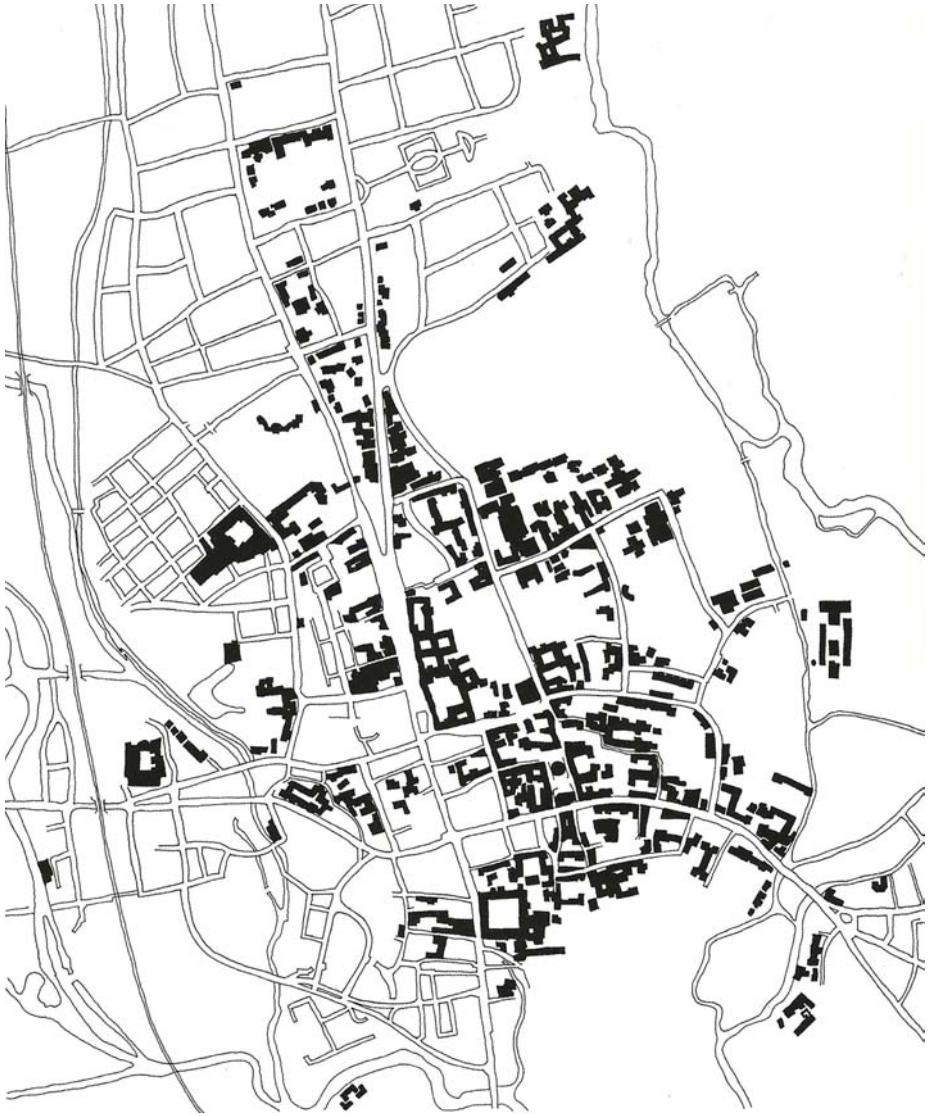


Figure 1.6. Nolli Map of Oxford University campus, Oxford.

Quadrangle Architecture

Architecturally, the term quadrangle, or quad, refers to a central rectangular or square courtyard, which is entirely or partially surrounded by buildings (Calvo-Sotello 2001:186). The quadrangle, began to emerge as a typical feature of university campus architecture around the late fourteenth century, when universities began to attract the highest patronage, as it was an efficient way of housing students in buildings around a central courtyard, rather than in large dormitories (Goode 2009:192). The resemblance of the quad in university architecture to the cloisters of medieval monasteries is fairly evident. Monastery cloisters, however, typically possessed covered arcades, while many of the earlier examples of university quadrangles, such as Mob quad (Figure 1.7) at Oxford, did not. The use of arcades and ornamentation in quadrangle architecture emerged later, as universities became more concerned with appearance and grandeur (Goode 2009:192).



Figure 1.7. Mob Quad at Oxford - one of the oldest examples of university quadrangle architecture

By the nineteenth century many new universities began to take on the form of large public buildings, such as the University of Vienna, which housed all the necessary spaces in one location. While the modern university owes its research ethos to the Germans and its education policies to English, its architectural character, typified by the university campus, is distinctly American (Goode 2009:964).

The Emergence of the Campus Typology

The term campus is believed to have been coined at Princeton University in the latter part of the 18th century and refers to the model of scattering buildings within a green environment (Goode 2009:964).

The campus prototype was characteristically located far from the city, in idyllic natural settings. In this regard, the campus prototype marked a return to some of the principles inherent in Medieval monasteries, such as detachment and seclusion. It has been argued by some that more than a return to the monastic tradition, the new campus prototype marked the pursuit for the Utopian paragon of the 'ideal city' (Calvo-Sotello 2001:189).

During the nineteenth and early twentieth centuries the Americans built more universities and colleges than any European country. These university campuses had many different stylistic influences including the classical French Beaux Artes style (i.e. University of Minnesota), the English Colleges style characterised by its quadrangles (i.e. Harvard University), and Mediterranean monastic style (i.e. Stanford - Figure 1.8) (Goode 2009:965).



Figure 1.8. Monastic influence at Stanford University.

The End of the University?

Throughout their history, universities have had to adapt in order to fit in with the social, political economic and cultural context of the times. Barnett (2000:409) has argued that the university of today is being presented with new challenges as a result of the changing nature of knowledge in our society. Michael Gibbons et al (1994) argue that a shift is occurring in the production of knowledge, and even go so far as to identify a distinct new form of knowledge production which they refer to as Mode 2. Mode 2 knowledge is contrasted with Mode 1 - the traditional form of knowledge production, characterised by its homogeneous nature, and its disciplinary and cognitive context. Mode 2 knowledge, on the other hand is trans-disciplinary, characterised by a heterogeneity of skills and players, and takes place in more transient organisational structures (Gibbons et al 1994).

Theories on the implications that the changing nature of knowledge might be having on the university as an institution are several. Some more drastic opinions declare it as being the "end of knowledge in higher education" (Delanty 1998). The arguments for this theory claim that knowledge in universities has no particular status and lacks legitimacy within the greater context of society as a result of being limited to a privileged minority group (Barnett 2000:411).

While changes in the nature of knowledge in society over the last few decades have been considerable, the `end of the university´ hypothesis seems a bit too radical to be entirely believable. More moderate commentators see the developments as a threat to the monopoly on "high status knowledge" that the university has enjoyed for centuries (Barnett 2000:411). One of the most serious challenges facing the 21st century university is the emergence of new sources of knowledge that may threaten to weaken the university´s authority.

Gibbons et al (1994:11) argue that the massification of higher education is causing a shift in the institutional nature of knowledge. The increasing numbers of university graduates is resulting in the creation of new sites where competent research and knowledge production can and does occur (Gibbons 1994:10). In producing graduates universities are producing more and more individuals capable of passing judgement on the knowledge produced by universities, and in turn capable of challenging the power held by traditional knowledge institutions (Gibbons et al 1994:11). Therefore, as knowledge is disseminated throughout society, the power of traditional knowledge institutions, such as universities, is undermined.

As a result knowledge is now increasingly being produced in a variety of different sites, such as companies, research institutions, laboratories, consultancies, and think-tanks (Gibbons et al 1994:11) as well as new emerging "hybrid fora" (Gibbons et al 1994:152). While the university undoubtedly continues to be an extremely important centre for knowledge production, the 21st century university is beginning to recognise that they are merely one such site, and that there are several more sites where competent knowledge production occurs.

"Fourteen centuries have learned,
From charred remains, that what took place
When Alexandria´s library burned
Brain damaged the human race...

...Where any nation starts awake
Books are the memory. And it´s plain
Decay of libraries is like
Alzheimer´s in the nation´s brain."

- from Hear It Again by Ted Hughes

Libraries

Pevsner (1976:92) states that until the late fourteenth century, books were kept in a variety of different places, few of which would fit into our classification of libraries today. Monasteries, for instance were assiduous collectors of books, often housing books in armariums or cupboards. Geoffrey of Ste Barbe-en-Ange is quoted as having said "*claustrum sine armario quasi castrum sine armentario*" or a `monastery without a book cupboard is like a fort without an armoury´ (in Pevsner 1976:92). It is important to remember, however, that the medieval monastery was as much a producer as a collector of books, as Pevsner (1976:91) points out. Before the advent of the printing press, texts had to be manually transcribed, a task that was mainly undertaken by scribes within monasteries (Meyvaert 1973:54).

The emergence of the university also played a vital role in the development and dispersion of the library. As the university began to emphasize the importance of reading as a complement to lectures, readership increased drastically and libraries suddenly started to play a much more significant role in university life (Carr 2010:66). It is of no surprise then that some of the most important libraries from the thirteenth century onwards were academic libraries, such as the library at the Sorbonne in Paris (Pevsner 1976:92). (Figure 1.9)

As the number of literate people, such as cenobites, students, merchants and aristocrats, increased so too did the availability of books. New books were produced, but many of these were of a technical nature, intended for reference, rather than for leisure (Carr 2010:62). For this reason many of the books in Medieval and Renaissance libraries were chained to lecterns, rather than on bookshelves as in modern libraries (Figure 1.10). This lectern system, however, was very inefficient in terms of storage and as a result shelves were added

above the lectern to provide additional space for books (Pevsner 1976:93). These new lecterns and shelves were normally placed in rows at right angles to the wall, creating aisles in between them and became known as the `stall system´ (Goode 2009:549).

As books became more readily available and readership increased, additional shelf space was provided against the walls, in what has been termed as the `wall system´ (Goode 2009:549). Pevsner (1976:96) argues that the German historians´ term "Saal-System" is a more accurate description of the typology, stating that while it is characterised by placing the bookshelves along the walls, the more important architectural feature is the resulting spacious Saal or hall. Regardless of the terminology, the wall system became the standard architectural library typology of the seventeenth and eighteenth centuries (Pevsner 1976:93).



Figure 1.9. Academic library at the Sorbonne, Paris.

While the transition from the `stall´ to the `wall´ system may seem like a minor change, it had a tremendous impact on the architecture of the library. The design of the windows and the façade had to change to accommodate the new arrangement of the shelves. With additional shelves placed around the walls it made it impossible to have large areas of glazing. While this change may seem quite minor, it completely altered the interior and exterior character of libraries (Goode 2009:549).



Figure 1.10. Chained books in a library.

Wren´s Trinity College Library

The Trinity College library in Cambridge, designed by Sir Christopher Wren in 1676, is one of the most celebrated and monumental seventeenth century English libraries (Pevsner 1976:100). The long two-storey building encloses the west side of Nevile´s Court with its west façade looking onto the river Cam (Whinney 1971:135). The east elevation (Figure 1.11) is comprised, on ground floor, of an arcade with Doric order columns. It is interesting to note that the openings of the arcade do not rise the full height of the arch, but that the top of the arch is solid, thus creating rectangular openings that match the height of the existing side loggias (Whinney 1971:136-7). The upper storey sits on a full entablature and is characterised by large arched windows framed by Ionic order pilasters and a balustraded parapet above (Whinney 1971:139).

The library itself is located on the first floor and for the most part employs the traditional stall sys-

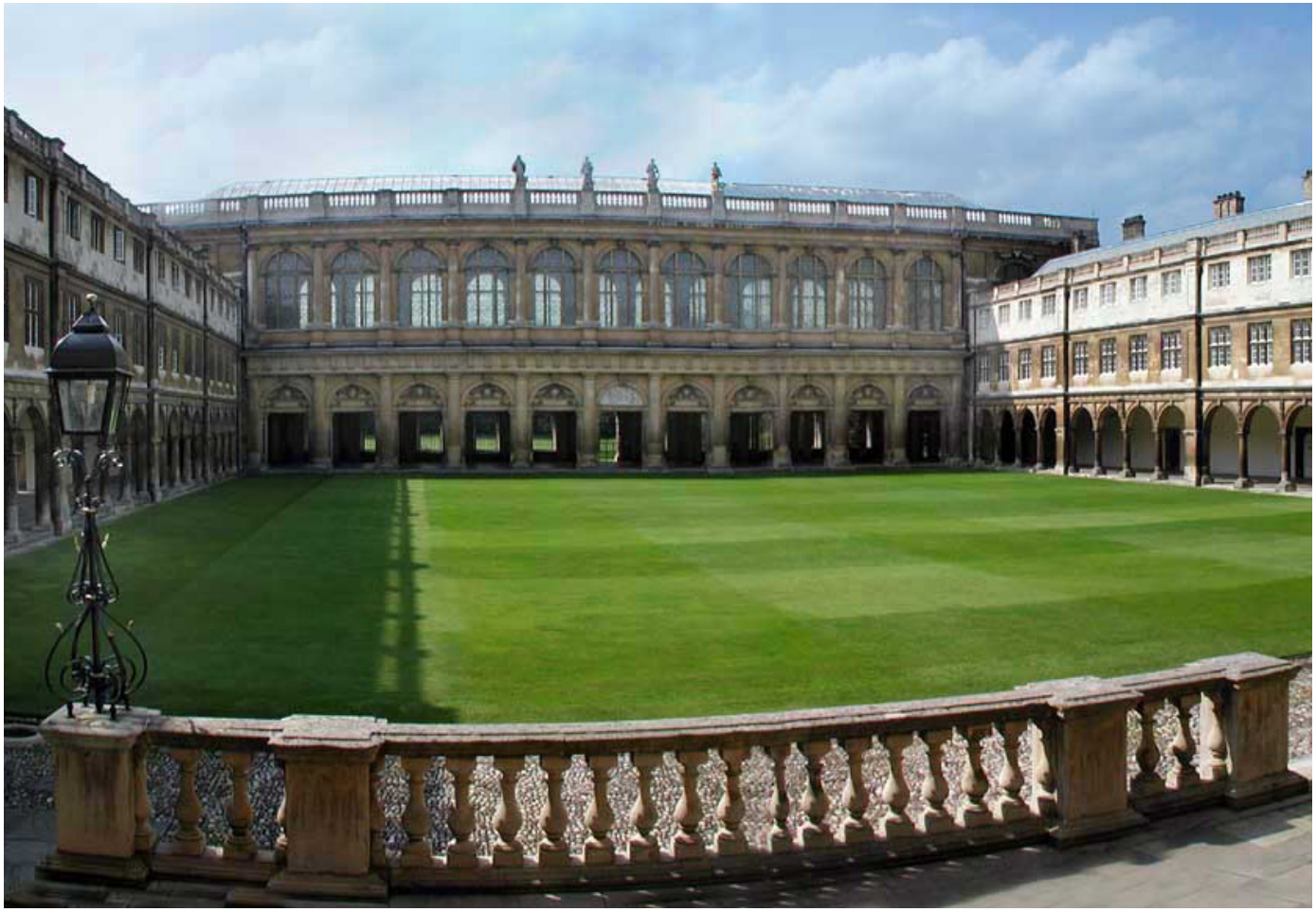


Figure 1.11. East elevation of Trinity College Library in Cambridge, designed by Sir Christopher Wren.

tem, although in a quite ingenious manner which shows that Wren was most likely aware of the emergence of the wall system (Pevsner 1976:102). The building´s exterior is deceiving as it looks like the cornice topping the lower order of columns and arches corresponds to the first floor level on the interior (Figure 1.12) of the building when in fact it does not. Internally, the first floor level is actually dropped to the springing point of the lower arches, made evident on the east elevation by the fact that the top of the arches are filled in (Pevsner 1976:102; Whinney 1971:139). This allowed Wren to place the first floor windows high enough so that the bookshelves can run along the outside wall without obstructing the windows, thus providing ample natural lighting from above (Pevsner 1976:102; Whinney 1971:139).



Figure 1.12. Interior of Trinity College Library in Cambridge, designed by Sir Christopher Wren.

Secularistaion of the Library

Libraries first emerged out of religious contexts and gradually became more secularised over time. Historically, libraries were considered places of privilege, and were the exclusive domain of the rich and educated elite (Goode 2009:549). Public libraries were unheard of. As the university developed and books became more readily available, the nature of the library began to change, emerging inro society for the first time as an independent entity.

The Wolfenbuttel library, designed by German architect Herman Korb in 1690, is credited as being the first completely detached secular library in Europe (Goode 2009:550; Pevsner 1976:99).

Libraries Today

The continuous increase in availability and demand for books from the eighteenth to the twentieth century had a tremendous impact on the spatial arrangement of libraries, which had to change to accommodate the increased number of books and users (Goode 2009:551). Today, however, libraries are faced with extremely different challenges. In an age categorised by the prevalence of communication technology, such as the internet and e-readers, the library is losing its traditional identity as the indispensable knowledge space that it once was.

The digitization of books and their emancipation from the physical constraints of a library space have cast uncertainty on the future of the library and the printed book. It has even been predicted that libraries will disappear from our society by the year 2019 (Dawson:2011). Whether such predictions turn out to be fulfilled only time will tell. One thing that does seem certain is that if the library is to remain relevant in the 21st century, it will have to embrace the dynamic nature of information in our society, and reinvent itself as a knowledge space.

The Seattle Public Library

The Seattle Public Library (Figure 1.14) is a prime example of a 21st century library that is reinventing itself to fit into its temporal context by embracing and celebrating new ways of thinking and communicating in a digital world. The library, designed by Office for Metropolitan Architecture (OMA) and LMN architects, was conceived as a more liberal and modern take on the library typology. The structural steel and glass building is divided into eight horizontal layers, grouped into five distinct programmatic platforms. These platforms are stacked vertically on top of each other, but shifted in the horizontal plane to maximise views and light (Figure 1.13). One of the most important considerations for the design was the incorporation of various types of digital and printed media. The architects parted from traditional library designs and devised unique forms of storage to house the printed book collections. The fiction books are housed in the "Living Room" while the non-fiction books are organised in continuous sequence along a four-story ramp, known as the "Dewey Ramp" (Arcspace 2011). On the top floor is the reading room which provides views of Puget Sound and the surrounding mountains. The in-between spaces act as multifunctional spaces, for work, interaction and play, and tie the different programmatic platforms together (Arcspace 2011).

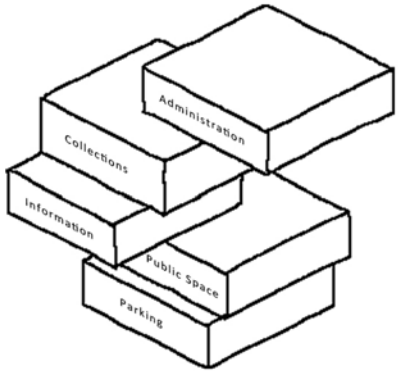


Figure 1.13. Concept sketch of Seattle Public Library.



Figure 1.14. Seattle Public Library by OMA.

Research Laboratories

The history of the research laboratory as a knowledge space is more difficult to trace than that of the monasteries, universities or libraries that have been discussed so far in the paper. Establishing the location and definition of the laboratory throughout history is a complex task (Shapin 1988:373).

For one, the emergence of the laboratory as its own distinctive architectural typology is unclear and has received little attention from scientist, architects and historians alike. Even the origin of the term laboratory, as Owen Hannaway (1986:585) explains, is somewhat of a mystery. There is some evidence of the use of the Latin term laboratorium in Medieval times, however, it was apparently not until the late sixteenth century that the word acquired anything of its modern connotation. Furthermore, it seems that its early usage referred specifically to alchemy and chemistry, only later evolving to refer to any place where investigation of natural phenomena occurred (Hannaway 1986:585).

Hannaway´s explanation of the etymology of the word laboratory gives us a clue as to the reason for its obscure history as a knowledge space. As the term evolved to include almost any place where investigation occurred, it became more encompassing and could be be applied to any number of different sites. Given the drastic evolution of these sites throughout history, it has become almost impossible to pinpoint the location of the laboratory. As Peter Galison (Galison and Thompson 1999:1) states, “there is no single transtemporal, transcultural entity that is `the laboratory´ that would include all spaces through the alchemist´s secretive basement array of furnaces, through the clinical research hospital, to the $10 billion Large Hadron Collider outside Geneva.”

Throughout most of history the house and the workplace were one and the same thing. The separation between place of residence and place of work is a construct that emerged out of modern society (Shapin 1992:27). As such, given that there was no specific space for scientific experimentation to take place, it is likely that throughout history most scientific experiments were conducted in domestic environments. As time went on the number of venues that were used for experimentation increased. In seventeenth century England for instance, sites ranging from the coffeehouse, to the apothecary´s and instrument maker´s shop, the royal palace, and the university were used for experimental work; however, the “residences of gentlemen” continued to be by far the most significant (Shapin 1988:378).

Since the emergence of the laboratory, one of the biggest questions surrounding it has been who should be allowed access to it and how should the knowledge produced within it be dealt with. The idea of public versus private is a ubiquitous one, not only in architectural discourse but in our everyday social life. Georg Simmel, early 20th century German sociologist and philosopher, argued that architecture begins at the door, and that the door was both a statement of connection and separation (in Galison and Thompson 1999:6). Steven Shapin (1988:374) argues that knowledge production is structured along much the same lines and that on either side of the threshold the conditions of our knowledge are different. If we cannot see something for ourselves we must either trust what we are told by others or continue to suspect it. As such “the threshold acts as a constraint upon the distribution of knowledge, its content, quality, conditions of possession, justification...” (Shapin 1988:375)

Brahe versus Libavius

While little attention has been paid to the location of the laboratory throughout history, Owen Hannaway´s 1986 essay Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe is an exception. This work, notable for being one of the pioneering studies on subject, discusses the emergence of the laboratory typology by comparing the laboratories of Tycho Brahe and Andreas Libavius, in terms of their differing approaches to knowledge.

Tycho Brahe was a Danish astronomer and author of the work *Astronomiae insturatae mechanica* (1598), which contained detailed descriptions of his Uraniborg observatory complex, located on the island of Hven in the Danish sound (Hannaway 1986:589). Andreas Libavius, was a Saxon physician, schoolteacher, who in 1606 published a commentary, which included a detailed description of the domus chemiae or Chemical House, an ideal chemical laboratory that also served as a residence for the artificer (Galison 1999:60; Hannaway 1986:587-8). Hannaway (1986:599) proposes that Libavius´ Chemical House was a direct and intentional criticism of Brahe´s approach to knowledge and science as embodied by his Uraniborg complex.

Tycho Brahe´s Uraniborg complex was comprised of a grand palatial building enclosed by a square wall, the corners of which were set in relation to the cardinal points so that the diagonal paths ran precisely east-west and north-south (Figure 1.15). The same dedication to symmetry is evident in the plan of the building itself which is comprised of a central square flanked on the north and south by circular bays (Figure 1.16). The domestic functions of the building were located mainly within the central square, the work areas were housed in the circular bays, and the chemical laboratory was located on the basement level of the southern circular bay. From the outside, the main structure was topped with an octagonal tower with a gallery, which housed a clock and a bell and the circular bays were characterised by their observation decks with pyramidal roofs (Hannaway 1986:591-4).

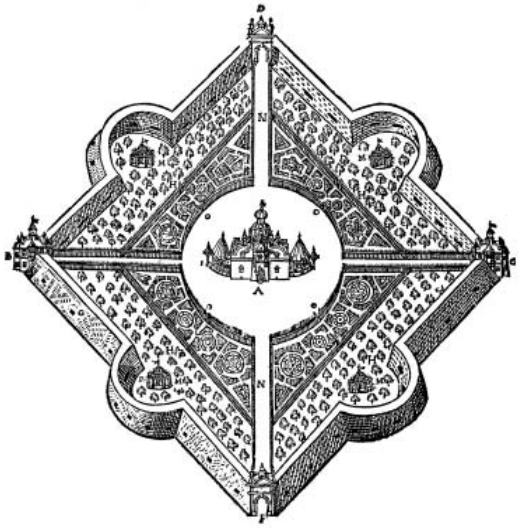


Figure 1.15. Site plan of Tycho Brahe´s Uraniborg complex.

Hannaway argues that Brahe buried his laboratory underground to keep his secrets away from public gaze (Galison 1999:60). Brahe, however, saw alchemy as a "terrestrial astronomy," a concept made evident by two vignettes in his work Astronomiae insturatae mechanica, which bear the inscriptions "*suspiciendo despicio*" (`in looking up, I look down´) and "*despiciendo suspicio"* (`in looking down, I look up´) (Hannaway 1986:597).

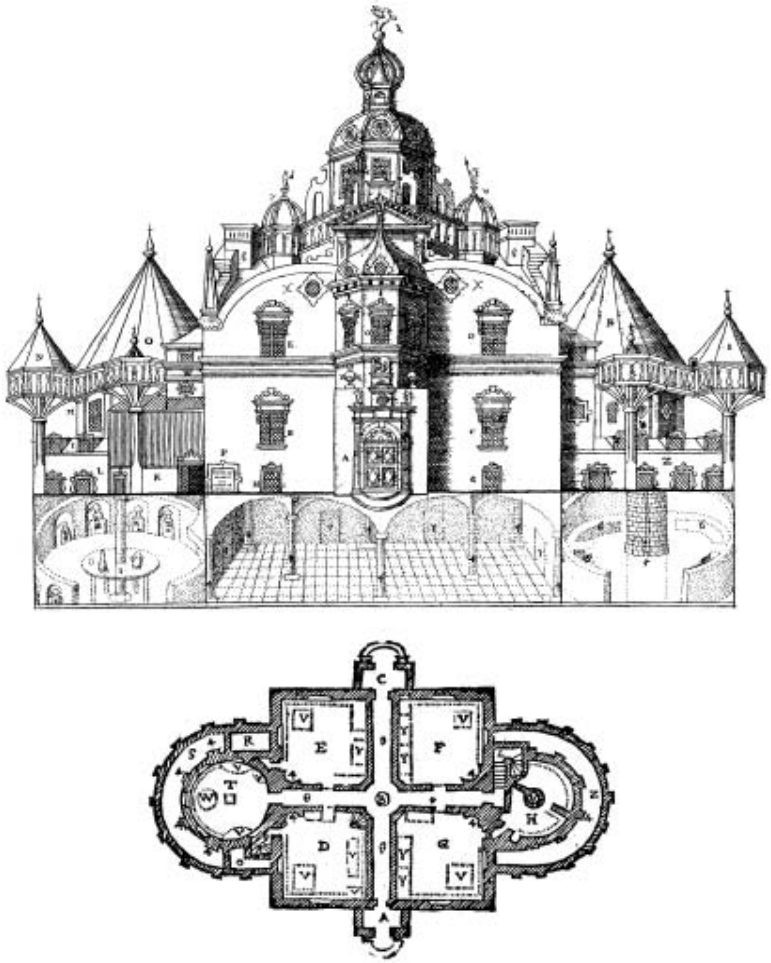


Figure 1.16. Plan and elevation of Uraniborg complex.

Therefore, the placement of his laboratory underground might have had a greater symbolic meaning, in addition to the functional purpose of keeping people out (Hannaway 1986:597-8).

In contrast to Brahe´s grand castle observatory, the chemical laboratory proposed by Libavius is not in the style of a royal residence, but rather a sixteenth century German townhouse; a place of work and residence for a citizen of the middle class (Hannaway 1989:590). Libavius´ laboratory (Figure 1.17), which Hannaway (1989:599) views as an embodiment of Libavius´ ideal of civic humanism, was consciously placed above ground and within the fabric of society, rather than isolated on an island. According to Hannaway, Libavius believed that what science needed was public exposure and not isolation. As such Libavius, both literally and figuratively, "sought to take chemistry out of Brahe´s basement and bring it into the light of day" (Hannaway 1989:599-600). Libavius´ Chemical House, similarly to Uraniborg, was comprised of three levels, although the first level of Libavius´ house, where the laboratory is housed, is located above ground. The rear elevation (Figure 1.18) shows three towers at the back of the house which Hannaway (1986:600) argues were inspired by the circular observation decks of Uraniborg. Upon entering the house one goes into an atrium space which is separated from the laboratory by a wall and door (Hannaway 1989:600). The door in this case is reminiscent of Georg Simmel´s description of the door as both an element of connection and separation, in that it separates the public atrium space from the private space of the chemist; the laboratory.

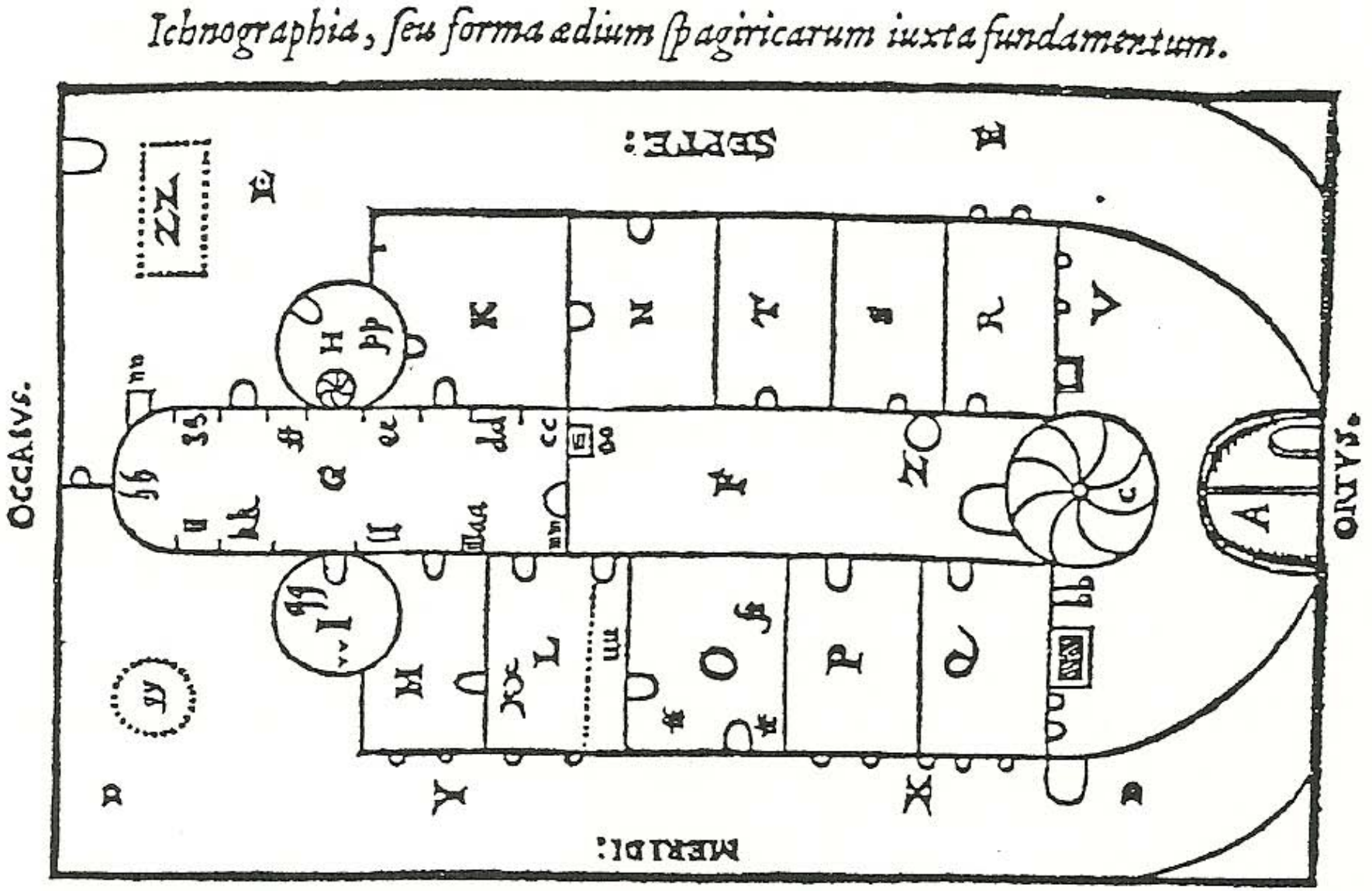


Figure 1.17. Plan of Libavius´ Chemical House.

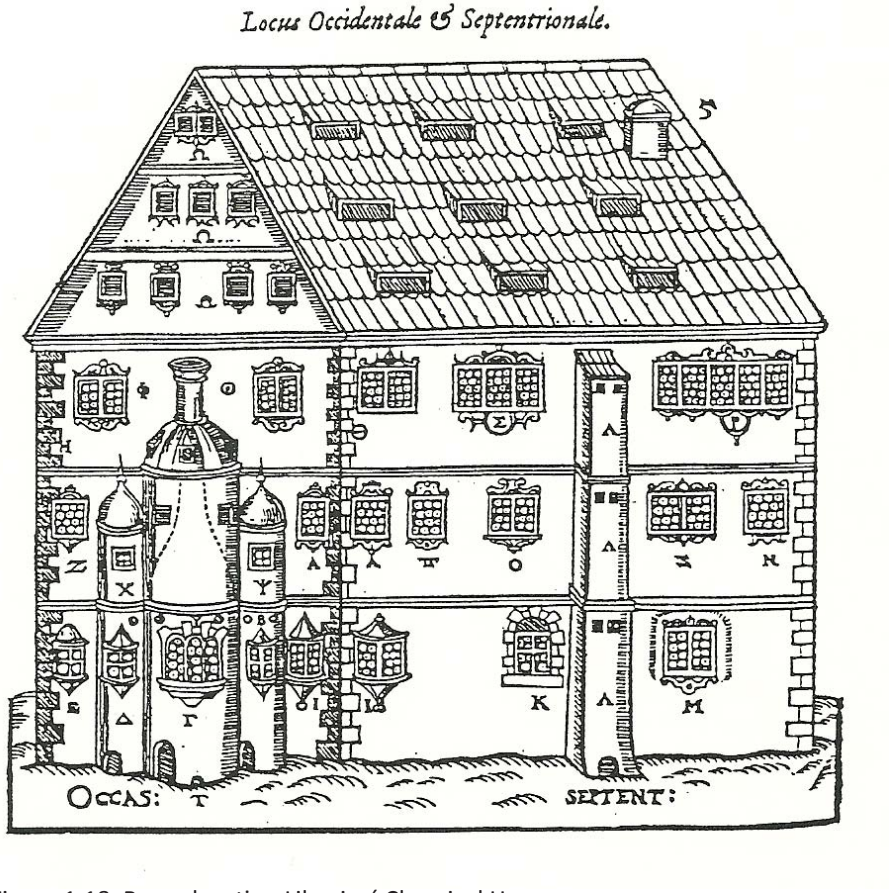


Figure 1.18. Rear elevation Libavius´ Chemical House.

Ultimately, Hannaway (1986) concludes that where Tycho advocated secrecy in chemical affairs, Libavius promoted its public dissemination as part of his civic humanist ideals. He used the examples of Brahe and Libavius, and their respective laboratories, in an attempt to establish a dichotomy between the old secretive methods of alchemy and the new accessible methods of chemistry (Galison 1999:60). Thus what Hannaway was really implying was that between Brahe and Libavius there occurred a shift in the nature of knowledge and science in society. While a ground-breaking study at the time, Hannaway´s central argument has received criticism from various academics who disagree with the duality that he attempts to trace between the approaches of Brahe and Libavius to science. As an exploration and analysis of the built form of the laboratory typology, however, his work still stands for itself and has been paralleled by few.

Science: Open or Closed?

For the most part, scientific research and experimentation have historically tended to take place behind closed doors, in highly regulated environments, far removed from the public (Peckham 2009:521). Robert Boyle, the seventeenth century Irish scientist is often considered an exception.

Boyle was one the great critics of the privacy and secrecy of knowledge production at the time and argued for the public dissemination of experimental knowledge. He was known for granting casual visitors access to his laboratory in Pall Mall, a site which quickly became an object of "intellectual pilgrimage" to locals and foreigners alike (Shapin 1988:386). As a result of his attitude towards knowledge, many historians consider Robert Boyle to be the founder of modern chemistry, by breaking away from the secretive tradition of alchemy. (Figure 1.19)

Even today, however, most scientific research seems to occur in highly controlled specialized environments, which are often withdrawn from the public. One of the main justifications for this practice is to guarantee the integrity of the research conducted within facility (Peckham 2009:521).

As places of knowledge production, laboratories cannot jeopardise their research by allowing free access to all. With the growing and varying interests in scientific development, both public and private, this segregation of scientific research and experimentation has come into question. Debates surrounding the accountability, as well as the ethical framework in which science operates have emerged and increased attention is being paid to new locations of knowledge creation (Peckham 2009:521).



Figure 1.19. The Alchemist by Pieter Brueghel, depicts a scene of an alchemist´s lab.

Knowledge in the Information Age

Throughout history society has been constantly shaped and transformed by emerging technologies. The way that we communicate and share knowledge has been revolutionized time and time again with the advent of inventions such as the printing press, the telephone, the radio, the television, the computer, and now the internet. All of these technologies have contributed to changing the way that we perceive and approach knowledge and have had a profound effect on society as a whole.

The internet has connected the world in an unparalleled way and put vast amounts of information at our fingertips (Figure 1.20). Today information is no longer static, found mainly in printed books or other such `permanent´ mediums. Thanks to the development of information and communication technologies in the past couple decades, information today is dynamic, evolving, interactive and accessible, for better or for worse. The impact that these technologies are having on our lives are profound and far-reaching – affecting not only the people who use them, but also the physical spaces that surround us.

Is More Always Better?

The amount of information contained on the internet is so immense that it is all but impossible to quantify. In a world where access to such vast amounts of information is but a click away, we must ask ourselves whether more is always better. If we need quick information Google is always there to "answer" our queries. However, not all information is created equal. The internet, while an extremely powerful and convenient tool, has no quality control and as such contains a great deal of dubious, irrelevant and untrustworthy content. It seems that unreliability is the price we pay for easily accessible information. This problem is exacerbated by the transitory nature of digital text, which seems to encourage untrustworthiness and incompleteness, as Nicholas Carr (2010:107) cogently states in the following quote:

"A printed book is a finished object. Once inked onto the page its words become indelible. The finality of the act of publishing has long instilled in the best and most conscientious writers and editors a desire, even an anxiety, to perfect the works they produce – to write with an eye and an ear toward eternity. Electronic text is impermanent. In the digital marketplace, publication becomes an ongoing process rather than a discrete event, and revisions can go on indefinitely..."

Ultimately Nicholas Carr (2010) makes a convincing case that the internet is reshaping our neural pathways and changing the way we think. The internet with its hyperlinks, constant distractions, and focus on speed, is literally rewiring the circuitry of our brains, by forcing it to focus on short term decisions. The implications of this are that only a very small part of the information that we process when online makes it into any deeper level of cognisance. As a result, our brains are being artificially molded to favour superficiality, speed and groupthink (Carr 2010:34).

Effect of Information Technology on the Built Environment

Architecture too is being affected by the emergence of new technologies and the changing context in which we live. Architecture is no longer just located in a physical realm, but also a temporal one. It is no longer sufficient to consider a building´s physical environment, but we must also consider the moment that it occupies in time, and all the associated implications.

William Mitchell (1999:15) architect and information technologist, argues "urban infrastructural networking" is as much as part of our age as shipping and waterways were to the 18th century, railroads to the 19th century, and electricity grids and inter-state highways to the 20th century. As much as we try to ignore them, these new technologies are a part of our society. In the 21st century, the infrastructure required for high-speed digital communication will reshape existing urban patterns, so that "silicon is the new steel, and the internet is the new railroad" (Mitchell 1999:16).

Many fear that the emergence of these new technologies will obliterate distance and physical spaces. Fears over the disappearance of the library as a knowledge space, have already been discussed in this paper. Mitchell (1999:29), however, contends that rather than seeing these new technologies as harbingers of doom, it is more useful "to recognize that the resulting new linkages provide us with a radical new means of producing and organizing inhabited space..." Information technology, rather than something that should be feared, should be embraced by architects as something that can inform the design process of buildings located in the 21st century context.





"Technology is neither good nor bad, nor even neutral. Technology is one part of the complex of relationships that people form with each other and the world around them."

- Samuel Collins

Figure 1.20.
Map of the world showing interconnection of people through Facebook.

Conclusion

Knowledge is a dynamic and constantly evolving part of our society. Throughout the ages, as society´s approach to knowledge has changed, so too have the spaces which serve knowledge in some form or another - from monasteries, to universities, to libraries, and laboratories. Architecture and knowledge have become so inextricably linked in these spaces, to the extent that the architecture becomes a physical embodiment of the ideologies and perceptions of knowledge held by society at a given time and place.

While the nature of knowledge, and our perception of it, has changed significantly throughout history, this is not to say that the historical precedents are no longer relevant. Historical precedents - from the monastery to the laboratory - are valuable examples, each offering unique insights into the relationship between architecture and knowledge.

The monastery for instance, can be seen a physical embodiment of communal living. Despite its secluded and segregated nature, the monastery was extremely successful in its spatial organisation of community life. While monasteries were designed specifically to accommodate communities of monks, many monastic principles are applicable to social life in general, or any other form of community life.

Monasteries typically possess a natural rhythm and order, which governs all aspects of life within its confines as well as its architecture. From monasteries we can learn several valuable lessons. For instance, the accommodation of functions in different scales and qualities of space, or the response and connection to the natural surroundings. The most important lesson to take from the monastery typology, however, is its masterful reconciliation of the opposing forces. It is arguably the reconciliation of the individual and the collective, the public and the private, which makes monasteries such successful examples of community living.

The library, is a prime example of how society´s perception of knowledge has had an impact on its architecture. The emergence of the library as a secular space, accessible to everyone, caused the library typology to undergo several significant changes. Throughout history, as society´s attitude towards knowledge has evolved so too has the spatial character of the library.

Today libraries are undergoing another drastic transformation as a result of the changing nature of knowledge in the information age. The library as a typology is having to reinvent itself in order to remain relevant in today´s knowledge society. This ability to keep up with the dynamic nature of knowledge is important in any knowledge space. The university, from the quad to the campus has taught us the importance of informal interaction in learning and education. Scientific studies have shown that social interaction and sharing of ideas is fundamental to learning and discovery. The university quadrangle is the physical embodiment of this ideal - a space for interaction outside of the confines of the classroom.

The laboratory, like the monastery, deals with issues of public and private. The legitimacy of research that is conducted behind closed doors is often called into question because of its lack of transparency. As physical spaces, however, laboratories often require controlled conditions and a degree of privacy for work to take place. The reconciliation of these opposing demands is critical to the laboratory and, ultimately, to any knowledge space.

The separate, yet convergent evolution of monastic, library, university, and research spaces suggests some common element that informs the development of these typologies as knowledge spaces. This essay has explored these individual spaces and identified some of the common threads that tie them together.

Linking Architecture and Neuroscience

"*We shape our buildings and thereafter they shape us.*"

- WInston Churchill (1960)

Architecture is one of the oldest disciplines in human history, neuroscience on the other hand, is one of the newest. Despite this architecture and neuroscience are more interconnected than they may first appear. How else can we explain the tremendous ability of architecture to influence our thoughts, feelings and behaviour? Architecture is experienced through the senses, which are rooted in the brain. For this reason the process of experiencing architecture ultimately takes place in the mind. Understanding how the brain is influenced by architecture can give us clues on how to design to suit the mind.

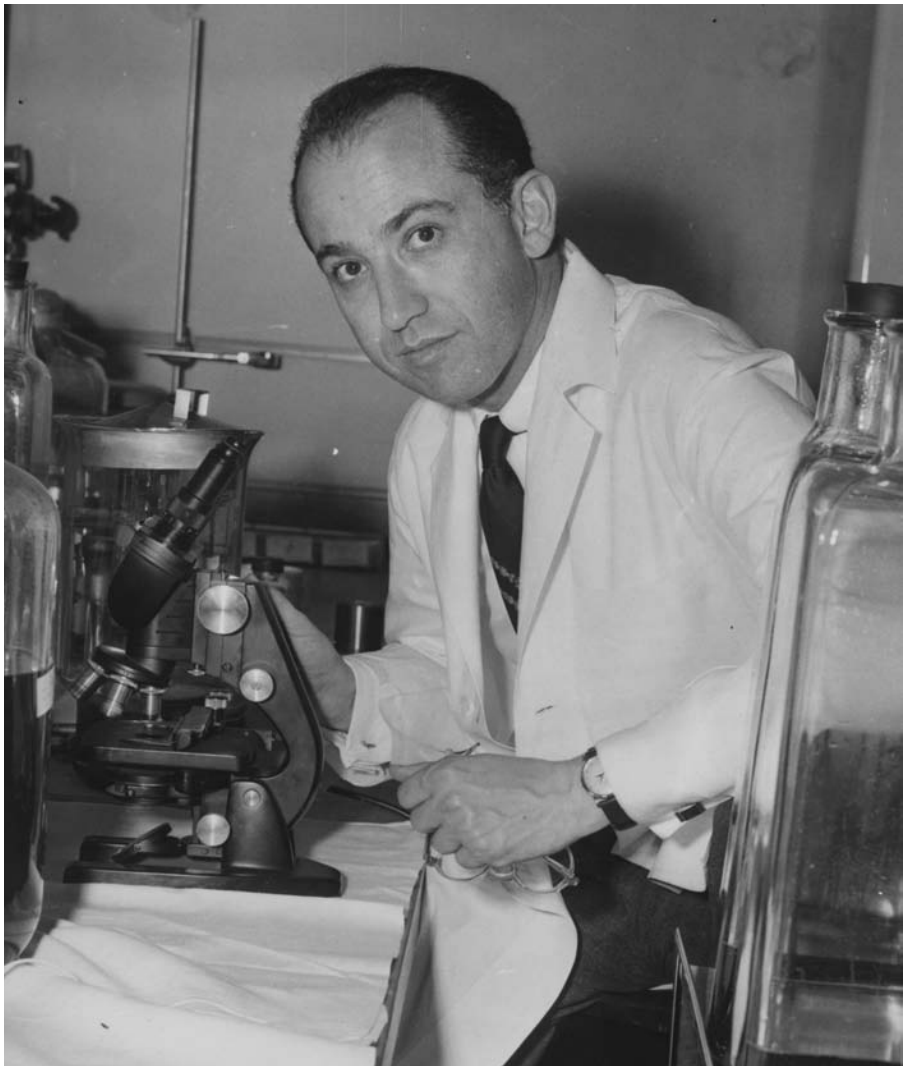


Figure 1.21. Jonas Salk, Nobel prize-winning doctor who developed the Polio vaccine.

The Jonas Salk Story

Jonas Salk was a Nobel prize winning biologist and doctor, who in the 1950s was working in a dark basement laboratory in Pittsburgh trying to find a cure for Polio (Anthes 2009:52).

Progress was slow, so to clear his mind Salk traveled to Italy, where he spent some time in a 13th century monastery. Amidst the monastery´s collonaded walkways, cloistered courtyards and serene architecture, he came up with the idea that would lead to the development of a successful Polio vaccine (Anthes 2009:52).

Salk was so convinced that the architecture of the monastery had influenced his mind and even claimed that he owed his discovery to the time he spent there. He believed so strongly that architecture was capable of influencing the mind that he teamed up with architect Louis Kahn to design the Salk Institute, a facility that would, through its architecture, encourage research and creativity (Anthes 2009:52).

In his legacy Salk made the appeal that neuroscientists continue to work with architects, as he had done with Louis Kahn (Sternberg and Wilson 1996:239).

Can architecture Benefit from Neuroscientific Research?

While at first glance architecture and neuroscience may appear to have little in common, several scholars have seen tremendous potential in promoting a cross-disciplinary knowledge base. The last decade has even seen the establishment of specialized organizations, such as the Academy of Neuroscience for Architecture (ANFA), which is attempting to bring the disciplines of architecture and neurosciences together in order to promote an interdisciplinary exchange of knowledge.

In recent years, neuroscience has discovered that the brain is significantly more plastic than was ever thought in the past. In other words, our brains have the ability to physically adapt to new experiences and situations (Carr 2010:34). Thus the environments in which we spend most of our time can literally influence the underlying structure of our brains and affect our behaviour (Eberhard and Gage 2003).

While there is substantial neuroscientific evidence to support that physical environments can influence our mind, understanding what makes for good design is a lot less scientific.

Designing hospitals that promote healing, schools that promote learning, and offices that minimise stress levels is nothing new in architecture, however until now these endeavors have tended to be based largely on intuition.

By drawing on the growing knowledge base of neuroscience, architects can build on these intuitive principles with empirical evidence.

Brain studies that help us understand how the human brain perceives space and reacts to the built environment could help architects design buildings that are better suited to their functions and in which people can operate at their fullest potential (Eberhard and Gage 2003).

Architecture for the Mind:

Some Design Principles from Neuroscience

Connection to Nature

Several studies have hinted at the benefits of natural views in built environments. A study conducted in 2000 showed that there was a link between natural views and attention span (Anthes 2009:54).

Another study, conducted by William Sullivan of the University of Illinois, reported similar effects in children with attention deficit disorder (ADD) (Anthes 2009:54). Sullivan argues that humans innately function most effectively in green spaces.

According to several scholars nature has a soothing and restorative effect on the mind. Stephen Kaplan, psychologist at the University of of Michigan argues that being surrounded by urban scenes and other products of the modern world, is more mentally straining, whereas looking onto a natural setting gives the mind some much needed rest (Anthes 2009:55).

Lighting Levels

Lighting also plays an extremely important role in our perception of space and our behaviour.

Firstly, we perceive objects visually through light. Inadequate lighting levels makes it difficult for the eye to discern edges of objects thus making difficult to navigate through space (Sternberg and Wilson 2006:239).

More fundamentally, however, light, in particular natural light, is responsible for maintaining our circadian rhythm, which regulates our sleep-wake cycles, keeping us alert during the day and making us sleepy at night.

Adequate levels of sunlight have also been shown to improve students´ test results according to a study carried out in California in 1999 (Anthes 2009:55).

Landmarks

Landmarks play an important role not only in creating a sense of place but also in navigating through a space. It has recently been discovered that the hippocampus plays a role in both navigation and the retrieval of memory, suggesting that creating a strong sense of place can help jog our memory (Sternberg and Wilson 2006:239).

A lack of landmarks or visual cues, on the other hand, can cause disorientation and confusion, which can trigger anxiety and stress responses in lab rats (Sternberg and Wilson 2006:239).

Ceiling Height

A 2007 study conducted at the University of Minnesotta showed that ceiling heights affect the way in which our brains process information. Spaces with high ceilings encourage more abstract and free thinking, while rooms with low ceilings promote more attention to detail (Anthes 2009:54).

Sharp vs. Soft Edges

A study conducted by neuroscientists at Harvard Medical School found that people instinctively prefer objects with smooth or rounded edges, when shown images of everyday objects. Moshe Bar argues that this is because our brain perceives sharp angles as dangerous, and triggers a primitive fear reaction in the amygdala. (Bar and Neta 2006).

Precedent Studies

The precedent studies that follow have been carefully selected each for their own unique reasons. Some look at buildings of the same typology. Others deal with completely different building typologies that nonetheless possess certain characteristics that may help inform the design of a research institute, such as the one proposed.

The Salk Institute for Biological Studies, La Jolla, USA
- Louis Kahn

Located in La Jolla, California and designed by Louis Kahn, The Salk Institute is arguably one of the most iconic buildings to have emerged out of the 20th century.

The Origins of the Salk Institute

Louis Kahn was first approached by Dr. Jonas Salk, the inventor of the Polio vaccine in December of 1959, after Salk had heard a talk delivered by Kahn in Pittsburgh (Coleman 2005:179). Salk was looking for Kahn´s advice on selecting an architect for a new biological research institute which he was building in La Jolla, California and did not originally intend to employ Kahn as the architect, however, Salk must have been swayed by his meeting with Kahn, as he decided to keep him as the architect on the project (Coleman 2005:179).



Figure 1.22. Axial view down central plaza looking towards the east.

Although, he gave Kahn a significant deal of creative liberty on the project, Jonas Salk had some very strong convictions of what the institute should be. Salk had an appreciation for both art and science and disagreed with the dualistic thinking that saw art and science as irreconcilable forces (Coleman 2005:174).

To Salk research was as much as a creative act as a scientific one. Furthermore, Salk sought to unify branches of knowledge, which have for centuries have been moving further away from each other. The aim of the institute was to provide a space that would encourage the inter-disciplinary exchange of knowledge; a space in which the "irrational" and the "rational" could be reconciled (Coleman 2005:174). As Salk himself stated to Louis Kahn:

"There is one thing I would like to be able to accomplish. I would like to invite Picasso to the laboratory" (in Coleman 2005:180)

Louis Kahn was also a man of strong architectural convictions and ideologies. In designing the Salk Institute Kahn drew on his convictions of the fundamental identity of the institution. According to Kahn the city is the first institution. As the architect himself stated: "The city is the assembly of the institutions of man. In other words, the city is the places where the institution occurs to men" (Louis Kahn in Coleman 2005:183).

Just as he envisioned the city as an institution, Kahn envisioned the Salk Institute as a small city, comprised of three main spaces; the laboratories, the meeting place, and the living space (Coleman 2005:183). Kahn designed the Institute with these three components, however, in the end only the laboratory component was in fact built (Coleman 2005:186).

Kenneth Frampton (1992:10) describes the Salk Institute as a "creative contact between modern technology and a limited monasticism. While the concept of a monastery for science might seem like a strange one at first, it is not in fact such a stretch. Much like Le Corbusier discovered, many monastic ideals are as applicable to monasteries as they are to other social institutions, including research laboratories. Much like Le Corbusier, both Salk and Kahn were inspired by monasteries and monastic ideals.

Salk spent some time at the Monastery of San Francesco in Assisi to clear his mind during a challenging time in his research career. He was so inspired by the natural and architectural setting that he claimed that he was able to do some of his most intuitive thinking that eventually lead to the development of the Polio vaccine (Coleman 2005:185). It is great part thanks to this personal experience that Salk undertook the challenge of designing a research institute, which he envisioned would be as much a monastery as an artist´s colony (Coleman 2005:174).



Figure 1.23. *The Street is a Room*. Drawings for the City /2 Exhibition. Louis I. Kahn, 1971.

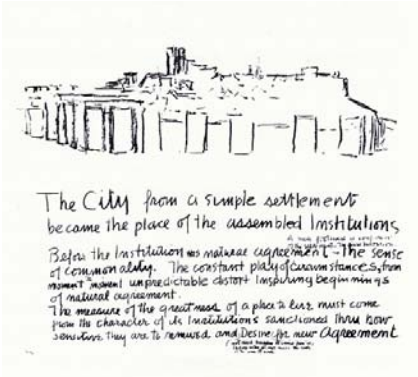


Figure 1.24. *The City*. Drawings for the City /2 Exhibition. Louis I. Kahn, 1971.

The Building

The building is located in Torrey Pines on a site adjacent to the University of California at San Diego. The site is defined by a dramatic canyon which opens out to the West overlooking the Pacific Ocean (Leslie 2005: 133). Kahn was inspired by the site and used it as the starting point in his design of the Salk Institute. His reaction to the site was that the building must find its "position in deference to nature" (Kahn quoted in Coleman 2005:188).

Kahn envisioned the project as being made up of three separate buildings, which he positioned on the site in a thoughtful manner meant to respond to and accentuate the surrounding landscape (Coleman 2005:186). In his original scheme four laboratory buildings were situated furthest inland at the head of the canyon on the east end of the site. The meeting place was located at the northern boundary of the canyon and directly across the canyon to the south, and some

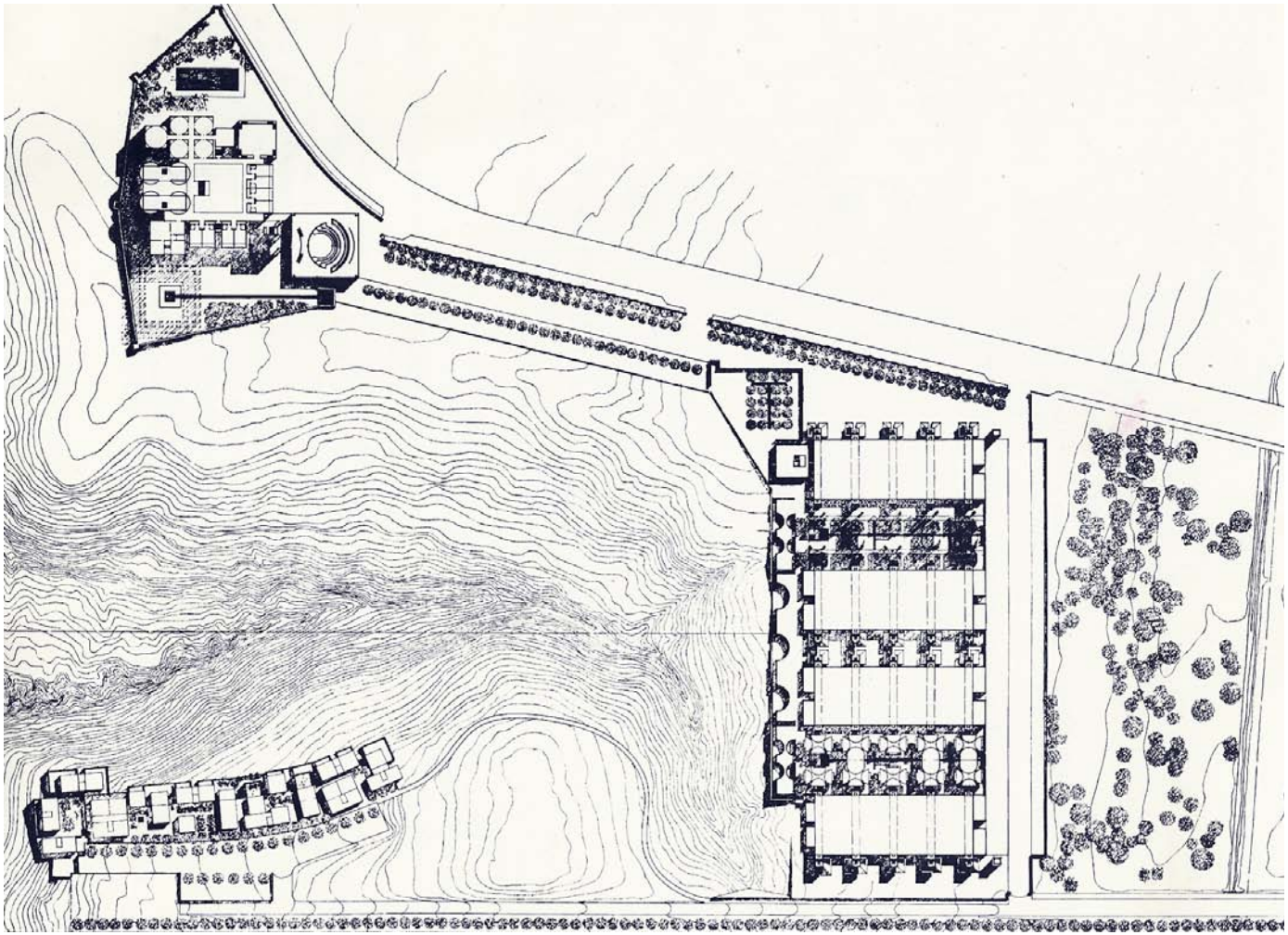


Figure 1.25. Louis Kahn´s original master plan for the Salk Institute, including laboratories, meeting house and residences.

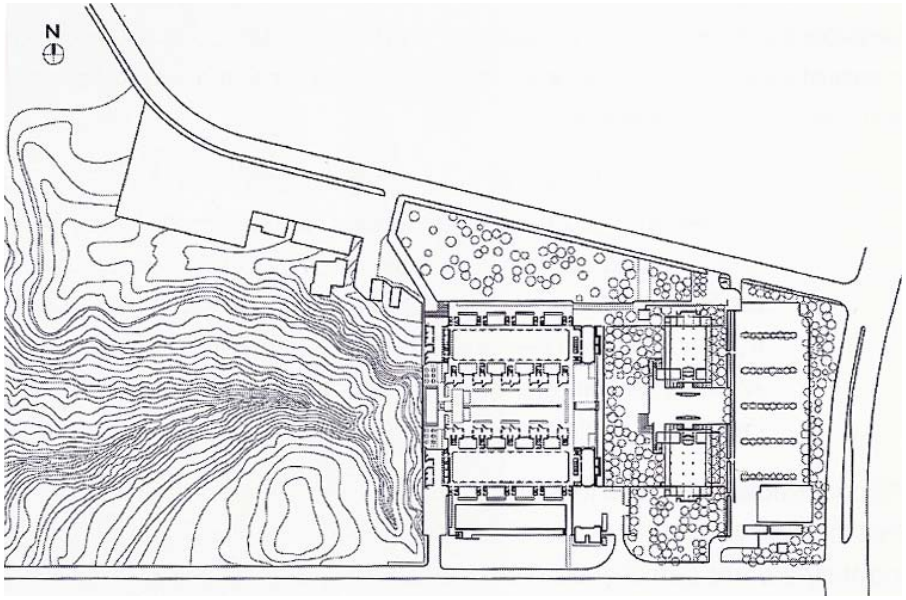


Figure 1.26. Site plan of the Salk Institute including later additions.

distance to the west of the laboratories, was the living space (Coleman 2005:187).

As the scheme evolved the four laboratory buildings, which were to be two storeys high, were abandoned in favour of two buildings each three storeys high (Komendant 1975:50). This is how the scheme evolved to its current configuration comprised of two symmetrical laboratory buildings, mirror images of each other, separated by a central plaza.

The laboratory buildings, constructed predominantly in off-shutter concrete, house three floors of laboratory space. Interstitial floors conceal the structural post-tensioned Vierendeel trusses while

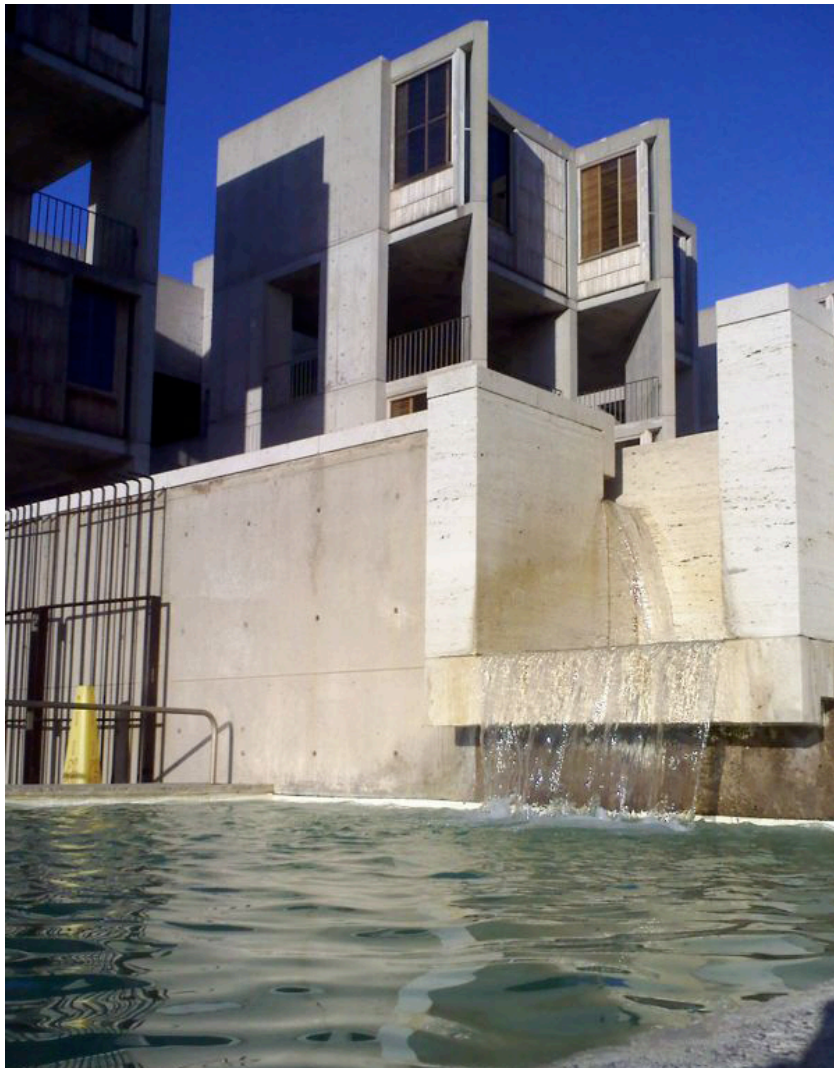


Figure 1.27. Photograph taken from lower court looking at water feature.



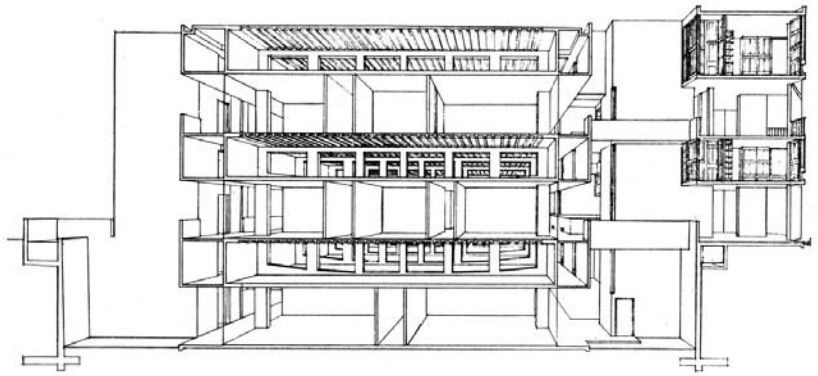


Figure 1.29. Section through laboratory block showing service floors.

accommodating the building services (Leslie 2005:145). By housing the services on separate interstitial floors Kahn was able to minimise the impact that the services had on the character of the building and maintain the flexibility afforded by the open-plan laboratory spaces (Coleman 2005:182).

Kahn cleverly separated the servant and served spaces in the design of the Salk Institute. Vertical circulation (i.e. stairs and elevators) as well as toilets are housed in servant towers which are located on the outside edge of each of the laboratory blocks and dedicated office buildings and mechanical buildings bound the laboratories on the west and east respectively (Komendant 1975:54-55).

Kahn also separated the office and study spaces from the laboratory spaces. By housing the offices and study spaces in dedicated zones separate from the laboratory block Kahn is intentionally separating the act of doing (i.e. the laboratory work) from the act of contemplating (i.e. mental work) (Leslie 2005:137).

The central plaza of the Salk Institute defined by the two laboratory blocks is the focal point of the scheme. An austere space paved in travertine with a narrow strip of water defining a central axis, was in fact not entirely Kahn´s conception (Coleman 2005:188). During the project Kahn consulted Mexican architect Louis Barragan who told Kahn "I would not put a tree or a blade of grass in this space. This should be a plaza of stone, not a garden. If you make this a plaza, you will gain a façade – a façade to the sky." (Frampton 1995:158) Barragan´s use of water, particularly at the Salk institute is reminiscent of water in Islamic architecture, notably in the Lions´ Court at the Alhambra in Granada (Coleman 2005:188).

The Salk Institute has a inspirational almost spiritual quality in the way that it mediates between the man-made and the natural surroundings. The combination of materials, light and shadow, as well as its presence amongst the "uninterrupted sky, the sea and the horizon" as Kahn put it creates a dramatic experience which is monumental in its own way without overpowering the natural landscape (in Coleman 2005:190).

Key Points:

- Reconciliation of individual versus collective spaces.
- Accommodation of wide range of activities.
- Relation to nature and natural surroundings.

Previous Page
Figure 1.28. Photograph of Salk Institute at sunset looking west towards the Pacific Ocean.

The Monastery of Ste. Marie de la Tourette, Eveux, France

- Le Corbusier

As a young architect Le Corbusier visited the Carthusian monastery at Ema, a building which would have an enduring influence throughout his architectural career. He compared the monastery to an organism in which the reconciliation of the individual and the collective was an ever-present theme and saw in it clues and implications for several scales of built form, from house to city. (Coleman2005:136). The influence of monastic ideals and concepts is evident throughout several of Le Corbusier´s works, including the Esprit Nouveau pavilion, the Immeubles villas, and the Unité d'Habitation (Serenyi 1967:277). This influence, however, is perhaps most evident in the design of his own monastery, Sainte-Marie de la Tourette, on which Le Corbusier worked between 1956 and 1960.

Sainte-Marie de la Tourette is a Dominican order monastery located in the French town of Eveux-sur-L´Arbresle, just outside of Lyon (Serenyi 1967:286). The design of La Tourette was deeply inspired and influenced by the Carthusian monastery at Ema as well as the Cystercian monastery of Le Thoronet both of which Le Corbusier had visited, the former as a young architect and the latter before designing La Tourette (Coleman 2005:144; Serenyi 1967:277).

The complex at La Tourette consists of three wings arranged in a U shape around a central courtyard, which is enclosed on the remaining side by the main church. The church at La Tourette is thus both linked to rest of the monastery through the courtyard, and separated from it



Figure 1.30. The convent of Ste. Marie de La Tourette designed by Le Corbusier.

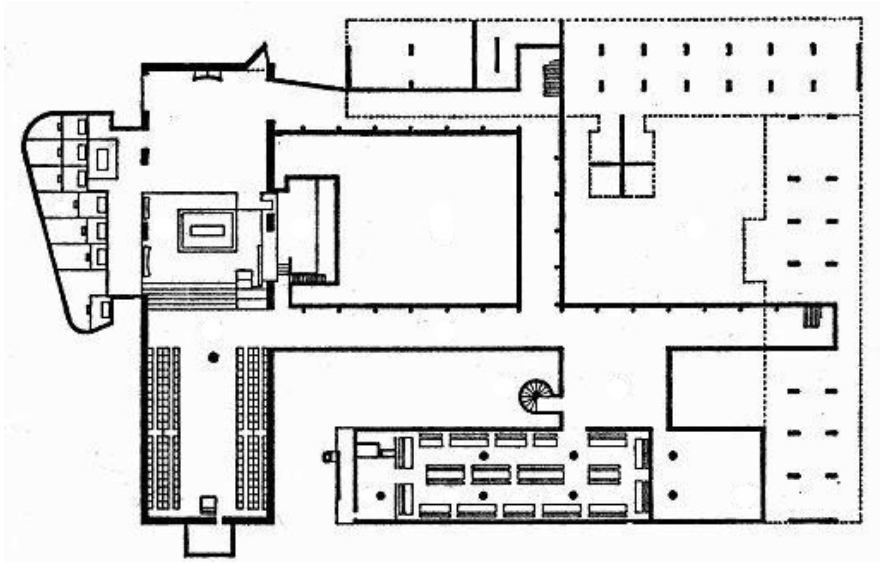


Figure 1.31. Plan of refectory floor, Ste. Marie de la Tourette.

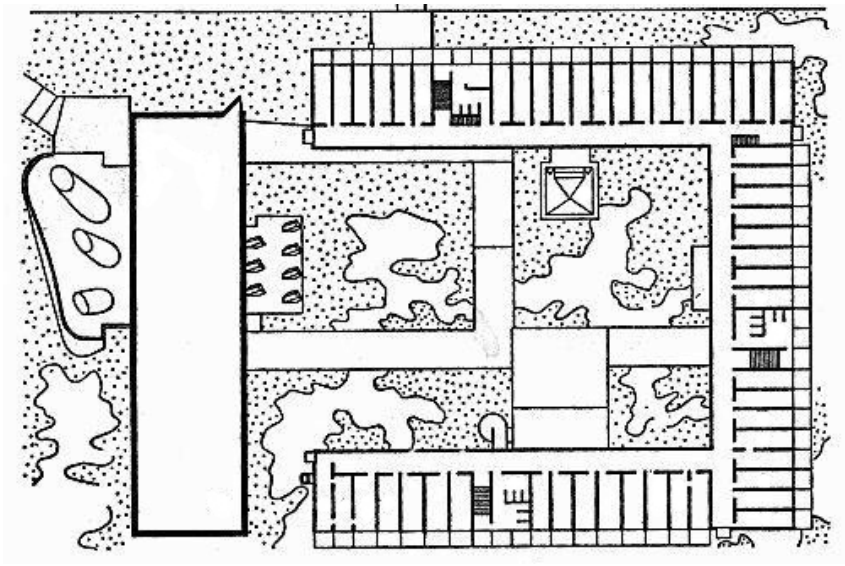


Figure 1.32. Plan of cell floor, Ste. Marie de la Tourette.

by being physically pulled away from the main monastery building Coleman 2005:141). The central courtyard is reminiscent of typical Christian monastic cloisters, although instead of the traditional arcaded passage surrounding the open court, La Tourette possesses fully enclosed hallways which separate the interior from the cloister space (Coleman 2005:139).

Much like the monastery at Ema, La Tourette sits on a hilltop site, with sweeping views of the valley below. In fact, at both complexes, the views from the monk´s dormitory cells, and the connection to nature are extremely important design features (Coleman 2005:139). The whole complex sits on a severe slope descending from east to west, so that the east wing of the building is comprised of three storeys and the west wing of five. Le Corbusier´s employs his famous pilotis to lift the building off the ground, allowing the site to flow underneath the building creating the sense that the building is floating (ACCR).

Due to the sloping site, the building is accessed on second floor level, which houses study halls and lecture rooms. The top two floors (3rd and 4th floors) house the private spaces, including the dormitory cells and study rooms. There are approximately 100 narrow cells, all of which open out on the outward façade to projecting loggias which provide views of the natural surroundings and shade the cells from the sun. Circulation occurs along



Figure 1.33. View of inner courtyard of La Tourette monastery.

the inside edge of the building in corridors lined by strip windows which look out onto the internal courtyard (ACCR).

The lower floors house the communal functions of the monastery with the first floor, on the western side of the complex, accommodating areas such as the atrium, the refectory, and the chapter house as well as circulation areas which divide the internal court into the form of a cross (ACCR). An austere concrete ramp takes one straight to the entrance of the main church, sacristy, high altar and side chapel are all located on the lower ground floor, removed from the rest of the building (ACCR).

The church itself is an austere concrete box, which is brought to life through Le Corbusier´s creative use of lighting and colour. To Le Corbusier, light was the key feature which allowed us to experience architecture. In his treatise Towards a New Architecture, Le Corbusier (1970:23) stated:

"*our eyes are constructed to enable us to see forms in light. Primary forms are beautiful forms because they can be clearly appreciated*"

This theme is one that is constantly reiterated throughout Le Corbusier´s writing as well as his designs, including the monastery of Sainte-Marie de la Tourette. In the church, for instance, daylight is allowed into the interior through five distinct types of openings including the giant domes of light which Le Corbusier referred to as light cannons (ACCR). Light, colour and form are cleverly employed by Le Corbusier to create the spiritual atmosphere of the building, without which the church would be a mere soul-less concrete box.

The three lower floors of the monastery possess a series of glass façades specially designed by Yannis Xenakis, an architect and musician who worked with Le Corbusier on the project. These façades, often reffered to as the Xenakis façades, consist of non-structural concrete fins spaced according to musical

harmonic divisions and fitted in between with undulatory glass panels (Coleman 2005:146). The glass panels serve to modulate light and air into the interior spaces and also provide unique floor-to-ceiling views of the surrounding landscape.

The presence and relation of La Tourette to the surrounding landscape is one of the key features in the design of the complex (Coleman 2005:144). The monastery´s overall aspect stands in contrast to its natural surroundings, clearly marking the separation between natural and man-made, but also sacred and secular. Henze (1966:17) argues that Le Corbusier´s La Tourette was conceived in relation to distance in typical Mannerist style. The buildings seems to be in sharp contrast to the immediate surrounding landscape, while at the same time connected to the distant landscape. It is in distance, Henze (1966:17) states, that the monastery "takes on a significant relationship with the earth, the sun and the clouds."

Key Points:

- Reconciliation of individual versus collective spaces.
- Accommodation of wide range of activities.
- Relation to nature and natural surroundings.
- Use of light as revealing form.

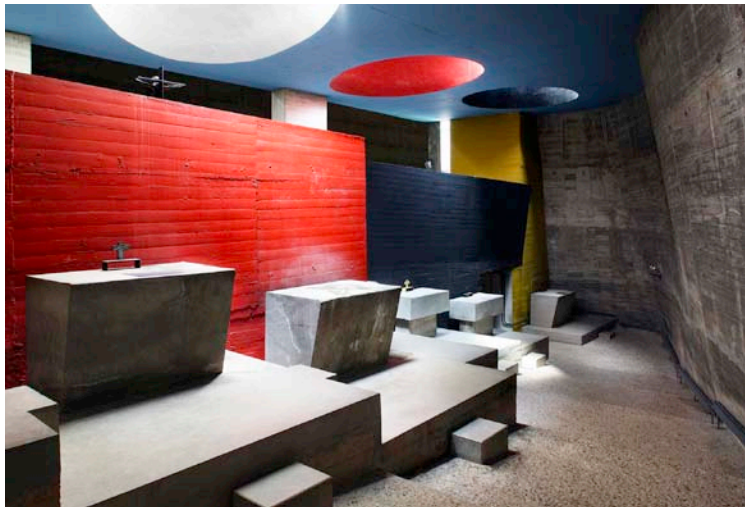


Figure 1.34. Creative use of light and colour in the building´s interior

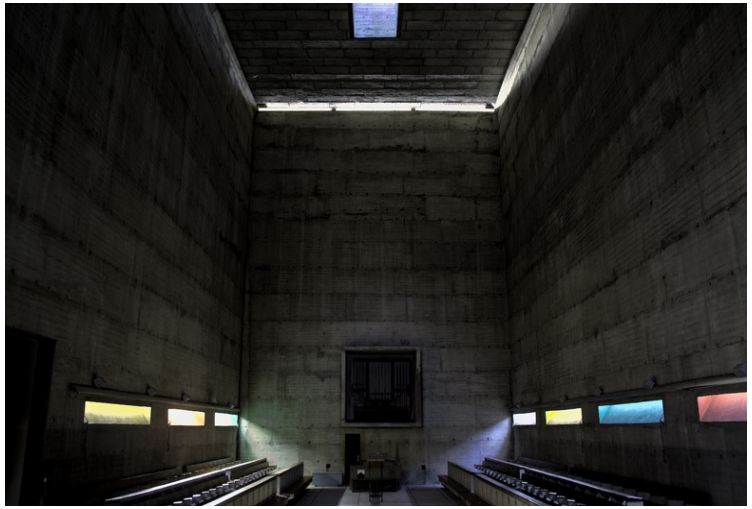


Figure 1.35. Austere interior of the chapel at La Tourette.

Neurosciences Institute, La Jolla, USA

- Tod Williams and Billie Tsien Associates

The Neurosciences Institute (NSI) designed by Williams and Tsien Associates is located in La Jolla, California an area which has come to be known as one of the world's leading centres for biomedical discovery. It is located in extremely close proximity to Louis Kahn´s Salk Institute, one of the most iconic works of modern architecture. Given its physical proximity to the Salk Institute the NSI could not ignore its celebrated neighbour and had to address its existence. As a result, the design of NSI clearly gestures towards the Salk Institute while simultaneously diverging from it (Coleman 2005:272).

The institute´s director and founder, Nobel laureate Dr. Gerald Edelman, played a vital role in the conception of the project. Understanding his leading vision for the project is key to understanding the project itself. While Edelman identified with the clarity and legibility of the Salk Institute, he saw its monumental "temple-like" character as its major shortcoming (Coleman 2005:272, 275). For his own institute he knew he wanted something like the Salk Institute, but different.

Edelman envisioned a "scientific monastery" which would promote the interdisciplinary exchange of ideas, while still maintaining a quiet and peaceful environment conducive to research. The architects had the challenging task of creating an environment that would cater to both private introspection and the interactive exchange of ideas (NSI). The design also needed to reflect the institute´s philosophy that scientific advancement is fostered by giving researchers more freedom and few constraining rules, thus liberating them to make new discoveries (Coleman 2005:278; NSI).



Figure 1.36. General view of the Neurosciences Institute in La Jolla, California

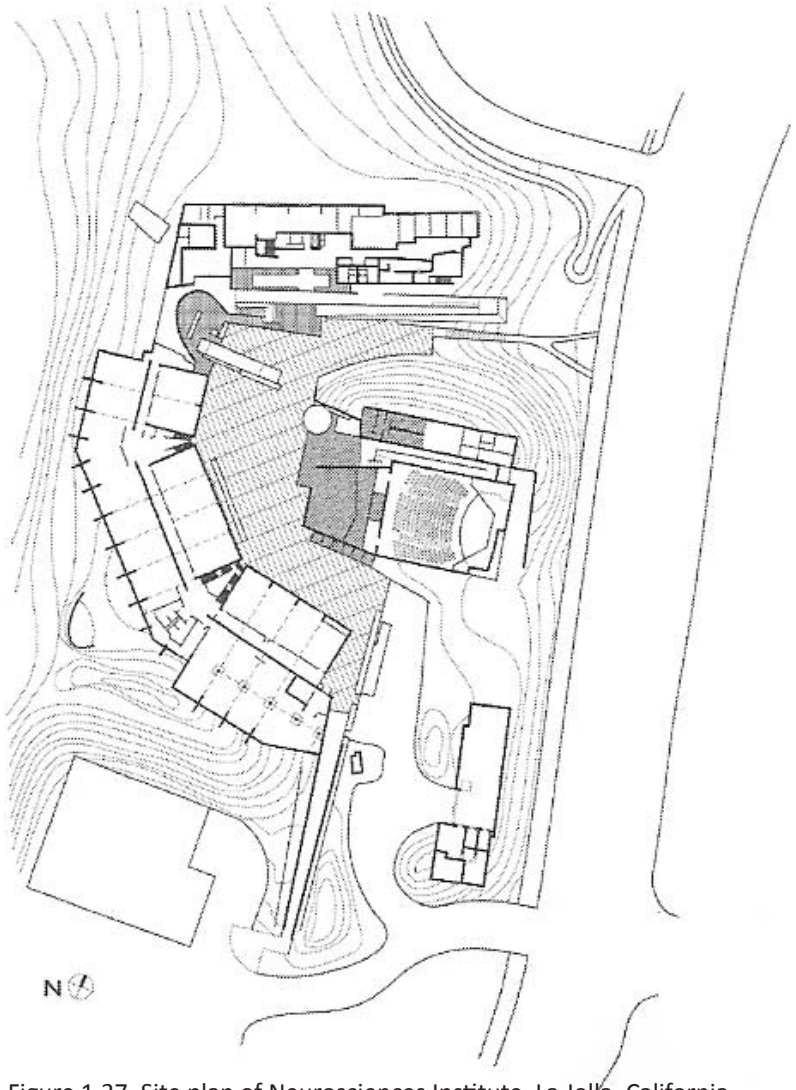


Figure 1.37. Site plan of Neurosciences Institute, La Jolla, California.

The architects definitely succeeded in giving the complex a cloistered character which coincides with Edelman´s monastic vision. The institute is situated on a sloped site located between North Torrey Pines Road and John Jay Hopkins Drive (NSI). Although the site is surrounded by main or access roads on all sides, the architects took advantage of the declivity of the land to set the buildings into a sunken courtyard below the level of road, thus creating a peaceful cloister-like environment throughout. In fact, with the exception of the Theory Centre which is raised above the road, the complex is almost entirely obscured from view (Coleman 2005:279).

The complex consists of three separate and architecturally distinct buildings, which house the institutes three main functions, unified by a central courtyard. From its inception the institute was to accommodate three main functions, including spaces for theory, wet science and an auditorium which could double as a small concert hall. Edelman, however, originally envisioned that these functions would be housed in a single building, but ended up with each of the functions being housed in its own building (Coleman 2005:278).

The central plaza, paved with terazzo and Italian green serpentine stone, is the focal point of the Institute from which all other structures emanate. Tod Williams described the plaza as “designed so it curves and flows unpredictably, following the land’s contours like a village street” (NSI). Not only does the plaza link all the buildings together but small nooks and crannies provide spaces which cater to both chance encounters between researchers and private contemplation (Coleman 2005:277). One such space is the curved concrete wall which acts as a knuckle connecting the Theory Centre to the laboratories.

The Theory Centre is a 3-storey building constructed of concrete, stainless steel, glass, and light-coloured Texas fossil stone located on the northern edge of the central plaza. It houses the offices for the



Institute's theoretical scientists, visiting scientists, administrative staff, computer facilities, reading room, kitchen, dining room, library, and conference rooms (NSI). A prominent concrete ramp located to the south of the Theory Centre, connects the plaza level to the upper walkway above in an architecturally dramatic but functional fashion (Coleman 2005:280).

On the western edge of the complex is a U-shaped building known as the Walsh Family Laboratories Building. This building houses the experimental research laboratories, scientific offices, a conference room and state-of-the-art research equipment. The building possesses a roof terrace which connects to the central plaza via two staircases located in the joints of the U-shaped plan where the structure bends (NSI). The walkway and terrace on the roof also connect a parking lot on the south to a tunnel under North Torrey Pines Road on the north and west, connecting the Institute to other neighbouring research institutions (NSI).

The final building is the auditorium which extends east from the central plaza space. The 325 seat auditorium was conceived to be able to double up as a small concert hall. An accomplished violinist, Edelman´s love of music is evident. He believes that music and art are a vital part of the institute´s humanist culture. Designed by Williams and Tsien in conjunction with renowned acoustic specialist Cyril Harris, the auditorium is considered to be one of the most acoustically impressive small performance halls in the United States (NSI).

Key Points:

- concept of scientific monastery
- combination of larger social spaces and smaller, contemplative spaces
- separation of functions into three distinct buildings
- dealing with similar programme to that of the Salk Institute in a very different manner



Figure 1.39. View of water feature and lanscaping.

Previous Page
Figure 1.38. Knuckle connecting the Theory Centre to the laboratories.

Biovac Institute, Cape Town, South Africa

- StudioMAS Architects and Urban Designers

The Biovac Institute is a clinical quality control laboratory involved in the testing and manufacturing of vaccines. In order to be accredited to perform such tasks the building had to adhere to strict international standards, while still remaining flexible enough to accommodate future growth and regulatory changes. Future expansion considerations played a significant role throughout the project as it was important to consider the long-term growth that is expected once the manufacturing rights for the production of vaccines are in place.



Figure 1.40. General view of the Biovac Institute designed by StudioMAS.

The brief called for a single level laboratory block with a small west-facing office component to take advantage of existing views across the site. The architects design consisted of a simple laboratory block and office building separated by an internal street, which acts an ordering spine. The laboratory itself is elevated by a full floor, with an area for parking underneath. The idea was to allow for the possibility of replacing the parking with an additional laboratory if required in future.

The offices are located on the west, as per the client´s request, in order to take advantage of existing views. This, however, meant that harsh western light had to be dealt with in order to ensure a comfortable work environment inside the building. The architects used this as an opportunity for both solar



Figure 1.41. Building façade.

shading and branding, by wrapping the whole western façade in a skin which is an enlarged image of a tissue sample. The result is a punctured sun screen with panels removed in a random but structured manner, allowing varying amounts of filtered light into the office spaces. The sun control skin is separated from the building by a walkway which allows access for servicing or cleaning, while also creating an

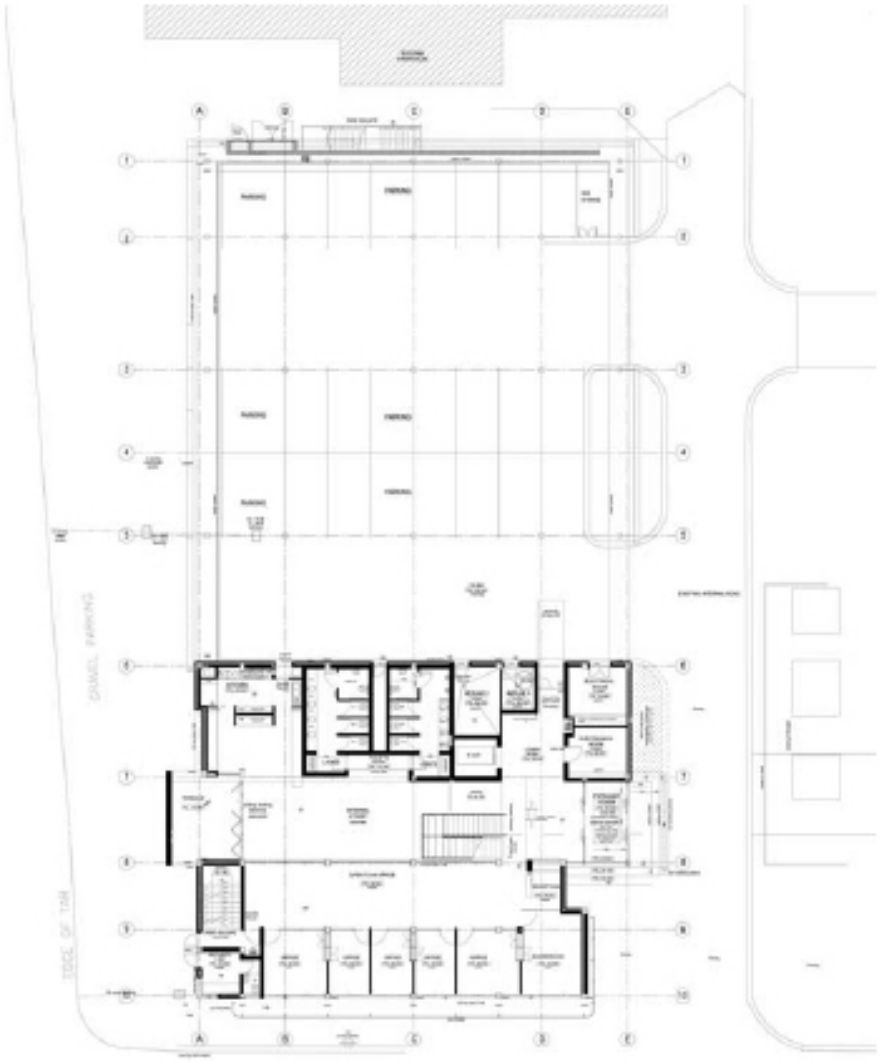


Figure 1.42 Ground floor plan of the Biovac Institute.

outdoor space which can be used for coffee breaks.

The interesting thing about this project is that the sunscreen has become its iconic identifying feature, even though it is only used on a small portion of the building. The laboratory component, which is by far the biggest and most important of the two receives little mention by comparison. In fact it is difficult to find photos of anything but the office sun screens and the interior of the building, which fail to give a clear picture of the overall building. One is left wondering what the rest of the building looks like or even what it would be like to experience the building as a whole.

Key Points:

- flexibility of spaces to accommodate future growth
- creating an a building identity (i.e. sunscreens)



Figure 1.43. Façade Details.



Figure 1.44. Façade Details.



Figure 1.45. Façade Details.

de Young Museum, San Francisco, USA

- Herzog and de Meuron



Figure 1.46. General view of the de Young Museum in Golden Gate Park.

Situated in San Francisco´s lush Golden Gate Park the de Young Musuem by Herzog and de Meuron is the revival of a pre-existing museum founded in 1895 on the same site (Perez 2010). The original museum was furnished with the collection of M.H. De Young, a wealthy publisher of one of San Francisco's daily papers (Sudjic 2010). The original building, however, was damaged by the Loma Prieta earthquake in 1989, leading to the decline and eventual closing of the musuem to the public on December 31, 2000 (Perez 2010).

The bold and striking design by Herzog and de Meuron provides a contemporary reinterpretation of the museum typology. While the new design is drastically different from original building, a heavily ornamented bulky concrete structure, the architects chose to pay homage to the pre-existing structure by retaining or reconstructing certain elements such as the sphinxes, the original palm trees, and the Pool of Enchantment (Perez 2010).

The new museum, with an area of almost 23,000m^2 consists of 3 main floors, one of which is half buried underground, providing direct access from the underground car park (Sudjic 2010). The main pedestrian access is provided through a courtyard on the floor above. Once inside the building a grand staircase takes the visitors up from the lobby to the third level (Sudjic 2010). The most striking feature, however, is the eight-storey high twisting tower located at one end of the building. This houses the education spaces in addition to a public observation platform which offers panoramic views of

the Bay Area (Perez 2010). Equally significant, argues Sudjic (2010) the platform provides views of the museum itself "turning it into the largest of exhibits."

According to the architects the building began with the conception of the musuem as distinctly linked pavilions. This gradually evolved over time into a denser configuration of spaces, ultimately resulting in pavilions linked by courtyards, atriums and pathways (Sudjic 2010). These help to draw not only the visitors, but also the surrounding landscape, into the museum´s interior. The careful choice of natural materials, such as copper, wood, stone and glass allow the building to blend into the surrounding landscape, becoming part of the land rather than an intrusion on it. Large ribbon windows encircle the exterior of the building, blurring the lines between inside and outside of by allowing park visitors glimpses of the inside of the museum and museum visitors glimpses of the park (Perez 2010).

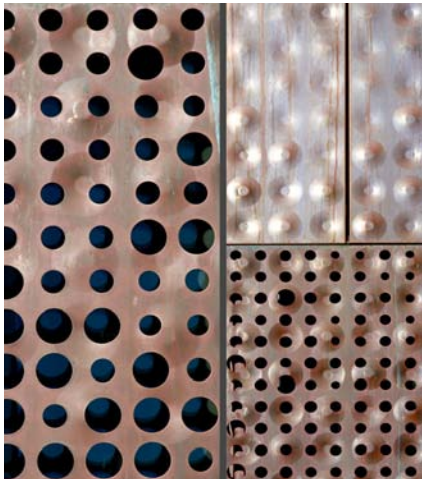


Figure 1.47. Close-up of copper façade.

Known for their experimentation with materials, Herzog and de Meuron chose to coat the building in a patinated copper façade which is perforated and textured to evoke the impression of light filtering through a tree canopy. According to Sudjic (2010) as the copper catches the sun´s last rays it causes the building to dematerialise into "something misty, ambiguous and undefined." Over time the copper will gradually assume a green tint that will allow the building to blend even more into its natural surroundings (Perez 2010).

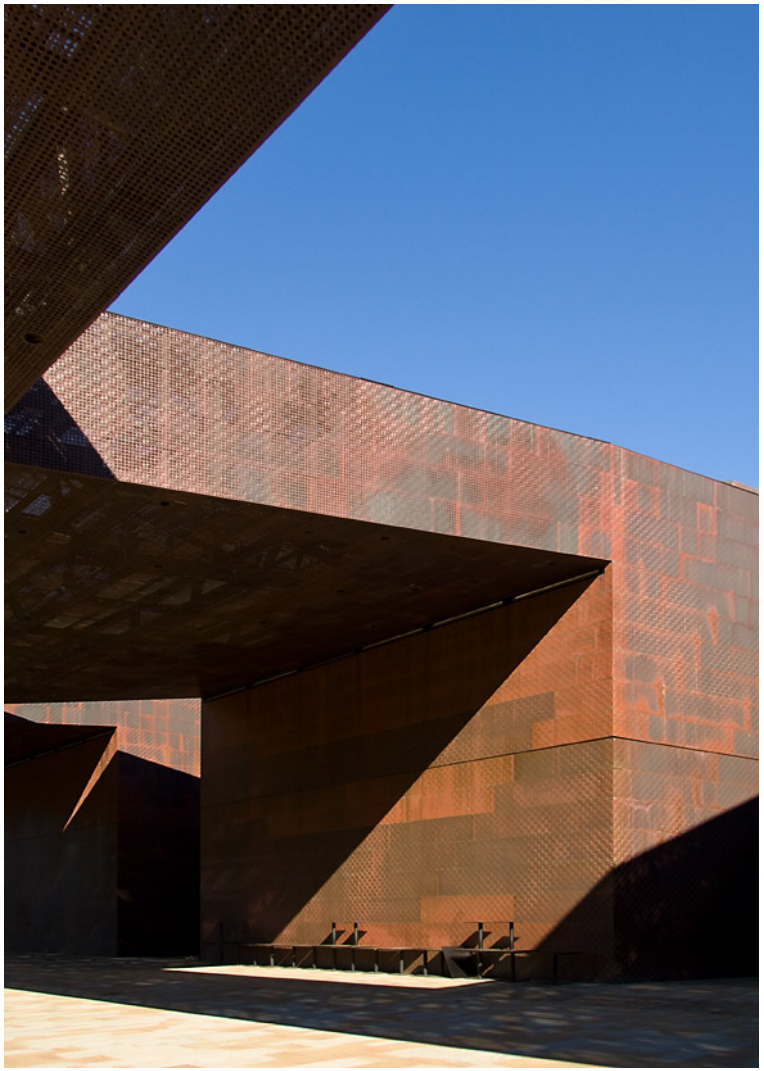
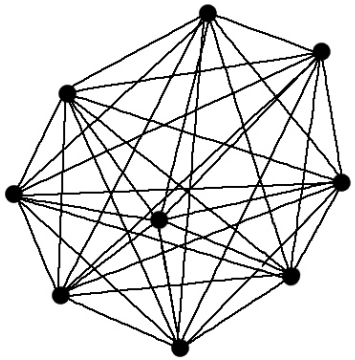


Figure 1.48. View of the museum entrance courtyard.

Guiding Principles

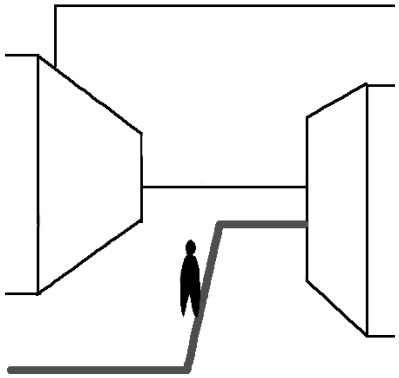
After conducting extensive research into the topic of architecture and neuroscience it became necessary to synthesize the information into something that could help inform the design process going forward.

The principles and recommendations that follow summarize some of the most salient principles that were learned from the theoretical studies carried out in this thesis.



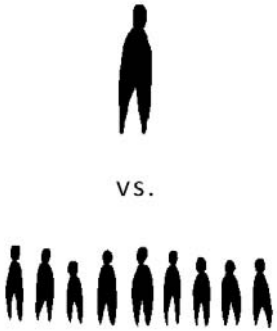
Connections

The idea of connections is a metaphor for the brain, which is made up of billions of connections. This principle also touches on the interconnected nature of knowledge itself, in which individual contributions are made to a larger collective body of knowledge. From an architectural point of view it refers to the connection of the building with its surroundings, as well as the connections within the building itself (i.e. between different spaces or programmatic functions).



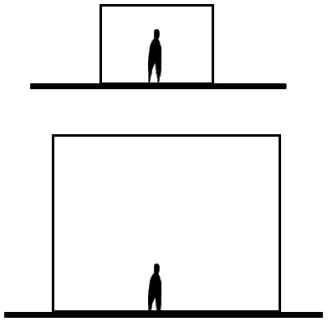
Route /Procession

This principle also relates back to the brain as a metaphor for the neural pathways which exist in the brain. From a more practical point of view it is significant in helping people navigate through space. A clear route with distinguishable landmarks gives people a sense of where they are and where they are going, thus reducing disorientation and confusion, which can trigger stress responses.



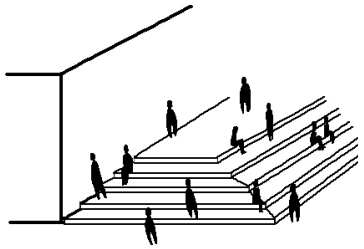
Individual vs. Collective

Every individual is one part of a greater whole - the collective. There is a constant symbiosis between the two, where the successful functioning of the one largely depends upon the other. In a research institution such as the one proposed, it is important to accommodate the spatial needs of both the individual (i.e. the researcher) and the collective (i.e. the community of scholars).



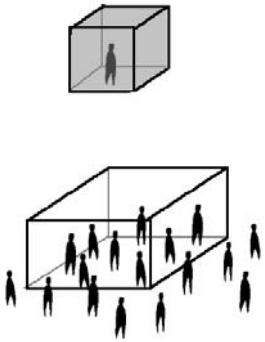
Scales of Space

There is no doubt that the size of a space in relation to the human body can have a profound effect on our emotions and even our behaviour when occupying that space. Contained spaces can feel claustrophobic or uncomfortable especially if occupied by too many people. Large spaces can be imposing and dominating making people feel small. A successful building requires a mix of different size and quality of spaces.



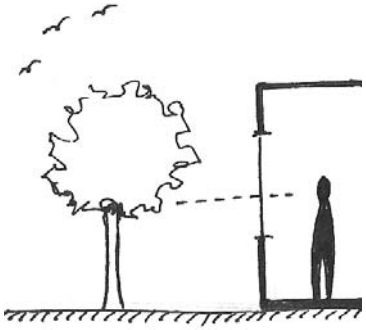
Informal Interaction

Informal interaction with others plays a vital role in the process of learning and understanding. Universities have long realised this and often provide large social spaces for this very purpose. Studies have shown that scientific breakthroughs are often a result of collaborative effort, and often arise out of informal discussions rather than in the constraints of a laboratory. For this reason, providing spaces for people from different disciplines to meet, socialise and share knowledge is of critical importance.



Public vs. Private

The reconciliation between public and private spaces is present in any architectural project. In the case of a research institute this becomes and even bigger undertaking. The laboratories in which science occurs, for instance, need to be private and controlled environments. This means that science is normally carried out behind closed doors, away from the public. Research institutions, however, also need public spaces where multi-disciplinary interaction can occur.



Connection to Nature

The benefits of visual and physical connections to natural surroundings from a neurological and behavioural point of view have already been discussed in this thesis. Nature not only reduces stress and promotes well-being but also increases mental focus. A strong connection to nature was one of the key features of monastic typologies and is one that is evident in several of the precdent studies that were carried out - from the Salk Institute, to La Tourette, to the De Young Museum.



Community

A group of scientists is a community of scholars and a research institution needs to take that into account. Monasteries are a prime example of how community life was organised architecturally, and as such is a relevant precedent for any place which caters to a community of people.

Bibliography

ACCR - Association des Centres Culturels de Rencontre Sainte Marie de la Tourette. INTERNET. http://www.accr-europe.org/ Accessed 6 June 2011.

ANTHES, E. (2009). Building around the (Mind). *Scientific American Mind*, Apr/May 2009, Vol. 20 Issue 2: pp. 52-59

ARCSPACE (2011). The Seattle Public Library. INTERNET. www.arcspace.com Accessed 28 April 2011

ASHA (2005). Mental Health Statistics. INTERNET. http://www.myasha.org/node/12 Accessed 25 June 2011.

BAR, M. and NETA M. (2006). Humans Prefer Curved Visual Objects. *Psychological Science*, Vol. 17, Issue 8: pp. 645-648.

BARNETT, R. (2000). University knowledge in an age of supercomplexity. *Higher Education,* 40: pp. 409-422.

BRAUN, H. et al. (1999). *Building for Science: Architecture of the Max Planck Institutes*. Berlin: Birkhaüser.

CALVO-SOTELO, P.C. (2001). The architecture of higher education: University spatial models at the start of the twenty first century. *Higher Education Policy* 14: pp. 183-196.

CAMBRIDGE UNIVERSITY. (2011). A Brief History of the University. INTERNET. http://www.cam.ac.uk/univ/history/index.html Accessed: 12 April 2011.

CARR, N. (2010). *The Shallows*. London, Great Britain: Atlantic Books.

COHEN, J. (2000). Architecture Discovers Science. *Science.* January 2004; 287: pp. 210-14.

COLEMAN, N. (2005). *Utopias and Architecture*. London and New York: Routledge

COULSON, J. et al (2011). *University Planning and Architecture: The Search for Perfection*. New York: Routledge.

CRAMPTON, J.W. and ELDEN, ed. (2007). *Space, Knowledge and Power: Foucault and Geography.* Great Britain: Ashgate.

DAWSON, R. (2007) The Extinction Timeline. INTERNET. http://www.rossdawsonblog.com/weblog/archives/2007/10/extinction_time.html Accessed 28 April 2011.

DELANTY, G. (1998). The idea of the university in the global era: From knowledge as an end to the end of knowledge? *Social Epistemology*, Vol. 12, No. 1: pp. 3-26.

DUNBAR, K. (2000). How Scientists Think in the Real World: Implications for Science Education. Journal of Applied Developmental Psychology 21(1): pp. 49-58.

EBERHARD, J.P. and GAGE, F.H. (2003) An Architect and a Neuroscientist Discuss How Neuroscience Can Influence Architectural Design. INTERNET. http://www.sfn.org/index.aspx?pagename=neuroscienceQuarterly_03fall_architect) Accessed 26 May 2011.

FULLER, S. (2003). The university: a social technology for producing universal knowledge. *Technology in Society* 25: pp. 217-234.

FRAMPTON, K. (1992). *Modern Architecture: A Critical History* - 3rd ed. London: Thames and Hudson.

FRAMPTON, K. (1995). *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*. Cambridge: The MIT Press.

GALISON, P. and THOMPSON, E. ed. (1999). *The Architecture of Science*. Cambridge, MA. and London, England: MIT Press.

GIBBONS, M. et al. (1994). *The New Production of Knowledge*. Great Britain: Sage Publications.

GOODCHILD, L.F. (2000). Oxbridge´s Tudor Gothic Influences on American Academic Architecture. *Pedagogica Historica*, Vol. 36, No. 1:pp. 266-298.

GOODE, P. ed. (2009). *The Oxford Companion to Architecture*. New York: Oxford University Press.

HANNAWAY, O. (1986). Design and the Aim of Science: Andreas Libavius versus Tycho Brahe. *Isis*, Vol. 77, No. 4 (December): pp. 584-610.

HEILBRON, J.L. (1992). Creativity and Big Science. *Physics Today*, Vol. 45, No. 42 (December): pp. 42-47.

HENZE, A. (1966). La Tourette: The Le Corbusier Monastery. Humphries and Co. Ltd.

HORN, W. (1973). On the Origins of the Medieval Cloister. *Gesta*, Vol 12, No. 1/2: pp. 13-52.

IATH - Institute for Advanced Technology in the Humanities. (2010). St. Gall Monastery Plan. INTERNET. http://www.stgallplan.org/en/index.html Accessed: 24 March 2011.

KOMENDANT, A.E. (1975). *18 Years with Architect Louis I. Kahn*. USA: Aloray Publisher.

LE CORBUSIER, translated by John Rockler (1970). *Towards a New Architecture*. Oxford: Architectural Press.

LESLIE, T. (2005). *Louis I. Kahn: Building Art, Building Science*. New York: George Braziller, Inc.

LYOTARD, J.F. (1984). *The Postmodern Condition: A Report onKnowledge*. Great Britain: Manchester University Press.

MCGRATH, P. (2007). Knowledge management in monastic communities of the medieval Irish Celtic church. *Journal of Management History*, Vol. 13, No. 2: pp. 211-223.

MEYVAERT, P. (1973). The Medieval Monastic Claustrum. *Gesta*, Vol. 12, No. 1/2: pp. 53-59

MITCHELL, W.J. (2000). *E-topia*. Cambridge, Mass. and London, England: MIT Press.

NSI - NEUROSCIENCES INSTITUTE (????). Learn About Our Architecture. INTERNET. http://www.nsi.edu/index.php?page=architecture_overview Accessed 6 June 2011.

OXFORD UNIVERSITY. (2011). A Brief History of the University. INTERNET. http://www.ox.ac.uk/about_the_university/introducing_oxford/ Accessed: 12 April 2011

PECKHAM, R. (2009). The City of Knowledge: rethinking the history of science and urban planning. *Planning Perspectives*, Vol. 24, No. 4 (October): pp. 521-534.

PEREZ, A. (2010). M.H. de Young Museum - Herzog & de Meuron. INTERNET ArchDaily. http://www.archdaily.com/66619 Accessed 10 August 2011.

PEVSNER, N. (1976). *A History of Building Types*. London, Great Britain: Thames and Hudson.

PICON, A. and PONTE, A. ed. (2003) *Architecture and the Sciences: Exchanging Metaphors*. USA: Princeton Architectural Press.

POPOVIC, S. (2007). Dividing the Indivisible: The Monastery Space – Secular and Sacred. *Zbornik radova Vizantoloskog instituta*, Issue 44: pp. 47-67.

SERENYI, P. (1967). Le Corbusier, Fourier and the Monastery of Ema. *The Art Bulletin*, Vol. 49, No. 4 (December): pp. 277-286.

SHAPIN, S. (1988). The House of Experiment in Seventeenth-Century England. *Isis*, Vol. 79: pp. 373-404.

SHAPIN, S. (1992). Why the public ought to understand science-in-the-making. Public Understanding of Science, Vol. 1, No. 1: pp. 27-30.

SHAPIRO, B.J. (1971). The Universities and Science in Seventeenth Century England. *The Journal of British Studies,* Vol. 10, No. 2: pp. 47-82.

SPARGO, P.E. (2005). Investigating the site of Newton´s laboratory in Trinity College, Cambridge. *South African Journal of Science* 101 (July/August): pp. 315-321.

STERNBERG, E.M. and WILSON, M.A. (2006). Neursocience and Architecture: Seeking Common Ground. *Cell* 127, October 2006.

SUDJIC, D. (2010). Herzog and de Meuron - The de Young Museum. INTERNET. Domus. http://www.domusweb.it/en/architecture/herzog-de-meuron-the-de-young-museum/ Accessed 10 Aug 2011.

UNKNOWN AUTHOR (2007). Biovac Institute. *Architect and Builder*. June/July 2007: pp. 62-69.

WHINNEY, M. (1971). *Wren*. Thames and Hudson: London, Great Britain.

WHO - World Health Organisation. Mental Health Statistics. INTERNET. http://www.who.com/mentalhealth Accessed 25 June 2011.

WILLIAMS, T. and TSIEN, B. (2010). The Physical Space of Science: The Neurosciences Institute and Skirkanich Hall. *Cell Cycle,* Vol. 9, Issue 1, January 2010: pp. 28-31.

ZAKNIC, I. (1984). Le Corbusier´s Epiphany on Mount Athos. *Journal of Architectural Education*, Vol. 43, No.4 (Summer): pp. 27-36.

ZERIAL, M. et al. (2003). *Gentle Bridges: Architecture, Art and Science.* Birkhaüser: Berlin.

Image References

Figure 1.1: Gruber. Artist Impression of the Plan of St. Gall. Reichenau (IATH 2011).

Figure 1.2: The Plan of St. Gall. Reichenau (after IATH 2011).

Figure 1.3: Benediktbeuern Monastery. Munich, circa 1800 (Galison and Thompson 1999:157).

Figure 1.4: Le Corbusier. Sketch of Ema Monastery. Florence (Coleman 2005:136).

Figure 1.5: Engraving of Trinity College. Cambridge, circa 1690 (http://commons.wikimedia.org/wiki/File:Trinity_College_ Cambridge _1690.jpg).

Figure 1.6: Nolli map of Oxford Campus. Oxford (Coulson et al 2011)

Figure 1.7: Mob Quad. Oxford, 14th century (http://devonvisitor.blogspot.com/2011_03_01_archive.html).

Figure 1.8: Stanford University. California (http://trustinginstincts.blogspot.com/).

Figure 1.9: Academic Library at the Sorbonne. Paris (http://www.comp.lancs.ac.uk/~rodger/rodgerdoris/index.php/Main/ParisFrance).

Figure 1.10: Chained books in a library. Unknown location (http://grou.ps/kvlibrarians/blogs/item/the-most-beautiful-libraries-in-the-world-photographs)

Figure 1.11: Wren. The Trinity College Library. Cambridge, begun 1676. (http://www.panoramio.com/photo/109156).

Figure 1.12: Interior of Wren´s Trinity College Library. Cambridge, begun 1676.(http://www.flickr.com/photos/cornelluniversitylibrary/3611677808/)

Figure 1.13: Concept sketch of Seattle Public Library. (after http://seattletimes.nwsource.com/news/local/library/graphics/concept.html).

Figure 1.14: Office for Metropolitan Architecture (OMA). Seattle Public Library. Seattle, Washington, 2004 (http://plusmood.com/2008/09/seattle- public-library-rem-koolhaas-oma/)

Figure 1.15: Uraniborg Complex – Site Plan. Hven, Denmark, 16th century. (Hannaway 1986:592).

Figure 1.16: Uraniborg Complex – Plan and Elevation. Hven, Denmark, 16th century. (Hannaway 1986:593).

Figure 1.17: Libavius. Plan of *Domus Chemiae* or `Chemical House´. Published in *Alchymia* 1906 (Galison and Thompson 1999:61).

Figure 1.18: Libavius. Elevation of *Domus Chemiae* or `Chemical House´. Published in *Alchymia* 1906 (Galison and Thompson 1999:61).

Figure 1.19: Pieter Brueghel. The Alchemist. (http://www.bemyastrologer.com/seven_hermetic_principles.html).

Figure 1.20: Paul Butler. The Facebook Map – Visualizing Friendships. (http://www.facebook.com/notes/facebook-engineering/visualizing-friendships/469716398919).

Figure 1.21: Photograph of Jonas Salk. Photo by Wide World Photos (http://www.californianhistory.com/articles/pics/2007-hall-of-fame/08jonassalk.jpg).

Figure 1.22: Louis I. Kahn. The Salk Institute for Biological Studies. La Jolla, California, 1965. Photo by Liao Yusheng (http://figure-ground.com/salk/).

Figure 1.23-24: Louis I. Kahn. Drawings for the City /2 Exhibition, 1971. (Coleman 2005:184).

Figure 1.25: Louis I. Kahn. The Salk Institute for Biological Studies. La Jolla, California, 1965. (Komendant 1975:46).

Figure 1.26: Louis I. Kahn. The Salk Institute for Biological Studies. (Coleman 2005:184).

Figure 1.27: Louis I. Kahn. The Salk Institute for Biological Studies. La Jolla, California, 1965. Photograph by Jim Hayes (http://www.jimhayes.com/architecture/Salk/index).

Figure 1.28: Louis I. Kahn. The Salk Institute for Biological Studies. La Jolla, California, 1965. Photograph by Alfred Essa (http://www.flickr.com/photos/tatles/339218853).

Figure 1.29: Louis I. Kahn. The Salk Institute for Biological Studies. La Jolla, California, 1965. (http://www.architangent.com/2011/08/kahn-salk-institute/).

Figure 1.30: Le Corbusier. Convent of Ste. Marie de La Tourette. Eveux-sur-L´Arbresle, 1960. (http://archidialog.com/authoreliinbar/).

Figure 1.31-1.32: Le Corbusier. Convent of Ste. Marie de La Tourette. Eveux-sur-L´Arbresle, 1960. (http://www.greatbuildingsonline.com).

Figure 1.33: Le Corbusier. Convent of Ste. Marie de La Tourette. Eveux-sur-L´Arbresle, 1960. (http://archidialog.com/authoreliinbar/).

Figure 1.34: Le Corbusier. Convent of Ste. Marie de La Tourette. Eveux-sur-L´Arbresle, 1960. Photograph by Zimmerman (http://www.images.bistum-hildesheim.de).

Figure 1.35: Le Corbusier. Convent of Ste. Marie de La Tourette. Eveux-sur-L´Arbresle, 1960. (http://www.grapheine.com/blog/divers/le-corbusier-couvent-de-la-tourette).

Figure 1.36: Tod Williams and Billie Tsien Associates. Neurosciences Institute. La Jolla, California, 1995. Photograph by Michael Moran (http://www.interiordesign.net).

Figure 1.37: Tod Williams and Billie Tsien Associates. Neurosciences Institute. La Jolla, California, 1995. (Coleman 2005:271).

Figure 1.38: Tod Williams and Billie Tsien Associates. Neurosciences Institute. La Jolla, California, 1995. Photograph by Tor (http://www.gotarch.com/projects/neuroscience_institute.html).

Figure 1.39: Tod Williams and Billie Tsien Associates. Neurosciences Institute. La Jolla, California, 1995. Photograph by Tor (http://www.gotarch.com/projects/neuroscience_institute.html).

Figure 1.40: StudioMAS. Biovac Institute. Cape Town, 2007. (http://www.biovac.com).

Figure 1.41-1.45: StudioMAS. Biovac Institute. Cape Town, 2007. (*Architect and Builder*, June/July 2007)

Figure 1.46-1.48: Herzog and de Meuron. De Young Museum. San Francisco, 2005. Photographs by Liao Yusheng (http://figure-ground.com/de_young/).

2. Site

Site Selection

Wits Health Sciences Campus

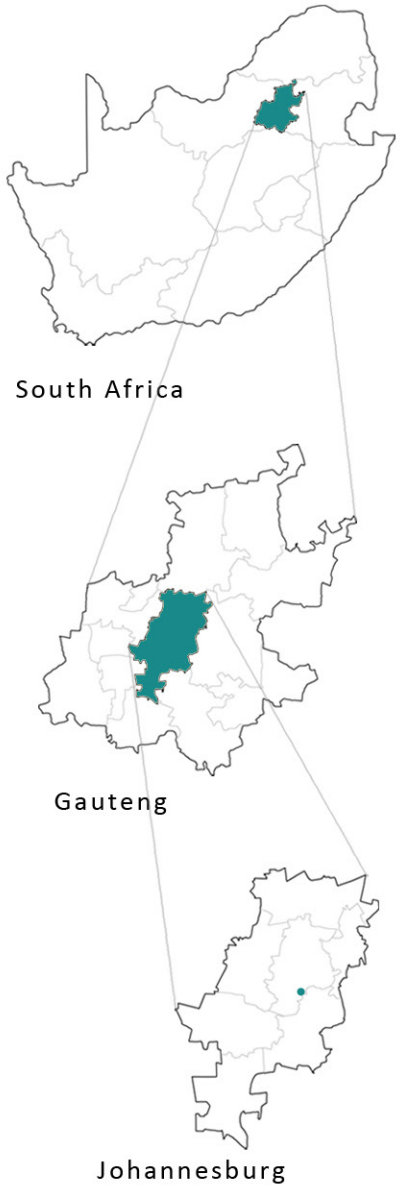
The site was chosen because of its close proximity and affiliation to both the university and the hospital. As a neuroscience research facility, the proposed building would likely have strong associations with both these institutions, thus making the site an ideal location for the type of facility proposed.

Following Page:
Figure 2.1. Aerial map of Parktown, highlighting the site of the Charlotte Maxeke Academic Hospital.



Parktown, Johannesburg

Greater Context



1. Wits Education Campus
2. Wits Health Sciences Campus
3. Charlotte Maxeke Hospital
4. Nurses Quarters
5. Parktown Reservoir


FACULTY OF HEALTH SCIENCES
WITS MEDICAL SCHOOL



Previous Page:
Figure 2.2. General view of the Wits Health Sciences campus, dominated by the imposing 6-storey concrete block.

This Page:
Figure 2.3. Aerial photograph of the area indicating the chosen site (in turquoise) which is currently a parking lot on the Wits Health Sciences Campus.



Figure 2.4. Photograph of Wits Medical School building

Introduction to the Area

The Wits Health Sciences campus is located just off Jubilee Road, immediately adjacent to the Charlotte Maxeke Academic Hospital (previously the Johannesburg General Hospital) in Parktown, Johannesburg. Historically the area was home to many of the mine magnates and their families, however few residential properties remain and nowadays the area is mostly defined by the presence of the hospital and the university.

Due to its location on a ridge the area offers some spectacular views, but is extremely isolated in terms of connections to the rest of the city, forming an island of segregated space in the city fabric. The roads leading to the Health Sciences campus and the hospital form oddly shaped loops around the complexes and possess no connections to the surrounding road networks. As a result the traffic is largely limited to people who are specifically visiting something in the area with little passing traffic.

The Wits Education campus is located to the southwest of the site and also borders onto Jubilee Road. The university buildings, however, have no connection to the street, but instead seem to turn their backs to the road. This not only makes the road an unpleasant place to walk along but also gives the campus an uninviting and isolated appearance. From the outside the education campus severely lacks a clear university identity. Anyone not familiar with the area would be forgiven for not realising that the complex of buildings is actually a university.

To the southeast of the site is the Parktown water reservoir. The reservoirs are subterranean, making it look as if the site is simply empty. This land is located in a prime position and yet remains fenced and entirely unusable. Both the Health Sciences and Education campuses look over this unkempt piece of land. The reservoir could offer great potential for providing a green space to the Health Sciences campus which currently has nothing of the sort.

The Parktown Ridge is an area with great potential that is not being fully realised. Its complicated history with the construction of the imposing Johannesburg General Hospital should not taint its character. The strong presence of the University of the Witwatersrand is extremely significant and should act as an incentive to revitalise and further develop the area in the near future.





Previous Page:
Figure 2.5 View looking East down Jubilee Road towards the Wits Health Sciences Campus. The Wits Education Campus is located behind the fence seen in the picture.

This Page:
Figure 2.6 View of Jubilee Road looking West. The fence seen in the picture is the edge of the Wits Education campus, which lacks a clear identity or any interaction with the street. The crooked sign conveys the disorderly, unkempt nature of the area



This Page:
Figure 2.7. Looking through the fence into the Wits Education campus. There is a distinct feeling of segregation and isolation from the street.

Following Page:
Figure 2.8. Edge of Wits Education campus along Western end of Jubilee Road. The severe and imposing concrete wall and high fence create an unfriendly and unpleasant edge to walk along.







Previous Page:
Figure 2.9. View down the Western edge of Jubilee Road towards the corner with Victoria Avenue.

This Page:
Figure 2.10. View from Jubilee Road towards the Wits Braamfontein campus and the CBD.

History of the Johannesburg Hospital

The history of the original Johannesburg Hospital is inextricably linked with the history of gold mining which gave rise to Johannesburg. Wagons, tents, mud huts and tin shanties began to pop up all over the landscape as the early diggers began to establish themselves in camps on existing farmland. Poor sanitary conditions in the camps made typhoid fever and dysentery common illnesses and the cold Highveld winters took their toll with bronchitis and pneumonia. Since there was no hospital, patients in need of care began to be accommodated at the jail, located just off Commissioner Street in Ferreirastown. A makeshift temporary clinic was set-up at the jail to deal with the sick, but it quickly became apparent that Johannesburg needed a hospital (JHB 1990:8).

The first Johannesburg Hospital Board was established in March 1888 and in August of 1888 set up a temporary hospital, located on Hospital Hill, which could accommodate 14 patients (JHB 1990:10). The accommodation provided by the temporary hospital, however, rapidly became inadequate and the Hospital Board decided that the construction of a larger permanent hospital was required. The first permanent Johannesburg Hospital was located immediately adjacent to the temporary hospital on 183m x 274m piece of land donated by the government (JHB 1990:11). The hospital, officially opened in 1890, was based on plans for the Bury Infirmary in Lancashire and could accommodate 130 patients (JHB 1990:12).



Figure 2.11. Photograph of old Johannesburg Hospital on Hospital Hill.

Over the next few decades the hospital experienced significant growth. Existing facilities were continuously expanded and new buildings constructed in order to accommodate the increasing demand for hospital services. Nursing staff too had to increase to keep up with the growing demand. As a result additional nurses residences had to be provided for.

In the early 1900s the hospital would acquire two separate buildings which would be incorporated to become branches of the Johannesburg Hospital. The first of these was the Queen Victoria Maternity Hospital, an existing 40-bed hospital located in Milner Park, which was acquired in 1913. The second was the donation of "Hohenheim," by Otto Beit which in 1915 was opened as the Otto Beit Convalescent Home (JHB 1990:24). Over time the hospital would possess several more branches including the Children´s Hospital, opened 1923, and the Non-European Hospital, opened in 1925 (JHB 1990:29-31).

The construction of the Medical School on Hospital street was another significant occurrence in the history of the Johannesburg Hospital. The first medical students were welcomed in 1921, raising the status of the hospital to a teaching hospital (JHB 1990:27).

The growth of the Johannesburg Hospital was made possible in large part through the generosity of the public. The hospital received several large private donations which allowed existing facilities to be updated or new facilities to be built (JHB 1990:42). As a result of the development of the Johannesburg Hospital occurred in a scattered fashion as funds or donations were received.

By 1968 the Johannesburg Hospital had 1500 beds scattered throughout many smaller hospitals. A Hospital Commission Enquiry decided that a new hospital should be built which could accommodate patients under one roof and so the new Johannesburg General Hospital was born (JHB 1990:67).



Figure 2.12. Patient being admitted to Johannesburg General Hospital.

The new hospital was to be a 2000 bed teaching hospital, complete with several staff residences and covered parking to accommodate 1 900 cars (JHB 1990:69). The site, donated by Sir Otto Beit was located on the Parktown Ridge. Its location was extremely controversial and as Flo Bird (in Davie 2002) stated, was seen by many as a conscious effort by the National Party to "smash the heart of British liberalism in the city." The building itself is an imposing 360m long double banked concrete structure.

The University of Witwatersrand Medical School, located immediately adjacent to the hospital, opened in 1981 and has been growing ever since.

Wits University Future Development Plans and Urban Design Framework

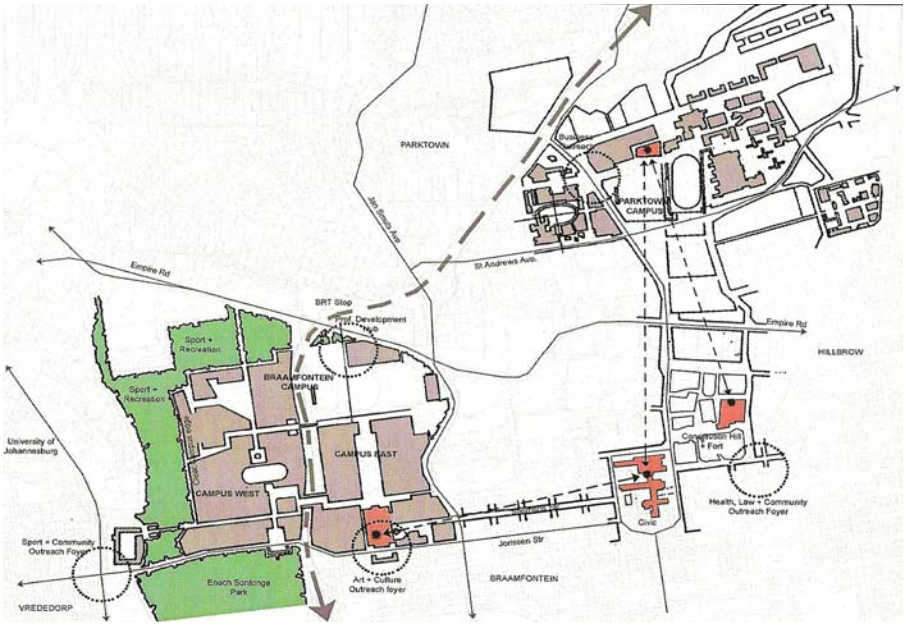


Figure 2.13. Sub-metropolitan diagrammatic integrative concept (Urban Solutions 2010).

The University of the Witwatersrand has several ambitious projects for the future development of the university. Several construction projects are already underway, with several more currently being planned.

One of the university´s most ambitious proposals is the aim to intergrate the various different campuses and residences, in order to create a more cohesive university identity. The University of the Witwatersrand is currently made up of several different campuses and residence facilities which are scattered throughout the urban fabric and entirely segregated from each other.

A preliminary urban design framework has been devised in order to address some of the university´s current planning issues. One of the main aims of the framework is to create a link between the university´s various campuses, as well as between the university and the broader city context.

The framework also identifies several areas on the existing campuses as potential sites for future development.

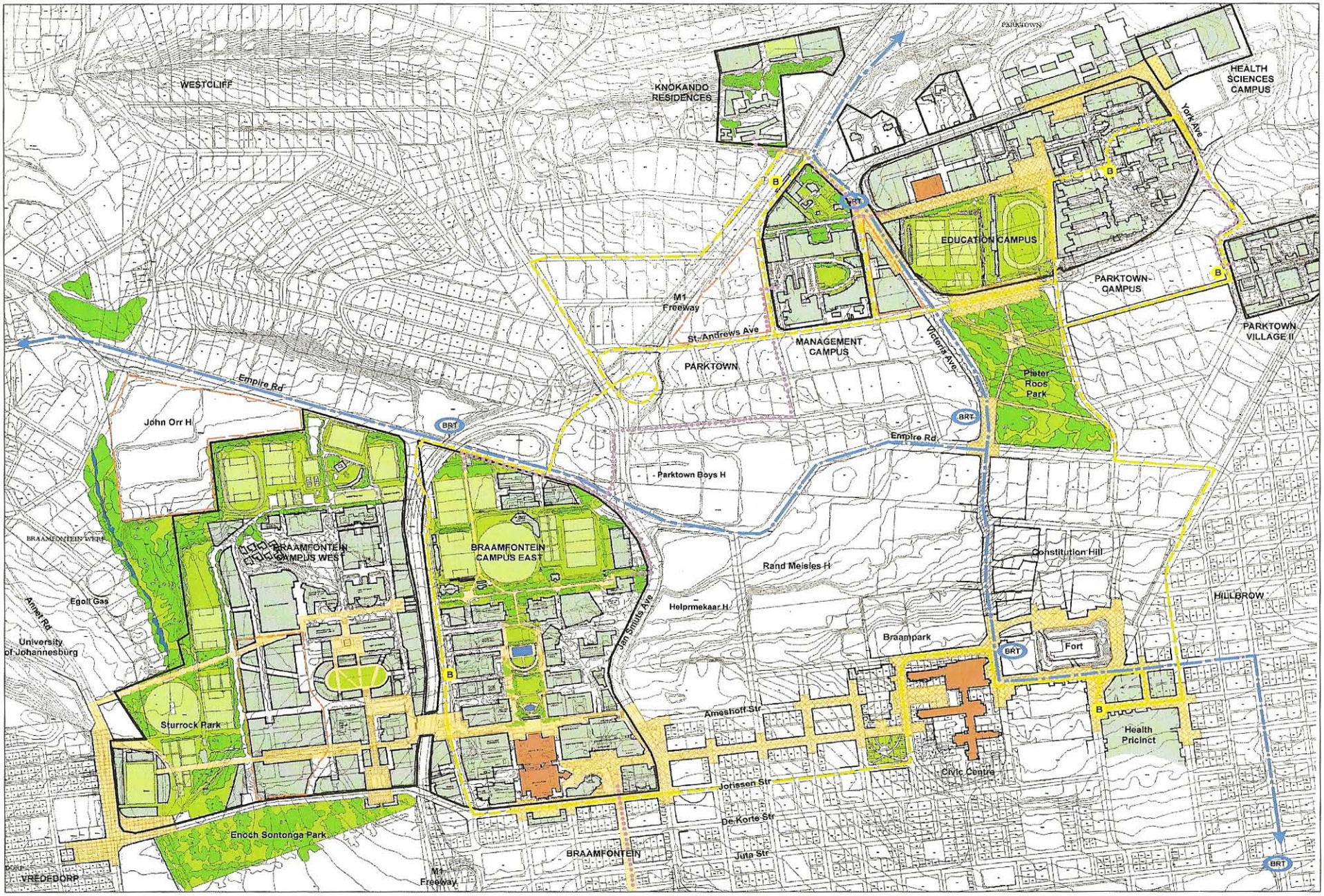


Figure 2.14. Sub-metropolitan spatial concept (Urban Solutions 2010).

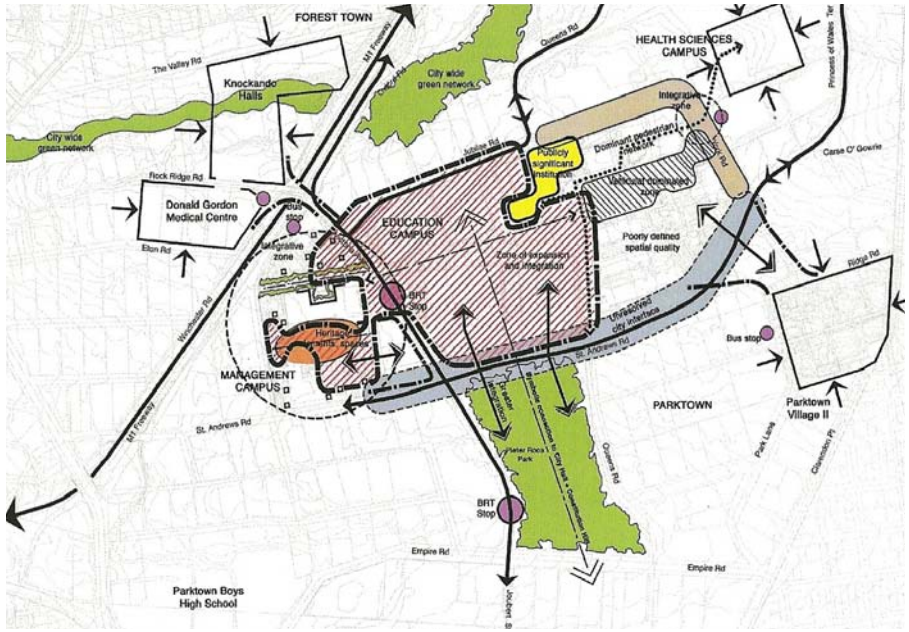


Figure 2.15. Parktown campus constraints and informants (Urban Solutions 2010).

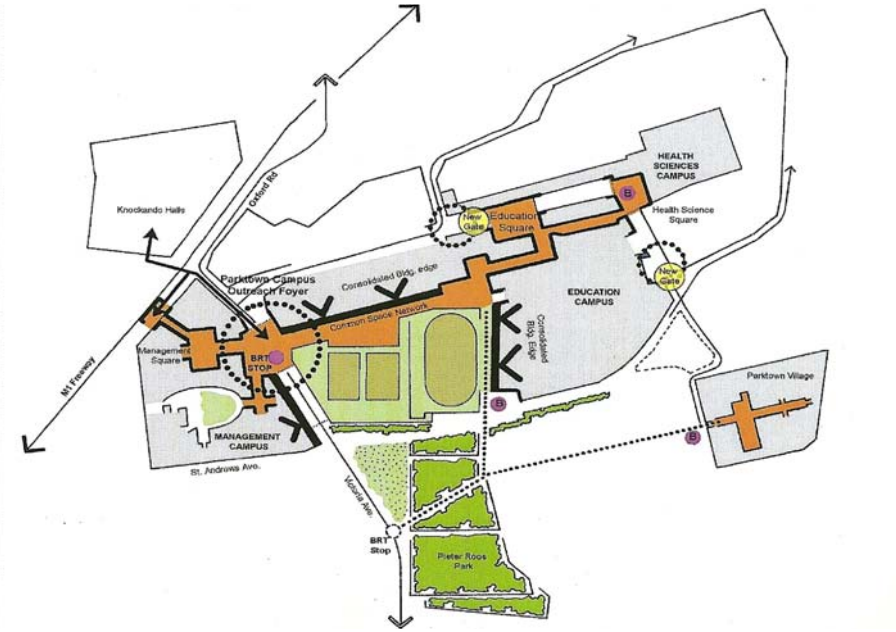


Figure 2.16 Parktown campus diagrammatic concept (Urban Solutions 2010).

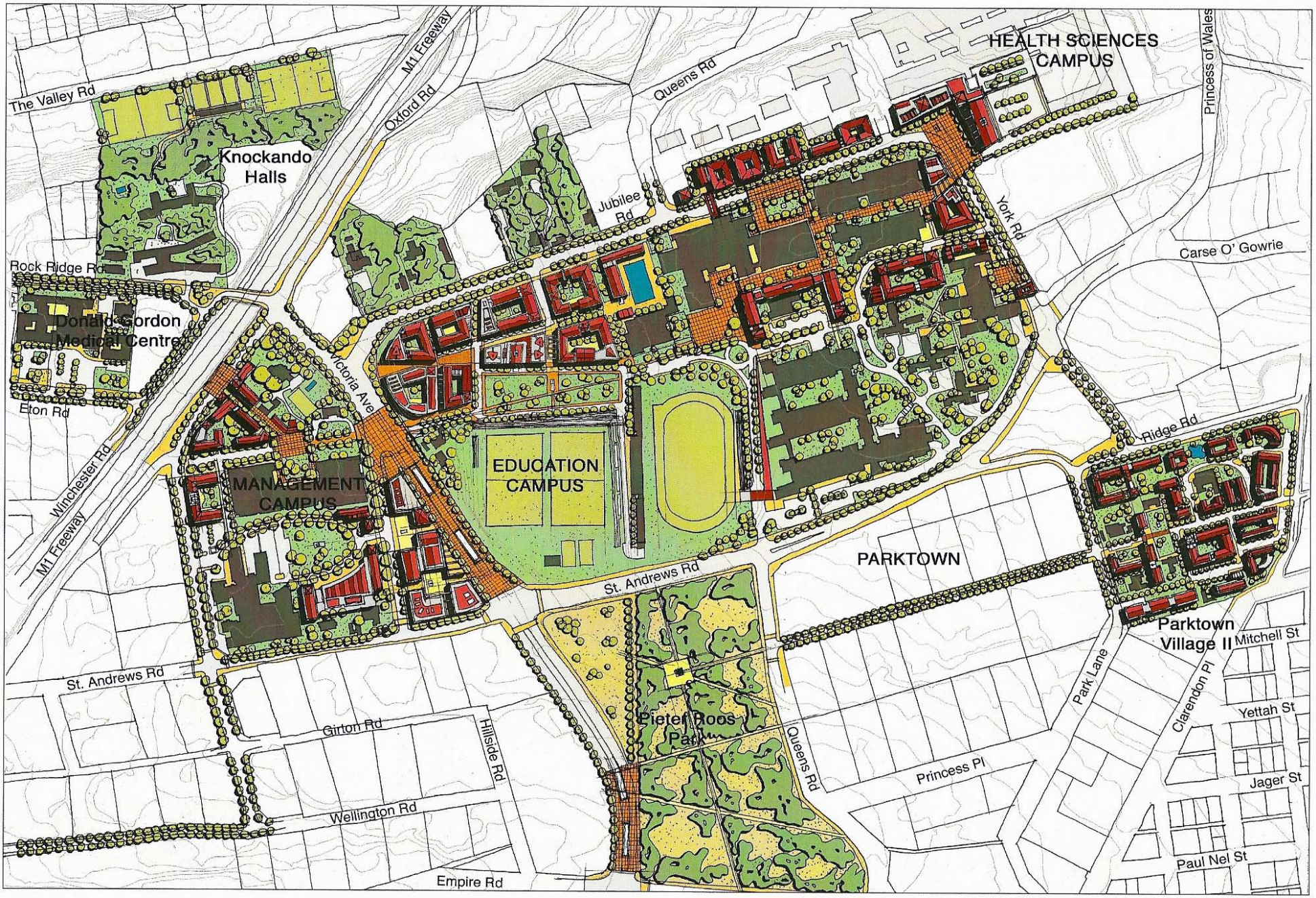


Figure 2.17. Parktown campus spatial concept (Urban Solutions 2010).



This Page:
Figure 2.18. Main vehicular and pedestrian entrance to the Wits Health Sciences campus. Currently the entrance is dominated by the demand to accommodate vehicles, with pedestrians having to cross the road or parking lot to get anywhere.

Following Page:
Figure 2.19. View from walkway looking South. This walkway provides the main pedestrian access to and from the medical school.


Telkom





Previous Page:
Figure 2.20. Existing visitor centre which seems to serve little purpose except to provide a security controlled route to the campus on weekends.

This Page:
Figure 2.21. Lower level car park located to the east of the pedestrian walkway.



This Page:
Figure 2.22. Existing green/social space located in front of the main entrance to the medical school building. This is one of the few green/social spaces on the Health Sciences campus

Following Page:
Figure 2.23. Axial route leading to main entrance of the medical school. The green space shown in the previous picture is located on the right hand side of the image



Site Mapping

Context

The Parktown area is surrounded by several distinct neighbourhoods, which vary significantly in character from one to another.

The map on the following page depicts some of the surrounding neighbourhoods, providing a brief description of each of these in order to place the site not only within its geographical, but also within a descriptive context.

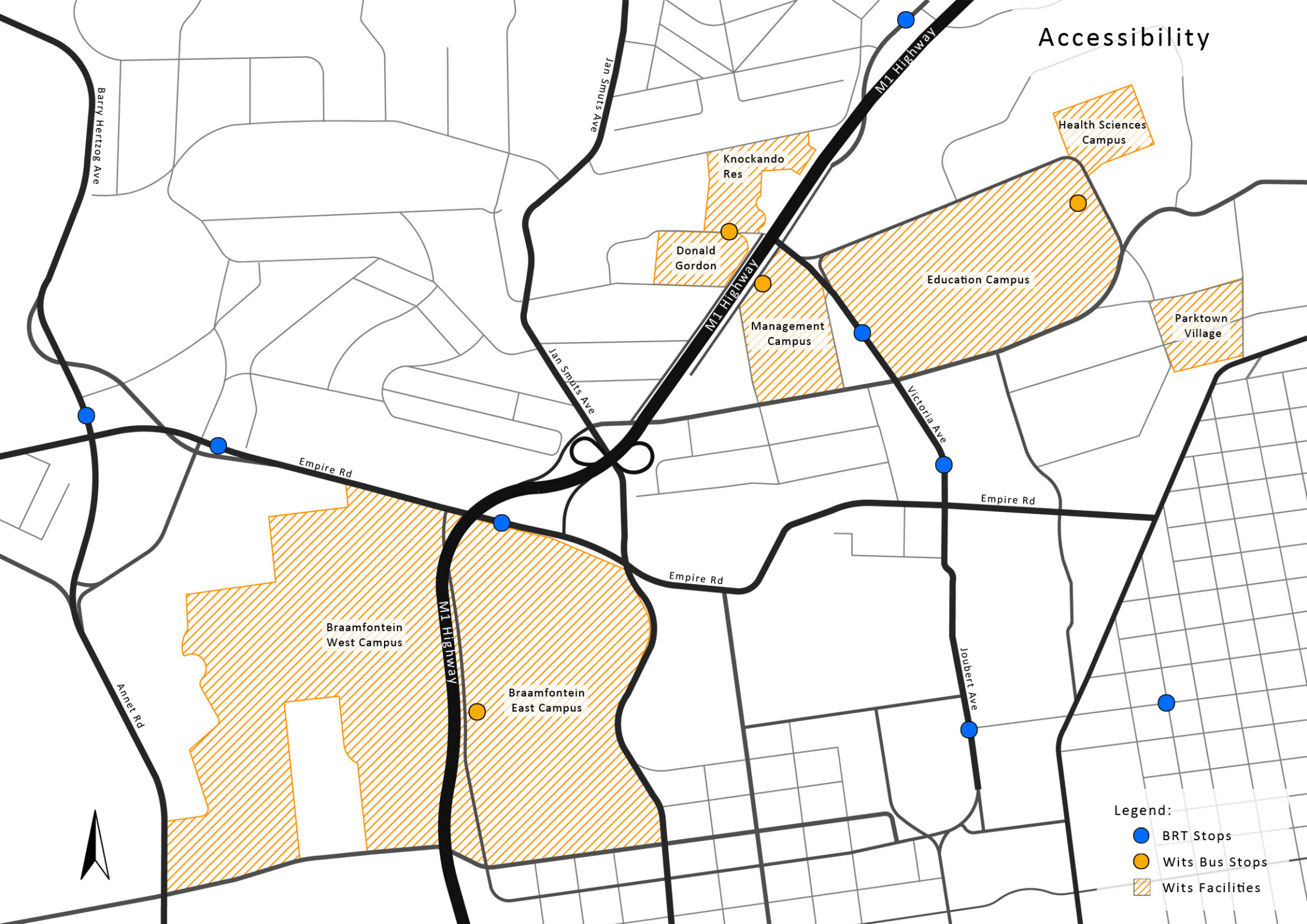

Context Map
Westcliff
Developed in the early 1900s as a new affluent suburb adjacent to Parktown. The area was home to many impressive mansions and has maintained its heritage and status as home to Johannesburg´s old money.
Barry Hertzog Ave
Jan Smuts Ave
Knockando Res
Health Sciences Campus
Houghton
Originally part of Klipfontein farm it was established as a high class suburb. St. John´s College by Sir Herbert Baker is located on the Houghton Ridge
Donald Gordon
Education Campus
Victoria Ave
Parktown Village
Management Campus
Jan Smuts Ave
Parktown
Old neighbourhood which was once home to many rich mine magnates. Many heritage buildings, including several by Sir Herbert Baker survive to this day. Today the area is mostly defined by the presence of the university campuses and the hospital.
Empire Rd
Empire Rd
Empire Rd
Berea
A high-density housing area characterised by apartments.
Annet Rd
Braamfontein West Campus
Braamfontein East Campus
Braamfontein
One of the original portions of farmland that made up Johannesburg. Today it is defined by the presence of the Wits University campus, as well as several office buildings.
Joubert Ave
Hillbrow
A once vibrant, cosmopolitan suburb which fell into disrepair and disrepute. Today it is one of the most populated areas in the world.

Accessibiliity

The M1 highway acts as the main artery running through the area in question. Empire Road and Jan Smuts Avenue are the two main roads that travel in an East-West and North-South direction respectively.

The Wits Health Sciences Campus is somewhat isolated from the rest of the city in terms of road networks, however, taxis and Wits buses provide access to the area.

The Bus Rapid Transit (BRT) system provides additional public transportation in the area, running mainly Empire Road and Victoria Avenue. The BRT serves places such as the Wits Braamfontein campus, Business school and Education campus which are all in close proximity to BRT bus stops.

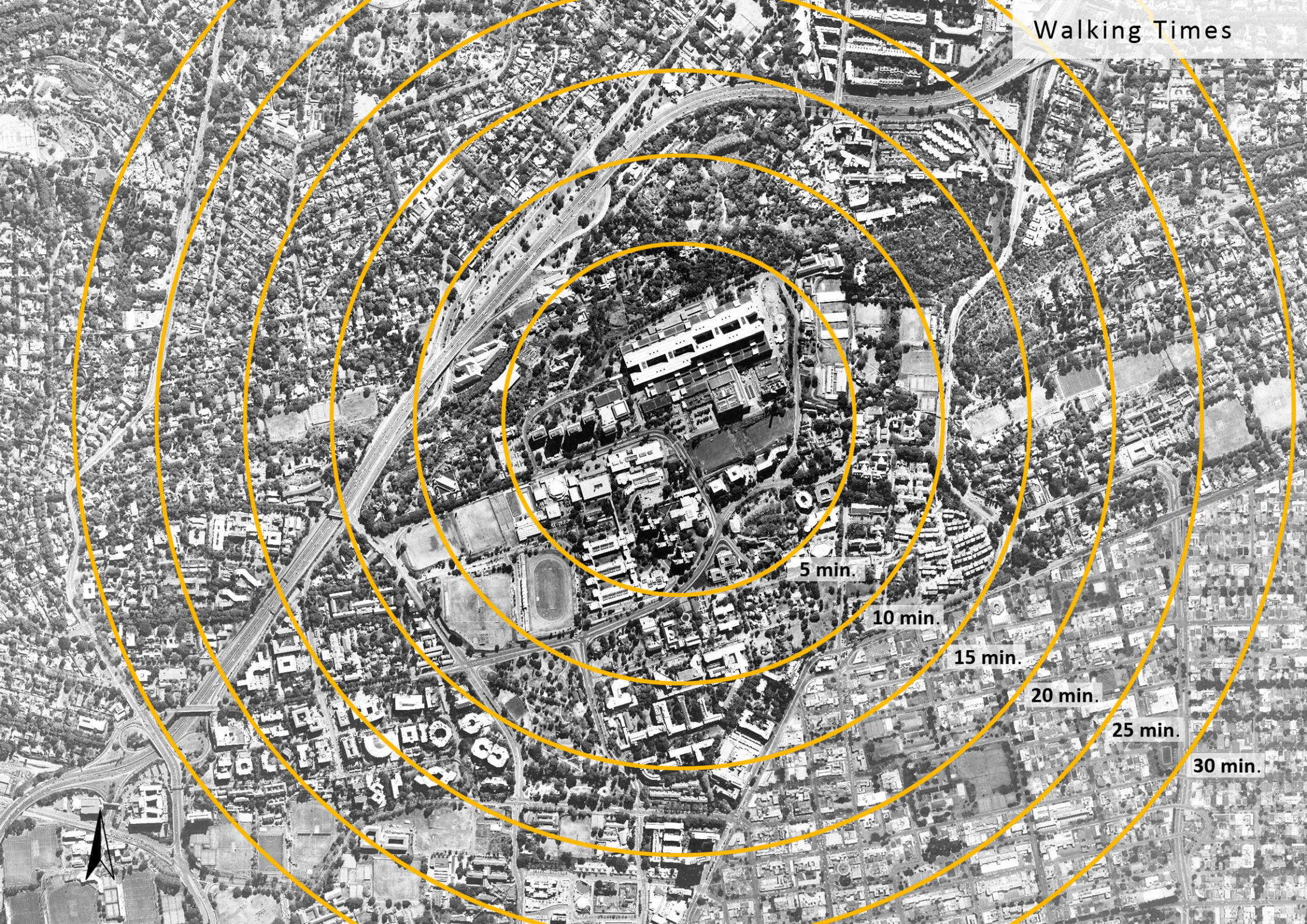

Accessibility
Barry Hertzog Ave
Jan Smuts Ave
M1 Highway
Knockando Res
Donald Gordon
Health Sciences Campus
Education Campus
Management Campus
Parktown Village
Victoria Ave
Empire Rd
Braamfontein West Campus
Braamfontein East Campus
Annet Rd
Joubert Ave
Legend:
BRT Stops
Wits Bus Stops
Wits Facilities

Walking Times

The map on the following page shows the site and its surroundings with relative walking times, using the Wits Health Sciences campus as starting point.

The figures are based on a walking speed of 5km/h., which is considered average for humans.

Based on this rate the Wits Braamfontein campus, for instance, is approximately a 35 minute walk from the Health Sciences campus.


Walking Times
5 min.
10 min.
15 min.
20 min.
25 min.
30 min.

Wits-Owned Land

The University of the Witwatersrand owns a significant amount of land throughout Gauteng. Most of the main university facilities, however are located in and around Parktown and Braamfontein.

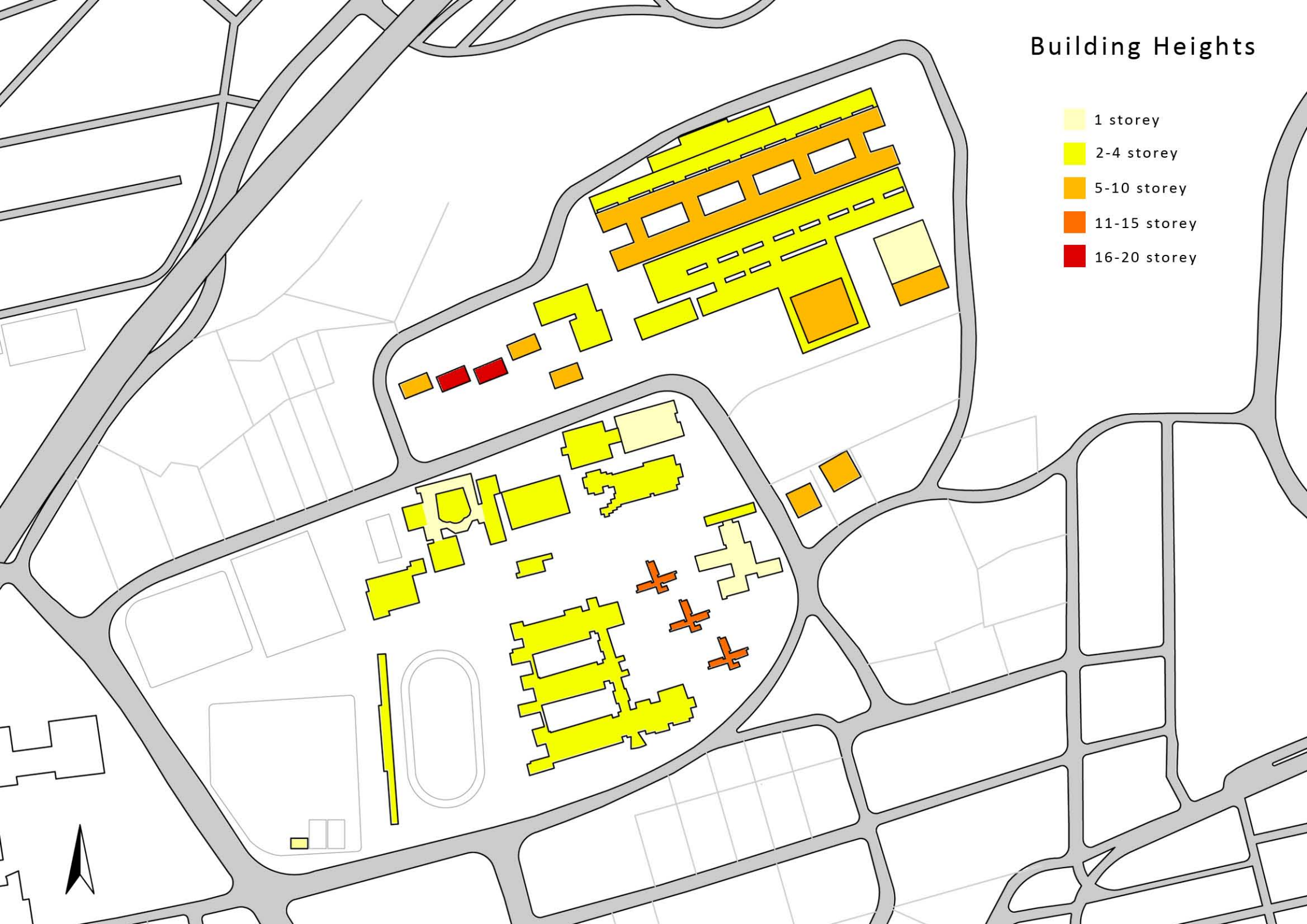
The map on the following page indicates the land owned by Wits in the Parktown area. This is significant because it shows how the development of the university has happened in a dispersed manner, but is also important to consider in the context of the university´s proposed urban design framework (page 100-103).


Wits-Owned Land
Oxford Rd
M1 Highway
Queen´s Rd
Queen´s Rd
Queen´s Rd
Jubilee Rd
Jubilee Rd
YorkRd
Carse O´Gowrie Rd
M1 Highway
M1 Highway
Victoria Ave
St. Andrew´s Rd
St. Andrew´s Rd
YorkRd
St. Andrew´s Rd
Victoria Ave

Building Heights

Some of the buildings in the surrounding area are several storeys high and quite imposing, particularly the nurses housing.

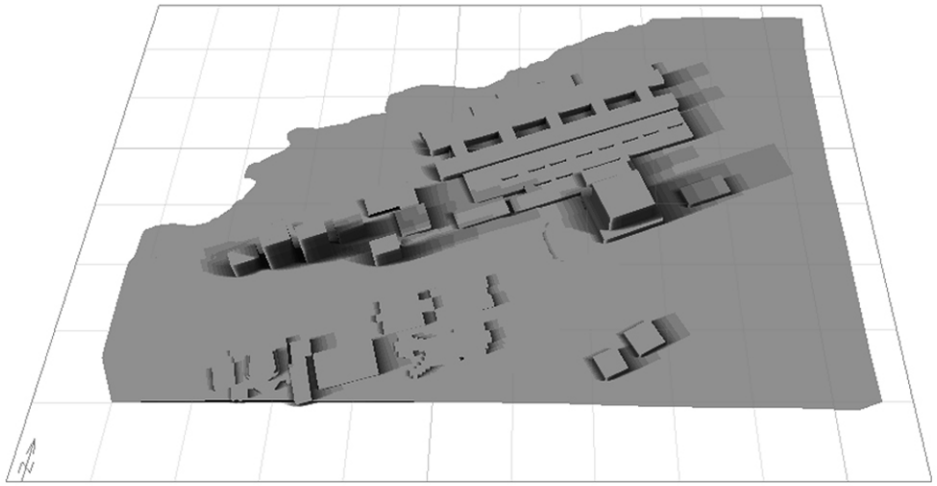
The diagram on the following page indicates the height of the existing buildings located on the site and its surroundings, giving a better understanding of the context that is being dealt with.


Building Heights
1 storey
2-4 storey
5-10 storey
11-15 storey
16-20 storey

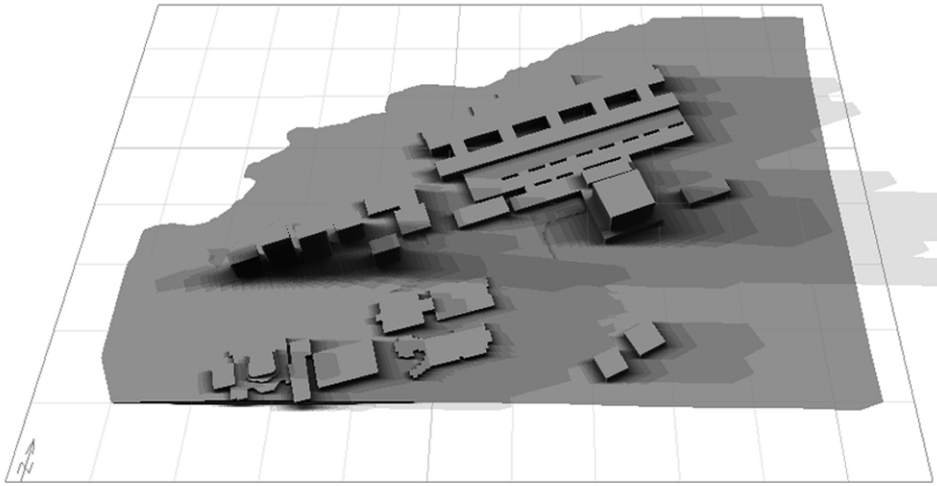
Solar Studies

Given the immense scale of some of the surrounding buildings, it was important to consider the shadows that they would cast onto the chosen site.

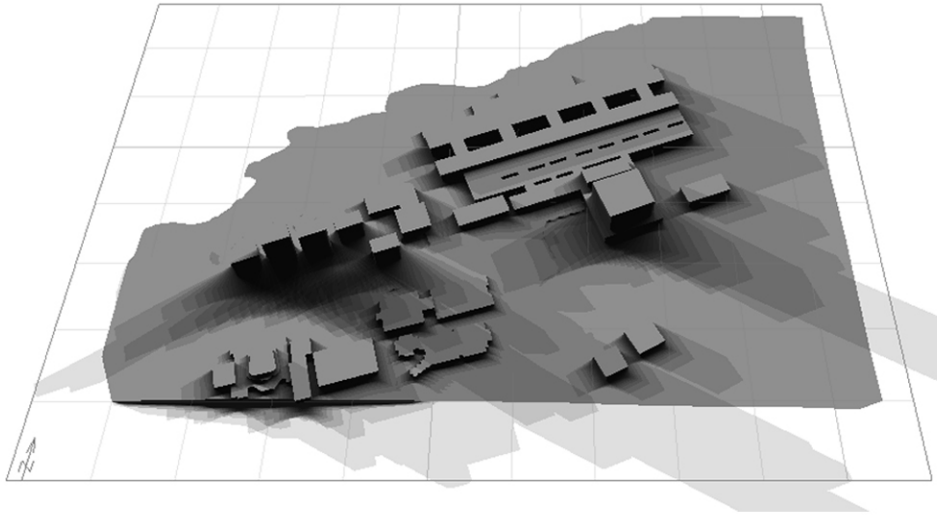
As such, a series of solar studies were carried out. The diagrams on the following page show the range of shadows cast between 8am and 6pm for each of the specified dates, giving an idea of the kinds of shadows that can be expected to be cast by the surrounding buildings.



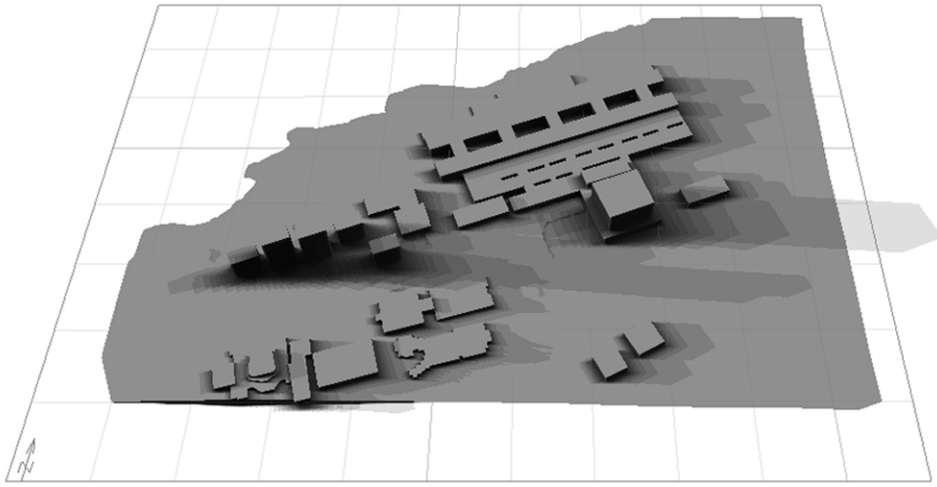
21st December (Summer Solstice)



21st September (spring Equinox)



21st July (Winter Solstice)



21st May (Autumn Equinox)



Figure 2.30
View from the Wits Health Sciences campus looking west.



Figure 2.31
View of the nurses housing towers from Jubilee Road.



Figure 2.32
View looking east down Jubilee Road towards the WIts Medical School.





Views and Surroundings



Figure 2.34
View of the Telkom tower in Hillbrow from the Health Sciences campus.



Figure 2.35
View looking southeast towards the CBD overlooking the Parktown water reservoir.



Figure 2.36
View from entrance to Health Sciences campus towards students residences on the Education campus.

Bibliography

JHB - Johannesburg Hospital Board (1990). Johannesburg Hospital 1890-1990. Johannesburg: Perskor.

URBAN SOLUTIONS et al. (2010) A Preliminary Development and Design Framework for the University of the Witwatersrand: An Executive Summary.

Image References

Figure 2.1. Aerial photograph of Parktown Ridge, Johannesburg. (Base image from Google Earth, adaption by author).

Figure 2.2. Wits Medical School, Health Sciences Campus, University of the Witwatersrand, Johannesburg. (Photograph by author).

Figure 2.3. Aerial photograph of Parktown Ridge, Johannesburg. (Base image from Google Earth, adaption by author).

Figure 2.4. Wits Medical School, Health Sciences Campus, University of the Witwatersrand, Johannesburg. (Photograph by author).

Figure 2.5. View down Jubilee Road, Parktown, Johannesburg. (Photograph by author).

Figure 2.6. View down Jubilee Road, Parktown, Johannesburg. (Photograph by author).

Figure 2.7. Wits Education Campus, University of the Witwatersrand, Johannesburg. (Photograph by author).

Figure 2.8. Edge of Wits Education campus onto Jubilee Road, Parktown, Johannesburg. (Photograph by author).

Figure 2.9. Corner of Jubilee Road and Victoria Avenue. (Photograph by author).

Figure 2.10. View from Jubilee Road towards Braamfontein, Johannesburg. (Photograph by author).

Figure 2.11. Old Johannesburg General Hospital, Hospital Hill. Photograph by Graeme Hill (http://finepixtrix.wordpress.com/2011/07/14/old-johanneburg-general-hospital-photowalk-02-07-11/)

Figure 2.12. Patient being admitted to Johannesburg General Hospital. Photograph by Mariella Furrer (http://www.mariellafurrer.com)

Figure 2.13 - 2.17. Urban design framework concept maps. (Hansen et al)

Figure 2.18. Main vehicular and pedestrian entrance to Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.19. Pedestrian walkway at Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.20. Jonathan Stone Architects. Visitor Centre at Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.21. Parking lot at Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.22. Outdoor space at Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.23. Main entrance to Wits Medical School, Wits Health Sciences Campus, Johannesburg. (Photograph by author).

Figure 2.24. Context Map. (Author´s own).

Figure 2.25. Accessibility Diagram. (Author´s own).

Figure 2.26. Walking Times. (Base image from Google Earth, adaptation by author).

Figure 2.27. Wits Owned Land Diagram. (Author´s own).

Figure 2.28. Building Heights Diagram. (Author´s own).

Figure 2.29. Solar Studies Diagram (Author´s own).

Figure 2.30. Wits Health Sciences Campus, University of the Witwatersrand, Johannesburg. (Photograph by author).

Figure 2.31. Nurses Housing at Charlotte Maxeke Academic Hospital, Parktown, Johannesburg. (Photograph by author).

Figure 2.32. View down Jubilee Road, Parktown, Johannesburg. (Photograph by author).

Figure 2.33 Aerial photograph of Parktown Ridge, Johannesburg. (Base image from Google Eath, adaptation by author).

Figure 2.34. View from Wits Health Sciences Campus towards South, Johannesburg. (Photograph by author).

Figure 2.35. Parktown Water Reservoir, Parktown, Johannesburg. (Photograph by author).

Figure 2.36. Student residences, Wits Education Campus, University of the Witwatersrand, Johannesburg. (Photograph by author).

3. Design

Design Brief

The advent of information technology and the changing nature of knowledge in our society are having profound effects on the way that research is carried out and even on the sites in which research takes place.

Traditional paradigms are being challenged and replaced by new ones. Nowadays greater emphasis is being placed on the importance of multi-disciplinarity, informal interaction and flexible environments in the production of knowledge. These notions all have potential implications on architecture and the built environment.

In the case of a research institution, the role of architecture is to provide environments which not only accommodate but are conducive to research, contemplation and understanding. It is with this in mind that the design brief for this project has been formulated.

The brief calls for the design of a neuroscience research institute where competent neuroscientific research can take place. The facility is to include offices, laboratories, imaging facilities, and multi-functional spaces to be used for research purposes.

The proposed design is purely a *research* facility, and as such does not possess a clinical component (i.e. medical wards), as this already exists at the hospital.

For this and other reasons the proximity and affiliation of the proposed institution with the hospital, as well as the university, is extremely important.

From a design point of view, it means that the building must cater to several different users (i.e. researchers, staff, students, visitors, etc.) as certain functions might be shared by the hospital and university.

The following principles form the main design objectives:

1. To create a physical environment which is conducive to research and knowledge production.

2. To create spaces where informal interaction between different users of the building can occur.

3. To achieve connectivity between the proposed new buildings, the existing buildings and the surroundings

4. To create a new entrance route to the Medical School.

Design Concept

Route and Connections

From the design principles that arose out of the theoretical research for this thesis (identified on pages 74 and 75), I have chosen to focus on two of these as design concepts; Route and Connections.

As discussed previously one of the aims of this project is to create a new entrance for the Wits Medical School. As such the concept of route or procession becomes critically important in the design.

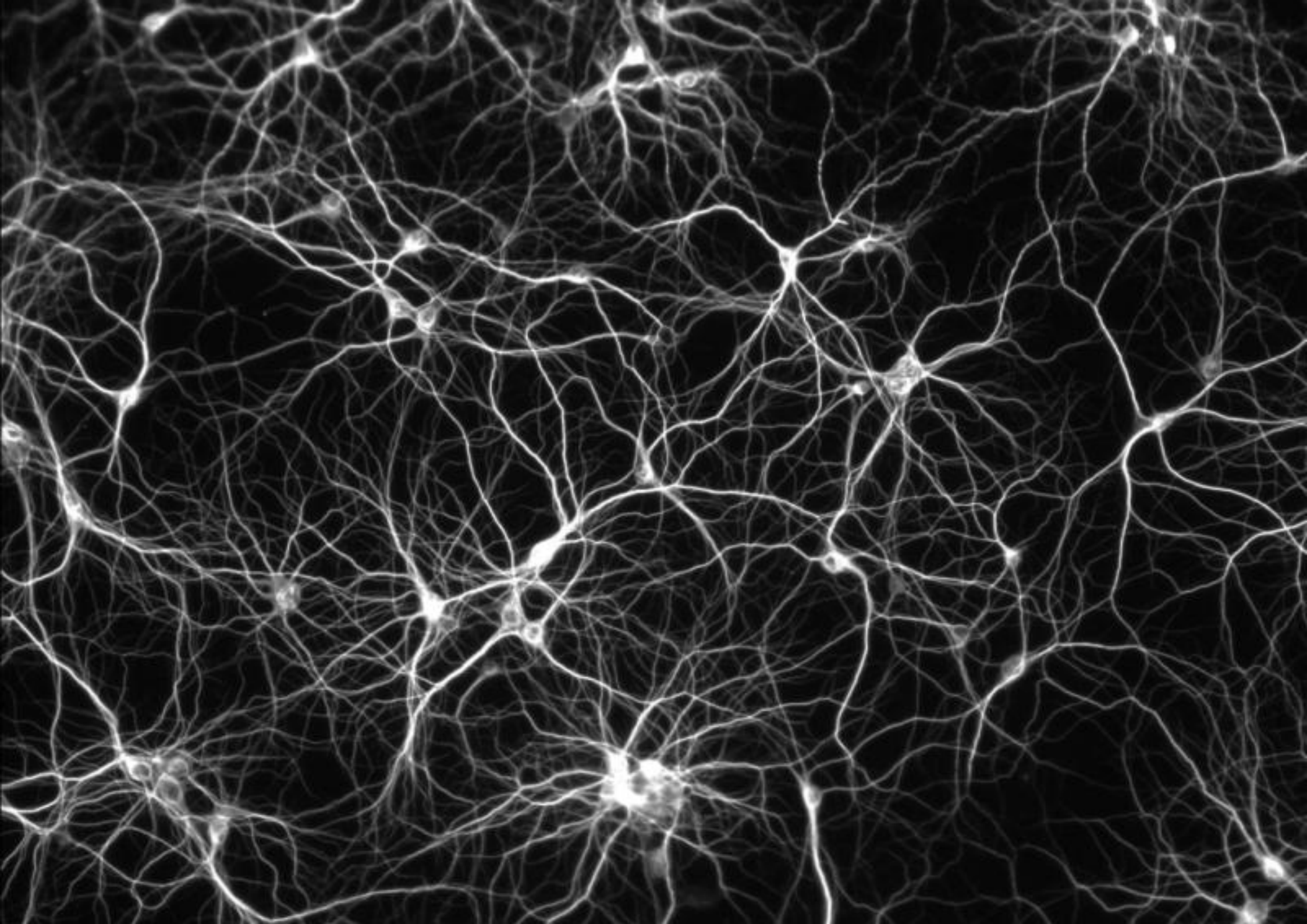
Another aim is creating connections between the new buildings, the existing buildings and the surroundings. This is especially important given that the proposed project is an insertion in an already built area.

From a metaphorical point of view both the concept of route and of connections have strong neurological resonance.

Not only are neurons within the brain connected to each other but they connect the brain to the rest of the nervous system and ultimately the rest of the body, In a metaphorical sense, the proposed building is a brain that connects to the rest of the body (i.e. the existing buildings and the surroundings).

The idea of route is also significant on a neurological level. The structure of our brains is defined by the neural pathways which make it up. These neural pathways shape who we are, how we think and how we behave. Recent studies in neuroscience, however, have shown that the brain is more plastic than previously thought and that our surroundings can affect the physical structure of our brains. This means that the architecture might be able to literally shape the mind.

Following Page:
Figure 3.1. Image of neuron connections in the brain



Programme

SCHEDULE OF AREAS AND ACCOMMODATION

	Degree of Privacy	Area (m^2)	Number
PUBLIC			
Lobby	1	200	1
Reception	1	25	1
Coffee Shop	1	200	1
		425	
THEORY			
Meeting Rooms	3	20	4
Library / Internet	2	300	1
Offices	4	350	
Multi-Purpose Venue	3	30	
		760	
IMAGING			
Reception	1	15	1
Waiting Area	2	40	1
Consultation Rooms	3	10	6
Change Rooms	4	2.5	4
EEG Room	4	40	1
Simulator Room	4	40	1
Testing Room	5	60	2
Control Room	5	7.5	2
Data Analysis Lab	5	50	1
Board Room	4	35	1
Meeting Room	4	20	1
Offices	4	200	
Break Room	3	25	
		670	

	Degree of Privacy	Area (m^2)	Number
LAB			
Laboratory – Wet Lab	5	250	1
Microscopy Laboratory	5	150	1
Data Analysis Lab	4	50	1
Work Rooms	3	15	5
Shipping / Receiving	3	50	1
		575	
AUDITORIUM			
Auditorium	3	100	1
Lobby	2	200	1
		300	
MISC.			
Social Spaces	1	200	
Kitchen	5	30	1
Security	5	30	1
Plant Room	5	100	1
Storage	5	100	
Generator	5	50	1
PABX	5	20	1
Maintenance	5	25	
		555	
TOTAL AREA		**3285**	

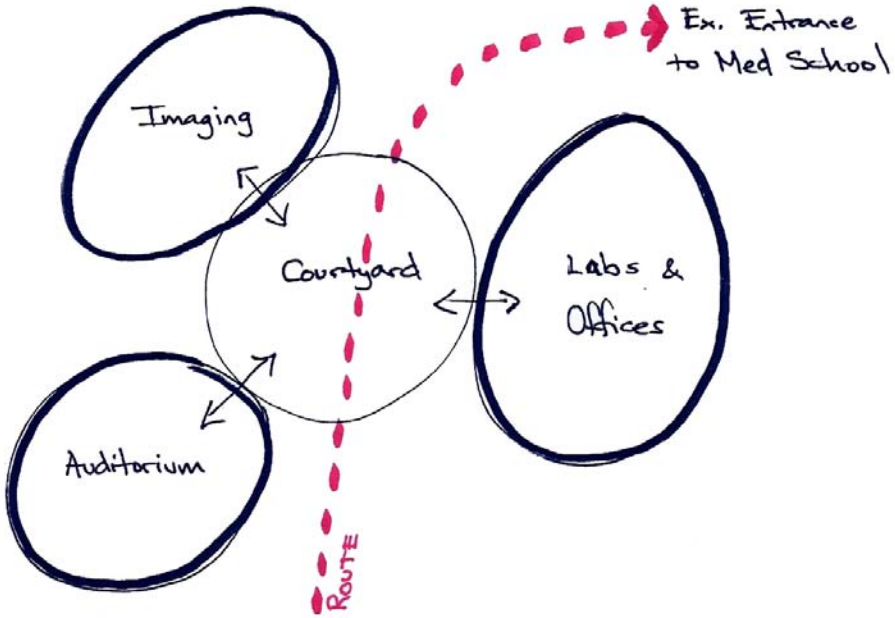


Figure 3.2. Conceptual programmatic bubble diagram.

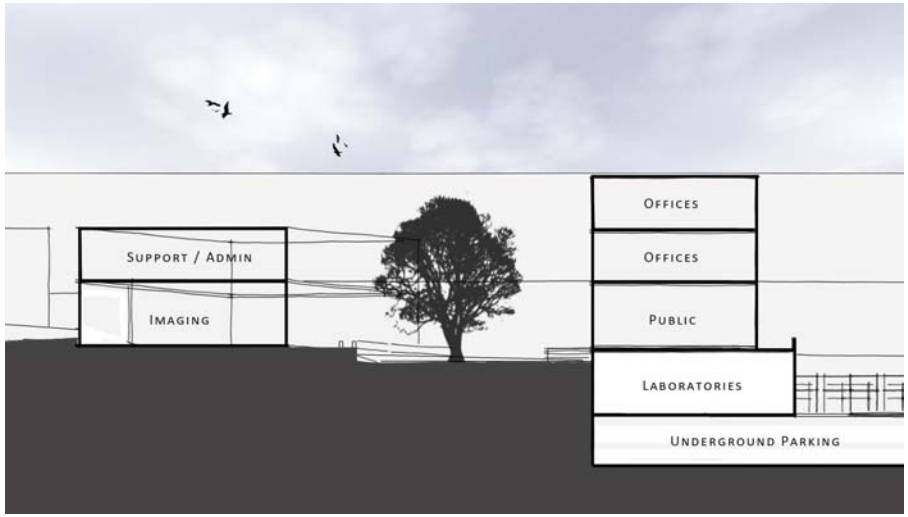
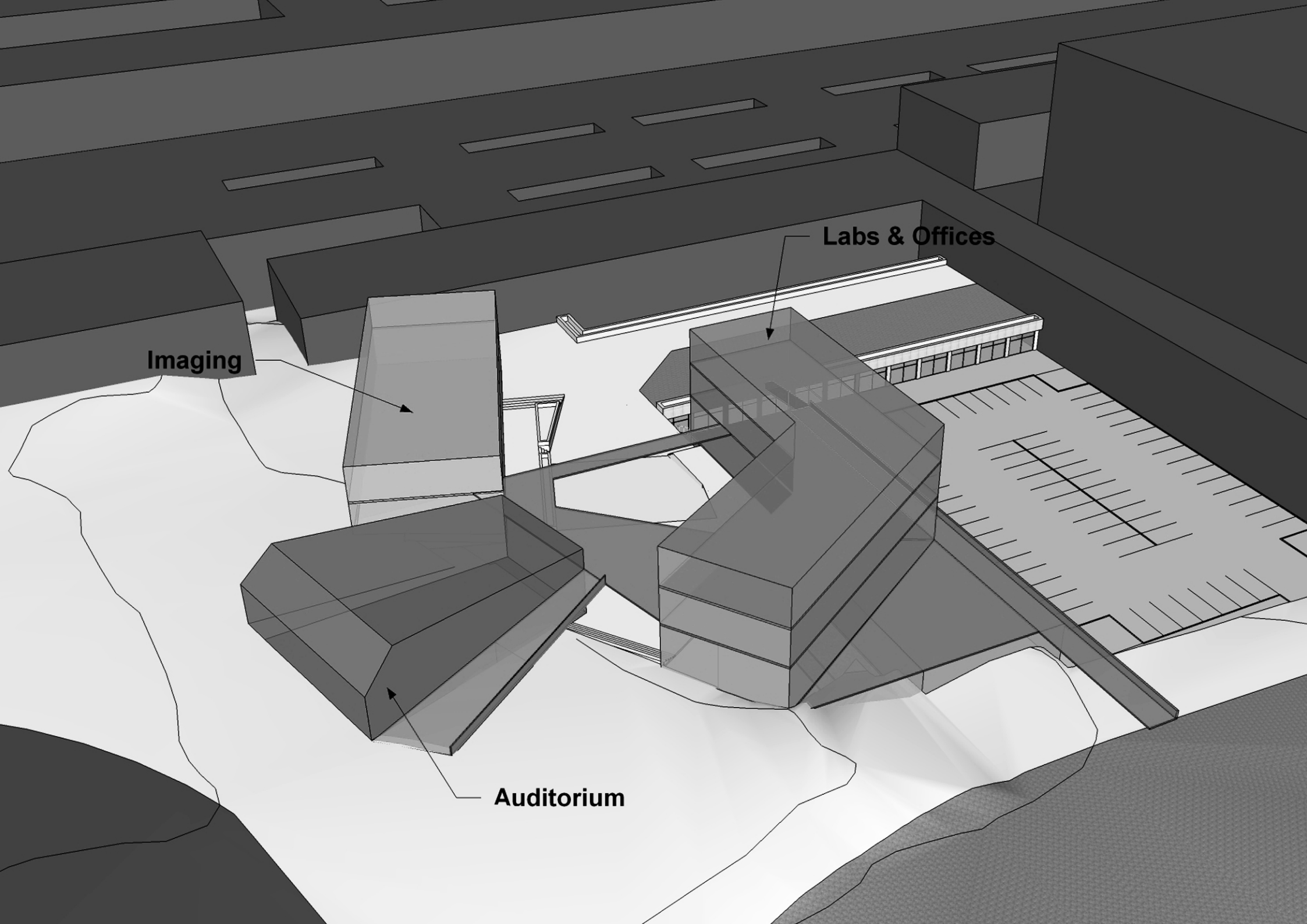


Figure 3.3. Diagrammatic representation of sectional organization of programme.

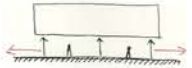
Following Page:
Figure 3.4. Massing model showing the arrangement of programme


Labs & Offices
Imaging
Auditorium

Design Development

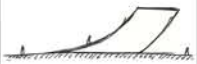
Following Page:
Figure 3.5. Preliminary sketches of architectural concepts to kickstart the design process

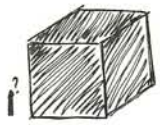

Separation


Connection


Peeling

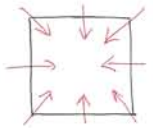

Slope

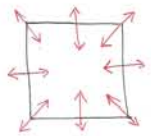

Emerging

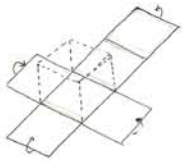

Opaque

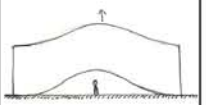

Transparent

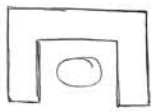

Enclosed

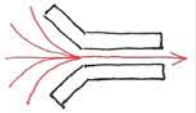

Permeable

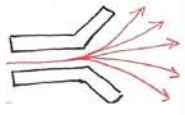

Interactive

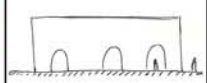

Adaptability

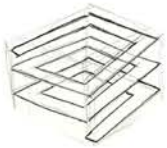

Accessibility

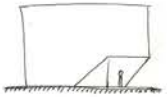

Enclosing / Defining Space


Convergence


Divergence

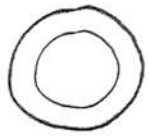

Entrance

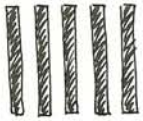

Circulation


Shelter

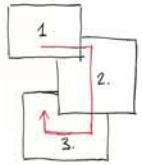


Threshold

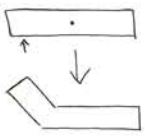

Unity

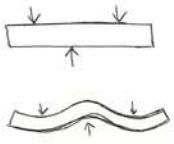

Linear

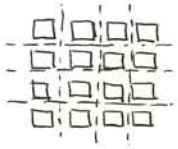

Disorder

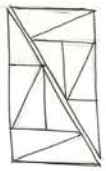


Sequence


Linear Transformation


Organic Transformation


Linear Array


Fractal Geometry


Symmetry

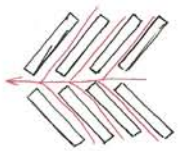

Porous Stacking

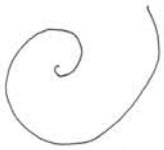

Chaos

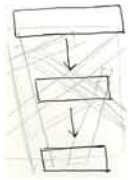

Horizontality

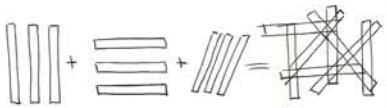

Verticality

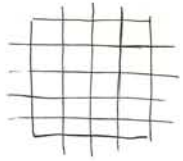

Disruption


Convergence


Geometric Order


Hierarchy


Stacking


Orthogonal Grid


Cellular Grid


Structural Grid

City Grid

Free Facade

Honeycomb

Cellular

Molecular

Grid Distortion

Catenary

Efficiency

Tensile Membrane

Porousity

Skeleton

Modular

Plasticity

Permeability

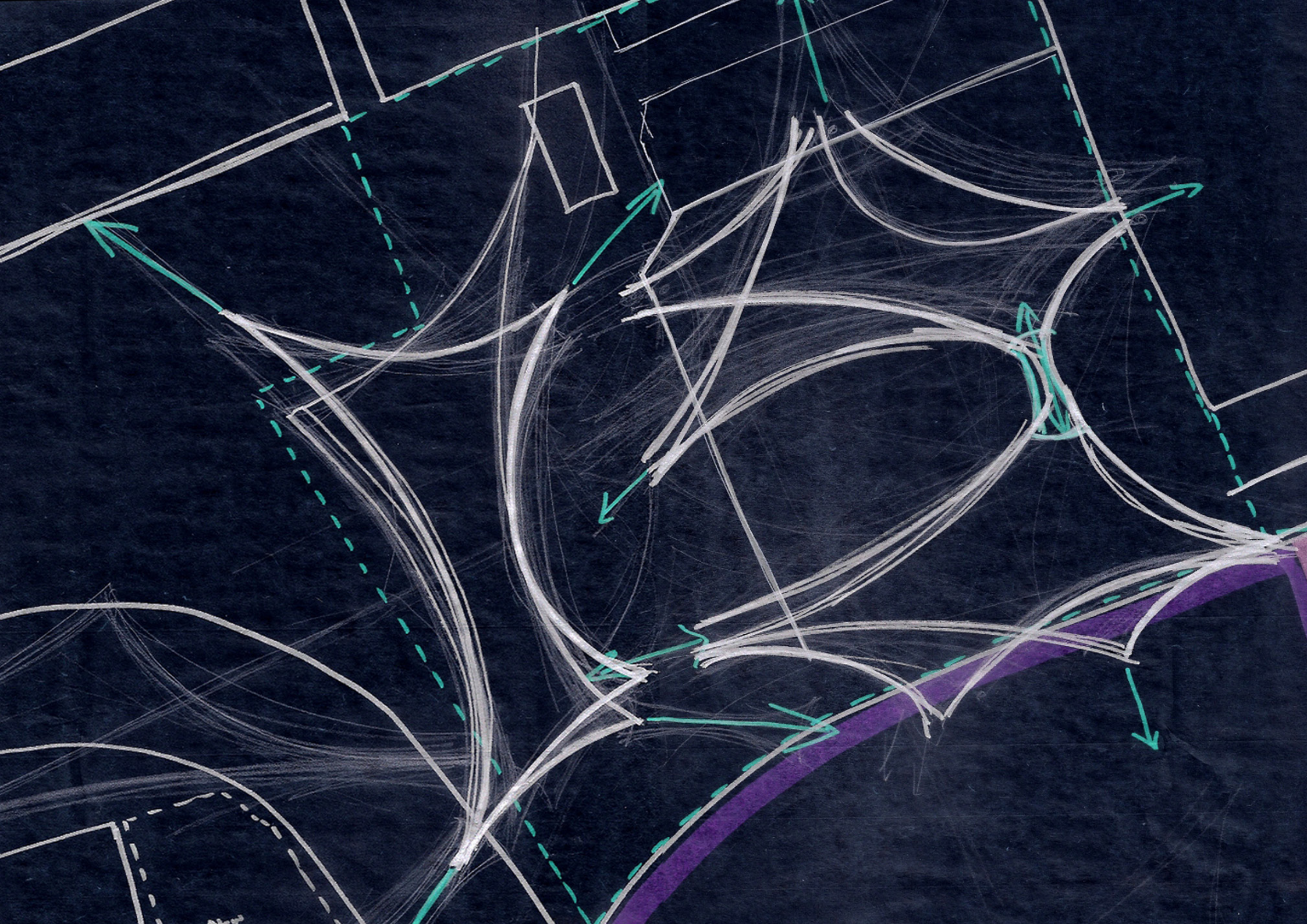
Solid

Solid with Cut-outs

Vertical Stacking

Shifted Stacking

Shear



Previous Page:
Figure 3.6. Sketch of original desgin concept.

Initial Response

The sketch on the previous page shows the first response to the design and to the site. The idea behind this concept was to create an architectural intervention driven by connections.

I envisioned the buildings connecting not only to each other but to the existing buildings, as well as the surroundings.

The design was a metaphor for the brain and its network of connections, where the architecture became a physical embodiment of the connections formed by structures such as neurons and synapses in our brains.

The buildings themselves took on an organic neuronal form, looking almost as if they had started off orthogonal and been stretched and pulled to form links to their surroundings.

While still very conceptual, and perhaps too literal, this design provided a starting point and established the concept of connection, which was to carry through the rest of the project.



Figure 3.7. Model depicting first scheme characterised by a series of buildings linked by an organic ramp/walkway structure



Figure 3.8. Experimentation with different layouts, maintaining the same progammatic functions and separation into various buildings.



Figure 3.9. Further experimentation with placement of buildings on the site to create an axis that would take people from the street to the existing medical school entrance.



Figure 3.10. Final scheme adopted. The central courtyard space is better defined by the buildings, providing a social space and a route to the medical school. This scheme also respects the orthognal nature of the surrounding buildings, while at the same time deviating from it as the it gets closer to the street edge.

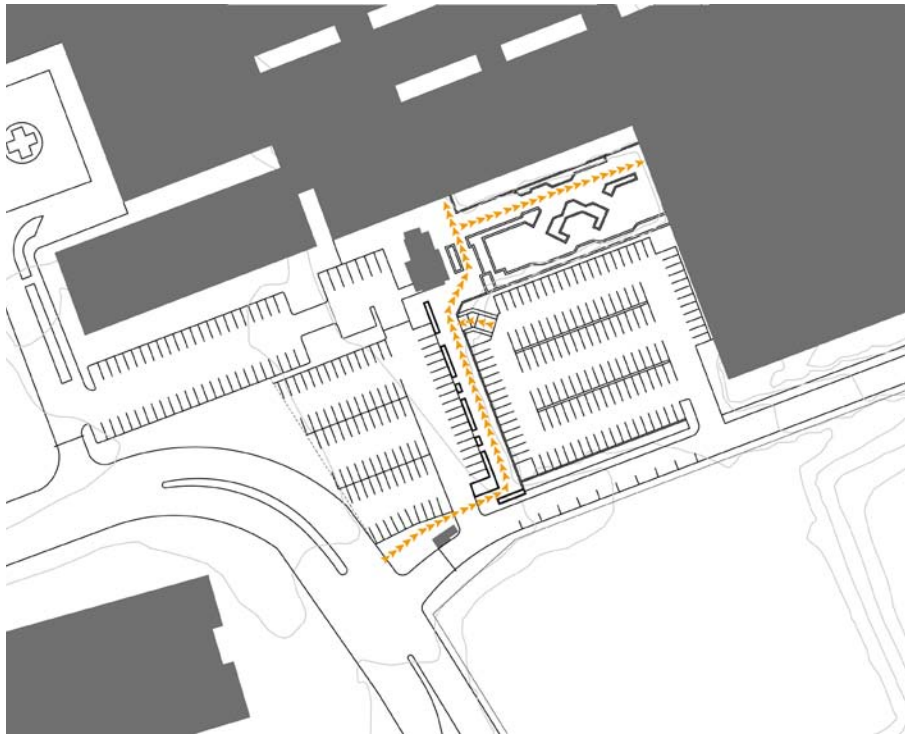


Figure 3.11

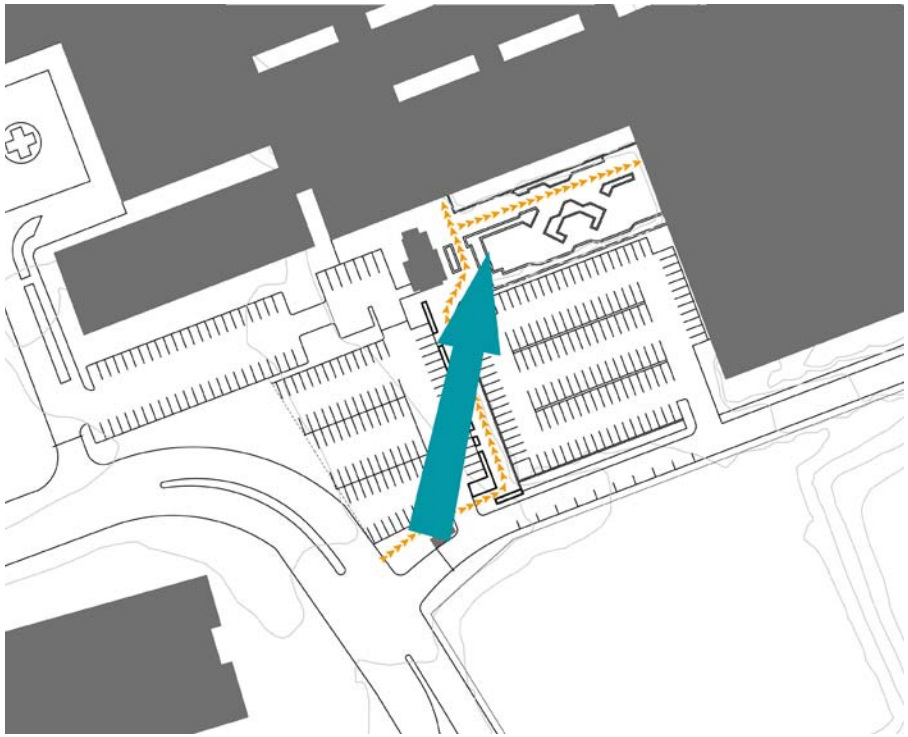


Figure 3.12

Pedestrian Movement

The site is dominated by the presences of vehicles, which severely limits the pedestrian movement across the site. Currently, pedestrians inevitably have to cross the road to get to the main entrance of the medical school, and are largely limited to walking along the pedestrian walkways.

Creating an Axis

The proposed design intervention would include the pedestrianization of a large part of the site to make it less vehicle dominated. In addition to the this would be the creation of a more direct access route from the street to the medical school, which would be made possible through the pedestrianization of the upper level parking area.

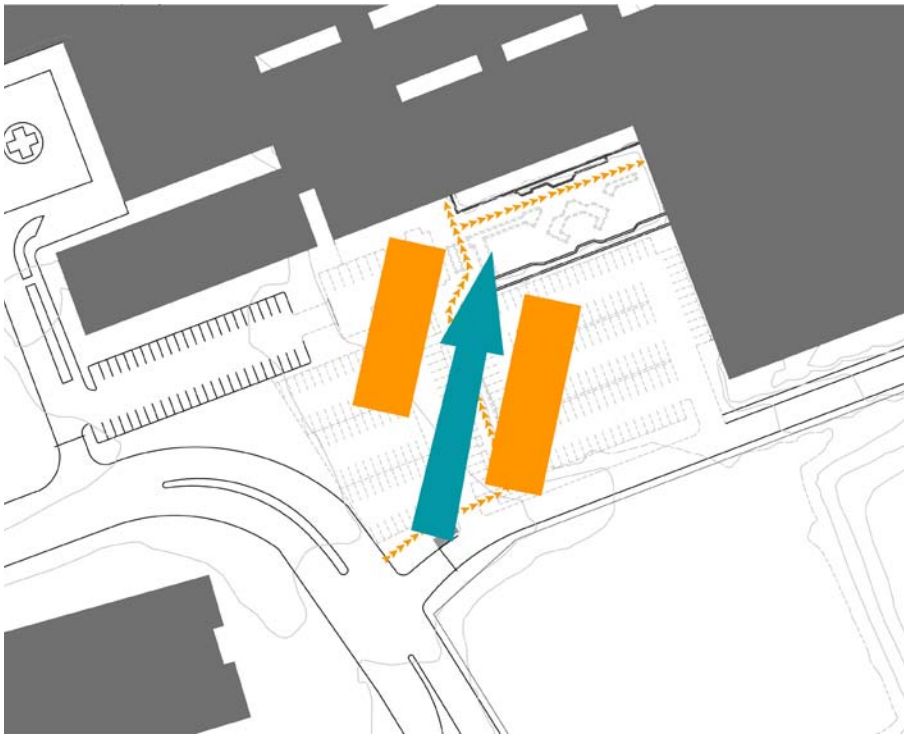


Figure 3.13

Building Massing

The basic building mass is placed on the site in response to the proposed movement axis.

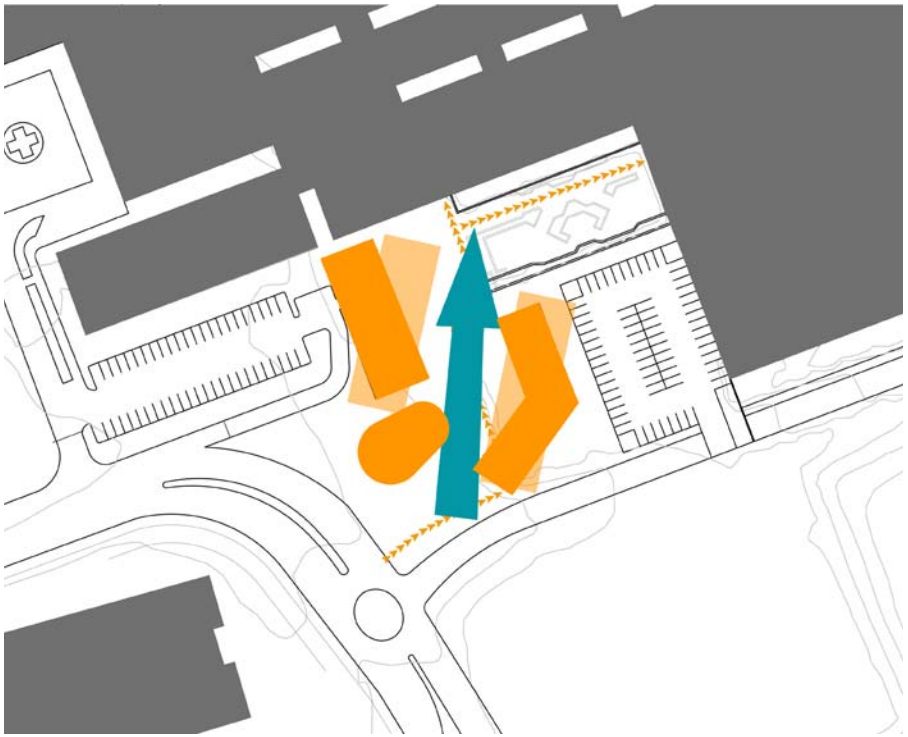


Figure 3.14

Manipulating Massing

The preliminary massing is manipulated to suit the programmatic requirements and to create a central courtyard space, from which the buildings are accessed.

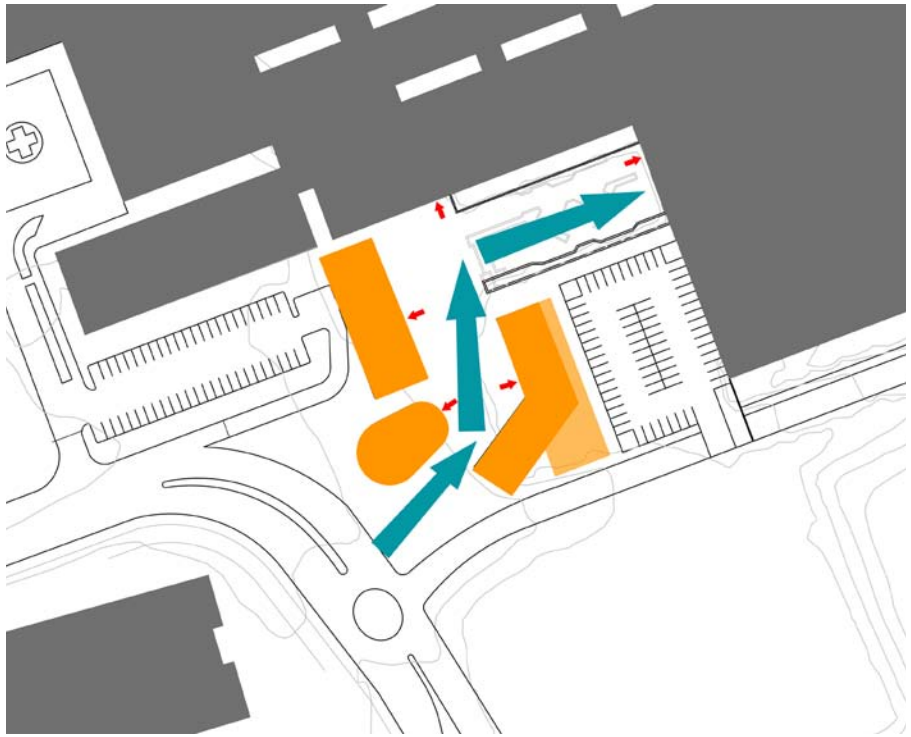


Figure 3.15



Figure 3.16

Establishing New Route

Once the massing has been manipulated a new access route to the existing main entrance of the medical school emerges. This route goes through the central courtyard space from which the proposed new buildings are accessed, as indicated by the red arrows.

Building Programme

The programme is accommodated within the buildings. In the proposed design it has been divided into 3 separate functions; Imaging, Auditorium and Labs and Offices.

The more public functions are placed in ground floor, and more private ones above, thus establishing a vertical privacy gradient.



Figure 3.17

Vertical Circulation

The vertical circulation occurs in dedicated circulation cores within the buildings. An external ramp running along the side of the auditorium also provides access to 1st floor level.



Figure 3.18

Connections

The buildings are linked to each other through a series of connections. These occur on different levels and connect the buildings not only to each other but also to the the surroundings

Construction Technology

Building Façades

The building skin is one of the most important elements in any architectural design project, providing the physical separation between inside and outside; between the building and its surroundings. The skin not only defines space, separates public from private and provides protection from the elements, but its aesthetic and expressive functions are equally significant (Schittich 2006:9) The façade is the building´s face to the world.

Over time trends in façade design have evolved tremendously as new materials and construction technologies have become available. The Industrial Revolution, which was a time characterised by significant advancements in manufacturing and technology, had a profound effect on architecture and engineering. The introduction of new construction materials gave architects and engineers of the time greater freedom for experimentation.

Glass was one of the materials that experienced significant advancements during the Industrial Revolution. The development of techniques for mass producing large glass sheets coupled with the introduction of new materials to hold the glass in place opened up a world of possibilities for its use in architecture (Wheeler). The Crystal Palace designed by Joseph Paxton for the 1851 Great Exhibition in London was one of the most ambitious architectural glass projects ever undertaken and has become an iconic symbol of the Industrial Revolution (Wheeler)

Glass began to be used extensively in 20th century Modern architecture, as it embodied the ideals of transparency, dematerialisation and honesty dominant in architectural discourse at the time (Wheeler).

Today, the challenges facing the architects in the design of building façades are different from the ones facing architects during the Industrial Revolution. With ever increasing environmental considerations to respond to buildings façades have become increasingly complex and multi-faceted (Schittich 2006:9). The façade is no longer merely a space defining element marking the transition between inside and outside, it is the mediator which juggles a series of complex environmental factors including noise, light and shadow, ventilation, humidity and solar radiation. The façade is now a mediator between human needs and the external environment (Comsa 2011:301).

This need to respond to a complex series of ever varying conditions has led to the development of the responsive façade capable of reacting flexibly to external conditions (Schittich 2006:9). This can include a variety of approaches from simple folding or sliding shutters, to adjustable louvres, to mechanically operated shading devices (Schittich 2006:9). The term “intelligent” is now even being used to describe buildings or façades that are able to respond and mediate between internal and external environmental factors.

According to Wigginton and Harris (2002:171) the term intelligent building has been around since the early 1980s, but perceptions and definitions of the term vary significantly from person to person. For the purposes of this thesis the term intelligent façade shall be defined according as follows:

“a series of manipulative layers which can respond either individually or cumulatively, to external climatic variations or internally generated functional changes” (Ian Murphy `The Smart Set´ in Wigginton and Harris 2002:173).

Bibliography

COMSA, D. (2011). Contemporary Ways of Space Envelopment – Intelligent Building? CSIT Vol. 5, 2011. IACSIT Press: Singapore.

SCHITTICH, C. ed. (2006). inDetail Building Skins. Birkhauser: Basel

WHEELER (Unknown Date). The History of Glass in Architecture. INTERNET http://www.articledashboard.com Accessed 20 October 2011.

WIGGINTON, M. and HARRIS, J. (2002). Intelligent Skins. Oxford: Architectural Press

My Project - Intelligent Façade

Since this thesis deals with neuroscience and architecture, it seems appropriate to have a component of the building that can mimic the functions of the brain and respond intelligently to varying internal and external factors, for this reason the technical component of this project shall focus on the building façade, in particular, but not limited to, the responsive façade applied on the West elevations.

The proposed building skin is made up of perforated stainless steel panels that have the ability to stack and fold in order to open and close the façade as required for solar shading. The proposed system is mechanically operated and controlled automatically but with the possibility for manual override of individual panels.

Individual panels, measuring 500 x 1200mm, are assembled in a frame structure into larger folding panels.

Each folding panel is comprised of 4 individual panels fixed to each other with a hinge system so as to permit movement in one plane (i.e. up and down). When the panels are parallel to the façade (0º) the skin is completely closed, creating a sun shade, and when the panels are stacked perpendicular (90º) to the façade, the skin is completely open.

Since the panels have a range of movement anywhere between 0º and 90º, the skin does not have to be either entirely open or entirely closed. Each set of panels (comprised of 4 individual panels) is also operated separately thus allowing for a dynamic façade capable of an almost unlimited number of configurations. So in addition to acting as an environmental control system, the skin becomes an expressive element of the building, which can be manipulated as desired.

The concept of intelligence is present in the idea of producing a system that not only responds to the external factors, but one that is capable of learning, much like the human brain does. Through collection of data over time the system should be able to respond not only to external factors, but also learn to understand individual user preferences and react to them. This would be achieved through the electronic collection of data and the production of a specific algorithm based on which the system will operate, but always with possibility for manual override.

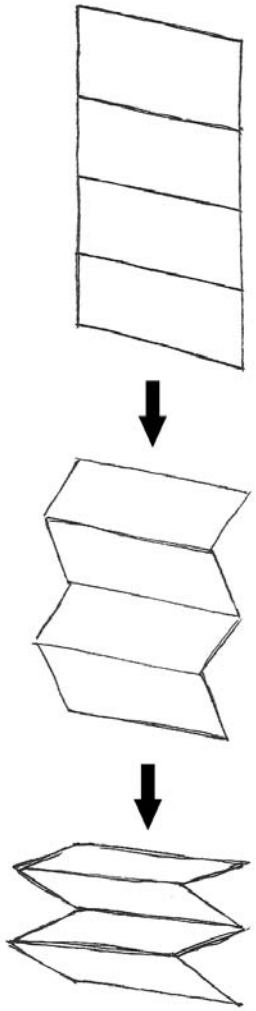


Figure 3.19. Façade stacking concept.

Façade Configurations

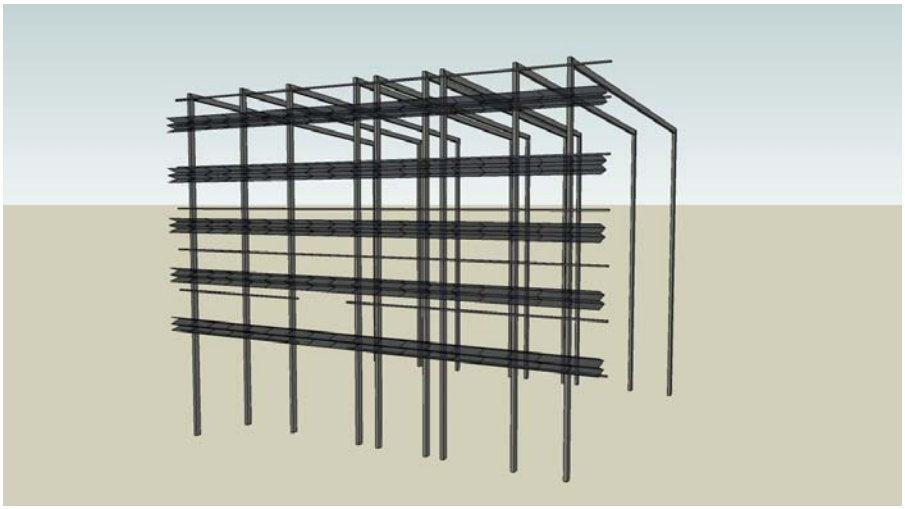


Figure 3.20. Façade almost entirely open.

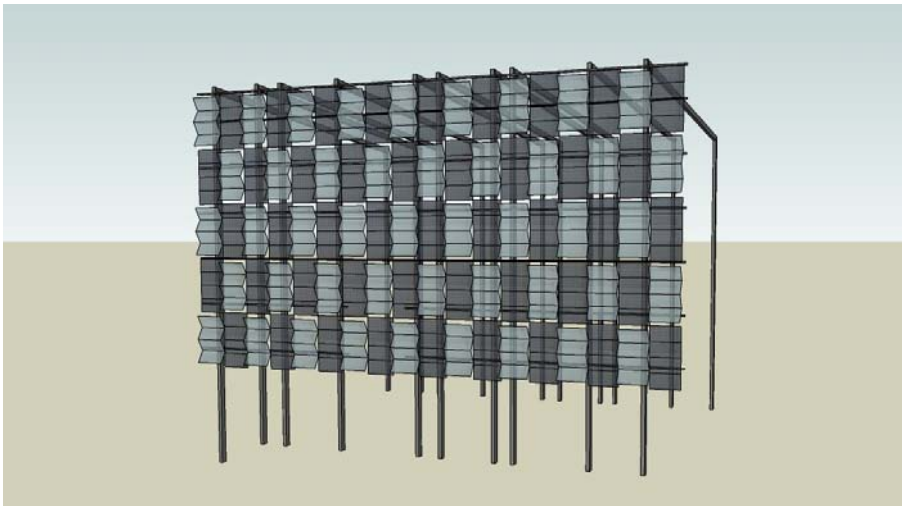


Figure 3.21. Façade almost entirely closed.

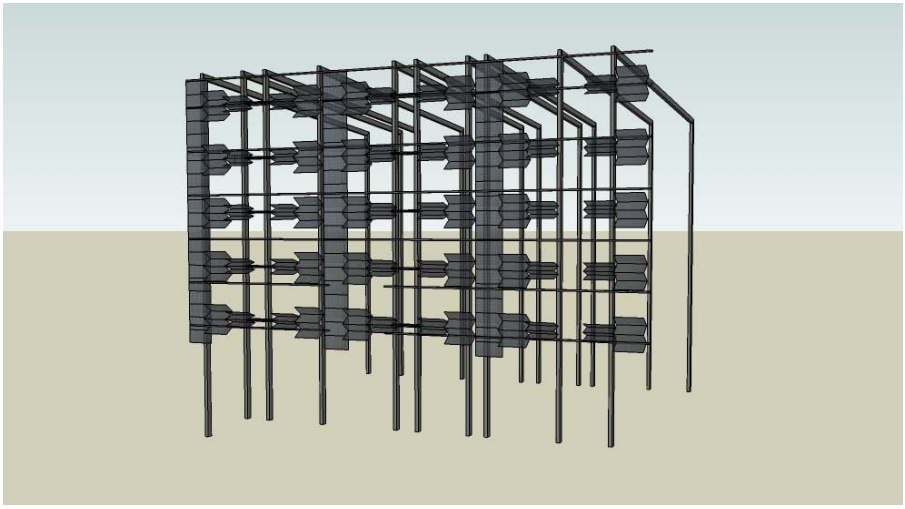


Figure 3.22. Façade in a pattern configuration.

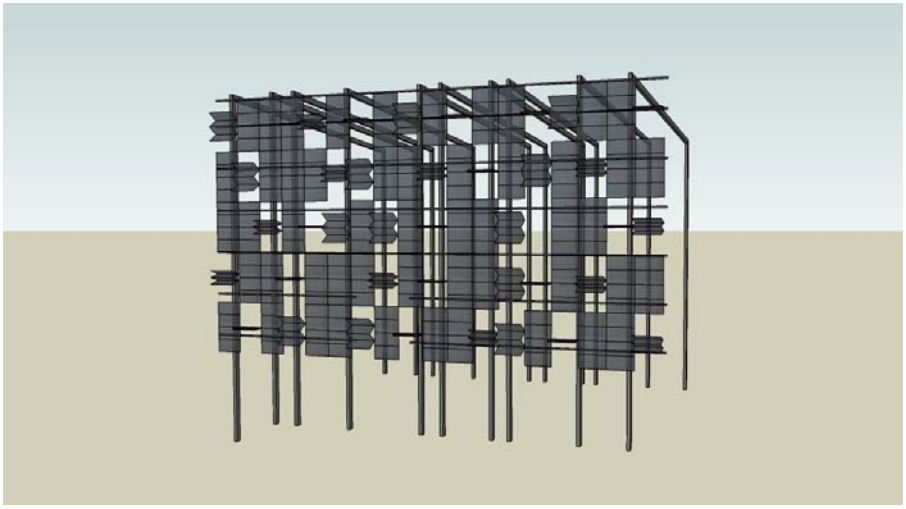


Figure 3.23. Façade in a random configuration.

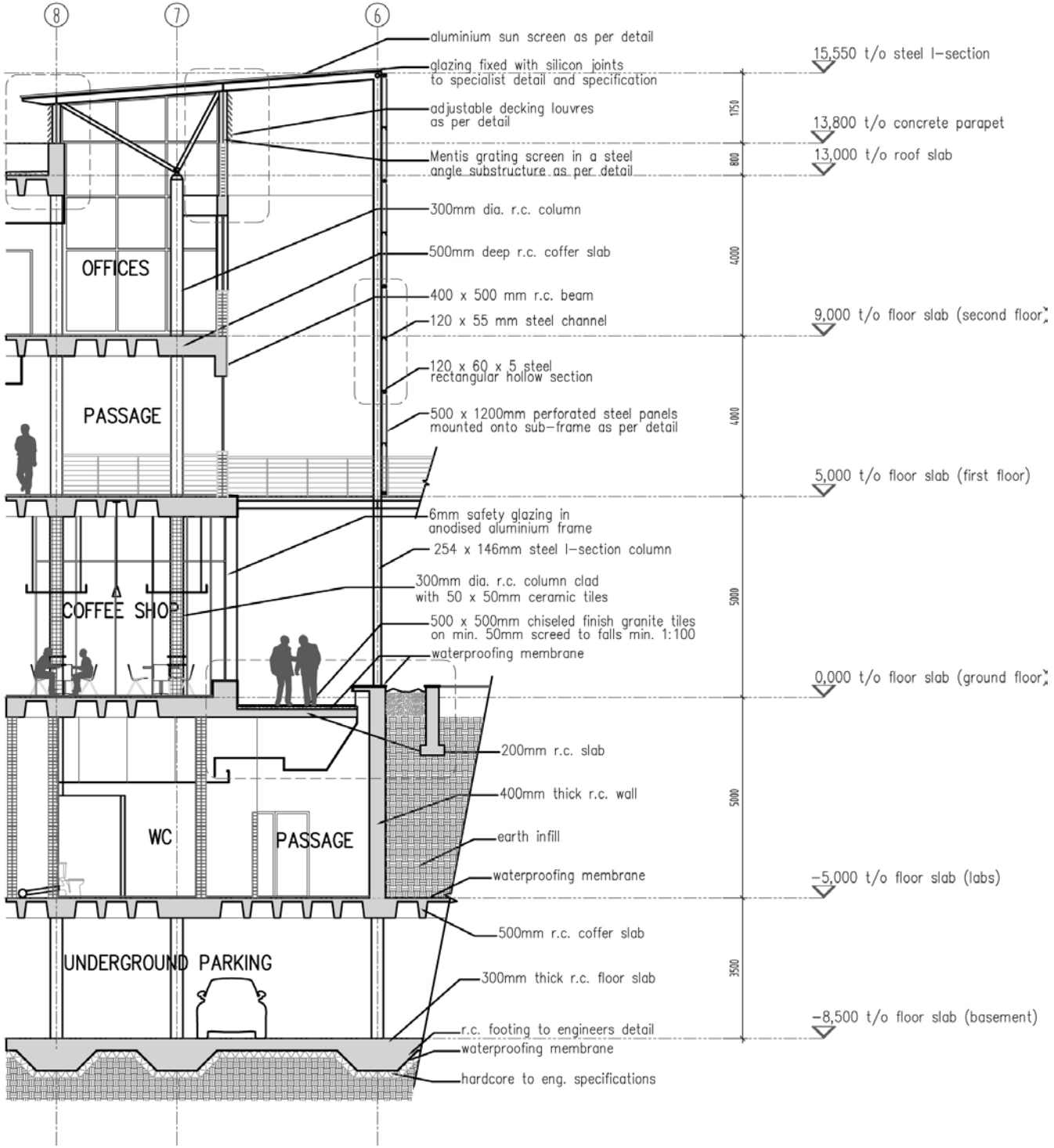


Figure 3.24

SECTION THROUGH WEST FAÇADE
NOT TO SCALE

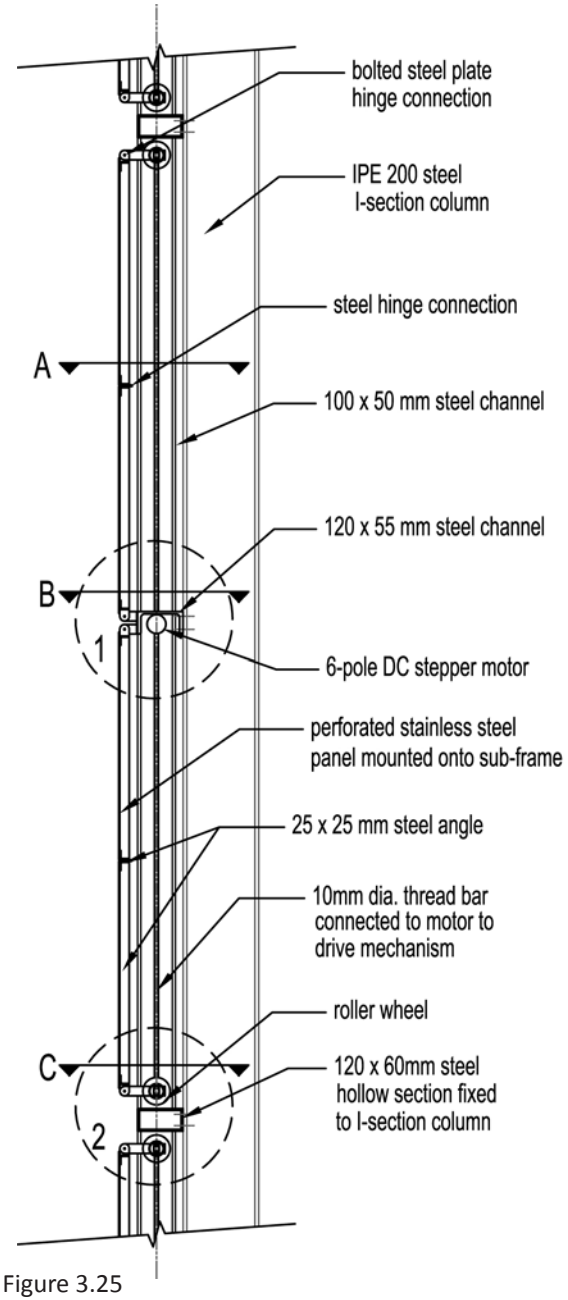


Figure 3.25

Section Closed Condition
scale 1:20

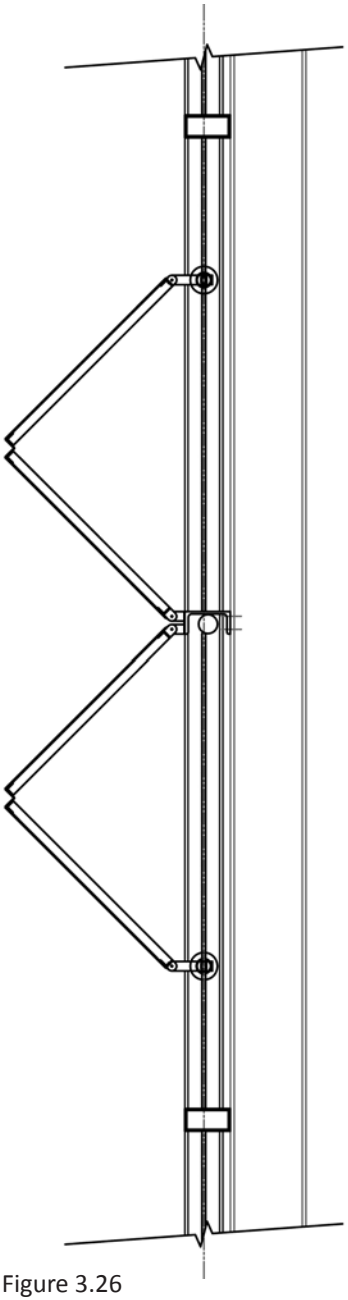


Figure 3.26

Section Intermediate Condition
scale 1:20

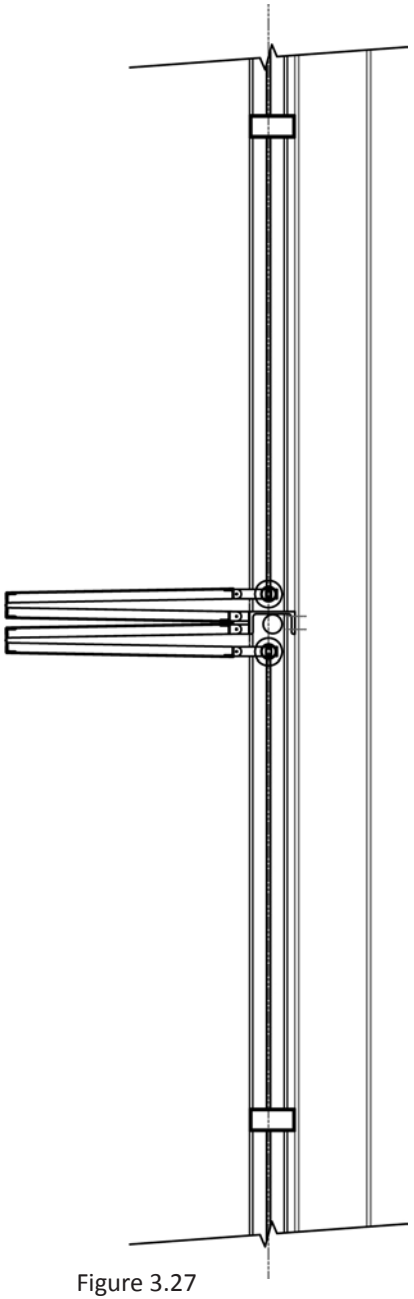


Figure 3.27

Section Open Condition
scale 1:20

Intelligent Façade Details

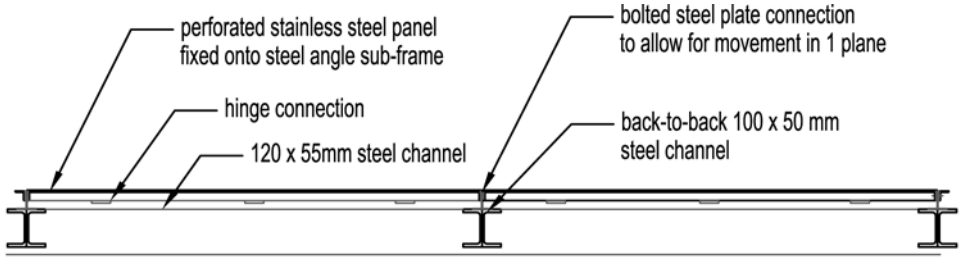


Figure 3.28

Plan A

scale 1:20

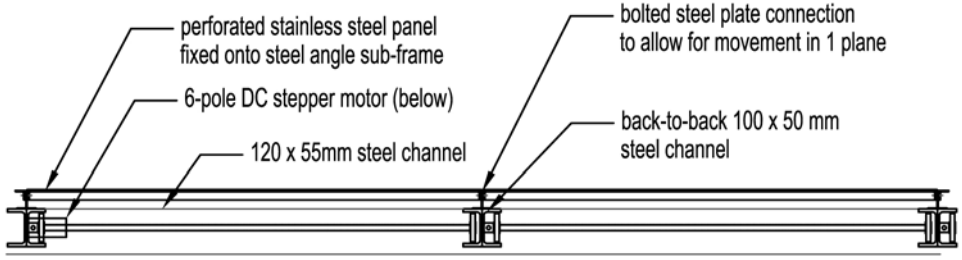


Figure 3.29

Plan B

scale 1:20

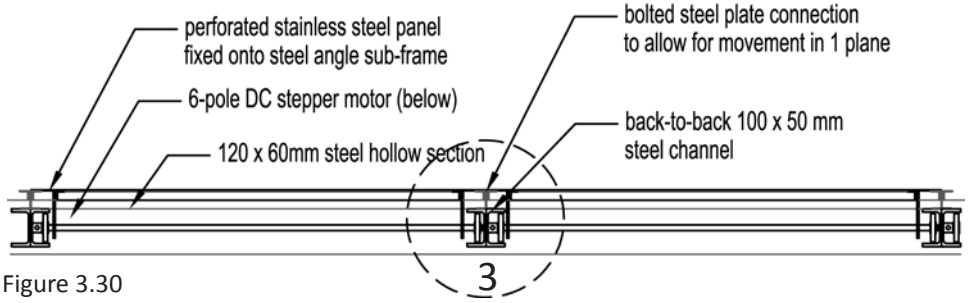


Figure 3.30

Plan C

scale 1:20

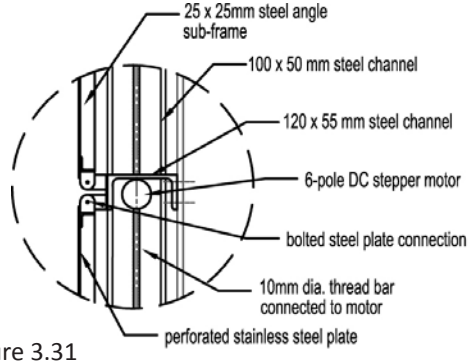


Figure 3.31

Detail 1

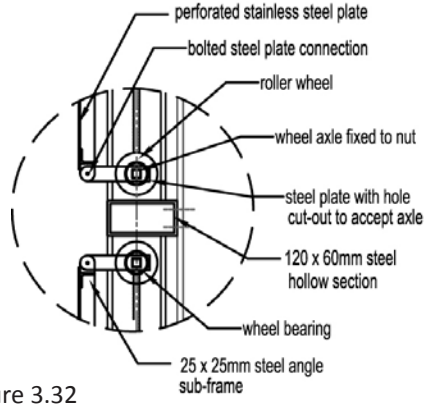


Figure 3.32

Detail 2

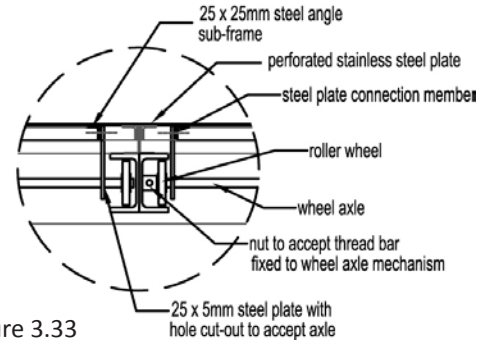


Figure 3.33

Detail 3

Final Response



Figure 3.34
Approach to the Site from Jubilee Road (from Southwest)



Figure 3.35
BIRD´S-EYE-VIEW OF FINAL MODEL



Figure 3.36
MASTER PLAN
NOT TO SCALE

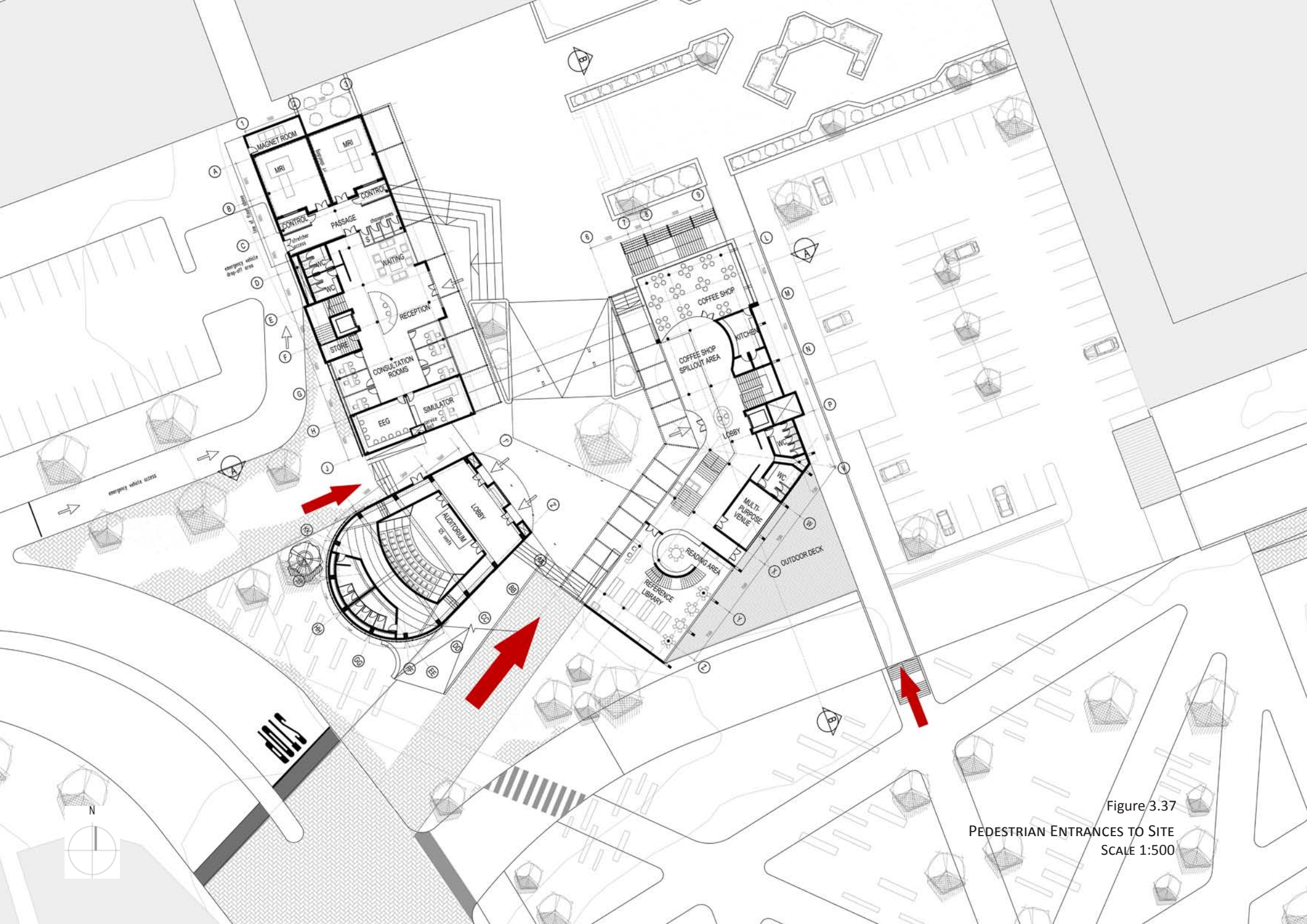


Figure 3.37

PEDESTRIAN ENTRANCES TO SITE

SCALE 1:500

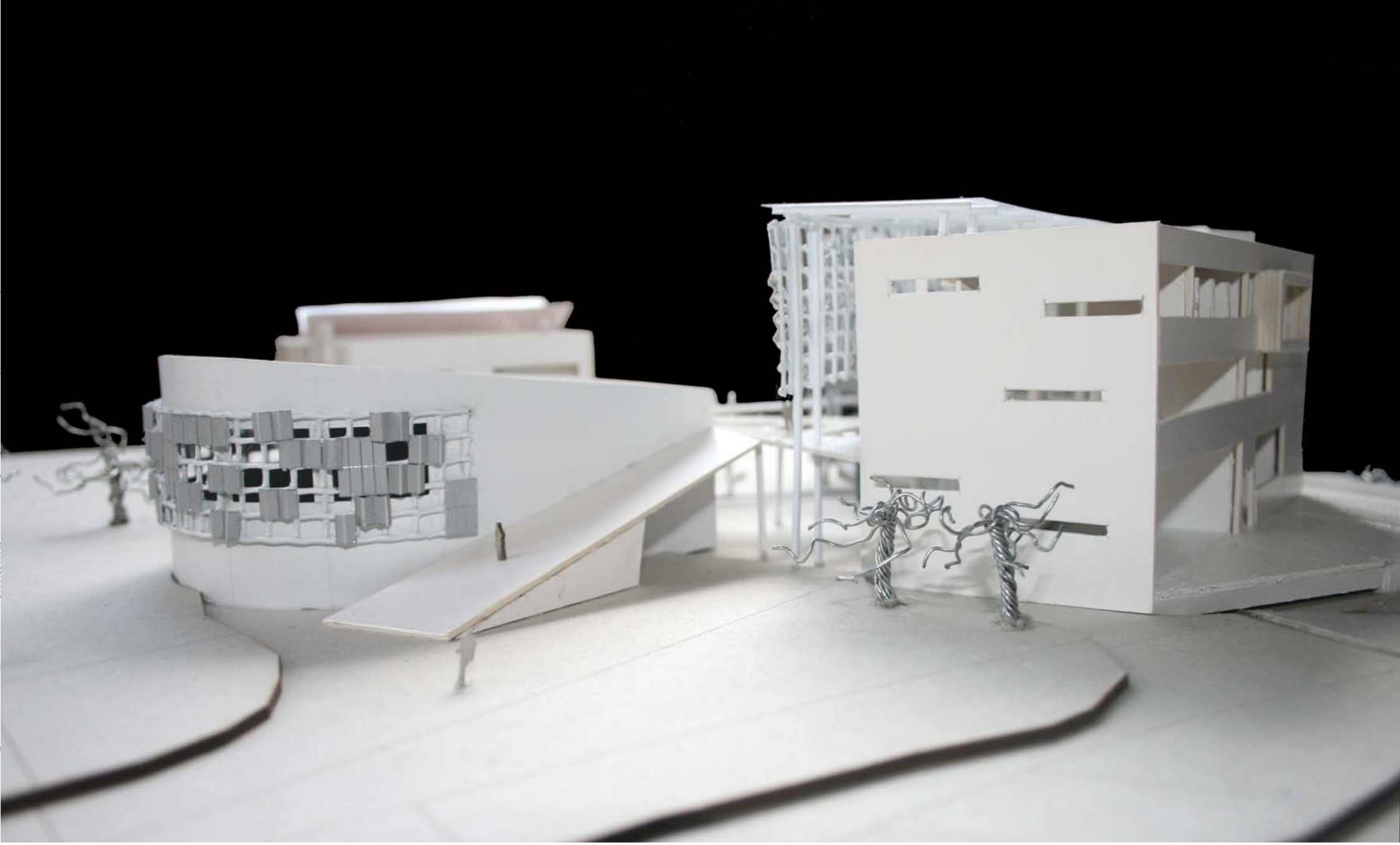


Figure 3.38
Approach to the Site (Model)

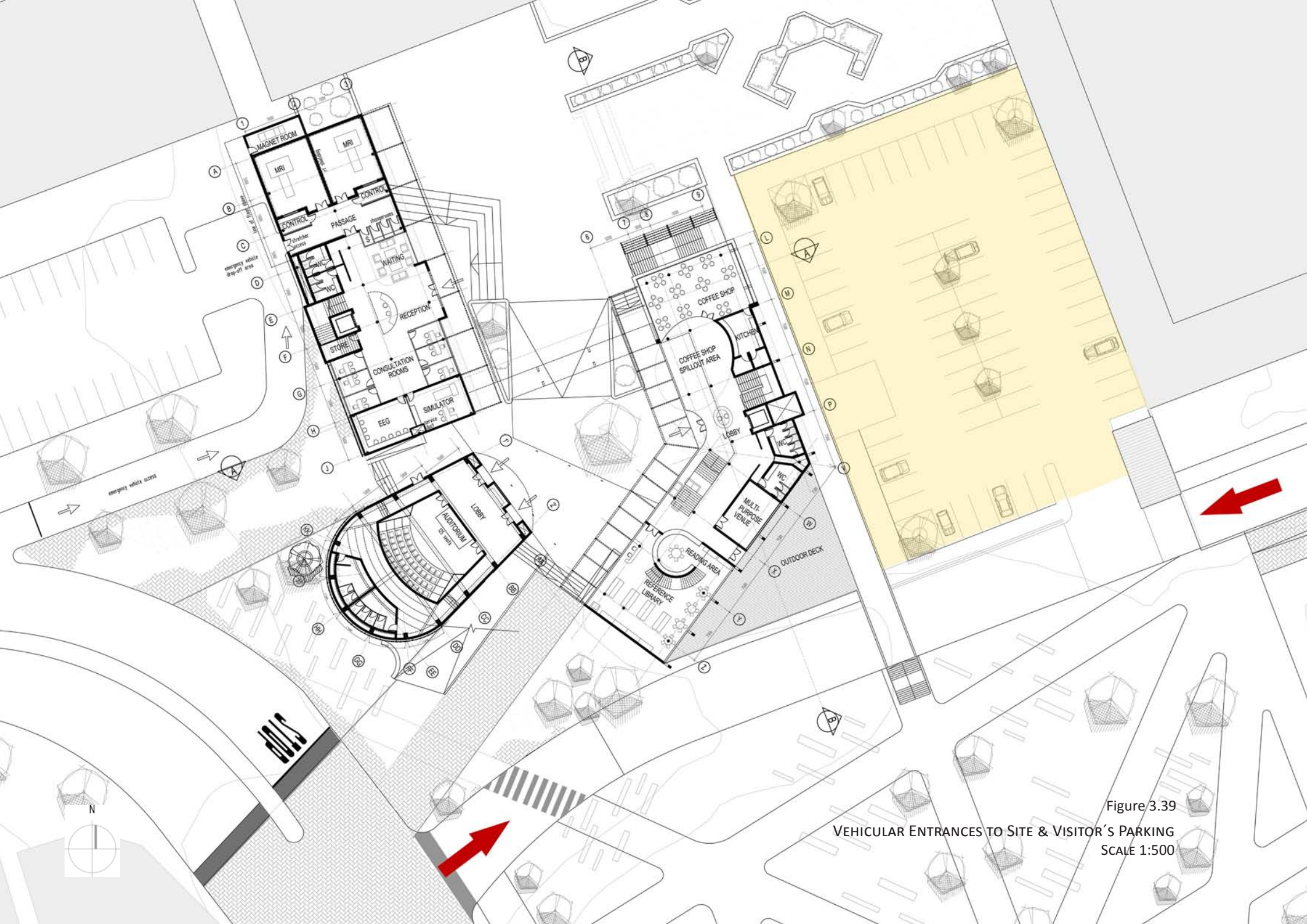


Figure 3.39

VEHICULAR ENTRANCES TO SITE & VISITOR´S PARKING

SCALE 1:500



Figure 3.40
Approach from Visitor´s Parking (Model)



Figure 3.41

View Towards the Buildings From the Visitor´s Parking



Figure 3.42

Lower Ground Floor Plan (Laboratories)
Scale 1:500



Figure 3.43

View of Central Courtyard Space (Model)

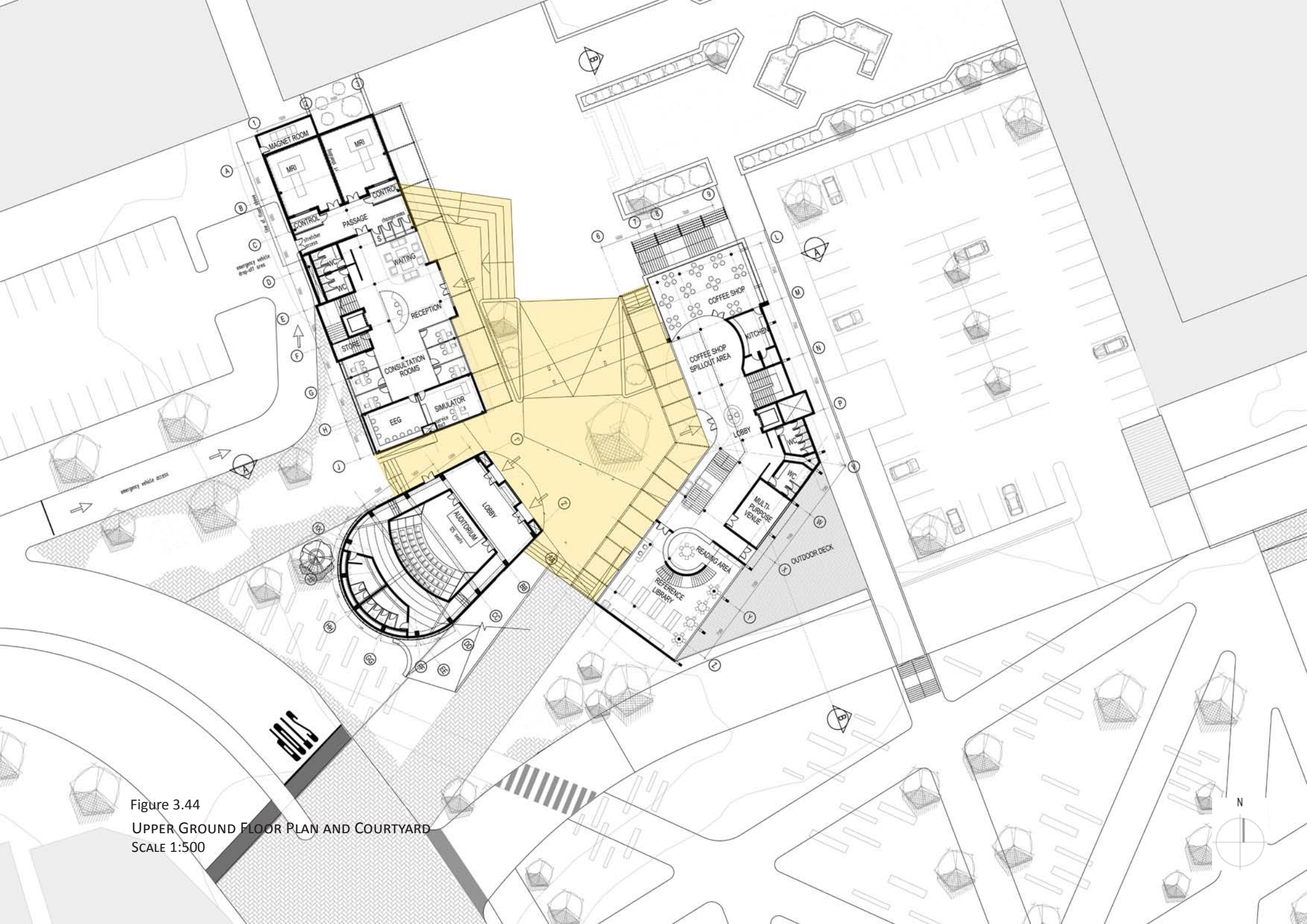


Figure 3.44
Upper Ground Floor Plan and Courtyard
Scale 1:500



Figure 3.45

View of Central Courtyard Space Looking North



Figure 3.46
View of central Courtyard Looking Towards the Main Building

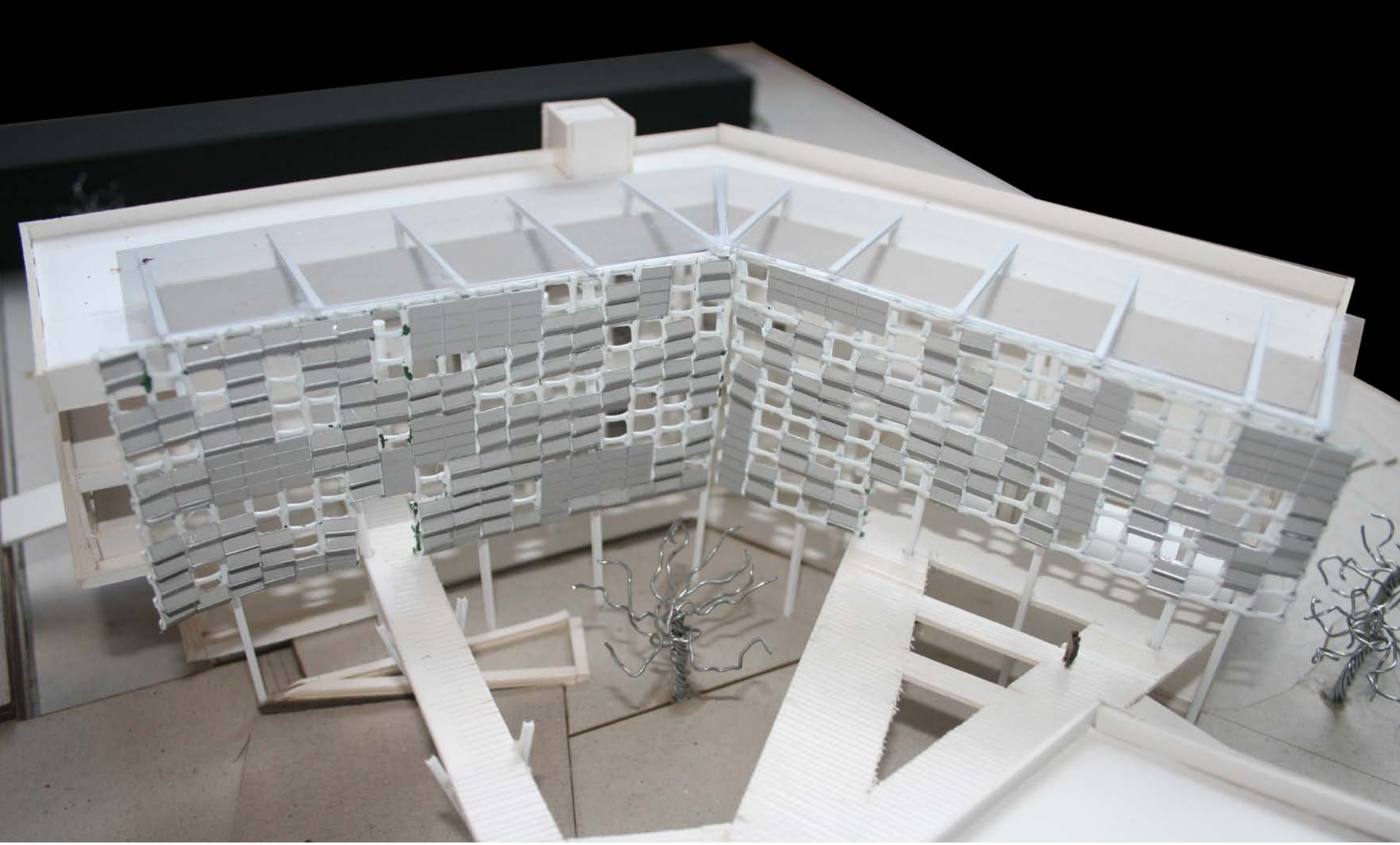


Figure 3.47

View of Main Building from West (Model)



Figure 3.48
Ground Floor Plan (Main Building)
Scale 1:500

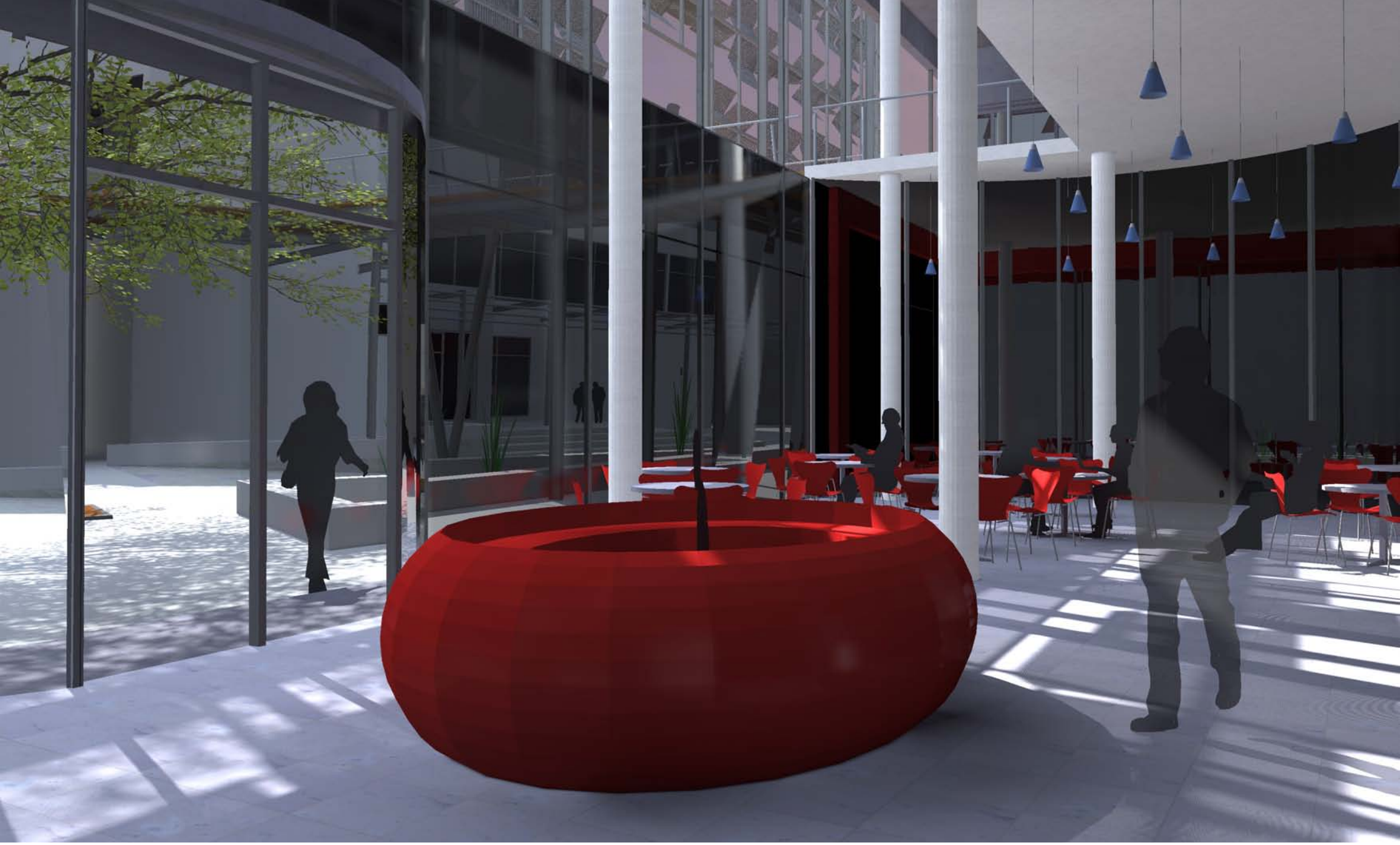


Figure 3.49

View of Main Reception



Figure 3.50
VIEW OF COFFEE SHOP



Figure 3.51

First Floor Plan (Main Building)

Scale 1:500



Figure 3.52
SECOND FLOOR PLAN (MAIN BUILDING)
SCALE 1:500



Figure 3.53

View from First Floor Deck Linking the Main Building to the Imaging Building

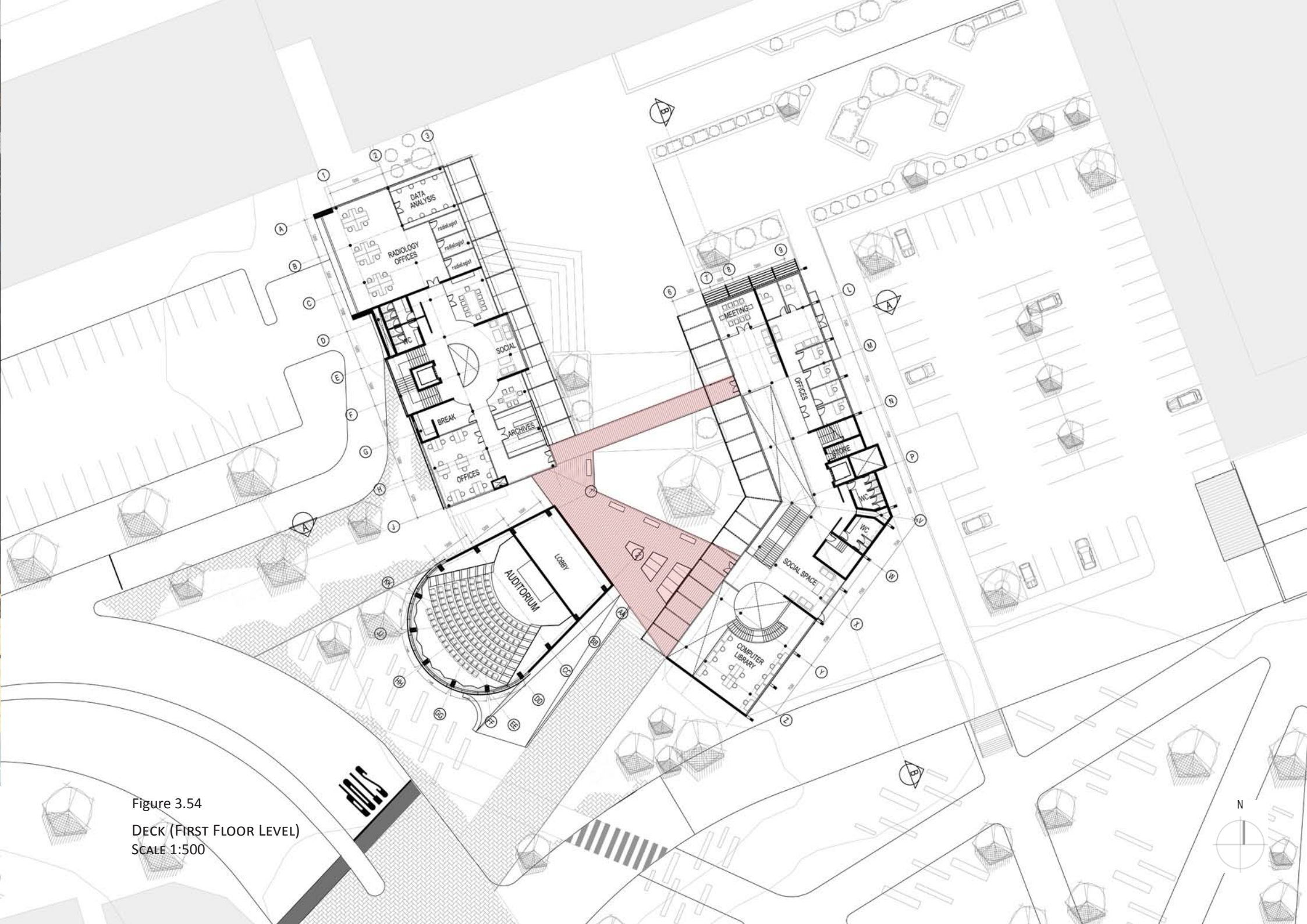


Figure 3.54

DECK (FIRST FLOOR LEVEL)
SCALE 1:500

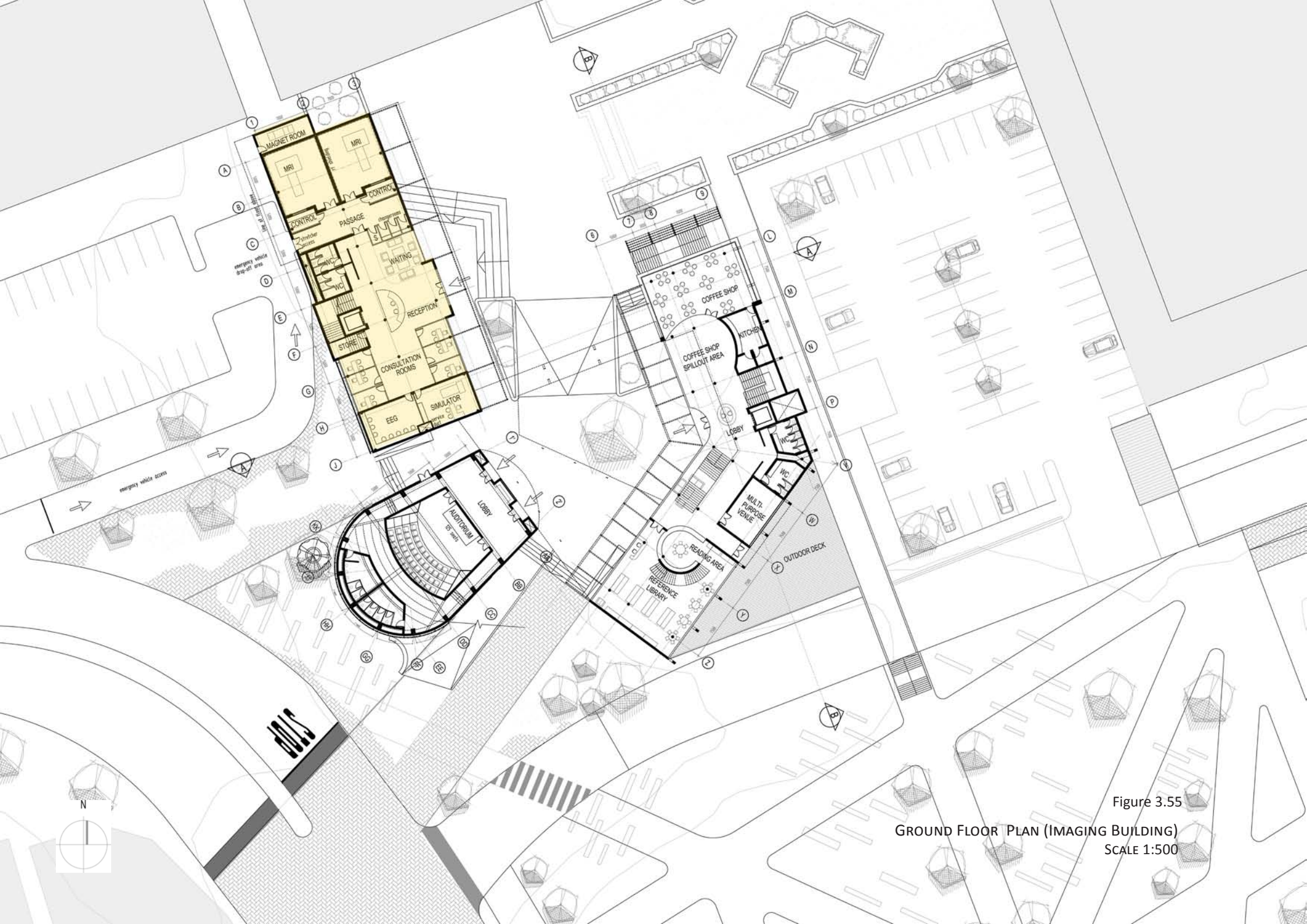


Figure 3.55

GROUND FLOOR PLAN (IMAGING BUILDING)
SCALE 1:500



Figure 3.56

View of Imaging Reception



Figure 3.57

FIRST FLOOR PLAN (IMAGING BUILDING)
SCALE 1:500



Figure 3.58

VIEW OF SITE FROM WEST (MODEL)



Figure 3.59

Ground Floor Plan (Auditorium)

Scale 1:500

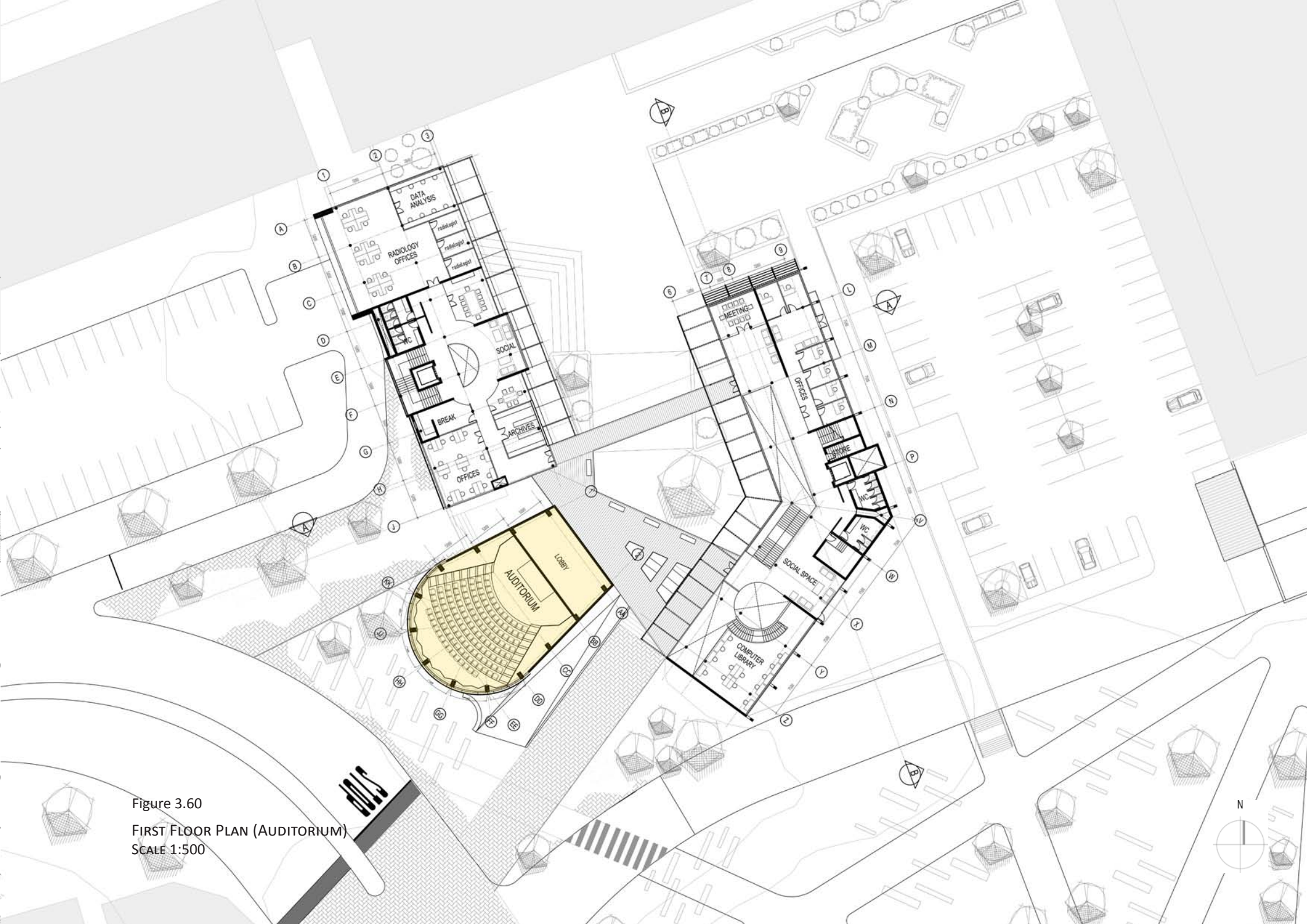
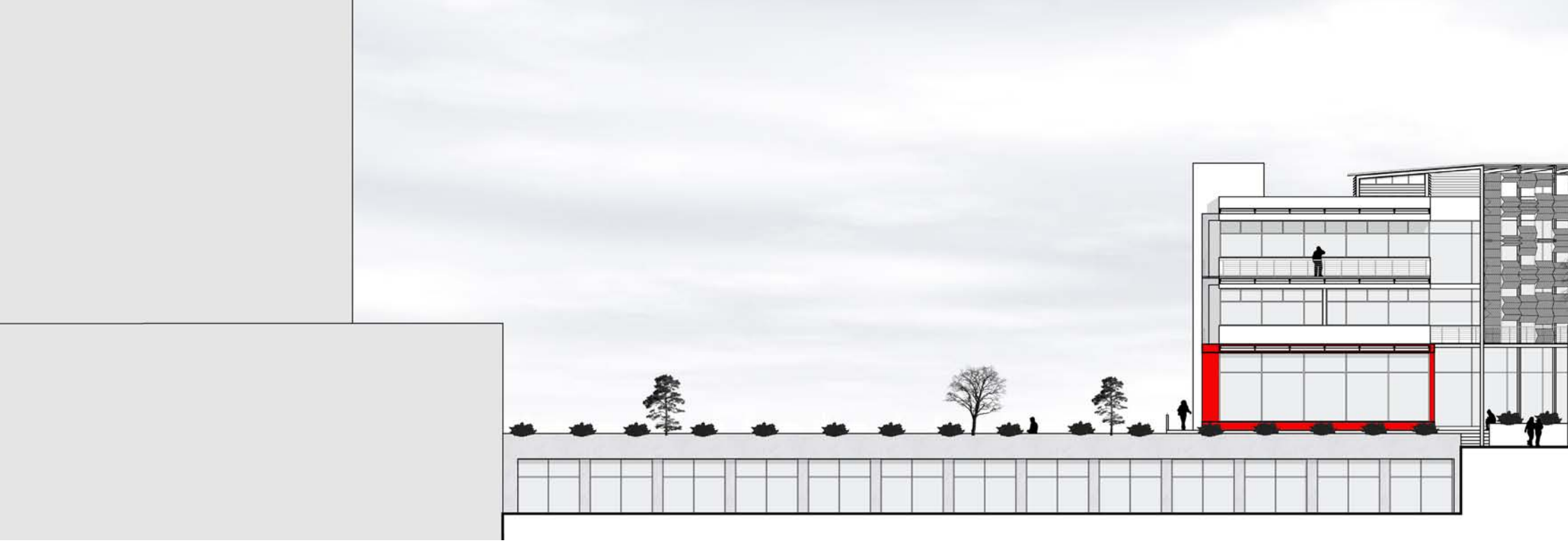
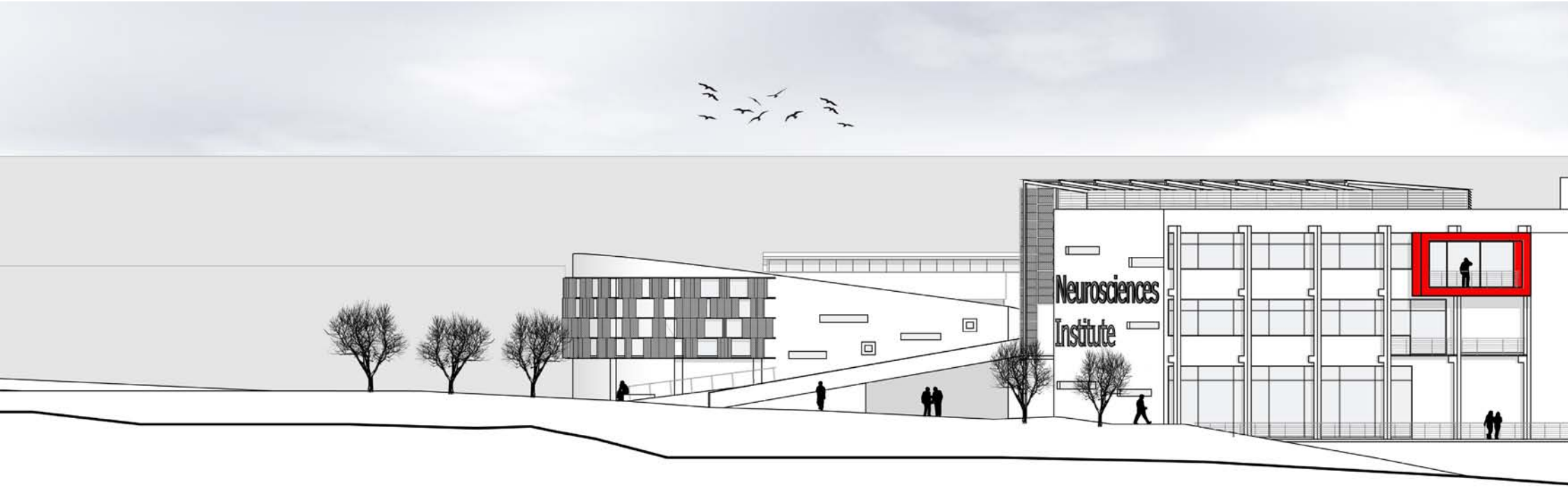


Figure 3.60

First Floor Plan (Auditorium)
Scale 1:500




Neurosciences
Institute

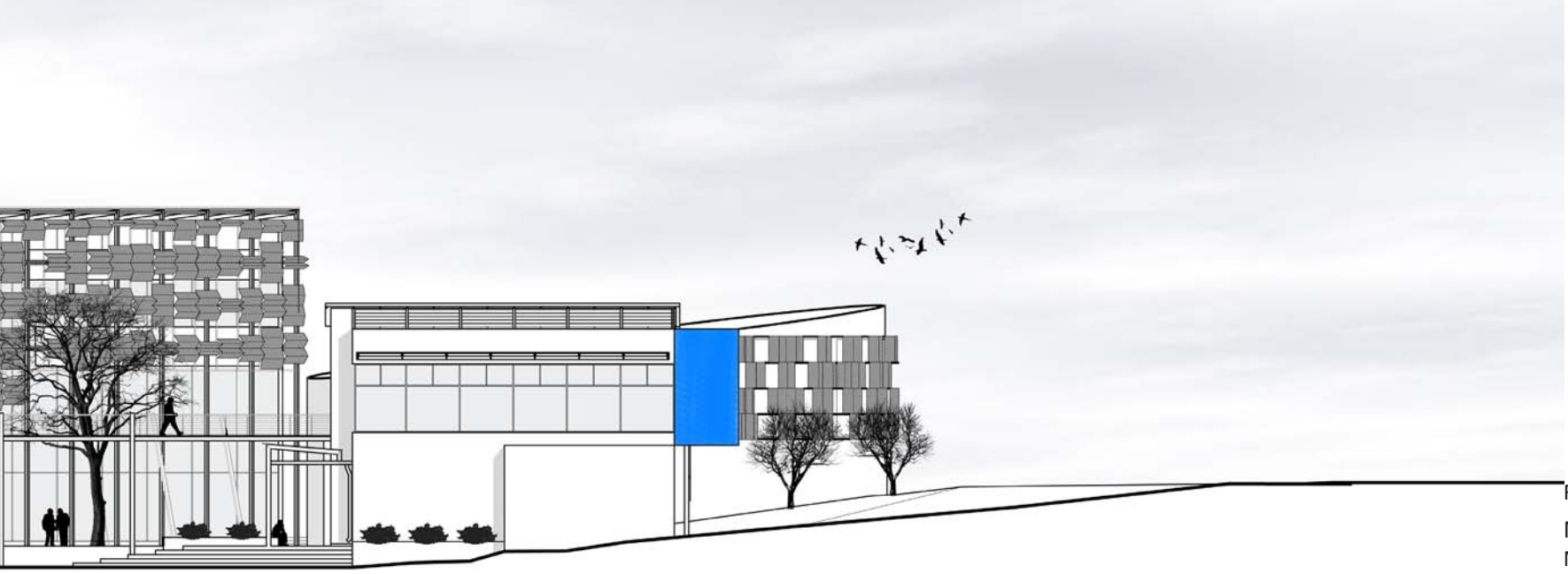
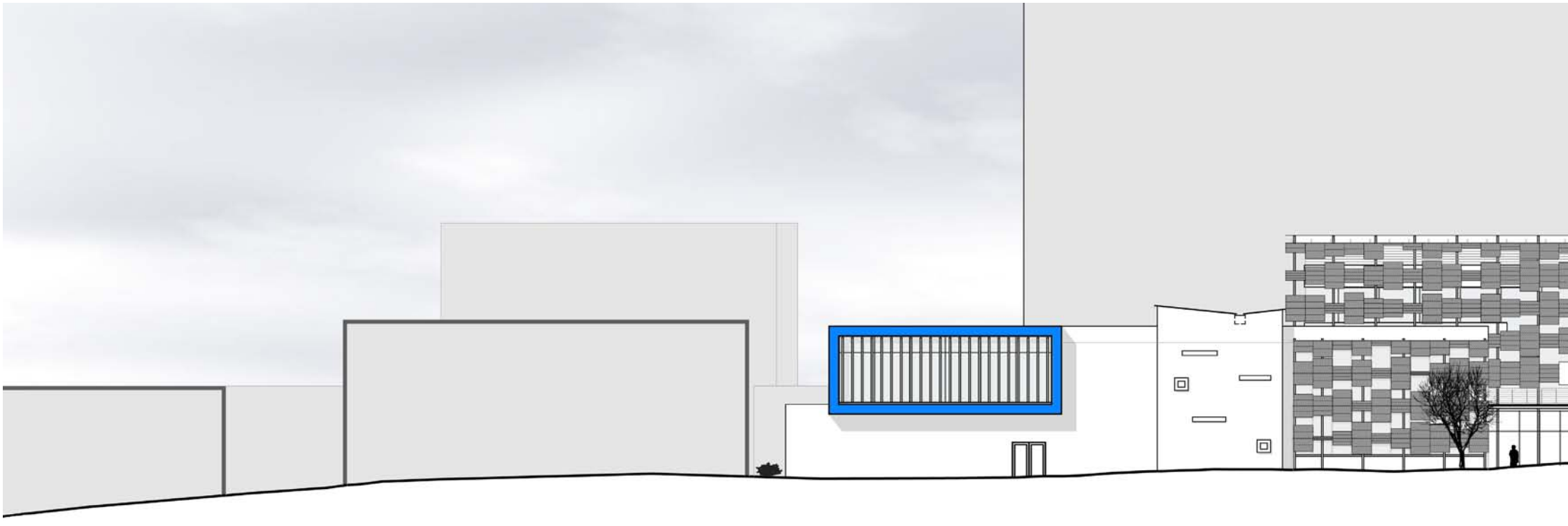


Figure 3.61
NORTH ELEVATION
NOT TO SCALE



Figure 3.62
SOUTH ELEVATION
NOT TO SCALE





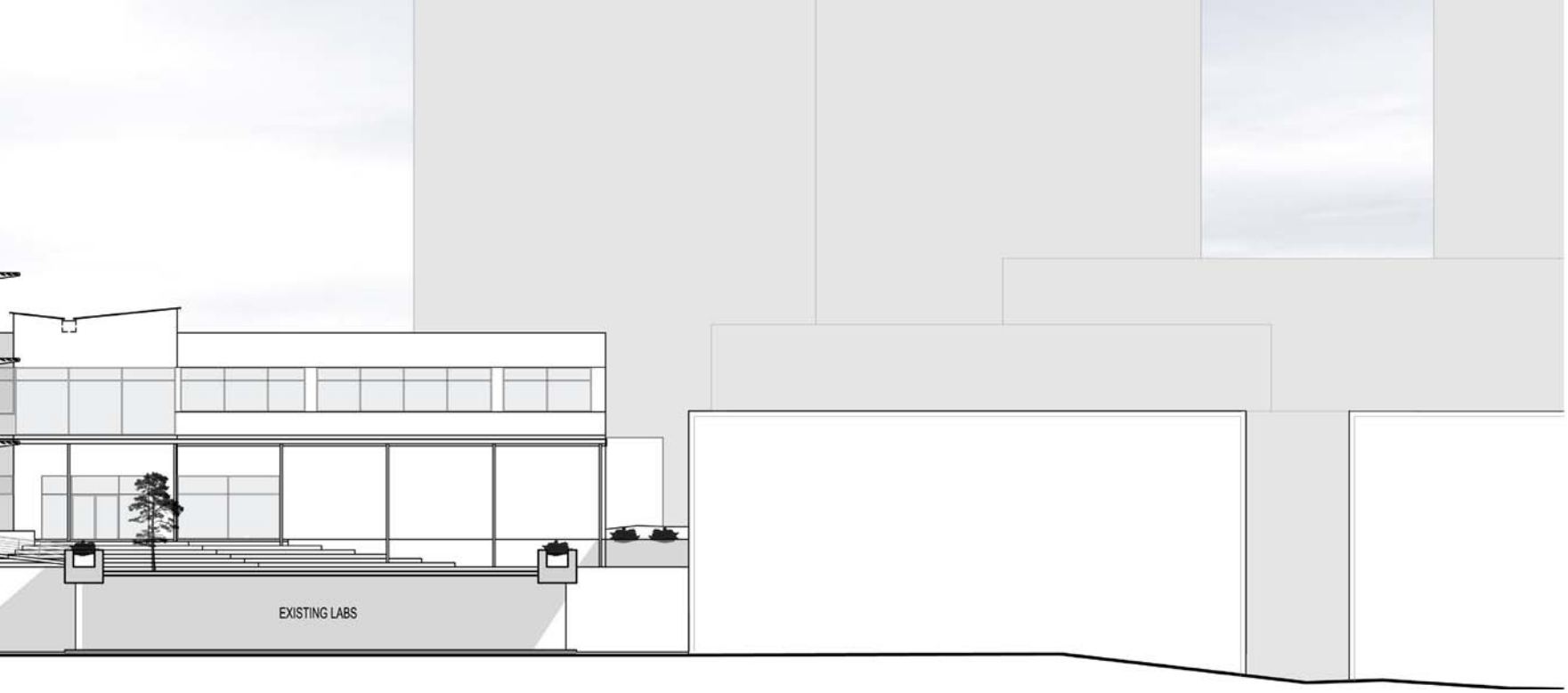


Figure 3.63
EAST ELEVATION
NOT TO SCALE

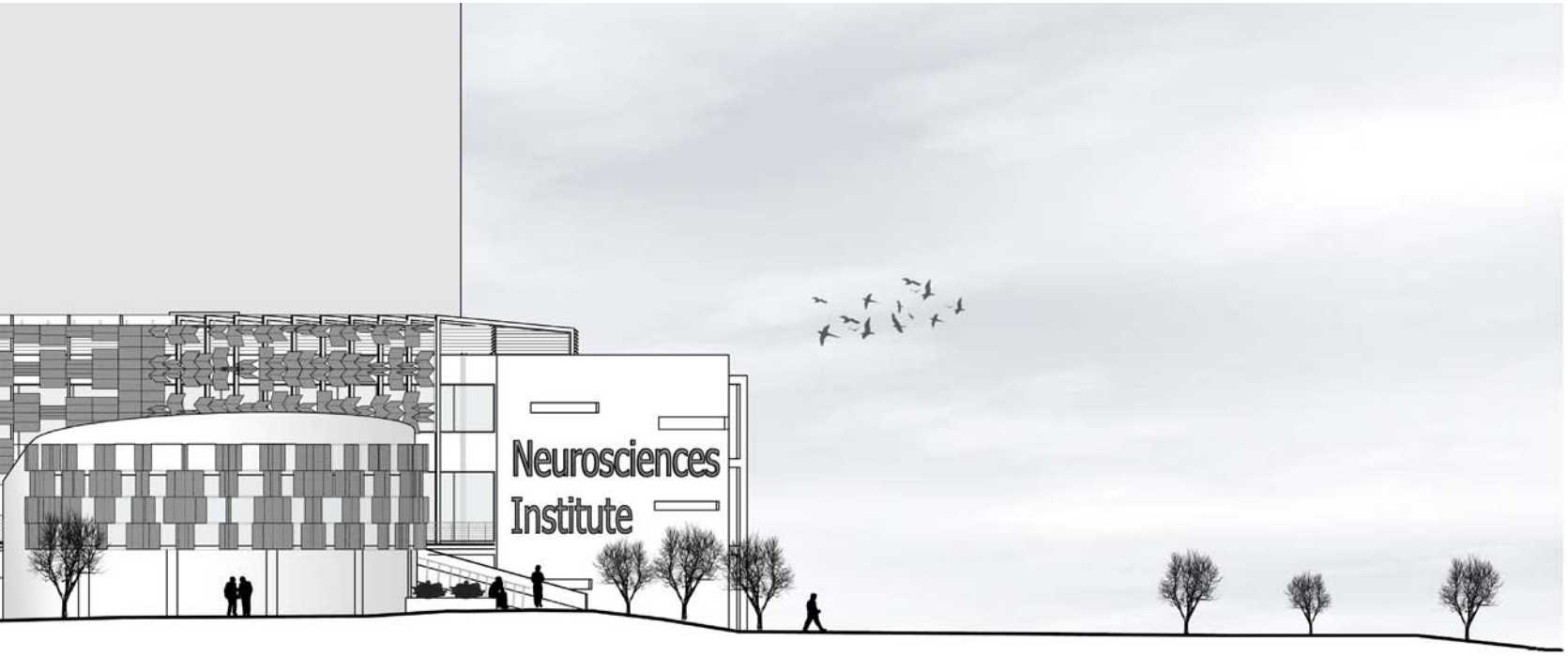
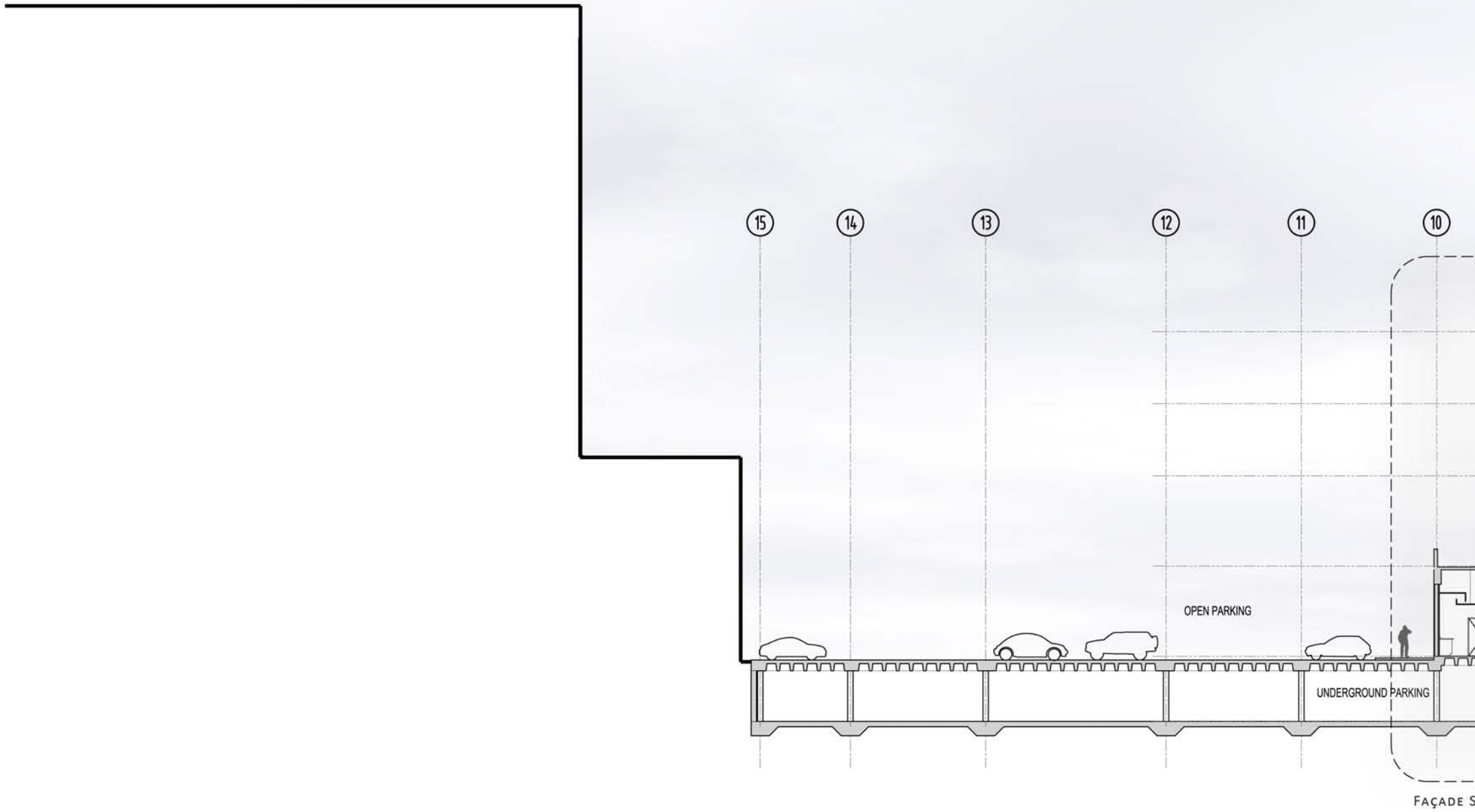


Figure 3.64
WEST ELEVATION
NOT TO SCALE


15
14
13
12
11
10
OPEN PARKING
UNDERGROUND PARKING
FAÇADE S

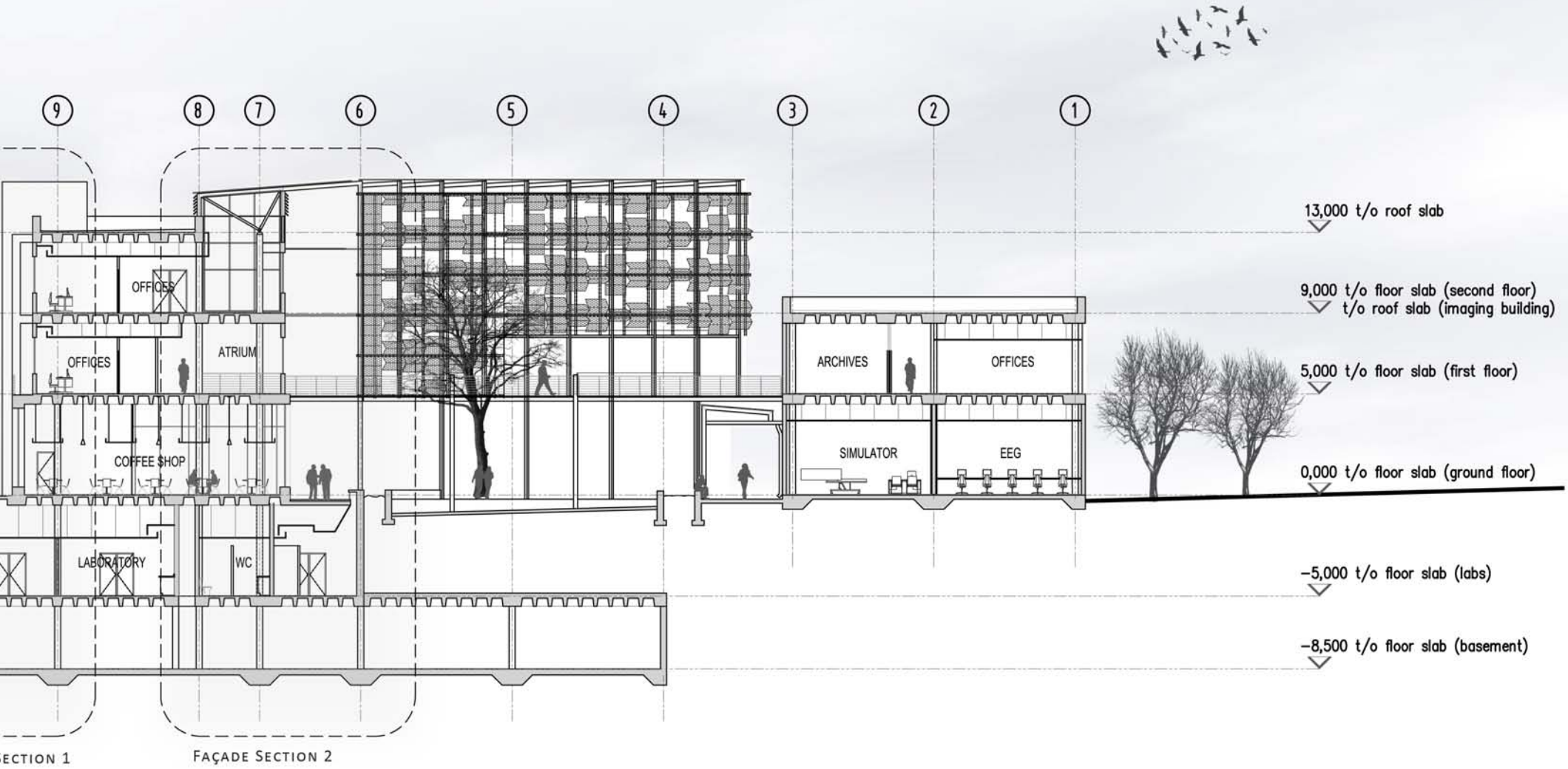


Figure 3.65
SECTION A-A
NOT TO SCALE


K
L
M
RESEARCHERS OFFICES
MEETING ROOM
PASSAGE
COFFEE SHOP
EXISTING WALKWAY
MICROSCOPY
LABORATORY
UNDERGROUND PARKING
LIFT LOB

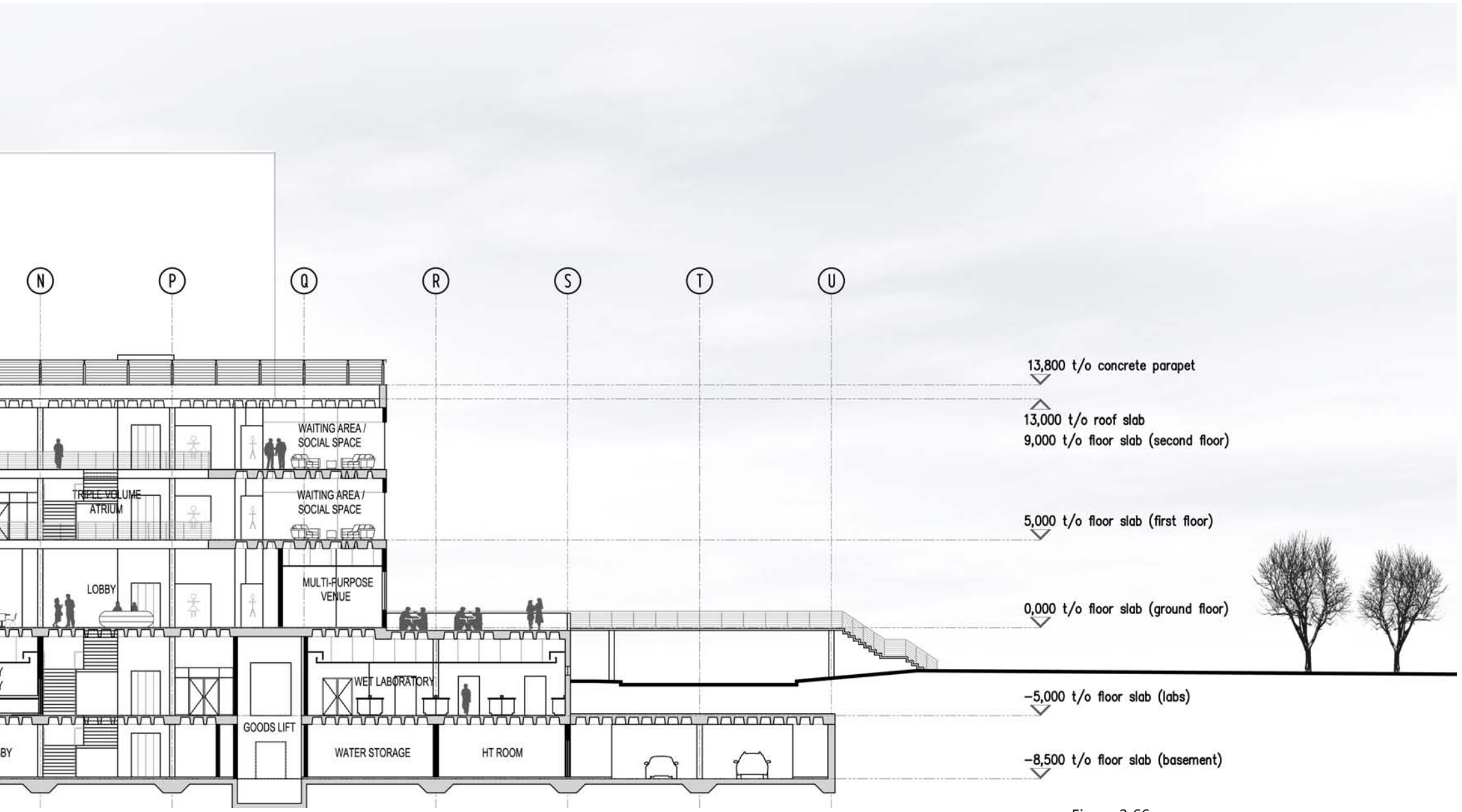


Figure 3.66
SECTION B-B
NOT TO SCALE

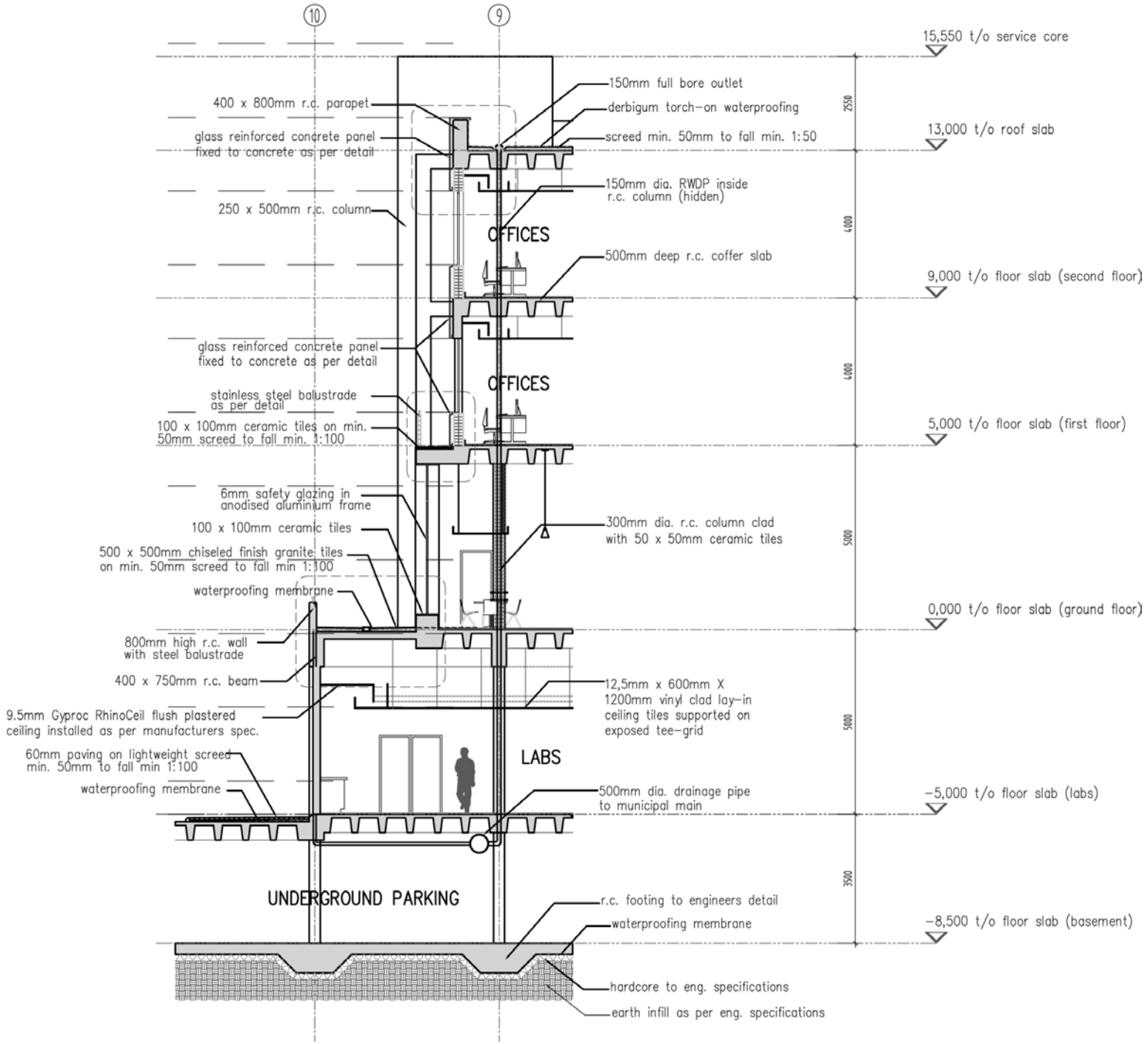


Figure 3.67

SECTION THROUGH EAST FAÇADE
NOT TO SCALE

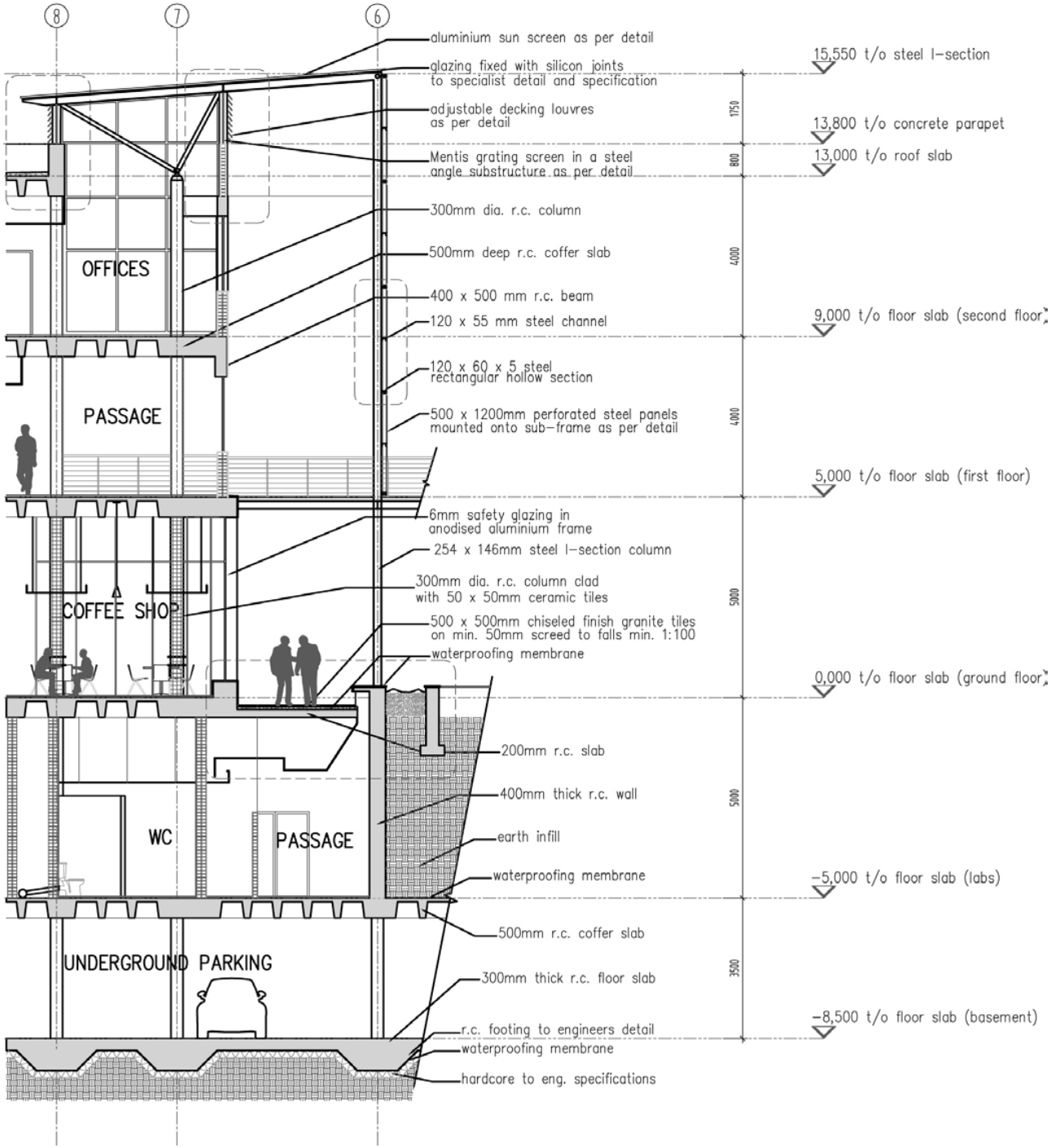


Figure 3.68

SECTION THROUGH WEST FAÇADE
NOT TO SCALE

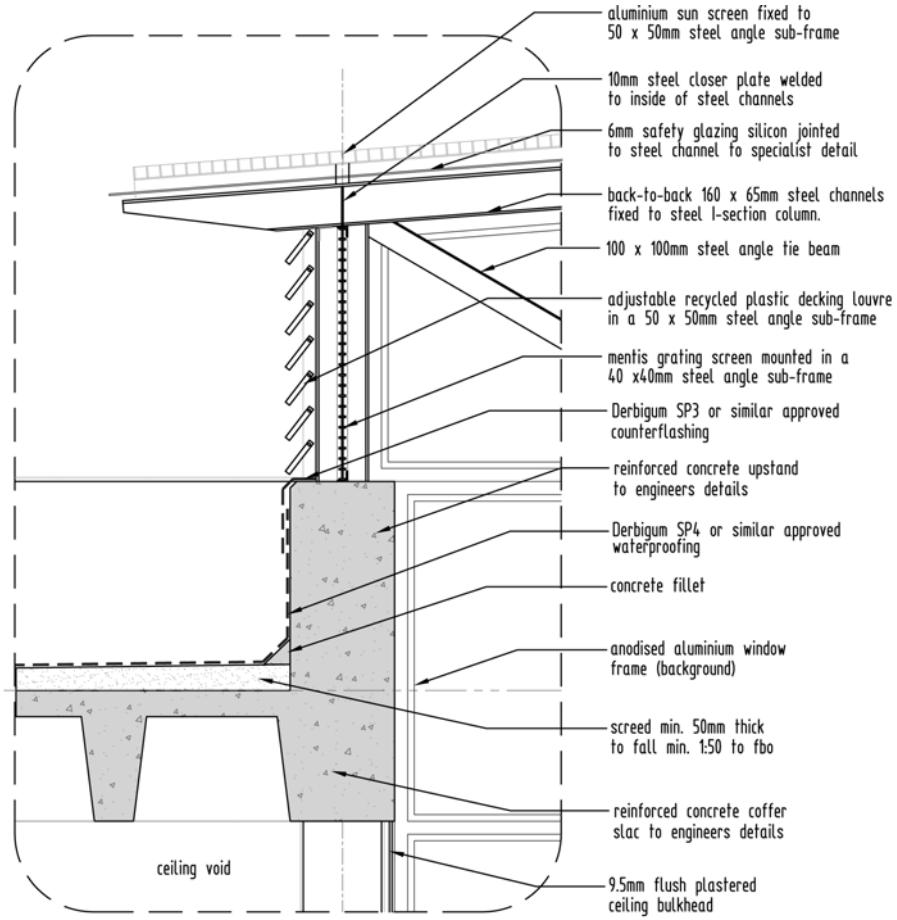


Figure 3.69

Parapet Detail (West Façade)

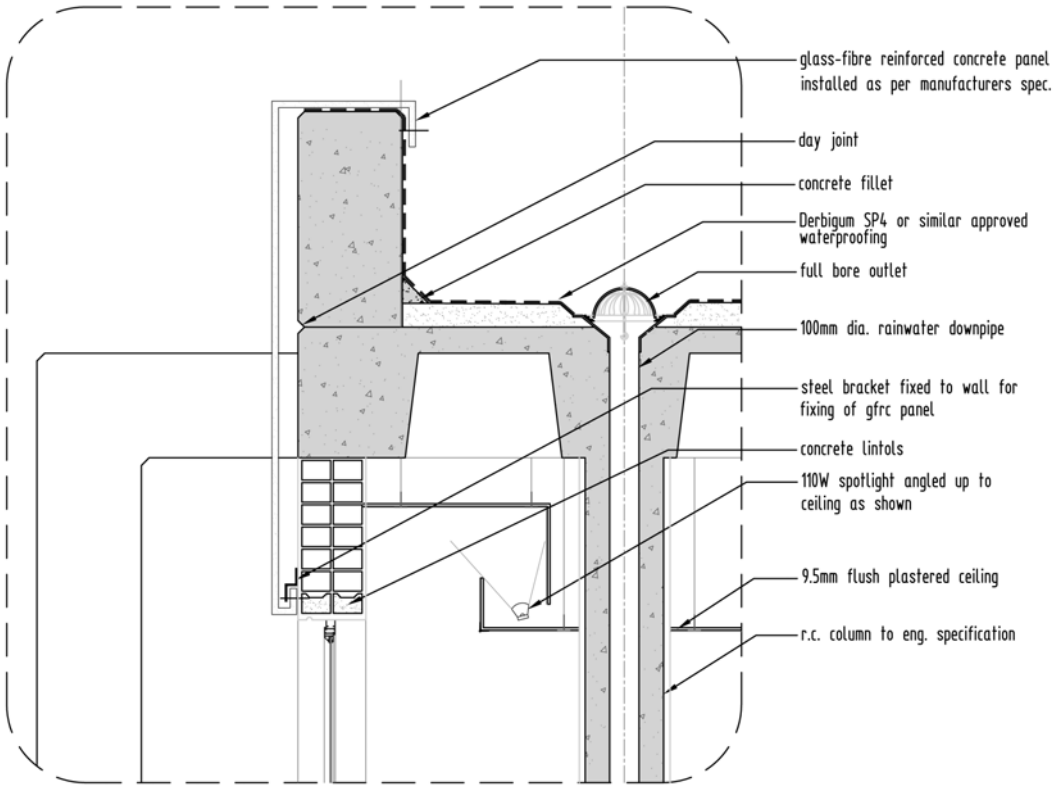


Figure 3.70

Parapet Detail (East Façade)

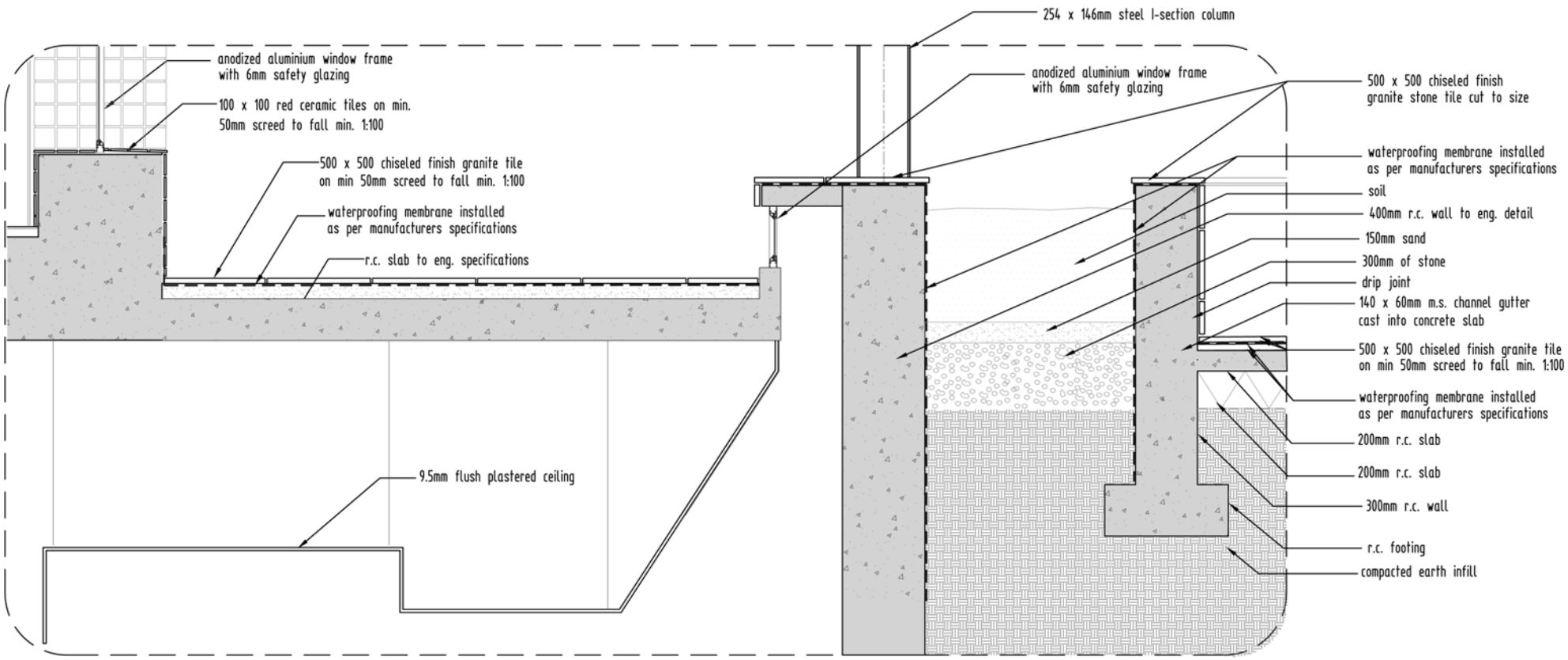


Figure 3.71

Walkway and Planter Detail (West Façade)

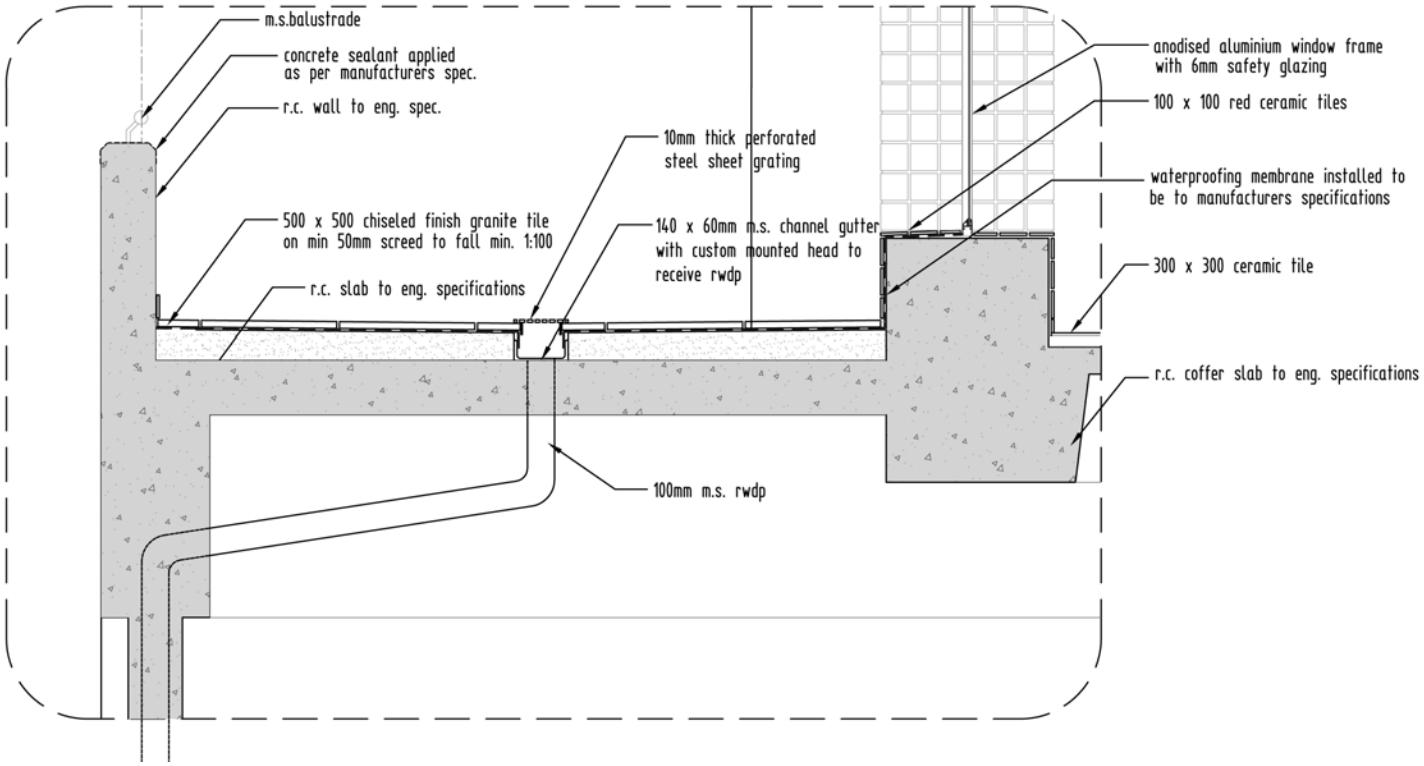


Figure 3.72

Walkway Detail (East Façade)

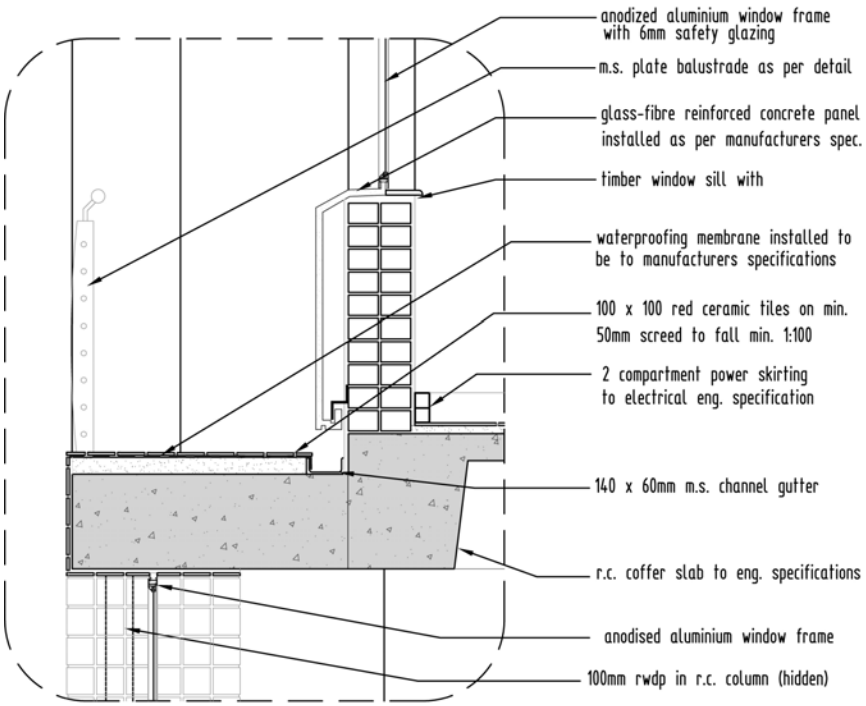
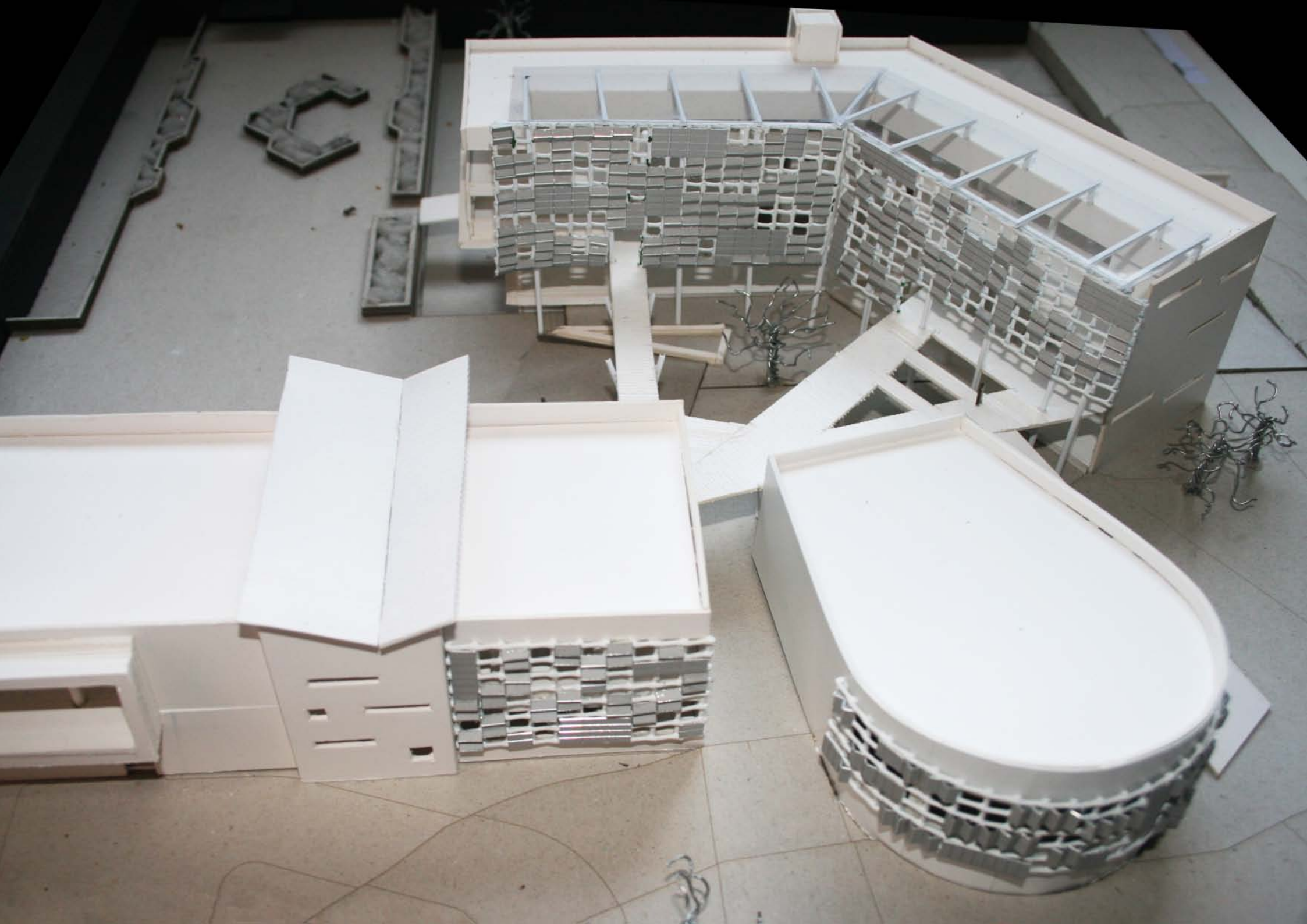
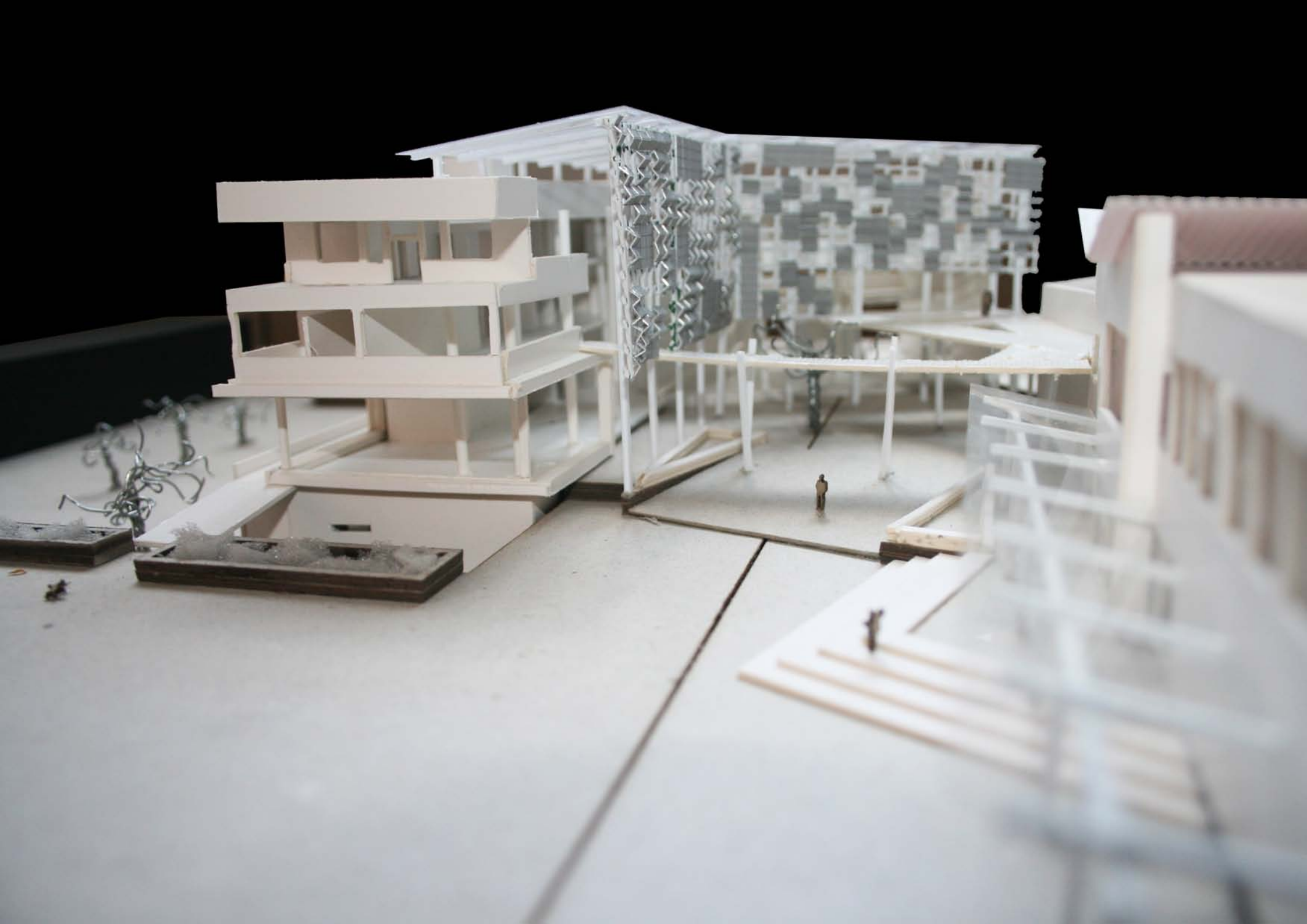
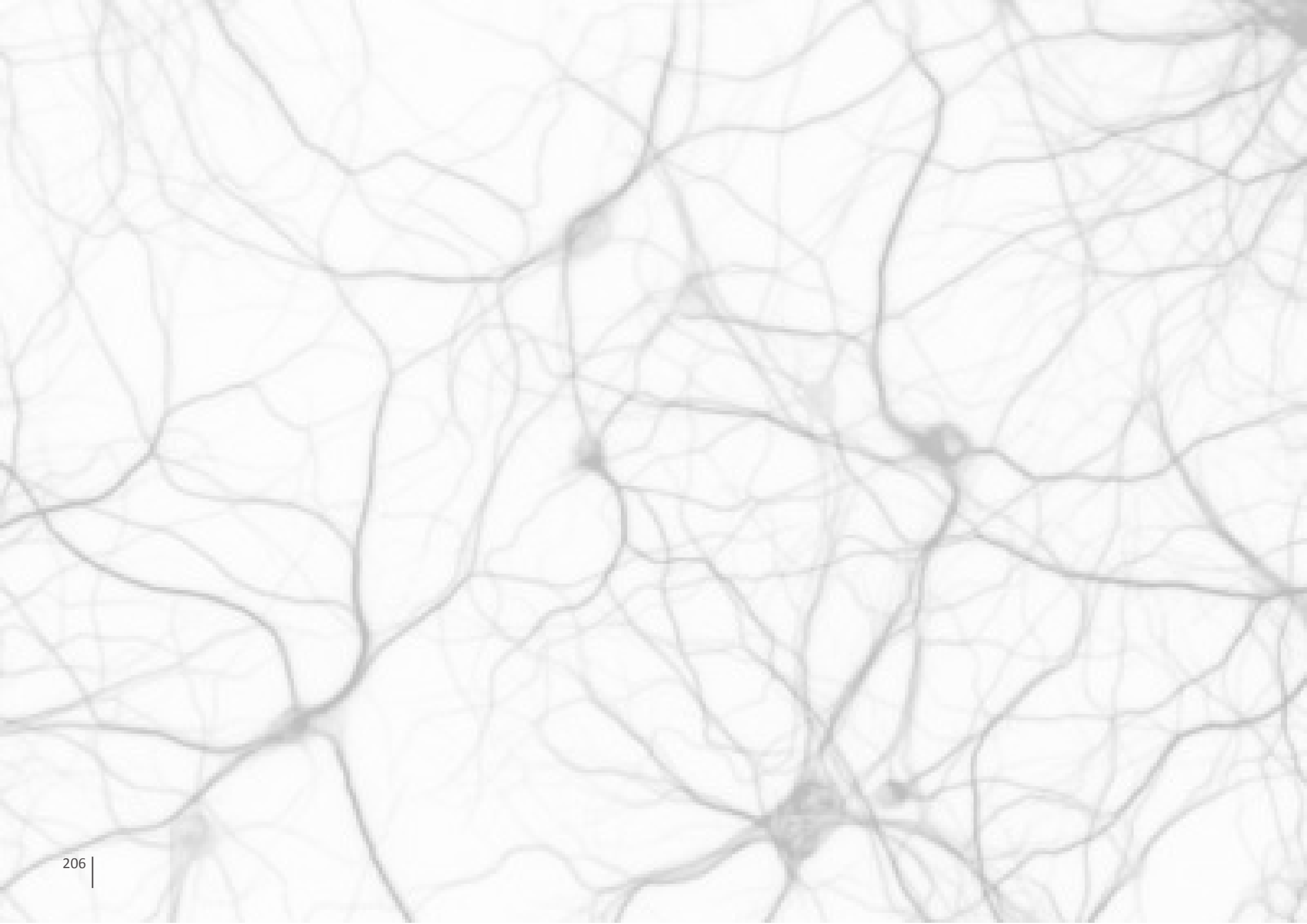


Figure 3.73

Balcony Detail (East Façade)







All unreferenced photographs and graphic work by Mariana Lamas

An architectural dissertation by Mariana Lamas
M.Arch(Prof.)
University of the Witwatersrand,
Johannesburg,
South Africa