ARCHITECTURE TO ENHANCE MEDICAL RESEARCH INNOVATION:

A Proposed Cancer Research Institute for Richards Bay.

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DECLARATION

This dissertation is a presentation of my own original work. Where contributions of others are involved, every effort is made to acknowledge this clearly, with due reference to the literature, all citations and discussions. This dissertation is being submitted to the College of Humanities, School of Built Environment and Development Studies at the University of KwaZulu-Natal, Durban, South Africa in fulfilment of the requirements towards the degree of Master of Architecture in the Graduate Programme in Architecture, University of KwaZulu-Natal, Durban, South Africa. This dissertation has not been previously submitted for any examination or degree at any university.

Signed:

Lenisha Pillay

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DEDICATION

To my Family

For your unwavering,

Love, Support, Encouragement and Belief in me.

Words do not do justice to express how eternally grateful I am for everything.

ABSTRACT

The focal point of the research of Architecture and Innovation, in the field of Medical Research, is based primarily on how architecture and the way we design spaces affect our productivity as human beings. The research of data available, can help to improve and enhance the process of innovation in the research environment. The literature explored is underpinned by both educational and architectural theories, that provide a means and a method that can be implored in order to improve the way we design spaces. This focuses on how architecture can improve the experience of the individual, creating an environment more conducive to better interaction, collaboration and engagement in a shared learning process. This would then substantially improve the morale of individuals within the space, creating a more cohesive unit, ultimately improving productivity.

The research problem essentially stems from the idea of architecture and the built environment. It focuses on the effect architecture and the built environment possesses on the process of creativity and innovation and how, this is often disregarded. The key question is therefore: What is the relationship between architectural spatial design and an innovative working environment in the field of research?

The research methodology includes analysis of safety protocols, a comprehensive literature review that explores what is currently in existence, both abroad and in the form of case studies. The literature review examines the theoretical framework of phenomenology and social constructivism, while also paying attention to concepts such as: Liminal Space, The Watercooler Effect and Third Place. These key areas start to focus on learning as a social activity, and how architecture and the built environment can begin to support this.

Ultimately, the research presented informs the design for a cancer research institute where the process of innovation through enhancing the creative process, through architecture is at its core.

Key words: social constructivism, interaction, shared learning, natural environment, experience, innovation, medical research

TABLE OF CONTENTS

DECLARATION.....1

ACKNOWLEDGMENTS.....2

DEDICATION.....3

ABSTRACT.....4

CHAPTER 1: INTRODUCTION TO THE RESEARCH.....11

1.1 INTRODUCTION.....12

1.1.1 Background.....12

1.1.2 Motivation/Justification of the Study.....13

1.2 DEFINITION OF THE PROBLEM. AIMS AND OBJECTIVES.....14

1.2.1 Definition of the Problem.....14

1.2.2 Aims.....14

1.2.3 Objectives.....14

1.3 SETTING OUT THE SCOPE.....15

1.3.1 Delimitation of the Research Problem.....15

1.3.2 Definition of Terms.....15

1.3.3 Stating the Assumptions.....16

1.3.4 Key Questions.....17

1.3.5 Hypothesis.....17

1.4 CONCEPTS AND THEORIES.....18

1.5 RESEARCH METHODS AND MATERIALS.....20

1.6 CONCLUSION.....21

1.7 OUTLINE OF DISSERTATION.....22

CHAPTER 2: LITERATURE REVIEW 23

2.1 INTRODUCTION 24

2.2 ASSESSING THE FACTORS 25

2.2.1 Architectural Space 25

2.2.2 Innovation 26

2.2.3 Research 26

2.3 WHEN ARCHITECTURAL SPACE, INNOVATION AND RESEARCH MEET 29

2.3.1 How does architectural space affect innovation in research? 29

2.4 CONCLUSION 31

CHAPTER 3: THEORETICAL FRAMEWORK AND KEY CONCEPTS 33

3.1 INTRODUCTION 34

3.2 ALTERNATIVE TEACHING AND LEARNING METHODS 36

3.2.1 Social Constructivism 36

3.2.2 Liminal Space 39

3.2.3 Third Place 42

3.2.4 The Water Cooler Effect 44

3.3 CONCLUSION 46

CHAPTER 4: TECHNICAL CONSIDERATIONS 47

4.1 INTRODUCTION 48

4.2 COLLABORATION 48

4.3 SPATIAL PLANNING 49

4.3.1 Human comfort and habitation 49

4.3.2 Work Spaces 49

4.3.3 Types of Laboratories 50

4.4 SERVICES 51
4.4.1 General 51
4.4.2 Typical Distribution 51
4.4.3 Gas Supply 53
4.4.4 Water Supply 53
4.4.5 Fume Extraction 54
4.4.6 Laboratory Waste 54
4.4.7 Workbenches 55
4.4.8 Ventilation 55
4.4.9 Hazardous Materials 56
4.4.10 Fire Systems 56
4.4.11 Plant Rooms 56
4.5 SAFETY 57
4.5.1 General 57
4.5.2 Safety Equipment 57
4.5.3 Safety Precautions and Planning 57
4.6 LIGHTING 58
4.6.1 Requirements 58
4.6.2 Natural Day-Lighting 58
4.6.3 Colour Considerations 58
4.7 FINISHES 59
4.8 STORAGE 60
4.9 BIOSAFETY LABORATORIES 60
4.10 CONCLUSION 61

CHAPTER 5: KEY PRECEDENT STUDY 62

5.1 INTRODUCTION 63

5.2 SALK INSTITUTE 63

5.2.1 Project Description 63

5.2.2 Justification of Precedent Study 63

5.2.3 Location 64

5.2.4 Layout and Spatial Planning 66

5.2.5 Spaces for Innovation 67

5.2.6 Service Approach 68

5.2.7 Conclusion 68

5.3 LOWY CANCER RESEARCH CENTRE 69

5.3.1 Project Description 69

5.3.2 Justification of Precedent Study 70

5.3.3 Location 70

5.3.4 Layout and Spatial Planning 71

5.3.5 Spaces for Innovation 73

5.3.6 Service Approach 74

5.3.7 Conclusion 75

5.4 DROPBOX HEADQUARTERS 76

5.4.1 Project Description 76

5.4.2 Justification of Precedent Study 76

5.4.3 Location 77

5.4.4 Layout and Spatial Planning 78

5.4.5 Spaces for Innovation 79

5.4.6 Service Approach 80

5.4.7 Conclusion 81

CHAPTER 6: CASE STUDIES 82

6.1 INTRODUCTION 83

6.2 K -RITH TOWER BUILDING 83

6.2.1 Introduction 83

6.2.2 Justification of the Case Study 84

6.2.3 Location and Background 85

6.2.4 Interviews and Observations 86

6.2.5 Interview: Bryan Mcmaster – Building Manager at K-RITH 91

6.2.6 Conclusion 94

6.3 ESPRESSO 95

6.3.1 Introduction 95

6.3.2 Justification of the Case Study 95

6.3.3 Location and Background 96

6.3.4 Interviews and Observations 96

6.3.5 Interview: Antony Ellis – Espresso 99

6.3.6 Conclusion 101

6.4 CONCLUSION 101

CHAPTER 7: SUMMARY OF THE STUDY, ANALYSIS AND FINDINGS 102

7.1 IDENTIFYING THE CHALLENGES 103

7.1.1 Limitations of the Data 103

7.1.2 Key Concerns 103

7.2 ANALYSIS OF CASE STUDIES **104**

7.3 FINDINGS **107**

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS.....109

8.1 ACHIEVING THE AIMS AND OBJECTIVES.....110

8.2 CONCLUSION TO THE RESEARCH.....111

8.3 RECOMMENDATIONS FOR A DESIGN PROPOSAL.....112

Appendix A: Biosafety Level 1 and 2.....120

Appendix B: Biosafety Level 3.....125

PART TWO: DESIGN REPORT

CHAPTER 1: INTRODUCTION TO THE RESEARCH

1.1 INTRODUCTION

1.1.1 Background

Architecture has for a long time, fostered multiple creative spaces, dating back a number of years and to locations such as the ancient Greek Agora, British teahouses and Parisian cafés, to name a few. These are spaces in which people would congregate and engage in conversation. This interaction between people, the exchange of ideas and thoughts, coming from both unique and diverse people is what one may label, “collaboration”.

According to Strategos (2018), innovation is a social process, one that is more likely to result from group discussions, rather than from independent study. In a sense, innovation is the resultant of creative collaboration between people and the sparks created through the friction of interaction.

Currently, many research institutes are in existence. Many work quite efficiently in order to create many innovative ideas and solutions and some do not. Taking cognisance of the past, one can make the assumption that, an architecture that begins to foster human interaction and collaboration through environments that spark discussion and new ideas, could potentially begin to inspire research innovation that our world is in dire need of, given the many pandemics we face today. Therefore, the focus of this study is to hone in on these spaces and produce an appropriate architectural response.

1.1.2 Motivation/Justification of the Study

As a country, South Africa, lacks research institutes that have been architecturally designed with the intention of promoting and enhancing medical research innovation. As a result, the mortality rates of non-communicable diseases are rising steadily with no intention of stopping if nothing is done about it.

According to Goldstein (2006), in the medical research environment, it is outside of the laboratory space, where chance encounters occur and spaces shared, that moments of clarity and insight occur.

Therefore, an architecture that begins to keep this in mind and fosters human interaction and an incubator of knowledge, could begin to possibly further, improve and innovate medical research in South Africa. The study is therefore motivated by the need to know how architecture can be improved on to stimulate creative and innovative environments.

1.2 DEFINITION OF THE PROBLEM. AIMS AND OBJECTIVES

1.2.1 Definition of the Problem

Innovation is an entity that is well sought after. However, in order to achieve it, a number of factors need to be considered. One of them being, architectural space and how it starts to affect the process of innovation or the lack thereof.

Looking at trends in developing countries, a large amount of focus and attention is being given to the development of innovation ecosystems, where major skills are utilized to develop communities and infrastructure that creates a conducive environment for innovation.

South Africa, in particular, is making headway with regards to innovation in the business and technology field, while trying to stay ahead of the curve of the impending fourth industrial revolution as per the SA Innovation Summit (Innovation Summit, 2018). However, South Africa lacks innovative medical research institutes that are dedicated to alleviating and possibly solving the pandemics of a variety of non-communicable diseases. It is because of this, that there is a dire need for innovation to occur in these fields. Architectural space that could promote creativity may just provide the platform to ignite the conversations needed to spark innovation.

1.2.2 Aims

The primary aim of this study is:

- To foster a creative and diverse built environment for research innovation.

1.2.3 Objectives

The objectives of this study are:

1. To create and design a built environment that promotes ease of communication and creativity.
2. To develop a research culture through architectural design in order to foster human friction and innovation.
3. To create dedicated spaces with the ability to transition and adapt with innovation in technology and people.
4. To design a built environment that improves the quality and quantity of innovation in research.

1.3 SETTING OUT THE SCOPE

1.3.1 Delimitation of the Research Problem

With regards to a topic such as this one, one of the many challenges that are faced is essentially the dominance of the functional requirements, as a research facility is a highly complex environment. This therefore poses the challenge of how to balance the functional requirements, taking cognisance of the fact that the institute is still an environment in which people work and interact with one another.

A design needs to facilitate the entire research process, from conceptualisation of a research idea through to publication of results at the conclusion of a research program. This needs to take cognisance of the fact that the laboratory is merely the place in which ideas are tested. Ideas are conceived when both formal and informal, inter- and multi-disciplinary interaction takes place. (Seitter:2007)

The design process will be conducted with this in mind. However, the temptation remains to design for the initial users of the building, therefore to take into consideration the ever-changing nature of technology and research programs and how the building can start to address these future needs is a daunting task, if not virtually impossible. It is therefore of utmost importance to determine the most appropriate service and program strategy.

1.3.2 Definition of Terms

Cancer: An abnormal growth of cells which tend to proliferate in an uncontrolled way and, in some cases, to metastasize.

Research: The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.

Institute: An organization having a particular purpose, especially one that is involved with science, education, or a specific profession.

Research Institute: A research institute or research centre is an establishment founded for doing research.

Social Interaction: A social interaction is an exchange between two or more individuals and is a building block of society.

Collaboration: The situation of two or more people working together to create or achieve the same thing.

Innovation: Innovation can be defined as a process that involves multiple activities to uncover new ways to do things. It should not be confused with creation since this can be defined as the act of making, inventing, or producing something. However, new innovations can be realized with creativity.

Creativity: The use of imagination or original ideas to create something; inventiveness.

Flexibility: The ability to be easily modified.

Advancement in technology: Scientific or technological advancement is the generation of information or the discovery of knowledge that advances the understanding of scientific relations or technology.

1.3.3 Stating the Assumptions

The assumption is therefore that the quality and quantity of research can be improved, by encouraging creativity and innovation, through collaboration and interaction between people and the built environment. Thus supporting and promoting innovation in research, improving the efficiency and effectiveness of cancer management and essentially improving the quality of life of individuals with cancer or possibly preventing the occurrence of it.

1.3.4 Key Questions

Primary:

- What is the relationship between architectural spatial design and an innovative working environment in the field of research?

Secondary:

1. How can the quality and quantity of innovation in research be improved by the built environment?
2. In what way can the built environment encourage creativity and interaction between researchers?
3. What is perceived as a spatial barrier between easy collaboration and not easy collaboration between researchers and how can this be improved by the built environment?
4. How important is the presence of transition spaces?
5. How important is the need to maintain a connection with outdoor spaces?

1.3.5 Hypothesis

The hypothesis for the purpose of this research document is that environments that facilitate social interaction and collaboration will ultimately result in an enhanced creative process and thus innovation will occur. In conjunction to this, it is hypothesized that an appropriate service and program strategy that indulges in flexibility is crucial to immediate and long-term success.

1.4 CONCEPTS AND THEORIES

Architecture has for a long time, fostered multiple creative spaces. These are spaces in which people would congregate and engage in conversation. This tells us that how people behave, interact with each other and a space is of vital importance. Therefore, this led to the architectural paradigm of phenomenology, in particular the theme of place, being researched and implored in this study. Furthermore, the concepts and theories that are also looked at includes: The Water Cooler Concept, Social Constructivism, Liminal Space and Third Place.

Phenomenology

According to Nesbitt (1996) this paradigm essentially speaks to both the body's interaction with the environment as well as the mind. It speaks to how the visual, tactile, olfactory and aural senses become an integral component in the perception and reception of a human being and architecture. This determines how a person receives and perceives an environment both physically and mentally, be it consciously or subconsciously.

Place

Nesbitt (1996) who looks at work by academics and architects such as Norberg-Schulz, Heidegger and Tando Ando to name a few, states that many theories of place speak to the spatial experience, the idea of the "**Genius Loci**" or what is also known as the unique spirit of the place. Ultimately, this refers to the relationship between man, architecture and nature and whether a space encourages man to interact, engage, embrace and feel at home.

Water Cooler Concept

According to Schaeffer (2014), workspace design has been an enabling factor in innovation. This indicates that the design of physical workspace can be used as a means of bringing people together to enhance innovation. One such method is the, **"water cooler concept"**, whereby the water cooler or similar entity becomes a point for informal conversation or informal transfer of knowledge which results in natural learning through peers. Allen (1977), a professor at MIT speaks of using communication to spark inspiration and creativity, both of which are a necessity for innovation to occur. Schrage(2005) and Watch and Wagner (2017) state that it is no longer seen as a trivial consideration where one locates a water cooler or similar social area.

Social Constructivism

Social Constructivism is a topic that has been delved into and discussed at length. Dating as far back as Dewey in 1938 progressing to Jerome Bruner in 1957 making its way to Jean Piaget in 1965 and eventually being met by Lev Vygotsky in 1978 as well as Herman Hertzberger in 2008. These key theorists provide essential insight to what the framework of "**social constructivism**" entails. This will be discussed further in later chapters, however, at its core, "**social constructivism**" focuses on the collaborative nature of learning, the process of learning and thinking through cooperative and interdependent relationships and the importance of collaboration in the process of innovation.

Liminal Space

The spatial concept of liminality dates back to Arnold Van Gennep (1909) where cultural rites of passage was looked at. It is here that we learn of the spatial concept of **"liminal space"**, which refers to "in-between situations of threshold and transition." These are spaces that invoke thought, clarity and resolution and potentially innovation. While it was Van Gennep who coined the term liminality, it is research conducted by the likes of Aldo van Eyck, Herman Hertzberger, Martin Heidegger and Peter Zumpthor as well as other architects and researchers that show the relation of liminality to architecture. It is through their work that we begin to see the spatial relevance and application of liminality when it comes to designing spaces that potentially invoke thought and breakthroughs.

Third Place

Looking at historical spaces where interaction occurs, what is referred to by sociologist Ray Oldenburg (2000), as the **"third place"**, where people gather and collide. In other words, spaces that result in interaction between people, essentially becomes the space for creative conversation, or as urban theorist Jane Jacobs (2000) calls it, "knowledge spill overs", could therefore spark innovation. This reaffirms that architecture plays an active role with regards to the manner in which people interact with each other and the creative connections they make.

Therefore, one can assume that, an architecture that begins to foster human interaction by putting people close together or planning for chance encounters and environments that spark discussion and new ideas, could potentially begin to inspire research innovation.

1.5 RESEARCH METHODS AND MATERIALS

The method of information collection through primary and secondary data has informed the design process and existing research facilities related to the health sector as well as in general have been looked at and relevant aspects of each have been examined. The focus of the research was qualitative and took on a number of exploratory methods and instruments. Speaking to individuals who are knowledgeable about specific sectors rather than a larger sample of people is what the intended focus was.

Looking at secondary data is imperative to any research. Therefore, a literature review has been conducted in order to draw on relevant theories that could possibly provide the answers to questions posed. The literature review served to give a broader analysis to the design of existing research facilities. It focused on the spaces required as well as the technical needs of research facilities in conjunction to the needs required for innovation. It was crucial that adequate literature was analysed to gain an understanding of the technicalities of the design of medical facilities.

Precedent studies have been analysed and assessed in order to gain an understanding as to how architecture has responded to the needs of a research facility. Each precedent has been assessed under the following headings:

- Project Description
- Justification of Precedent Study
- Location
- Layout and Spatial Planning
- Spaces for Innovation
- Services Approach
- Conclusion

Primary data can essentially be defined as any information gathered first hand, through direct interaction with the source. With regards to the following research, primary data consisted of case studies that were visited in order to understand the functionality and use of research spaces as well as engage with people who use the space. This research was recorded

graphically in the form of photographs. Architectural observation in the form of viewing and analysing plans was necessary as well. In conjunction, interviews with staff within the research institute and people who engage with creative spaces occurred. This process included personal interviews of a semi structured nature and observation.

Recorded information has been subjected to analysis in order to obtain maximum data from it and enable it to be used for comparison and lessons to be learned. This analysis included addressing all of the conceptual and theoretical framework and analysing according to this.

1.6 CONCLUSION

Innovation is the key to moving forward if we as human beings want to progress and survive the everchanging world we live in. However, if we are to accomplish the task of reaching and achieving innovation in a variety of fields, one thing is certain, the environment we exist in needs to compliment this motive.

Therefore, an architectural response that begins to cultivate innovation is of crucial importance. A proposed cancer research institute is one method of portraying this. The research environment is in dire need of change architecturally and socially if we are to attempt to solve any of the epidemics we face.

To conclude, this study intends to convey an architectural response that cultivates and promotes innovation in the research environment.

1.7 OUTLINE OF DISSERTATION

Chapter One has proceeded to outline the structure of the study. Chapter Two will proceed to conduct a literature review that aims at addressing the different factors mentioned and to assess them individually. The review will include lessons learned from a number of authors. Chapter Three will expand on the theoretical and conceptual framework that have been discussed in Chapter One in order to provide a framework for the study.

Due to the technical nature of such an environment, it is of crucial importance that it is analysed and taken into consideration. Therefore, Chapter Four will delve into the technical considerations and safety aspects.

Key precedents will form the basis of Chapter Five. This will include looking at built examples of both the typology as well as built examples of the literature explored. This will assist in observing how the theoretical and conceptual framework can come into fruition.

Local examples of a similar typology as well as built examples of the literature explored has been discussed through case studies as well as interviews had in Chapter Six.

Chapter Seven will proceed to identify the challenges and limitations of the data as well as draw a succinct analysis of the literature discussed and explored.

Second to last, Chapter Eight will provide a conclusion to the research and recommendations towards an architectural design proposal. Following that, part two will include a detailed design report for the design of a cancer research institute.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

To gain an understanding in any situation, it is crucial to gain an understanding of all contributing factors. Therefore when looking at how architectural spaces can enhance medical research innovation, it is important to assess each factor individually first. This chapter begins to assess each factor individually, namely: Architectural Space, Innovation and Research Spaces and Research as a whole, before proceeding to an amalgamation of the factors and an assessment as to how they begin to affect one another. In addition, it will proceed to deal with:

- How can the quality and quantity of innovation in research be improved by the built environment?
- In what way can the built environment encourage creativity and interaction between researchers?
- What is perceived as a spatial barrier between easy collaboration and not easy collaboration between researchers and how can this be improved by the built environment?

This literature review will begin by breaking down each entity, assessing it individually and how its contribution towards architectural spaces can potentially enhance medical research innovation.

2.2 ASSESSING THE FACTORS

2.2.1 Architectural Space

Encyclopaedia Britannica defines space as an immaterial essence. This definition leads us to believe that space is not just a mere vacuum that surrounds us, but rather a makeup of physical form and characteristics that are abstract and complex.

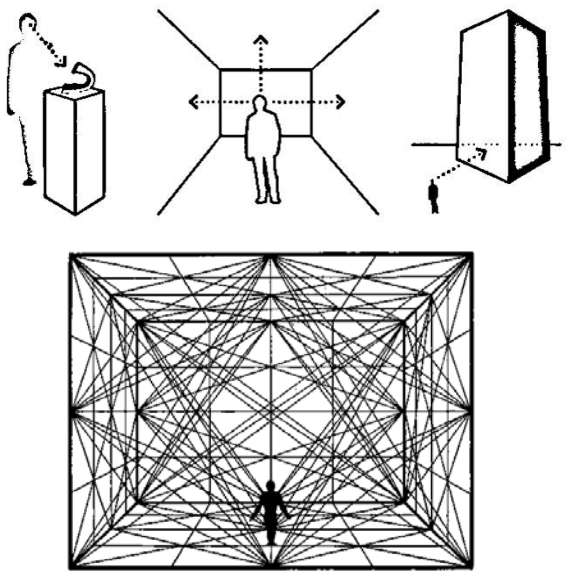


Figure 1: Man-Space Relationship
Source: Author

According to Kurtuncu, et al (2008), spatial experience is interrelated to a number of concepts that include the physical, emotional and mental experience. Essentially, this starts to speak to more than just the vacuum that space supposedly is but rather about the key element of a "man-space relationship" as seen in figure 1. (Dursun, 2009)

Essentially, a space is more than just four walls and a roof but rather about the way a person experiences it with regards to all five senses. These senses and the factors affecting them begin to, persuade a person's perception of any given space.

Proshansky (1970), states that the physical environment in which we exist can be seen as a social phenomenon. However, Lefebvre defines space as a social product (Lefebvre, 1998). Space is the resultant of social relations between individuals such as friends, colleagues, etc. Lawson (2005) considers architectural and urban space as an entity that houses spatial behaviour. Architecture or urban space becomes the vehicle for social interaction.

Ultimately, space is seen as more than just physical characteristics but invisible characteristics that focuses on a man-environment relationship and the architectural potentials that a particular space provides such as social and cultural characteristics. The spaces we inhabit therefore influence the way we act as well as the way we feel about ourselves and about each other. The spaces we exist in have the potential and the ability to determine how we interact with one another and how we behave and engage on a social platform. This can therefore have an effect on how we as human beings begin to innovate, this idea will be explored further in the next section.

2.2.2 Innovation

O'Sullivan (2008) describes Innovation as a process of making changes for the better. This essentially means that innovation is not just a process of introducing, implementing and transforming newer concepts but involves multiple activities to uncover new ways to do things. Ultimately, innovation is an entity on its own. One that is constantly seeking new ideas, processes and concepts.

When does innovation occur?

For innovation to occur, what is required is a willingness to fail and learn from both yourself and others. Abraham Maslow, informed us that an individual only engages in learning when he is comfortable and feels safe enough to do so.

Figure 2: Innovation requires an open-mindedness and collaborative interaction.
Source: (https://digitalhealthage.com/knowledge-transfer-partnership-announced-by-nhs-england/)

This therefore tells us in order to continuously innovate, a new mindset and attitude toward failures and mistakes is needed. However most organisational environments do not allow for this comfort, due to the learning structure and structure of the spatial environments in which people work. This looks at how social activity begins to facilitate the transfer of knowledge when striving for innovation.

Ultimately innovation requires an open-mindedness and collaborative interaction as well as the ability to feel comfortable with uncertainty. How architectural spaces are designed will essentially affect this mindset.

2.2.3 Research

Research is defined as a careful consideration of study regarding a particular concern or a problem using scientific methods. The term can be applied to multiple disciplines. The term medical research refers to research conducted with regards to human health. According to American sociologist Earl Robert Babbie (Bhat, 2019), research is both an inductive and deductive process that involves systematic inquiry to explain an observed phenomenon. Therefore, a research environment would be one such entity that houses a person conducting the research process and the process that accompanies it.

Medical research environments can be divided into the following two categories:

- Individual Centered Research Environments: Research environments that prioritise solitude. (Parkin, et al., 2006)
- Group Centered Research Environments: Research environments that focus on collaboration.

Many medical research environments are required to include laboratory spaces because of the purpose of the research. Webster defines Laboratories as, *"a place equipped for experimental study in a science or for testing and analysis, a place providing opportunity for experimentation, observation, or practice in a field of study."* (Webster, 2019)

Typically, a medical laboratory is seen as a solitary environment in which there is minimal interaction with others. However, a newer model of medical laboratories start to focus on interaction between peers. Driving this is the need:

- To encourage collaboration.
- To balance the inclusion of "open" and "closed" labs.
- To accommodate change and technology.
- For environmental sustainability. (Watch, 2008)

According to Daniel D. Watch, in "Building type basics for research laboratories", there are a few features that are essential in new laboratory design, namely: Creating team-based research environments, meeting spaces, team-based labs, "open" versus "closed" labs, flexibility and sustainability.

Creating team-based research environments

According to Watch (2008), most medical scientists have knowledge of the content of each other's work, therefore modern science essentially becomes a social activity much like the research and working environment of an architectural design studio or advertising agencies, to name a few. He adds that an environment that encourages social interaction actively promotes innovative methods.

Meeting Places

Watch (2008) states that it is essential to create places where people can interact outside labs or offices to socialize as seen in figure 3, to provide opportunity for chance encounters and thus an exchange of ideas. (Watch, 2008).

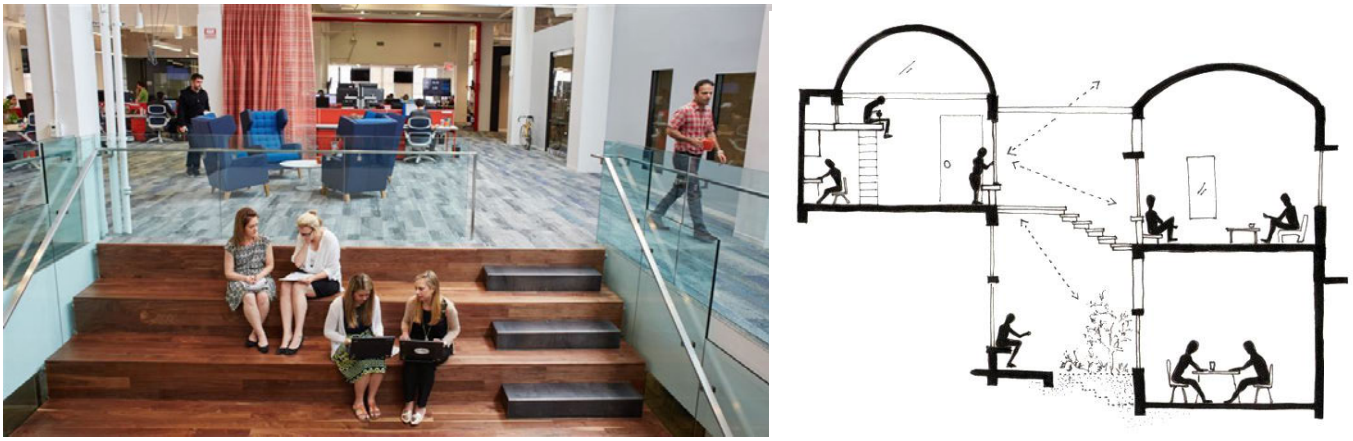


Figure 3: Stairs offer opportunities for interaction and meeting places and providing interaction spaces assists in accidental encounters.
Source:(https://www.wsj.com/articles/office-stairs-with-more-than-a-walk-on-role-1431511202)

Team-Based Labs

Watch (2008) says that it is essential to design laboratories that are easily manipulated in order to easily support diverse research teams and allow collaboration. (Watch, 2008).

"Open" Versus "Closed" Labs

Closed labs were designed for the individual researcher while the modern open lab environment allows investigators to share the space, equipment and support staff and thus encourages interaction as seen in figure 4.

Figure 4:Open labs encourage collaboration and team based research.
Source: (https://www.amgenbd.com/specific-article?Id=4CBFB03D-E6D3-4E24-9881-5981618AE90C)

Even though the open labs are encouraged in modern research facilities, closed labs are still essential for particular natures of investigation. In conjunction, it also provides the option for those researchers who prefer a solitary environment. An individual closed lab can be designed to have a direct access to a shared open lab. This gives a researcher a freedom to work in the space they are comfortable in (Watch, 2008). Glass walls can begin to serve as visual links while retaining individual spaces as seen in figure 3.

The aforementioned architectural requirements of medical research facilities of today begin to speak to the concept of creating research environments, that begin to foster social interaction between scientists in order to inspire innovation in the research environment.

2.3 WHEN ARCHITECTURAL SPACE, INNOVATION AND RESEARCH MEET

2.3.1 How does architectural space affect innovation in research?

In order to achieve goals, focus on tasks at hand or simply to gain mental clarity, the environment in which one begins to cultivate their thoughts is important. The process of innovation is no different. This means that an environment that is conducive to optimum thought processes increases the probability of achieving creativity and innovation.

Studies of the brain that have been conducted by furniture brand Haworth (2017) have shown that in order to facilitate creative thinking, offices require availability of spaces for both high-focus work and restorative activities both with ourselves and with others.

According to Haworth's research, two varying types of workplace behaviour are needed in order to foster innovation: A concentrative mode of working and the need for restful activities, which create opportunities for insight. (Morris, 2017) What is found is that offices are more likely to support one or the other.

However, in order to facilitate the creative process and therefore innovation, Haworth (2017) shows that offices need to account for the four stages of cognition as seen in figure 5, these being:

- Preparation: Gathering Information.
- Incubation: Integration of old and new knowledge.
- Insight: The "ah-ha" moment.
- Verification: Evaluating or elaborating on a creative idea until it is fully formed.

In conjunction to this, the three neural networks of the brain needs to be supported. Namely:

- The Salience Network: This dictates how external stimuli affects thought and behaviour. (Haworth, 2017)
- The Executive Control Network: Develops new ideas. (Morris, 2017)
- The Default Network: Conducts divergent, out of the box, thinking.

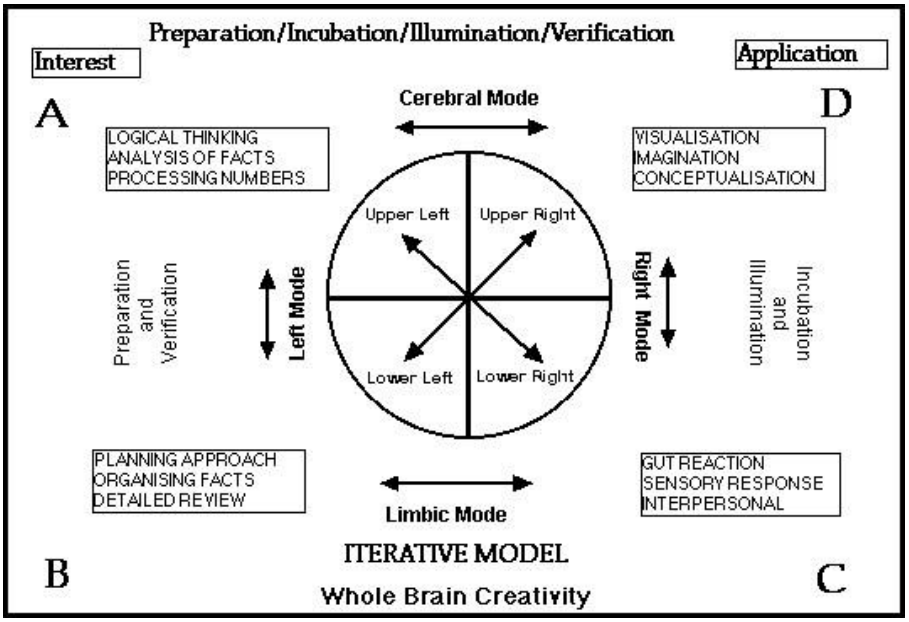


Figure 5: The Creative Process that leads to innovation being achieved.
Source: (http://members.optusnet.com.au/charles57/Creative/Brain/wallis.htm)

Essentially, offices need to be designed for creative rhythm that accommodates for focus, rest and the in-between. Two approaches can be taken:

- The Top-Down Approach: This limits irrelevant stimuli that divert efforts to focus.
- The Bottom-Up Approach: This approach looks at how boredom can have a positive affect by stimulating the default network, it begins to encourage imagination.
- In addition, transitional spaces as seen in figure 3 help to refine ideas by allowing for loitering therefore varied postures and stimuli. Information is absorbed effortlessly, generated and refined all at once.

Taking cognisance of what science entails about supporting convergent and divergent thinking and the different types of spaces that need to be provided, it is fair to say that design considerations should factor in spaces of privacy as well as spaces that promote collaboration.

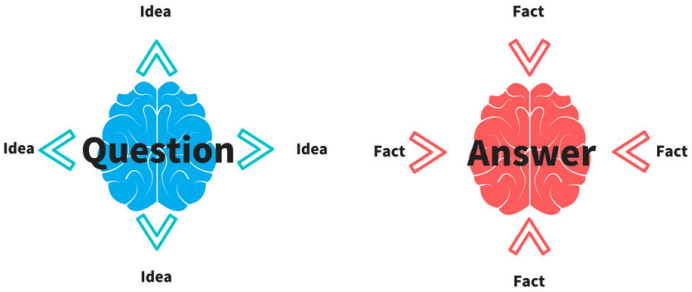


Figure 6: Spatial organisation needs to account for both convergent and divergent thinking.
Source: (https://za.pinterest.com/pin/281052832980723782/?lp=true)

Looking at a study conducted by Toker (2003) where spatial organization of workspaces in university research centers and how it plays an influential role in the encounters among researchers and therefore the innovation process outcomes was analysed. What is learned is that face to face encounters result in the most insight and information gained. Toker (2003) claims that the way we configure space plays a pivotal role in our lives. Ultimately, the social aspect of architecture proceeds to engage people with their environment as well as with each other. Therefore, the quality of communities, organisations, individuals and the innovation produced is a resultant of the aforementioned quality of the spatial organisation as seen in figure 6.

What is learned is that, collaboration becomes a central driving factor when it comes to driving innovation forward and there is still a high value in face-to-face communication. Spatial design needs to accommodate the creative rhythm. Thus including spaces for focused work, collaboration as well as rest and restoration.

2.4 CONCLUSION

Upon assessing the different factors individually, namely: Architectural Space, Innovation and Research Spaces and then all together under the heading, “When architectural space, innovation and research meet”, one learns that one factor cannot exist without the other.

It is through the method of assessing them individually that it is learned how difficult it is to separate these factors. One learns that without architectural spaces that are designed for optimal interaction, creativity cannot flourish therefore innovation cannot occur. If architectural spaces are not designed to house medical research environments, optimum research cannot exist therefore, neither can innovation.

In addition, the answers to questions posed at the beginning of the chapter become more evident. The questions being:

- How can the quality and quantity of innovation in research be improved by the built environment?
- In what way can the built environment encourage creativity and interaction between researchers?
- What is perceived as a spatial barrier between easy collaboration and not easy collaboration between researchers and how can this be improved by the built environment?

In its entirety, it is established that the above mentioned factors are co-dependent and it is almost impossible to discuss one without the other. Therefore, a theoretical and conceptual framework that begins to take this into account will be discussed further in the chapter to follow.

CHAPTER 3: THEORETICAL FRAMEWORK AND KEY CONCEPTS

3.1 INTRODUCTION

The theoretical and conceptual framework of this dissertation aims at providing an insight as to how spaces begin to affect the way people behave, interact with one another, create and innovate. By understanding the relevance of such theoretical and conceptual framework, one begins to see the importance of alternative learning and teaching methods in different environments and how different outcomes are achieved because of it. The creative and resultant innovative process is given priority when it comes to designing architectural spaces and is therefore discussed below.

Phenomenology

According to Nesbitt (1996) this paradigm essentially speaks to both the body's interaction with the environment as well as the mind. It speaks to how the visual, tactile, olfactory and aural senses become an integral component in the perception and reception of a human being and architecture. This determines how a person receives and perceives an environment both physically and mentally, be it consciously or subconsciously.

Therefore, phenomenology focuses essentially on human experience. However, upon looking at phenomenology and architecture, it becomes the relationship between the environment and man and how man experiences phenomena such as: sight, hearing, touch, smell, taste and feel and how these begin to affect human existence, experience and behaviour.

Phenomenology is a widely discussed phenomenon in the psychological, philosophical and architectural realm. It is a topic discussed by many such as Martin Heidegger (1962), Maurice Merleau-Ponty (1962) Christian Norberg-Schulz (1980), Seamon, D (2019) and Juhani Pallasma (2005) to name a few. It is through the writings of the study of phenomenology that the relationship between man and his environment is brought into light and further explored.

Looking at the writings of the German philosopher Martin Heidegger (1962), Heidegger makes the realisation of the relationship between person and world. Here, he describes them as being indivisible and co-dependent. It is here that Heidegger (1962) developed the term "being in the world" and goes on to express that architecture is about feeling rather than just thinking, feeling that is dependent on time, place, subject and experience.

The French philosopher Maurice Merleau-Ponty (1962) shared views on phenomenology similar to that of Heidegger. However, Merleau-Ponty (1961) paid special attention to the perceptual experience had. According to Merleau-Ponty (1962) the mind becomes an extension of the body itself therefore the mind's access to the outside world is dependent on the environment in which the body is placed. This is similar to the argument posed by Pallasma (2005) where the human body is considered "the centre" and that tactile senses and the importance of the experience had by the body is important. Thus, the environment in which we place our bodies in begins to affect our mental perception and state.

Work by the contemporary author, Christian Norberg-Schulz (1980) portrays an existential emphasis on space. According to Norberg-Schulz (1980) the investigation into how one dwells is the basis of establishing a significant relationship between man and the environment therefore the existential purpose of a building is to create place and uncover meanings in the environment. Thus, this places the importance on the psychological effects the environment has and how it begins to affect our perception.

In essence, phenomenology acknowledges the responsibility of the architect to create an experience. In order to create a memorable encounter that ignites thought, enhances experience and encourages interaction, this theory promotes the integration of sensory perception within the built form, due to the effect it has on man and thus this shows the intangible and perceived interrelationship that is evident between man and his environment. Ultimately this theoretical paradigm forms the basis for theories and concepts that pay special attention to man in an architectural environment. It provides the basis needed to further investigate and study concepts such as:

- The watercooler concept
- Social Constructivism
- Liminal Space
- Third Place

The above mentioned concepts that will be further discussed, play an integral role in the investigation of architectural space can potentially enhance medical research innovation, due to their ability to insight alternative learning methods as well as a unique environmental experience.

3.2 ALTERNATIVE TEACHING AND LEARNING METHODS

3.2.1 Social Constructivism

Upon reading the name of any theory or concept, one begs the question: What does this mean? Therefore, breaking down "Social Constructivism" into two separate entities is a valid starting point. Merriam-Webster defines social as, *"Tending to form cooperative and interdependent relationships with others."* (Webster, 1857)

According to Mvududu and Thiel-Burgess (2012), constructivism is essentially a method to investigate children's level of understanding. Therefore, constructivism refers to how of learning and thinking. This would mean that "Social Constructivism" is the process of learning and thinking through cooperative and interdependent relationships with others.

Dewey (1938), a key contributor in this area of study, described progressive learning as a socially engaging experience which emphasises the need to learn by doing. Dewey found that effective education came primarily through social interactions. (Flinders & Thornton, 2013). From Dewey's educational point of view, human beings learn more effectively when they are allowed the opportunity to interact with their environment in order to adapt and learn.

Jean Piaget (1965), another key author in this area of study, looks at development through a cognitive lens where knowledge is experience that is acquired through interaction with the world, people and things. Ultimately Piaget makes strong reference to development progressing, as a result of the environment we are in. If the environment is conducive to development and learning, development and learning in individuals will be the resultant.

Lev Vygotsky (1978), begins by taking us through the process of the development of a child. In the scenario, a child is given a new task to complete, one of which the child has never experienced before. As is customary, the child sets out to accomplish this task, however some difficulty is experienced. The child is stunned, confused and bewildered but perseveres. Eventually, the child looks to the task giver for help, making eye contact, facial expressions or incomprehensible baby talk but essentially asking for help. Help is given and the child learns that when help is around and when help is asked for when experienced with a difficulty, it is available. This means that, this trait is something that is inherent in us and is essentially how learning occurs in a social environment.

What is also made reference by Vygotsky is the Zone of Proximal Development (ZPD).

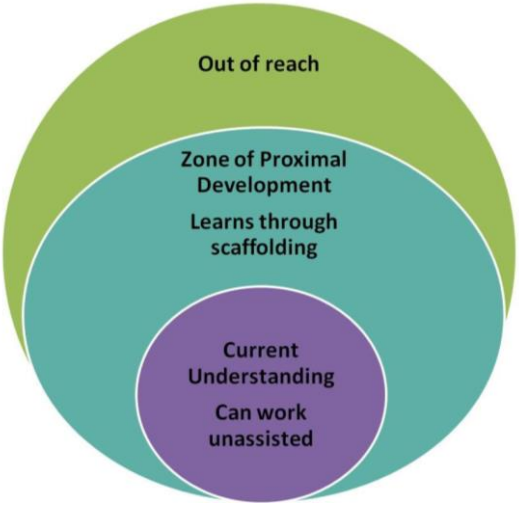


Figure 7: The Zone of Proximal Development is the zone in which shared learning occurs.
Source: (https://www.texthelp.com/en-gb/company/education-blog/july-2017/get-in-the-zone/)

Within the Zone of Proximal Development as seen in figure 7, what is noted is that, when any one person cannot perform a task and those who are more skilled or contain more knowledge are in close proximity are engaged with, the task is accomplished and the unskilled individual learns something new through collaboration therefore reinstating the idea of potential development through guidance and collaboration.

Jerome Bruner (1957), offered a few insights on the topic at hand as well. According to Bruner, the instigation of experiences and the seeking of information is necessary to solve problems, thus engaging in "discovery learning" or "guided discovery."

Looking at both the work of Bruner and Vygotsky, both paid special attention in the emphasis of the environment and the social environment of learning, more so than Piaget. Bruner, in particular, made reference to the process of "scaffolding" which is extremely similar to Vygotsky's concept of the "zone of proximal development". Both of these concepts and ideas involve, structured interaction and can be used interchangeably. This can be seen in group and collaborative environments through peer learning.

Another key theorist in the development of spaces designed for optimum learning is Herman Hertzberger. Although much of this authors work pays special attention to the spatial development and planning of schools, at its core, the focus is essentially on space and learning and the relationship and alliance that exists between the two.

Additionally, it is crucial that space forms place as this determines the level of stimulation, activities, quantity and comfort level of individuals experienced within said space. Therefore, in order to achieve the balance between group and individual working scenarios as well as stimulation and comfort and to somewhat deinstitutionalize the institution, the following needs to be considered according to Hertzberger (2008):

- The distinction between linear spaces and secluded spaces.
- Differences in floor to ceiling height as taller spaces tend to encourage collective behaviour and shorter spaces tend to encourage working by one's self.
- Openings in floors in order to maintain and encourage visibility and accessibility.
- Central spaces to encourage the congregating action of people.
- Introducing daylight into a space as light attracts people and encourages them to socialize and interact with one another. As well as providing darker spaces that can be used for individual reflection.
- Materials play an important role in both the acoustic capability and the distinguishing of places. Therefore, they need to be considered carefully.

Ultimately, the key idea that remains constant throughout these key authors, is that, learning and growing is most effective when done so in a social environment, one which allows for interaction, a sharing of ideas, collaboration and learning as seen in figure 8.

It is within these environments that people grow mentally, physically and emotionally. People are more inclined to make connections with others due to them feeling emotionally comfortable in an environment thus promoting healthy mental stimulation and a higher chance of a cross pollination of ideas occurring through this interaction and collaboration. This can seen in open plan offices, group settings and the likes.

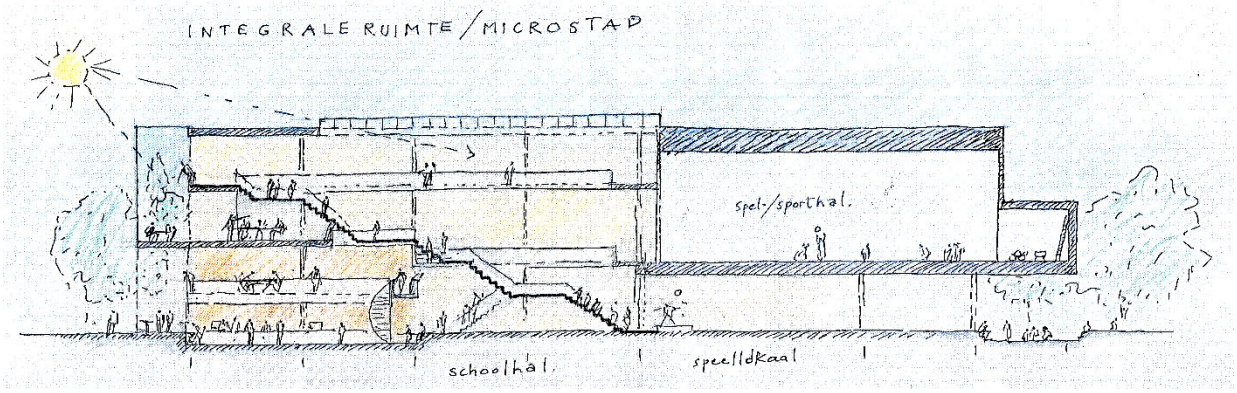


Figure 8:Drawing by Hertzberger shows how interaction opportunities for shared learning to occur can be planned for.
Source: (https://architectureandeducation.org/2016/02/03/interview-with-herman-hertzberger/)

3.2.2 Liminal Space

Arnold Van Gennep (1909), initially coined the term and concept of liminality as a change of place, state, social position and age. This comes in three major phases:

- Separation: Breaking free from previous practices and routines.
- Transition or Liminality: In this phase, the creation of the tabula rasa (blank slate) occurs and a passing through a threshold which results in considerable changes.
- Incorporation: A new identity is achieved.

Being so great, the transition from one stage to the next demands an intermediate stage, that is, the liminal stage.

Rediscovering the terms “liminal” and “liminality” was Victor Turner in 1967. Turner (1967) focused on the liminal phase as a state and a transition. Looking at applying the understanding of liminality to architecture, we learn that the threshold between spaces is crucial and that liminality points towards blurring the zones between the experiential and making spaces. (Smith, 2001)

Research by selected theories of liminality conducted by architects like Herman Hertzberger, Martin Heidegger and Peter Zumpthor shows that there are characteristics that can be extracted and applied to architectural design. The factors can be divided into:

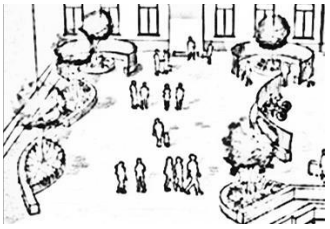
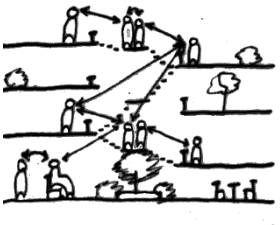
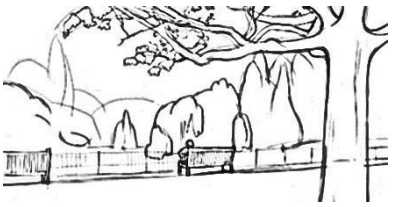
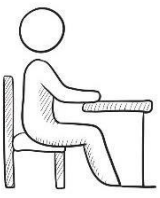
- Spatial Division: These are seen as in-between spaces and provide a transition space.
- Spatial Condition: Essentially spatial condition begins to form the separation that is commonly founded between inner and outer and give meaning to leftover space by making it socially interactive.
- Spatial Experience: Spatial experience refers to how a person begins to perceive spaces, in particular, liminal space as leftover spaces, the interconnection between interior and exterior.

Because of the complexity that the liminal state provides, being an amalgamation of a number of transitory experiences, the architectural interpretation of these states is needed Ibrahim (2012) provides a tabulated description as seen in table 1 and architectural examples of which can be seen in table 2:

Table 1: State Definitions

State	Definition
Transition	Movement, passage, or change from one position, state, stage, concept, etc
Separation	Point of parting
Dissociation	State of withdrawal from any previous associations and segregation
Abstraction	State of being taken away/ separated
Layering	State of overlapping elements
Blurring	State of confusion, indistinctness, obscurity in vision
Aggregation	State of being in collection of an overall whole
Dissolution	State of broken-up assemblies, dispersal of components or organization
Integration	State of being combined with the whole

Table 2: Architectural Representation of States

States	Architectural Representation	
Integration/ Aggregation	Public seating, public gathering areas	 *Source: Author*
Layering/ transition	Corridors, walkways, level changes, paths, elevators, escalators, stairs	 *Source: Author*
Dissociation/ dissolution	Physical barriers, walls, partitions, columns, physical obstructions, interruptive objects	 *Source: Author*
Blurring	Unexpected objects or findings that are out of context, a visual deterrence, a visual obstruction, heavily frosted glass, screen	 *Source: Author*
Abstraction	Reflection moments , platforms that allow for opportunities to ponder and reflect, lookout points	 *Source: Author*
Separation	Isolated spaces, space for an individual	 *Source: Author*

Ultimately, liminality refers to the in-between spaces and how we as human beings perceive them, experience them and exist in them. It speaks of these in-between spaces how they have the ability to be more than just an empty void but rather a place with the potential to have an impact on a human being, physically, mentally and emotionally. With the aforementioned tables and information, one can gauge how to use these spaces architecturally and optimally in order to achieve the desired outcome. Essentially, liminal space has the ability to ignite thought, clarity and a sense of purpose through reflection. These are moments that are needed to produce new thoughts and ideas.

3.2.3 Third Place

Ray Oldenburg (1997), a sociologist who is also a key theorist with regards to "Third Place" literature, provides an almost blatant and layman's description to what exactly a "third place" is. He states:

> *"Third places are nothing more than informal public gathering places. The phrase "third places" derives from considering our homes to be the "first" places in our lives, and our work places the "second."(Oldenburg, 1997:6)*

Figure 9: Third Places in the form of shared kitchens, lounges and central spaces etc.
Source: (https://www.brookings.edu/research/innovation-spaces-the-new-design-of-work/)

In essence, a third place is a place that is neither work nor home but a place where people can gather, come together and socialise thus allowing for a sharing of knowledge, experience and conversation rife with a variety of topic selection, people and viewpoints as seen in figure 9.

Oldenburg (1989), explores a number of characteristics that begin to represent and describe these third places and the informal gathering places they provide. These characteristics are:

- On neutral ground: These are spaces in which people may enter and leave when they see fit and every individual feels comfortable and at home.
- The third place as a leveller: Oldenburg (1989) suggests that third places succeed in providing a place that is a level-playing field where people or participants may come and interact .
- Conversation is the main activity: A place that is both neutral ground and a level playing field allows people to feel a sense of comfort in order to communicate freely.
- Accessibility and accommodation: According to Oldenburg (1989), the most productive third places are those that are easily accessible and comfortable.
- The Regulars: An important characteristic of a third place is that it has regulars that are available to welcome newcomers in order to provide maximum comfort.
- A low profile: The physical nature of a third place is typically plain and unassuming.
- The mood is playful: A third place should be a place that allows for relaxation, acceptance and one that is free from alienation.
- A home away from home: This should be a place that feels like a good home where psychological comfort and support is extended.

Essentially, the environment and fostering the conditions will allow a productive and comfortable third place to emerge.

Economic theorist Jane Jacobs (1969) makes reference to knowledge spill overs. The belief is that places that result in interaction between people essentially becomes the place for creative conversation or “knowledge spill overs”. This is because these knowledge spill overs or third place if you will, facilitate the exchange of ideas and promote creativity and innovation due to the interaction and cross pollination of different ideas between different people.

Soja (1996) identified three spatial notions, namely:

- Firstspace: This is classified as the ‘real’ material world, essentially, the physical world.
- Secondspace: This is the interpretation of the aforementioned reality, the imagined representations of spatiality.

- Thirdspace: This is the space and spatiality people constructed through social practices and is essentially the space that is directly lived in and used, containing both real and imagined spaces co existing.

Ultimately Thirdspace becomes a place where race, creed or gender becomes null and void and people coexist and engage.. Following the reviewed literature, it is a fair conclusion that a third space or a third place is, at it's a core, is a platform that allows free and open speech to anyone who exists in it and experiences it. This space needs to be designed in a manner which aims at achieving an open and diverse experience that ignites healthy debate and conversation in order to spark and share new thoughts and ideas.

3.2.4 The Water Cooler Effect

It is a well-known phenomenon that the organization of a physical environment tends to have a significant impact on the patterns of informal interaction and communication between people existing in a space. Because of this, it has not only become a trend but almost a necessity to consider the location of a social area. As Naeem Zafar wrote:

"It is not trivial to carefully consider the location and configuration of the water cooler and the social area where people informally meet to chat during the coffee break." (Watch & Wagner, 2017:34)

Figure 10: The watercooler becomes a point for informal interaction.
Source:(http://www.keywordbasket.com/d2F0ZXIgY29vbGVyIGNhcnRvb25zIGJsdWVz/)

These spaces have proven important, particularly in innovation circles, where these spaces are said to spark "communication for inspiration", a term coined by Thomas Allen (1977), a professor at MIT. This concept of "communication for inspiration" is found to stimulate creativity, a necessity for innovation. Schrage (2005) likened these spontaneous interactions to the water cooler effect that many workplace studies have identified. Word Spy defines the water cooler effect as:

"The effect created by two or more employees having an informal, face-to-face conversation, as though at a watercooler." (Spy, 2002)

With reference to the above definition, the water cooler effect therefore occurs at a communal entity as seen in figure 10, one that provides the opportunity for collaboration. Literature

suggests that there are three key types of interactions that occur at this common point, namely:

- Informal conversation: Nardi (2005) states that these are the conversations that contain greetings and a general conversation quality that is of a lower substance but sets the basis for strong social bonds for productive conversations.
- Information transfer: Information transfer refers to conversation of a more substantive nature occurring at the said communal entity.
- Knowledge exploration: Knowledge exploration is essentially the height of the conversation and ultimately the water cooler effect that is being sort out. When these exchanges occur, people engage in discussions, questions and begin to challenge and explore each other and the information they provide, thus providing different viewpoints and learning of an informal nature.

Fayard & Weeks (2005) goes on to provide a number of physical and social characteristics that begin to affect the relationship between environments and the effectiveness of the water cooler effect, namely:

- Proximity: It is known that increasing the physical distance separating people at work is likely to decrease the amount of spontaneous, informal contact among them (Allen (1977); Keller and Holland (1983); Davis (1984)). Therefore, decreasing the physical distance through spatial planning and organisation makes it physically convenient for people to interact with one another spontaneously and informally.
- Privacy: A healthy balance between public and private spaces is needed.
- An ecological approach: This basically looks at the key aspects of both proximity and privacy and the effects the perception of the physical environment begins to have on informal interactions. Literature by Sykes, Larntz and Fox (1976) speaks of the assumption made that a decrease in perceived distance is directly associated with an increase in the obligation to communicate.
- Symbolic Interactionism: Symbolic Interactionism looks at and refers to the symbolism associated with different spaces and what certain spaces mean and indicate to a person.
- Affordances: James Gibson (1979) states that almost immediately, an organism will assess the environment and assess the behavioral possibilities it affords. These factors

that are assessed are referred to as affordances. These affordances affect the way a person interacts with the environment and the people within that environment.

Ultimately, the water cooler effect refers to the importance of creating a space in which people can interact both intentionally and unintentionally. A growing emphasis is placed on informal, communal spaces that need to now become a design consideration as research conducted at the Google office in Zurich found relaxation and interaction to be crucial to innovation and stimulating original thought in both individuals and groups of people.

3.3 CONCLUSION

The aforementioned conceptual and theoretical framework provides the researcher with an adequate voice of reason, as well as a standpoint that speaks to and reaffirms the initial idea that architectural space plays a vital role in determining the way human beings interact with each other.

What is learned is that, architectural space ultimately shapes the environment both intentionally and unintentionally, the way people perceive, experience and behave in the environment they exist in. This then affects the process of and the success of creativity thus innovation, as innovation is essentially achieved through the collaboration of different ideas from different people.

Therefore, if one is provided with architecturally designed space with a purpose and a platform that promotes comfortability, mental stimulation and healthy conversation, innovation will thrive.

CHAPTER 4: TECHNICAL CONSIDERATIONS

4.1 INTRODUCTION

A laboratory environment is one that is extremely technical and specialised due to the activities that occur within and the substances and conditions that are dealt with.

Because of this, the following factors need to be considered before undergoing the task of designing spaces:

- Collaboration
- Spatial planning
- Services
- Safety
- Lighting
- Finishes
- Storage
- Biosafety Laboratories

The literature to follow is drawn from many of the key authors in this field as well as technical manuals that need to be consulted with regards to the above topics.

4.2 COLLABORATION

Given the aforementioned literature in conjunction with the conceptual and theoretical framework discussed, it is fair to say that the need for spaces of collaboration and interaction becomes not only a necessity but a crucial component to the technical considerations and spatial design of medical laboratories and research environments.

Authors such as Watch (2001) and Wagner (2017) speak of what was then and what is now the new model of medical laboratory design which speaks to and promotes the idea of collaboration and interaction between researchers. Ultimately referring to the need to create “social buildings”.

Watch (2001) in particular, successfully outlines the architectural response to promoting and facilitating collaboration and social interaction by providing us with factors to consider and elements to include:

- Meeting Places: These are common meeting places to encourage interaction.

- Team Based Labs: While still including spaces needed for individual research purposes, space needs to be provided for the addition of team based labs collaboration

- Less segregation between departments: This will allow for the cross pollination of ideas while promoting permeability.

- Using technology to promote collaboration: Due to the advancements in technology, using technology in order to communicate becomes a definite consideration with regards to promoting collaboration.

The above mentioned factors are a few aspects to consider when designing a medical research environment. These factors use the spaces in order to achieve optimum opportunity for cross pollination, interaction and collaboration.

4.3 SPATIAL PLANNING

4.3.1 Human comfort and habitation

Human comfort can be defined as a point at which a human being feels a state of physical and mental ease. It is an environment in which the appropriate conditions are reached in order to ensure a maximum sense of comfort. Physical comfort is of utmost importance in the working environment in order to ensure work efficiency, effectiveness, satisfaction and physical and psychological well-being. According to Whole Building Design Guide (2018), building design must include an integrated perspective that aims to:

- Provide an appropriate acoustic environment.
- Maintain optimal thermal comfort
- Create a high quality visual environment.
- Provide furniture and equipment that is ergonomically designed for maximum comfort and performance.
- Create outdoor amenities that provide a welcome break.
- Incorporating natural light within the building.

The above ensures that optimum human comfort is experienced.

4.3.2 Work Spaces

Due to the nature of medical laboratory spaces and the acts performed within, adequate space needs to be provided for both individual and team based projects. The laboratory module is pivotal in any laboratory facility for functionality as well as collaborative purposes. A common laboratory module has a width of approximately 3m but will vary in depth from 6m to 9m. (Watch, 2008)

In conjunction to laboratory spaces, space needs to be provided for office work as well as write up spaces. These spaces can either be enclosed or open plan in order to promote collaboration.

4.3.3 Types of Laboratories

According to Watch (2001) there are two approaches one could take when designing a laboratory, that is, open laboratories and closed laboratories. These open or closed laboratories can then be further classified as wet or dry. The different types essentially begin to govern the kind of relationships developed within.

Open laboratories: Allow for shared interaction between researchers and a sharing of resources which promotes communication between researchers and laboratory users as seen in figure 11.

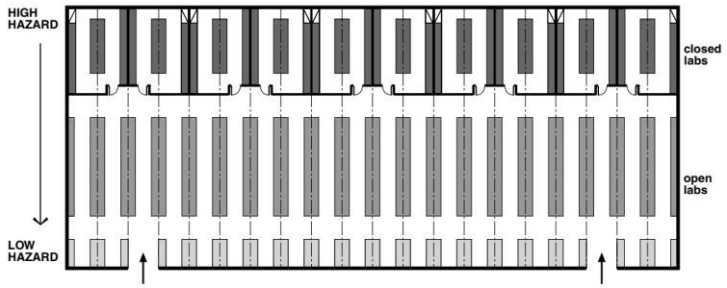


Figure 11: Open vs Closed Laboratories.
Source:(file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

Closed laboratories: Closed laboratories as seen in figure 12 are designed for individual researchers with a specific set of goals to accomplish and research to conduct with needs for specialised equipment and a specific environment.

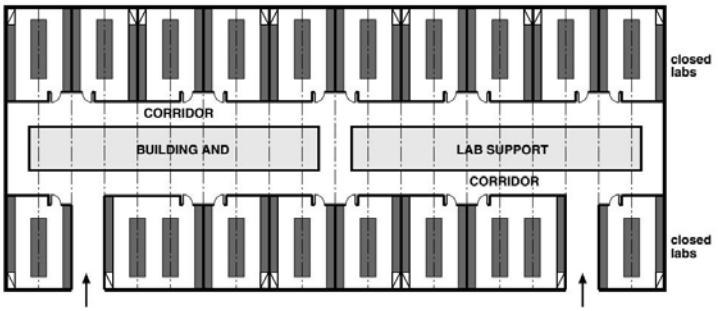


Figure 12: Closed Laboratories.
Source:(file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

Wet laboratories: Contain and house entities such as sinks, piped gas and fume hoods with special requirements such as countertops that are chemically resistant or a constant supply of outside air.

Dry Laboratories: Usually have a significant amount of electrical and data wiring in addition to being computer intensive.

4.4 SERVICES

4.4.1 General

Due to the nature of laboratory buildings and the kind of tasks that occur within, a great demand is put on the services that such a building requires in order for it to function optimally.

4.4.2 Typical Distribution

Because laboratory buildings are extremely utility intensive, it proves more difficult to route utilities throughout the building. Space for a backup generator as well as the location of an uninterrupted power supply needs to be considered. Generally a laboratory building can be serviced by a standard 220 V system with distribution boards located every 55 m². However, according to Loring (1986), there are said to be four notable methods of service distribution in the laboratory environment, namely:

- Continuous End – Wall Service Corridors as seen in figure 13
  There is an enclosed zone in which services run, often rendering the laboratory space internalised, not making an allowance for natural light to enter the space. However, this allows each laboratory direct access to utilities, allows for flexibility and ease of maintenance and modification. It also reduces the floor to floor height.

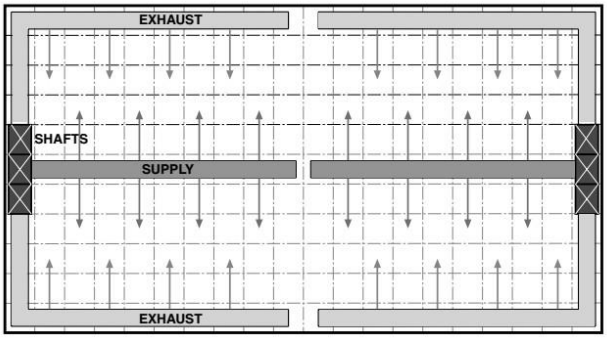


Figure 13: Continous End - Wall Service Corridors.
Source: (file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

- Horizontal Distribution as seen in figure 14

  Major service lines are grouped and hung from the underside of the structural floor system, being laid and run at ceiling level and tapped off where required resulting in more flexibility. However, this method has a higher floor to floor requirement.

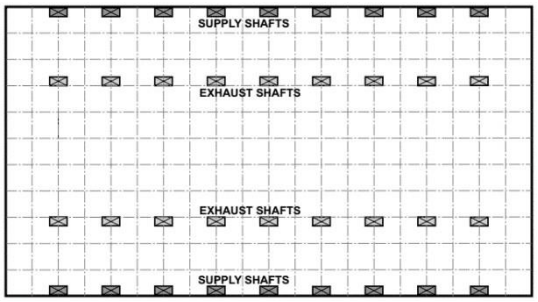


Figure 14: Horizontal Distribution.
Source: (file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

- Vertical Distribution as seen in figure 15

  Offering lower initial costs and minimum floor to floor heights, this method is relatively inflexible and costly to modify and maintain.

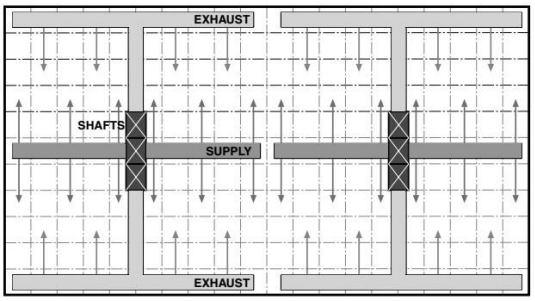


Figure 15: Vertical Distribution.
Source: (file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

- Interstitial Floors as seen in figure 16

  While this method increases the initial structural and construction cost, it does however decrease the maintenance and modification costs in the long term. This method essentially houses utility services and equipment between occupied floors thus proving greater flexibility, ease of maintenance and modification.

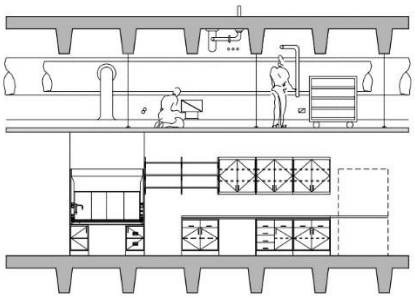


Figure 16: Interstitial Floors.
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4.4.3 Gas Supply

Many medical laboratories engage in activities and studies that involve using a variety of gases as part of their study, therefore it is both a requirement and necessity to make provisions for such supply. Gases that are usually used on a regular basis and in large volumes are readily available, through piping that carries gas to the workbench from a central storage facility, such as a service corridor. Gases that are used on a less frequent basis are supplied in small cylinders. The gas storage facility should to ensure a safe environment:

- Be outdoors and above ground;
- Have provisions to avoid overheating;
- Be located away from combustible sources.

In addition, materials for piping need to be totally inert to the piping content and need to consider refrigeration grade copper tubing, stainless steel, polypropylene and ABS piping.

4.4.4 Water Supply

Water systems are a crucial component to consider in the design of laboratory spaces. There are a few types of water systems that may need to be installed in a medical laboratory, namely:

- Potable Water: Ambient and hot water for general use.
- Non Potable Water: Hot (60 Degrees Celsius) and ambient temperature water is reticulated to laboratory fixtures.
- Analytical grade or laboratory grade water: Higher grade water at an ambient temperature that is used for sensitive experiments.

A provision needs to be made for the prevention of back flow to prevent contamination. This could be in the form of a break tank. In addition, filtration units need to be installed to protect the water supply from blockages and flow control devices to ensure constant water supply of the highest quality.

Similar to the gas supply, water for use in laboratories needs to be reticulated in inert matters such as polypropylene, ABS piping and refrigeration grade copper piping. Pipes should be of an appropriate size to compensate for a variety of uses. Water that is being supplied to a hazardous area needs to be zoned and protected accordingly to prevent contamination.

4.4.5 Fume Extraction

Limiting hazardous fume production is of utmost importance in the medical laboratory environment. Therefore contained environments have become a necessity and need to be considered architecturally. This is where the fume hood and extraction comes into play so that fumes generated can be pulled away and safely dispersed into the atmosphere.

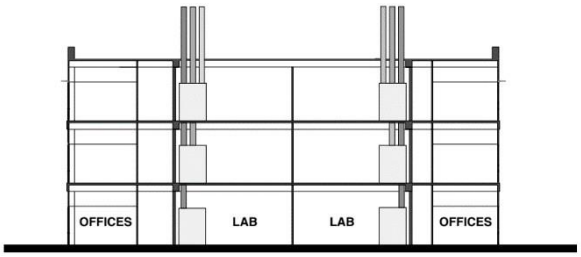


Figure 17: Fume Extraction through roof.
Source:(file:///C:/Users/lenis/Downloads/epdf.pub_building-type-basics-for-research-laboratories.pdf)

Ideally, a fume extraction as seen in figure 17 or fume cupboards should be situated at a perimeter window wall away from a fire escape route to minimise the risk in the event of an explosion. These fume cupboards and hoods should be mounted on a metal frame for maximum comfort and ease of cleaning.

4.4.6 Laboratory Waste

Due to the nature of the medical laboratory environment and the actions undertaken within, hazardous and toxic waste is often produced in the form of vapour, solids and liquids. It is therefore of utmost importance that the appropriate facilities be arhcitecturally accounted for in order to dispose of such waste in a safe and efficient manner.

Solid waste

Dedicated and adequate space needs to be allocated for the accumulation and temporary storage of hazardous waste material that is generated. Waste is often cleaned first at a particular temperature and then transferred to boxes that are designed to house hazardous materials, before it is sent to be incinerated by specialist contractors, to ensure safety.

Liquid waste

With regards to liquid waste, Watch (2001) states that a medical laboratory is not allowed to pour chemicals into a drain that flows directly into the public water system. Because of this, chemicals need to be handled within the lab with holding tanks that are then removed by a waste management contractor.

4.4.7 Workbenches

Furniture within a laboratory can mean many things. Often this includes casework, freestanding tables, desks and file cabinets. The National Research Council (2000) informs us of the different types of casework, this includes:

Figure 18: Built in Casework.
Source:(https://formaspace.com/articles/gov-military/custom-army-diagnostics-lab/)

- Built-in casework as seen in figure 18 are usually the cabinets below the laboratory bench that is used to support the bench top.
- Modular casework as seen in figure 19 is a system of modular units that consists of a frame that independently supports the laboratory bench, upper and lower bench cabinets. This can be arranged in different modules as suited for the laboratory.
- Freestanding casework

Figure 19: Modular Free Standing Casework.
Source: (http://www.myofficeone.com/architectural-products/laboratory-casework/)

Freestanding casework allows for full flexibility through moveable benches and equipment while still having certain fixed entities. Moveable benches allow for many adjustments such as height and position to be made in order to suit the researcher and research space.

4.4.8 Ventilation

In order to enforce compliance with occupational health and safety regulations and giving due consideration to energy conservation, it is of crucial importance to extract hazardous airborne contaminants such as fumes, dust, mists, vapour etc that are generated in medical laboratories. Because the air from wet labs should not be recirculated, this kind of lab should be kept under negative air pressure when in use. This is done by ensuring that the exhaust air volume exceeds the supply air volume.

Even though fume hoods are used during activities that generate a large volume of toxic gas, according to Loring (1986), a laboratory environment requires 15 to 25 air changes per an hour in order to remove odours and gases that may be created within. This change is best accommodated for by use of a decentralised plant system instead of a central system.

4.4.9 Hazardous Materials

Hazardous materials and the treatment of it is a vital factor to consider in the medical laboratory environment. According to Putnam Gould (1986:58) the specific spaces need to be treated in the following manner:

- Clean rooms need to be provided with positive air pressure
- Negative air pressure and prohibition from recycling air from contaminated areas
- Allow for adequate ventilation rates in spaces
- Installation of high efficiency filters
- Inclusion of air locks and contamination areas as required

4.4.10 Fire Systems

Apart from the general municipal fire safety requirements, Loring (1986) states that a laboratory environment should have a combination of a fully automatic wet pipe sprinkler system and a complete fire stand pipe that is installed in the laboratories. In addition, Watch (2001) states that a fire suppression system may be necessary as well as a gas, vacuum and emergency power, deionized water capability, first aid, spill control, a burn kit and a fire extinguisher should be readily available at each work station. These need to be taken into consideration when designing these spaces.

4.4.11 Plant Rooms

Plant rooms are the spaces in which primary mechanical equipment systems are located, due to:

- Proximity to support utilities such as gas, electricity, water and sewers.
- The distance of distribution systems.
- The size of equipment as well as the noise and vibration emitted.
- Whether there is opportunity for flexibility and expansion.

Central plant rooms are more economical and more efficient due to its location. However, with regards to taller laboratory buildings, the interstitial space renders itself more useful and efficient, due to its capability of servicing every floor with ease and flexibility.

4.5 SAFETY

4.5.1 General

Safety in any environment and under any conditions is imperative to the well-being of any person. However, in a research environment and in a medical laboratory in particular, safety becomes necessary for survival. .

4.5.2 Safety Equipment

Due to the need for efficiency in the event of a crisis, it is of utmost importance that the proximity of safety equipment is close together and in a consistent location. This needs to be taken into account when designing spaces architecturally.

According to the National Research Council (2000) and Griffin (2005) the need for a safety station is imperative. It should include the following:

- A safety shower as seen in figure 20 with drench shower enclosures that is installed within the laboratory at a point which forms part of the essential circulation, near an exit point and on the hinged side of the door.
- A face and eyewash fountain that is located less than ten seconds away from any potential source of exposure while supplying a soft stream or spray of aerated potable water for at least 15 seconds. In addition, this sink should be separate from the usual sink that is used during everyday use.

Figure 20: Safety shower and eyewash fountain. *Source: (https://ehrs.upenn.edu/health-safety/lab-safety/lab-design-equipment/emergency-irrigation-equipment)*

4.5.3 Safety Precautions and Planning

In addition to strategically located safety equipment with regards to planning, there are other factors to be considered. This includes:

- Access control that is controlled via the degree of risk, credentials and training.
- Means of emergency egress needs to be planned accordingly by considering all the factors, namely: the pathway of discharge and location.
- An additional and dedicated storage space for potentially hazardous chemicals needs to be provided in order to prevent accidental contact.

In addition to the above, a fire rated isolation between users and the environment needs to be provided. Safety is of utmost importance and should not be taken lightly in this environment.

4.6 LIGHTING

4.6.1 Requirements

Being able to see without obstruction in any environment is crucial. This consideration is no different in a medical laboratory environment. According to Griffin (2000:121) the following factors need to be accounted for in lighting decisions:

- Sufficient lighting needs to be provided to ensure a safe and comfortable environment
- The lighting should minimise glare on work spaces as much as possible
- The lighting needs to be controlled
- Shadows being cast onto workbenches need to be limited
- Waterproof lighting and fixtures should be provided
- Surface or pendant type is preferable
- Provide diurnal lighting

Generally most tasks require a level of 500 lux. Although natural daylight is encouraged, no direct sunlight should fall onto the workbench as per Griffin (2000) suggestion. Therefore, windows need to be strategically placed.

4.6.2 Natural Day-Lighting

As is customary, natural day light should be seen as the primary source of lighting in order to:

- Reduce cost and promote efficiency
- Act as an agent to kill bacteria naturally
- Increase comfort and enhance productivity
- Provide uniform lighting

It is a well-known phenomenon in the architectural world that natural day lighting is a commodity when utilised to its full potential therefore it is one that should not be ignored.

4.6.3 Colour Considerations

According to Israel Pedrosa*, "a colourful sensation is produced by the nuances of light refracted or reflected by a material, commonly the word colour is designated to those shades that function as stimuli in a chromatic sensation."* (Pereira, 2018). Given the above statement, choosing colours for spaces becomes an important factor.

4.7 FINISHES

Often finishes are done with a particular aesthetic look in mind. However, in the medical laboratory environment, more than aesthetics is crucial in the consideration of materiality. Architecturally, what needs to be considered are a number of things. This includes:

- Durability
- Chemical resistance
- Permeability
- Ease of cleaning
- Cost
- Aesthetics

Floors

Resilient sheet vinyl: Durable, easy to clean, comfortable to walk on and somewhat aesthetically pleasing is one way to describe this material. Having a relatively good chemical resistance due to the limited number of joints is an additional bonus. However, this material is fairly costly and difficult to repair.

Walls

Because internal dividing walls are usually constructed out of brick, concrete or dry walling such as gypsum wallboard, it is important to treat them as these materials are quite porous. Therefore, they need to be painted with acrylic or epoxy wall paints, the corners will require wood or metal guards in order to provide protection from scrapes.

Ceiling

Often, ceilings are open to expose structure and mechanical systems and sometimes they consist of a lay in ceiling tile. In the event of exposure, acoustical liners are used to minimise noise from ductwork and pipes are painted to prevent dust collection.

Working Surfaces

In this case, the same factors apply. Therefore materials such as epoxy coated metal, moulded epoxy resin and stainless steel are used due to their durability, easy to clean and suitability.

4.8 STORAGE

General

It goes without saying that shelving and cabinets are a necessity in every medical laboratory. In some cases they may be located under bench, over bench or full height wall storage.

Specimens

Storage of specimens is pivotal to results produced. Griffin (2000:109) provides us with what needs to be provided for specimen storage:

- Stable thermal control
- Continuous ventilation to dilute off-gassing
- Spill control ventilation
- Sufficient and a variety of air movement to minimise mould growth

Generic recommendations include:

- A minimum air change rate of 6 air changes within the time frame of 24 hours.
- The use of radiant cooling or heating devices as a form of heat transfer that access deep within shelving.
- The use of dehumidifier devices with selective catalytic reduction control.
- Permeable shelving with mount temperature dewpoint sensors.
- High spill risk specimens placed under a manually operated extraction hood.
- Well insulated and vapour sealed enclosures with conditioned air locks.

4.9 BIOSAFETY LABORATORIES

Biosafety laboratories are those medical laboratories that are used when studying potentially harmful and contagious materials. These laboratories are used so that these studies can be conducted in a safe and effective environment. There are four biosafety levels (BSLs) that are used. Each one defining a different level of contamination and the type of equipment and design required. Information on these can be found in the appendices provided at the end of the document.

4.10 CONCLUSION

In conclusion, it is fair to say that the medical laboratory environment is one that is fairly technical and filled with multiple specifications and protocols that needs to be adhered, in order to ensure the safety of both the environment as well as the people that consume the space.

These environments need to be designed knowledgeably to compensate for said specifications while also being flexible to allow for future growth and development within the field. Ultimately, safety comes first and then human comfort in this environment and this needs to be a priority when designing these spaces architecturally.

CHAPTER 5: KEY PRECEDENT STUDY

5.1 INTRODUCTION

The following chapter reviews and analyses key precedent studies that pay special attention to both the medical research environment, and the considerations that need to be taken when designing an environment of its nature. Additionally, this chapter also proceeds to review precedent studies that pay special attention to and require the creative and innovative process in order to thrive as institutions.

These precedent studies have been critically analysed against the various theories and concepts discussed in previous chapters, as well the technical considerations required for a medical research environment. This analysis allowed for conclusions to be drawn that informed the design decisions made.

5.2 SALK INSTITUTE

5.2.1 Project Description

Having been commissioned and developed for medical researcher and virologist, Jonas Salk who is best known for his discovery of the vaccine for Polio, this institute is considered one of the most famous projects for renowned architect Louis Kahn.

Both these men began this venture with the intention of connecting the disciplines of art and science as a synthesis of intuition and reason. (Carlson & Huang, 1967) As a result of this rigorous process, many themes are explored within the design: the play of light and shadow upon form, the concept of monumentality, the tension between the effable and ineffable.

This is because Jonas Salk intended for a research facility that begins to inspire the creativity through its setting and design. In addition, a low maintenance facility that will age gracefully while offering a transcendental experience through materiality and design was also a requirement. The result of these factors and such requirements is a building that inspires creativity and innovation through its setting.

5.2.2 Justification of Precedent Study

Being a research institute that initially required the accommodation of 10 major scientists, each of whom required approximately 930 m^2 of space with the inclusion of room for expansion, meeting rooms and administration. This institute posed as an ideal candidate to be analysed.

In addition to paying attention to how services were handled to result in one of the most flexible laboratory spaces, the design took into account the exchange between people and the positive effects it has on research and innovation.

According to Crosbie (1993) Salk called the process of collaboration and communication, “Osmosis”, whereby people exchange ideas and thoughts through interaction. Therefore special attention was paid to informal discussion places, stairways and courtyards etc. to influence and facilitate interaction.

5.2.3 Location

Geographically, The Salk Institute is located at as seen in figure 21:

10010 N Torrey Pines Road, San Diego, California, 92307, United States.

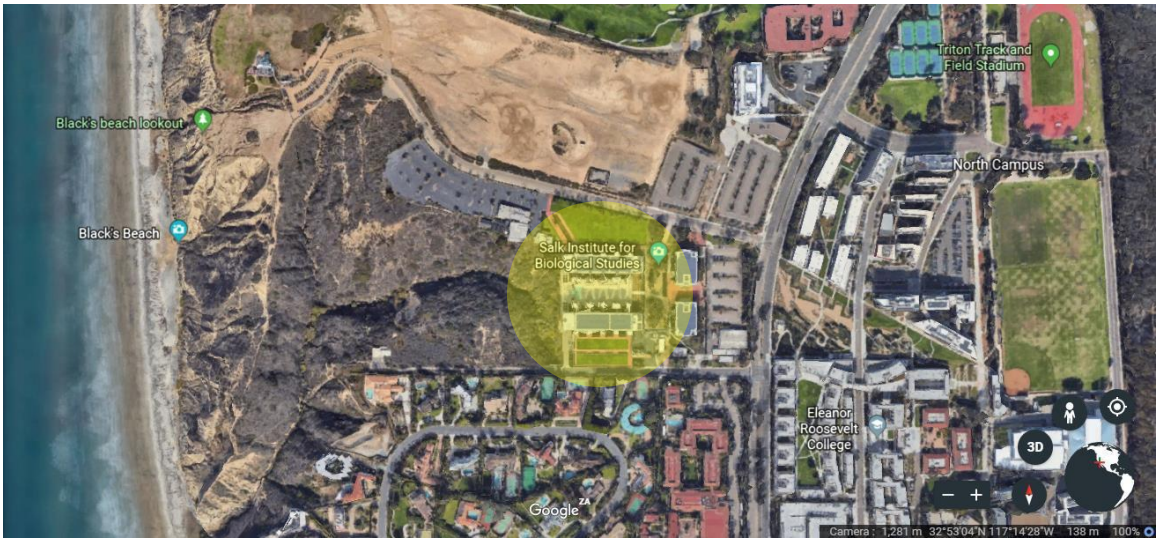


Figure 21: Geographic Location.
Source: Google Earth

Scenically the Salk Institute is built on a high coastal site in La Jolla, perched on the edge of an extraordinary cliff that overlooks the Pacific Ocean located in southern California.

This building that was tackled as an “intellectual retreat” is considered monumental, as well as spiritually inspiring as it draws inspiration from the design of monasteries in terms of its use of an axis as seen in figures 22 and 23, symmetry as seen in figures 24 and 25 and rhythm as seen in figures 26 and 27. Essentially, the strong axis created by the two groups of buildings being divided by an open plaza provides a beautiful and humbling experience framing the stunning backdrop and landscape of the sky and the ocean.

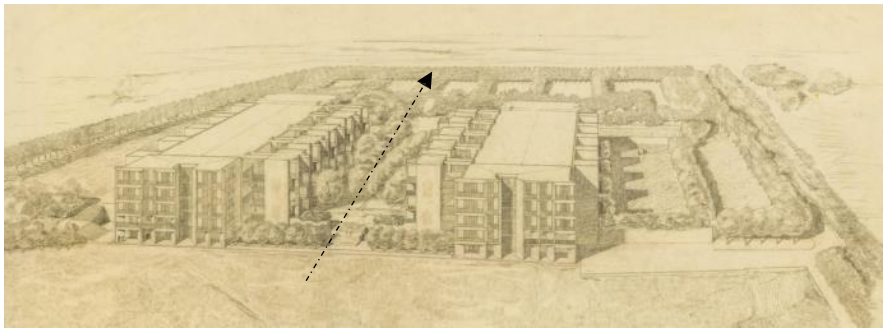


Figure 22: Axis dividing two buildings.
Source: (Inskip, et al., 2016:54)

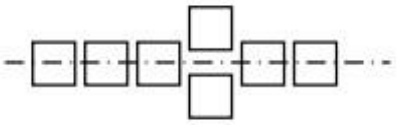


Figure 23: Axis dividing two buildings.
Source: Author

Figure 24: Symmetry created by mirroring the two buildings.
Source: (Inskip, et al., 2016:48)

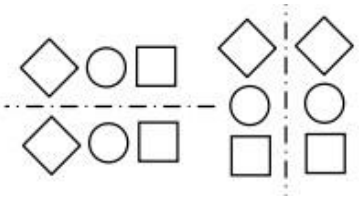


Figure 25: Symmetry through mirroring.
Source: Author

Figure 26: Rhythm and repetition created through juxtaposition.
Source: (https://www.archdaily.com/61288/ad-classics-salk-institute-louis-kahn/5037df8528ba0d599b000124-ad-classics-salk-institute-louis-kahn-photo)

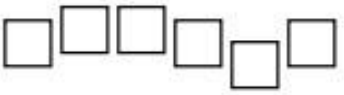


Figure 27: Rhythm and repetition through juxtaposition.
Source: Author

Ultimately, the building and its location makes continuous reference and expresses the landscape that it is encompassed by as seen in figure 26.

5.2.4 Layout and Spatial Planning

The Salk Institute is another example of Louis Khan's strong sense for preserving and creating lines. Therefore its complexity is based on symmetry that utilizes a linear axis framing the views and vistas. It is divided into two elongated groups of buildings that are divided by an open plaza. Each of these groups of buildings are six floors in height. Three of the six floors house laboratories while the other three house services and utilities. However, two of these floors are below ground level.

The elongated buildings that frame the central plaza are a series of detached towers that include rhythmical diagonal protrusions as seen in figure 28 that allow for westward ocean facing windows. These towers are then connected by small bridges to the laboratory blocks. Because each laboratory floor has its own interstitial space, the design of said laboratories are flexible enough to allow for the reconfiguration of open laboratories when and if required.

Figure 268: Elevation showing rhythmically diagonal protrusions.
Source: (Inskip, et al., 2016:48)

In addition mechanical systems are sealed behind block walls and not concrete walls to ensure that they are movable during maintenance as well as to allow for flexible spaces to promote spontaneous collaboration.

The material palette of the institute is fairly simple, honest and raw. Exposed concrete, teak, lead glass and steel are used as seen in figure 29. In conjunction, Kahn makes extensive use of nature with the use of wood, water features and constant views of the sky and ocean to ensure comfort for the user and ease of maintenance.

Figure 279:Honest and Raw material palette.
Source: (https://www.archdaily.com/61288/ad-classics-salk-institute-louis-kahn/5037dfa028ba0d599b00012a-ad-classics-salk-institute-louis-kahn-photo?next_project=no)

5.2.5 Spaces for Innovation

Considering the aforementioned theoretical and conceptual framework and the principles and factors they dictate, it is important to analyse the Salk Institute with these in mind.

Figure 30: Liminal space shown in the play of light and shadow.
Source: (https://www.archdaily.com/61288/ad-classics-salk-institute-louis-kahn/5037df9728ba0d599b000128-ad-classics-salk-institute-louis-kahn-photo?next_project=no)

Looking at the exterior of the building, the central plaza or courtyard which was originally intended to be a central courtyard space in which people gather, has instead become a spiritual and a liminal space due to the discomfort caused by the harsh weather conditions in the form of heat and glare as seen in figure 30. It has therefore undertaken the characteristics of a metaphysical space that induces inspiration within.

Even though the upper courtyard is not used for its intended purpose, there are other spaces that compensate for the purpose it no longer serves. This is seen in the lower courtyard and the cafeteria that provide a much needed respite from the laboratory space. Being filtered with natural light and surrounded by nature, this space provides a third space in which people can interact and collaborate thus promoting the watercooler effect.

The buildings themselves have been designed to promote collaboration as there are no walls separating the laboratories on any floor. These open plan laboratories and offices enhance interaction between people and a shared sense of learning, thus reiterating the idea of social constructivism.

Ultimately, this building succeeds in providing ample opportunity for interaction between people and the promotion of collaboration despite it being designed in 1959.

5.2.6 Service Approach

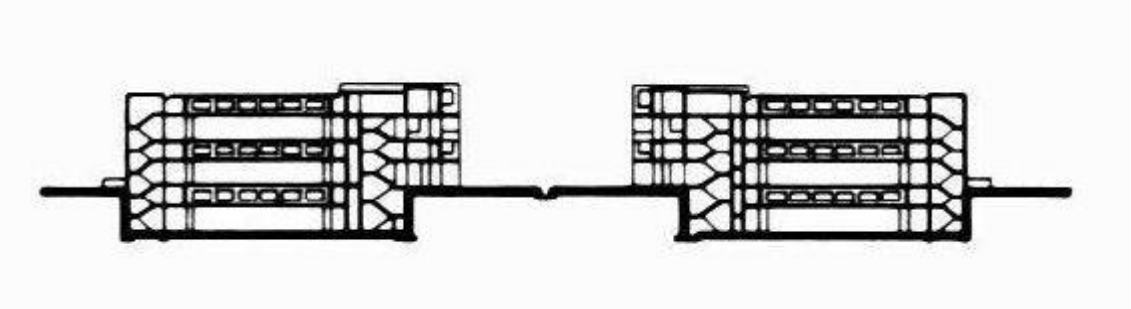


Figure31 : Interstitial floors above every laboratory.
Source: (https://www.archdaily.com/61288/ad-classics-salk-institute-louis-kahn/5037df7e28ba0d599b000122-ad-classics-salk-institute-louis-kahn-section?next_project=no)

The service approach that was taken in this building might be the reason for the functional success of the building. This is because Louis Kahn had a strong hatred for the use of ducts and pipes, therefore interstitial space to contain mechanical systems and utilities was used as seen in figure 31. Essentially this is a 2.75m high Vierendeel truss that spans 20m that is present on every alternate floor above a laboratory space. This space allows for flexibility below as it reduces the need for the support of columns, thus allowing for the modification of services and a reconfiguration of spaces if necessary. Major equipment spaces are found on the western façade in addition to being along the north and south facades in intervals.

Even though, this system comes with a number of perks, it does however increase the volume and height of the building due to the additional floors needed.

5.2.7 Conclusion

In conclusion, this research facility is extremely functional and ahead of its time in its thinking with regards to collaboration, social interaction and innovation.

Commendable attributes and concerns of this building include:

- The integration of natural features in order to increase user comfort and induce thought and spaces for collaboration and liminal experiences.
- The use of interstitial space to house mechanical services.
- The courtyard being used for a different purpose than originally intended but also becoming a liminal space.
- The building being divided by the central plaza which defies the concept of interaction that is sought after.

5.3 LOWY CANCER RESEARCH CENTRE

5.3.1 Project Description

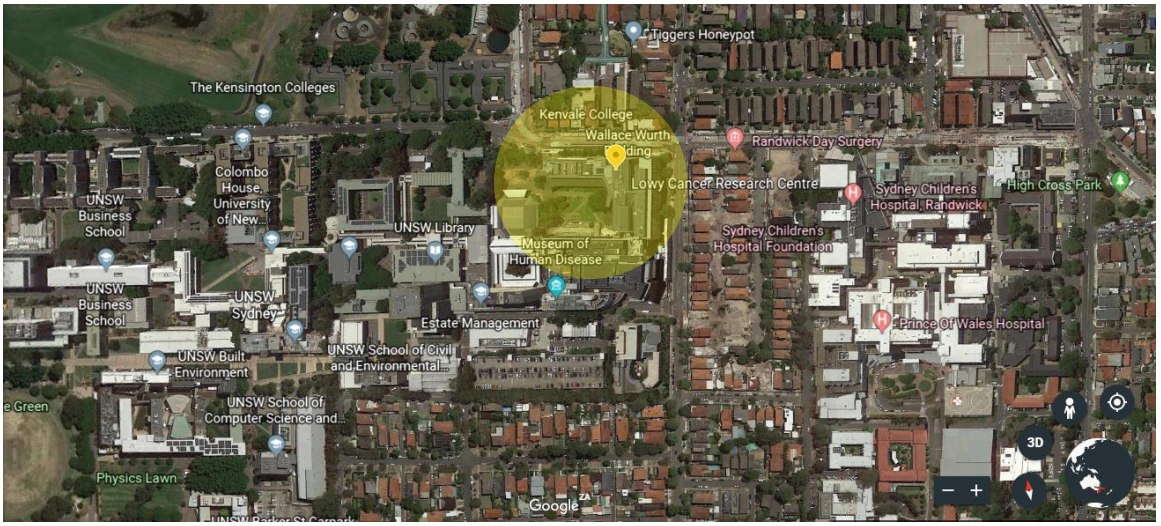


Figure 32: Geographic Location.
Source: Google Earth

Designed by Laznimmo Architects in conjunction with Wilson Architects this building is a culmination of many things: cutting edge design, sustainable design and a first in the Australian medical faculty. Being a collaboration between the faculty of medicine of the University of New South Wales and the Children's Cancer Institute of Australia, this building is not only built on the premises of the university but also alongside three teaching hospitals as seen in figure 32.

Figure 33: Building integrated with nature and its surroundings.
Source: (https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128bed28ba0d67170004e8-lowy-cancer-research-centre-lahznimmo-architects-photo)

With its project year being 2009, this fairly new establishment is the first of its kind in Australia being the largest dedicated cancer research centre in Southern Australia. Given the field of study, innovation is a crucial factor to be considered. Making reference to previously mentioned literature, the site selection is a major contributing factor to the innovative process. This building in particular is strategically located in close proximity to buildings that include like-minded individuals that provide opportunity for collaboration and interaction. In addition, being designed to meet the existing Wallace Wurth building and being wrapped around an existing tree provides the opportunity for constant interaction with nature as seen in figure 33 to inspire thought and creativity.

5.3.2 Justification of Precedent Study

Figure 34: Breakaway Spaces.
Source:(https://cubic.com.au/project/unsw-c25-lowy-cancer-research-facility)

Lowy Cancer Research Institute is a dedicated institute that focuses on innovation and medical advancements in this field. It is strategically located in an environment that is conducive to innovation. A variety of breakaway spaces that focus on the human comfort and stimulation provide a number of opportunities for integration and collaborative work, thus increasing the chance of innovation as seen in figure 34.

Because this is a new facility, it includes a fresh and new approach to innovative building design while taking cognisance of past buildings and literature. The result being a flexible and continuously evolving research facility that is capable of adapting to a developing research.

This facility is the culmination of functioning laboratory space and new methods of learning that promote innovation in the research environment. Therefore, it provides the perfect opportunity for lessons to be learned.

5.3.3 Location

The physical location for this institute is as follows:

University of New South Wales, High Street, Kensington NSW 2052, Australia.

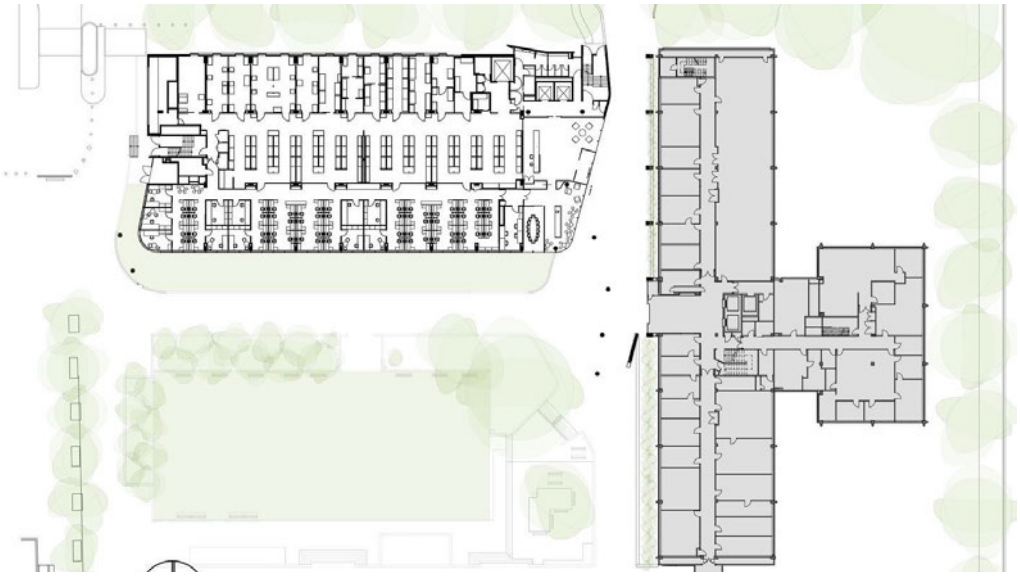


Figure 35: Site Plan showing integration with nature and link to existing buildings.
Source:(https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128c2528ba0d67170004f4-lowy-cancer-research-centre-lahznimmo-architects-site-plan?next_)

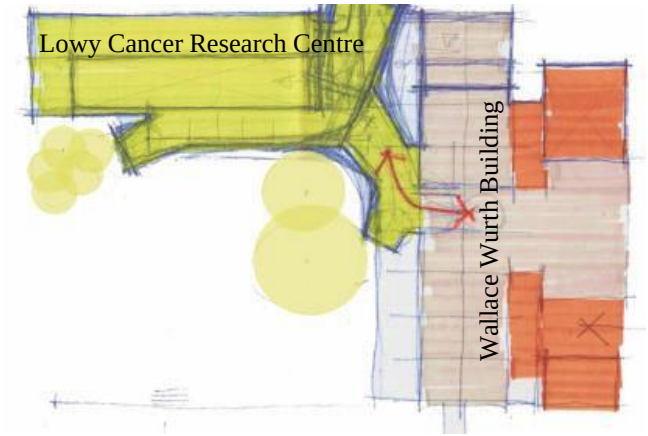


Figure 36: Link between Wallace Wurth Building and Lowy Cancer Research Centre.
Source: (https://archello.com/project/lowy-cancer-research-centre)

The building is constructed on the northern end of the University of New South Wales, Kensington campus. It forms a component of the universities biomedical precinct which essentially includes the Biological Sciences Building and the Wallace Wurth building. Ultimately, this world class facility serves as a uniting element, bringing together over more than four hundred researchers and support staff.

Being adjacent to the medical sciences buildings enhances the probability of collaboration and innovation to occur due to the opportunity for the cross pollination of ideas. In addition, being constantly surrounded by nature provides a constant sense of community and integration between researchers.

5.3.4 Layout and Spatial Planning

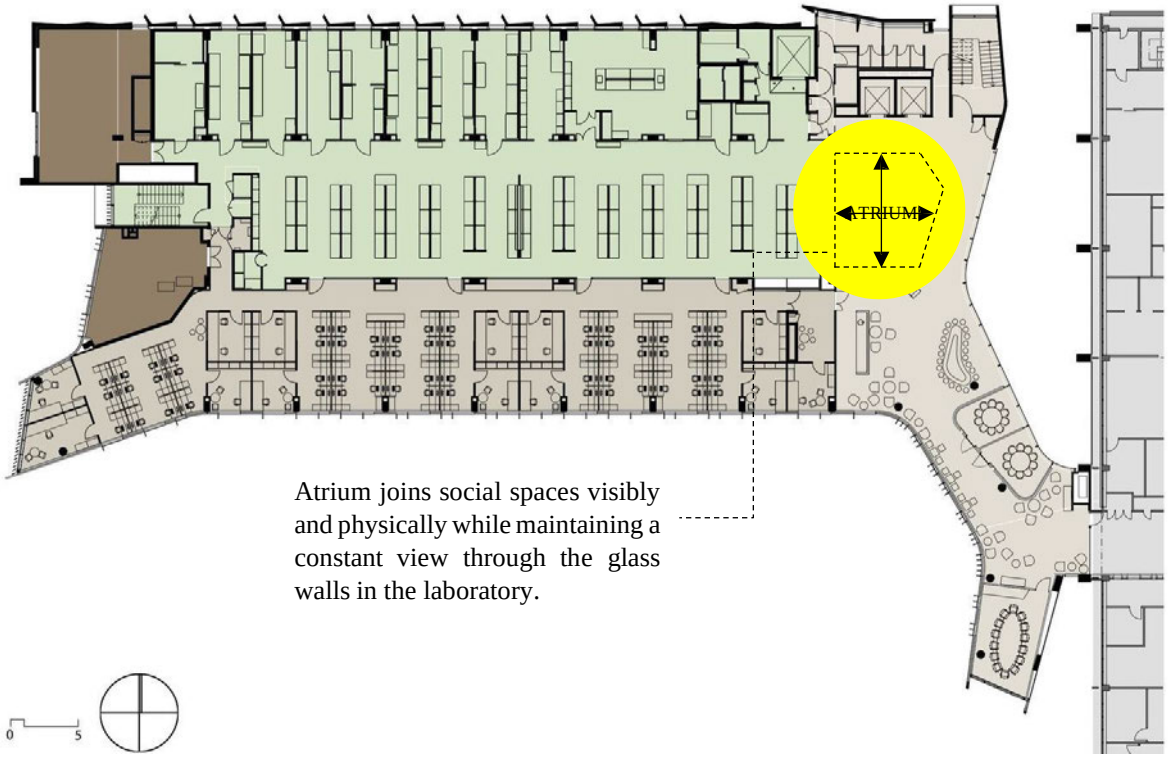


Figure 37: Floor Plan showing open plan laboratories and offices. *Source: (https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128c1a28ba0d67170004f1-lowy-cancer-research-centre-lahznimmo-architects-plan?next_project=no)*

Consisting of eight levels, this facility amounts to an area of 17 000 m². Within this area of 17 000 m², the following services are encompassed:

- Four levels of generic microbiological research laboratories.
- One level of shared support laboratories.
- One level for animal research.
- One level for administrative services.
- Shared common interaction areas which serve as a link to the adjacent Wallace Wurth Medical Sciences building.

Due to the laboratory components and the technical requirements that accompany it, the building is automatically divided into formal and semiformal workspaces.

What is deemed as the “Lab Box” aims to reach a balance between these formal and semiformal workspaces. In conjunction to comprising of laboratories and support spaces, it includes spaces such as write up spaces and a number of shared break out spaces, that provide the perfect opportunity for collaboration to occur.

In an attempt to achieve an open ended building that begins to encourage interaction between both people, and people and nature, the atrium serves as a uniting element that not only allows light into the space but links the laboratory floors while containing all vertical circulation, breakout and meeting spaces. Additionally, the facility is linked to the Wallace Wurth Medical Faculty by means of a diagonal path and an actual bridge, as seen in figure 36, therefore a literal and metaphorical connection is had.

In order to further encourage interaction, the corridor spaces are augmented in order to include informal kitchens, lounges and semi open plan work areas.

While a sense of openness is enjoyed visually, many of these spaces have restricted access due to the work being done within. This is an important element to account for. Essentially, while accounting for all the technical requirements and considerations, a healthy balance is found with regards to spatial openness, visually and literally and social space within this building.

5.3.5 Spaces for Innovation

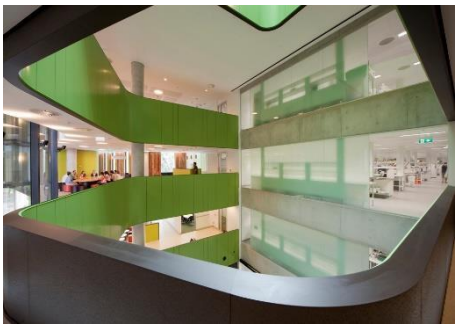


Figure 38: Central atrium to encourage interaction.
Source:(https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128bfb28ba0d67170004eb-lowy-cancer-research-centre-lahznimmo-architects-photo?next_project=no)

Although this facility is function heavy in terms of the laboratory component, interaction in the form of an atrium is a major factor that has been considered and designed for in order to encourage collaboration.

The atrium space as seen in figure 38 is regarded as the main social space, due to its unifying nature both literally and metaphorically. It has been labelled the "science knowledge bank" where knowledge is the strength and core of the people that exist within this space and how it is used, shared and exchanged.

Bringing people together with no real means of hermitage or opportunity, to avoid one another is the beginning of collaboration and the social constructivist view of shared learning experiences through interaction.

Because of this idea of shared spaces enhancing the potential for collaboration and a cross pollination of ideas between individuals, this facility provides what is often called "**third place**" which encourages the concept of the watercooler effect as previously mentioned.

Figure 39: Open laboratories encourage collaboration.
Source: (https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128c0b28ba0d67170004ee-lowy-cancer-research-centre-lahznimmo-architects-photo?next_project=no)

These third place**s** reveal themselves in the form of shared and informal kitchens, lounges, open plan work areas and write up spaces. Within these spaces, interaction is inevitable. What is essential to the success of this environment is the consideration and addition of nature when designing. Within this facility, researchers have the relief of an enriching view of a garden that this building is encompassed by. This view and surrounding spaces provide the opportunity for a liminal experience to be had thus resulting in breakthroughs and new thoughts with potential to ignite the creative process of innovation. In addition, the use of colour as seen in figure 38 and 39 within this building is one that is inviting and refreshing, while refraining from being too overwhelming to the user.

5.3.6 Service Approach

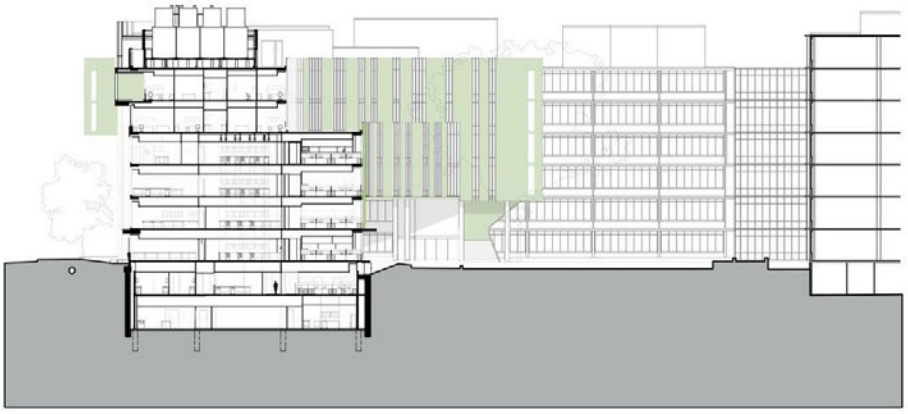


Figure 40: Section showing laboratory spaces and a plant room on every floor.
Source: (https://www.archdaily.com/77592/lowy-cancer-research-centre-lahznimmo-architects/50128c2228ba0d67170004f3-lowy-cancer-research-centre-lahznimmo-architects-section?next_project=)

The service approach in this facility is one in which efficiency has been prioritised. As a result, there is a plant room on every floor for each lab and office area. With this approach, all noisy heat-generating equipment has been grouped together in order to manage heat efficiently. Efficiency and sustainability was taken into account with regards to many aspects. These include:

Energy:

- A 750 kW engine-powered cogeneration plant that is located on the roof of the building generates low carbon electricity while capturing waste heat in order to generate hot water for heating and domestic hot water use.
- High-efficiency fluorescent fittings that include daylight occupancy sensors reduce energy consumption.

Water:

- In conjunction to having water efficient fixtures installed throughout the building, bore water from the university's aquifer provides non-potable water for use in sanitation and cooling towers.

Waste:

- In order to achieve efficient recycling and to minimise waste to landfill sites, waste is collected and disposed of accordingly by a third party facility.

5.3.7 Conclusion

To conclude, being a fairly new facility as well as a facility that is dedicated to cancer research, this facility includes a number of guidelines and opportunities for lessons to be learned.

In particular:

- The site selection which considered the surroundings in terms of facilities, people and nature.
- Using nature to its maximum potential.
- The manner in which breakaway spaces and spaces for collaboration are integrated into the design so that they do not appear as obvious spaces but rather accidental.
- The sustainability features within this building.
- The treatment of services and the approach taken.

Ultimately, this building is function driven while including a number of opportunities for collaboration and in turn, innovation.

5.4 DROPBOX HEADQUARTERS

5.4.1 Project Description

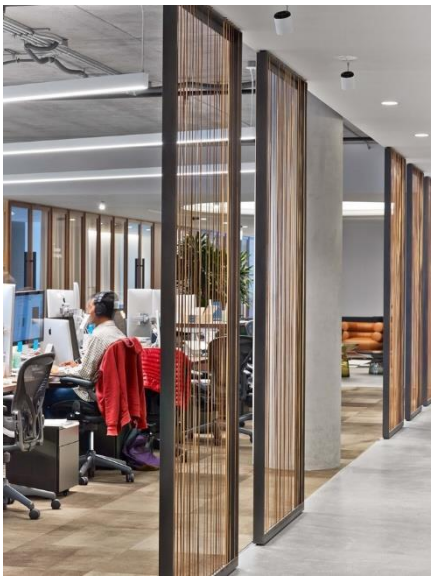


Figure 41: Combination of public and semiprivate spaces.
Source: (https://officesnapshots.com/2017/01/03/dropbox-offices-san-francisco/)

Dropbox, is a leading collaboration platform that has successfully transformed the way people and teams work together.

This particular project is the Dropbox Headquarters that is located in San Francisco, one which succeeds in accommodating multiple employees in a 300 000 square foot office space that successfully cultivates a creative environment and allows employees to collaborate and work anywhere they like.

Being designed by Rapt Studio, an architecture firm in California, this building strikes a balanced combination of public and semiprivate spaces, as seen in figure 41, that encourage group collaboration while respecting the need for individual user preference. This is accomplished through its unique neighbourhood concept of a radially expanding village that has both a strong core and smaller nodes.

Once defined by a software engineer within the company as a space that constantly pushes an employee out of their comfort zone, this creative agency is home to a multitude of creators and innovators.

5.4.2 Justification of Precedent Study

A company such as this includes a diverse group of people that range from quiet, industrious engineers to vocal marketing creatives. Thus a variety of spaces that align with different needs of different departments and individuals are required. Therefore, facilitation of interaction and collaboration is a vital component to the success of this space.

Succeeding in achieving a coherent space that celebrates simplicity, function and collaboration while maintaining an individualistic and humane feel that accommodates for all functional requirements, as well as a space that actively promotes innovation both intentionally and unintentionally, make this a valuable precedent study.

5.4.3 Location

The physical address of this particular building is:

333 Brannan St, San Francisco, CA 94107, USA

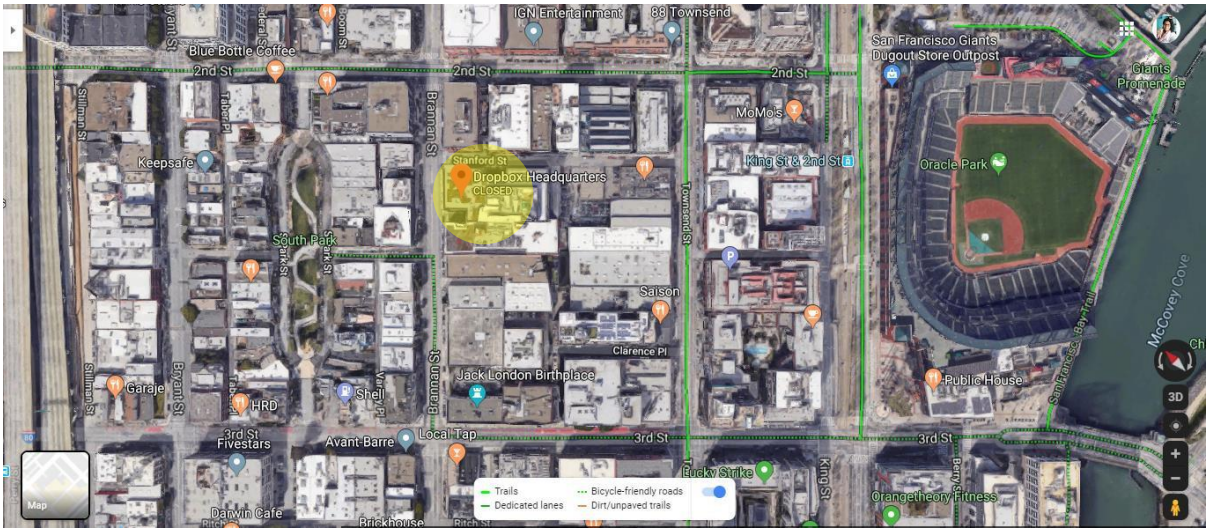


Figure 42: Geographic Location.
Source: Google Maps

Being part of an urban setting, this building forms part of the South Market district that is becoming popular as an area for its vibrant and bustling hub, that practices the phenomenon of “live, work, play” due to the close proximity of amenities.

Additionally, alternative forms of transport are encouraged in the form of stations, bike routes, an on-site car share program as seen in figure 42. What can be seen is the active practice of the theoretical framework of new urbanism. Whether this is intentional or not, it is uncertain however, it has proven to be successful.

The building itself is a culmination of two buildings being seamlessly joined together to form a coherent organism. Being 300 000 square feet, this building consists of six floor levels as well as a rooftop garden that overlooks the bustling city below. In addition to many indoor plant fixtures, this was a means of bringing nature to the city.

Figure 43: Passive Ventilation through operable exterior windows and louvres.
Source: (https://www.sandis.net/projects/dropbox-hq-333-brannan)

In keeping with the characteristics of the area, this building is a Leadership in Energy and Environmental Design Platinum Certified building, that features large highly flexible open office floors that surround a central court. Additionally, passive ventilation and the

introduction of natural light is used to its full potential, with operable exterior windows as seen in figure 43. Courtyards that are richly and openly landscaped face the existing neighbourhood while the exposed brick and concrete ensures that the building blends with the historically industrial neighbourhood.

5.4.4 Layout and Spatial Planning

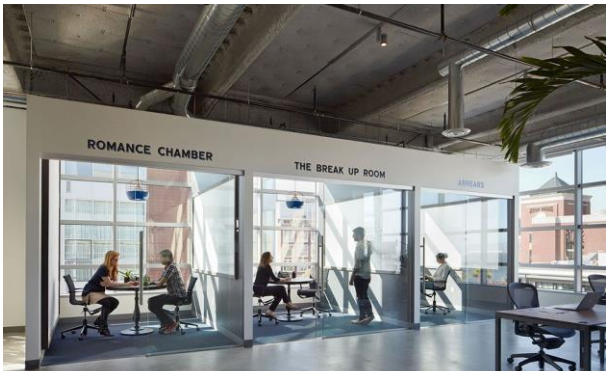


Figure 44: Variety of open plan spaces and secluded offices.
Source: (https://officesnapshots.com/2017/01/03/dropbox-offices-san-francisco/)

Rapt Studio, took the approach of creating a neighbourhood and a village within the confines of a building. This is because while conducting research and speaking to many of the employees of Dropbox, a sense of frustration was conveyed with regards to the planning of older office spaces, where narrow hallways with little boxes of office space was the go to.

Instead, the approach that was undertaken was one that made reference to a bustling city layout, that includes landmarks and distinctive neighbourhoods which are flanked by portals and meeting rooms, that align with the different departments as seen in figure 44. Therefore, groups of 40 to 50 people begin to create their own subcultures and spaces. This results in a space that is primarily open plan.

Figure 45: Inside outside feel enhanced through the introduction of nature in the space.
Source:(https://officesnapshots.com/2017/01/03/dropbox-offices-san-francisco/)

As in navigating a city or a village, strategic spaces for different modes of work act as landmarks. This includes spaces such as: the library, the purposeful deep focus room, the karaoke bar, the coffeeshop, classrooms, conference and meeting rooms as well as a distinct lobby.

Another important factor that was considered is the idea of the sought after “inside outside feel.” This is achieved through the use of massive mirrors that collapse the distinction between inside and out, indoor plants and the use of massive suspended terrestrial moss balls as seen in figure 45. A sense of diversity and comfort is achieved in scale, material, colour and sensory cues that are ignited through the different spaces for different moods or working styles.

5.4.5 Spaces for Innovation

In a company such as this, innovation is crucial. From the spatial planning we learn that the concept of collaboration was a driving factor in the organization of spaces as well as learning of a few spaces that have been designed with the intention of igniting thought and experience.

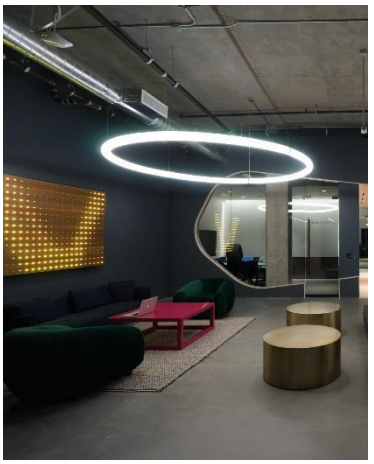


Figure 46: Deep focus room to allow for liminal thinking.
Source:(https://officesnapshots.com/2017/01/03/dropbox-offices-san-francisco/)

From the moment you enter the building, you are met with a serene lobby that invites an individual to experience nature while simultaneously being inside. This is reinstated not only by the large windows and mirrors but by the large suspended terrestrial moss balls as shown in figure 45, the use of indoor plants as well as the materiality palette. Therefore, despite being located in an urban setting, nature is successfully introduced within the space and the feeling of human comfort is enhanced.

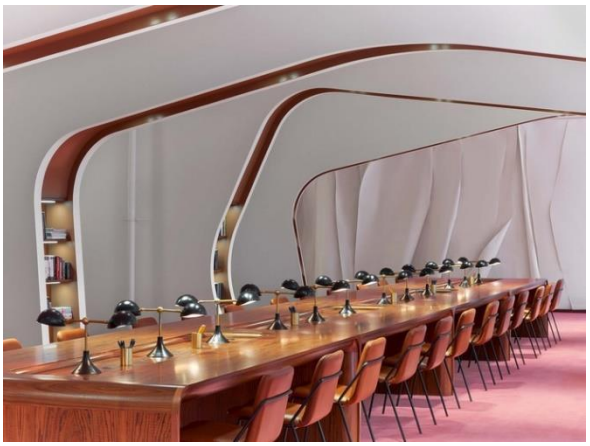


Figure 47: Library space with communal desk for collaboration.
Source:(https://officesnapshots.com/2017/01/03/dropbox-offices-san-francisco/)

Using the neighbourhood concept in a literal sense, the architect created distinct working spaces in which people can relate to and exist in. This eliminates the use of secluded office spaces and a neutral platform is created. This platform serves as so called "**third place**" as it creates the perfect opportunity for accidental interaction and communication simply by sharing a common workspace and the idea of social constructivism is enhanced.

However, this concept of social constructivism is not only experienced via the neighbourhood concept but also through the library space that was included in the design of this building as shown in figure 47. Providing a comfortable retreat that feels familiar becomes an attractive destination. One such space that is known for its quiet time not only provides relief to a person, but also invites a person to interact through the large collegiate communal desk provided.

If the library did not allow an individual to experience relief, the architects have also included what is being labelled as, "The Deep Focus Room". The deep focus room as shown

in figure 46 is a dark room characterized by dimness, dark colours and clean lines. Making reference to previously mentioned literature in chapter 3, this space creates the perfect opportunity for a liminal experience to be had. One may feel comfortable in such as space and allow themselves to experience serenity, insight and deep thought.

A company such as this recognizes the need for creativity and efficient production as well as the necessity for down time and relaxation. Thus, people can come together in micro kitchens, communal spaces or the Karaoke Bar as shown in figure 48. The introduction of these spaces are an obvious take on the watercooler concept. In conjunction to the actual watercooler, these intentional spaces are provided in order to encourage communication, interaction and collaboration.

Figure 48: Karoke Bar that acts as a third place to encourage interaction.
Source: (https://officesnapshots.com/2017/01/03/dropbox-offices-san-francis co/)

5.4.6 Service Approach

Dropbox being a global software company, the building relies heavily on the steady supply of electricity in order to function. Important considerations include: the need for uninterrupted power supply, the need for sufficient electrical connections within the facility etc.

Therefore the method of horizontal distribution is used. This is a system whereby major service lines are grouped and hung from the underside of the structural floor system. This system offers more flexibility and simplicity and is ideal for a facility such as this.

Providing sustainability was also a contributing factor. Thus, the roof contains integrated photovoltaic panels that reduce energy usage by more than 25%. Additionally, on site rain water capture occurs reducing the potable water demand by more than 45%.

5.4.7 Conclusion

In conclusion, this building provides many insights to the creation and design of creative spaces that will potentially encourage innovation.

What is learned is that:

- Spaces for communal interaction and learning is crucial as it provides a neutral platform for people to interact, learn and discuss.
- Eliminating the use of individual offices provide a better sense of neutrality and eliminates the concept of hierarchy.
- Despite the need for communal interaction, space should be provided for down time that allows a person to step away from others.
- Regardless of setting, it is crucial that nature be considered and introduced into design.
- Materiality, colour and scale plays an important role in setting the mood of a space.

Ultimately, this space proves to be successful in igniting creativity and thus innovation.

CHAPTER 6: CASE STUDIES

6.1 INTRODUCTION

Case studies play an important role under any research circumstance, more so in the architectural world. This is because in order to understand, learn from mistakes and potentially improve upon, it is highly beneficial to both investigate, observe and experience what already exists. It is for this reason that the following case studies have been visited:

- Africa Health Research Institute – K – Rith Tower Building
- Espresso Advertising Agency

At first glance, both of these case studies seem extremely different and in many ways they are. However, given the research topic at hand, it is important to investigate both spaces that involve technical aspects and the environment needed in medical research, in conjunction to spaces that thrive on creating and promoting innovation. Both these case studies were visited and a considerable amount of time was spent here in order to observe the space, take photographs, speak to people and conduct interviews. In both instances, tours were given through the institute by people who utilize the space on a daily basis and are familiar with the functionality and use of the space. These interviews and discussions are included at the end of each case study.

6.2 K -RITH TOWER BUILDING

6.2.1 Introduction

Figure 49: Exterior of K-Rith Tower Building.
Source:(http://www.parsonsandlumsden.com/index.php/krith-laboratory/)

Like many research institutes designed for student use in conjunction with professionals, the K-Rith tower building has an anchor tenant in the form of the University of KwaZulu Natal's Nelson R. Mandela School of Medicine.

This building that originally began as the KwaZulu Natal Research Institute for TB-HIV has slowly evolved and has become a leader in its field due to it joining forces with the Africa Centre for Population Health in order to become the Africa Health Research Institute (AHRI).

Designed by FGG Architects and having secured funding by world renowned agencies, which includes the Howard Hughes Medical Institute and Wellcome Trust to support its activities up to 2023 and beyond, this building is the grounds for an exciting interdisciplinary research institute.

In its entirety, the building consists of eight floors joined by a central atrium as seen in figure 50. In the pursuit of gaining a better understanding, forming better treatment protocols and ultimately curing HIV, tuberculosis and related illnesses, the seventh floor is home to a 600 m² biosafety level 3(BSL3) facility which essentially allows scientists to safely handle air-borne diseases and pathogens.

This building is an exciting modern addition to the dated and historic buildings that the University of KwaZulu Natal has come to be known for. Despite it being a cramped site, this building is able to house world class facilities.

6.2.2 Justification of the Case Study

Figure 50: Central Atrium to encourage interaction.
Source: (http://www.parsonsandlumsden.com/index.php/krith-laboratory/)

Due to this research looking at the architectural ability to enhance medical research innovation it is only fitting that a research institute be investigated. This is because of the insight needed with regards to designing a research facility and the technical considerations that need to be taken into account. Looking at KwaZulu Natal as a whole, this facility has proven to be one of the most prominent research facilities following its win of a regional award given in 2017, by the South African Institute for Architects, its Corobrik-South African Institute of Architects merit award in 2018, and its joint venture with the Africa Centre for Population Health to form the Africa Health Research Institute (AHRI) in October 2016.

A building such as this succeeded in providing invaluable insight into the research environment and the process it involves. Due to its successful integration with the existing Nelson R. Mandela School of Medicine, and the inclusion of sophisticated state of the art laboratory facilities, this building provides not only historical information, but also insight into the addition of new biomedical research facilities and the requirements they possess.

6.2.3 Location and Background

Location: K-RITH Tower Building, Nelson R. Mandela Medical School,

719 Umbilo Rd,

Umbilo,

Durban,

4001

Architects of K-Rith Tower Building: FGG Architects

Architects of old facility (Doris Duke Medical Research Institute): Robert Johnson Architects and Associates; FGG Architects; Langa Makhanya Architects and East Coast Architects

Figure 51: Geographic Location.

Source: Google Maps

Originally, the Nelson R. Mandela School of Medicine was home to only the Doris Duke Medical Research Institute. This institute was launched in 2003 and aimed at providing a dynamic and integrated research environment, for inter and multi-disciplinary medical research. The building was just 5 000 m² and contained 10 specialised laboratories over 2 floors. In conjunction, it accommodated for support functions in the form of administration, seminar rooms, multi-disciplinary research centres and clinical trial spaces accommodated over 3 floors in a linking structure.

However, over time this facility proved to be inadequate. FGG Architects were commissioned to design an addition to the pre-existing facility. This addition came in the form of the K-Rith Tower Building. This tower that is successfully integrated into the existing facilities acts as a landmark and an anchor that unifies the existing facilities as seen

Figure 52: K-Rith Tower building located at Nelson Mandela Medical School.
Source:(https://www.santheafrica.org/about/partners/main-santhe-sites/africa-health-research-institute-ahri)

in figure 52. The tower consists of a U shaped plan that is a total of 8 floors where the 4 storey high atrium is covered with an iconic inverted roof, which is symbolic of the US aviator and philanthropist Howard Hughes (1905 – 1976) who is the key sponsor of this addition.

Once the K-Rith Tower was built, the Africa Centre for Population Health merged with it to form the Africa Health Research Institute which is now a leading institute in the fight against HIV and Tuberculosis.

6.2.4 Interviews and Observations

Figure 53: Ground floor entrance.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

Upon visiting this institution one is met with a 5 storey dedicated parking garage which is adjacent to the K-Rith Tower Building. This is due to the spatial constraints on site. One enters through the ground floor as seen in figure 53 that provides direct access to multi-purpose spaces opening to a breakaway court and cafeteria space as seen in figure 56. The atrium encloses this circulation, multi-purpose spaces in the form of four seminar rooms and public ablutions, while also serving as a linking element to the two existing buildings at four levels. The atrium is finished with special acoustic timber along the floors and walls in order to create a comfortable, warm and homely space, that encourages social interaction between students, visitors and scientists. In addition the timber floor continues onto the open deck, thus creating a link and a continuous flow to the indoor and outdoor space that leads to a water feature. The first and second floors make up the office component which is occupied by staff, students and the Centre for the AIDS programme of Research in South Africa (CAPRISA). Looking at the topmost four floors, one would note that these are laboratory spaces which are concentrated on the northern wing only. The last floor of the tower is dedicated to services only, containing a massive plant room that services the laboratory spaces below as seen in figure 54. In addition the northern corner is splayed with expressed elements that focus on sun control. Beyond the first impression, observations were made with regards to the technicalities of spaces needed.

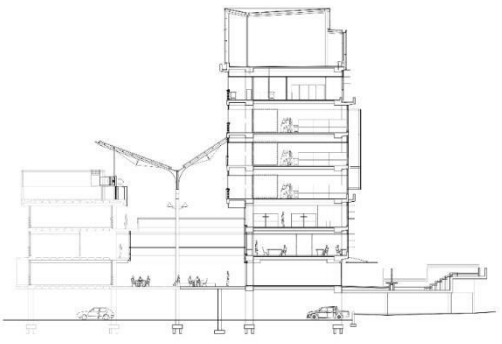


Figure 54: Section showing internal spaces, parking and plant room.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

Spatial Organisation

The first floor at K-Rith contains open plan office space as seen in figure 57. K-Rith laboratories are essentially a combination of both open and closed laboratories as seen in figure 58. While the laboratory floors are predominantly open, they do contain closed laboratories for specific work that requires an enclosed environment, with special equipment and specific safety precautions.

Figure 55: Plant Room.
Source:(http://www.parsonsandlumsden.com/index.php/krith-laboratory/)

The laboratories are stacked on top of each other in order to make servicing simpler. In addition to the dedicated BSL 3 laboratory directly under the service floor as seen in figure 59, every floor has a dedicated BSL 3 space, which are also stacked on top of each other in order to maintain coherency and simplicity in servicing. Every floor contains a distribution board that is clearly labelled.

While there is a dedicated plant room at the top most floor as seen in figure 55, space on the exterior of the ground floor within the parking garage has been allocated for plant rooms for the production of nitrogen, a cold storage for the storing of blood samples, storage for carbon dioxide, water and a dedicated space for the storage of the requirements for an uninterrupted power supply.

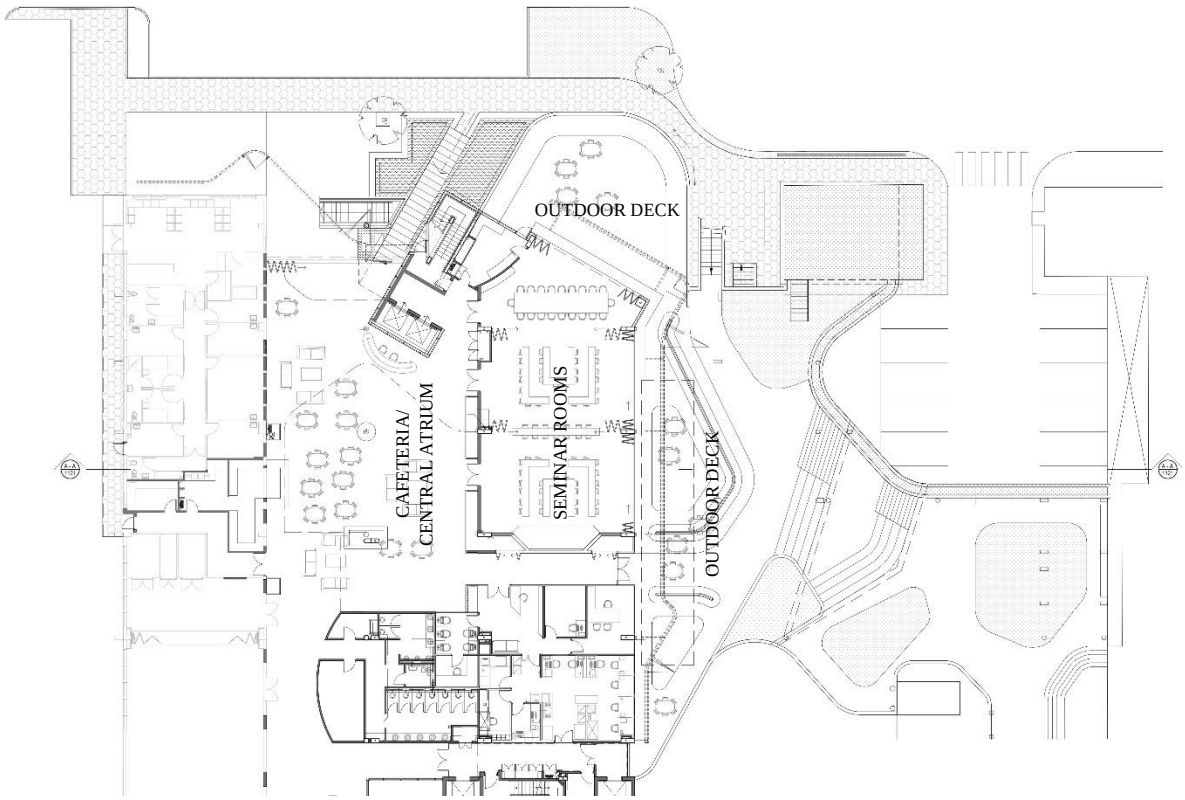


Figure 56: Ground Floor with multi-purpose spaces accessible off the atrium.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

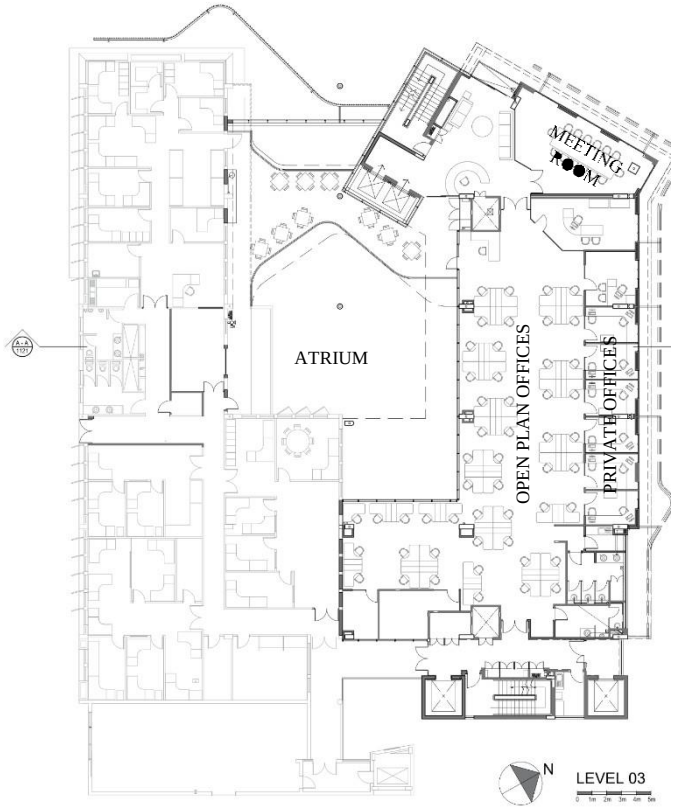


Figure 57: First Floor Office Space. *Source: (https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)*

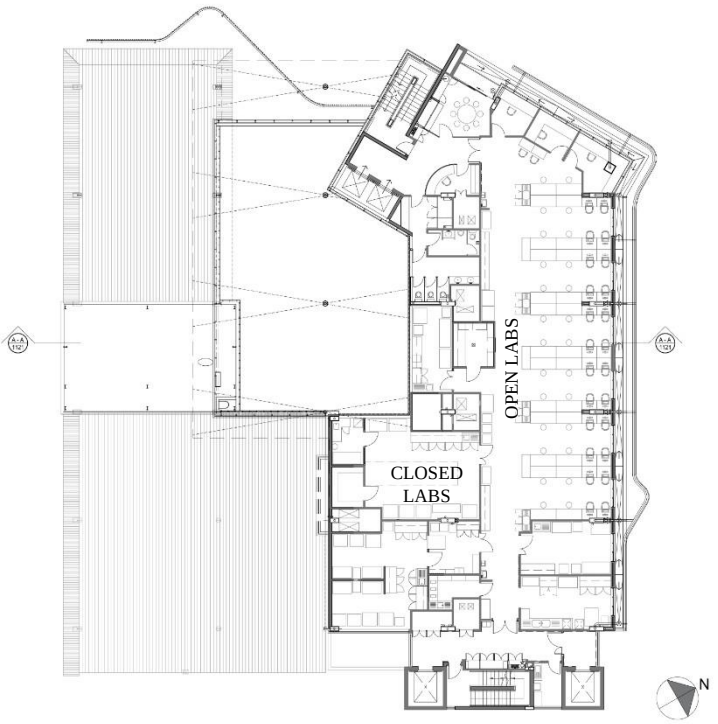


Figure 58: 3rd Floor Open Laboratories.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

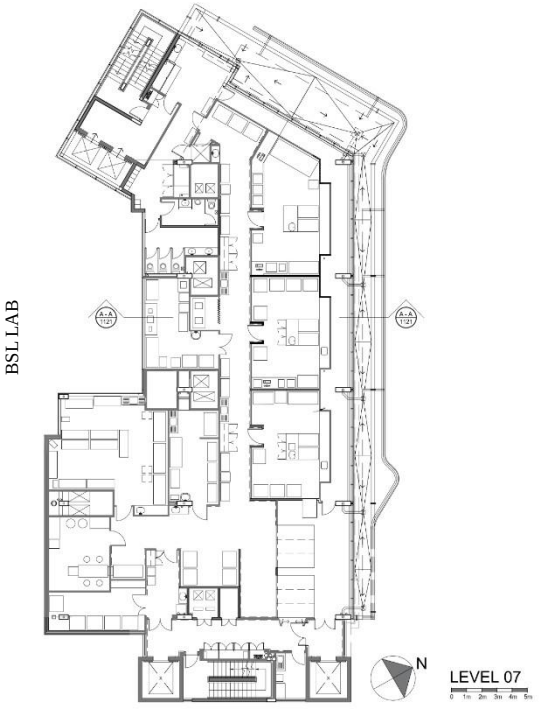


Figure 59: 6th Floor dedicated laboratory space.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

Furniture and Fittings

Figure 60: Typical open plan laboratory with furniture and fittings.
Source:(http://www.parsonsandlumsden.com/index.php/krith-laboratory/)

According to laboratory safety guidelines seen in attached appendices, every floor within a laboratory needs hand wash basins, eye washers and showers, in the event of a person coming into contact with any dangerous substance. The laboratories have solid granite working tops because they are good for resisting chemicals and keeping equipment stable as seen in figure 60. Storage space is provided in the form of cupboards, freezers and chemical stores.

Given that infection control is extremely important in a space like this, fittings and finishes are used accordingly. Basins use taps that open and close with elbows. Washing and sterilizing spaces are provided for every floor. Laboratories have double doors in order to allow for massive equipment. Every floor also has fire hose reels and fire extinguishers in order to comply with fire regulations. Above every doorway is a gauge and fire alarms, that detect the change in interior negative pressure, that keeps the negative pressure at a constant in order to maintain a sterile environment. Additionally, every space is access controlled to ensure that only authorised people access sensitive and dangerous substances and areas.

Biosafety Level 3 (BSL3)

Due to scientists engaging with risky strains of HIV and TB during research, K-Rith is therefore required to meet the standards for Biosafety Level 3 laboratories. It is because of this all rooms are under negative pressure; in simple terms this means that there are fans constantly sucking the air out of the room, and that the air is filtered out through high efficiency air-filtration systems, to ensure that the air is sterile as it leaves the building as seen in figure 61. Within these rooms with negative pressure, no air is reused. The BSL 3 laboratory differs in that you enter an anteroom first where you are required to put on protective equipment called Tyvek suits to protect clothing,

Figure 61:Air being extracted at roof level.
Source:(http://www.parsonsandlumsden.com/index.php/krith-laboratory/)

N95 masks for respiratory purposes, double pairs of gloves and shoe covers. Additionally, the ceiling, doors, triple glazed mechanically ventilated and double glazed windows and signs are sealed in order to monitor the air within.

Figure 62: Louvres and glazing used to save energy. Artwork at the entrance.
Source:(https://www.kznia-journal.org.za/sites/default/files/saia-kzn_2-2017.pdf)

Energy Saving Systems

The offices are equipped with occupancy sensors and the buildings management system monitors the lights on all floors. In conjunction to this, the building has louvers on all north and west facing façade glazing as seen in figure 62. The building reuses all water and condensate used and created during the air conditioning process, thus not making use of municipality water.

Artwork

The mosaic designs done by artist and architect Jana du Rand follow critical regionalism and biophilia principles. Many of the paintings and designs are that of cells, viruses and indigenous plants.

6.2.5 Interview: Bryan Mcmaster – Building Manager at K-RITH

Design Program:

- **Was there a driving design concept in the building? If so, what was it?**
  The aim was to achieve a modern aesthetic, while completely satisfying the technical requirements needed to effectively perform its research function. In addition the exterior of the building is designed to reflect the varying functions performed at each level, and the intention was to create a BSL3 laboratory that is the largest in the southern hemisphere. In addition the primary circulation is via a staircase and lifts located in a glass tower that aesthetically ties the levels together.

- **How have you achieved function and space making integration?**
  The laboratory spaces are stacked on top of each other to ensure functionality as well as simplicity in servicing and consistency. In this way, every floor has the necessary spaces needed in terms of laboratory spaces and social spaces.

- **How has environmental factors such as topography, orientation, surrounding land functions, vehicle and pedestrian movement and potential impacts (such as sound, vibration and other environmental pollutants) or surrounding activities on the site been designed for?**
  The site restrictions has governed the orientation and the development. This is because it was impossible to accomplish every space required if the development were to occur laterally therefore the development occurred vertically. In this way movement was dictated to be vertical for both cars and people. Because it is an industrial area, the building is structurally sound and surfaces hard to ensure that the vibrations occurring does not affect sampling. In addition, laboratories have efficient and sufficient air filtration systems to ensure that air leaving the building is safe.

- **How has security concerns and access been approached in the building?**
  Every floor and laboratory space is governed by card access. This ensures that only personnel who have undergone safety training are allowed to enter spaces.

- **How have you maintained transparency with secure areas and those that are accessible to everyone?**

  Laboratories have glass windows on doors as well as glazing on its surrounds to ensure transparency. The addition of the viewing space ensures visibility is maintained.

Servicing:

- **What were the specific requirements for servicing and how did you approach it?**

  Due to servicing demands of this type of facility, the laboratory spaces on each floor are stacked in order to ensure ease of connections and servicing. Each floor has a clearly labelled distribution wall that correlates with every electrical port in the building. The building has allocated space for an uninterrupted power supply as well.

- **Has long term flexibility been addressed in the building? If so, how?**

  The only possible way for expansion of this facility due to the site constraints is if one builds up.

- **What support spaces were included and what is their relation to the served space and to each other?**

  Support spaces include the ground floor that includes conferences spaces and a cafeteria that provides space for interaction. The first and second floor include office spaces as well as break rooms and cafeteria like spaces. The laboratories include break rooms and kitchens for people to eat and socialize away from the laboratories.

- **What have been the complications, advantages and disadvantages of the different servicing systems implemented?**

  By placing the plant room directly above the main BSL3 laboratory space, this ensures that servicing is at its most efficient and this allows for expansion and movement of spaces.

Physical Components:

- **What structural approach has been followed and what influence does this have on servicing and the creation of "human" spaces?**

  The structural approach was to maintain consistency and coherency of spaces, when planning to ensure that there would be a consistent structural grid.

- **How has the notion of the creation of an environment to optimize the functioning of the human mind been translated into the design of an appropriate range of micro-environments within research facilities, such as social, private, public, research and teaching environments?**

  The research laboratories include both open and closed laboratories to ensure communication and visibility amongst researchers, as well as to allow for singular research for those who require it. Every floor includes break room spaces and kitchens for people to interact with each other away from the laboratory. In addition, the ground floor is completely public with the inclusion of seminar rooms, a cafeteria and large break space to ensure communication and interaction. The office spaces are semi private and overlooks the public spaces therefore promoting interaction while ensuring a sense of privacy is had. Although this space is open plan, acoustic panels are arranged in clusters to allow privacy while maintaining visibility.

- **What has been the approach, if any, to the inevitable changing demands that the research places on the environment in which it is conducted in the short and long term?**

  Open and closed laboratories allow for change and the stacking of laboratories accommodate the services efficiently. However they do not leave room for much change.

- **What has been the approach to minimalizing the environmental impact?**

  The offices on level two and level three are equipped with occupancy sensors and the buildings management system monitors the lights on all floors. The building has louvers on all north and west facing façade glazing. The reuse of all water and condensate used and created during the air conditioning process ensures that municipal water is not used.

6.2.6 Conclusion

The K-Rith Tower Building is a state of the art facility that positively acts as a landmark and a unifying element to all the buildings and structural elements located at the University of KwaZulu Natal Nelson R Mandela medical campus.

The architects skillfully navigated the constraints that the site posed by developing vertically instead of horizontally. In this way, they were able to take into consideration and include every technical and design aspect. While there are spaces designed for interaction, it is primarily concentrated to the ground floor and decreases in size allocation and consideration as you progress to the laboratory floors. Even though, this is the case, open laboratories allow for successful interaction and communication between scientists and researchers, thus allowing for creativity and learning to thrive to potentially promote the idea of innovation.

The buildings services were successfully and strategically planned and placed on each floor, in order to make the process simpler and more efficient. In addition, the building design prioritises safety. Ultimately, this building has been skillfully design and extremely functional above all.

6.3 ESPRESSO

6.3.1 Introduction

Espresso is an all-encompassing group that includes services such as marketing, advertising and communications. This is a company that takes on a neutral approach that focuses on strategic thinking, in order to create powerful creative content that delivers a wide variety of media.

It is known for its modern-classic advertising that prizes the fundamental principles of the industry: vibrancy, uniqueness and smart thinking. Through Espresso's fifteen years of existence, it has completed a record number of 11 291 projects. Thus making a thriving company that is worthy of investigation, with regards to creativity and innovation.

Their advertising genius extends to helping widely known clients such as Nu Metro, Toys R Us, Galleria Mall, Labello, Nivea, Clover and Dove to name a few.

6.3.2 Justification of the Case Study

In order to justify this institution as a case study, it is important to note the previous literature that speaks of creativity to spark innovation. This is evident in the aforementioned theoretical and conceptual framework which discussed the following:

- The Watercooler Concept
- Liminal Space
- Social Constructivism
- Third Place

Due to this institution needing creative thinking in order to function, it is a centre for shared learning between co-workers thus embracing the idea of third place, as well as the concept of social constructivism. This is evident in the open plan working spaces in which people are encouraged to interact with each other.

In addition to thriving on creative thinking, it focuses on breakthroughs thus it makes excessive use of the idea of liminal space. This can be seen in transition areas that allow for integration as well as large windows that maximise views.

It is because of these reasons, that this case study provides the perfect opportunity for learning to be had with regards how innovation is achieved in real life circumstances.

6.3.3 Location and Background

Figure 63:Espresso located adjacent to the N2 but separated by a green belt.
Source: Google Maps

Location: Unit 4, River Junction
10 Hippopark Avenue
Riverhorse Valley Business Estate
Durban
4017

This full service group of marketing, advertising and communications company is headquartered in Durban, South Africa. This location is within the Riverhorse Valley Business Estate and is adjacent to the N2 highway. Even though it is adjacent to the highway, there is a green belt that is comprised of trees and a river that serves as a buffer zone to both the scenery and the noise as seen in figure 63.

6.3.4 Interviews and Observations

Figure 64: Crescent shaped building.
Source: Author

Upon entering the site, you are met with a somewhat crescent shaped building as seen in figure 64. On the North Western side, this building is bordered by a green belt that consists of both vegetation and a river as well as the N2 highway whereas the southern part of the building consists of a car park.

Figure 65: Modern and rustic interior.
Source: Author

However, the institution visited does not comprise of the whole building. It forms a part of many tenants that occupy the space. Upon entering the institution visited, one is met with a modern yet rustic interior, that displays the tectonic nature of materials as well as attempts to introduce nature into the space through the use of potted plants and warm colours as seen in figure 65.

Spatial Organisation

The work spaces at Espresso are divided in order to group like-minded people with a common goal and purpose. This division includes:

- An accounting department
- A human resources sector
- A creative studio

Each of these spaces are a combination of both open plan and closed office spaces, while maintaining a sense of transparency through the use of open doors and glass walls. The work spaces are open plan in order to encourage interaction between individuals working in the space, thus promoting a cross pollination of ideas and concepts.

Furniture and Fittings

Figure 66: Moody aesthetic of boardroom.
Source: Author

The furniture and fittings and the mood created by each component differs between the spaces within this institution, to ensure that spaces are conducive for their specific purpose.

The boardroom consists of a comfortable dark and moody aesthetic that creates a comfortable atmosphere, as seen in figure 66, that is ideal for the coming together of people in order to relax, brainstorm and engage in thought provoking conversation.

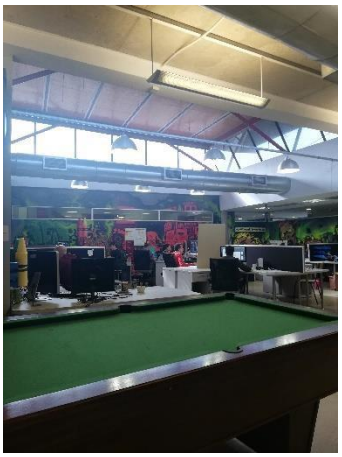


Figure 67: Creative Studio.
Source: Author

The accounting department and human resources sector are considered the least creative component, of an agency such as this. However, the interior aesthetic of this space is fun, light hearted and a little quirky. This can be seen in the use of different pieces of furniture, to enhance a sense of comfort and belonging as well as the variety in wallpaper.

The creative studio is the largest component of this institution. The space is housed under high ceilings with large clerestory windows that allow natural light to fill the space, in order to maintain the light airy feel needed to gain clarity of thought as seen in figure 67. This space finds a healthy balance between fun and a serious workplace environment. While there are individuals constantly at work, fun wallpaper, a doodle wall and a pool table provide the opportunity for a break to be had, and for people to gather and engage in conversation with one another.

Individual offices reflect the personalities of the person occupying the space with an assortment of personal belongings as seen in figure 68. This succeeds in becoming a home away from home.

Figure 68: Individual Offices.
Source: Author

6.3.5 Interview: Antony Ellis – Espresso

Understanding Creative Spaces:

- **How do you think the physical environment that you're in influences the creative and innovative process?**

  Often, the space you get to work with depends on the success of the company, and the kind of office space you can afford. However, I believe that any space can be made your own and a view can be made out of anything. The physical environment you're in, the interior design of it, open spaces or closed spaces, odd or weird shapes that evoke emotion and the materials chosen definitely has an impact on the way people feel and thus the creative process. These have the ability to affect the mood, the thought process and the general atmosphere in which one exists.

- **How do you ensure that the environment remains conducive to the creative process?**

  Providing comfort and allowing people to customize their environment while still ensuring that they are aware that it is a work environment is crucial. Space should reflect the people and the process within. When people are comfortable, they often produce their best work.

- **Do you rely on formal or informal communication when it comes to encouraging the creative process?**

  A bit of both. Sometimes it is informal communication in a formal setting, this is often how open plan offices work. However, sometimes people choose to work from home and often produce some of the most creative outcomes.

- **Were you involved in the design of spaces or how did you customize it to suit the creative flow that you're known for?**

  We were not involved in the design of the building itself. However, once we moved into this building, we took the liberty of making it our own. This can be seen in the furniture pieces, the wallpaper, the light fittings, just little things that begin to make a space feel like home to you. In addition, moveable walls are always a bonus so that we create the kind of space we need, whether it is open plan or closed offices needed

at any specific point in time. People often have different phases and I find spaces that are able to accommodate for that, often yield the best creative flow.

- **Do you value nature being incorporated into the building? If so, why?**

  I do, provided there isn't sunlight on our computer screens. Natural light and high ceilings allow for a sense of clarity to be achieved. Like, the green belt and the river adjacent to our building has so much potential which is not maximized and it provides great opportunity for breakaway spaces.

- **What would you change in order to create a more conducive work environment?**

  I would consider introducing and exploring:

  - Hot desking
  - Music
  - Lighting and how it affects the mood and the atmosphere
  - Creating pockets of spaces
  - More breakaway spaces for privacy while still maintaining a sense of transparency
  - More people centric environments so that you are allowed to feel humane within the space
  - A library or the introduction of more analogue spaces
  - Modular or organic spaces that allow for changes
  - Environments that allow for chance encounters to occur

6.3.6 Conclusion

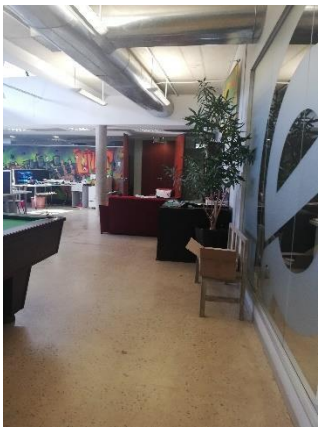


Figure 69: Open plan studio and individual offices with glass walls and open doors.
Source: Author

Espresso is essentially a creative agency, this is evident through the design of spaces. This agency proves that any space can be made your own and can be made to work efficiently.

The constant use and emphasis of shared learning experiences through open plan offices as well as the need for breakaway and adaptable spaces, as seen in figure 69 that start to feel like a home away from home. This reassures the level of value that social constructivism and the introduction of a third place has on the creative process and the development of people as a whole.

The need for space in terms of high ceilings and the introduction of light is clearly emphasized, as an element that contributes significantly to the clarity of thought that is needed in order to achieve breakthroughs and insights.

In conclusion, this successful institution provided many insights and adequately proved that any space can be made your own, if you are able to find a little bit of yourself in it.

6.4 CONCLUSION

In conclusion, paying a visit to each of these case studies provided rather insightful and informative experiences. Interacting with individuals who make use of these spaces on a daily basis, learning from them and observing and experiencing the spaces myself enabled a cohesive and comprehensive case study report.

The importance of providing adequate servicing for laboratories, the servicing requirements as well as safety precautions that need to be taken were observed and learned, in order to inform and provide a more comprehensive design outcome.

In addition, the importance of the aforementioned theoretical and conceptual framework discussed previously in the study, was affirmed. In creative spaces, it is crucial that individuals are provided the opportunity to interact with one another, learn, gather and form a home away from home in their work environment, in order to achieve ultimate creativity and thus innovation. A visit to each of these institutions provided both a learning curve and a once in a lifetime opportunity.

CHAPTER 7: SUMMARY OF THE STUDY, ANALYSIS AND FINDINGS

7.1 IDENTIFYING THE CHALLENGES

7.1.1 Limitations of the Data

It is crucial that the limitations of the data that has been collected be outlined. This is because many fields of study come with their own issues and limitations.

A key issue that can be identified is that, due to safety precautions, the researcher was only able to view these spaces from the outside looking in through means of a viewing deck. As a result, more detailed research was required, in order to adhere to the correct safety protocol and design standards of such an environment.

In addition, the case study analysis was restricted to visiting one major research institute, instead of a variety due to difficulty in obtaining permission needed to make the case study analysis a viable one. The same can be said for the case study analysis with regards to experiencing an environment that thrives of creativity and thus innovation. This case study analysis was also limited to one major creative agency, instead of a variety due to difficulty in obtaining permission.

Despite these hinderances, further research was done in order to fill in the information gap. However, this research would have benefited had more institutions been visited in order to understand the inner workings of different fields, as well as if the researcher were allowed to experience restricted parts of the laboratory. These case studies were done in order to comply with safety regulations as well as the scope allowed with regards to obtaining permission.

7.1.2 Key Concerns

- Existing research institutions are concerned with producing results instead of ensuring that the research environment is conducive to doing so.
- The focus area of the majority of research institutions in South Africa is HIV AIDS prevention and cure as it is seen as the leading health challenge we face.
- Spatial allocation in research institutes is focused mainly on laboratory spaces and the services they require rather than the need for breakaway spaces and spaces for interaction. If this is addressed from the outset, innovation outcomes could change for the better.
- The provision of outdoor spaces and landscaping is not recognised when determining optimum functionality of a research institute.

7.2 Analysis of Case Studies

7.2.1 K-Rith Tower Building

Layout and Spatial Planning

Being an accessible medical research institute, this particular case study carries immense merit and validity in terms of providing valuable insights and information. As mentioned in chapter two, the design of research spaces is crucial to how people behave and experience the space within. What is also mentioned is the importance of creating the following environments:

- Individual centered research environments
- Group centered research environments
- Open and closed laboratories
- Opportunities for meeting places and the importance of planning for a social building

Figure 70: Large atrium for interaction.
Source: (https://www.iol.co.za/dailynews/pics-ukzn-building-wins-architecture-prize-15846136)

As seen in the plans and figures provided, within the laboratory spaces, provision is made for both open and closed laboratories. Open laboratories to encourage interaction between researchers while closed laboratories that are required for specialized work, where containment is necessary. In addition, looking at research environments outside the laboratory, adequate office space is provided, both in open plan as well as closed offices. This in turn allows for individual centered research as well as group centered research.

This institute is also seen as a social building. This can be seen in the large central atrium space, as seen in figure 70, that allows for visibility, accessibility, the opportunity for meeting people and chance encounters as the main circulation is around this space. This circulation principle is something that may prove useful to apply.

Spaces for Innovation

In order to provide an adequate analysis with regards to spaces for innovation, it is important to make reference to chapter 3 where a theoretical and conceptual framework is established.

Here, liminal space, the watercooler concept and third places are discussed, along with phenomenology and social constructivism.

Figure 71: Natural light in stairwells.
Source: (https://www.iol.co.za/dailynews/pics-ukzn-building-wins-architecture-prize-15846136)

The K-Rith tower building has been designed in order to obtain maximum visibility amongst researchers and to allow for many encounters to be had. Chapter 2 states that it is these moments of interaction that ultimately result in innovation.

These spaces can be seen in the form of a large circulating atrium, large central spaces that provide seating as well as cafes that encourage milling and conversation. In addition, the introduction of natural light and nature ensures that the user feels grounded and a breath of fresh air as seen in figure 71.

Service Approach

Being a laboratory, this institute comes with many service requirements. As a result, there is a main plant room located at the top most floor. This plant room provides the adequate services for the entire building. Each floor contains a well labelled distribution wall.

As mentioned during the interview, the building contains an uninterrupted power supply, gas storage as well as water storage located within the parking. In order to be more sustainable, the building utilizes and reuses all air conditioning condensate.

While the plant room at the top of the building services the building spectacularly, it leaves minimum room for flexibility within laboratory spaces.

7.2.2 Espresso

Layout and Spatial Planning

Espresso is, at its core, a creative agency therefore the creative process and environments that stimulate it are important. What is learned in chapter two is that, the design of spaces influence behavior, experience and interaction that is crucial to creativity, and in turn innovation. Therefore, it is important that we create environments that allow for:

- Individual centered research environments
- Group centered research environments
- Opportunities for meeting places and the importance of planning for a social building

According to the interview had with Mr. Antony Ellis, it is learned is that very rarely to companies such as this have the opportunity to design their own building, therefore a space is rented in an already existing building. It is for this reason that it is up to the occupants to make the space their own in whatever manner they see fit. In this institute, offices are open plan, as seen in figure 72, in order to promote interaction between users and to allow for group centered environments.

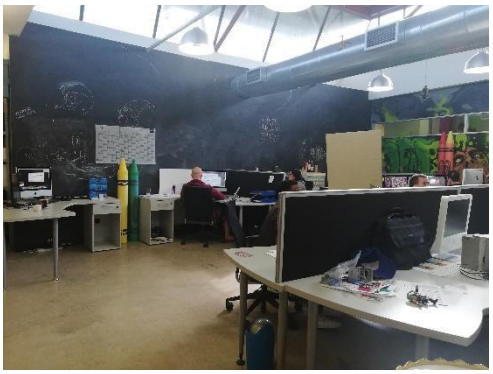


Figure 72: Open Plan Offices.
Source: Author

Additionally, individual offices are supplied for senior management in order to provide the opportunity for individual centered environments. Materiality plays a vital role with regards to making a space one's own. This can be seen in the addition of personal items, wallpaper, and furniture that is seemingly mismatched but gels together as seen in figure 73.

Spaces for Innovation

Reflecting on chapter three where a theoretical and conceptual framework is established. What is learned is that the concepts discussed namely: liminal space, the watercooler concept and third places are discussed, along with phenomenology and social constructivism are key in order to achieve innovation.

This institute thrives on creativity and interaction, therefore the studio space is open plan, fun and light hearted. High ceilings, natural light and spaces such as a lounge area around a pool table allow for informal communication to be had. Additionally, many breakaway spaces that

Figure 73: Personal items make a space comfortable.
Source: Author

include comfortable furniture, warm tones, dimmed lighting in certain areas. It also has a bar space allows that for reflection, contemplation and a sense of relaxation.

Through the interview, it is learned that a person is most productive when said person feels a sense of comfort. Therefore, in this space comfort is a priority in order for innovation to occur.

Service Approach

Essentially, this institute is an office that is in operation from 8am to 5pm. Therefore, it is dependent on services during this time frame. Services for this kind of institute includes multiple plug points that supply computers, printers and other electronic devices. There is a central distribution point that supplies power as well as a central air conditioning system. An institute such as this does not require a plant room of a large magnitude, due to it not needing to maintain laboratory machinery.

7.3 Findings

The precedent studies, as well as the case studies, were analysed through the literature review in conjunction with the theoretical framework, conceptual framework and technical considerations discussed in previous chapters. It is through this that a relationship has been established between architecture and the process of innovation at large and specifically the medical environment.

The case studies portray successfully the need for an all-encompassing environment that accounts for the needs of both the group and the individual, as well as the need to recognize that a building is essentially a social hub and social environment, that naturally brings people together.

However, through a case study like the K-Rith Tower Building that specialises in medical research, it is evident that finding a healthy balance between the technical environment and a social environment is no easy task. Therefore, the following needs to be considered:

- The proximity of laboratory spaces to breakaway spaces that allow for social interaction.
- The proximity of laboratory spaces to nature as literature depicts that this allows for more productive thinking, a freer thought process and liminal experiences to be had, as mentioned in chapter three.
- The creation of spaces where the intended purpose is socialising. This makes reference to social constructivism and third places that is discussed in chapter three.
- The strategic placement of common amenities as these are places where informal interaction of conversation occurs. The watercooler concept discussed in chapter three emphasises the importance of such points.

These findings have been significant in formulating a comprehensive design response and provide recommendations in the next chapter.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 ACHIEVING THE AIMS AND OBJECTIVES

The primary aim of this study is:

- *To foster a creative and diverse built environment for research innovation.*

The aim of this study was achieved by gaining an understanding as to how the innovation and creative process works, and the potential architecture has with regards to enhancing said processes. This is done through the exploration of a comprehensive theoretical and conceptual framework, as well as the analysis of a number of institutions in existence. It is learned that by providing the opportunity of chance encounters, shared learning spaces and allowing for interaction through architecture the process of innovation is enhanced. In conjunction, special attention needs to be paid to the use of natural outdoor spaces to improve creativity, learning and experience.

The objectives of this study are:

- *To create and design a built environment that promotes ease of communication and creativity.*

This objective is achieved through the planning of spaces and the selection of materials. A number of open plan spaces have been accounted for, as well as the use of glass walls in order to increase visibility and accessibility to make it easier to communicate.

- *To develop a research culture through architectural design in order to foster human friction and innovation.*

An open research culture is encouraged through the use of open plan spaces that encourage people to interact with each other. In addition multiple pockets of spaces have been allocated, to encourage the convening of the human entity and movement through the space, gently nudges one into a space where interaction is ultimately inevitable.

- *To create dedicated spaces with the ability to transition and adapt with innovation in technology and people.*

This can be seen in the emphasis placed on so called multipurpose open plan spaces that become third places. With regards to the laboratory space itself, the provision has been made in the form of interstitial floors, that allow for flexibility in the planning and movement of casework. Essentially, the laboratory equipment can be moved to accommodate the needs of the researcher, developments in technology and innovation.

- *To design a built environment that improves the quality and quantity of innovation in research.*

This objective is ultimately achieved, by designing for interaction, chance encounters, collaboration and ensuring that a human being experiences both comfort and a stimulating environment.

8.2 CONCLUSION TO THE RESEARCH

From the institutes explored in this study, both international as well as case studies visited, it is fair to say that a number of institutes have not been designed to encourage the process of innovation through shared learning and collaboration.

Although this may be the case at this point in time, what can be seen is a change in how spaces are being designed and the role of the architect is becoming a more prominent one. Newer institutes and those designing them are beginning to take into account the need for interaction between human beings, collaboration, integration of nature to promote creativity and a good sense of well-being. The resultant outcome of this is spaces that begin to enhance the process of innovation.

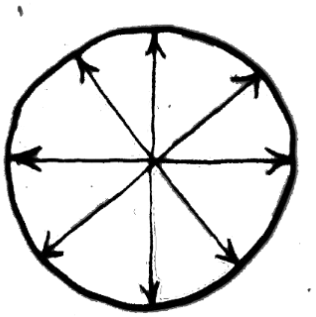
The research study has brought forward the key idea that human beings need one another to function optimally. This is done by gently nudging and in some cases forcing people together with no real means of hermitage, through architecture and how we design spaces. It is at these points of interaction where breakthroughs are had, new thoughts generated and the attainment of innovation, is a consequence.

8.3 RECOMMENDATIONS FOR A DESIGN PROPOSAL

The following section proceeds to outline some suggestions for the design proposal, of a research institute that focuses on the process of innovation in the medical research faculty. These recommendations stem from literature reviewed, precedents studied, case studies observed and the lessons learned.

Special attention is paid to creation of spaces that encourage interaction between people as well as the interaction between people and nature. This is because it is these spaces that enhance and result in the process of innovation.

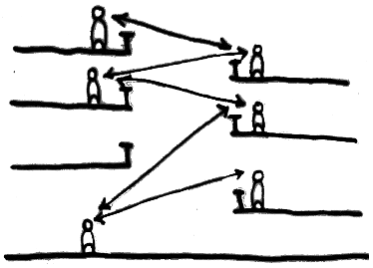
Bringing People Together



A design with innovation in mind should focus on bringing people together. This can be seen in a large central space that becomes the primary circulation. Alternatively, pockets of spaces that begin to encourage milling around and interaction in turn, should be considered.

Figure 74: Bringing people together.
Source: Author

Visibility



Research shows that a human being is more likely to interact, feel a connection with and feel comfortable with another human being if they are accustomed to seeing them on a regular basis and there is a sense of familiarity had. Therefore, visibility plays an important role.

Figure 75: Visibility between floors.
Source: Author

Accessibility to other Humans

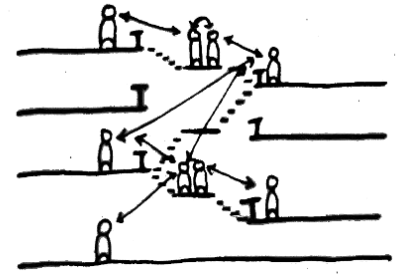


Figure 76: Accessibility to other Humans
Source: Author

It goes without saying that interaction cannot occur if people cannot access one another. It is because of this that accessibility becomes an important factor that needs to be considered. Due to the moments in which people collide, converse and interact with each other being the basis for innovation to occur, accessibility to each other becomes vital.

Interaction with nature and third places

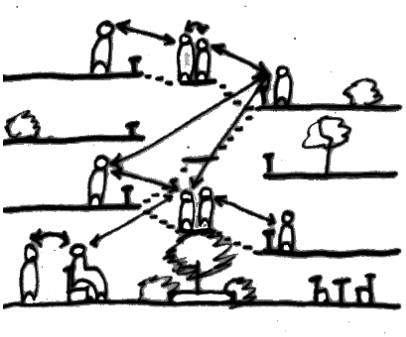


Figure 77: Interaction with nature and third places.
Source: Author

When provision is made for human beings to interact with nature and with each other, a liminal experience happens. When a human being is given the opportunity to relax and reflect in a comfortable environment and in nature, breakthroughs and insightful thought occurs. In a research environment, these moments are crucial. Therefore, providing spaces such as these is a necessity.

Strategic placement of common amenities

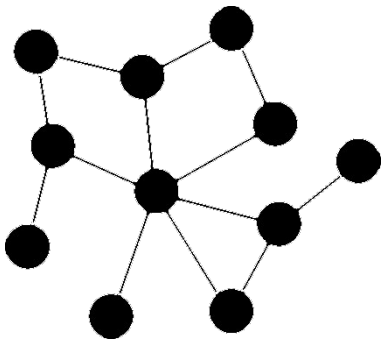


Figure 78: Strategic placement of common amenities help to create social nodes.
Source: Author

The strategic placement of common amenities as these are places where informal interaction of conversation occurs. The watercooler concept discussed in chapter three emphasises the importance of such points.

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Appendix A: Biosafety Level 1 and 2

Code of practice

In many laboratories and national laboratory programmes, this code may be used to develop written practices and procedures for safe laboratory operations. Each laboratory should adopt a safety or operations manual, that identifies known and potential hazards, and specifies practices and procedures to eliminate or minimize such hazards. Specialized laboratory equipment is a supplement to but can never replace appropriate procedures. The most important concepts are listed below.

Access

1. The international biohazard warning symbol and sign must be displayed on the doors of the rooms, where microorganisms of Risk Group 2 or higher risk groups are handled.

2. Only authorized persons should be allowed to enter the laboratory working areas.
3. Laboratory doors should be kept closed.
4. Children should not be authorized or allowed to enter laboratory working areas.
5. Access to animal houses should be specially authorized.
6. No animals should be admitted other than those involved in the work of the laboratory.

Personal protection

1. Laboratory coveralls, gowns or uniforms must be worn at all times for work in the laboratory.
2. Appropriate gloves must be worn for all procedures that may involve direct or accidental contact with blood, body fluids and other potentially infectious materials or infected animals. After use, gloves should be removed aseptically and hands must then be washed.
3. Personnel must wash their hands after handling infectious materials and animals, and before they leave the laboratory working areas.

4. Safety glasses, face shields (visors) or other protective devices must be worn when it is necessary to protect the eyes and face from splashes, impacting objects and

sources of artificial ultraviolet radiation.
5. It is prohibited to wear protective laboratory clothing outside the laboratory, e.g. in canteens, coffee rooms, offices, libraries, staff rooms and toilets.
6. Open-toed footwear must not be worn in laboratories.
7. Eating, drinking, smoking, applying cosmetics and handling contact lenses is prohibited in the laboratory working areas.
8. Storing human foods or drinks anywhere in the laboratory working areas is prohibited.
9. Protective laboratory clothing that has been used in the laboratory must not be stored in the same lockers or cupboards as street clothing.

Procedures
1. Pipetting by mouth must be strictly forbidden.
2. Materials must not be placed in the mouth. Labels must not be licked.
3. All technical procedures should be performed in a way that minimizes the formation of aerosols and droplets.
4. The use of hypodermic needles and syringes should be limited. They must not be used as substitutes for pipetting devices or for any purpose other than parenteral injection or aspiration of fluids from laboratory animals.
5. All spills, accidents and overt or potential exposures to infectious materials must be reported to the laboratory supervisor. A written record of such accidents and incidents should be maintained.
6. A written procedure for the clean-up of all spills must be developed and followed.
7. Contaminated liquids must be decontaminated (chemically or physically) before discharge to the sanitary sewer. An effluent treatment system may be required, depending on the risk assessment for the agent(s) being handled.
8. Written documents that are expected to be removed from the laboratory need to be protected from contamination while in the laboratory.

Laboratory working areas
1. The laboratory should be kept neat, clean and free of materials that are not pertinent to the work.
2. Work surfaces must be decontaminated after any spill of potentially dangerous

material and at the end of the working day.
3. All contaminated materials, specimens and cultures must be decontaminated before disposal or cleaning for reuse.
4. Packing and transportation must follow applicable national and/or international regulations.
5. When windows can be opened, they should be fitted with arthropod-proof screens.

Biosafety management

1. It is the responsibility of the laboratory director (the person who has immediate responsibility for the laboratory) to ensure the development and adoption of a biosafety management plan and a safety or operations manual.
2. The laboratory supervisor (reporting to the laboratory director) should ensure that regular training in laboratory safety is provided.
3. Personnel should be advised of special hazards, and required to read the safety or operations manual and follow standard practices and procedures. The laboratory supervisor should make sure that all personnel understand these. A copy of the safety or operations manual should be available in the laboratory.
4. There should be an arthropod and rodent control programme.
5. Appropriate medical evaluation, surveillance and treatment should be provided for all personnel in case of need, and adequate medical records should be maintained.

Laboratory design and facilities

In designing a laboratory and assigning certain types of work to it, special attention should be paid to conditions that are known to pose safety problems. These include:
1. Formation of aerosols
2. Work with large volumes and/or high concentrations of microorganisms
3. Overcrowding and too much equipment
4. Infestation with rodents and arthropods
5. Unauthorized entrance

Design features

1. Ample space must be provided for the safe conduct of laboratory work and for cleaning and maintenance.
2. Walls, ceilings and floors should be smooth, easy to clean, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratory. Floors should be slip-resistant.
3. Bench tops should be impervious to water and resistant to disinfectants, acids, alkalis, organic solvents and moderate heat.
4. Illumination should be adequate for all activities. Undesirable reflections and glare should be avoided.
5. Laboratory furniture should be sturdy. Open spaces between and under benches, cabinets and equipment should be accessible for cleaning.
6. Storage space must be adequate to hold supplies for immediate use and thus prevent clutter on bench tops and in aisles. Additional long-term storage space, conveniently located outside the laboratory working areas, should also be provided.
7. Space and facilities should be provided for the safe handling and storage of solvents, radioactive materials, and compressed and liquefied gases.
8. Facilities for storing outer garments and personal items should be provided outside the laboratory working areas.
9. Facilities for eating and drinking and for rest should be provided outside the laboratory working areas.
10. Hand-washing basins, with running water if possible, should be provided in each laboratory room, preferably near the exit door.
11. Doors should have vision panels, appropriate fire ratings, and preferably be self-closing.
12. At Biosafety Level 2, an autoclave or other means of decontamination should be available in appropriate proximity to the laboratory.
13. Safety systems should cover fire, electrical emergencies, emergency shower and eyewash facilities.
14. First-aid areas or rooms suitably equipped and readily accessible should be available.
15. In the planning of new facilities, consideration should be given to the provision of mechanical ventilation systems that provide an inward flow of air without recirculation. If there is no mechanical ventilation, windows should be able to be opened and should be fitted with arthropod-proof screens.

16. A dependable supply of good quality water is essential. There should be no cross connections between sources of laboratory and drinking-water supplies. An anti-backflow device should be fitted to protect the public water system.
17. There should be a reliable and adequate electricity supply and emergency lighting to permit safe exit. A stand-by generator is desirable for the support of essential equipment, such as incubators, biological safety cabinets, freezers, etc., and for the ventilation of animal cages.
18. There should be a reliable and adequate supply of gas. Good maintenance of the installation is mandatory.
19. Laboratories and animal houses are occasionally the targets of vandals. Physical and fire security must be considered. Strong doors, screened windows and restricted issue of keys are compulsory.

Laboratory equipment

Together with good procedures and practices, the use of safety equipment will help to reduce risks when dealing with biosafety hazards. The laboratory director should, after consultation with the biosafety officer and safety committee (if designated), ensure that adequate equipment is provided and that it is used properly. Equipment should be selected to take account of certain general principles, i.e. it should be:

1. Designed to prevent or limit contact between the operator and the infectious material
2. Constructed of materials that are impermeable to liquids, resistant to corrosion and meet structural requirements
3. Fabricated to be free of burrs, sharp edges and unguarded moving parts
4. Designed, constructed and installed to facilitate simple operation and provide for ease of maintenance, cleaning, decontamination and certification testing; glassware and other breakable materials should be avoided, whenever possible.

Appendix B: Biosafety Level 3

Code of practice

The code of practice for basic laboratories – Biosafety Levels 1 and 2 applies except where modified as follows.

1. The international biohazard warning symbol and sign displayed on laboratory access doors must identify the biosafety level and the name of the laboratory supervisor who controls access, and indicate any special conditions for entry into the area, e.g. immunization.
2. Laboratory protective clothing must be of the type with solid-front or wrap-around gowns, scrub suits, coveralls, head covering and, where appropriate, shoe covers or dedicated shoes. Front-buttoned standard laboratory coats are unsuitable, as are sleeves that do not fully cover the forearms. Laboratory protective clothing must not be worn outside the laboratory, and it must be decontaminated before it is laundered. The removal of street clothing and change into dedicated laboratory clothing may be warranted when working with certain agents (e.g. agricultural or zoonotic agents).
3. Open manipulations of all potentially infectious material must be conducted within a biological safety cabinet or other primary containment device.
4. Respiratory protective equipment may be necessary for some laboratory procedures or working with animals infected with certain pathogens.

Laboratory design and facilities

The laboratory design and facilities for basic laboratories – Biosafety Levels 1 and 2 apply except where modified as follows:

1. The laboratory must be separated from the areas that are open to unrestricted traffic flow within the building. Additional separation may be achieved by placing the laboratory at the blind end of a corridor, or constructing a partition and door or access through an anteroom (e.g. a double-door entry or basic laboratory – Biosafety Level 2), describing a specific area designed to maintain the pressure differential between the laboratory and its adjacent space. The anteroom should have facilities for separating clean and dirty clothing and a shower may also be necessary.

2. Anteroom doors may be self-closing and interlocking so that only one door is open at a time. A break-through panel may be provided for emergency exit use.
3. Surfaces of walls, floors and ceilings should be water-resistant and easy to clean. Openings through these surfaces (e.g. for service pipes) should be sealed to facilitate decontamination of the room(s).
4. The laboratory room must be sealable for decontamination. Air-ducting systems must be constructed to permit gaseous decontamination.
5. Windows must be closed, sealed and break-resistant.
6. A hand-washing station with hands-free controls should be provided near each exit door.
7. There must be a controlled ventilation system that maintains a directional airflow into the laboratory room. A visual monitoring device with or without alarm(s) should be installed so that staff can at all times ensure that proper directional airflow into the laboratory room is maintained.
8. The building ventilation system must be so constructed that air from the containment laboratory – Biosafety Level 3 is not recirculated to other areas within the building. Air may be high-efficiency particulate air (HEPA) filtered, reconditioned and recirculated within that laboratory. When exhaust air from the laboratory (other than from biological safety cabinets) is discharged to the outside of the building, it must be dispersed away from occupied buildings and air intakes. Depending on the agents in use, this air may be discharged through HEPA filters. A heating, ventilation and air-conditioning (HVAC) control system may be installed to prevent sustained positive pressurization of the laboratory. Consideration should be given to the installation of audible or clearly visible alarms to notify personnel of HVAC system failure.
9. All HEPA filters must be installed in a manner that permits gaseous decontamination and testing.
10. Biological safety cabinets should be sited away from walking areas and out of crosscurrents from doors and ventilation systems.
11. The exhaust air from Class I or Class II biological safety cabinets, which will have been passed through HEPA filters, must be discharged in such a way as to avoid interference with the air balance of the cabinet or the building exhaust system.

12. An autoclave for the decontamination of contaminated waste material should be available in the containment laboratory. If infectious waste has to be removed from the containment laboratory for decontamination and disposal, it must be transported in sealed, unbreakable and leakproof containers according to national or international regulations, as appropriate.
13. Backflow-precaution devices must be fitted to the water supply. Vacuum lines should be protected with liquid disinfectant traps and HEPA filters, or their equivalent. Alternative vacuum pumps should also be properly protected with traps and filters.
14. The containment laboratory – Biosafety Level 3 facility design and operational procedures should be documented.

Laboratory equipment

The principles for the selection of laboratory equipment, including biological safety cabinets are the same as for the basic laboratory – Biosafety Level 2. However, at Biosafety Level 3, manipulation of all potentially infectious material must be conducted within a biological safety cabinet or other primary containment device. Consideration should be given to equipment such as centrifuges, which will need additional containment accessories, for example, safety buckets or containment rotors. Some centrifuges and other equipment, such as cell-sorting instruments for use with infected cells, may need additional local exhaust ventilation with HEPA filtration for efficient containment.

Health and medical surveillance

The objectives of health and medical surveillance programmes for basic laboratories – Biosafety Levels 1 and 2 also apply to containment laboratories – Biosafety Level 3, except where modified as follows:
1. Medical examination of all laboratory personnel who work in containment laboratories – Biosafety Level 3 is mandatory. This should include recording of a detailed medical history and an occupationally-targeted physical examination.
2. After a satisfactory clinical assessment, the examinee may be provided with a medical contact card stating that he or she is employed in a facility with a containment laboratory – Biosafety Level 3.

PART TWO

DESIGN REPORT

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION....4

1.1 INTRODUCTION....5

1.2 PROJECT DESCRIPTION....5

1.3 THE NOTIONAL CLIENT....7

1.3.1 The Client's Organisation....7

1.3.2 The Client's Requirements....8

1.3.3 Detailed Client Brief....9

1.3 CONCLUSION....11

CHAPTER 2: SITE SELECTION, SURVEY AND ANALYSIS....12

2.1 INTRODUCTION....13

2.2 HISTORICAL BACKGROUND OF SELECTED SITE....13

2.2.1 History....13

2.2.2 Site Location....14

2.2.3 Urban Context....15

2.3 DESCRIPTION OF EXISTING SITE CONDITIONS (SITE SURVEY)....16

2.4 SITE ANALYSIS....18

2.4.1 Contextual Analysis....18

2.4.2 Site Analysis....19

2.5 CONCLUSION....20

CHAPTER 3: DESIGN DEVELOPMENT AND RESOLUTION....21

3.1 CONCEPTUAL AND THEORETICAL DEVELOPMENT....22

3.1.1 Introduction....22

3.1.2 Urban Design Concept Development....22

3.1.3 Architectural Design Concept Developments etc....23

4. PHYSICAL MODEL.....26

5. ARCHITECTURAL DESIGN DRAWINGS.....28

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

As is mentioned throughout the study, architecture has, for a long time fostered some of the most creative spaces in the world where people interact with one another, exchange ideas, argue, discuss and essentially collaborate. The resultant of this is the process of innovation.

Currently, in the world around, many research institutes are in existence. Many work quite efficiently in order to create many innovative ideas and solutions and many do not. Taking cognisance of the past, one can make the assumption that, an architecture that begins to foster human interaction and collaboration through environments that spark discussion and new ideas, could potentially begin to inspire research innovation that our world is in dire need of, given the many pandemics we face today. Therefore, the focus of this study has been to hone in on these spaces and produce an appropriate architectural response.

It has been identified, that the correct architectural response in this scenario is a research institute that is focused on being functional while also promoting the idea of collaboration and thus innovation.

1.2 PROJECT DESCRIPTION

South Africa is home to a few notable research institutes such as the Africa Health Research Institute (AHRI) and the Africa Cancer Institute (ACI). However, South Africa as a country lacks research institutes that have been architecturally designed with the intention of promoting and enhancing medical research innovation. As a result of this, the mortality rates of non-communicable diseases are rising steadily with no intention of stopping if nothing is done about it.

Therefore, this project intends to encourage an architecture that begins to foster human interaction and collaboration in order to create an environment that is conducive to creativity and innovation. As a result, the intended outcome is a Cancer Research

Institute that will eventually serve as an incubator of knowledge that explores creative and innovative environments.

Urban Design Requirements:

- The site should form a contributing factor to the proposed medical precinct within the immediate area.
- The building should be a hub for collaboration, interaction and innovation in the field of medical research.
- There should be an ease of connection to both vehicular and pedestrian routes, other medical institutes, other research institutes and universities.
- The building needs to fit within its context and respect the existing architecture as well as the existing site conditions.

Architectural Requirements:

- The building should act as a driver for both collaboration and interaction. It should include multiple pockets of spaces that encourage interaction with a multitude of people.
- The building should encourage an individual to experience the flow of movement through spaces as this increases the chance of chance encounters and conversations between people.
- The design should allow for privacy and protected access to be maintained to laboratory and sensitive spaces.
- Quality of space needs to be a priority in terms of materiality and organisation as these choices tend to have an effect as to how people behave within a space and how they begin to experience and feel within a space.
- A number of "accidental meeting places" need to be included within the design as the hope is that this design will form a creative and innovative hub in which people gather, engage and collaborate.

1.3 THE NOTIONAL CLIENT

1.3.1 The Client's Organisation

Due to their active involvement in the research industry in conjunction to being dedicated to achieving innovation in a variety of fields, the client is the Council for Scientific and Industrial Research (CSIR). The Council for Scientific and Industrial Research (CSIR) is a leading scientific and technology research organisation that is actively involved in researching, developing, localizing and diffusing technologies that is aimed at accelerating socioeconomic prosperity in South Africa. Being established in 1945 through an Act of Parliament, their mandate is as follows:

> *"The objectives of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."*
>
> (Scientific Research Council Act 46 of 1988, amended by Act 71 of 1990)

Their vision, mission and values include:

CSIR vision

We are accelerators of socio-economic prosperity in South Africa through leading innovation.

CSIR mission

Collaboratively innovating and localising technologies while providing knowledge solutions for the inclusive and sustainable advancement of industry and society.

CSIR values

Our beliefs, principles and the impact we wish to make to improve the quality of life of South Africans are **EPIC**. Team CSIR pursues **Excellence**, celebrates **People**, personifies **Integrity**, and welcomes **Collaboration**.

1.3.2 The Client's Requirements

The CSIR plays an integral role in supporting both the public and private sectors through directed research. As a result, at the core of their business, they have crafted the following objectives in order to achieve their mission. This is as follows:

Conduct research, development and innovation, localise transformative technologies and accelerate their diffusion:

- Collaboratively improve the competitiveness of high-impact industries to support South Africa's re-industrialisation;
- Drive socio-economic transformation through RD&I that supports the development of a capable state;
- Build and transform human capital and infrastructure; and
- Diversify income, and maintain financial sustainability and good governance.

Working with a range of organisations and institutions which include the focus areas of:

- Energy
- Health
- Industry
- Defence and Security
- The natural built and digital environments

Their core values are EPIC and they are the driving force behind our ability to conduct cutting-edge research and technological innovation to improve the quality of life of South Africans. The CSIR pursues Excellence, celebrates People, personifies Integrity, and welcomes Collaboration.

It is because of these reasons that the client requires a building that personifies innovation and collaboration while putting the needs of the people first and foremost in conjunction to being environmentally friendly and sustainable.

1.3.3 Detailed Client Brief

The building is required to provide adequate amenities needed in order to conduct basic cancer research. In conjunction to this, these spaces need to encourage interaction, communication and collaboration. The required spaces are as follows:

1. Laboratory Spaces:
   This includes both open and closed laboratories as well as specialist laboratories such as BSL 3 laboratories.

2. Laboratory Support Spaces:
   In addition to storage spaces, this includes wash up spaces and locker rooms.

3. Researcher Offices:
   These are either individual research spaces that allow for privacy or open plan offices that accommodate for teamwork research and research in general. In conjunction to this, amenities such as meeting rooms and break away spaces will also be taken into account. The support functions here include; the central computer server room as well as conference rooms and multipurpose spaces.

4. Social Amenities:
   Even though some social spaces will be incidental, some need to be included with the intention of socializing. This includes spaces such as a cafeteria, library, outdoor spaces, spaces intended for rest and relaxation as well as interaction.

5. Servicing:
   This includes mechanical plant rooms, central storage, hazardous waste storage, external gas storage, generator room, uninterrupted power supply storage, water storage, cold rooms for sample storage and spaces needed for the generation of gases such as nitrogen.

6. Parking
   Every building requires an adequate number of parking bays in this day and age.

Schedule of Accommodation				
	Space	Quantity	Size	Total Area
Lab	BSL 3 Laboratories	2	15 x 13.5	202,5 m²
	Waste Disposal	1	7.5 x 7.5	56,25 m²
	Locker Rooms	1	7.5 x 7.5	56.25 m²
	Write-up space	1	7.5 x 38	285 m²
Servicing	External Gas Storage	1	3.5 x 15	52.5 m²
	Grey Water	1	7.5 x 15	112.5 m²
	Central Storage / Mechanical Plant Room / Computer Server Room / Generator Room/ UPS / Cold Storage	1		1 012.5 m²
Offices	Open Plan	100	1.5 x 1.5	225 m²
	Seminar Rooms	2	7.5 x 18	135 m²
	Meeting Rooms	1	7.5 x 7.5	56.25 m²
	File Storage	1	4 x 7.5	30 m²
	Printing / Copying	1	4 x 7.5	30 m²
	Waiting Areas	4	7.5 x 7.5	56.25 m²
	Reception	2	7.5 x 10	75 m²

Schedule of Accommodation				
	Space	Quantity	Size	Total Area
Social	Upper Cafe	1	7.5 x 30	225 m²
	Library	1	7.5 x 15	112.5 m²
	Cafe	1	15 x 15	225 m²
	Meeting Space	1	7.5 x 15	112.5 m²
	Courtyard	2	1 575	1575 m²
	Ramps	3	7.5 x 50	1125 m²
	Green Roof	1	15 x 37.5	562.5 m²
	Public Ramp	1	15 x 75	1 125 m²
	Ramp to Office	1	15 x 22	330 m²
	Social Balcony Space	2	22.5 x 22.5	506.25 m²
	Outdoor Space	1	15 x 45	675 m²
Ablutions	Male: Water Closets	13	1.5 x 1	19.5 m²
	Female: Water Closets	13	1.5 x 1	19.5 m²
Total Area				8 978.25 m²

1.3 CONCLUSION

Ultimately, the creative process and innovation being the resultant of it, is at the forefront of the design outcome and resolution. Therefore, it is fair to say that the chosen client: The Council for Scientific and Industrial Research is an appropriate one due to their dedication to research, innovation and advancements in a number of fields.

It is evident through the requirements and schedule of accommodation that it is necessary that the design outcome be all encompassing and inclusive of both technical and social spaces designed with the process of collaboration as the intention.

CHAPTER 2: SITE SELECTION, SURVEY AND ANALYSIS

2.1 INTRODUCTION

Before conducting any sort of architectural work on any site in the world, it is of crucial importance that one delves into the history and context in order to gain an understanding so that one may provide the most appropriate architectural response.

It is for this reason that this section will include a historical background as well as an analysis of Richards Bay as a city and eventually an analysis of the site itself.

2.2 HISTORICAL BACKGROUND OF SELECTED SITE

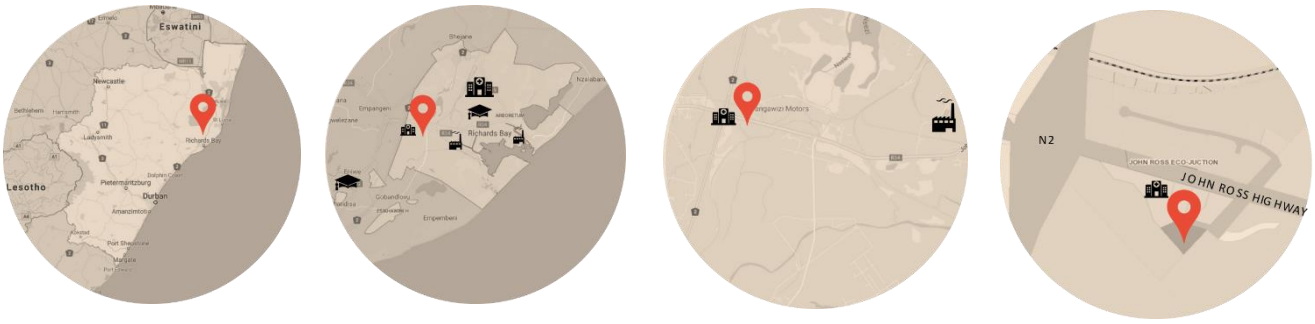
2.2.1 History

As far as the settled built environment and permanent human settlement goes, Richards Bay is seen as a fairly young settlement. Being affectionately called “The Real Gateway to Zululand and Maputaland”, Richards Bay, which is situated on what was originally a floodplain, began as a small fishing village with a temporary harbour during the Anglo Boer War of 1879 until the port was opened in 1976.

During this time period, Admiral Sir Frederick Williams Richards, a commander of the British Naval Division was stationed here and thus the town gained its name. Being located along a lagoon on the Mlatuzi River, Richards Bay now boasts the largest export coal terminal in the world where 65 million tons is loaded every year.

Apart from harbour and mining activities, this town is known for its beautiful wetland scenery, rich biodiversity in terms of both fauna and flora. Today, it is seen as a vibrant town filled with excellent scenery and recreational activities for residents and visitors alike. In conjunction to this, it is known for its rapid expansion and potential in a variety of sectors which include industrial and business to name a few.

2.2.2 Site Location



The chosen site within the town of Richards Bay is located within the new John Ross Eco Junction development. This development is a new upcoming upmarket development has a masterplan and is still in the process of being built. A development such as this holds great potential for any institution that is built within it.

The precinct is found along the R34 John Ross Highway which links Richards Bay to Empangeni. In this way it is easily accessible to the N2 and thus provides high level exposure for any institution. According to the masterplan provided, the site adjacent to the hospital located within this precinct is designated for medical offices, institutions and the like. Therefore the site has been strategically chosen in that it is easily accessible and in close proximity to a variety of institutions that may possibly aid users in the future. These include:

- The Melomed Richards Bay Private Hospital: This institution is located on an adjacent site and is within a walking distance.
- Queen Nandi Regional Hospital: This institution is a 14 minute drive being only 11 km away.
- The University of Zululand: This university is a 22 minute drive being only 22 km away.

In conjunction to being in close proximity to like-minded individuals as mentioned in literature and research presented previously, it also located to an adjacent eco hub that is filled with a variety of fauna and flora which can proceed to provide a number of liminal experiences and insight and thus innovation.

2.2.3 Urban Context

In terms of existing urban context, there is close to nothing in terms of the built form. However, the masterplan that is in existence and yet to be completed provides us with an idea of what is to come.

This masterplan has taken into account the new urbanism theoretical framework. This is evident in the following principles that have been employed:

- Walkability: It is a fairly street friendly design being lined with trees and welcoming roads.
- Connectivity: The interconnected grid encourages this.
- Mixed Use and Diversity: The plan includes provisions for mixed use entities and encourages it.
- Increased Density: Amenities are in close proximity to each other.
- Smart Transportation: Walking is encouraged.
- Sustainability: Due to the strong factor of fauna flora in this region, the buildings are being sustainably designed in order to maintain the rich biodiversity.

2.3 DESCRIPTION OF EXISTING SITE CONDITIONS (SITE SURVEY)

Special Zone 6

1. Special zone created for portion 24 (of 17) of ERF 11451 Richards Bay (John Ross interchange park – mixed use)

2. Summary – reason for special zone created: Historical DFA Application for the John Ross Interchange Park included in the Richards Bay Town Planning Scheme which could not be converted to a zone in terms of this Scheme.

3. Purposes for which buildings may be erected and used:

COLUMN 1	COLUMN 2	COLUMN 3
Purposed for which buildings may be erected and used (permitted uses)	Purposed for which buildings may be erected and used only with the formal consent of council (consent uses)	Purposed for which buildings may not be erected and used
Automotive showroom / vehicle dealership Commercial workshop Hotel Industry - service Medical Institution Launderette Office - general Parking erf / parkade Place of amusement Public garage Public office Residential - dwelling House (caretaker only) Shop - General General showroom Shop – factory Shop - wholesale Warehouse	Educational building	Buildings and land uses not included in columns 1 and 3

4.1 Conditions and restrictions applicable: Maximum permissible floor area ratio (far):

Floor Area Ratio (FAR)	Coverage	Height
0,70	70%	3

4.2 Building lines, side and rear spaces applicable:

Road	Building line
Provincial Road	15m
Internal Roads	7,5m
Side and Rear Spaces	0m

4.3 Parking bay ratio and loading zones applicable:

Use	Parking Bay Ratio	Loading bays
Shop	1 per 16,6m² GLA	Not specified in the DFA Judgement, therefore the provisions of this scheme shall apply
Office – General	1 per 25m² floor area	n/a
General Showroom	1 per 40m² floor area	Not specified in the DFA Judgement, therefore the provisions of this scheme shall apply
Any other use allowed in terms of this zoning	As per the provisions of this Scheme	

5. Interpretation

Where in this zone reference is made to the “Scheme” or to “Clauses”, such reference shall be deemed to refer to the uMhlathuze Land Use Scheme and the provisions thereof. The provisions of the Scheme, where not at variance with the foregoing, shall apply mutatis mutandis.

2.4 SITE ANALYSIS

2.4.1 Contextual Analysis

Climate

Being situated in the transition zone between subtropical and tropical climatic conditions, the climate is humid and warm to hot with a high year round rainfall. The mean annual temperature is approximately 21.5ºC and the mean annual rainfall is 1 292 mm. Although most of the rainfall occurs within summer with winter being somewhat less humid.

Geomorphology

The landscape in this region is typically described as a low-relief area along the coastline and high relief terrain on the landward side. Due to this area being a part of the Zululand coastal plain, the area has a history of erosion and sedimentation as well as sea level fluctuations with a high probability of flooding within the next fifty years. This gives it a unique landscape.

Biodiversity

Falling within the Maputaland-Pondaland-Albany Biodiversity, this area has the second richest floristic region with approximately 80% of the South Africa's remaining forests, rich birdlife and a variety of species.

Water Resources

The soils are very permeable and almost all the rainfall infiltrates into the groundwater where it is temporarily stored before being discharged into the streams, lakes and wetlands. In conjunction this creates a large underground storage reservoir that sustains the coastal lakes.

Structuring Elements

The uMhlathuze Municipality has been shaped by a number of man-made and natural phenomenon's. These include a number of wetlands and natural water features such as Lakes Cubhu, Mzingaze, Nsezi and Nhlabane as well as major rivers such as Mhlatuze and Nsezi. In conjunction to this, the main roads have played a major role in the structure of this municipality. This is due to the main access being the N2 as well as the railway lines.

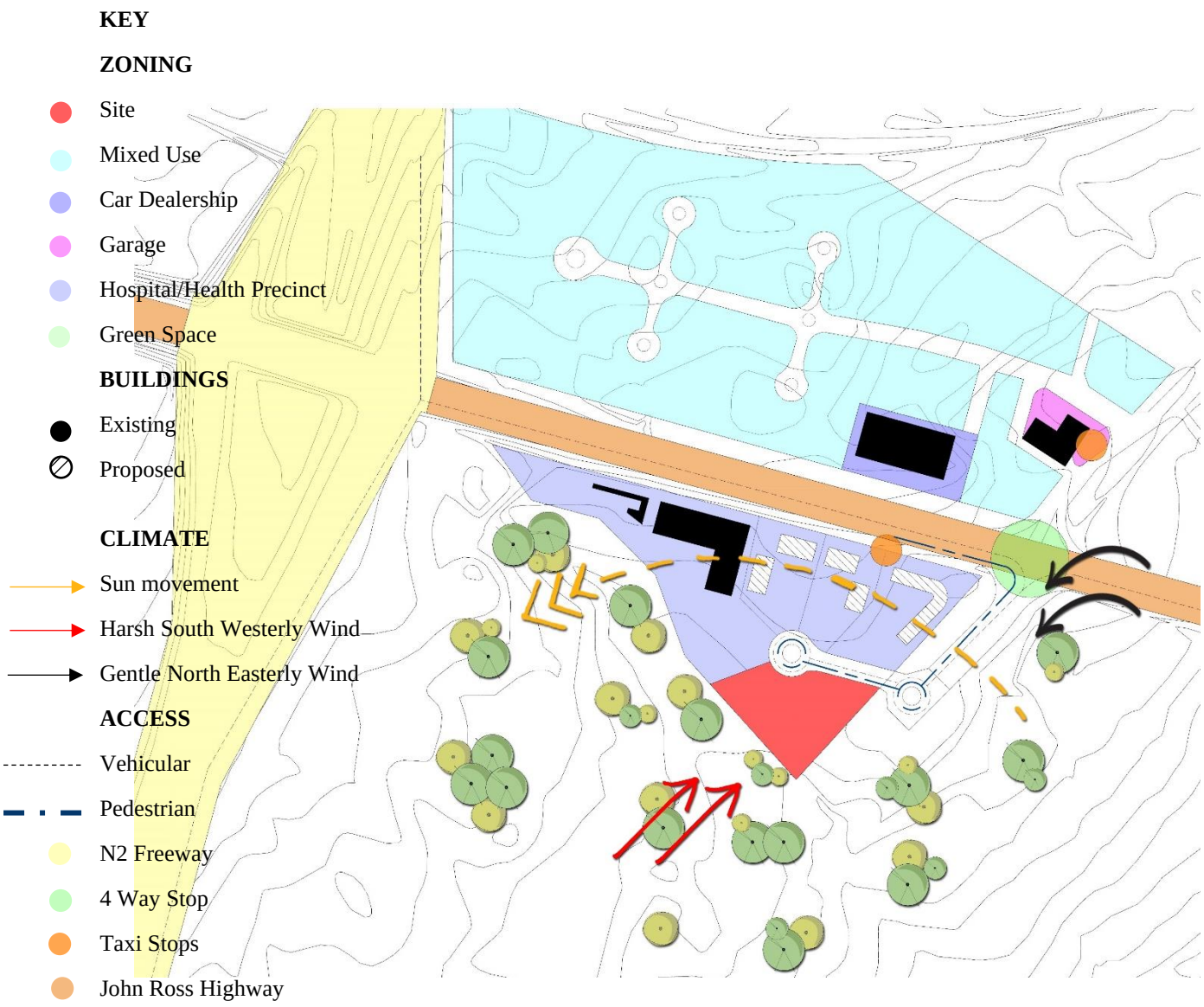
Nodes and Corridors

The primary nodes include the central business district in Richards Bay and Felixton. Emergind. Primary nodes include ESikhaleni as well as the John Ross Eco Junction with ENseleni and Bhuchanana being classified as a tertiary node.

Surrounding Buildings

The site is adjacent to the Melomed Richards Bay Private Hospital that is a total of four floors high. In addition the surrounding sites are undeveloped although a garage as well as offices are proposed. Across the road, while it is also unbuilt, it includes car dealerships and show rooms, a garage and a number of offices and mixed use facilities.

2.4.2 Site Analysis



2.5 CONCLUSION

In conclusion, it is integral to take into account every aspect learned through the process of analysis in order to create a comprehensive and holistic design. Richards Bay is seen as an extremely diverse area and prides itself in the diversity of fauna and flora it displays. Therefore it should be celebrated.

In addition, while the soil is buildable, it is vulnerable to water content and retention, this needs to be taken into account. Due to the site being situated within a new development, there is extreme potential for growth and exposure. The masterplan shows a clear and thought out process that takes into account the architectural theoretical framework of new urbanism.

This area has great potential for development.

CHAPTER 3: DESIGN DEVELOPMENT AND RESOLUTION

3.1 CONCEPTUAL AND THEORETICAL DEVELOPMENT

3.1.1 Introduction

Often, an informed design comes from reviewing work done in the past as well the framework followed and taken into account. This helps guide the design and forms a framework.

Due to this being a tried and tested method, a few architectural concepts and theories will be looked at in order to learn lessons and provide a comprehensive design.

3.1.2 Urban Design Concept Development

As is mentioned above, in terms of existing urban context, there is close to nothing in terms of the built form. However, the masterplan that is in existence and yet to be completed provides us with an idea of what is to come.

Upon reviewing this masterplan, it is learned that it has taken into account the new urbanism theoretical framework as within this small eco junction the following principles have been employed:

- Walkability: It is a fairly street friendly design being lined with trees and welcoming roads.
- Connectivity: The interconnected grid encourages this.
- Mixed Use and Diversity: The plan includes provisions for mixed use entities and encourages it.
- Increased Density: Amenities are in close proximity to each other.
- Smart Transportation: Walking is encouraged.
- Sustainability: Due to the strong factor of fauna flora in this region, the buildings are being sustainably designed in order to maintain the rich biodiversity.

3.1.3 Architectural Design Concept Developments etc

As is mentioned previously in the literature, the following theoretical framework as well as conceptual framework has been implored:

Phenomenology

According to Nesbitt (1996) this paradigm essentially speaks to both the body's interaction with the environment as well as the mind. It speaks to how the visual, tactile, olfactory and aural senses become an integral component in the perception and reception of a human being and architecture. This determines how a person receives and perceives an environment both physically and mentally, be it consciously or subconsciously.

Place

Nesbitt (1996) who looks at work by architects and theorists such as Norberg-Schulz, Heidegger and Tando Ando to name a few, states that many theories of place speak to the spatial experience, the idea of the "Genius Loci" or what is also known as the unique spirit of the place. Ultimately, this refers to the relationship between man, architecture and nature and whether a space encourages man to interact, engage, embrace and feel at home.

Water Cooler Concept

According to Schaeffer (2014), workspace design has been an enabling factor in innovation. This indicates that the design of physical workspace can be used as a means of bringing people together to enhance innovation. One such method is the, **"water cooler concept"**, whereby the water cooler or similar entity becomes a point for informal conversation, informal transfer or knowledge exploration where learning can be achieved more naturally and through peers. Allen (1977), a professor at MIT speaks of using communication to spark inspiration and creativity, both of which are a necessity for innovation to occur. Schrage(2005) and Watch and Wagner (2017) state that it is no longer seen as a trivial consideration where one locates a water cooler or similar social area.

Social Constructivism

Social Constructivism is a topic that has been delved into and discussed at length. Dating as far back as Dewey in 1938 progressing to Jerome Bruner in 1957 making its way to Jean Piaget in 1965 and eventually being met by Lev Vygotsky in 1978. These key theorists, each building upon the work of the one before, provide essential insight to what the framework of

“social constructivism” entails. This will be discussed further in later chapters, however, at its core, “social constructivism” is a variety of cognitive constructivism that emphasises the collaborative nature of learning, the process of learning and thinking through cooperative and interdependent relationships with others and the importance of such collaboration in the process of innovation.

Liminal Space

The spatial concept of liminality dates back to Arnold Van Gennep in 1909 where cultural rites of passage was the subject of study. It is here that we learn of the spatial concept of **“Liminal Space”**, which refers to “in-between situations of threshold and transition. These are spaces that invoke thought, clarity and resolution and potentially innovation. While it was Van Gennep who coined the term liminality, it is research conducted by the likes of Aldo van Eyck, Herman Hertzberger. Martin Heidegger and Peter Zumpthor and other architects and researchers that show the relation of liminality to architecture. It is through their work that we begin to see the spatial relevance and application of liminality when it comes to designing spaces that potentially invoke thought and breakthroughs.

Third Place

Looking at historical spaces where interaction occurs, what is referred to by sociologist Ray Oldenburg (2000), as the **“third place”**, where people gather and collide. In other words, spaces that result in interaction between people, essentially becomes the space for creative conversation, or as urban theorist Jane Jacobs (2000) calls it, “knowledge spill overs”, could therefore spark innovation. This reaffirms that architecture plays an active role with regards to the manner in which people interact with each other and the creative connections they make.

3.2 CONCLUSION

In conclusion, as will be seen in the images and design drawings presented, the design approach has resulted in a Cancer Research Institute that focuses on the process of creativity and as a result innovation. Special attention has been paid to the importance of collaboration and interaction both between human beings and nature as well as the interaction had between human beings themselves.

The building sits well within its context and maintains links between adjacent sites both physically and functionally while also becoming an incubator for knowledge and innovation.

The design proceeds to display how technical aspects can be considered and designed for while also taking cognisance of the importance of social interaction and the experience of a space.

The literature explored and framework discussed has been adequately and successfully applied to the design proposal which essentially results in a holistic and all encompassing architectural resolution that enhances the process of medical research and thus, innovation.

4. PHYSICAL MODEL

5. ARCHITECTURAL DESIGN DRAWINGS

Architectural Spaces to enhance medical research innovation:

A Proposed Cancer Research Institute for Richards Bay

WHY?
S.A lacks research institutes designed to enhance innovation.

WHAT?
Architecture that fosters human interaction & collaboration thus creativity & innovation.

WHO?
Researchers, pathologists, students, academics & scientists. 100 people.

WHERE?
Richards Bay. Near Hospitals & Universities

HOW?
Through a framework that fosters human interaction & collaboration in architecture.

Theoretical & Conceptual Framework

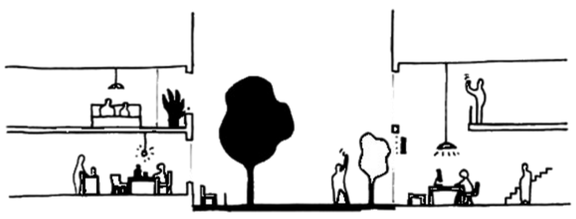
PHENOMENOLOGY

SOCIAL CONSTRUCTIVISM

Experience → Human Perception → Interaction → Shared Learning → Formal/Semi Formal Learning → Chance Encounters

LIMINAL SPACE
In-between situations of threshold and transition. Spaces that invoke thought, clarity & resolution.

- Corridors, walkways, level changes, stairs.
- Physical barriers, walls, partitions, interruptive objects
- Findings out of context, screen, visual obstruction.
- Platforms, lookout points.
- Isolated spaces.



THE WATERCOOLER CONCEPT
Gathering point for informal conversation, transfer or knowledge exploration.

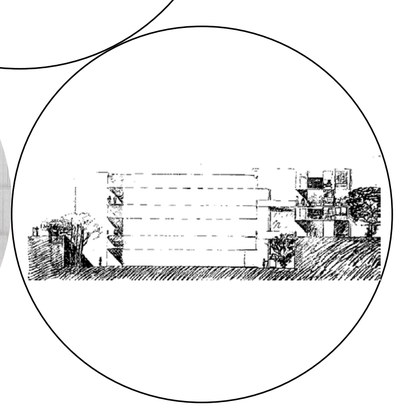
- Space for public gathering.
- Integration/ Aggregation
- Strategically placed corridors/printers
- A central atrium
- Internal staircases
- Kitchens/Cafes
- Lounge or adaptive spaces
- On neutral ground
- Space for public gathering.

THIRD SPACE
A space where people feel comfortable for creative conversation or "knowledge spill overs."

- A home away from home
- Conversation is the main activity
- Accessible & accommodating
- Unassuming
- Playful & relaxed

Precedent Studies

SALK INSTITUTE
Traditional Research Institute. Stark. Hard Surfaces with efficient service planning by using interstitial floors.

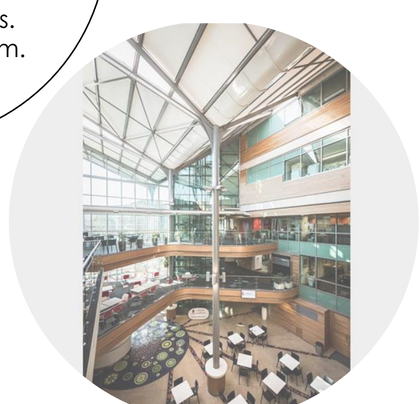


DROPBOX HEADQUARTERS
Spaces designed to enhance creativity, interaction & collaboration. Use of third spaces, interaction & shared learning.

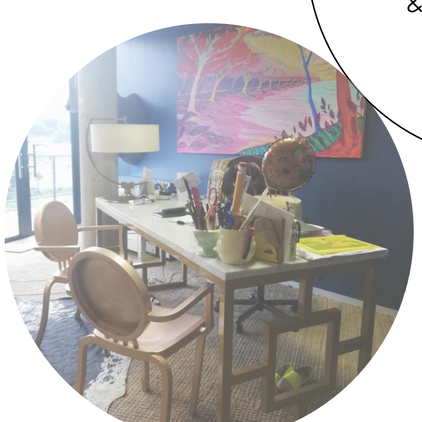
LOWY CANCER RESEARCH CENTER
Integrating concepts of third space & the watercooler concept in the laboratory. Integration of nature and people. Large central atrium.

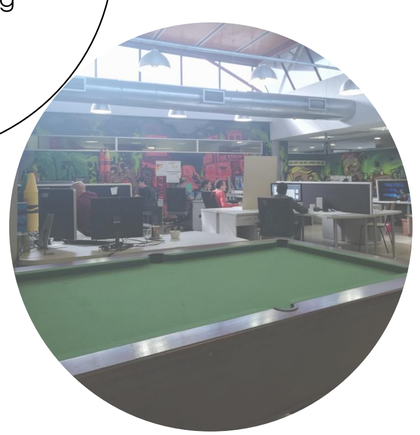
Case Studies

K – RITH TOWER BUILDING
Africa Health Research Institute. Functional components of a laboratory with interaction spaces. Large central atrium.



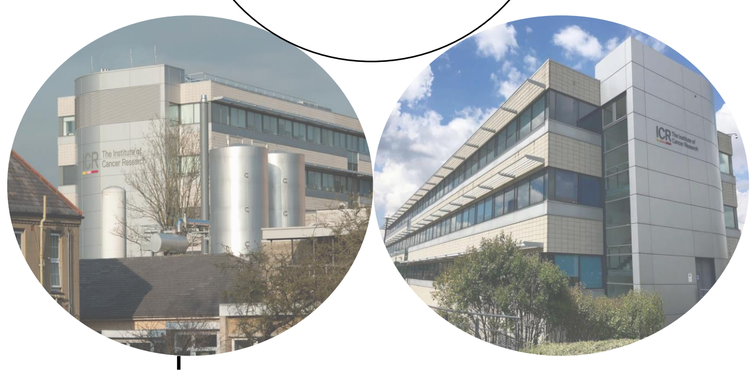
ESPRESSO DBN
Agency that thrives on creativity & innovation. Use of creative spaces & relaxed working spaces.





Existing Facilities

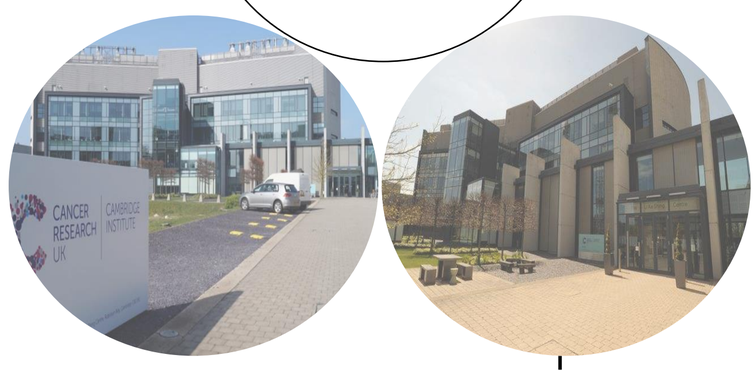
THE INSTITUTE OF CANCER RESEARCH LONDON

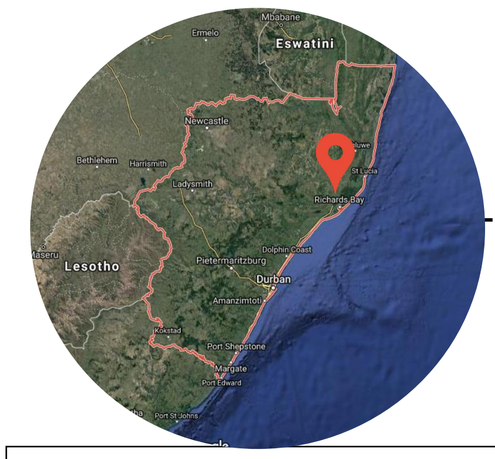


Tall & Industrial like buildings. Minimal introduction of nature within the space & minimal opportunity for collaboration. Laboratory space and technical central.

UGANDA CANCER INSTITUTE

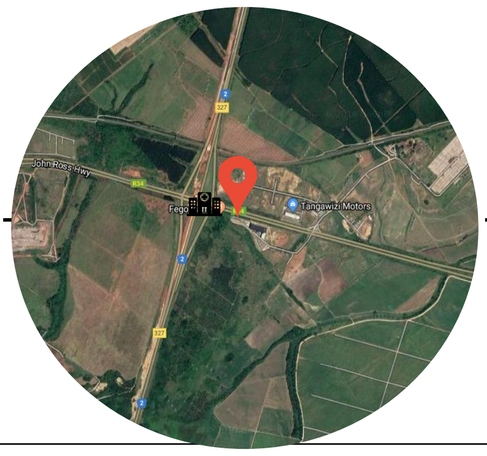
CANCER RESEARCH UK CAMBRIDGE INSTITUTE



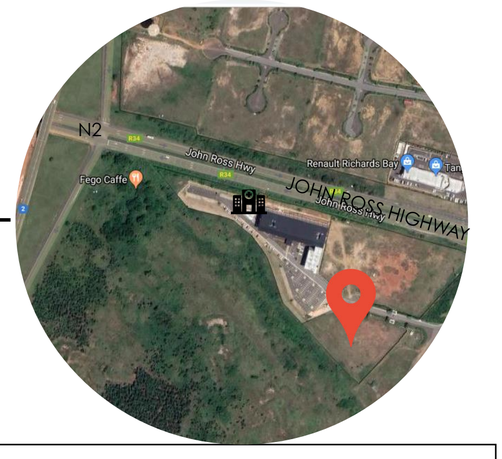


Young settlement. Built around the port.

Warm to hot, humid climate. Mean temp & rainfall = 21.5° C & 1292mm.



Sea levels to rise by 30m in 100 years. Berea red soil. Biodiverse surroundings.

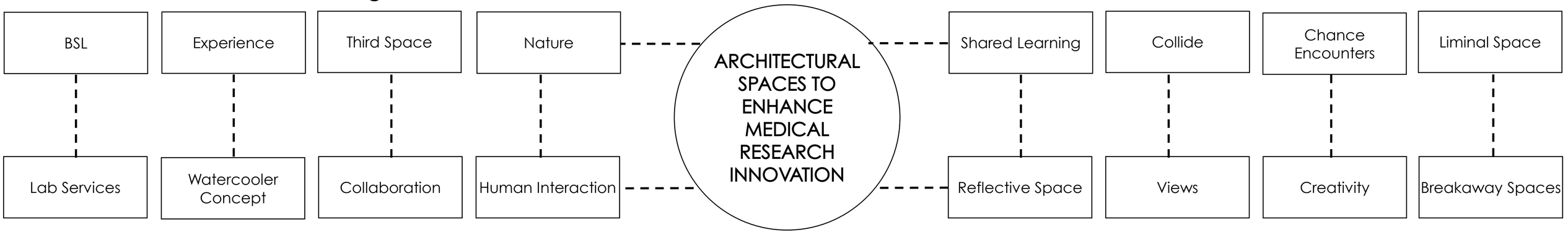


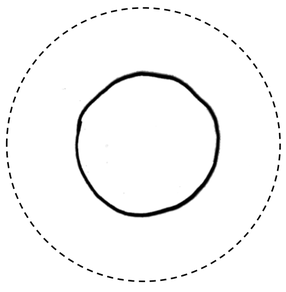
Site part of John Ross Eco Junction. Easy access from N2, to hospitals & universities.

Site Analysis

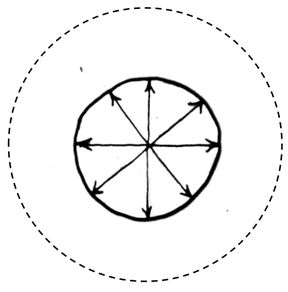
John Ross Eco Junction, Richards Bay, Kwa Zulu Natal

Initial Sketches & Thoughts

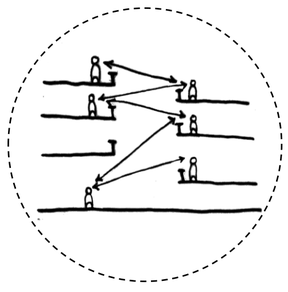




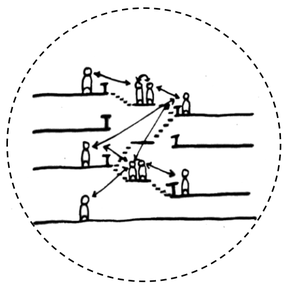
Bringing people together



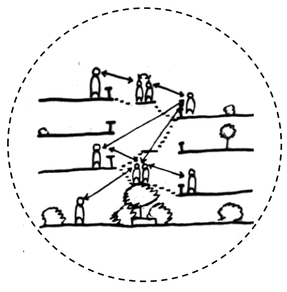
Promoting interaction



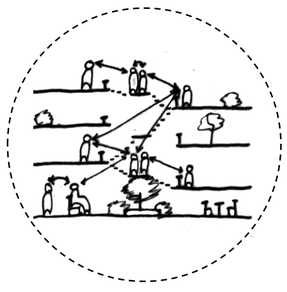
Visibility



Accessibility/ chance encounters/ collision

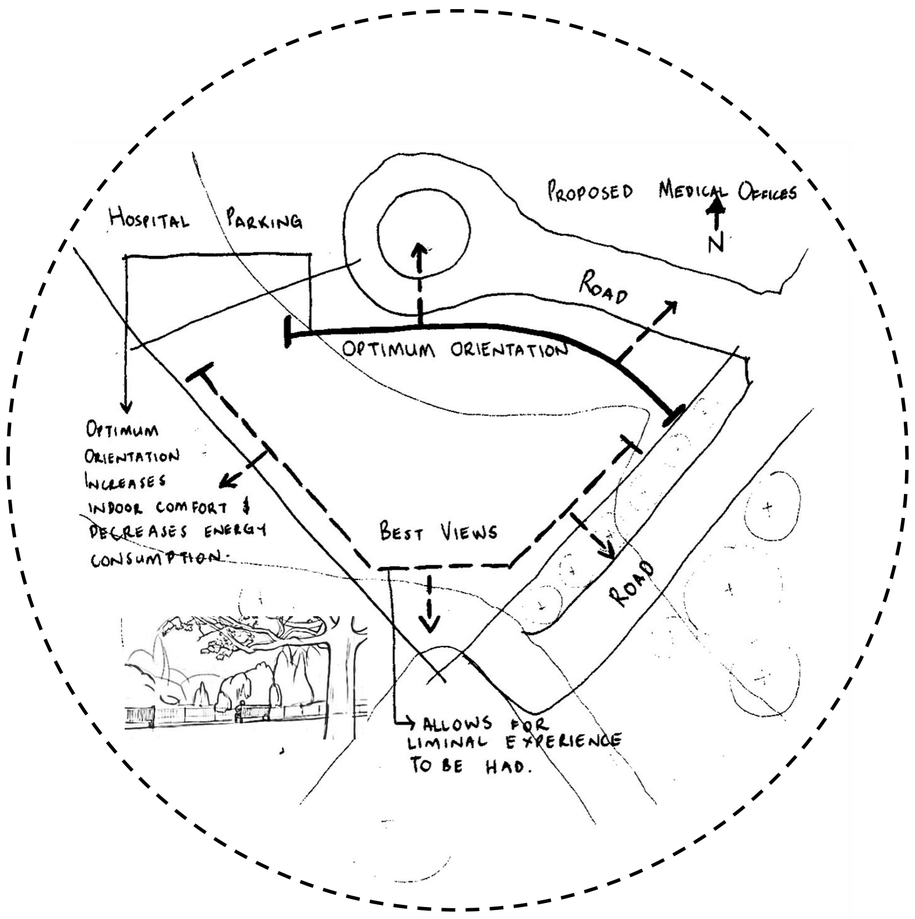


Nature/Breakaway Spaces

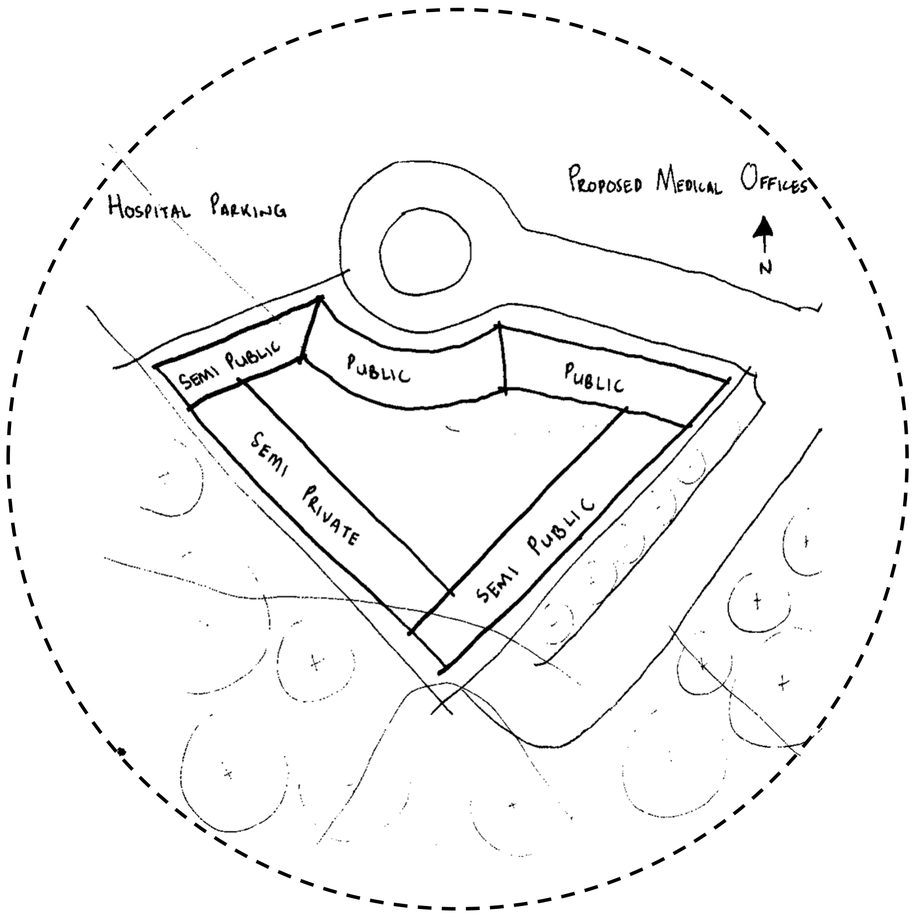


Third Space/Experience

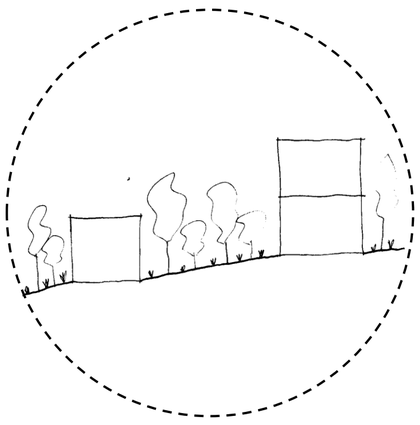
Design Development



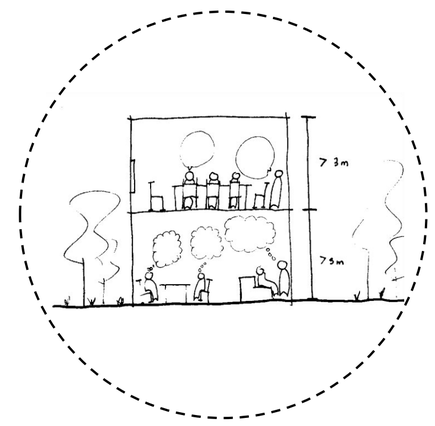
ORIENTATION /VIEWS /ACCESS



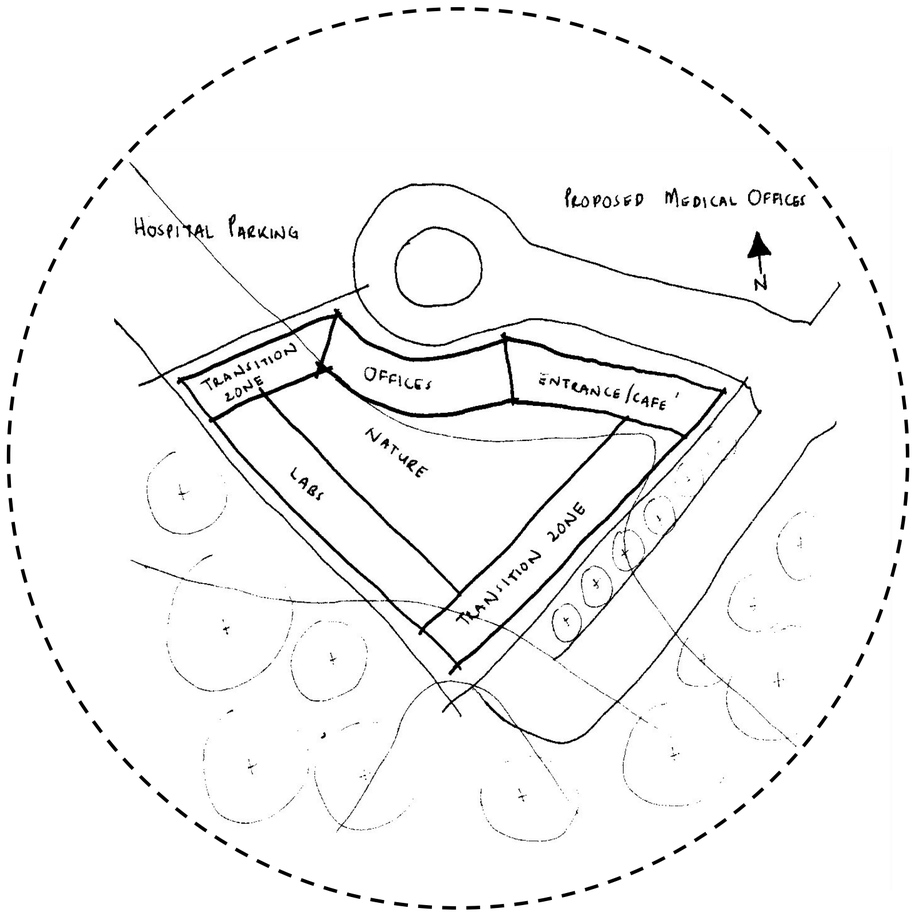
PRIVACY GRADE



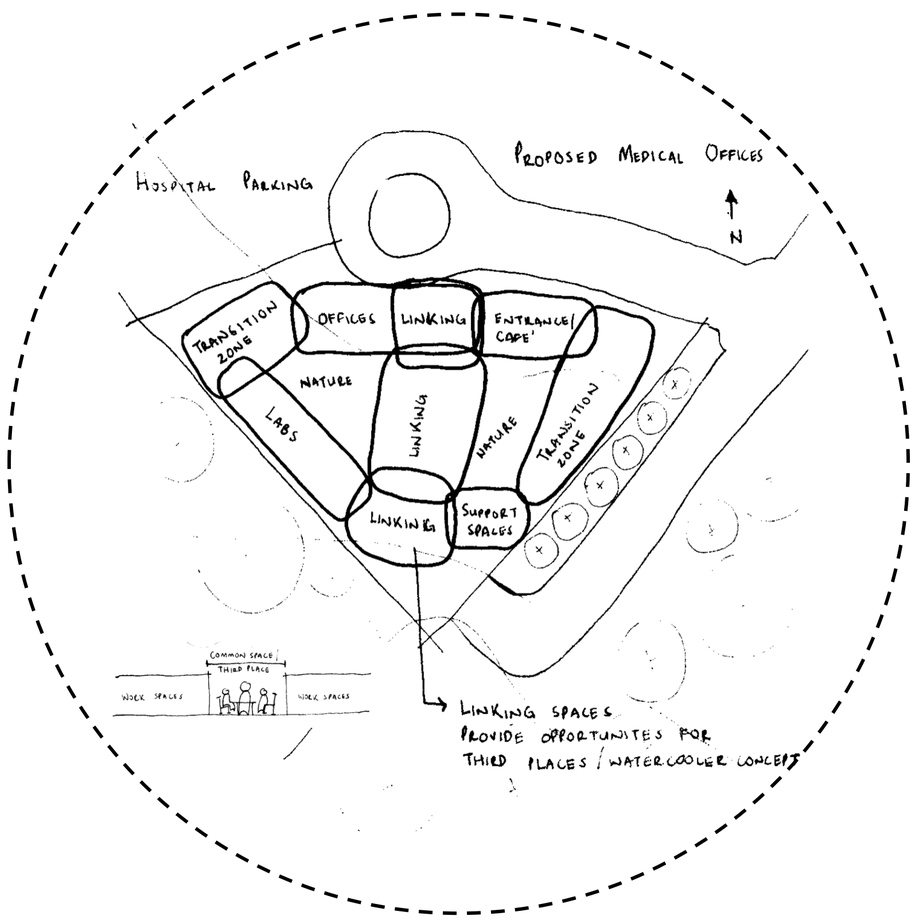
USING NATURE ON THE SITE



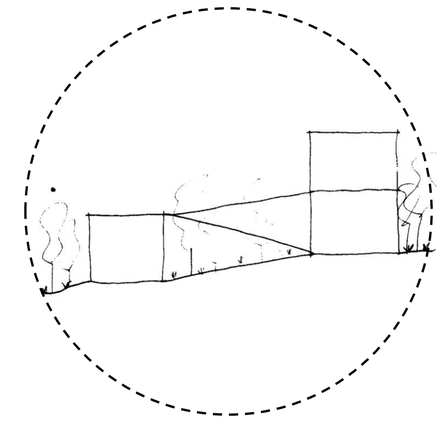
LARGER VOLUMES MAKE FOR CLEARER THOUGHTS



SPACE ALLOCATION THROUGH PRIVACY NEEDED



BUBBLE DIAGRAM OF SPACES



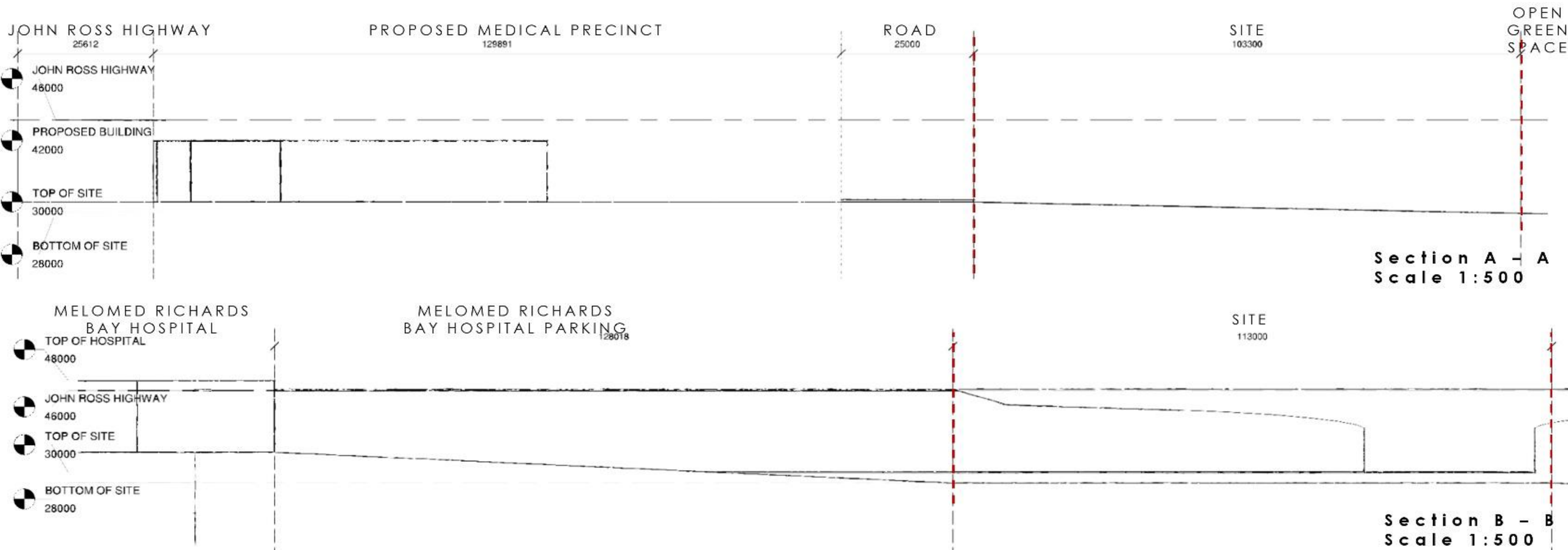
LINKING OF SPACES

Schedule of Accommodation

Schedule of Accommodation				
	Space	Quantity	Size	Total Area
Lab	BSL 3 Laboratories	2	15 x 13.5	202,5 m²
	Waste Disposal	1	7.5 x 7.5	56,25 m²
	Locker Rooms	1	7.5 x 7.5	56.25 m²
	Write-up space	1	7.5 x 38	285 m²
Servicing	External Gas Storage	1	3.5 x 15	52.5 m²
	Grey Water	1	7.5 x 15	112.5 m²
	Central Storage / Mechanical Plant Room / Computer Server Room / Generator Room/ UPS / Cold Storage	1		1 012.5 m²
Offices	Open Plan	100	1.5 x 1.5	225 m²
	Seminar Rooms	2	7.5 x 18	135 m²
	Meeting Rooms	1	7.5 x 7.5	56.25 m²
	File Storage	1	4 x 7.5	30 m²
	Printing / Copying	1	4 x 7.5	30 m²
	Waiting Areas	4	7.5 x 7.5	56.25 m²
	Reception	2	7.5 x 10	75 m²

Schedule of Accommodation				
	Space	Quantity	Size	Total Area
Social	Upper Cafe	1	7.5 x 30	225 m²
	Library	1	7.5 x 15	112.5 m²
	Cafe	1	15 x 15	225 m²
	Meeting Space	1	7.5 x 15	112.5 m²
	Courtyard	2	1 575	1575 m²
	Ramps	3	7.5 x 50	1125 m²
	Green Roof	1	15 x 37.5	562.5 m²
	Public Ramp	1	15 x 75	1 125 m²
	Ramp to Office	1	15 x 22	330 m²
	Social Balcony Space	2	22.5 x 22.5	506.25 m²
	Outdoor Space	1	15 x 45	675 m²
Ablutions	Male: Water Closets	13	1.5 x 1	19.5 m²
	Female: Water Closets	13	1.5 x 1	19.5 m²
			Total Area	8 978.25 m²

Site Sections



Section A – A
Scale 1:500

Section B – B
Scale 1:500

Basement
Scale 1:200

N

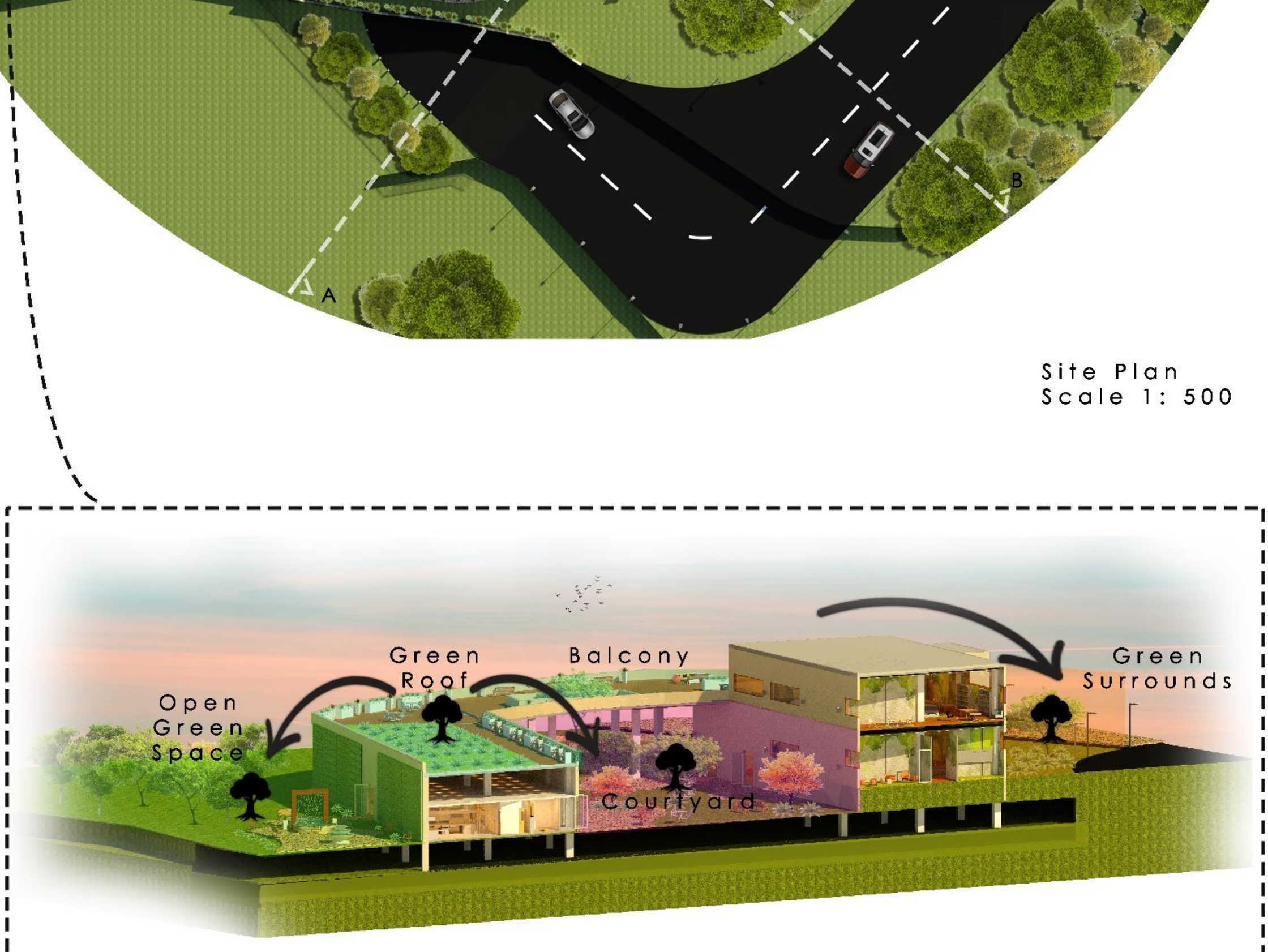
A

B

B

A

Site Plan
Scale 1: 500



Outdoor - Outdoor Relationship

N

Library

Meeting Place

Seminar Room

Seminar Room

Stair Landing

Reception

Storage

Reception

Entrance

Cafe

Courtyard

Ramp to Upper Cafe

Ramp to Lab

Courtyard

A

A

A

Grey Water

Bsl 3 Lab

Bsl 3 Lab

Outdoor Space

Write-up Space

B

B

Locker Room

Gas Storage

Waste Disposal

Outdoor Space

Ground Floor
Scale 1: 200

Indoor - Outdoor Relationship

N

Printing/Chill Space

Open Plan Office

Open Plan Office

Meeting Room

Outdoor Chill Space

Outdoor access to Green Roof

First Floor to Cafe Ramp

Ground Floor Ramp

Green Roof

Storage

Ramp to Entrance

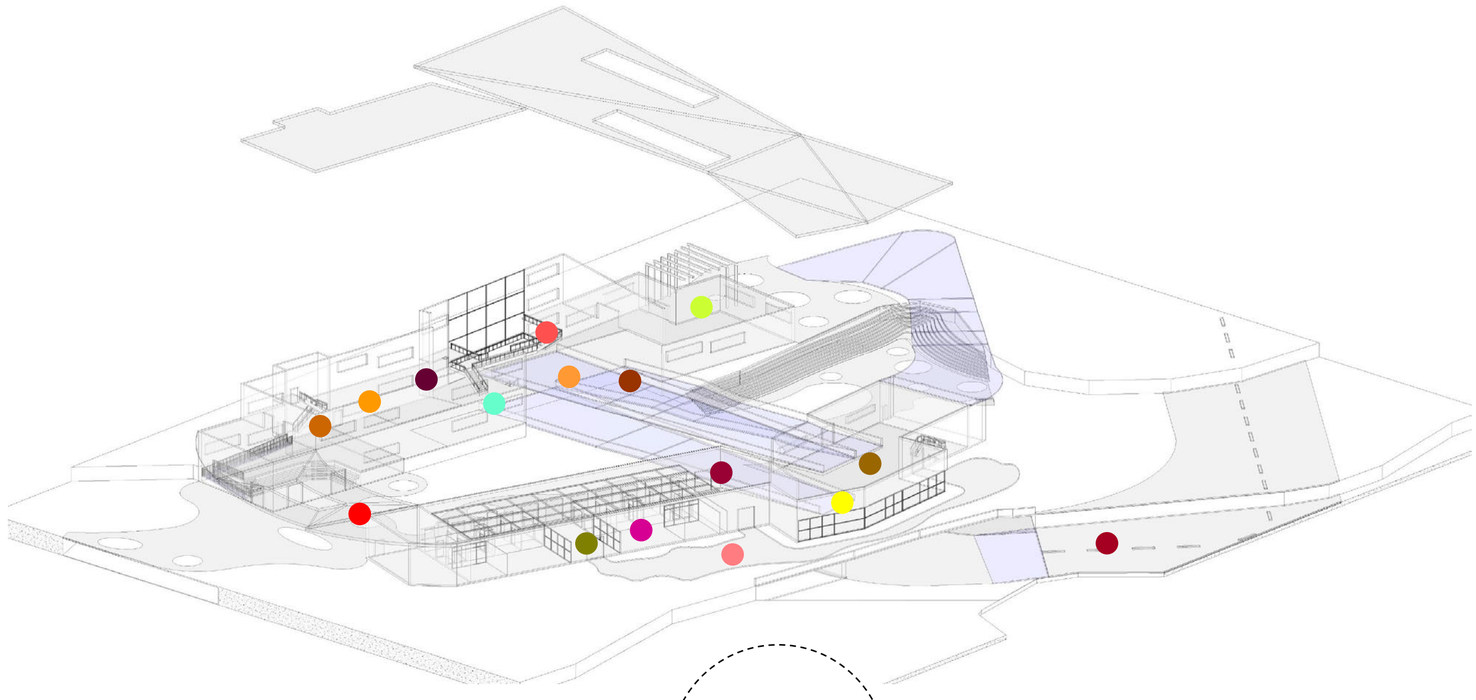
Outdoor Cafe Space

Cafe

First Floor
Scale 1: 200

Indoor - Indoor Relationship

Researcher Arrival By Car: Spaces Experienced

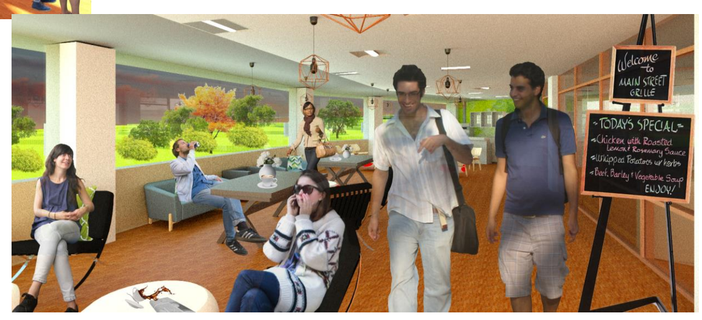


Basement Entrance

Lift Lobby

Ramp to Upper Cafe

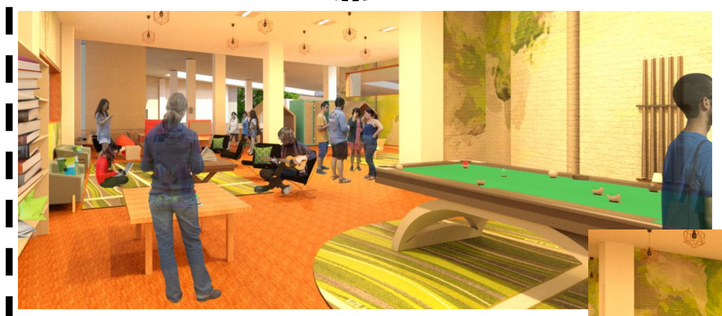
Upper Cafe

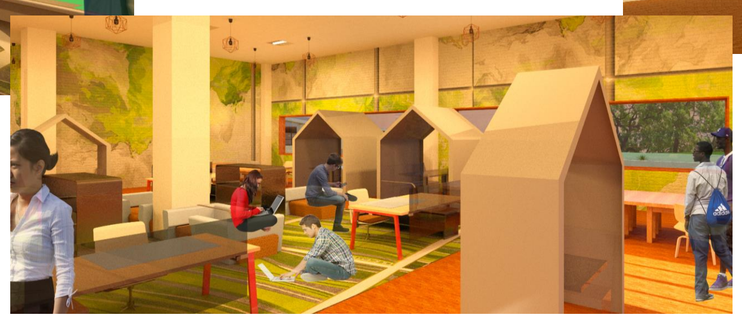


Breakaway Space

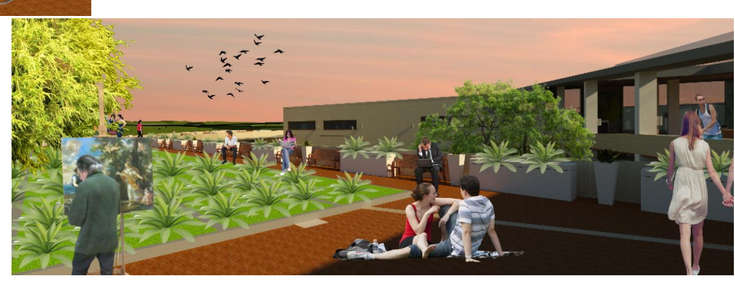
Bridge to Office

Open Plan Office



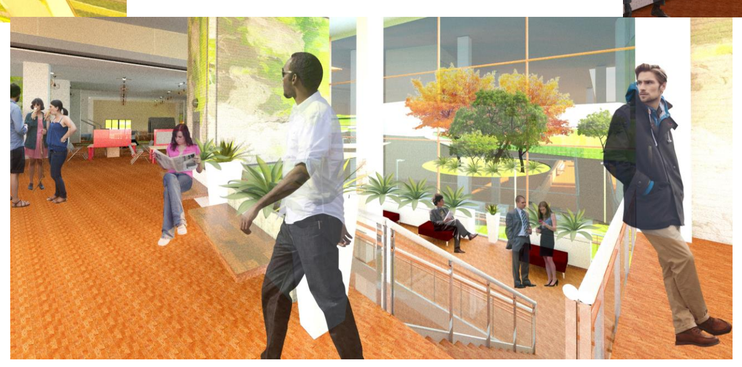


Green Roof



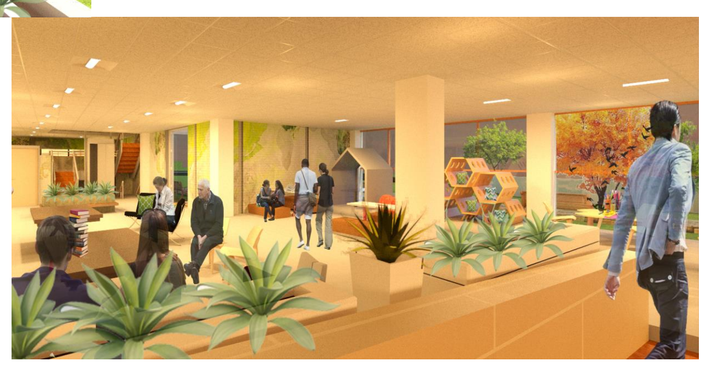
Private Office Space

Staircase



Ramp to Lab

Lab Write - up Space



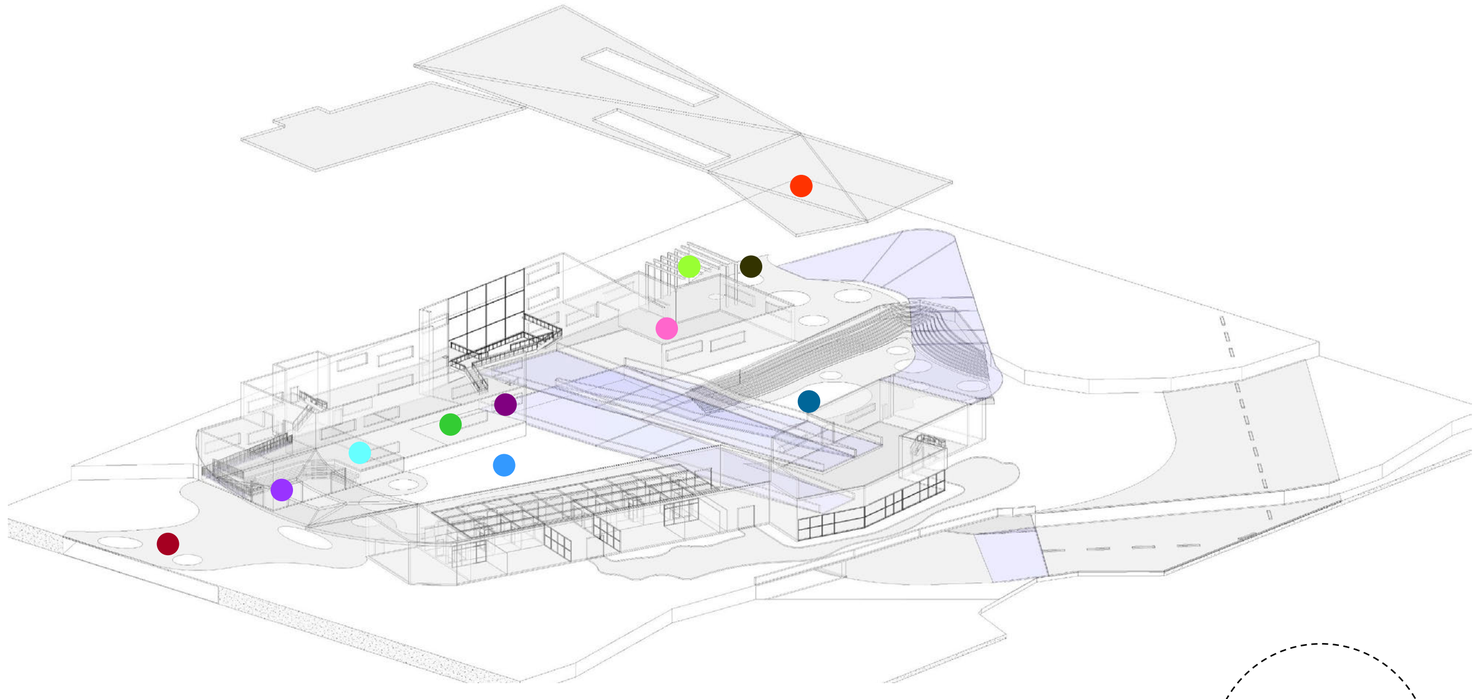
Outdoor Office Space

Lab Breakaway Space

Lab

Lab Entrance

Student Arrival By Foot: Spaces Experienced



Pedestrian Entrance

Access to Entrance & Ramp to Upper Cafe

Cafe

Library

Seminar Room

Waiting Area

Large stepped Meeting Area

Inner Courtyard Space

Inner Courtyard Space

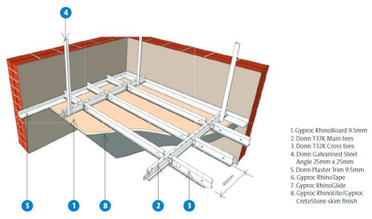
View from John Ross Highway

View from Hospital

Technologies & Materials

- Durable
- Adaptable
- Non-combustible, low flammability
- Noise reduction
- Sustainably economical
- Recyclable
- Saves on energy costs

ALUCOBOND



- Suitable for hospitals and sterile environments
- Sustainable
- Noise reduction
- Thermal properties
- Versatile
- Aesthetic

GYPCEIL PRESTIGE S

- Durable
- Low maintenance
- Does not rust, rot, or burn
- Absorbs & retains heat
- Wind & water resistant
- Non-combustible
- Noise reduction

CONCRETE

- Lead-free walling for laboratories
- An innovative board
- Creates safe spaces
- Suitable for sterile environments

XROC WALLS

- Durable
- Environmentally friendly
- Slip-resistant
- Low-maintenance/upkeep
- Unique
- Natural aesthetic

NATURAL STONE PAVING

- Chemical Resistant
- Wear Resistant
- Easily Cleaned
- Decorative
- Low Maintenance
- High slip, thermal & abrasion resistance
- Impermeable

FLOWCRETE FLOORING

- Improve air quality
- Cools surroundings
- Purify rainwater
- Reduce soil erosion
- Reduce the risk of fire hazards
- Improve physical & mental well-being

GRASS

- Durable
- Environmentally friendly
- Maintenance & hygiene
- Improve physical & mental well-being

WOODEN FLOORING

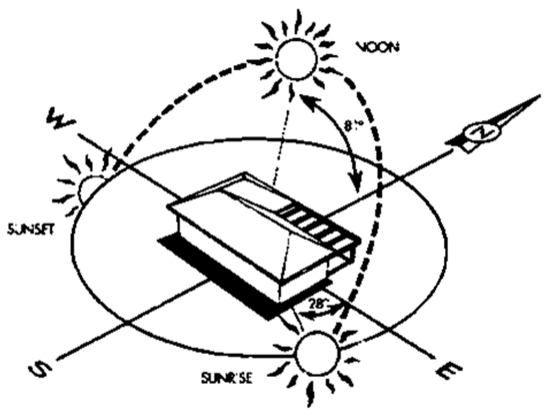
- Purifies the air
- Improves of well-being
- Energy cost reduction
- Ambient noise reduction
- Stress reduction
- Boosts productivity
- “Healing environment”

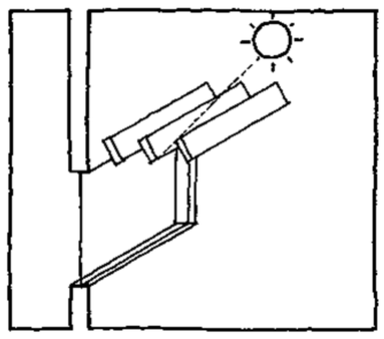
GREEN WALL

- Boosts creativity
- Inspires innovation
- Promotes harmony & balance
- Enhances creative performance
- Reduces anxiety
- Reduces eye strain

GREEN PAINTED WALLS

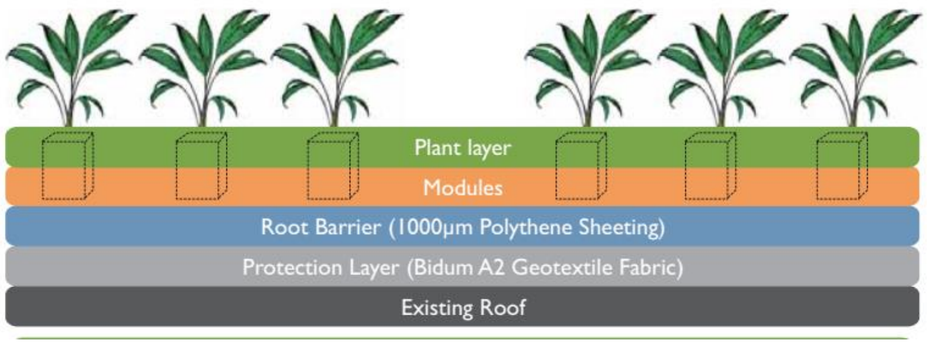
Sustainable Principles



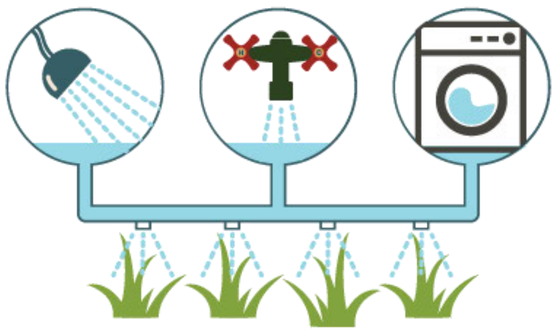


MAXIMISING OPTIMUM ORIETATION AND PASSIVE COOLING METHODS

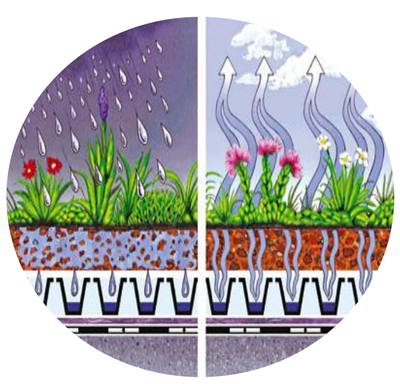
UTILISING RETRACTABLE SCREEN DOORS THAT ALLOW VENTILATION ACROSS RAMPS



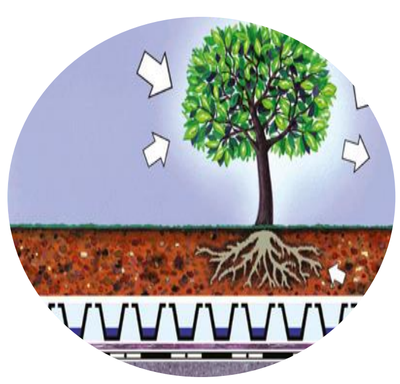
MODULAR GREEN ROOF SYSTEM



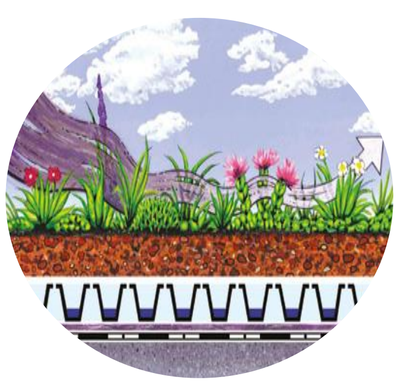
GREYWATER COLLECTED USED TO SUPPLY GREEN ROOF IRRIGATION



PROVIDES RAINWATER MANAGEMENT



IMPROVES THE MICROCLIMATE



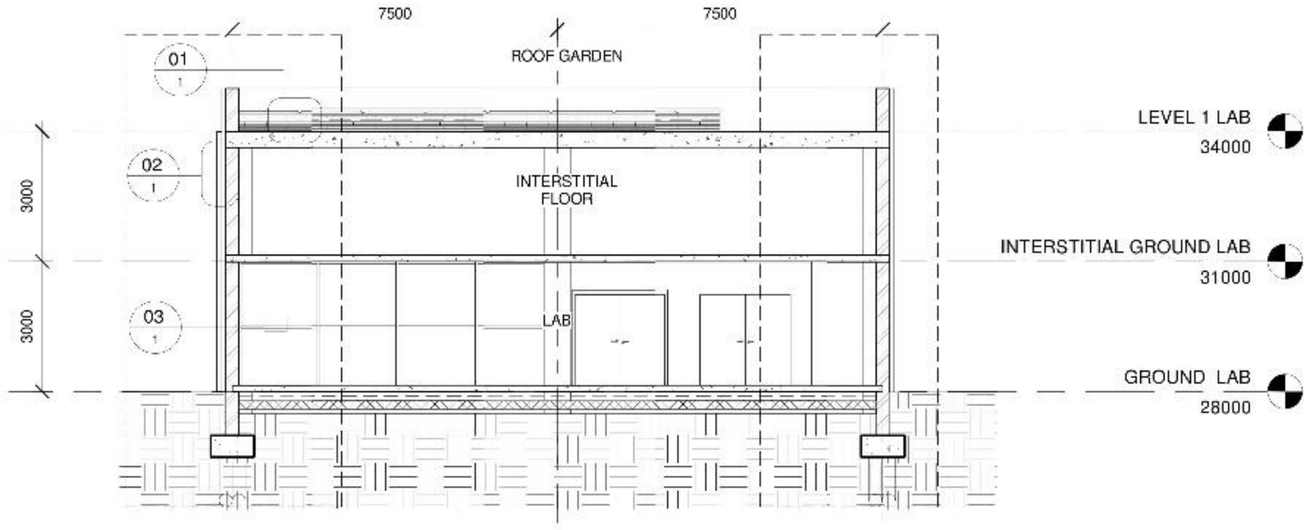
BINDS DUST AND TOXIC PARTICLES

IMPROVES NOISE PROTECTION

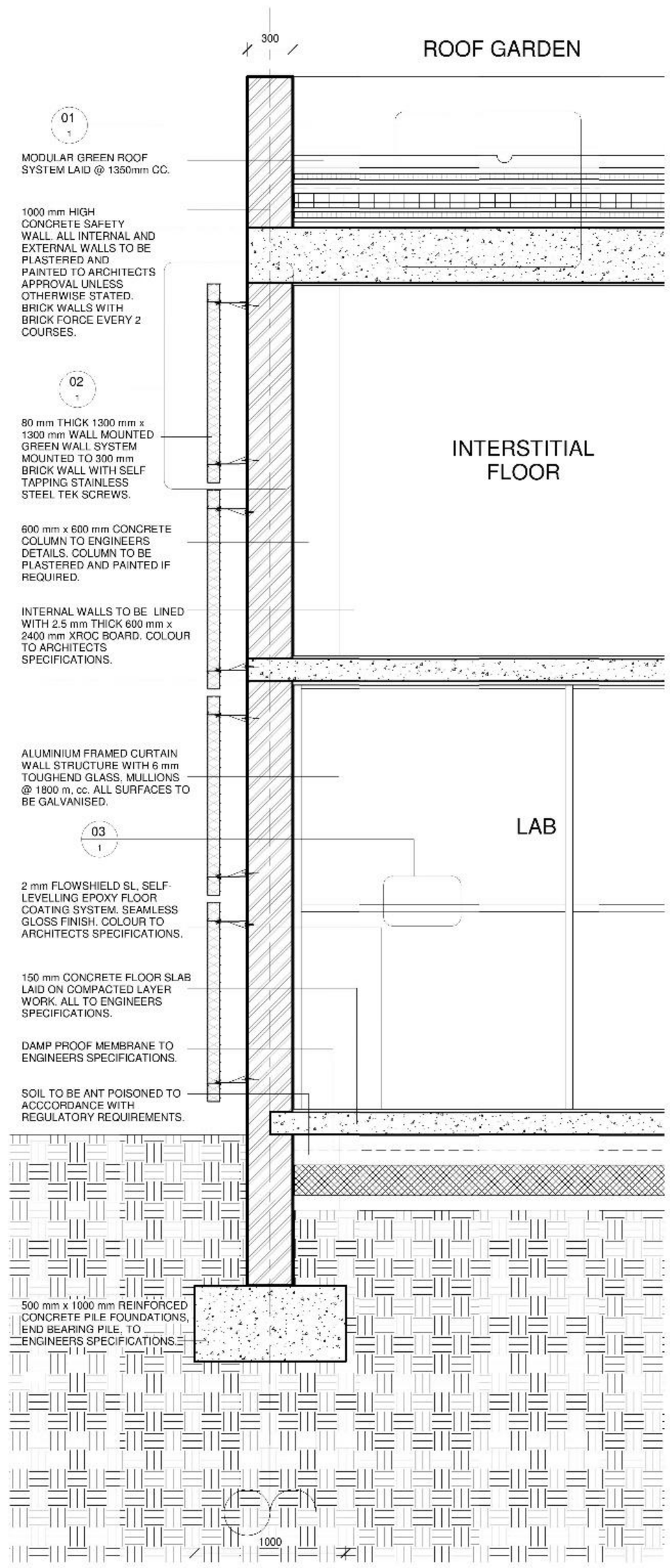
PROVIDES NATURAL BIODIVERSE HABITATS

SUPPORTS RECYCLING

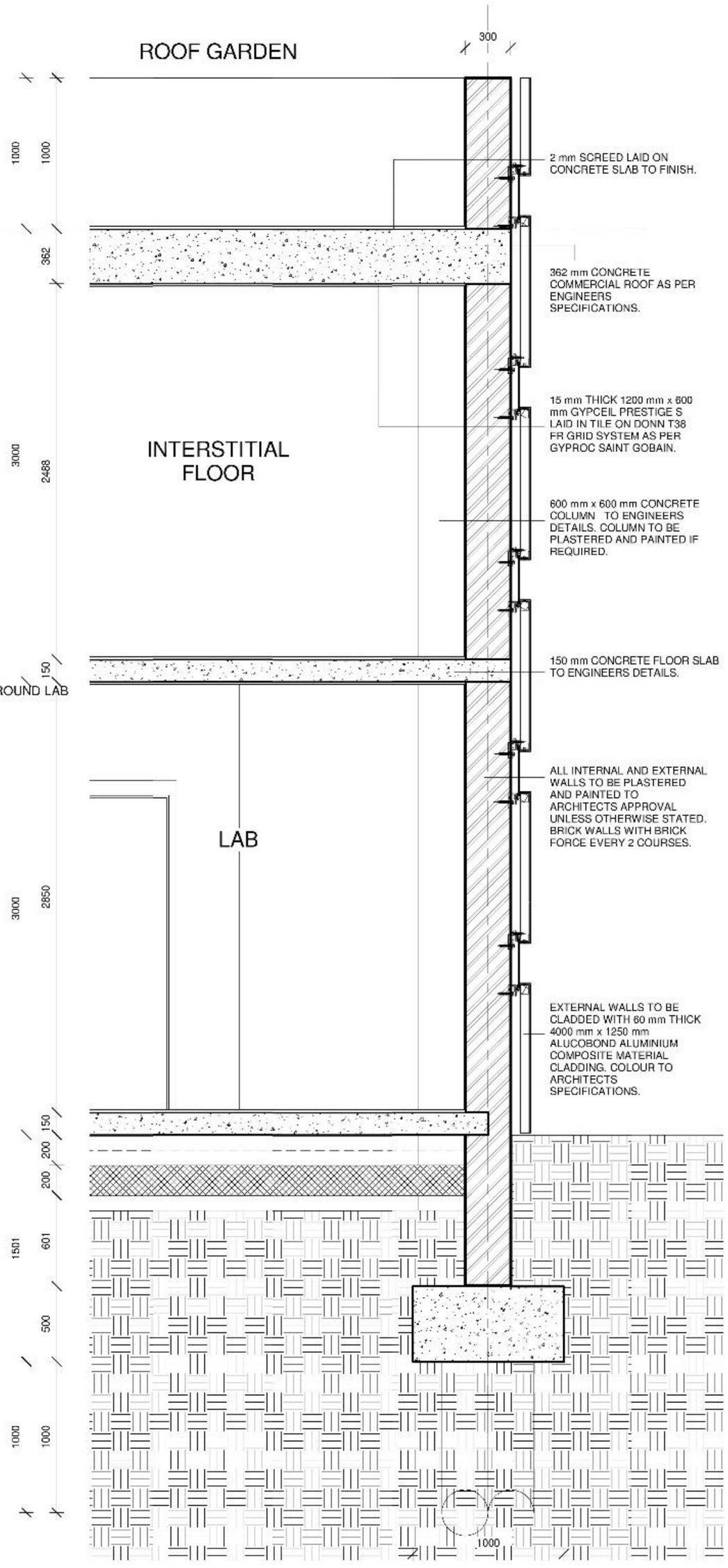
GREEN ROOF THAT ENGAGES IN GREYWATER HARVESTING



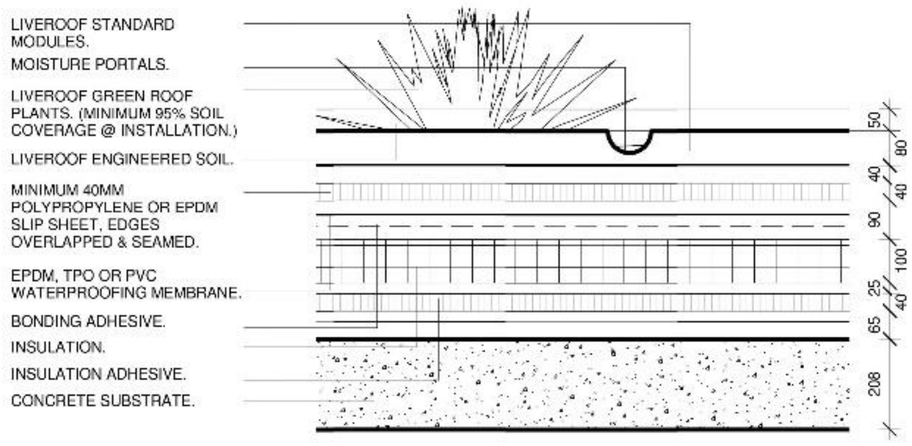
SECTION A-A
SCALE 1:100



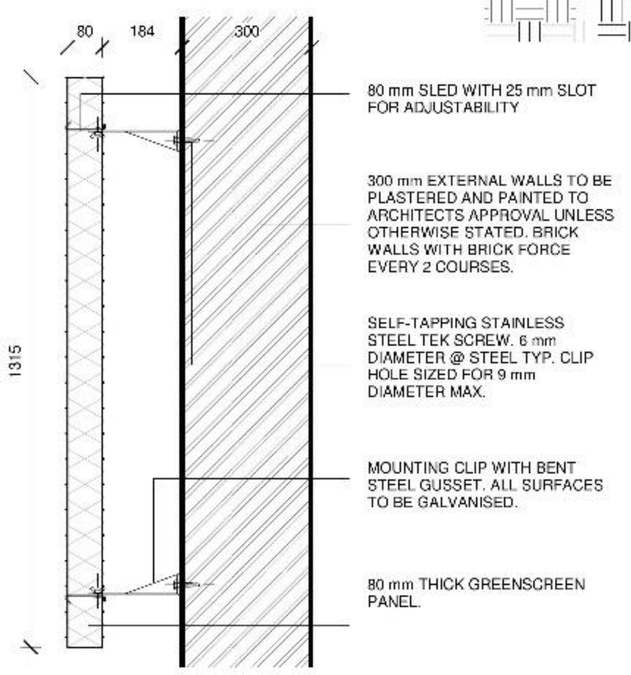
SECTION A-1
SCALE 1:20



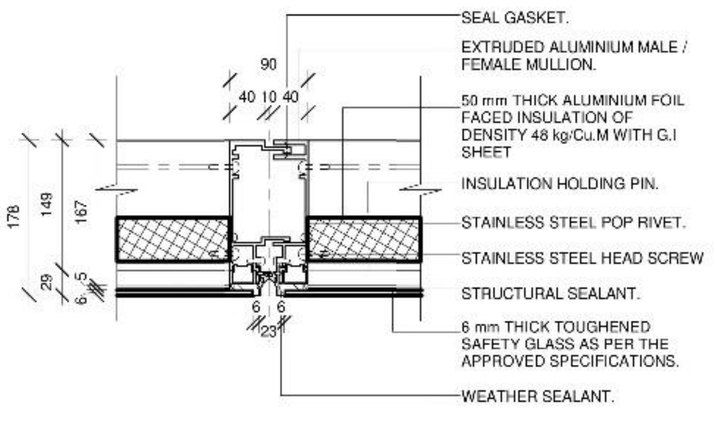
SECTION A-2
SCALE 1:20



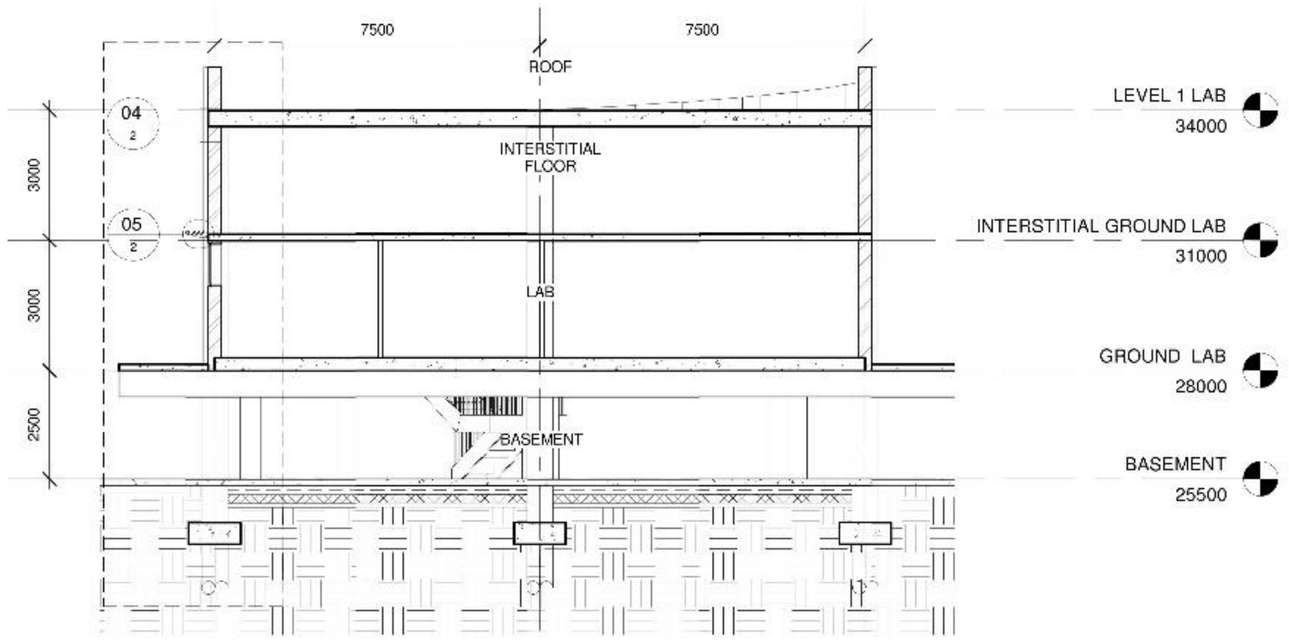
LIVE ROOF DETAIL 1
SCALE 1:10



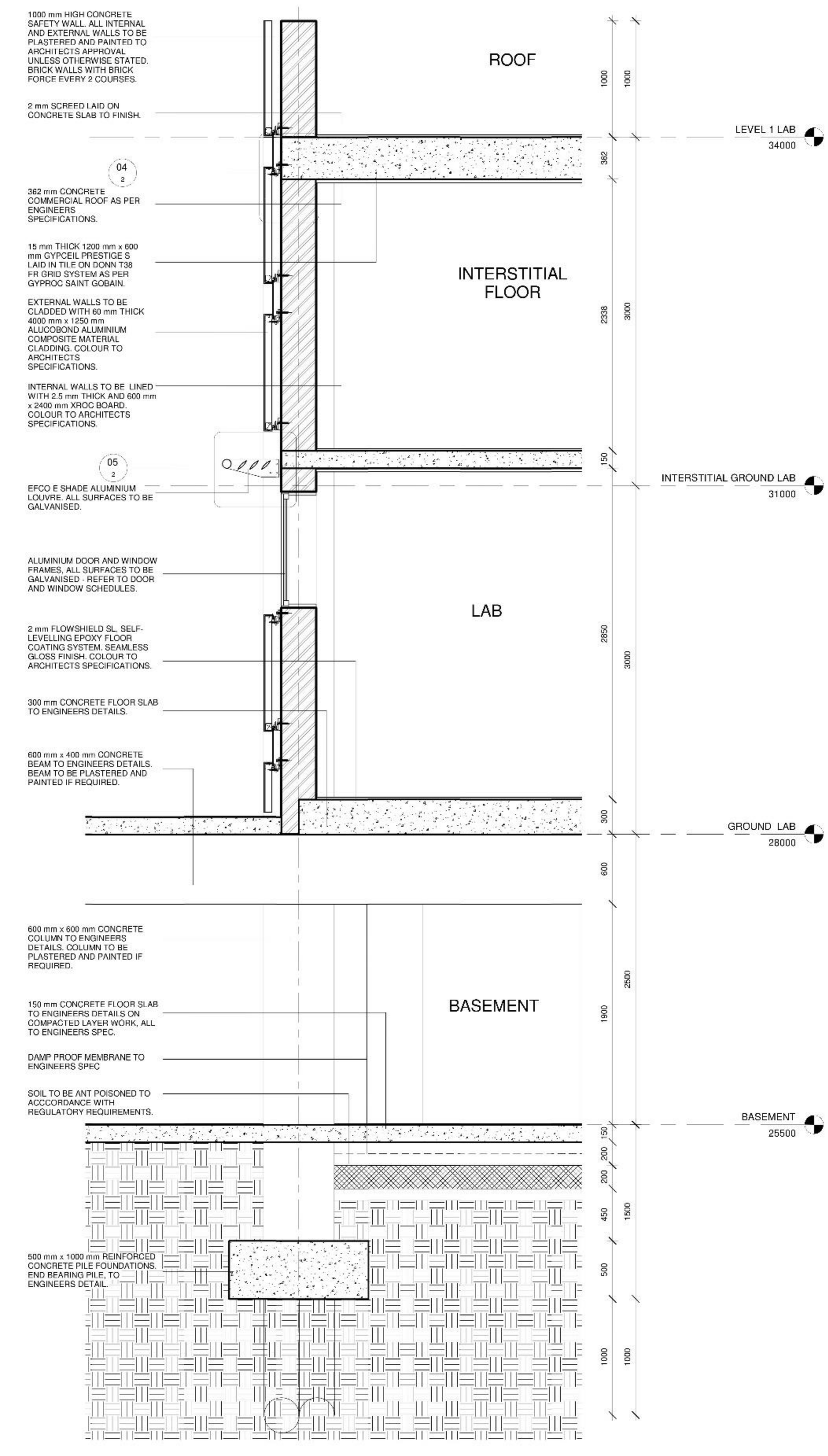
GREEN WALL DETAIL 2
SCALE 1:10



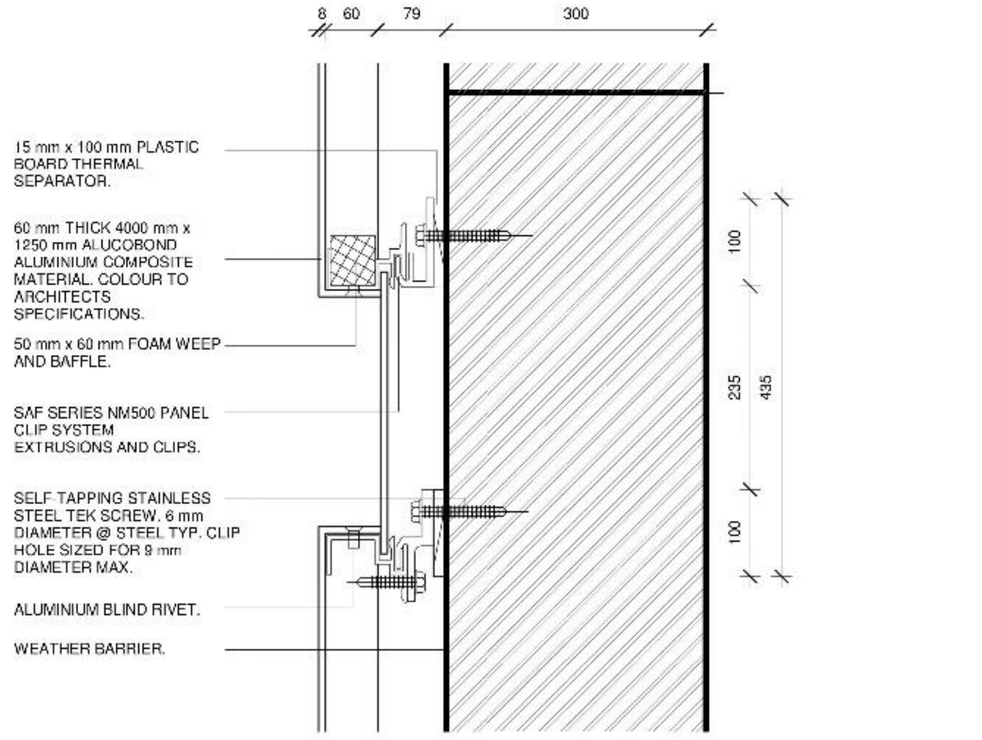
MULLION DETAIL 3
SCALE 1:5



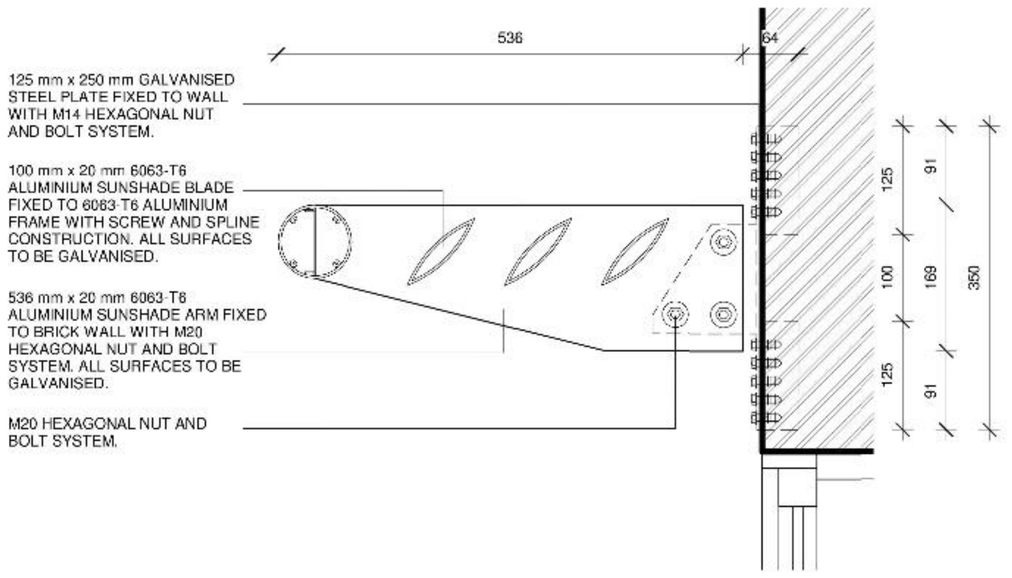
SECTION B-B
SCALE 1:100



SECTION B-1
SCALE 1:20



ALUCOBOND CLADDING DETAIL 4
SCALE 1:5



LOUVRE DETAIL 5
SCALE 1:5

GENERAL NOTES:

- All work is to be in strict accordance with the SANS 10400.
- All dimensions and levels are to be checked on site before work commences. Architect to be notified immediately of any discrepancies.
- Only figured dimensions are to be taken, drawings are not to be scaled.
- All reinforced concrete work to be strictly in accordance with structural engineer's details and specifications.
- Every drawing to be cross referenced with all related consultants drawings before construction.
- All walls to be reinforced with two courses brickforce at cill and wall plate levels.

DRAINAGE NOTES:

- All waste pipes and drains to be accessible along their entire length.
- Inspection eye(ie's) to be provided at all bends and junctions in the drain and max. of 25m lengths along straight runs of drain.
- All ie's must have marked covers at ground level.
- Cleaning eyes(ce's) to be provided at all bends and junctions of waste pipes.
- Waste to be fitted with 64mm reseal traps.
- Where the vertical drop from the soil fittings to the main drain exceeds 1,2m. These fittings are to be anti-syphoned.
- All soil vent pipes(svp's) must be taken to a min. height of 1,8m above the nearest adjacent window head - if not a two way vent valve pipe.
- Drains passing under buildings must be encased in 150mm concrete and in a straight run under the building. No bends or junctions and must have ie's at each end at a minimum of 600mm beyond the building.