

[HARVEST] . The Insect
An Experimental Biotic Platform for Species Interaction, Research
And Production

Urban Vision

“Silent Industry”, Productive Park as Alternative Typology

-

Old Rosema Waterkloof Brick Quarry

103 Skilpad Road, Monument Park, Tshwane, Gauteng, South Africa

Waterkloof 428 - JR

Submitted in fulfilment of part of the requirements for the degree of
Masters of Architecture in the Faculty of Engineering, Built Environment and Information Technology
University of Pretoria
2013

Course Co-ordinator: Dr Arthur Barker

Study Leader: Neels van Rooyen

By Elita van Graan

ABSTRACT

The study contemplates the idea that, as modern man lives and thrives on Earth, we cannot look with anticipation into the future alone, but we have to integrate our every action with the past. Maintaining a delicate balance between past and future is the major struggle and responsibility for mankind. This is also the case for architecture, for it is one of the elemental ties to our past and to our future, because the buildings are the result of history. It is these connections between past and future, building and user, building and site, user and the natural site, which shape the spaces we dwell in.

The intention of the study is to create architecture which promotes harmony within these connections between human habitation (future) and the natural world (past), through design approaches so sympathetic and well integrated with its site that buildings, furnishings, and the natural surroundings become part of a unified, interrelated composition.

The selected project is a production facility with a fly factory and integrated urban insectary, endangered insect containment research facility, harvesting a natural ecosystem on the old Rosema & Klaver Waterkloof Quarry site in Monument Park, South Africa.

TABLE OF CONTENTS

Title	
Table of contents	
List of figures	
Abstract	
1. Introduction	2
Site.....	6
General dissertation Issue.....	8
Framework Issue + Intentions	8
Architectural Intention.....	10
Programme	10
Concept	10
2. Theoretical discourse.....	11
Problem Statement.....	16
Theoretical Approach.....	16
3. Context and Site	24
Locality.....	26
History of the site.....	28
Ecology	30
Intangible context analysis.....	36
4. Framework	44
Issues and Vision.....	46
5. Precedents.....	48
The Story of the Fly.....	49
Agriprotein	52
Munich Olympic Stadium.....	56
6. Design development.....	58
4 Species under the lens	60
Concept Development.....	68
Final design concept	78
7. Technology.....	82
Concept of Materiality	84
Materials.....	86
Systems.....	92
8. Technical documentation.....	94
9. Bibliography and Addendum.....	112

LIST OF FIGURES

CHAPTER 01. INTRODUCTION

Figure 1.1: Old map indicating position of the site relative to the Pretoria CBD (Author, 2013)

Figure 1.2: Current site conditions (Author, 2013)

Figure 1.3: Ruins on site (Author, 2013)

Figure 1.4: Site location (Author, 2013)

Figure 1.5: Recreation (<http://www.vintag.es/2011/12/pictures-of-anonymous-lives-long-past.html>)

Figure 1.6: Research (<http://www.synbio.org.uk>)

Figure 1.7: Production (Rosema & Klaver, 2013)

Figure 1.8: Lady in a corsette (<http://my.opera.com/christelharper/blog/corset>)

Figure 1.9: Sketch of a wasp (<http://modishvintage.blogspot.com/2011/03/insect-prints.html>)

Figure 1.10: Waste generation in a suburb (Author, 2013)

Figure 1.11: Insect conservation (Author, 2013)

Figure 1.12: Butterfly harvesting (Author, 2013)

Figure 1.13: Recreation, paper boats (<http://www.gingerlillytea.com/2013/07/sailing-paper-boats.html>)

CHAPTER 02. THEORETICAL DISCOURSE

Figure 2.1: Pinned dragonfly specimen (Zoology UP, 2013)

Figure 2.2: Frog (Author, 2013)

Figure 2.3: X-ray of a frog (<http://www.nahnyc.com/radiology.htm>)

Figure 2.4: Tapestry of urban and natural ecosystems (Author, 2013)

Figure 2.5: Tapestry of connections (Unknown, 2013)

Figure 2.6: Table indicating species survival (IUCN, 2013)

Figure 2.7: Series of British stamps, endangered and extinct insect species (<http://blog.insectmuseum.org/?p=1049>)

Figure 2.8: Sir David Attenborough (http://the-bulb.com/wp-content/uploads/2011/11/David_Attenborough)

Figure 2.9: Sir David Attenborough (<http://www.listal.com/viewimage/252977>)

Figure 2.10: Concept of natural destruction (Author, 2013)

Figure 2.11: Pinned mantis (<http://www.wksu.org/news/images/32643/MANTIS-PIN.jpg>)

Figure 2.12: Endangered butterflies (Zoology UP, 2013)

Figure 2.13: Endangered natural (Author, 2013)

Figure 2.14: Insect harvesting as recreational (Author, 2013)

Figure 2.15: Girl with giant African bullfrog (<https://www.facebook.com/LoxHerp>)

Figure 2.16 – 17: Scientific data capturing, *Xaenopus laevis* (<http://www.intechopen.com/books/cell-interaction/cell-interaction-during-larval-to-adult-muscle-remodeling-in-the-frog-xenopus-laevis>)

CHAPTER 03. CONTEXT AND SITE

Figure 3.1: Site location (Author, 2013)

Figure 3.2: Ruins indicated on the current site (Author, 2013)

Figure 3.3: Site informants (Author, 2013)

Figure 3.4: Site informants, current and historical (Author, 2013)

Figure 3.5: Old waterkloof quarry plans (Rosema & Klaver, 2013)

Figure 3.6: Old waterkloof quarry plans (Rosema & Klaver, 2013)

Figure 3.7: Old waterkloof quarry plans (Rosema & Klaver, 2013)

Figure 3.8: Geology map (Thomson, 2013)

Figure 3.9: Vegetation map (Thomson, 2013)

Figure 3.10: Current site ecological condition (Author, 2013)

Figure 3.11: Current site ecological condition with building ruins (Author, 2013)

Figure 3.12: Current site ecological condition with building ruins (Author, 2013)

Figure 3.13: Current site ecological condition with newly formed water habitats (Author, 2013)

Figure 3.14: Current site ecological condition with building ruins and new water habitat (Author, 2013)

Figure 3.15: Current site ecological condition with building ruins where vegetation has taken occupancy (Author, 2013)

Figure 3.16: Current site ecological condition with building ruins where vegetation has taken occupancy (Author, 2013)

Figure 3.17: Current site vegetation (Author, 2013)

Figure 3.18: *Xaenopus laevis* on site (Author, 2013)

Figure 3.19: Micro-climate map of site (Thomson, 2013)

Figure 3.20 – 21: Left: Urban issue (Author, 2013)

Figure 3.22 – 23: Right: Urban issues as abstract visuals (Author, 2013)

Figure 3.24 – 25: Left: Programme issue (Author, 2013)

Figure 3.26 – 27: Right: Program issue as abstract visuals (Author, 2013)

Figure 3.28 – 29: Left: Site issue (Author, 2013)

Figure 3.30 – 31: Right: Site issues as abstract visuals (Author, 2013)

Figure 3.32 – 33: Left: Architectural issue (Author, 2013)

Figure 3.34 – 35: Right: Architectural issues as abstract visuals (Author, 2013)

CHAPTER 04. FRAMEWORK

Figure 4.1: Era brick factory (Author, 2013)

Figure 4.2: Current bio-diversity on site (Author, 2013)

Figure 4.3: Gated community, alienation of site (Author, 2013)

CHAPTER 05. PRESEDENTS

Figure 5.1: Black soldier flies (Unknown, 2013)

Figure 5.2: Black soldier flies in cages (<http://www.faz.net/aktuell/gesellschaft/umwelt/nachhaltige-geschaefsidee-made-in-south-africa-11857044.html>)

Figure 5.3: Black soldier fly breeding (<http://www.cleantick.com/users/alfredolle/projects/mass-rearing-of-black-soldier-fly-hermetia-illucens/20609>)

Figure 5.4: Agriprotein process diagram proposal for program (Author, 2013)

Figure 5.5: Organic waste, left-over food (Author, 2013)

Figure 5.6: Waste containers (<http://www.agriprotein.com/>)

Figure 5.7: Black soldier flies larvae (larval pellets) ready to be feed to animals (<http://www.agriprotein.com/>)

Figure 5.8: Munich Olympic stadium roof design (<http://kylejanzen.wordpress.com/category/history/>)

Figure 5.9: Munich Olympic stadium lightweight transparent roof design (<http://www.handpickedbyronandchris.com/2012/07/olympic-tuesday-let-games-begin.html>)

Figure 5.10: Munich Olympic stadium lightweight transparent roof design (<http://www.handpickedbyronandchris.com/2012/07/olympic-tuesday-let-games-begin.html>)

CHAPTER 06. DESIGN DEVELOPMENT

Figure 6.1: Adult black soldier fly (BSF) (<http://bugguide.net/node/view/184752/bgimage>)

Figure 6.2: BSF life stages (<http://brewcovery.wordpress.com/>)

Figure 6.3: Chickens feeding on BSF larvae (<http://retirednoway.wordpress.com/2011/07/16/>)

Figure 6.4: Adult black soldier fly in breeding cages (<http://bugguide.net/node/view/184752/bgimage>)

Figure 6.5: BSF cage concept (Author, 2013)

Figure 6.6: Giant African bullfrog breeding in Taiwan (http://squamates.blogspot.com/2012_08_01_archive.html)

Figure 6.7: Giant African bullfrog (<http://www.frogforum.net/african-bullfrogs/3348-fearing-i-too-got-scammed-dwarf-african-bullfrogs-pyxies-sold-giants.html>)

Figure 6.8: Lacewing (Author, 2013)

Figure 6.9: Lacewing eggs on timber bridge (<http://www.pesticide.org/the-buzz/natural-aphid-predators-lacewing-larvae>)

Figure 6.10: Dragonfly (<http://bugsofpopoagie.wordpress.com/category/entomology-general/>)

Figure 6.11: Dragonfly life cycle (http://www.diytrade.com/china/pd/6403517/Specimen_Life_Cycle_of_Dragonfly.html)

Figure 6.12: Design concept diagrams (Author, 2013)

Figure 6.13: Design concept (Author, 2013)

Figure 6.14: Concept for recreational route (Author, 2013)

Figure 6.15: Concept for recreational route (Author, 2011)

Figure 6.16: Site plan indicating important nodes (Author, 2013)

Figure 6.17: Series i – vi of conceptual design diagrams (Author, 2013)

Figure 6.18: Site plan indicating important nodes (Author, 2013)

Figure 6.19: Series i – vi of conceptual design diagrams indicating abstract program (Author, 2013)

Figure 6.20: Series i – iv of conceptual design explorations (Author, 2013)

Figure 6.21: Series i – vii of conceptual design explorations (Author, 2013)

Figure 6.22: Series i – vi of conceptual design explorations with models (Author, 2013)

Figure 6.23: Series i – vii of advanced design explorations with models. The roof structure is also explored (Author, 2013)

Figure 6.24: Birds' view of the model of the finalised design layout. Building faces north and link suburb with industrial core creating a landscaped portal (Author, 2013)

Figure 6.25: Diagrams of the various floor plan layouts of the finalised design (Author, 2013)

Figure 6.25: Perspectives of finalised design model. Roof is absent on this model (Author, 2013)

CHAPTER 07. TECHNOLOGY

Figure 7.1: Concept of biomimicry visual (Author, 2013)

Figure 7.2: membranes and exoskeletons in nature (<http://modishvintage.blogspot.com/2011/03/insect-prints.html>)

Figure 7.3: Applied concept of membranes and exoskeletons to building (Author, 2013)

Figure 7.4: Concrete and aggregate on site (Author, 2013)

Figure 7.5: Geopolymer concrete (<http://www.gizmag.com/green-geopolymer-concrete-technology/13016/>)

Figure 7.6: Use of concrete structure with brick infill on site. Old brick quarry ruins (author, 2013)

Figure 7.7: Clay ceiling bricks with precast, prestressed, load-bearing concrete brick beams (<http://beodom.com/en/news/entries/making-of-amadeos-first-floor-slab-with-precast-beams-and-ceiling-bricks>)

Figure 7.8: Clay brick ceiling surface (<http://www.wienerberger.com/brands-products/porotherm-bricks-ceiling-system/product-range-porotherm/brick-ceilings>)

Figure 7.9: Porotherm clay brick with air cavities (<http://www.wienerberger.com/brands-products/porotherm-bricks-ceiling-system/product-range-porotherm/brick-ceilings>)

Figure 7.9: Concept visual of fabric architecture and meshed roofing (Author, 2013)

Figure 7.10: Concept of leaf structure (<http://www.pinterest.com/source/mcgregor.sbs.auckland.ac.nz/>)

Figure 7.11: Sketch of initial concept of a leaf capturing water as a roof solution (Author, 2013)

Figure 7.12: Final roof concept (Author, 2013)

Figure 7.13: Final roof concept (Author, 2013)

CHAPTER 08. TECHNICAL

Figure 8.1: Urban framework plan (Author, 2013)

Figure 8.2a: Site plan (Author, 2013)

Figure 8.2b: Site plan (Author, 2013)

Figure 8.3: Lower basement level, "Fly Factory" (Author, 2013)

Figure 8.4: Upper basement level, "Fly Factory" (Author, 2013)

Figure 8.5: Ground level, "Landsaped portal" (Author, 2013)

Figure 8.6: Upper level, "Urban research facility and insectary" + Roof plan (Author, 2013)

Figure 8.7: Section AA (Author, 2013)

Figure 8.8: Perspectives (Author, 2013)

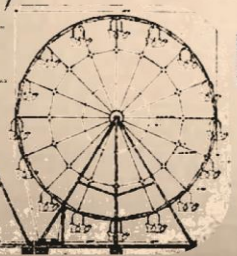
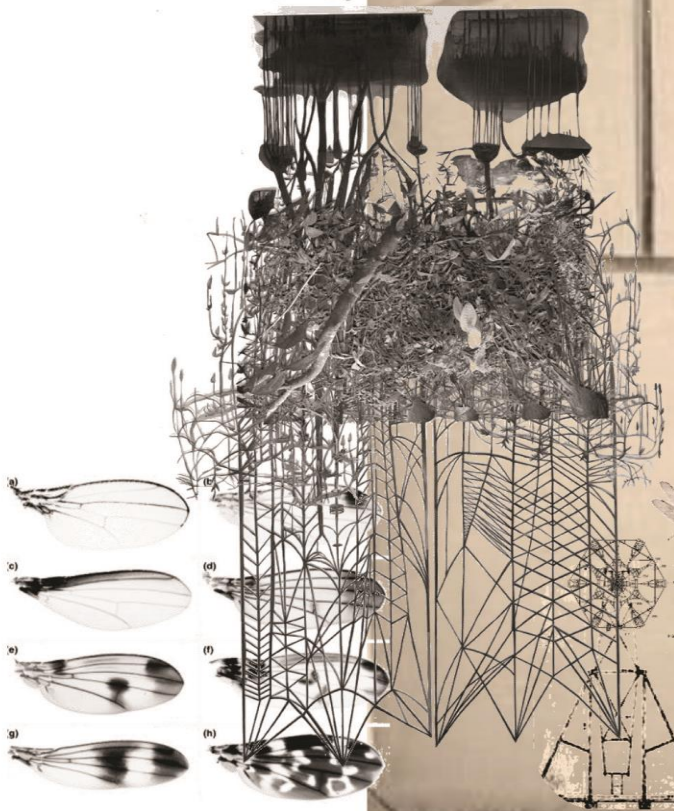
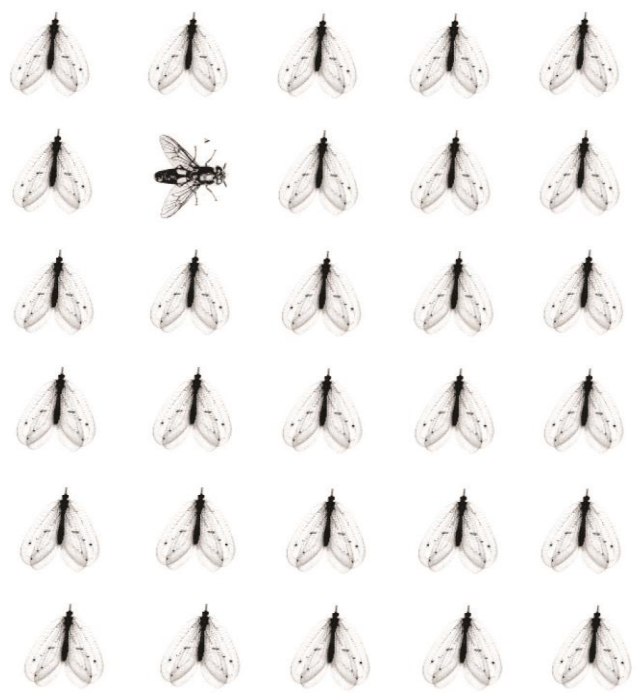


Thank you to my Christ and Saviour, who gave me the creativity and strength to meet His expectations.

Special thanks to:

My family, Tiaan van Graan, Neels van Rooyen, Dr Arthur Barker and Prof Piet Vosloo for all their wisdom, support and encouragement throughout the year.

The class of 2013



INTRODUCTION. Chapter 01



TITLE

[HARVEST] The insect. An experimental biotic platform for specie interaction, research and production

URBAN VISION TITLE

“SILENT INDUSTRY” Productive park as alternative typology

This chapter introduces the programme and its aims and intentions. It provides a background to the suburban surrounds to contextualise the site, framework and design discourse, which will follow in later chapters.
The methodology is briefly explained and issues are raised.



Figure 1.1: Old map indicating position of the site relative to the Pretoria CBD (Author, 2013)



Figure 1.2: Current site conditions (Author, 2013)

Figure 1.3: Ruins on site (Author, 2013)

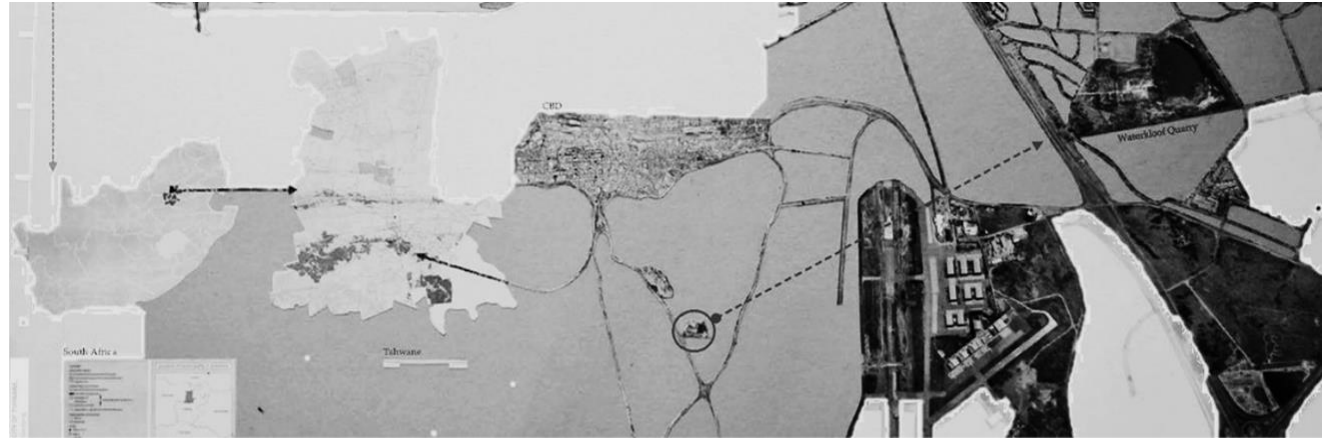


Figure 1.4: Site location (Author, 2013)

SITE

Site location:

Old Rosema Waterkloof Brick Quarry, 103 Skilpad Road, Monument Park, Tshwane, Gauteng, South Africa

The site is located 10 km south of the CBD of Pretoria, in the suburban area of Monument Park, with Waterkloof Ridge forming the eastern and southern borders of the site. It is predominantly surrounded by a suburban residential fabric, with some of these residences converted to businesses on the north-western corner. South-west of the site runs the R21, which crosses the N1 just 3 kms south from the nearest access point. The Groenkloof Nature Reserve is located 1 km north-west of the site. The site was operational as a clay brick quarry, run by Rosema & Klaver from 1933 up until 1993. The site itself currently lies dormant, as a historical artefact hidden by both private ownership, and 20 years of undisrupted plant growth.



Figure 1.5: Recreation
(<http://www.vintag.es/2011/12/pictures-of-anonymous-lives-long-past.html>)



Figure 1.6: Research (<http://www.synbio.org.uk>)



Figure 1.7: Production (Rosema & Klaver, 2013)

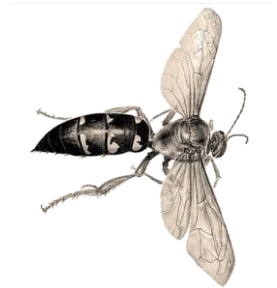


Figure 1.8: Lady in a corset
(<http://my.opera.com/christelharper/blog/corset>)

Figure 1.9: Sketch of a wasp
(<http://modishvintage.blogspot.com/2011/03/insect-prints.html>)

GENERAL DISSERTATION ISSUE

“Happiness is the sublime moment when you step out of your corsette at night”
(<http://victoriancondition.blogspot.com/2012/01/happiness-is-sublime-moment-when-you.html>)

In the 1500s-1600s, corsets, whalebone hourglass, metal rigidity, leather fetish defined and moulded the human shape into a perfect “wasplike” silhouette. 500 years later this once superficial relationship between human and insect has developed into something far more serious than a “wasplike” waistline. Of the 44 838 species assessed worldwide using the IUCN red list criteria, 905 are extinct and 16 928 are listed as under threat of becoming extinct. Sub-Saharan Africa has the highest count on endangered species. In the past, natural events caused large-scale transformations of the environment and five global mass extinctions. Now, ecosystems are again undergoing a massive loss of biodiversity. This time, the changes are caused mainly by human activity. Economic development, rapid urbanisation, deforestation, and expansion of agricultural lands have caused habitat loss to many endangered organisms in South Africa. Over-exploitation, global warming, pollution, predation and the competition in resources are also causing an upset in this sensitive equilibrium within this ecosystem, and contribute to the endangerment of all species within this sensitive system. This stress effect on biodiversity is starting to surface as a global food crisis, excessive waste generation, water scarcity, water pollution, pest breakouts, petrol price hikes and electricity shortages. The connections between human, endangered species, pest species and excess waste generation within an urban context will be explored and addressed in this study.

The intention is to explore a different perspective on not only how these connections work and what cause these imbalances, but also how to utilise and grow from this knowledge while dwelling through an operational built and natural space. The building instigates a metamorphosis on both the tangible (species) and the intangible (knowledge and thought).

FRAMEWORK ISSUES + INTENTIONS

The selected site has been unoccupied for over 20 years, but has developed into a piece of land with buried cultural and ecological significance. There are plans for the development of a lakeside estate on the site, and the RSDF proposed by the city does not grant policy potent enough to counter this proposal. The vision proposed by this dissertation and group framework intends to envisage what the site could be, by unlocking its potential for regenerating both the community and the ecology, and cementing its importance in the macro- and micro-contexts.

The current models of industry are outdated and unsustainable, with aggregated colonies of industry on the perimeters of the urban context. The intention is to decentralise these colonies of industry and rescript the current models of centralised industries based on ecosystemic thinking and principles. The selected site also contains unutilised potential with a rich ecology, geology and a water source. The site has an unwritten historical narrative of brickmaking but with no acknowledgement of industrial heritage and its consequences. The intention is to remedy the whole disturbed ecology, which exists as a result of industry. The current conditions are not optimal for biodiversity – it is a contaminated site – thus the intervention will seek to recreate a sustainable miscellany of natural and urban ecosystems within a productive landscape. The suburban/urban fabric appears to be disconnected from the adjacent terrain. This constitutes an alienation between community and the immediate natural site. The intention is to integrate by addressing an issue within this suburban context and to explore the concept of recreation as connective tissue between the site, the structure and the user.



Figure 1.40: Waste generation in a suburb (Author, 2013)



Figure 1.11: Insect conservation (Author, 2013)

Figure 1.12: Butterfly harvesting (Author, 2013)

Figure 1.13: Recreation, paper boats
(<http://www.gingerlillytea.com/2013/07/sailing-paper-boats.html>)

ARCHITECTURAL INTENTION

The aim of the architecture is to frolic with the fixed concept of an enclosed production line, a “factory”, and to reinstate production and research as integrated processes, while elemental recreation will allow dwelling through both positive and negative production space, will connect the natural and the built elements, and will allow the user to mature in knowledge as they dwell through the various phases of productive research.

PROGRAMME:

In connection with what a factory offers, the programme focuses on the production and harvesting of insects both beneficial and pest, utilising them within both the immediate natural site and the neighbouring suburban context.

The programme will gestate enclosed ecosystems (vivariums), with a collection of integrated research facilities and test tube laboratories to breed and harvest endangered species (using the research of Sir John Gurdon), and in parallel having a production facility which reproduces pest species and utilising these nuisance species in addressing the issue of mass organic waste generation. The intention is to breed endangered species, research the factors affecting their survival, understanding beneficial insects and their medicinal significance, and then releasing these species as part of the programme’s research initiative. The proliferation of pest species and their impact and role will then also be closely examined and applied as a resource.

CONCEPT:

The conceptual scenario has developed from an understanding of both the theory and the site. Samways’s description of this interwoven tapestry of life form connections between the human, the insect and other life forms within their bio-context (Samways, 2000). Elements of the site were identified, such as ecology, structure and route. These are translated into an architectural language that uses “recreation” and route as a connector between this harvested tapestry, the natural ecology, and the industrial process that defines the structure. The abstract objective delineates a maturing in knowledge as one dwells past the productive spaces and “taps” into this “tapestry of production”.



134

THEORETICAL DISCOURSE. Chapter 02



Figure 2.1: Pinned dragonfly specimen (Zoology UP, 2013)

EXTINCT

North Central America (256) 341
 Oceania (185) 185
Sub-Saharan Africa (50) 129
 Europe (16) 43
 South and South East Asia (36) 36
 South America (29) 32
 North Africa (2) 22
 East Asia (20) 20
 West Central Asia (11) 15
 North Asia (2) 9
 Antarctic (1) 1



TOTAL EXTINCT (was 608 in 2008) 833 in 2013
 (IUCN Red List version 2013.1: Table 6a, Updated: 08 July 2013)

(http://www.iucnredlist.org/documents/summarystatistics/2013_1_RL_Stats_Table_6a.pdf)

ENDANGERED

Sub-Saharan Africa (5 614) 8286
 South America (5 033) 5930
 South and South East Asia (4 784) 7455
 Oceania (2 093) 4396
 Europe (2 075) 3372
 East Asia (1 383) 1 864
 West Central Asia (1 302) 2022
 North Central America (1 261) 5940
 North Africa (327) 571
 North Asia (268) 343
 Antarctic (63) 55

TOTAL ENDANGERED (was 24 203 in 2008) 40 234 in 2013
 (IUCN Red List version 2013.1: Table 5, Updated: 08 July 2013)

(http://www.iucnredlist.org/documents/summarystatistics/2013_1_RL_Stats_Table_5.pdf)

Of the 63 837 species assessed worldwide using the IUCN Red List Criteria, 40 234 are endangered, 19,817 are threatened with extinction and 833 are extinct with 41% of our amphibians, 33% of the reef building corals, 25% of our mammals, 13% of the birds, and 30% of the conifers." (<http://www.iucnredlist.org/about/summary-statistics>)

Sub-Saharan Africa has the highest count on endangered species

In the past, natural events caused large-scale transformations of the environment and five global mass extinctions. Now, ecosystems are again undergoing a massive loss of biodiversity. This time, the changes are caused mainly by human activity.



Figure 2.2: Frog (Author, 2013)

Figure 2.3: X-ray of a frog
 (<http://www.nahnyc.com/radiology.htm>)

ECOSYSTEM DIAGRAMS

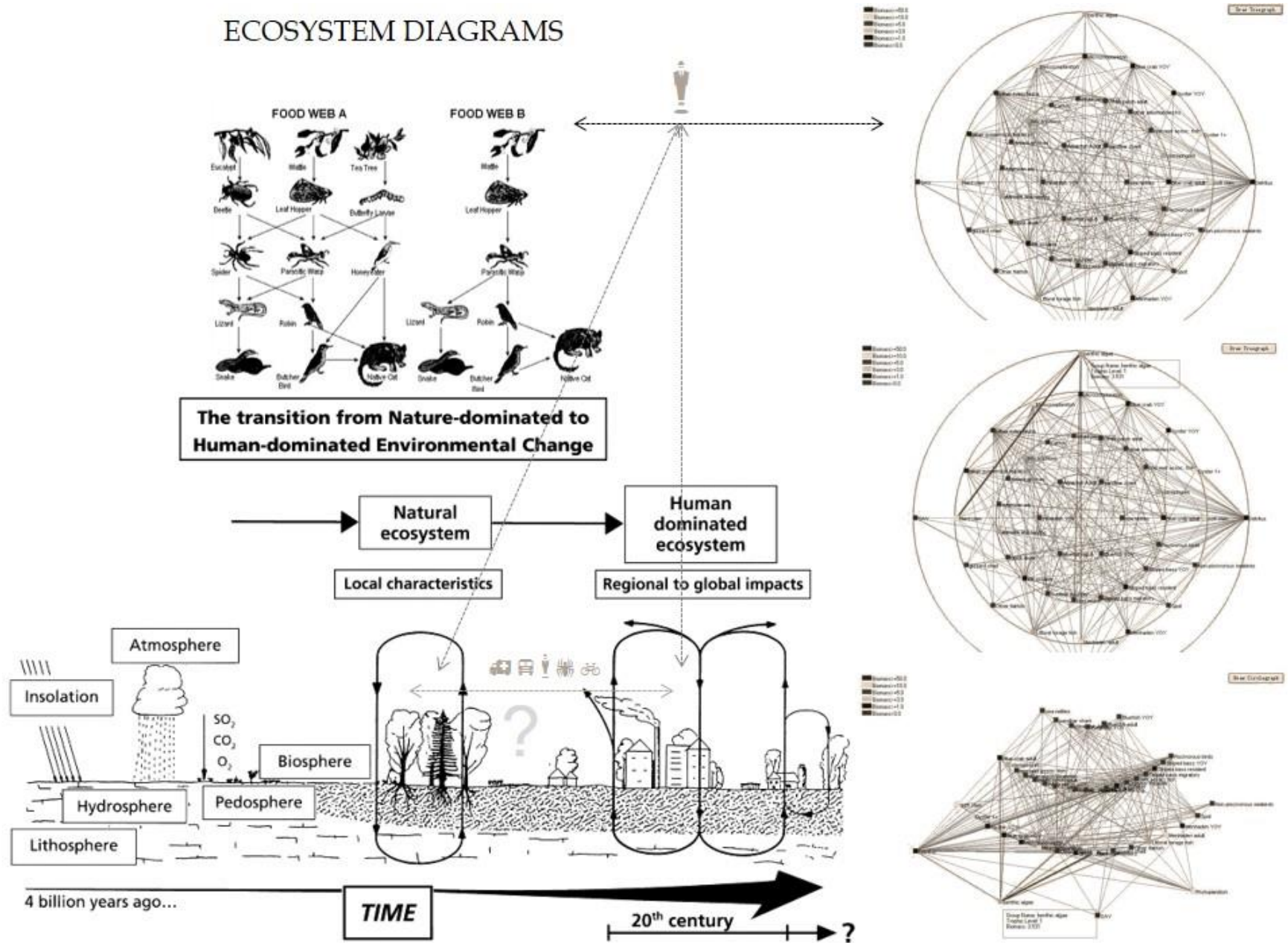


Figure 2.4: Tapestry of urban and natural ecosystems (Author, 2013)

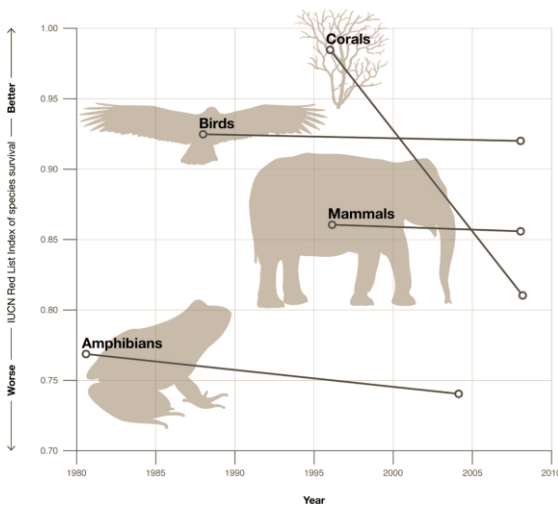
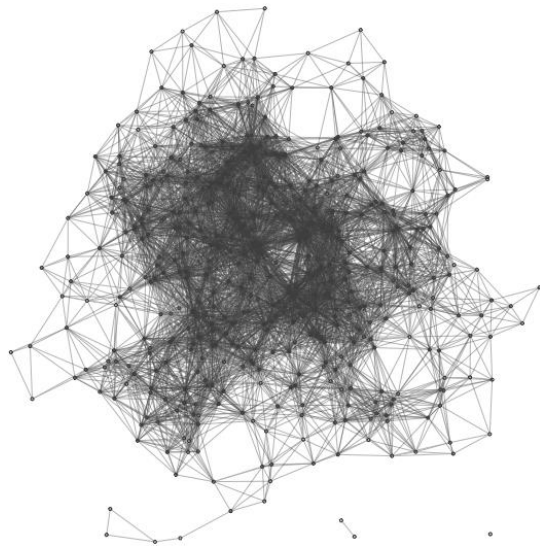


Figure 2.5: Tapestry of connections (Unknown, 2013)

Figure 2.6: Table indicating species survival (IUCN, 2013)

PROBLEM STATEMENT

Global Ecological Issue

The IUCN (International Union for Conservation of Nature) maintains a Red List of Threatened Species. This is the most comprehensive inventory of the global status of plant and animal species. The IUCN calculates that around 40% of the world's organisms are endangered. (<http://data.iucn.org/dbtw-wpd/edocs/RL-2009-001.pdf>). The loss of biodiversity affects the environment and also a larger, very sensitive, interlinked ecosystem, of which *Homo sapiens* forms part. This ecosystem, which we all form part of, can be seen as a huge tapestry (or blanket). Each species lost is like a thread being pulled out of the blanket. The more threads that are lost, the greater the chance that the whole blanket will weaken and soon fall apart. A large number of animals form part of this tapestry. But, economic development, rapid urbanisation, deforestation, and expansion of agricultural lands have caused habitat loss to many endangered organisms in South Africa. Overexploitation, global warming, pollution, predation (by humans) and the reduction/competition in resources are also causing an upset in this sensitive equilibrium within this ecosystem, and contribute to the endangerment of all species within this sensitive system.

As Architects we are very much aware of the flora (plants) which form part of this interwoven tapestry, but tend to forget that the fauna (animals) and smaller invertebrates also have a crucial role within this closed ecosystem and contribute to health of the whole.

Many people in the past also saw nature as inexhaustibly sustainable, which we now know is the case only if we care for it. It is not difficult to forgive destruction in the past which resulted from ignorance. Today, however, we have access to more information, and it is essential that we re-examine ethically what we have inherited, what we are responsible for, and what we will pass on to coming generations. Our marvels of science and technology are matched if not outweighed by many current tragedies, including human starvation in some parts of the world, and the extinction of other life-forms. The exploration of space takes place at the same time as the Earth's own oceans, seas, and fresh water areas are growing increasingly polluted. Many of the Earth's habitats, animals, plants, insects, and even micro-organisms that we know as rare may not be known at all by future generations. (<http://www.cbd.int/doc/publications/cbd-ts-50-en.pdf>)

THEORETICAL APPROACH

The Origin of species

The diversity of insect life today is, as far as we know, the richest it has ever been. The variety is so great that insects make up three-quarters of all species. Insects have radiated into so many diverse forms that we have been able only to describe a small fraction of them. They are a major component of all life we see around us. Out of simple beginnings, the earliest life forms continued to radiate through the process of variation/selection/retention to endow the earth with a fantastically rich tapestry of form and colour, of development and dispersal that has enriched every corner of terrestrial systems with insect character of some sort. Humans are a latter-day arrival who hold in their palms the future of the insect mosaic. This insect variety is losing its spatial and compositional integrity as we enter the new era, the Homogenocene, which is a mere Blink of a geological eyelid (Samways, 2005).

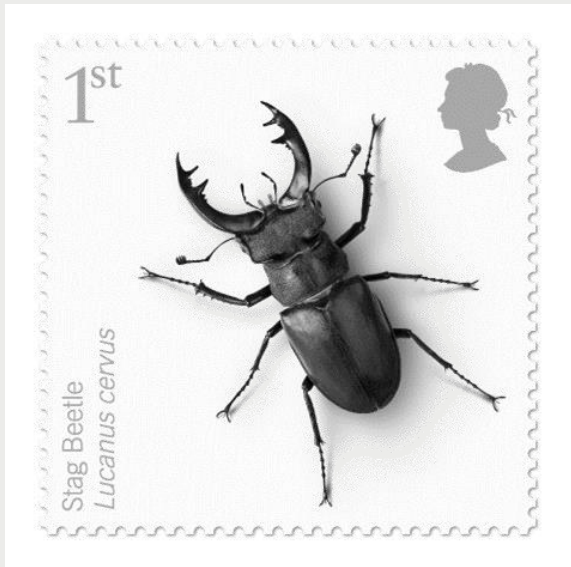


Figure 2.7: Series of British stamps, endangered and extinct insect species (<http://blog.insectmuseum.org/?p=1049>)

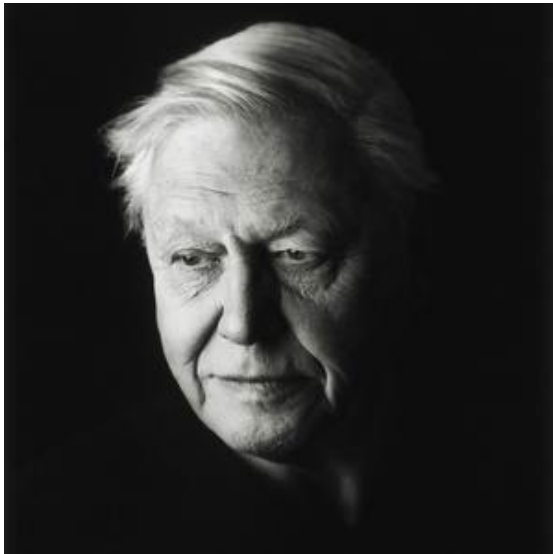


Figure 2.8: Sir David Attenborough (http://the-bulb.com/wp-content/uploads/2011/11/David_Attenborough)

Figure 2.9: Sir David Attenborough (<http://www.listal.com/viewimage/252977>)

World in crisis

Sir David Attenborough reckons that “humans are a plague on the Earth”. He also expressed to *The Telegraph* on 4 February 2013 that “it’s not just climate change; it is sheer space, urbanisation, places to grow food for this enormous horde. Either we limit our population growth or the natural world will do it for us, and the natural world is doing it for us right now”. The television presenter said that humans are threatening their own existence and that of other species by using up the world’s resources. He also said that humans depend on the health of the natural world (the whole ecosystem).

The sharp increase in consumerism and human population growth over the last few decades has stimulated an acute awareness of the adverse impacts on the natural environment. A feeling has developed that all is not well in the world, and that wild nature, unsullied by humans, may even have come to an end (McKibben, 1990). There are also growing awareness and accumulating evidence that our world is in crisis – but not necessarily doomed (Cincotta & Engleman, 2000). Out of these changes has developed a strong movement, that of deep ecology, which provides a sense of wisdom combined with a course for action.

Deep ecology is not something vague, as some have claimed. It is an ontology, which posits humanity as inseparable from nature, and with an emphasis on simplicity of lifestyle and on communication with all critics. Naess (1989) termed this approach *ecophilosophy* (shortened to *ecosophy*). It is the utilisation of basic concepts from the science of ecology, such as complexity, diversity and symbiosis, to clarify the place of our species within nature through the process of working out a total view (Rothenberg, 1989). This is especially relevant to insect conservation, as the insect world is indeed complex and diverse, and it is one where symbioses in the widest sense are widespread. Also, it is at the core of the landscape approach to conservation, where focusing on individual species and interactions is insufficient to conserve the vastness of insect and systemic diversity. This emerging arena of ecophilosophy, ecopsychology or transpersonal ecology is likely to play a role in future conservation (Fox, 1995). Indeed, Johnson (1991) advances a potent argument on behalf of the morally significant interests of animals, plants, species and ecosystems. He notes that in a moral world, all living things, insects included, have a right to survival.

Overcoming the impasse between utility and deep ecology theories

Although deep ecology and even some schools of thought in landscape ecology (Naveh & Lieberman, 1990) include humans in the global ecological equation, it is nevertheless this very factor – humanity – that is threatening the planetary processes which in the past have led to the current, rich world-ecology. Although deep ecology purports a human omnipotence, the risk here is that a sense of place, and, in turn, places of wild nature, are left out. To ignore ecological differentials across the globe and to homogenise all, would simply be sad. After all, it is the essence of conservation biology to conserve diversity, which, quite literally, is all the differences within nature and across the globe. Norton (1991) argues persuasively that utility (instrumental value) and deep ecology (intrinsic value) theories are confrontational, and he then asks whether there is perhaps an alternative, shared value that humans may place on nature.

The instrumental and intrinsic value theories share four questionable assumptions and obstacles: (1) a mutual exclusion of each other, (2) an entity, not process, orientation, (3) moral monism, and (4) placeless evaluation. To overcome these impasses, Norton (1991) suggests an alternative value system, which recognises a continuum of ways that humans value nature. Such a spectrum would value processes rather than simply entities, be pluralistic and value biodiversity in place. Such a universal earth ethic would value nature for the creativity of its processes (Norton, 1991). This ethic is vital when we consider not only the sustainability of nature, whether for itself or for humanity, but arguably and more importantly, it is crucial for maintaining the evolutionary potential of biodiversity, especially in extensive wild places (Samways, 2005).

The value of wild places is high; such places are often the seat of interesting, curious and irreplaceable biodiversity. The problem with placing great emphasis on wild places is that reserves constitute less than 4% of the Earth’s land surface (World Resources Institute, 2013). This emphasises the fact that much of nature is now within a stone’s throw of humans, and the degree of anthropogenic modification varies from very little to very much. This spectrum has various degrees of ecological integrity. As such, a major goal of conservation is to



Figure 2.10: Concept of natural destruction (Author, 2013)

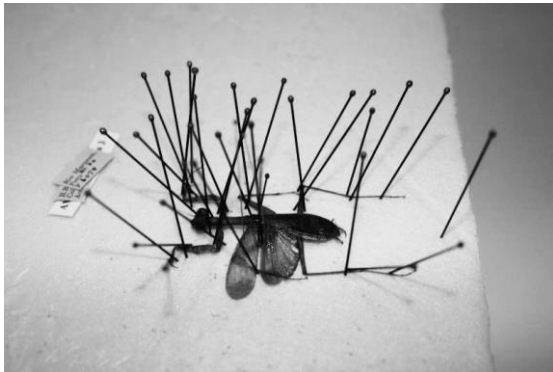


Figure 2.11: Pinned mantis
(<http://www.wksu.org/news/images/32643/MANTIS-PIN.jpg>)

Figure 2.12: Endangered butterflies (Zoology UP, 2013)

Figure 2.13: Endangered natural (Author, 2013)

conserve as much as possible of this remaining integrity, with due respect to the role of critical processes in maintaining that integrity (Hunter, 2000a). Indeed, even wild places are only likely to survive in the long run if recognised as wildland gardens that continue to be used with minimum of damage (Janzen, 1999). Rolston (1994) has illustrated that there are various types or levels of values: natural and cultural, diversity and complexity, ecosystem integrity and health, wildlife, anthropocentric and natural intrinsic. All enter the essence of conservation biology, and all impinge on insect diversity conservation. It is this diversity of values, when maintained, that enrich the world, not just for us, but also for all the other organisms and all the processes that make this, as far as we know, a unique planet.

Conservation action must have a sound philosophical and ethical foundation. This gives the action meaning and direction. It is the “why” we are doing it. At the most superficial level, that of utility, nature is at our service to be used, ideally sustainably. In this philosophy, humans have complete dominion over nature, and this is the language of most international agreements and conventions. Deeper levels require more wrestling with thoughts and ideals. Among these is one philosophical approach where humans and nature are still separate, but nature is to be admired and enjoyed. An alternative view is that humans are part of the fabric of nature, and nature is used sustainably yet respected deeply. In recent years, a more profound environmental philosophy has emerged, where all organisms, including insects, have the right to exist without necessarily being of any service to humans. A powerful epithet to this deep ecology view has emerged: that we should appreciate and love other organisms without expecting anything in return. But the poetry of this avowal has evolved into a further interest in nature where organisms and the class Insecta have been studied and used to imitate the models, systems, and elements of nature for the purpose of solving complex, present-day human problems.

The conservation of insect diversity has received an enormous upsurge in recent years, principally with the recognition of the major role that insects play in maintaining terrestrial ecological processes. Yet there is recognition too, that insect individuals and species are being lost at an enormous rate. “Survival of the fittest” seems to be a much debated subject when zooming in on the connections between humans, endangered species and pest species. How do we go about conserving these insect species and why are some valuable species perishing, while other “nuisance” species are proliferating?

Insect Conservation and Environmental philosophy

No conservation effort can meaningfully begin without a firm foundation of human value systems or ethics. Such ethics are the language of conservation strategies. Without some moral guidelines, it is difficult to define our goals and hence the expected outcomes of conservation activity. There is little to separate insects from other organismal aspects of biodiversity in environmental philosophy. A noteworthy exception is that not all insects are good for each other, or for us. Insects can be parasitoids, disease vectors or pests. Indeed, we exploit parasitoids as biological control agents.

At the arguably lowest level of ethical consideration, insects have utilitarian or instrumental value for us. This includes aesthetic, food, adornment, ornament, service, spiritual and cultural, heuristic, scientific, educational, conservation planning and ecological values. These utilitarian values have two facets. The first is that they are there for us to enjoy aesthetically and be left alone. This is the Romantic-Transcendental Preservation Ethic (Callicot, 1990). This goes beyond just the insects themselves. It considers all their interactions and ramifications with other aspects of nature. It is an ethic that we adopt when we visit a nature reserve. The second utilitarian facet is that insects are there for sustainable use or as beneficial organisms (Callicot, 1990). This is the Resource Conservation Ethic. The harvesting of honey from honeybees is an example. But this ethic may apply to a wider, indirect set of services that insects supply, such as pollination and natural biological control. Where insects do not fit snugly into this ethic is when many actually do a disservice to our resources by nibbling, piercing and burrowing into plants, transmitting disease and killing animals. To entertain this ethic may indeed involve some degree of controlling insects. In both the Romantic-Transcendental Preservation Ethic and the Resource Conservation Ethic, humans are seen as essentially separate from the rest of nature, and organisms are seen as having positive, negative or neutral value. In contrast, Leopold (1949) articulates in a subtle and charming way, that other species have come about through the same ecological and evolutionary means as humans, and as such, deserve equal consideration. Humans, nevertheless, reserve the right to use and manage nature, but there is a recognition of the intrinsic value of other species and the integrity of ecosystems (Rolston, 1994). This is the Evolutionary Ecological Land Ethic. Rolston (1994) goes a step further, and points out that culture has now emerged out of nature, which brings with it a



Figure 2.14: Insect harvesting as recreational (Author: 2013)



responsibility for humans to nurture other organisms. Samways (1996) then illustrates that culture has now become an evolutionary path and the human self-manipulating genome the driving force. Ideally, we now need to build into our new genome an environmental ethic. Maybe we as intelligent minds can make a paradigm shift, within this new environmental genome of thinking, and view these nuisance species (alias pests) in a more favourable light, and rather utilise the characteristics which led them to proliferate. Maybe harvesting a trait of survival as a descendant of the second utilitarian facet?

Insect Harvesting

Sir John Gurdon was awarded the 2012 Nobel Prize in Physiology or Medicine. For over 20 years, since the 1960s, he carried out a long series of research programmes using a toad (of the species *Xenopus laevis*), which lays lots of very large eggs outside her body (http://www.nobelprize.org/nobel_prizes/medicine/laureates/2012/press.html). Gurdon harvested these and carefully removed the nucleus from an egg. The nucleus is the part of the cell that contains all the genetic information, the DNA. He puts into this "empty" egg a nucleus that he had taken from the cell of a different type of toad, for example from the gut, and let the egg develop. And it did, leading to the production of tadpoles. It was the first example of cloning, taking a cell from the body and using its nucleus to create a whole new organism. This research was also used as a base to clone "Dolly" the sheep.

Some more research has been done on insects that consist of genetic information similar to that of humans which can resist mutations causing some strands of cancer, e.g. gastro-intestinal cancer. Toads seem to be of more value than mice and chimpanzees when doing stem cell research (http://www.nobelprize.org/nobel_prizes/medicine/laureates/2012/press.html).

Although in practice insects are rarely harvested in the same way as many other organisms (e.g. toads), the principle of utility value still applies to them. The most significant feature of insects in terms of this utilitarian philosophy is to ensure continuance of their ecological services, so that ecological integrity and health are maintained. This is where we largely do not understand the consequences of our actions. To name one example: landscape fragmentation and attrition of landscape patches influence the insect assemblages in such a way that the services they normally supply may no longer be possible.

In the agricultural context, it is not always possible to maintain ecological integrity, even though specific insects are being conserved and human intentions are good. Natural ecosystems adjacent to agricultural fields are often utilised for pools of natural enemies that invade the crop and control pests. On harvesting of the crop, the natural enemies then flood back to the surrounding natural ecosystem where they exert strong, albeit local, impact on natural hosts. This is a manifestation of the human demand for harnessing the interaction between host and parasitoid or predator. Biological control is one of the most sought-after services of insects, and one which is not without risks to ecological integrity, but if controlled and researched it could prove very valuable.

Ecological services from insects include more than predation and parasitism. Among these is the pollination of crops, both by wild insects and captive insects. Encouragement of these pollinating insects can hardly be overdone, as the same insects can play a major role in maintaining indigenous plants, and hence in their conservation (Kwak et al., 1996). Insect farming can take some pressure off the wild populations by providing reared specimens that are often in visibly better condition than specimens caught in the wild. Perhaps the utilitarian aspects of insects have been underexploited. While we are likely to see only limited progress in the direct harvesting of insects, there may be some future for medical products and research in biomimicry. However, the heuristic value of insects in genetic research is undeniable. Caring for the Earth (IUCN/UNEP/WWF, 2011), which is a world conservation strategy, implicitly addresses many facets of the conservation of insect diversity that underpin the wellbeing of humans. Insects and their activities are vital for conserving our life-supporting systems and for renewing our resources through services in addition to pollination, such as soil maintenance, population regulation, and biomimicry.

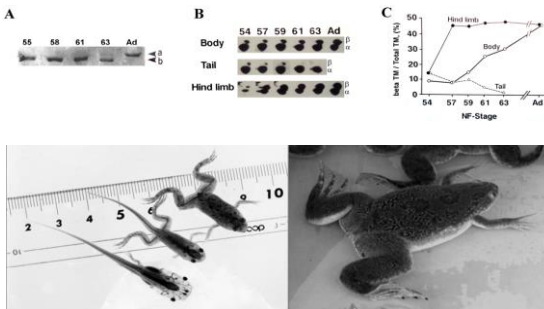


Figure 2.15: Girl with giant African bullfrog (<https://www.facebook.com/LoxHerp>)

Figure 2.16 – 17: Scientific data capturing, *Xenopus laevis* (<http://www.intechopen.com/books/cell-interaction/cell-interaction-during-larval-to-adult-muscle-remodeling-in-the-frog-xenopus-laevis>)



CONTEXT AND SITE. Chapter 03



Figure 3.1: Site location (Author, 2013)



LOCALITY

Old Rosema Waterkloof Brick Quarry, 103 Skilpad Road, Monument Park, Tshwane, Gauteng, South Africa

The site is located 10 km south of the CBD of Pretoria, in the suburban area of Monument Park, with Waterkloof Ridge forming the eastern and southern borders of the site. It is predominantly surrounded by a suburban residential fabric, with some of these residences converted to businesses on the north-western corner. Elephant Road and Orion Avenue run along the northern and eastern boundaries of the site, respectively. The Monument Park Tennis Club forms the north-western boundary of the site, and residential properties run along the southern boundary. South-west of the site runs the R21, which crosses the N1 just 3 kms south from the nearest access point. The Groenkloof Nature Reserve is located 1 km North-west of the site. The site was operational as a clay brick quarry, run by Rosema & Klaver from 1933 up until 1993. The site itself currently lies dormant, as a historical artefact, hidden by both private ownership and 20 years of undisrupted plant growth.

Description of the site

The site slopes from east to west, and lies between the altitude of 1460 m (Skilpad Road end) and 1520 m (Orion Avenue end) above mean sea level (Thomson, 2003). A large quarry pit with open water makes up approximately one quarter of the area of the site. Most of the remaining areas comprise a mixture of earth berms, excavations, old workings, old broken down infrastructure and buildings, stands of exotic trees and earth dumps. Small sections of disturbed re-established grassland occur in between the workings on the south-western section of the site. The western corner of the site, while also somewhat disturbed, is the only piece of property still in a near-natural state. This section of the property is underlain by quartzite which is exposed in places, forming low rocky outcrops.

Analysis of physical attributes

Surrounding context

As mentioned earlier in this chapter, the built fabric that surrounds the old quarry site in Monument Park and Waterkloof Ridge is predominantly suburban – residential use of one to two storeys high. Within this fabric, some small-scale businesses have been opened, especially along busy roads and closer to where the shopping centres are located. One of these centres was developed and opened by Rosema & Klaver, and is still in their ownership. It is located just north-west of the site. The road that connects it to the site, Skilpad Road, functions as one of the main access roads from the north. It crosses Elephant Road on the site’s north-west corner, and the latter is the closest access to the R21 highway. Both of these roads currently accommodate buses and taxis, with regular stops, as indicated on the map.

As part of the character of contemporary suburban living in the Pretoria residential landscape. One such community is located directly south of the site. An area that used to be integrated with the rest of the Monument Park suburban community has been physically closed off, with a single entrance for the monitoring of vehicular activity. To the western edge, along Orion Avenue, are the larger, double-storey houses, most of which have high solid walls facing the street. This is in contrast to the residences on the northern and eastern edges, which are mostly single-storeyed, and fenced rather than walled. It is thus evident and important to note that the surrounding community currently ‘turns its back on’ the site.

In order to come to a better understanding of the population density in the area, a comparison was drawn with that of Sunnyside. The population density of a typical residential area in Sunnyside would be from 1000 to 3000 inhabitants per square kilometre (http://en.wikipedia.org/wiki/File:Tshwane_2001_population_density_map.svg). In Monument Park, the population density is much lower, at 300 to 1000 inhabitants per square kilometre. With the projections for population growth, and the influx of more people into urban areas (<http://www.peopleandplanet.net/?lid=26729&topic=44§ion=40>), the fabric itself will be under pressure for development. This is indicated and explained in the attached group framework document.



Figure 3.2: Ruins indicated on the current site (Author, 2013)

Figure 3.3: Site informants (Author, 2013)

ROSEMA EN KLAVER
OPPERVLAKTEPLAN VAN STEENROEF
SKAAL 1:1000

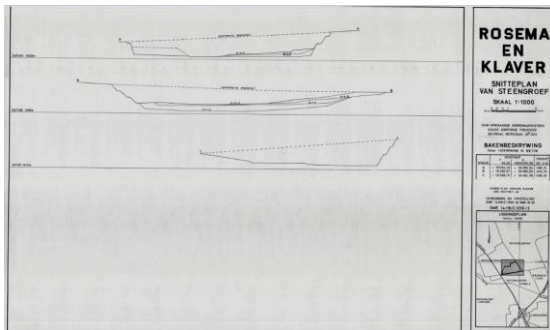
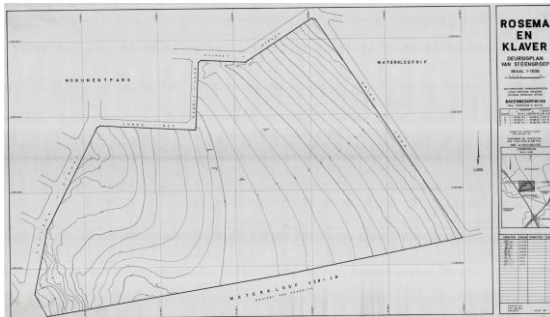
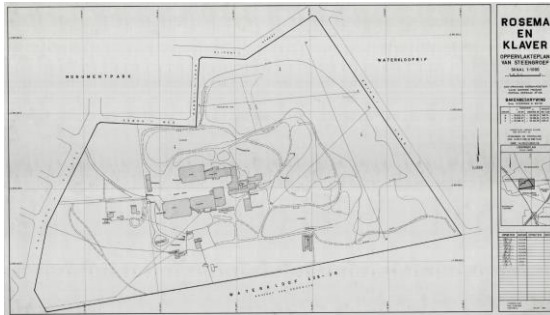
ALLE RECHTE VAN TOEGANG EN VERKEER SINDS 1900
SINDS 1900

SAKINGSKORTING

SAKINGSKORTING	SAKINGSKORTING
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56
57	57
58	58
59	59
60	60
61	61
62	62
63	63
64	64
65	65
66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

1:1000

Figure 3.4: Site informants, current and historical (Author, 2013)



HISTORY OF THE SITE

Story of Place

Although no record was found about what the land was used for before the advent of development and industry, it is assumed that the site used to be part of one of the various farms around Pretoria.

Clay was discovered here, and in 1930 Rosema & Klaver, a brick-making company still existent today, bought the land, which stretched from Waterkloof Ridge (North) to just a few kilometres south of where the site is located today. Mining commenced around 1933, and the company built a brick factory on-site around the same time.

According to Hans, a foreman who had been working for the company for over 25 years, the bricks produced at the quarry helped build many of the traditional face-brick buildings in and around Pretoria. The company grew, and because of Waterkloof becoming more of a desired residential neighbourhood, Rosema & Klaver saw the opportunity of developing what is today known as Monument Park. Residential stands were laid out, together with a shopping centre which the company still owns. As the factory grew and the residential fabric became denser around the quarry site, the people who settled in Monument Park complained about the dust and noise caused by the quarrying process. Black wattle trees were planted along the edges in an attempt to solve the problem. This however did not solve the problem and in 1980 a court notice was served which stipulated that the quarry had 10 years to close down production.

Within this time an underground water source was struck, presumably located in a dolomitic chamber located beneath the shale layer (Matthys Dippenaar). This clean water had to be pumped out daily, as the clay needed to be dry in the initial steps of the brick-making process. Mining thus became extremely uneconomical and difficult. In 1993 the labourers had a strike and in the same year the quarry was finally closed down. Most of the structures were demolished in the following years, because of legal reasons regarding safety, but some parts of the structures are still intact which are now occupied by temporary vagrants from time to time, as well as the vegetation which has completely taken ownership of the site.

The original photographs of the factory show that many of the structures were steel and concrete frames with sheets of corrugated iron but these had been removed completely. The remaining structures are of brick and concrete, most of which are not suitable for re-use. They do, however, have enough integrity to be preserved, where it is relevant to do so.

Most of what is left can be seen on the ground, as most of the slabs, foundations, basement structures and excavations are still present. To a large degree, these will need to be replaced where new functions are introduced, but the physical evidence on site together with the historical knowledge of the structures can become major informants in the design of any new structure proposed on site.

Figure 3.5 - 7: Old waterkloof quarry plans (Rosema & Klaver, 2013)

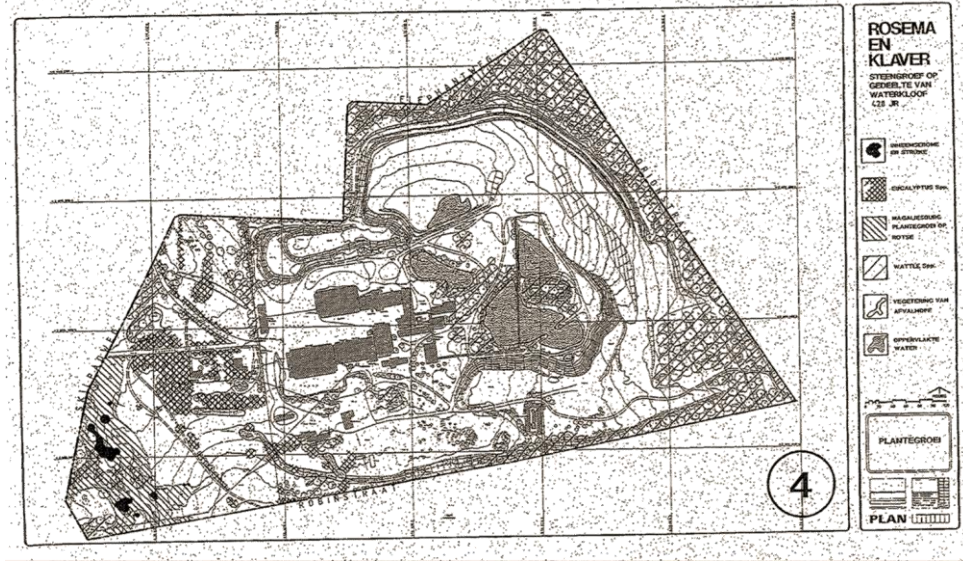
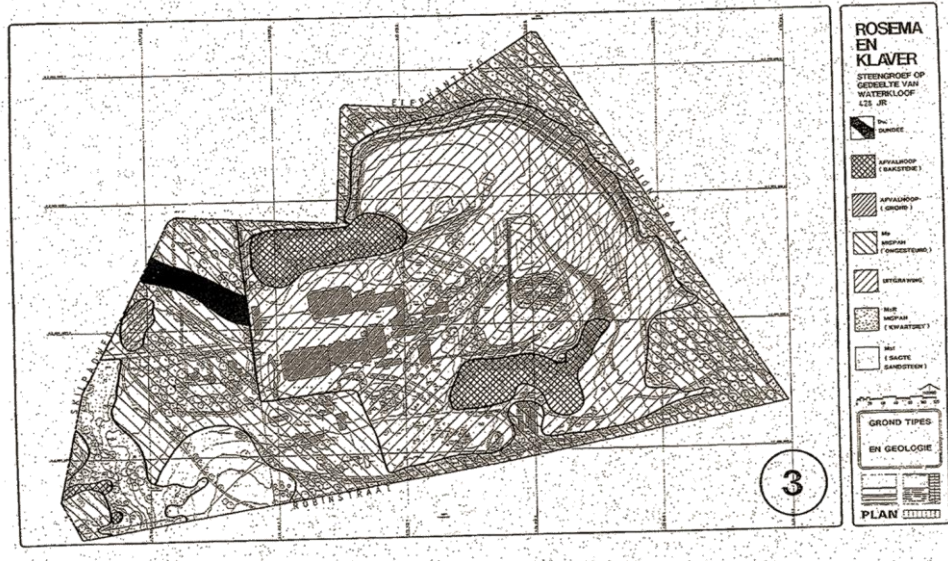


Figure 3.8 - 9: Geology and vegetation maps (Thomson, 2013)



Figure 3.10: Current site ecological condition (Author, 2013)

Figure 3.11: Current site ecological condition with building ruins (Author, 2013)

ECOLOGY

Geology

The site is predominantly shale (clay) with two man-made clay brick berms on the eastern edge of the natural wetland as well as on the western edge of the lake. The south-western corner of the site is dolomitic and thus not suitable for development. A typical geological appearance is this neighbouring shale and dolomite. Matthys Dippenaar, Hydrogeologist from the University of Pretoria, explained that the dolomite will lay at a 35° angle to the shale. Dolomite is characterised by water-filled cavities and tunnels.

Hydrology

The site is owner to a rich source of clear water, as a result of the clay mining, on the eastern edge of the site. There is a natural runoff of storm water to the west due to slope. The overflow of this water drains into a storm water connection at Tiger Road where this in return drains north into the Apies River. As Dippenaar (2013) explained the constant supply of clear water into this mined quarry whole is due to the water filled dolomite shafts which lays at this 35 ° angle to the clay covered site. He suspects that while they were digging for clay, they accidentally opened into a dolomite tunnel and for this reason the lake keeps filling up, when water is pumped out, due to hydrolic pressure.

Slope and Drainage

As already explained the site lies west of Waterkloof Ridge line which runs in an approximate north-south direction with the average westward slope being generally less than 1:10 (Thomson, 2003). Within the site boundaries, the major prohibitive slopes are the man-made quarry excavations along the north-eastern edge. These slopes are often steeper than 1:1 and reach heights of 30m in place. The slope follow the direction of clay excavations losing height towards the south (Thomson, 2003). Other steep slopes occur as a result of brick material dumping with the major dumps occurring along the south-eastern area and the north-western edge south of the tennis club.

Generally the study area has two major drainage influence. Firstly the natural drainage pattern flowing westward to the major drainage corridor running along the eastern edge of the R21 highway. This drainage corridor then flows northwards through Fountains Valley and into the canalized Apies river (Thomson, 2003). Due to the large scale excavations of clay, the site secondly has a pronounced inner “closed” drainage system comprising almost half of the total site area.

Habitat and Biological life

4 Broad habitat types have been identified on the site. These include a wetland habitat, exotic stands, dumps and rock outcrops. The wetland habitat which are the dam and the shallow water areas on the site are rich in animal and plant life. The exotic stands are covered in wattle and gum stands with little or no undergrowth and therefor few animals utilize this habitat. Dumps consist mainly of overburden waste ash and reject bricks and vegetation has established itself in some places with Acacia Karoo and Elephantorrhiza sp. The rock outcrops is in a relative undisturbed state and provide the best habitat for wildlife (Thomson, 2003).

The site has been taken over by mostly invasive species of trees and grasses, because of the company planting them to mitigate concerns from the surrounding community. This has had an influence on the pH balance of the soil (Thomson, 2003), which hinders the growth and flourishing of many other plant species. This natural established ecology do, however, become home to many different animal, bird and insect species (Thomson, 2003). Plant growth overall on site is very dense, and this also strengthens the concerns of the surrounding community, as visibility is low, and safety is thus affected. Most of the plants on site, therefore, will have to be removed and replaced by plants that will contribute to the biodiversity of both fauna and flora.

The ruins themselves have been enveloped and sometimes penetrated by the vegetation. This layer significantly adds to the character of the place, and also becomes an integral part of the story.



Figure 3.12: Current site ecological condition with building ruins (Author, 2013)



Figure 3.13: Current site ecological condition with newly formed water habitats (Author, 2013)



Figure 3.14: Current site ecological condition with building ruins and new water habitat (Author, 2013)

Vegetation

The site is located within the Grassland Biome and more specifically, the Rocky Highveld Grassland (Thomson, 2003). This is synonymous with what Acocks (1988) termed the Bakenveld (A61). The area historically comprised cool temperate grasslands which were transitional between the typical grassland of the high inland plateau and the bushveld of the lower inland plateau. The area would historically have contained vegetation typical of this veld type which was once common on the Witwatersrand. The western corner of the site has exposed quartzite which forms a low rocky outcrop in this area. The rocky ridge habitat is similar to other rocky ridge habitats which can be found in and around Pretoria, in Midrand (three main sites), and along the ridges in and around Johannesburg and Suikerbosrand. It represents the southern limit of the bushveld complex within the Bakenveld (Thomson, 2003). Despite the habitat alterations which have taken place, some indigenous flora and fauna still exist in the area. These areas are restricted mainly to the relatively undisturbed western corner of the property, in the grassland and along the quartzite ridges.

Gauteng ridges

The Quartzite ridges of Gauteng, together with the Drakensberg escarpment, should be regarded as one of the most important natural assets in the entire region of the northern provinces of Southern Africa or the world (Bredenkamp & Brown, 1998). Ridges are particularly suitable for providing a future refuge for biodiversity in an urbanised landscape, as they function as islands – even within a natural landscape – due to their structural and environmental isolation from the landscape (Samways & Hatton, 2000).

Ridges are Habitats for Red data and Threatened Species:

65% of Red data species have been recorded growing on ridges in Gauteng; 71% of Gauteng Endemic plant species have been recorded on ridges. Ridges of Gauteng are important wildlife corridors and play an important role in ecosystemic principles (Department of Agriculture, Conservation, Environment and Land Affairs: Development guidelines for ridges).

32

Green Spaces within the Urban Framework

Biodiversity – the variety of life on earth, at the level of ecosystems as well as their components

Ecosystem – a way of describing nature’s functioning and it consists of components (plants, animals, micro-organisms, water, air, etc), as well the interactions between these components

Ecosystem Services – the benefits that humans derive from Nature.

Ecosystemic Services can be divided into four categories:

1. Provisioning Services – raw materials, fresh water, medicinal resources
2. Regulating Services – local climate and air quality regulation, carbon sequestration and storage, waste-water treatment, erosion prevention and maintenance of soil fertility, pollination
3. Habitat/Supporting Services – habitat for species, maintenance of genetic diversity
4. Cultural Services – recreation/mental/physical health, aesthetic appreciation, inspiration for culture/art/design, spiritual experience and sense of place.

Negative impacts of invasive and alien species:

1. Threat to South African biodiversity and species richness
2. Consume a lot of water
3. Affect soil conditions, change the pH of soil
4. Endanger endemic animal and insect life, due to encroachment on their natural habitat.



Figure 3.15 -16:

Current site ecological condition with building ruins where vegetation has taken occupancy (Author, 2013)

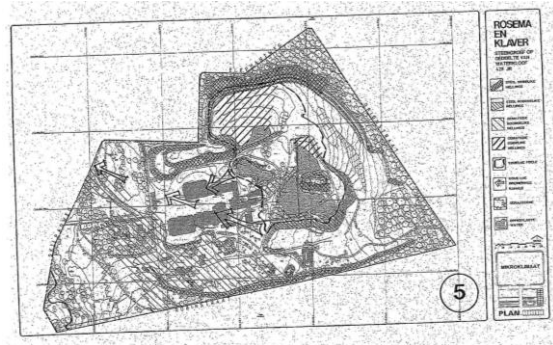


Figure 3.17: Current site vegetation (Author, 2013)

Figure 3.18: *Xenophis laevis* on site (Author, 2013)

Figure 3.19: Micro-climate map of site (Thomson, 2013)

Fauna and flora documented on the site

(Thomson, 2003)

Exotic Florae recorded on site:

Acacia dealbata
Acacia mearnsii
Achyrocline satureioides
Araujia sericifera
Arundo donax
Bidens pilosa
Caesalpinia sp.
Chloris gayana
Chromolaena odorata
Cynodon dactylon
Eucalyptus sp.
Jacaranda mimosifolia

Amphibians:

Xenophis laevis (Platanna)
Rana angolensis (Common River Frog)
Bufo gutturalis (Guttural Toad)

A comprehensive record of all the indigenous plant and bird species are listed in attached framework document.

Climate and Microclimate

The site is situated on the south west facing slope. Cold air will drain into the site from the north and east side and most of the cold air will pool in the forming a frost pocket. Cold air drainage from this pool will be to the west forming a cold belt along the line of the ancient stream bed. A possible second area of cold area pooling is in the extreme south west corner of the site causing another frost pocket. Cold air drainage from this pocket will be into the Apiesriver valley (Thomson, 2003).

The pit is surrounded by the steep sides, in the north and in winter, the near verticality of the south facing slopes will cause extensive shadows in the pit, causing the area to remain cold during most of the day. North facing slopes will however be warmed (Thomson, 2003).

The area south of the entrance road has a gentle 1:5 north facing slope. This will reasonable warm during winter and because it is exposed cooling winds may be expected in summer (Thomson, 2003).

The site receives summer rainfall of between 650 and 750mm per year. Total annual precipitation averages 517 mm. Temperatures vary between -12°C and 39°C (Thomson, 2003), with a mean temperature of approximately 17.3°C. Monumant Park has a subtropical steppe/ low-latitude semi-arid climate that is hot all year (Köppen-Geiger classification: BSh). Life zones system of bioclimatic classification Pretoria is close to the subtropical dry forest biome. Annual sunshine averages 3254 hours (<http://www.pretoria.climateps.com>).



INTANGIBLE CONTEXT ANALYSIS



URBAN ISSUE

Within the context of the greater Pretoria, various green spaces seem to be lost. These disconnected lost spaces lie dispersed and unutilised within the urban fabric.

As mentioned in the framework document, pockets of industry occur on the perimeters of the city as a result of the older model of industrial development in the Witwatersrand. We thus have these centralised industries of power forming a boundary between the urban core and the natural ecological mantle.

Response + Intention

The intention is to connect these “lost” green spaces to form a “Green Lung”. The purpose of this lung is to have smaller productive cells (de-centralised industrial pockets) working as an interconnected manufacturing system. A productive network with a dual recreational role linking the urban and natural as opposed to the older model of isolation. The intention of these industrial cells is to enhance these ecologies.

Figure 3.20 – 21: Left: Urban issue (Author, 2013)

Figure 3.22 – 23: Right: Urban issues as abstract visuals (Author, 2013)



INTANGIBLE CONTEXT ANALYSIS



MAIN PROGRAMME ISSUE

The stress effect on biodiversity is emerging as food crisis, water scarcity, water pollution, virus breakouts, petrol price hikes and electricity shortages. Endangered species, pests and excess waste are three biological components within the system which have been identified as indicators of this imbalance. There also exists an imbalance between the Natural and the Urban Ecosystem, where the urban seems to be dominating and exploiting the existing open land (natural ecologies) as a means of expansion.

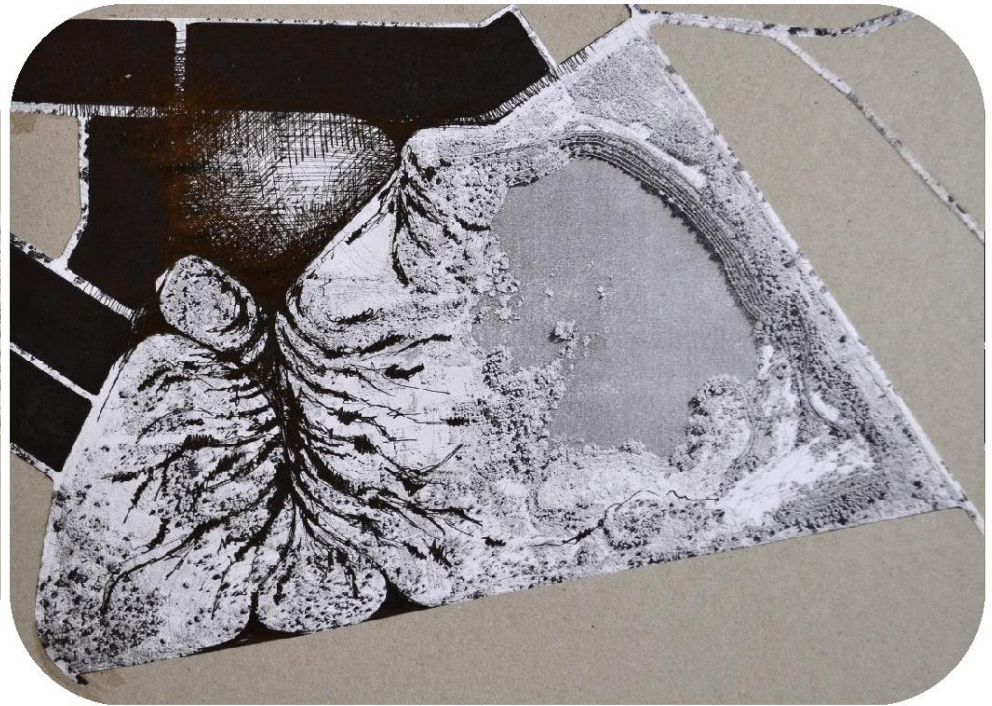
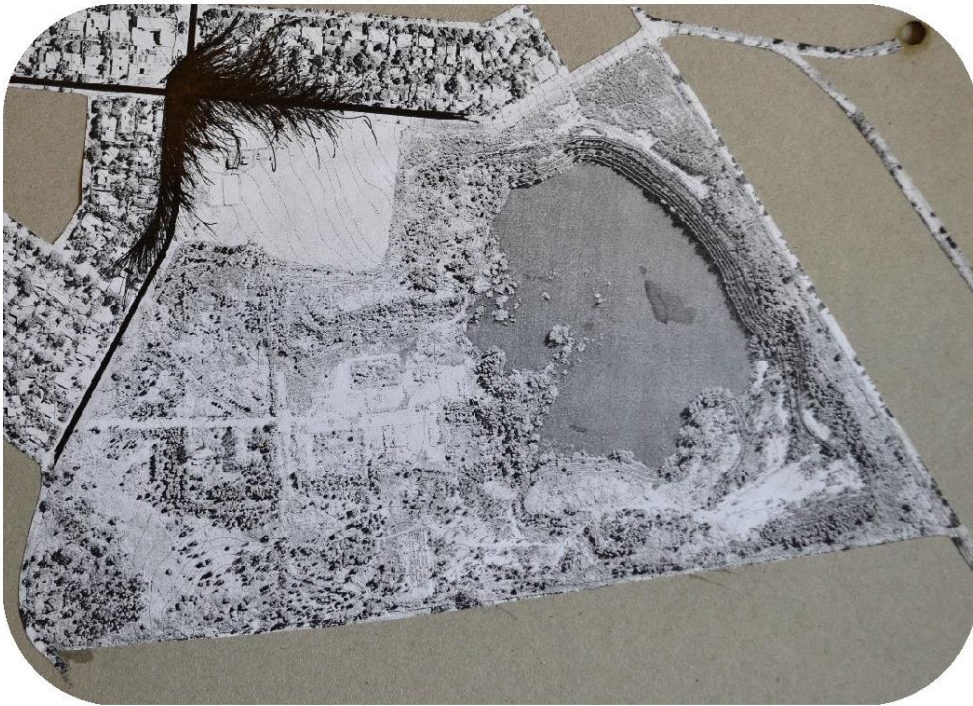
There is, as already mentioned, this perception around factories as a “closed system”, which only depletes resources and harms the environment.

Response + Intention

Within the scope of this research, the study has identified major accelerators for exploration. These accelerators are endangered species, pest species, excess organic waste generation and exhausted resources. The study will utilise the connections between these elements and use them as a base for generating a programme. The programme will then rescript and research these accelerators and disconnections, utilising the site as a laboratory and also introducing the concept of a factory which does not remove but does replenish resources

Figure 3.24 – 25: Left: Programme issue (Author, 2013)

Figure 3.26 – 27: Right: Program issue as abstract visuals (Author, 2013)



INTANGIBLE CONTEXT ANALYSIS



SITE ISSUE

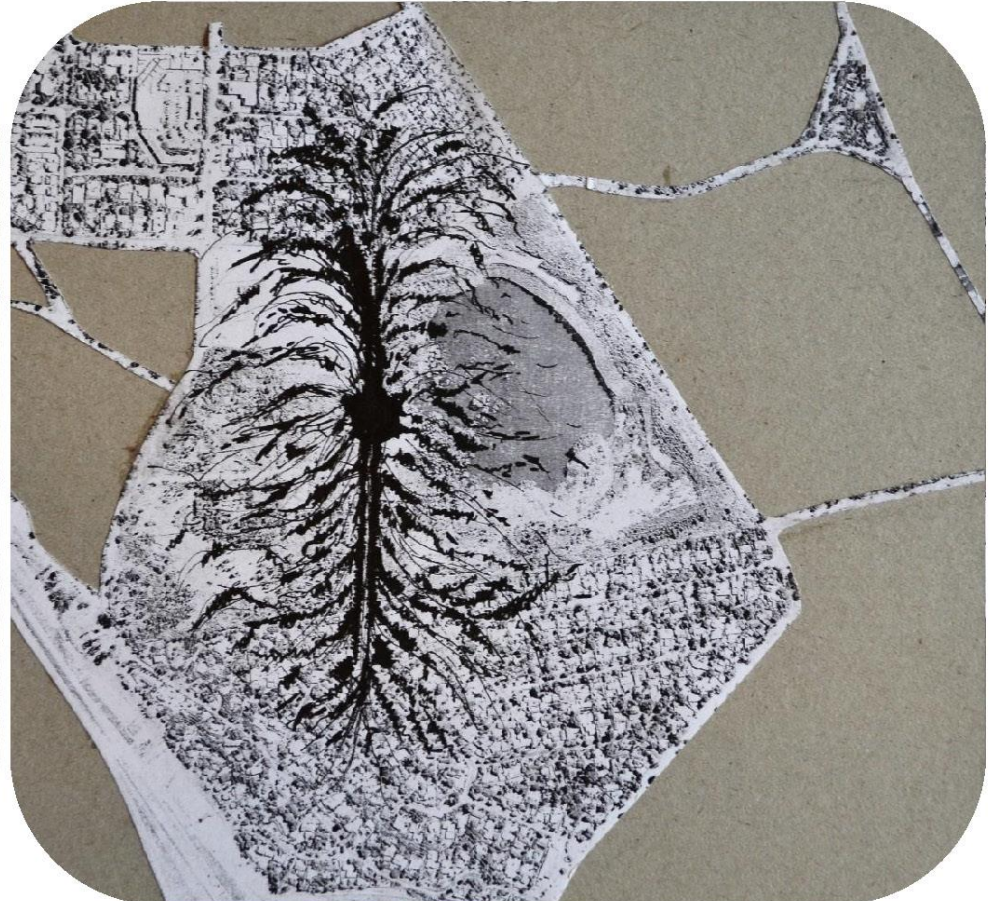
The neighbouring suburban fabric seems to be disconnected from the adjacent terrain. There thus exists an alienation between community and the immediate natural site. The north-western corner has a lot of informal commercial activity. The main vehicular artery which is Skilpad Road, west of the site, has a dual function of vehicular traffic and commercial activities. There also seems to be no acknowledgement of industrial heritage, ecology and industry on the site.

Response + Intention

Integration will be achieved by responding to the direct suburban density and creating opportunities on site in an attempt to integrate. The study will explore this notion of using industry, amusement, recreation and ecology as connectors, and also the symbiotic relationship between de-centralised industries on site as well as between the ecology (site), industry and the neighbouring suburban fabric.

Figure 3.28 – 29: Left: Site issue (Author, 2013)

Figure 3.30 – 31: Right: Site issues as abstract visuals (Author, 2013)



INTANGIBLE CONTEXT ANALYSIS



Figure 3.32 – 33: Left: Architectural issue (Author, 2013)

Figure 3.34 – 35: Right: Architectural issues as abstract visuals (Author, 2013)

ARCHITECTURAL ISSUE

There exist this concept of a factory as a “closed system”, which only depletes resources. The fixed concept of an enclosed production line, a “Factory” and test tube facility. The general consensus is to have centralised industrial communities on the edges of the suburban and urban fabric. Could the suburban species become part of the energy of these spaces without interfering with the actual production and scientific processes? Could it inform the chain of biodiversity within both the natural and the artificial space?

Response + Intention

The Architectural intention thus is to achieve integration between programme, community, production, ecology, industrial heritage (brick-making) and industry. The study aims at exploring the concept of amusement and recreation as connectors between programme, community, production, ecology, industrial heritage (brick-making) and industry. It also aims to perforate the visual explorations of industrial systems within a factory and reverse the process of removal of resources. The purpose is to create beneficial mutualisms and connections between the human, the insect, production and the research process.



FRAMEWORK. Chapter 04



Figure 4.1: Era brick factory (Author, 2013)



Figure 4.2: Current bio-diversity on site (Author, 2013)

Figure 4.3: Gated community, alienation of site (Author, 2013)

CONTEXT MAPPING AND RSDF ANALYSIS

After a thorough study and analysis the above mentioned issues were reviewed and précised into three main issues. The contextualised issues are industrial heritage, urban and ecology. These are listed and rationalised in the attached "Silent Industry" framework document. A full context analysis as well as the group framework for the site will be the main

ISSUES AND VISION:

1. Encroachment

It is currently proposed that the site be developed into a residential estate. The historical narrative of the site is not taken into consideration in this proposal, and if it is implemented, the homogenous nature of the adjacent suburb will spill over the edges and cover the entire site.

Vision: It is envisioned that the new interventions will establish the site as an amenity for the local community, because it provides the required and relevant facilities and goods and also has a sense of place that is specific to its history and its context. It is further proposed that the site becomes a primary function – a place for recreation.

2. Centralisation of Power and Industry

Industry at present is primarily owned by singular organisations, and the models of these industries are focused on singular resources and processes. Because these models are expected to provide for the whole of the local society, the scale of production is immense, and the extraction of resources therefore too.

Vision: The programmes on the site are selected with the intention to make use, within respected limits, of the resources on site, while replacing in excess rather than removing. This will be done on a small scale as a production model, and the decentralisation of power will also be addressed, as a variety of businesses will be invited to contribute to the function of the programmes, and input of the local community will also be invited. The collective programmes form part of a component integrated into a larger urban network of similar developments.

3. No Acknowledgement of Industrial Heritage and its consequences

The development schemes for the site as well as the local community do not recognise the previous historical mining activities on the site, or how these have contributed to our current culture of consumption. Our age is very different, and it requires us to do things differently. We need to be aware of our past mistakes and expose their aftermaths.

Vision: The new schemes proposed are expected to take the history and the existing ruins into account in the design of the new buildings. Past activity will also inform the new processes on site, and will be reinterpreted into functions that offer a regenerative transformation of the site and the well-being of the surrounding community.

4. Conditions not optimal for bio-diversity

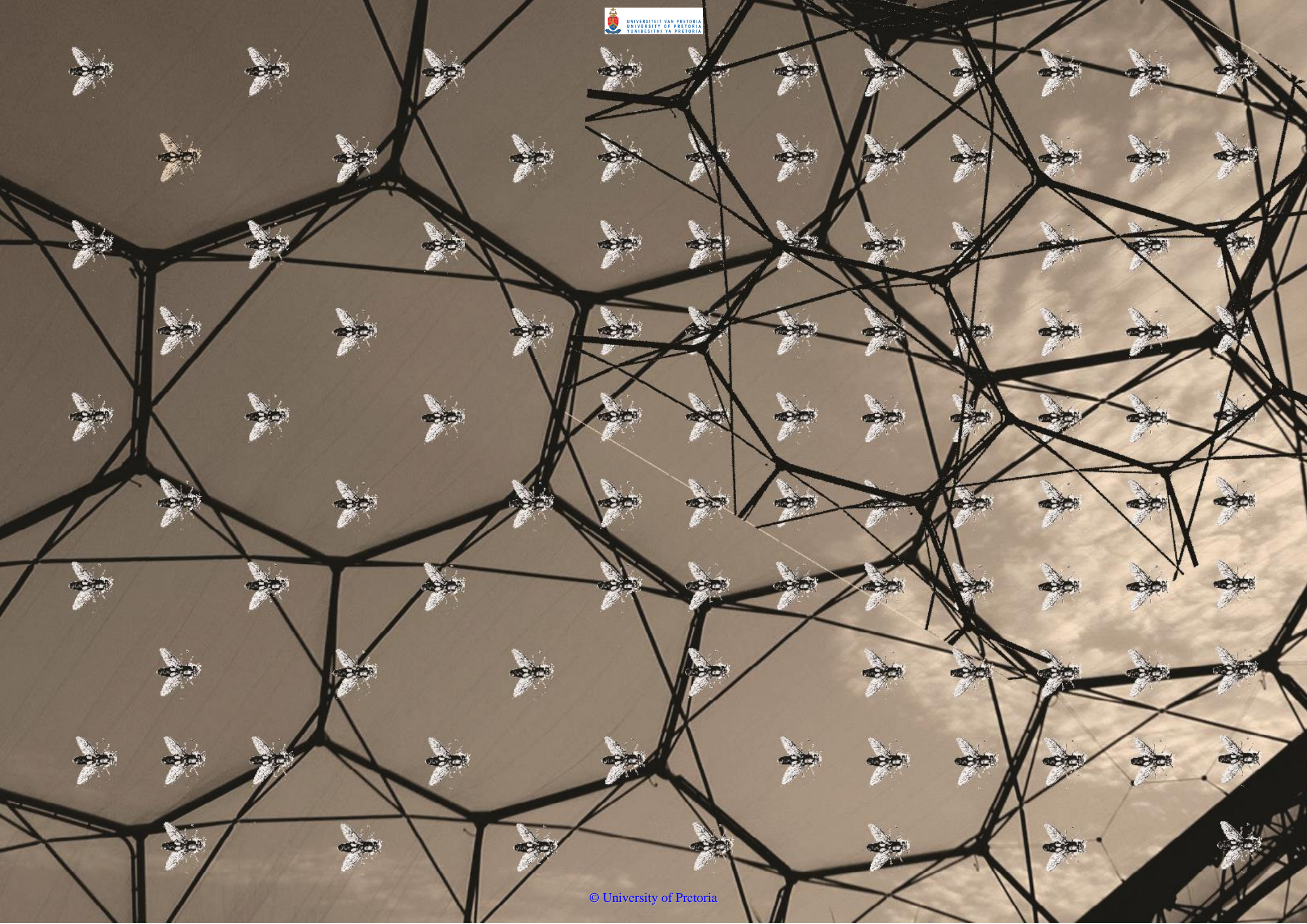
Due to a dominance of clay, only certain types of plant species can grow on the site. In addition, because the previous owners had planted exotic tree species (e.g. black wattle), these have flourished and have taken over as the monopoly of plant species. This has in turn an affect on the biodiversity of the fauna, and thus indirectly on us as humans. Diversity in use and activity is not enabled by the current state.

Vision: The new processes will take cognisance of the lack of biodiversity, and will aim to establish a richer variety of both fauna and flora; systems and processes will be based on the enablement of support for these new eco-systems.

5. Alienation of Community and Terrain

The community is presently completely turning their backs on the site. Visibility is minimal from the outside in and residents of the surrounding neighbourhood see the site as a safety risk, in that it presumably provides shelter for criminals in the area. Also, the ownership is still in dispute and contributive action is therefore prohibited. The site has therefore become disconnected from its surroundings, both physically and mentally.

Vision: The interventions are envisaged to make use of contributions from the community and also aim to provide for needs that the community might have. The process on site can be enabled and supported by micro-processes in the surrounding area, e.g. people's backyards may be linked to these in a very concrete and interactive manner. In this way, connections between the site and the community may be established.



PRECEDENTS. Chapter 05



Figure 5.1: Black soldier flies (Unknown, 2013)



Figure 5.2: Black soldier flies in cages
(<http://www.faz.net/aktuell/gesellschaft/umwelt/nachhaltige-geschaeftsidee-made-in-south-africa-11857044.html>)

Figure 5.3: Black soldier fly breeding
(<http://www.cleantick.com/users/alfredolle/projects/mass-rearing-of-black-soldier-fly-hermetia-illucens/20609>)

THE STORY OF THE FLY...

Flies exist on every inhabited continent, yet few if any of us understand its importance and use, and fewer still how it could be at the core of a new industry. It is after all a mere insect which most of us consider a pest.

Throughout history, innovative humans – including Napoleon Bonaparte's surgeon, NASA, various forensic entomologists and the UK National Health Services – have harnessed and researched the fly to help mankind. But ultimately the fly can be viewed as a future hero that could help save the world. How? By recycling waste nutrients and generating sustainable protein (animal feed), plant feed, chitin and biofuel.

Jason Drew formulated this nutrient recycling concept and advocates that we should embrace the potential of the fly as a protein and energy source, given their exceptional breeding rates and the fact that they are a natural food, tried and tested by Mother Nature for tens of millions of years.

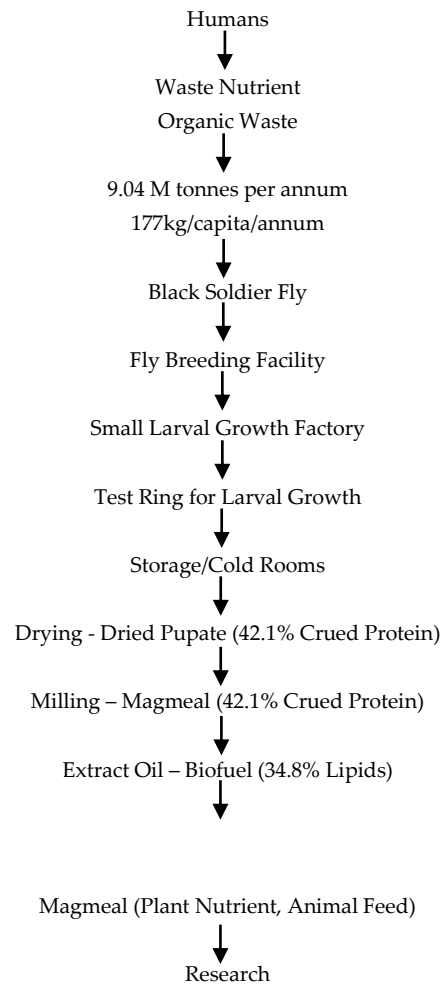
Fly Facts: (Drew and Joseph, 2012)

- One pair of flies could easily spawn 6-7 generations and quintillion offspring in just 5 months. If none were killed or eaten, that would be enough to blanket the entire Earth with a layer of flies 47-foot deep!
- Chemosensory hairs on the fly's feet allow the fly to taste food by merely walking across it.
- Genghis Kahn's armies travelled with cartloads of flies, whose larvae they used to disinfect their wounds.
- Flies have been around on Earth for more than 20 million years (surviving the dinosaur extinction).
- Blowflies can smell death from up to 16 kilometers away.



Figure 5.1: Agriprotein process (<http://www.agriprotein.com/>)

Agriprotein Fly Farm Process



AGRIPROTEIN

General information

Location: Stellenbosch, South Africa

Concept: Jason Drew and his brother David Drew

Year of construction: 2012

Function of building: Manufacturing and Recycling

Degree of enclosure: Fully enclosed structure, brick and concrete and sheet metal

Short description of the project

Jason Drew and his brother David founded AgriProtein in Tulbagh, Western Cape in 2009 (Drew, 2013). Their primary objective was to reduce and eventually eliminate the use of fishmeal in industrial farming by substituting it with magmeal (milled fly larvae).

Society takes for granted the fact that one should recycle glass, newspapers, cans and – more recently – plastic and water. Businesses and services have sprung up to enable us to achieve this. Creating and discarding nutrients in the form of organic waste, sewage, manure and abattoir blood has a far higher environmental impact. Nearly one third of the fish taken from our seas – some 50 million tons a year – is used in industrial agricultural and pet food industries. Yet at the same time, hundreds of millions of tons of nutrient-rich waste is disposed of. It is not just our human food waste – from supermarkets and food processing businesses – discarding unsightly but perfectly good apples and oranges or out of date but edible foods. It goes much further; it takes as much land, diesel, water and our precious seas to make the bits of a chicken that we eat as the bits we throw away. Manure/faeces – both animal and human – is also a key source of valuable nutrients. Most animals absorb only a small percentage of the nutrients that pass through them. In nature this is recycled. An animal would drop its manure on the field or die in the bush, and nature would recycle the waste nutrients, using insects. A fly would lay its eggs on the waste nutrient source, the eggs would hatch into larvae and birds and fish would eat many of those larvae or flies – recycling the nutrients – as well as cleaning up the bio-hazard. Each species of fly and its larvae are naturally adapted to different types of waste (Drew, 2013).

Having this knowledge, Jason Drew decided to industrialise fly farming. They gathered waste nutrients from slaughterhouses – blood and guts – and fed this to the eggs laid by the fly breeding stock. Each species of fly and its larvae are naturally adapted to different types of waste. Free-range chickens in fields and fish in streams feed on larvae as part of their natural diet. This natural source of protein has been increasingly replaced in our industrial farming operations with the more readily available fishmeal. The chemical composition of fishmeal is almost exactly the same as that of fly larvae – which is why it was chosen as a substitute. Agriprotein has copied nature and led the process of making protein from waste nutrients profitably, sustainably and on a large scale. They are already in production and believe that they can produce Magmeal™ at scale for around R9 000 per ton, which compares favourably with fishmeal – which is currently around R20 000 per ton, and likely to increase unless the oceans can be better managed (Drew, 2013).

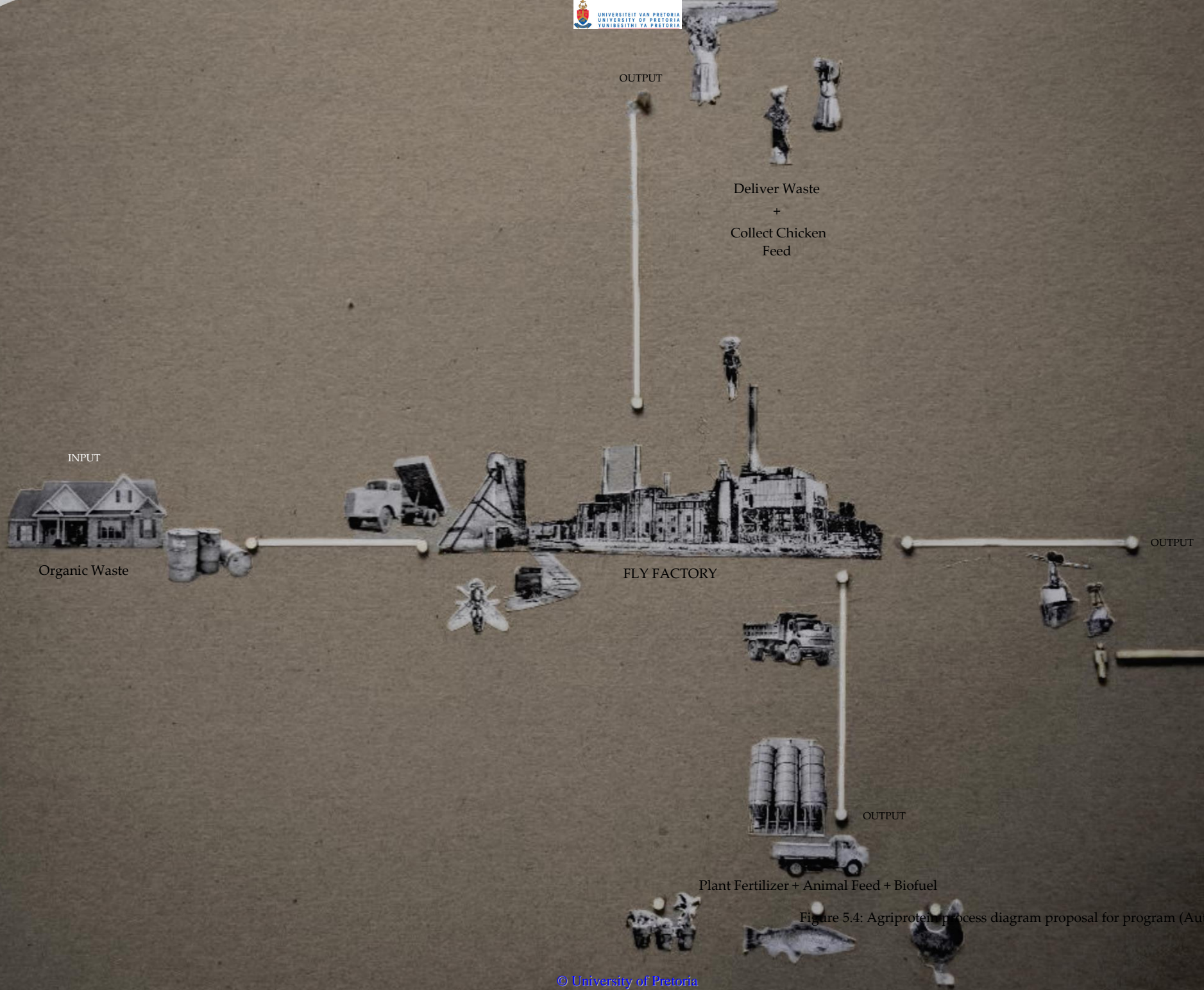


Figure 5.4: Agriprotein process diagram proposal for program (Author, 2013)



Figure 5.5: Organic waste, left-over food (Author, 2013)

Figure 5.6: Waste containers
(<http://www.agriprotein.com/>)

Figure 5.7: Black soldier flies larvae (larval pellets) ready to be feed to animals (<http://www.agriprotein.com/>)

Process (Drew, 2013)

Mr. David Drew from Agriprotein explained the concept to me. AgriProtein grows larvae using three different types of flies: the common housefly (*Musca domestica*), the black soldier fly (*Hermetia*) and the blowfly (*Calliphoridae* family).

The flies feed on specific types of organic waste. The common housefly and the blowfly feed on abattoir waste, whereas the black soldier fly prefers materials that contain carbohydrates, such as manure and vegetable matter.

The fly farm consists of enormous fly cages filled with flies, which are geared towards the large-scale laying and collection of eggs. The fly farm has 22 cages, each one holding up to 750 000 flies. The eggs are removed from the cages, but with a portion retained in order to maintain a breeding stock. The eggs taken from the cages are combined with waste nutrients (to feed on). The eggs will then hatch within 24 hours and start to feed on the waste material. Each fly will lay up to 1 000 eggs and each kilogram of eggs will turn into 380 kg of larvae within 72 hours – depending on the species. The larvae can consume 15 kg of organic waste per square meter of larvae in 12 hours. These larvae are then taken through three processes of extraction, drying and then milling. The whole process from egg to product takes 14-17 days.

AgriProtein's large plant, set to employ more than 80 people, will cost roughly R57 million at current exchange rates. This new industry can produce 600 tons of protein per hectare, compared with under 50 tons of protein in a typical agricultural setting, notes Drew. It also reduces the potential hazardous landfill of the waste, which is now used to feed the flies.

Product

In a telephone conversation Dr Elsje Pieterse, University of Stellenbosch researcher, involved in the fly breeding at the Agriprotein facility informed me a bit more on the biological and scientific aspects of the process and product of this facility. As mentioned above the harvesting of these flies produce nutrient rich larvae which are taken through three processes of extraction, drying and then milling, giving us magmeal (fishmeal replacement), dried larvae (animal feed), biofuel, chitin and enzymes (Pieterse, 2013).

Magmeal can be mixed into animal rations and contains no toxins and has no side-effects that could be found to date "It is, in fact, easy to digest, while it is also a renewable source of animal feed" (Pieterse, 2013).

Fly larvae also have a high fat content, with the ideal fatty acid mix for biodiesel production. The 34% extracted biofuel can be converted into biodiesel yielding a B100 Biodiesel product. The chitin in the larvae can also be used in the manufacturing of filters used in harvesting uranium from the sea, as well as to take heavy metals out of polluted water and produce biodegradable plastic. Biomedically speaking, the larvae have value in the production of cholesterol medication, without the side-effects seen in current medicines. The enzymes in the larvae can also be used to heal diabetic sores. "Fly larvae also carry antitumour, antibiotic and anti-inflammatory properties that are just waiting to be researched," says Pieterse.

They are also exploring the concept of using the fly larvae to convert human faeces and manure into the above mentioned products. They are in the process of conducting studies and using townships in the Western Cape as study area. This concept are still disclosed and they did not want to share the particulars of it.

Video

<http://www.youtube.com/watch?v=wc9v6cgxY2A>

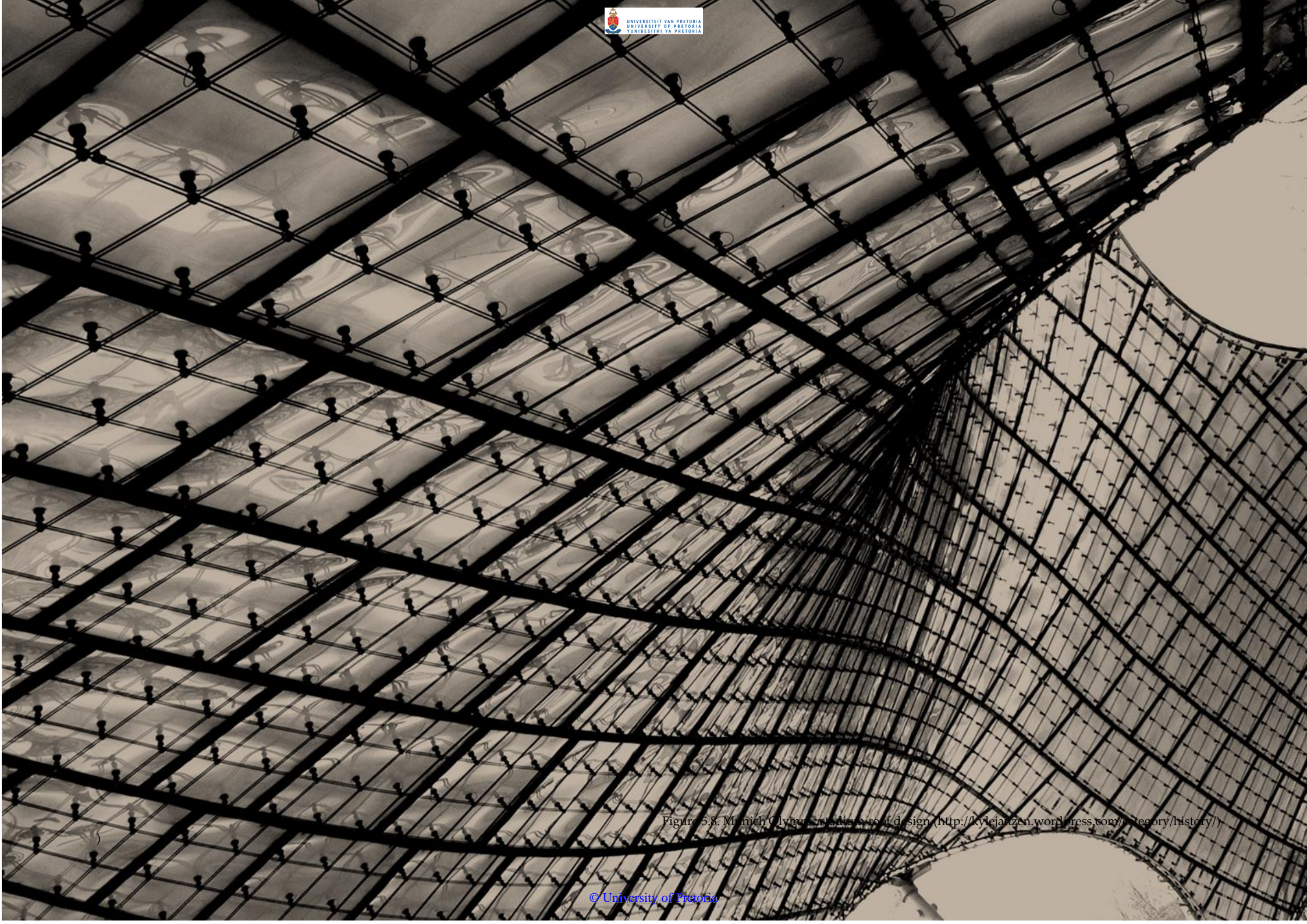


Figure 5.8. Munich Olympic stadium roof design (<http://kylejaazen.wordpress.com/category/history/>)



MUNICH OLYMPIC STADIUM

General information

Location: Munich, Germany

Concept + Design: German architect Günther Behnisch and the engineer Frei Otto

Year of construction: 1972

Function of building: Stadia

Degree of enclosure: Fully enclosed structure, tensile structure (cable and fabric)

Short description of the project

Roof

The design express a continuous, undulating translucent roof covering nearly 80000 m² of landscape. The stadium, pool and arenas were conceived not as individual buildings but as a series of moulded earth forms sheltered by silvery lightweight umbrellas. After the Games were over this imaginatively reclaimed airfield would be open to the public as an undulating, grassy park for everyday recreation and pleasure. Initial concept to avoid rigid, rectangular shapes emerging from the design process, as tends to happen when planning is done by means of drawing boards and T-squares, Behnisch and his team evolved the basic design concept using the softest and most malleable of all media: a sand model. For the protecting umbrellas Behnisch wanted the kind of lightweight, translucent skin used at Expo '67. He therefore brought Frei Otto and Leonhardt & Andrä into the design team.

As built, the nets are formed of crossed pairs of strands spaced 750 mm in both directions – a relatively narrow spacing with many advantages including safety and convenience for workmen. This spacing remains constant throughout, regardless of the net shape; all changes of plane in the double-curved surfaces were accommodated by changes in the strand intersection angles. Intersection joints were formed by an automatic process, aluminium clamps with central holes being pressed on to all strands at exactly 750-mm centres under a defined level of pre-stress. The two sets of strands could thus be formed into a 750 x 750-mm mesh with no need for measurement, simply by connecting the aluminium clamps. The connections used one bolt per joint, resulting in a freely rotatable node that allowed the mesh to adjust to any angle of intersection. With regard to cable specification, a balance had to be struck between the need for cable flexibility (which favours a strand spun from many thin wires) and durability (which favours some being spun from fewer and thicker wires). The decision was to form the net from strands spun from 19 heavily galvanised 2,3- and 3,3-mm steel wires, with a lay length of 10 x the lay diameter.

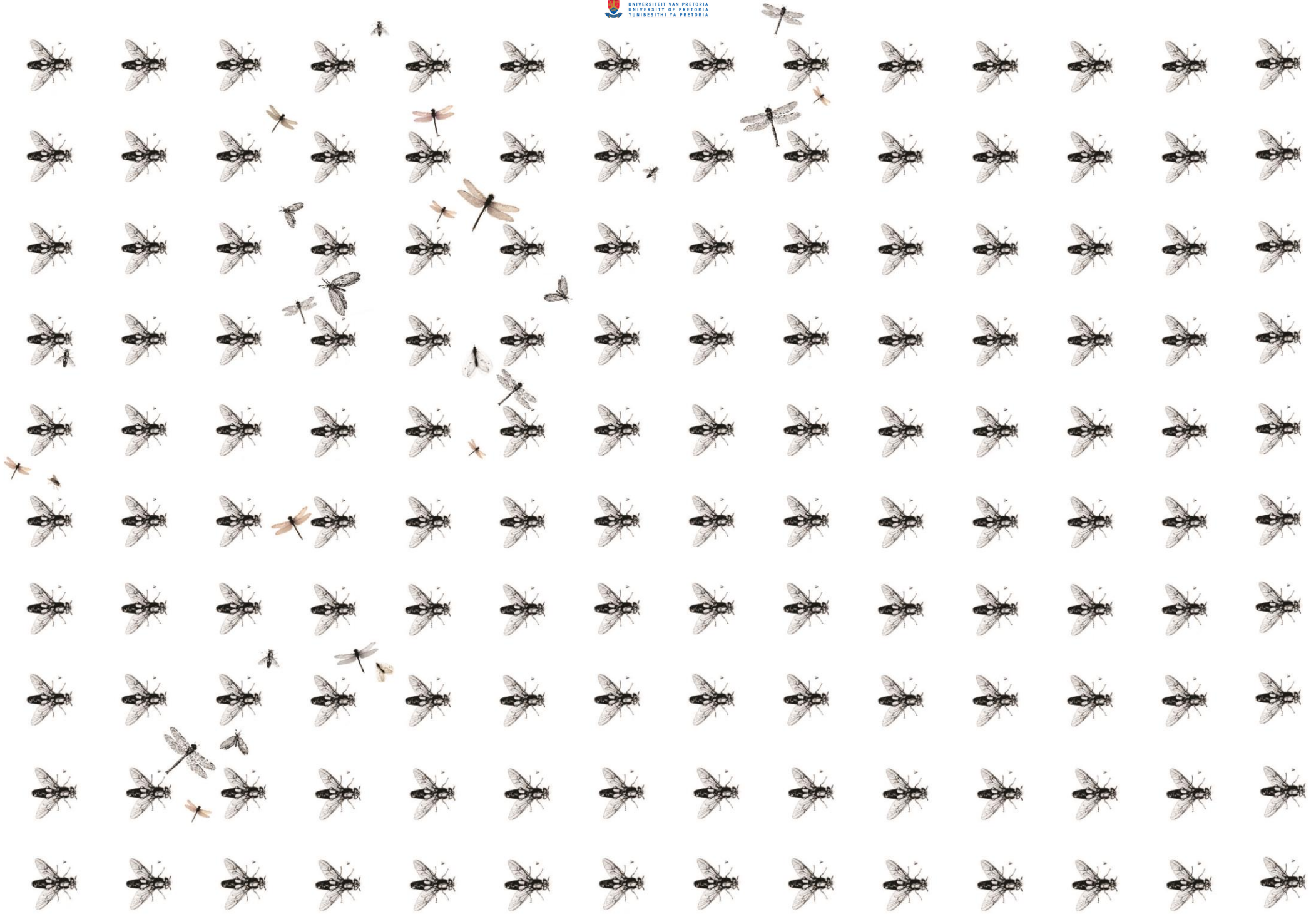
Main and edges cables: The main cables, composed of five strands formed from between 37 and 109 wires each, had to be held at high tension to control deformation of the roof under snow and wind loads. The edge cables vary in specification, a typical example being a locked-surface wire rope of 81 mm diameter. With a safety factor of 2, the permissible load is 3 mN (300 ton) and again, several ropes are coupled where forces exceed this figure.

Foundations and masts tension: Foundations were needed to anchor the main cables down to the earth. Upward pulls of up to 50 mN (in the case of the big edge cable of the stadium) are exerted on such foundations, and three foundation types were used:

- inclined slot foundations, working rather like tent pegs;
- gravity anchor foundations, deriving their anchoring effects from self-weight plus the weight of the soil surcharge;
- earth anchor foundations were needed to support the masts.

Figure 5.9 – 10: Munich Olympic stadium lightweight transparent roof design
(<http://www.handpickedbyronandchris.com/2012/07/olympic-tuesday-let-games-begin.html>)

DESIGN DEVELOPMENT. Chapter 06



FOUR SPECIES UNDER THE LENS

Black Soldier Fly

Hermetia illucens

The **black soldier fly**, or *Hermetia illucens*, is a common and widespread fly of the family Stratiomyidae, whose larvae are common detritivores in compost heaps. Larvae are also sometimes found in association with carrion, and have significant potential for use in forensic entomology (http://en.wikipedia.org/wiki/Hermetia_illucens).

Black soldier fly larvae (BSFL) may be used in manure management, for house fly control and reduction in manure volume. Mature larvae and prepupae raised in manure management operations may also be used to supplement animal feeds (Sheppard, 1992).

Life cycle

Black soldier fly eggs take approximately four days to hatch. The larvae range in size from 3 to 19 mm. Although they can be stored at room temperature for several weeks, their longest shelf life is achieved at 10–16°C (http://en.wikipedia.org/wiki/Hermetia_illucens).

The adult fly, which measures about 16 mm (Savonen, 2005), is a mimic, very close in size, colour and appearance to the organ pipe mud dauber wasp and its relatives. The adult soldier fly has no functioning mouthparts; it spends its time searching for mates and reproducing. The adult's life span is 5 to 8 days (Savonen, 2005).

Benefits

Black soldier fly larvae (BSFL) are used to compost and sanitise waste, and/or convert the waste matter into animal feed. The harvested pupae and prepupae are eaten by poultry, fish, pigs, turtles, and even dogs. The waste matter includes fresh manure, and food waste of both animal and vegetable origin (Drew & Joseph, 2012).

Larvae are beneficial in the following ways:

1. They prevent houseflies and blowflies from laying eggs in the material inhabited by black soldier fly larvae (http://en.wikipedia.org/wiki/Hermetia_illucens).
2. They are not attracted to human habitation or foods. As a detritivore and coprovores, the egg-bearing females are attracted to rotting food or manure (Drew & Joseph, 2012).
3. They quickly reduce the volume and weight of organic waste. The larva breaks apart its food, churns it, and creates heat, increasing compost evaporation. Significant amounts are also converted to carbon dioxide (respired by the grubs) and symbiotic/mutualistic micro-organisms (Drew & Joseph, 2012).

Requirements of space and shape of breeding chambers

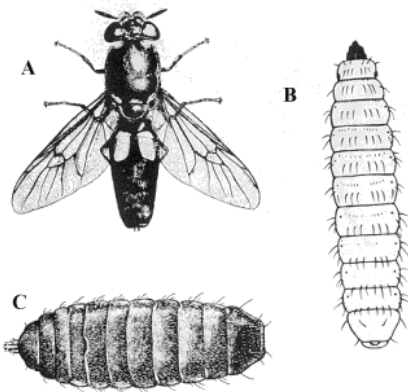
Various tests were executed on the mating patterns and conditions of the BSF. No mating occurred under artificial lighting. Mating only occurred under natural light conditions. Jason Drew and his team managed to breed these under artificial light conditions but were not willing to share this information.

Heat requirements

Adults typically mated at temperatures of 24°C up to 40°C or more. Drew and Joseph (2012) as well as Sheppard (1992) reported that 99,6% of mating in the field occurred at 27,5°C to 37,5°C.



Copyright © Maury Helman



Black soldier fly. A, Adult female. B, Larva. C, Puparium.

Figure 6.1: Adult black soldier fly (BSF)
(<http://bugguide.net/node/view/184752/bgimage>)

Figure 6.2: BSF life stages
(<http://brewcovery.wordpress.com/>)

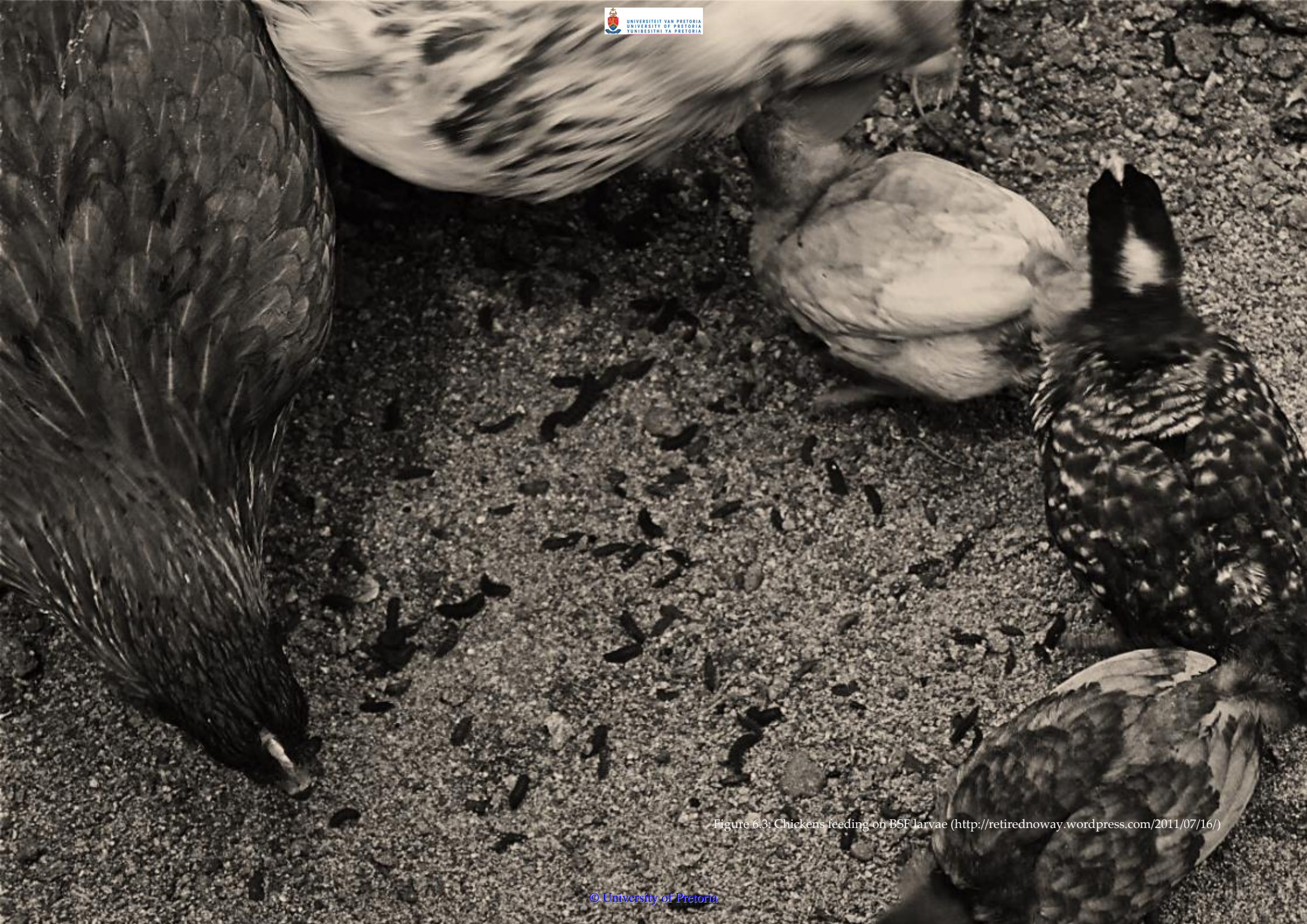


Figure 6.3: Chickens feeding on BSF larvae (<http://retirednoway.wordpress.com/2011/07/16/>)

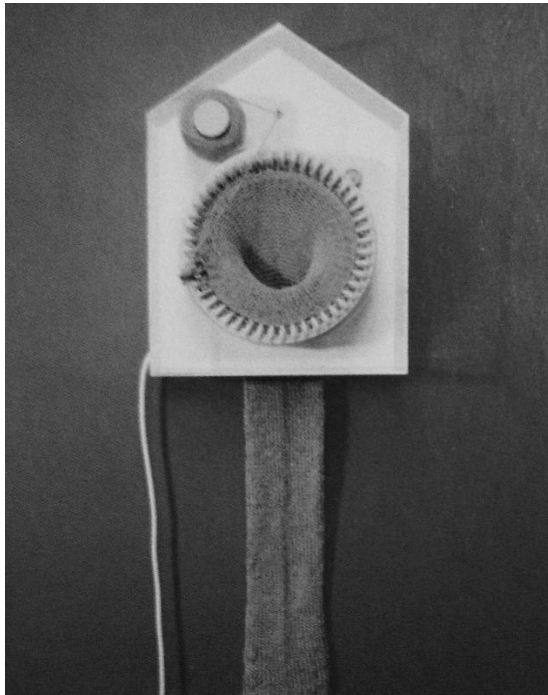


Figure 6.4: Adult black soldier fly in breeding cages (<http://bugguide.net/node/view/184752/bgimage>)

Figure 6.5: BSF cage concept (Author, 2013)

Light requirements

Minimum lighting level for mating is estimated at 3,500 lumens (Drew, 2013):

1000 lux	Overcast day; typical studio lighting
10000–25000 lux	Full daylight (not direct sun)
32000–130000 lux	Direct sunlight

Table 6.1: Indication of standard lux levels (<http://en.wikipedia.org/wiki/Lux>)

Humidity

Relative humidities of 30-90% support mating (Drew, 2013).

Description and Life cycle

Adults:

Members of the soldier fly family Stratiomyidae can range in colour from yellow, green, to black or blue, with some having a metallic appearance. Adults range from 15 to 20 mm in length (Sheppard et al., 2002). Two days after adult emergence from the pupal case, mating can occur (Tomberlin & Sheppard, 2001).

Eggs:

The female black soldier fly deposits a mass of about 500 eggs in cracks and crevices near or in decaying matter such as dung, carrion, garbage, and other organic waste. The eggs hatch into larvae in about four days. Each oval-shaped egg is about 1 mm in length, and pale yellow or creamy white in colour (NCIPML, 1998).

Larvae:

The larvae can reach 27 mm in length and 6 mm in width. They are a dull, whitish color with a small, projecting head containing chewing mouthparts. Larvae pass through six instars and require approximately 14 days to complete development (Tomberlin & Sheppard, 2001). During larval development, black soldier fly larvae are insatiable feeders. As adults they do not need to feed, and rely on the fats stored from the larval stage (Newton et al., 2005).

Pupae:

Before pupation, the sixth instar larvae disperse from the feeding site to dry sheltered areas, such as ground vegetation, to initiate pupation. The exoskeleton darkens and a pupa develops within. Pupation requires about two weeks (Drew, 2013).

The black soldier fly will be used within the factory as a measure to convert organic waste into usable resources such as bio-fuel, animal feed and plant feed. This is an Agriprotein concept where the study will utilise their research as a basis for the factory: a "Fly Factory".



Figure 6.7: Giant African bullfrog (<http://www.frogforum.net/african-bullfrogs/3348-fearing-i-too-got-scammed-dwarf-african-bullfrogs-pyxies-sold-giants.html>)



The listed species, namely the African Bullfrog, the Dragonfly and the Lacewing, will be harvested in the research facility and used as a measure of control and for research purposes within enclosed vivariums as well as on the site. They have been selected based on their endangered status as well as their beneficial nature within a natural ecosystem.

These will be closely monitored within the parameters of the site. None of the selected beneficial species have a tendency to become pest species (Chinery, 1986).

African Gaint Bullfrog

Pyxicephalus adspersus

The Giant Bullfrog is the largest amphibian in Southern Africa (males may reach a body mass in excess of one kilogram). Unfortunately, only when environmental conditions are conducive, do these frogs breed in large numbers. Prior to 2004, the last known large-scale breeding event of Giant Bullfrogs took place during 1992-1994. The reliance of this species on specific environmental conditions makes it consequently very susceptible to local extinction. In addition, the apparent core of this species' distribution range lies within Gauteng Province, which represents the current epicentre of urban development in South Africa. Here, large tracts of grassland and wetlands are increasingly being developed into industrial or residential areas, leaving virtually no undisturbed habitat. For these reasons the continued survival of the Giant Bullfrog is in danger in Gauteng, and probably South Africa in general. At present this species is listed by the World Conservation Union (IUCN) as "Near-Threatened" in Southern Africa. Measures to protect Giant Bullfrogs are urgently required to prevent the extinction of significant populations of this species in southern Africa (<http://www.up.ac.za/bullfrog/>).

The African Gaint Bullfrog will be harvested in an attempt to increase their numbers to save this species from extinction and also as a means to evaluate the reasons for their decreasing numbers.

Green Lacewing

Chrysopidae rufilabris

Green lacewings are delicate insects with a wingspan of 6 to over 65 mm. The wings are usually translucent with a slight iridescence (<http://en.wikipedia.org/wiki/Chrysopidae>). Green Lacewing larvae feed primarily on soft-bodied garden pests (Chinery, 1986). Lacewing larvae are most effective in humid areas such as greenhouses and interior gardens. They are considered a very good natural control of a number of insects, including aphids, spider mites and red mites, thrips, whiteflies, long-tailed mealybugs, eggs of leafhoppers, moths and leafminers, small caterpillars, beetle larvae and tobacco budworms (Chinery, 1986). Most of these pests feed on fruit, vegetables, herb and other food crops. Green Lacewing larvae can be used on a number of different plants and food crops as a measure of control. Lacewing larvae are very active and can kill up to 600 aphids while in their larvae stage, which lasts from two to four weeks (<http://voices.yahoo.com/how-green-lacewings-garden-pest-control-7713626.html>).

Figure 6.7: Giant African bullfrog
(<http://www.frogforum.net/african-bullfrogs/3348-fearing-i-too-got-scammed-dwarf-african-bullfrogs-pyxies-sold-giants.html>)

Figure 6.8: Lacewing (Author, 2013)

Due to the nature of the industries on site, where one of the programmes deals with medicinal plants and herbs, the study has selected the lacewing as a measure of control and for experimental purposes.

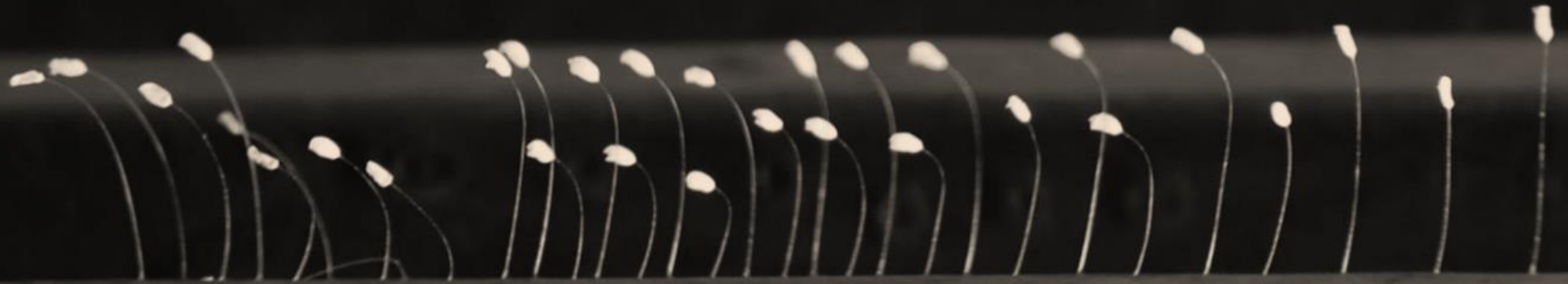


Figure 6.9: Lacewing eggs on timber bridge (<http://www.pesticide.org/the-buzz/natural-aphid-predators-lacewing-larvae>)

Dragonfly

Pseudagrion Newtoni



The dragonfly is characterised by large multifaceted eyes, two pairs of strong transparent wings, and an elongated body. Dragonflies are important predators that eat mosquitoes, and other small insects like flies, bees, ants, wasps, and very rarely butterflies. They are usually found around marshes, lakes, ponds, streams, and wetlands because their larvae are aquatic. Some 5680 different species of dragonflies (Odonata) are known in the world today (http://aggiehorticulture.tamu.edu/galveston/beneficial/beneficial-11_dragonflies.htm). The adult dragonfly is focused on feeding and mating. The female returns to a wetland area to meet the male. After mating, the female lays eggs in plants near or in water, directly on the water surface, or on mud at the water's edge –depending on the species. Predated upon on environmental conditions and species, eggs may hatch in as few as 7-9 days, or may require several months to hatch (http://aggiehorticulture.tamu.edu/galveston/beneficial/beneficial-11_dragonflies.htm). After the eggs have hatched, the young are generally known as immatures (Chinery, 1986).

In the immature stage, they feed on aquatic insect larvae such as mosquitoes, tiny fish and tadpoles. The dragonfly flies away from the water until it becomes sexually mature. This results in a dispersal where the dragonfly finds other wetland areas.

As with many beneficials, providing a suitable habitat is vital to maintaining their populations. Michael Samways has also written about the threats to dragonflies: "Riverine alien trees, especially Black Wattle *Acacia mearnsii* in northern parts of the country and the Long-leaved Wattle *A. longifolia* in the southwest, are the principal threat to the globally Red-Listed species. These invasives have dense canopies that effectively shade out the habitat (Samways & Taylor, 2004). Twelve of South Africa's 160 species of Odonata (i.e. the dragonflies and damselflies) were placed in IUCN threat categories when they were reviewed by Professor Michael Samways, one of South Africa's leading specialists on this taxon in 2004 (Samways & Taylor, 2004).

Due to the occurrence of the above-mentioned black wattle tree on the site as a result of the effect of mining and industry on ecology, the study has selected the dragonfly for experimental purposes to research the effect of these invasive plants on the insects, and also to use these insects to monitor water and wetland health and control of harmful pests such as mosquitoes.

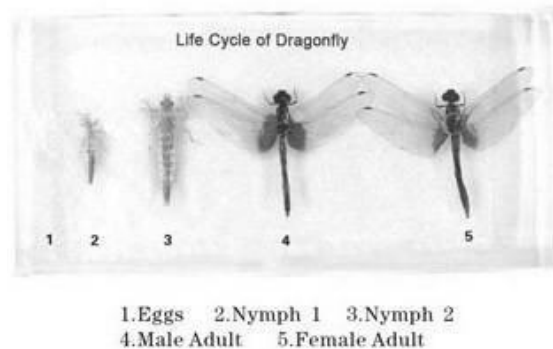


Figure 6.10: Dragonfly

(<http://bugsofpopoagie.wordpress.com/category/entomology-general/>)

Figure 6.11: Dragonfly life cycle

(http://www.diytrade.com/china/pd/6403517/Specimen_Life_Cycle_of_Dragonfly.html)

Beneficial Insect Specifics

As with beneficial insects, it is recommended that one monitors the population of insect species closely. It is important that the larvae have an adequate food source to be able to sustain the life cycle. One should plan on deploying them at least four times, two weeks apart; this would ensure that one has overlap and is able to take advantage of the insect species through their life cycles. One should also plan on the larvae one first placed on the plants laying eggs and replacing these larvae in about 4 to 6 weeks. Using this natural cycle, one can ensure that pest insects are controlled throughout the growing season (Chinery, 1986). In order to properly maintain the population of beneficial insects throughout the growing season it may be necessary to supplement the adult insect food supply. It is important that the adult insect stays near the monitored garden or where they are released to ensure that they will lay eggs again in the monitored garden and thus control the pest insects. Without food one will find that the adult beneficial species will disperse, and one will need to harvest additional larvae later in the growing season. There are commercially available foods or "honeydew" that can be used for this purpose. These should be refreshed during the evening as the adults are most active during the night (Chinery, 1986). In a typical small garden or insectory of 750 m² it is recommended to release 1 000 larvae or less. In situations where insects are being deployed to control pest insects in large crops, one would need larger concentrations of the beneficial species – generally 5 times that amount per 4 000 m² to be effective (Chinery, 1986).

It is best to disperse the insect larvae throughout the infected garden plants. One can do this by simply spreading them around from a container. It is important that the larvae be kept out of direct sunlight in the container and that one provides them with sufficient room to feed, as they are cannibalistic and will eat one another (Chinery, 1986).

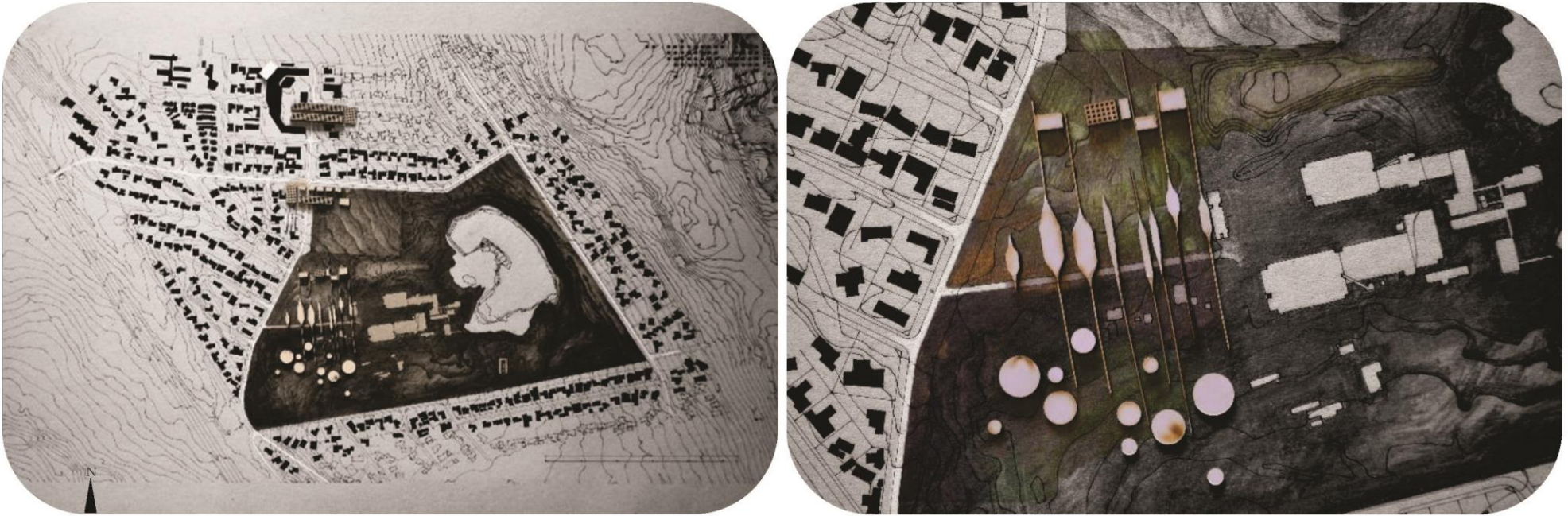


Figure 6.12: Design concept diagrams (Author, 2013)

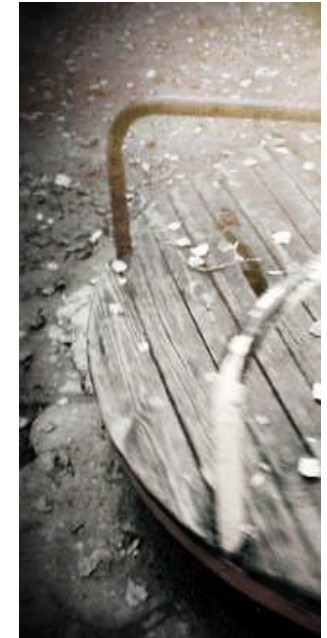
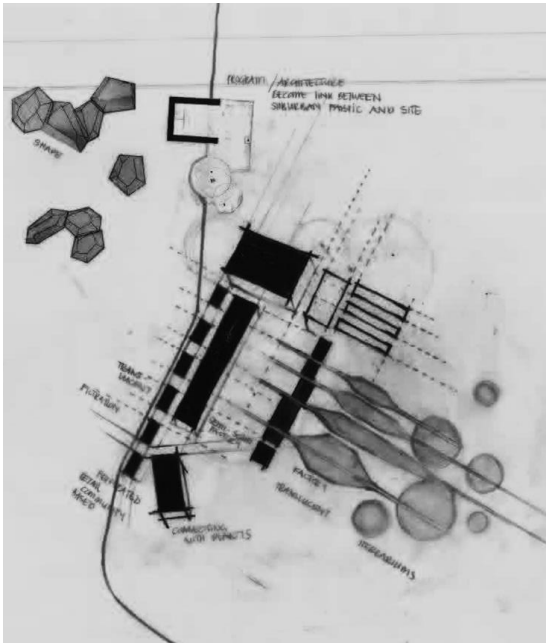


Figure 6.13: Design concept (Author, 2013)

Figure 6.14: Concept for recreational route (Author, 2013)

Figure 6.15: Concept for recreational route (Bloom, 2011)

CONCEPT DEVELOPMENT

Design concept

The initial intention was to have both production facility (the factory) as well as the research initiative (the insectary) as an integrated system. The conceptual thought wondered around the idea of perforating this integrated production space with recreational routes. By puncturing this functional membrane the process of production become visible to the dweller.

As the diagrams clearly indicate, the design focus of pockets of interlinked functions which are connected on a vertical as well as horizontal plane with horizontal movement arteries which run through the building membrane. The idea thus is to blur this concept of a "closed production line" and to make these functional systems visible.

The orientation of the building are along the active vehicular arterie, skilpad road. This decision was based on displaying the building as an industrial process. The decision was also based on maintaining the edge of the site and preventing urban sprawl into the treasured site. Another argument for positioning the building on this north-south axis was safety on the site. By positioning the building in such a way as to protect the site and its activities but also to aid as a measure of passive surveillance. By perforating the building structure one also have visual access into the site which add another level of security.



Figure 6.16. Site plan indicating important nodes (Author, 2013)

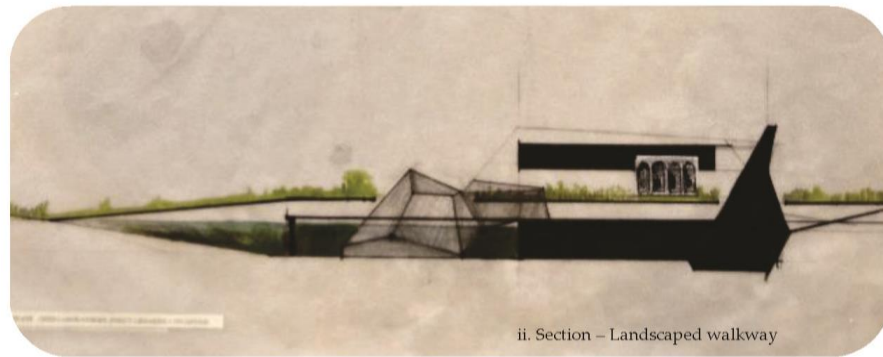
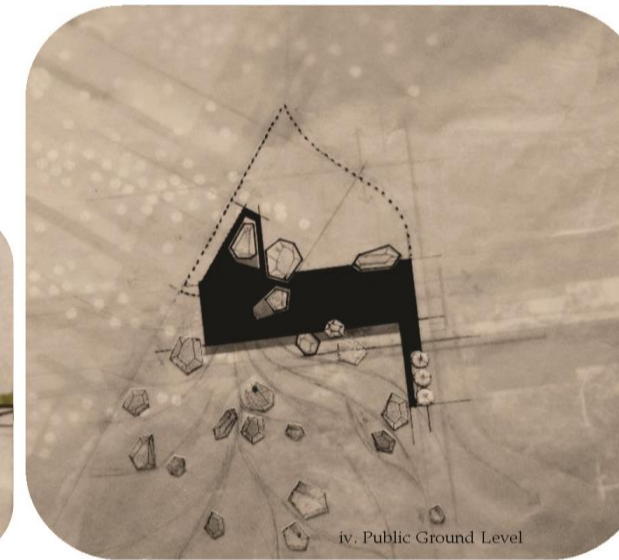
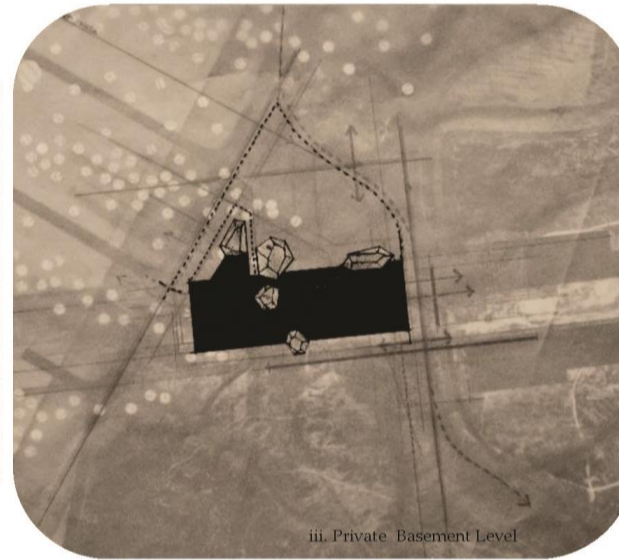
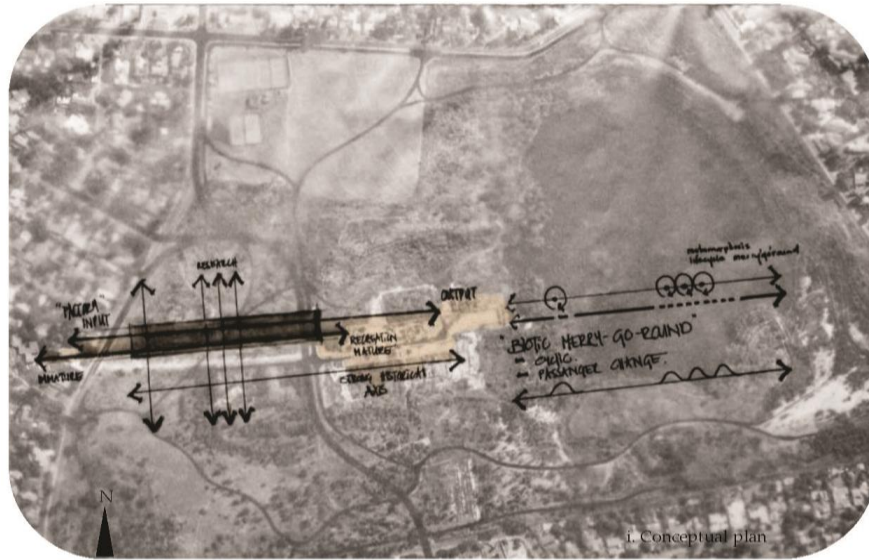


Figure 6.17: Series i – vi of conceptual design diagrams (Author, 2013)

As indicated on the site plan, to the left, the main vehicular Skilpad road runs west to the site with the active commercial node on the north-western corner. The framework proposed a central public square in the heart of the site. Monument park suburban fabric neighbours the site on the western axis where the intended harvesting facility will be. The group framework also propose a higher residential density around the site. The site is vast in its approach with very little guidance into the site. The program realised that there is a need for a portal into this recreational "core" within the site. By positioning the program in such a way, facing north, as to connect the western suburban fabric with the eastern recreational heart and hence guiding the user into the site. The objective will be to have a landscaped portal which will allow the user to dwell into the site. The aim is thus to construct this "planted" route which will puncture through the productive body dividing it into two private productive entities. One to form the productive firmament, research facility with offices and the other to form a submerged factory. As the user dwells through this public space he can observe how insects are harvested and undergo this metamorphoses of knowledge.



Figure 6.18. Site plan indicating important nodes (Author, 2013)

On a horizontal plane: The concept of the portal was divided into two parts with the factory to the western side and the research facility on the eastern side. The factory needed constant and easy road access for waste input and product output. The research facility harvest the more fragile insect species and need protection form the busy road. The research facility will receive DNA and RNA input from the less active new road through the site. On a vertical plane: The structure will have a raised research space, where insects are cloned, with laboratories and its supporting spaces raised; the it will have laboratories hanging form this raised level for observations by the dweller; as well as a submerged productive plant where the flies are harvested and waste converted into product.

The figures below illustrate (from left to right); i. The concept of connections between species and the effect of species dying out; ii. The selected 4 species for harvesting; iii. The input output of each specie; iv. The production facility acting as thoroughfare whilst producing and releasing and how the dweller become part of this process; v. This recreational platform which pass the various enclosed test tube facilities and integrate the user into the process of cell divisions and specie awareness; vi. The intention of having this recreational "green" route which link production and research but also guiding the user into the site.

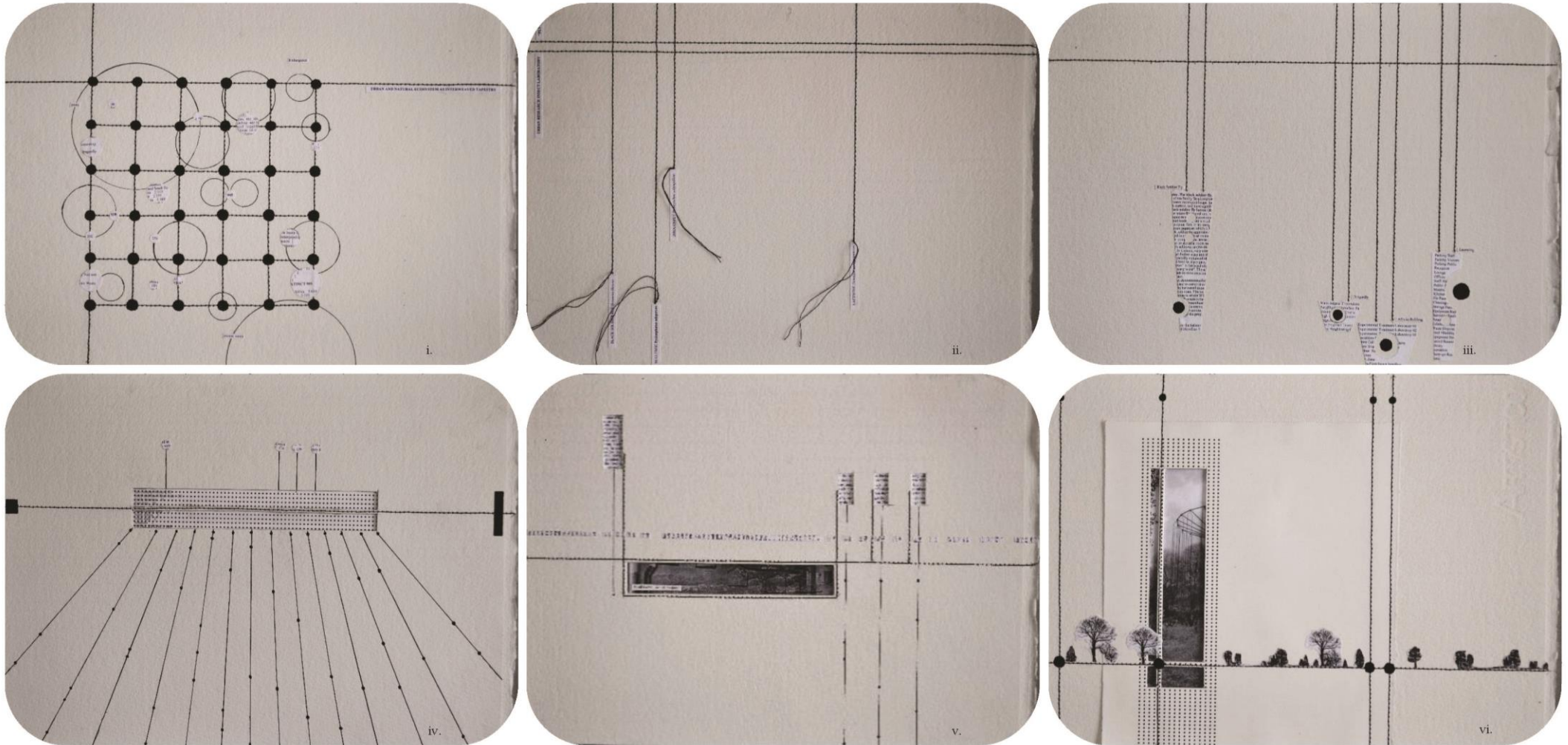


Figure 6.19: Series i – vi of conceptual design diagrams indicating abstract program (Author, 2013)

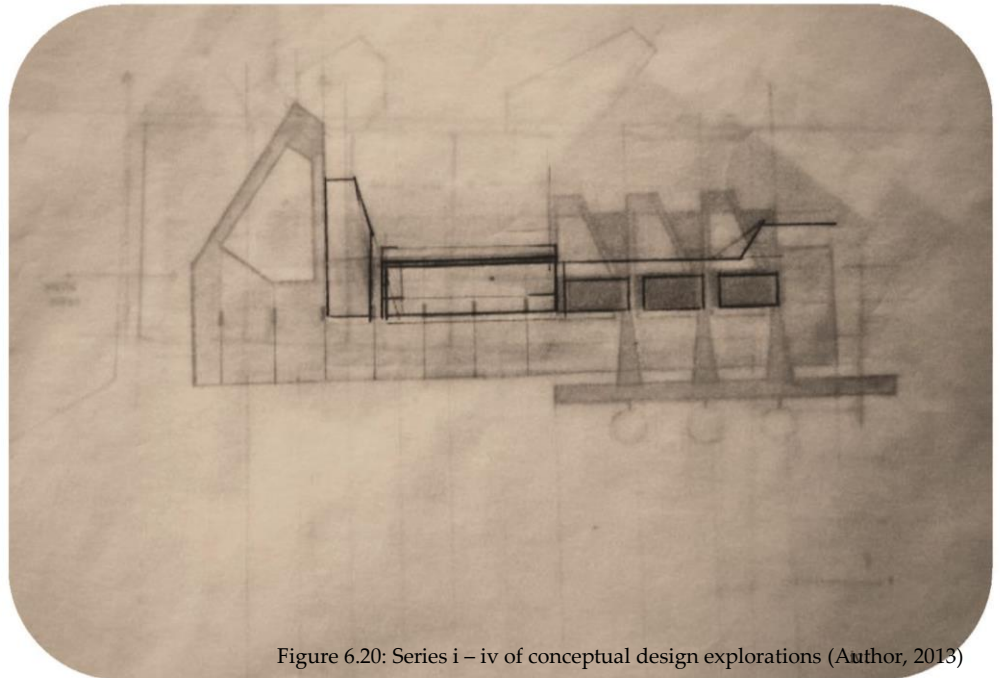
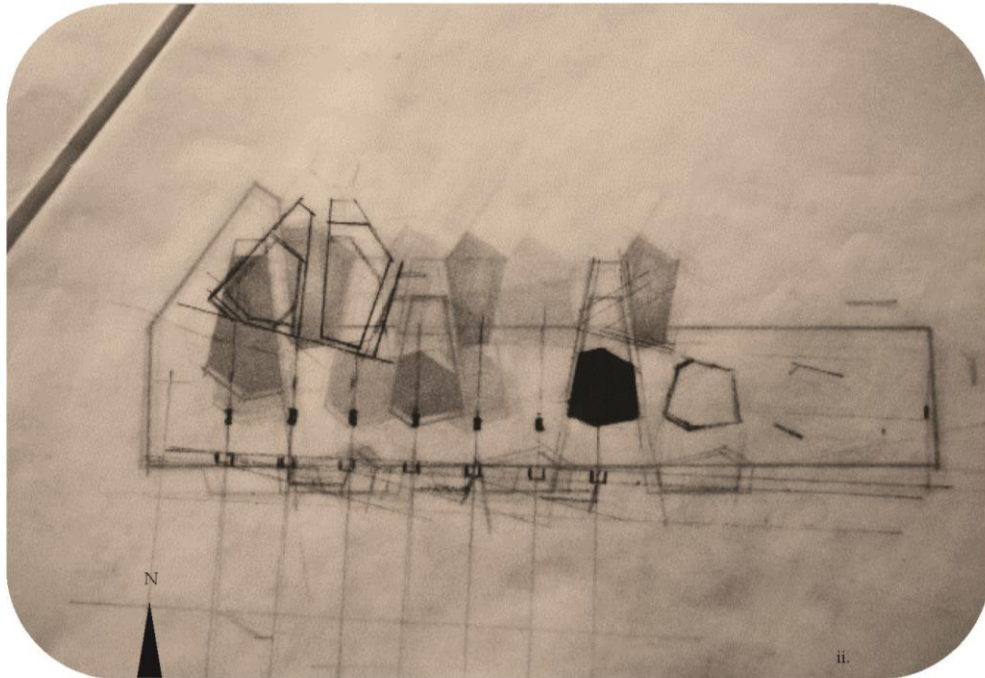
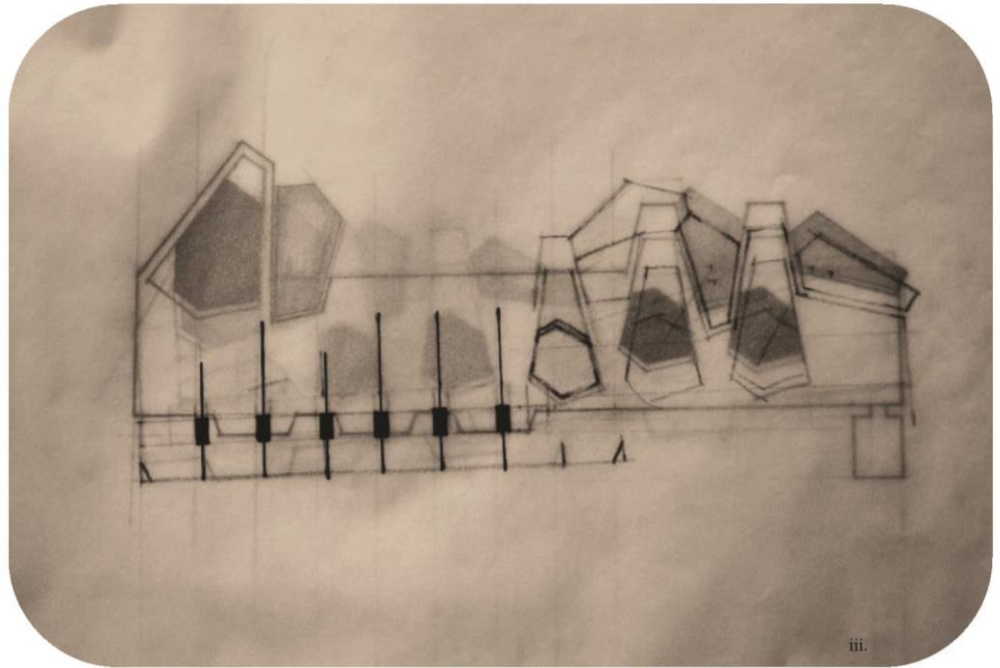
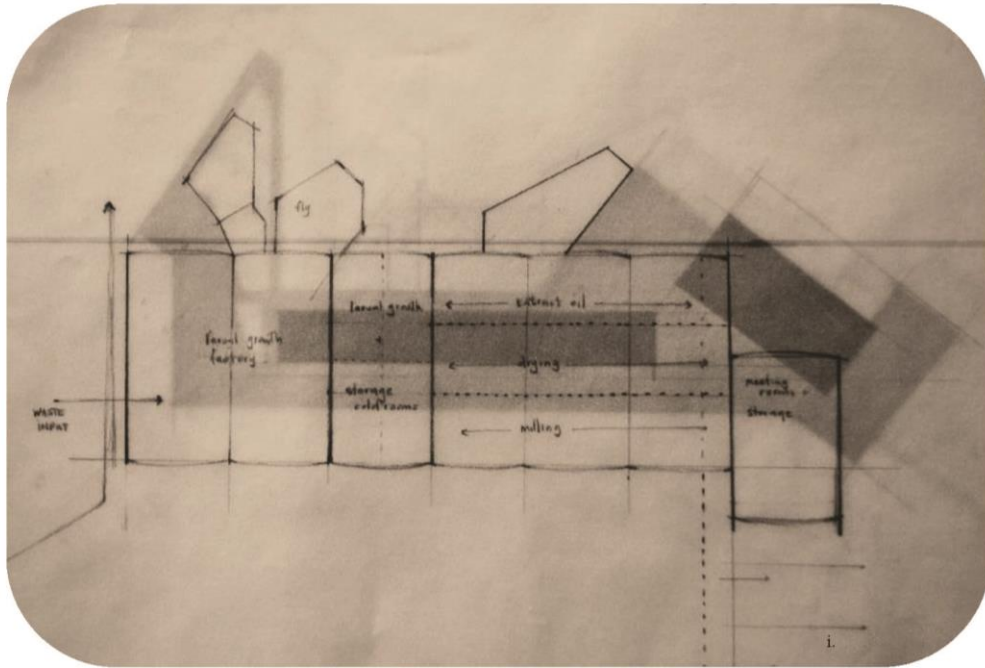


Figure 6.20: Series i – iv of conceptual design explorations (Author, 2013)

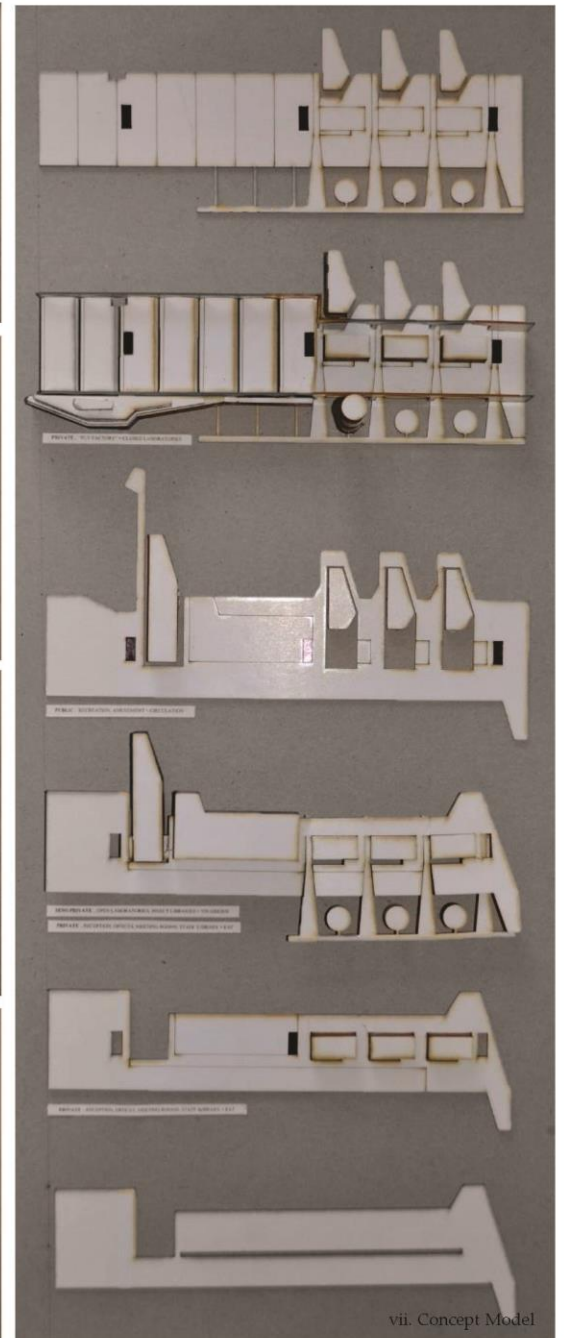
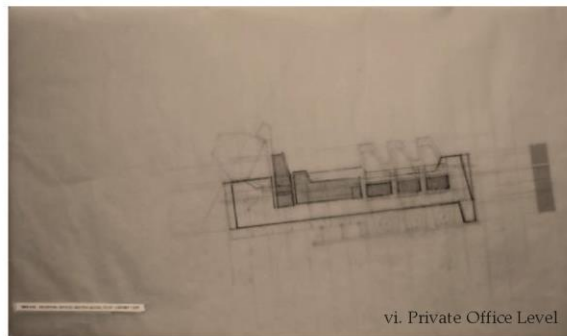
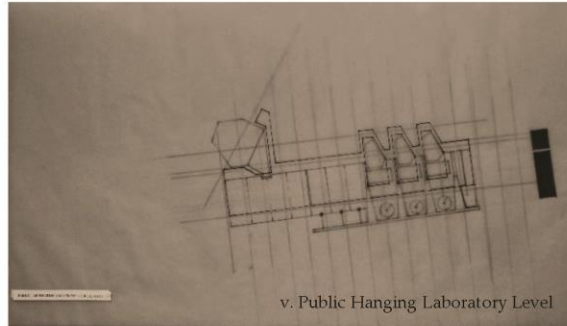
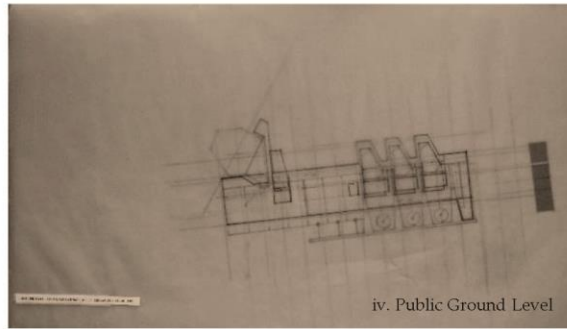
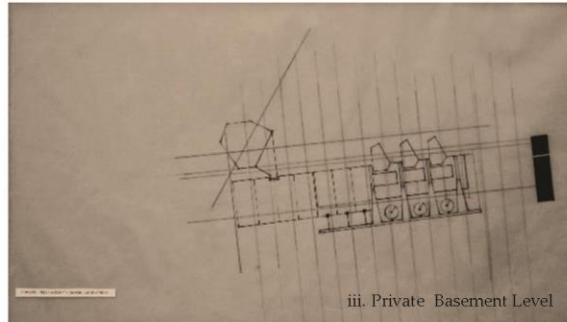


Figure 6.21. Series i – vii of conceptual design explorations (Author, 2013)

ii. Concept Model

vi. Private Office Level

vii. Concept Model

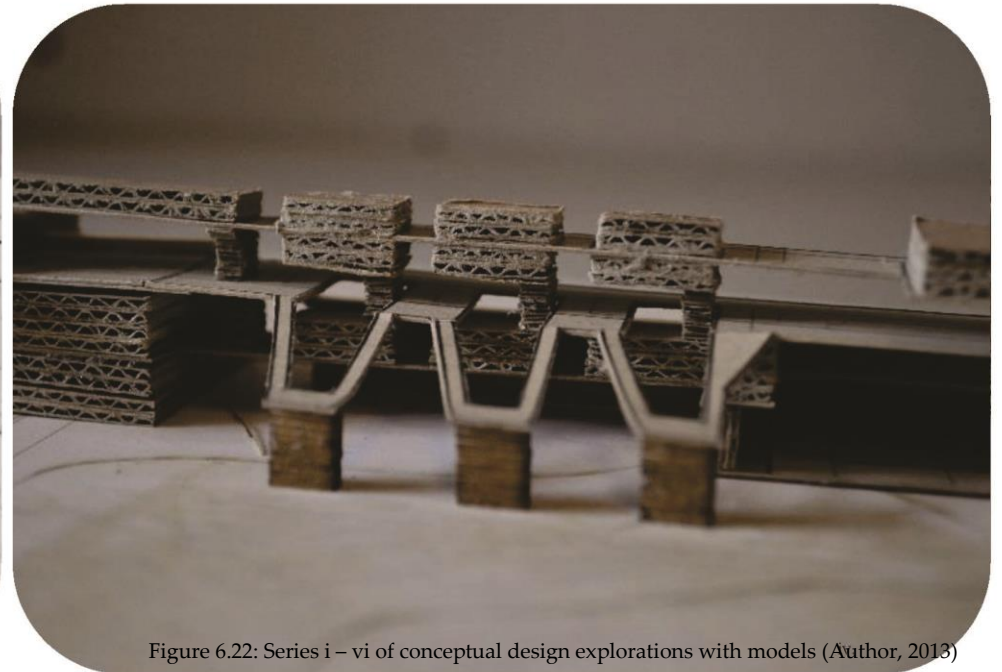
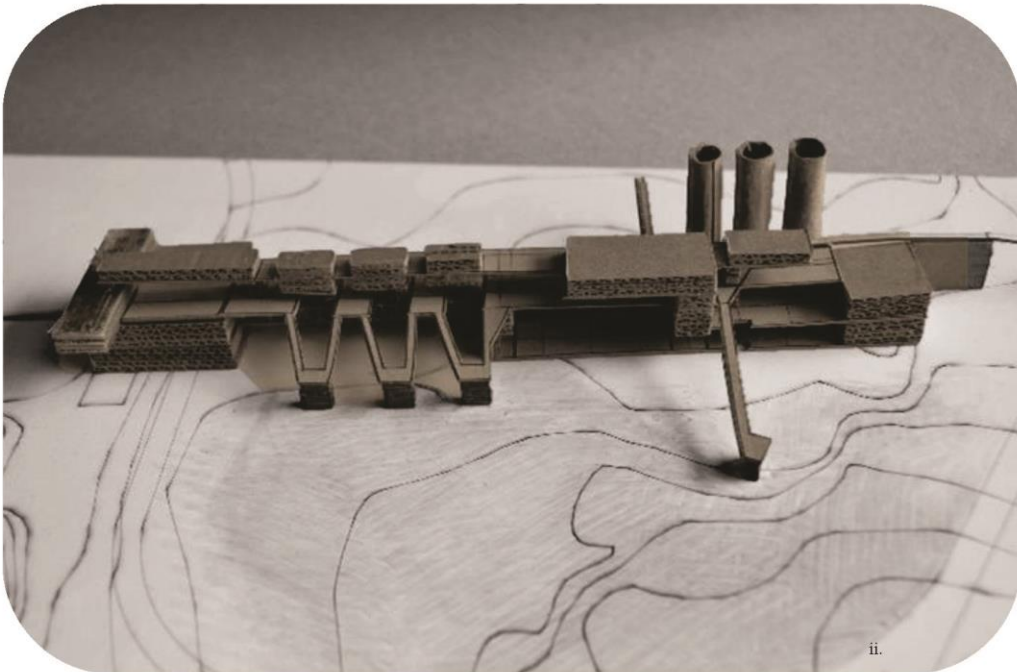
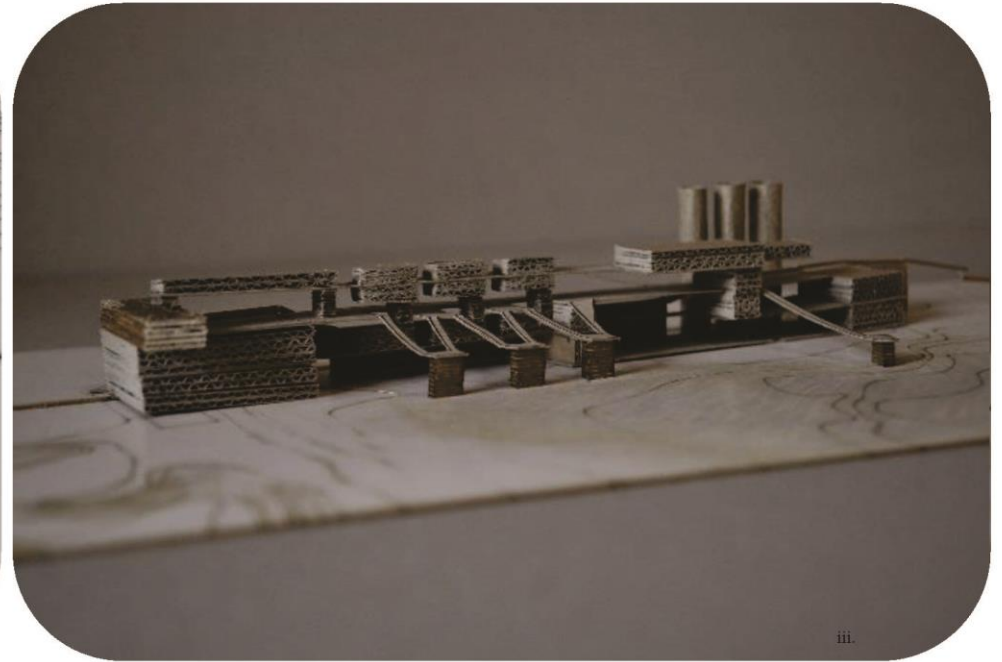
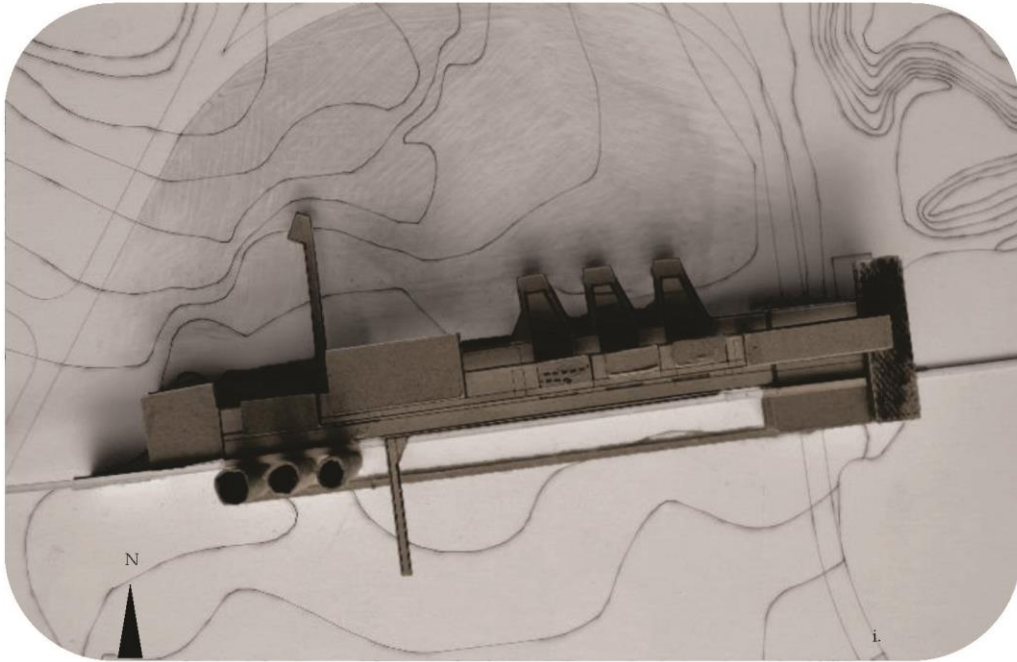
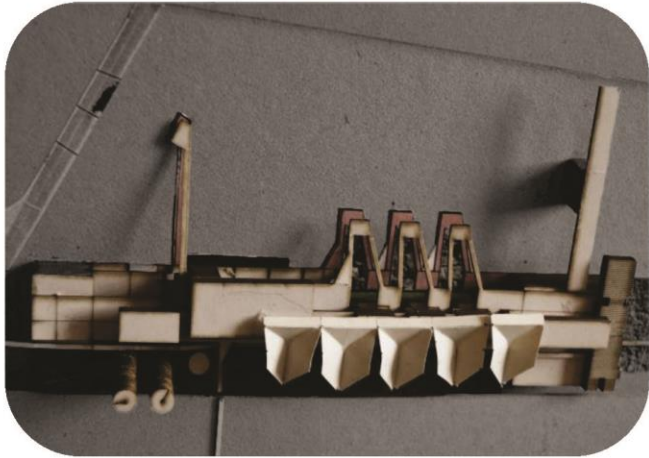
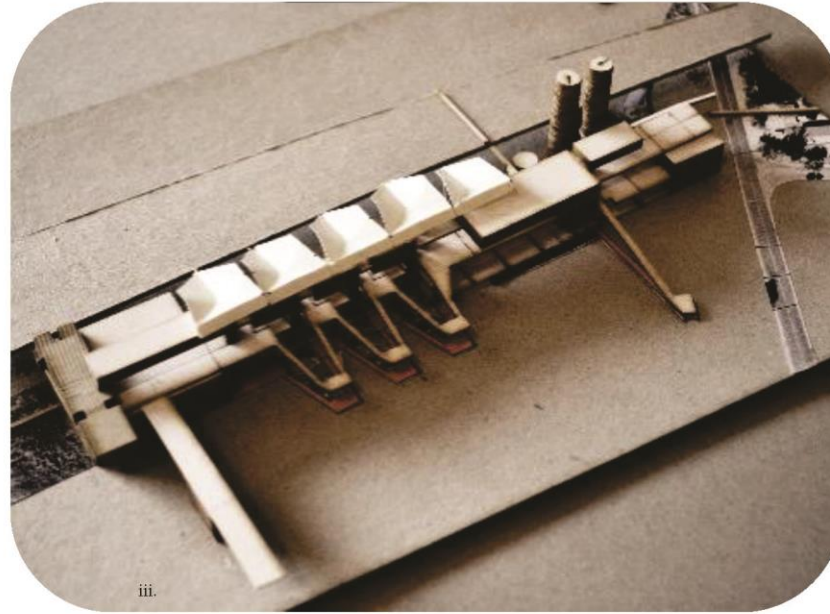


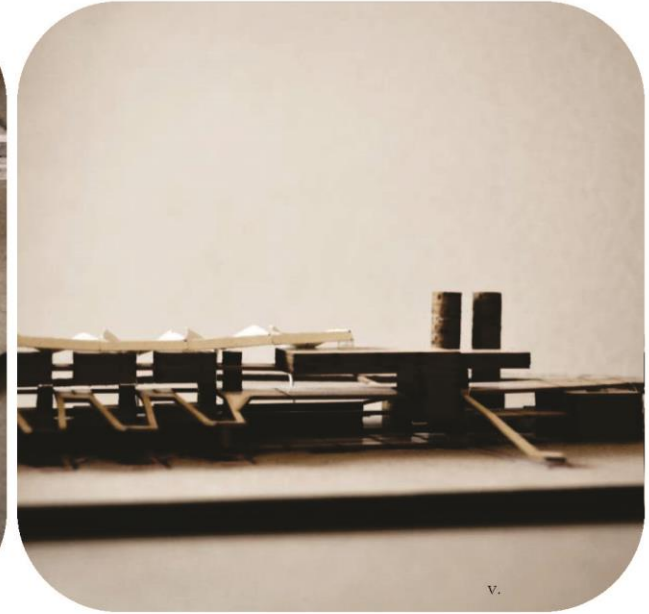
Figure 6.22: Series i – vi of conceptual design explorations with models (Author, 2013)



i.

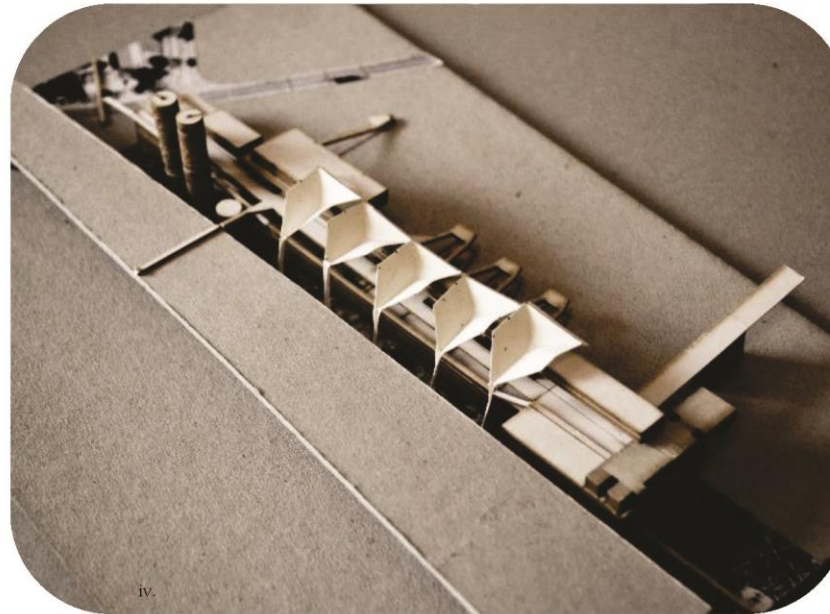
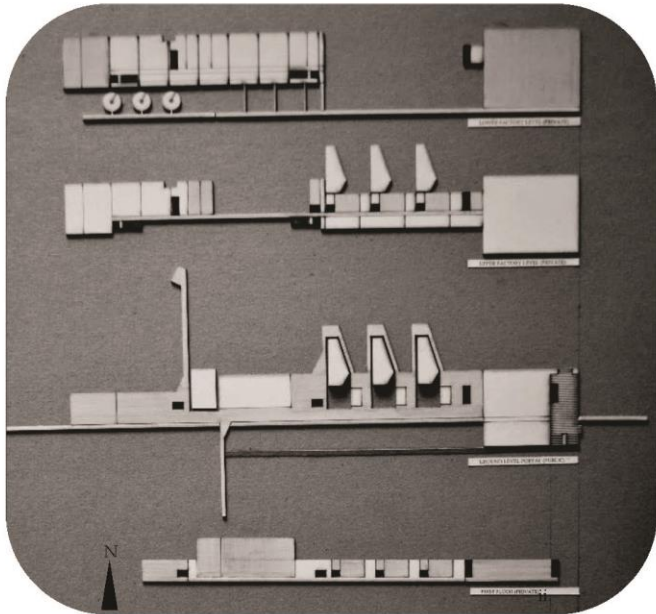


iii.

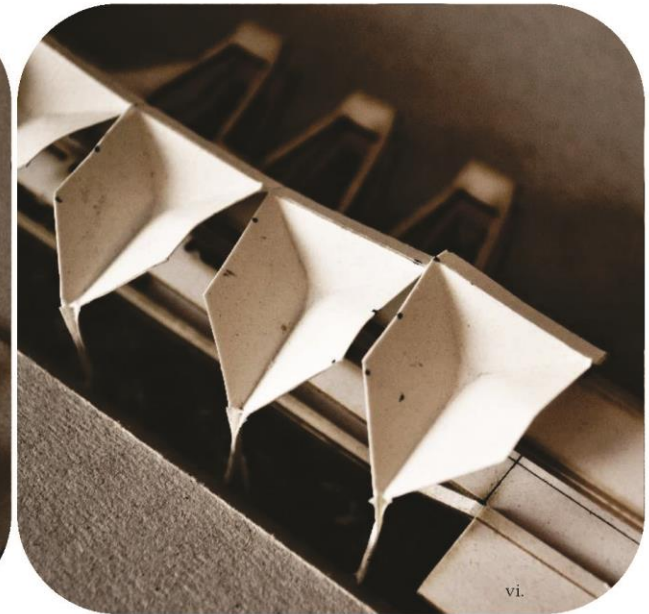


v.

Figure 6.23. Series i – vi of advanced design explorations with models. The roof structure is also explored (Author, 2013)



iv.



vi.



Figure 6.24: Birds' view of the model of the finalised design layout. Building faces north and link suburb with industrial core creating a landscaped portal (Author, 2013)

Urban Insect Laboratory

Nature
 Endangered Species
 DNA + RNA Collection
 Insect Cell Libraries
 Open Lab (Semi-Private)
 Closed Labs (Private)
 Experimental Treatment Laboratory 01 (for each specie)
 Experimental Treatment Laboratory 02 (for each specie)
 Experimental Treatment Laboratory 03 (for each specie)
 Quarantine Laboratory
 Latent Cell Division Laboratory
 Indoor Monitored Vivarium
 Outdoor Site Vivarium
 Vivarium
 Touch Zone
 Human-Plant-Insect Interface
 Human-Water-Insect Interface

Parking Staff
 Parking Visitors
 Parking Public
 Reception
 Lounge
 Offices
 Staff Ablution
 Public Ablution
 Meeting Rooms
 Kitchen
 Eat Pause
 Cleaning Facilities
 Storage Facilities
 Equipment Repair
 Servicing Facility
 Waste Disposal
 Food +Bedding Storage
 Equipment Storage
 Record Rooms
 Library
 Recreation
 Merry-go-Round
 Biotic
 Mature
 Immature
 Uninformed
 Informed

FINAL DESIGN CONCEPT

The factory will have input and output on a horizontal plane where the research facility have input and output on a vertical plane. The initial intent of having the factory closer to the main vehicular Skilpad road and the research facility closer to the quieter core of the site prove efficient and has been maintained. The factory will have two levels. A lower basement level and an upper basement level. The waste input and product output will occur on the upper basement level. The waste will be collected from the surrounding selected 5 suburbs. The waste will be delivered in containers from where it will offloaded in a loading bay and then manually feed into cisterns from where it will be feed to the lower basement larval feeding beds. From there the larvae will be stored in cold rooms where it will then go through a process of oil extraction, drying and then milling. The product will then be stored in silos form where it will be dispatched for use. The flies are breed outside on the upper basement level from where the eggs will go to larval growth beds and hatch within 4 days, from where they will be used in the larval feeding beds.

Both upper and lower basement levels will have supporting facilities. The factory will be accessed by staff from a central underground parking bay. This bay will serve the central public facilities of the site as well. The staff will go through a baffle space from where can go into a changing room and to the factory. The e same procedure will be followed when exiting as to prevent contamination of other species DNA and spreading of disease.

The urban insect research facility will have 9 laboratories in total with three vertically linked laboratories for each specie. The DNA input will happen on the first floor laboratory, the “development lab” or “cell libraries” where DNA material is gathered and cloned from there it will travel vertically downwards to the ground level laboratory, the “pre-production lab” where cell mutation and control is monitored. This will be the public lab which allows the dweller to observe as he pass through the program. From pre-production the genetic material will travel another level down to the “production lab” this lab is completely enclosed with no natural light and has enclosed vivariums where the cells will mature so that it can be released into the monitored outdoor vivarium enclosure. In these outdoor vivariums the insects are exposed to natural environmental conditions to allow normal growth. All the selected species undergo metamorphoses and has an aquatic life stage and therefore the vivariums are positioned in the wetland. These vivariums will be messed as to allow natural light, ventilation and climatic conditions. The intention is to measure the factors influencing normal insect growth as well as the factors causing species to become endangered. When the species has matured they will be transferred to on site enclosed vivariums where their beneficial nature will be tested and controlled on the selected plant species harvested on the site. The intention is to release controlled quantities of the species, like the lacewing to naturally control aphids on the herbs grown and the dragonfly to monitor the water and wetland health. The site will also provide a protected environment for the species to interact and for the giant African bullfrog to move within its natural habitat.

The first level will house all the offices and meeting rooms for both the Insectary staff as well as the factory staff. It will also have the necessary ablation facilities and a staff pause area with a library. The first level will be connected via vertical circulation with the ground and basement levels as well as the public parking.

On ground level the user will be able to access form both the suburban fabric on the west and from there dwell though this productive insect landscaped space into the site or the occupant can access from the central core of the site (parking bay) and from there either pass through the harvesting facility. This level will provide ablation facilities with a “parklike” eatery overlooking the wetland and vivaiums. It will also guide the user through the insect housings and laboratories.

The ground level will be the landscaped portal into the site where the user can dwell through the program and observe how species interact and allow the user to interact with these species. The portal will form the strands of this tapestry of connections between recreation, research and production. This biotic merry-go-round he will allow the user to escape and mature in knowledge as he nearer the core of this “silent industry”.

The user will be able to access form both the suburban fabric on the west and from there dwell though this productive insect landscaped space into the the site or the occupant can access from the central core of the site (parking bay) and from there either pass through the harvesting facility. On the

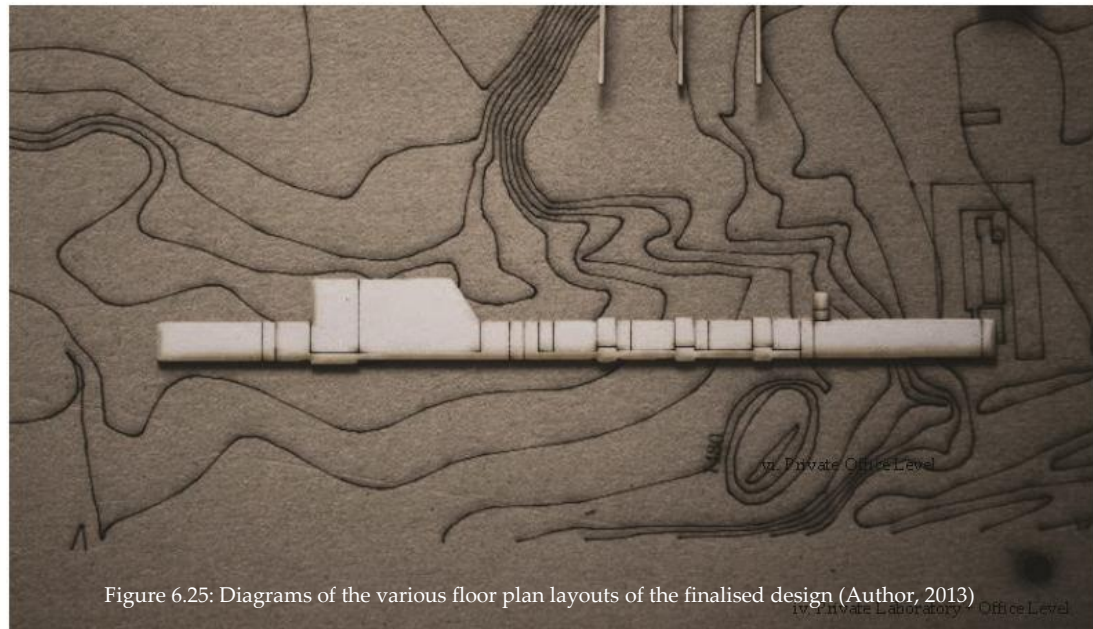
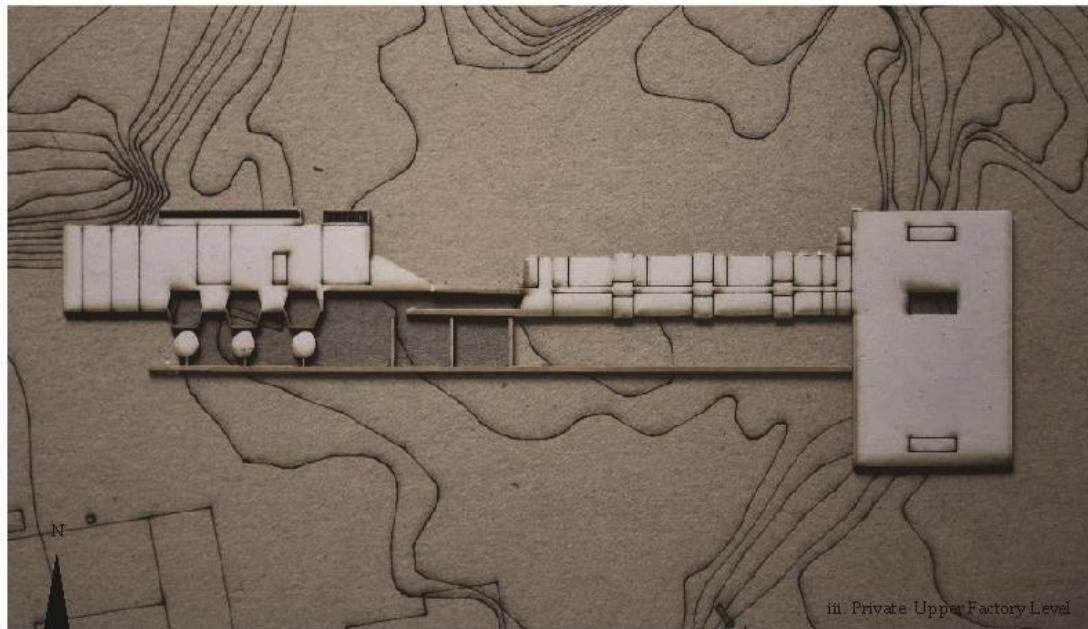
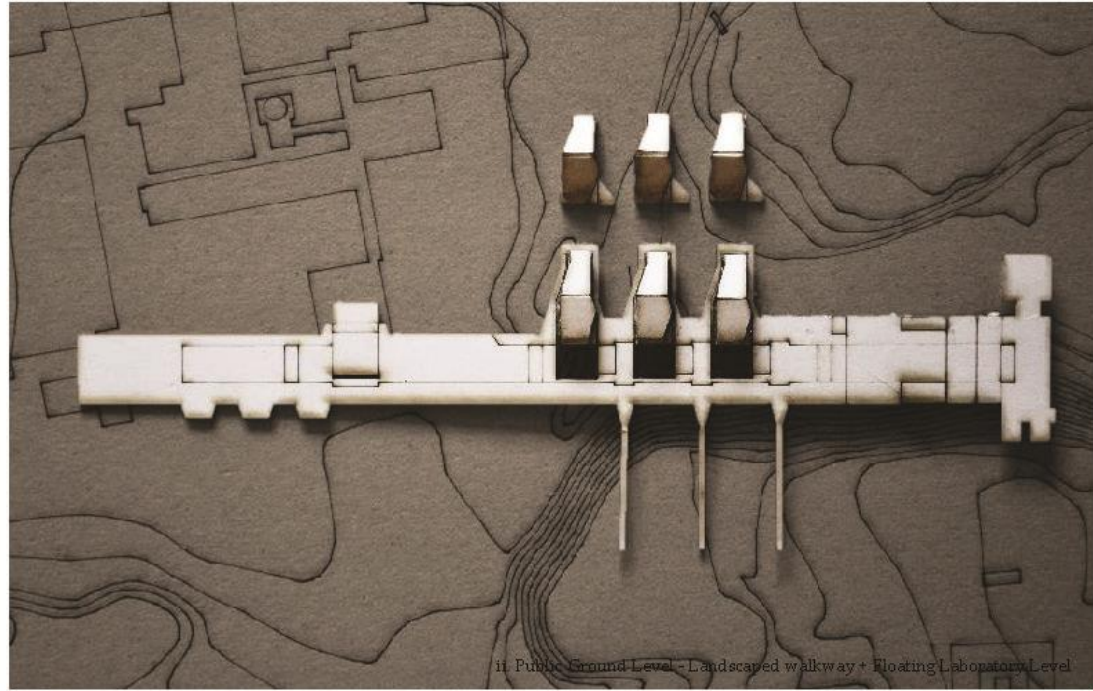
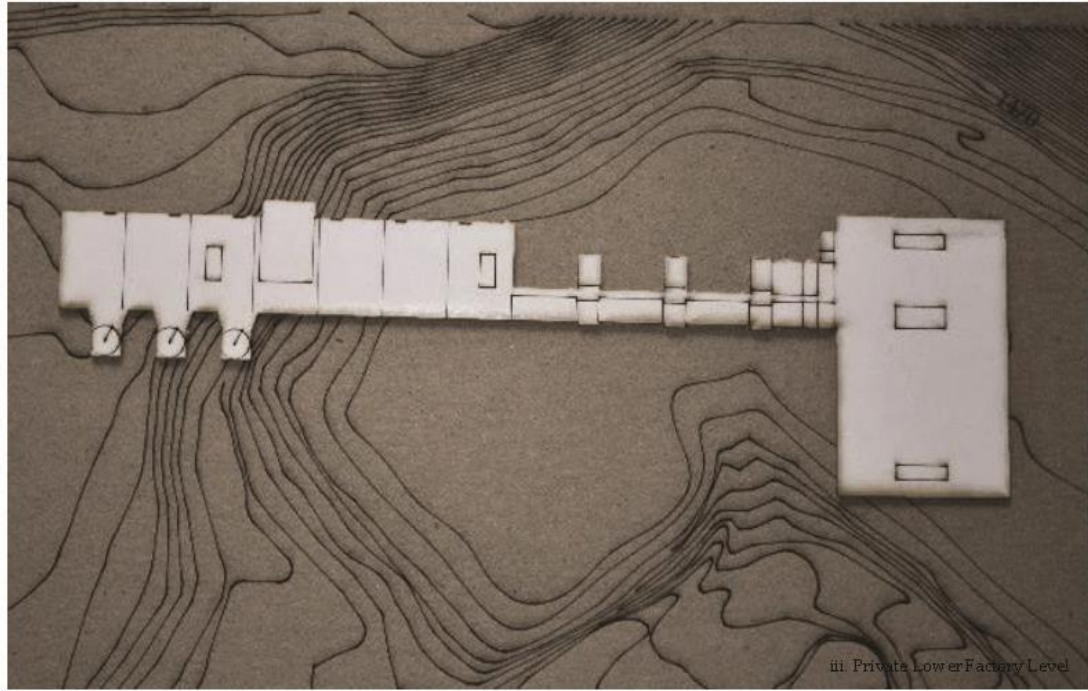


Figure 6.25: Diagrams of the various floor plan layouts of the finalised design (Author, 2013)

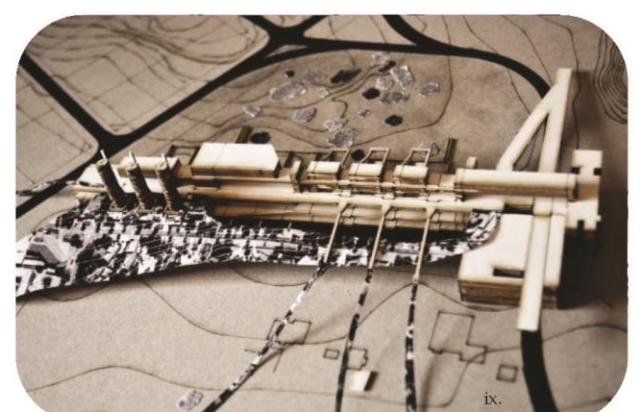
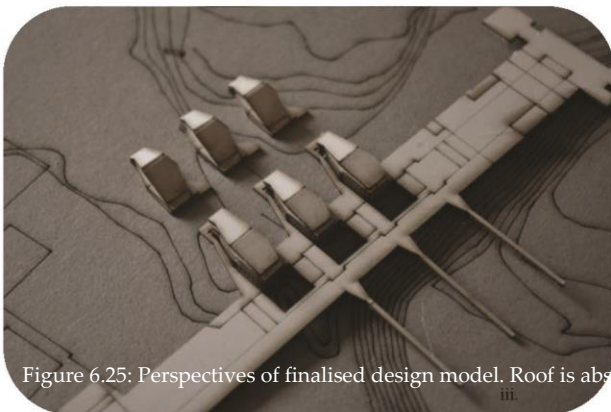
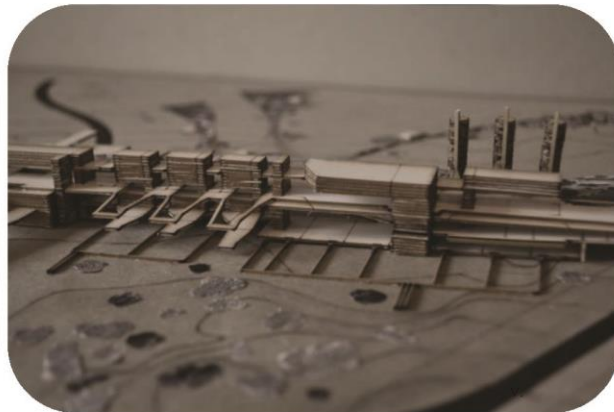
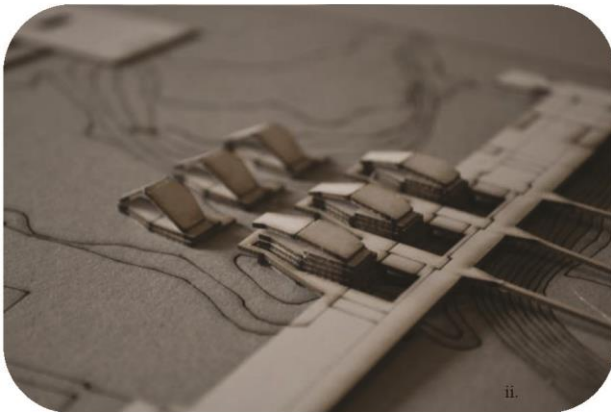
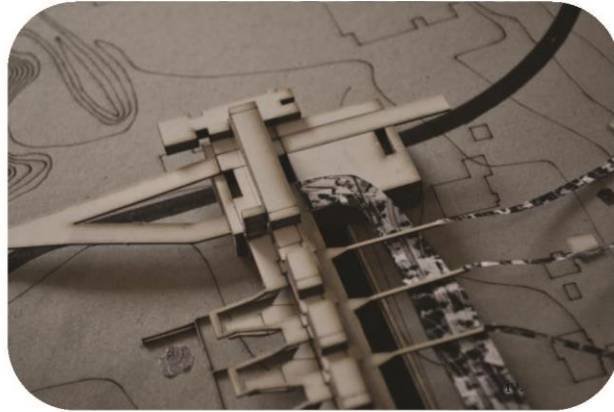
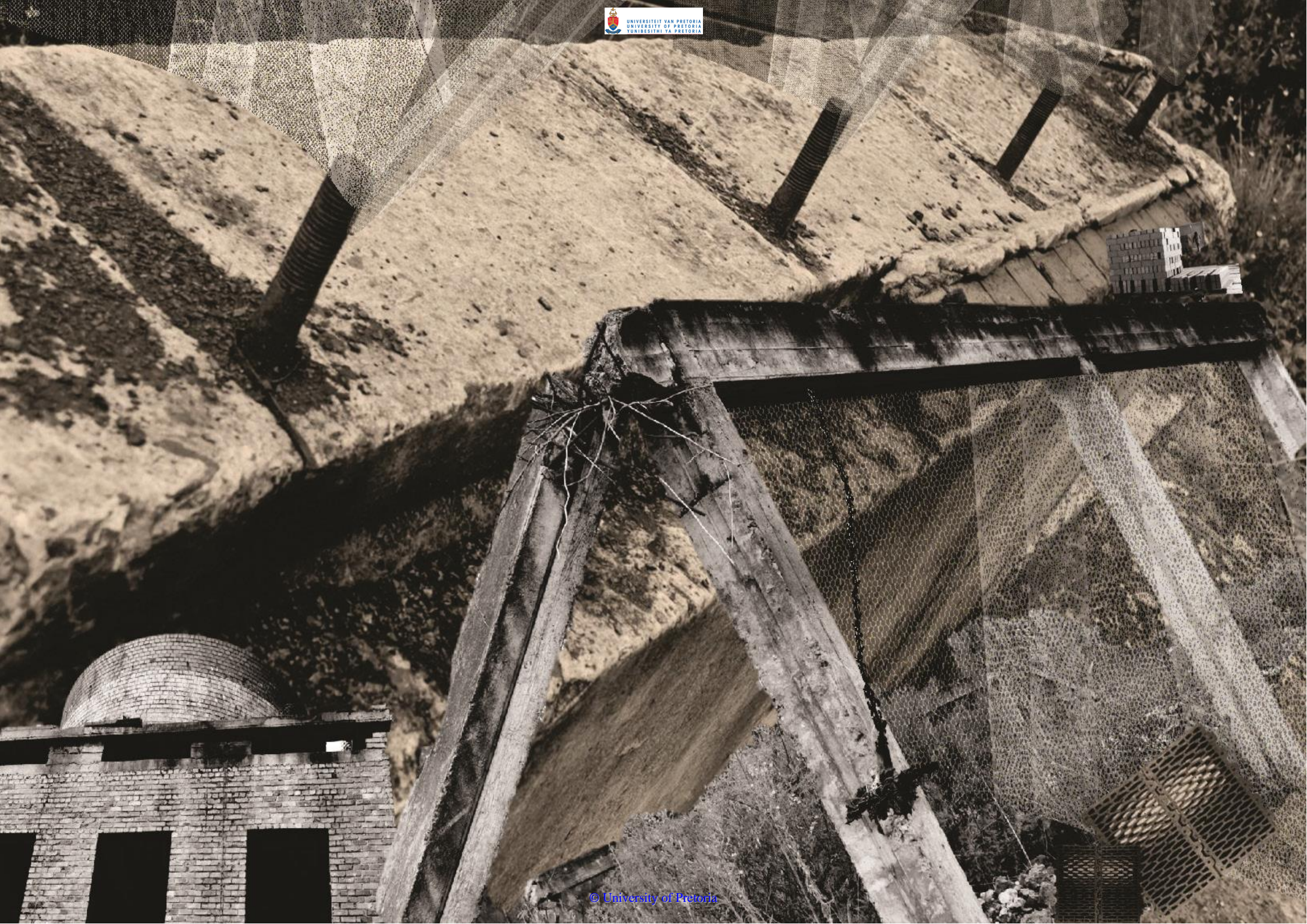
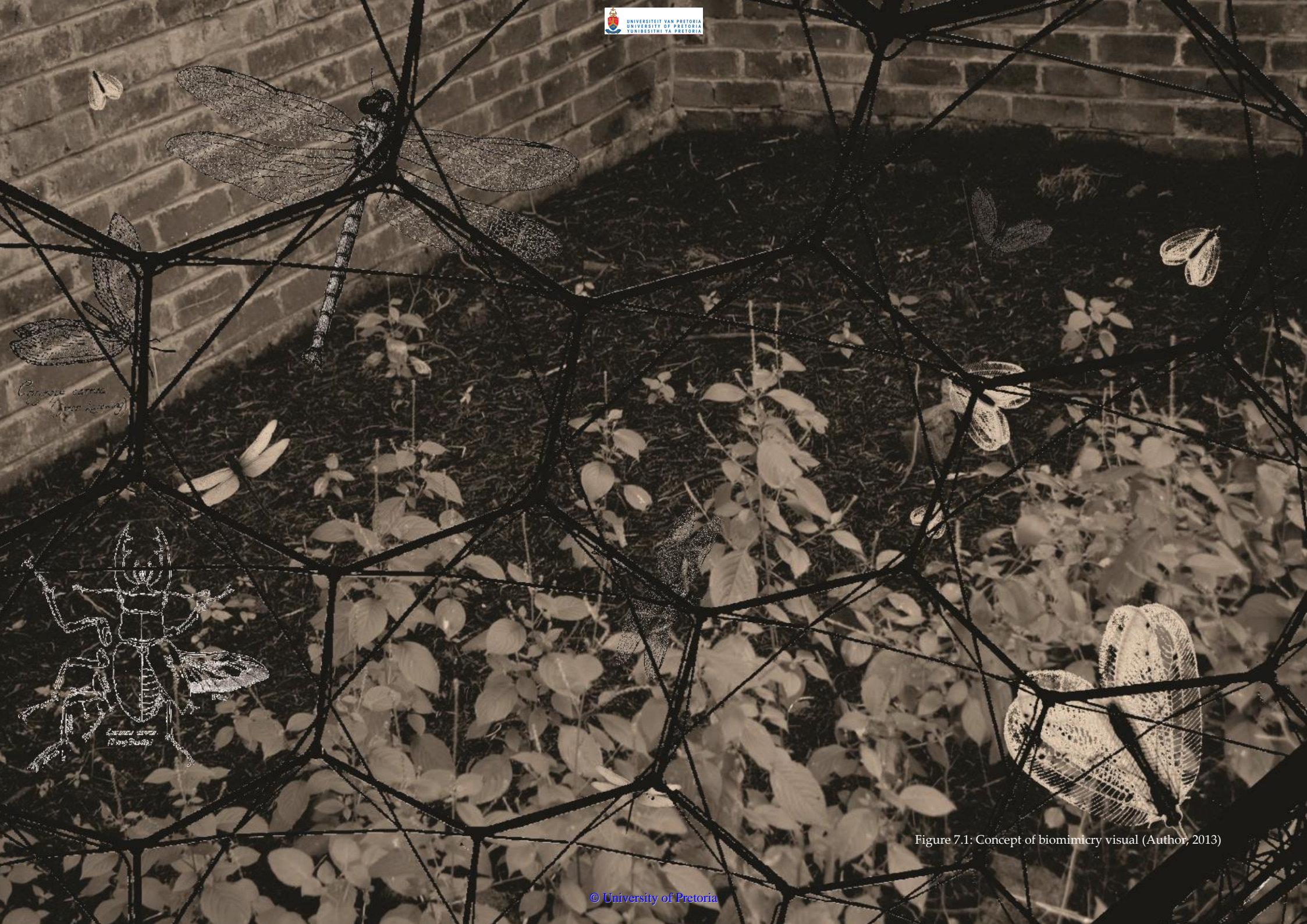


Figure 6.25: Perspectives of finalised design model. Roof is absent on this model (Author, 2013)



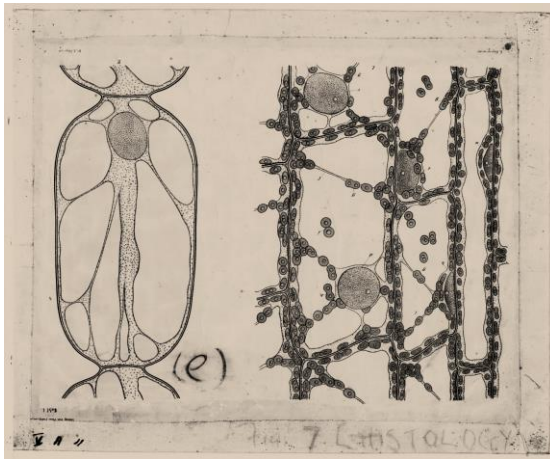
TECHNOLOGY. Chapter 07



Cynoptera carina
(Great Horned Owl)

Carabus aeneus
(Great Ground Squirrel)

Figure 7.1: Concept of biomimicry visual (Author, 2013)



CONCEPT OF MATERIALITY

The building envelope has changed significantly from ancient times to the modern era. It has shifted from being made of massive elements, which were used both for climate control and for structural purposes, into thin elements occasionally made of state-of-the-art materials that do not necessarily have a structural role.

However, during the entire history of construction, the basic structure of the building envelope, a laminated entity made of different layers that are used as a barrier, has remained unchanged. Today, the building envelope must cope with increasing demands for performance. The common solution is changing the dimension (mainly the thickness) and/or the material of one or more layers that constitute the envelope. The paper explores the concept of a cellular-type envelope, inspired by skeletons and membranes in nature.

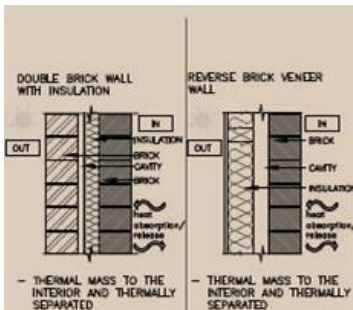
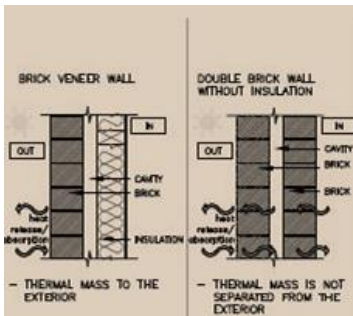


Figure 7.2: membranes and exoskeletons in nature (<http://modishvintage.blogspot.com/2011/03/insect-prints.html>)

Figure 7.3: Applied concept of membranes and exoskeletons to building (Author, 2013)

Inspiration from nature

Building envelopes have numerous distinct functions. Hutcheon (1963) organised these functions into two groups, with a total of 11 functional requirements. The first group consists of the items that relate to the facade as a barrier for the control of heat flow; air flow; water vapour flow; rain penetration; light, solar and other radiation; noise; and fire. The second group consists of overall requirements, such as providing strength and rigidity; being durable; being aesthetically pleasing; and being economical. Similar functional requirements exist in the natural world. During evolution, living organisms developed various approaches and strategies to fulfil these requirements. Architecture has a long history of looking at nature for inspiration. Some approaches concentrated on the rather formal aspects of nature or natural form. These approaches include, among others, art nouveau architecture (Russell, 1979), organic architecture (Pearson, 2001), and zoomorphic architecture (Aldersey-Williams & Victoria, 2003). The focus of this research is a different approach, generally called biomimicry, which examines the performative aspects of natural form and tries to extract insights for creation of architectural form, structure and processes (Benyus, 2002; Gruber, 2010). More specifically, this research examines membranes and skeletons in flora and fauna as a possible inspiration for the performance of a building structure. A recent review by Gruber and Gosztanyi (Gruber, 2010) presented a summary of the sparse existing academic research and studies related to biometric façade, and compared the functions of skins of organisms and their analogy in architecture. A more specific study by Badarnah et al. (2010) examined various strategies for thermoregulation based on insights from nature and shading strategy based on organisational features in leaves (Badarnah & Knaack, 2008). Laver et al. suggested a cellular structure for a high-performance masonry wall system, based on insight from termites and barrel cacti (Laver et al., 2008). None of the above research suggested an overall framework or an argument for a shift to a cellular approach in building envelopes, and none of the studies explored the composition of the insect anatomy as inspiration.

Insects have developed a range of strategies to cope with ever-changing external and internal environments: membranes and skeletons play an important role as separating and connecting structures required to protect, confine and contain processes of life from the external environment.

The **skeleton** is the body part that forms the supporting structure of an organism. In a figurative sense, skeleton can refer to technology that supports a structure such as a building (<http://en.wikipedia.org/wiki/Skeleton>). There are three types of skeletons: hydrostatic skeletons, endoskeletons and exoskeletons. Hydrostatic skeletons are found in cold-blooded animals including invertebrates. Human beings have endoskeletons (Hickman et al., 2001).



Figure 7.4: Concrete and aggregate on site (Author, 2013)



Figure 7.5: Geopolymer concrete
(<http://www.gizmag.com/green-geopolymer-concrete-technology/13016/>)

Figure 7.6: Use of concrete structure with brick infill on site. Old brick quarry ruins (author, 2013)

Hydrostatic skeletons

Hydrostatic skeletons are found in soft-bodied and cold-blooded animals. This skeleton has a coelom, which is a fluid-filled cavity. This coelom is surrounded by muscles and the rigidity caused by the fluid and the muscles serve as a supporting structure for the organism. The fluid pressure along with the motion of the supporting muscles help the organism to change shape and move. Invertebrates, the majority of the earth's living organisms, are found in a diverse number of habitats. These invertebrates have a hydrostatic skeleton system that helps them to thrive in a varied number of environments (Hickman et al., 2001).

Endoskeletons

The simplest definition for an endoskeleton is that it is the skeleton found inside the body. It forms the framework for the insect. The tissues and muscles are formed around the skeletal system and the muscular forces are transmitted to this skeleton. The endoskeleton is for support. The endoskeleton supports the animal structure and is composed of mineralised tissues (Hickman et al., 2001). Humans also have endoskeletons, which in simple terms are called our bones.

Exoskeletons

These are skeletons found outside the body. It forms a protective covering for the animals. It supports and also protects the animals. All crustaceans have exoskeletons. Crabs, spiders, lobsters, insects are all crustaceans. This is because large animals could not be supported by exoskeletons and need bones to support them. The exoskeleton is soft and thin at the joints where it has to bend. The larger exoskeletons are called shells (Hickman et al., 2001).

MATERIALS

Geopolymer Concrete (low calcium fly ash-based geopolymer concrete)

The demand for concrete is increasing every day for satisfying the need of development. It is a well established fact that the production of Portland cement not only consumes significant amounts of natural resources and energy, but also releases a substantial quantity of carbon dioxide into the atmosphere (Wallah & Rangan, 2006). Therefore, it is essential to find alternatives to make concrete more environment-friendly. The production of one ton of cement emits approximately one ton of carbon dioxide into the atmosphere. Moreover, cement production is not only highly energy-intensive, next to steel and aluminium, but also consumes significant amounts of natural resources. Geopolymer is an inorganic aluminosilicate compound, synthesised from fly ash (Wallah & Rangan, 2006). Already huge volumes of fly ash are generated around the world; most of the fly ash is not effectively used, and a large part of it is disposed in landfills. Heat-cured low-calcium fly ash-based geopolymer concrete has excellent compressive strength, suffers very little drying shrinkage and low creep, shows excellent resistance to sulphate attack, and has good acid resistance (Wallah & Rangan, 2006). One ton of low-calcium fly ash can be utilised to produce about 2,5 m³ of high quality geopolymer concrete, and the bulk price of chemicals needed to manufacture this concrete is cheaper than the bulk price of one ton of Portland cement (Sumajouw & Rangan, 2006). Given the fact that fly ash is considered to be a waste material, the low-calcium fly ash-based geopolymer concrete is, therefore, cheaper than the Portland cement concrete (Hardjito & Rangan, 2005).

Alien tree and plant species will be excavated and removed from the site in an attempt to remedy the vegetation contamination. The intention of the study is to utilise fly ash generated from the burning of these alien tree species. The fly ash will be used as key ingredient in the proposed geopolymer concrete.

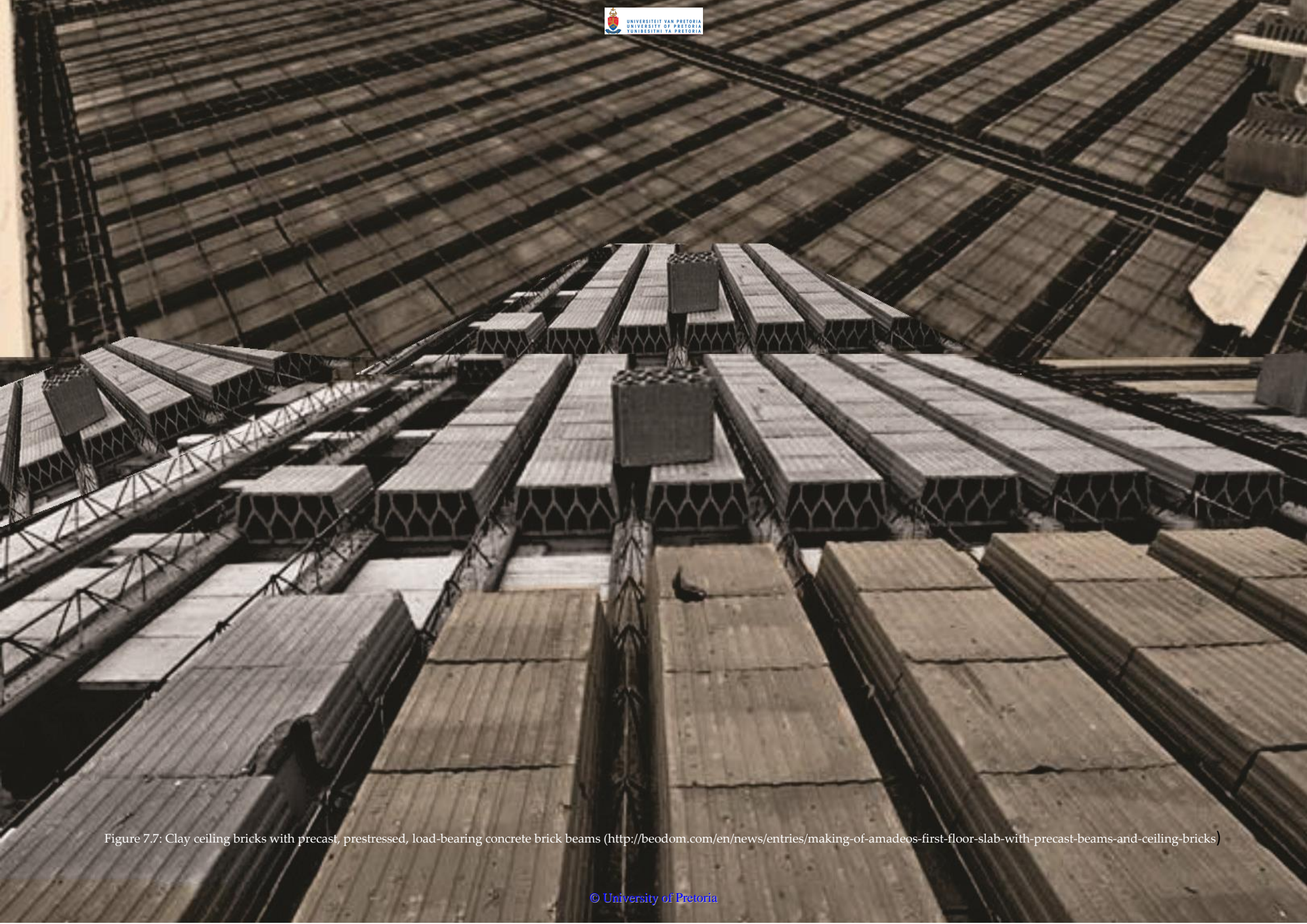


Figure 7.7: Clay ceiling bricks with precast, prestressed, load-bearing concrete brick beams (<http://beodom.com/en/news/entries/making-of-amadeos-first-floor-slab-with-precast-beams-and-ceiling-bricks>)

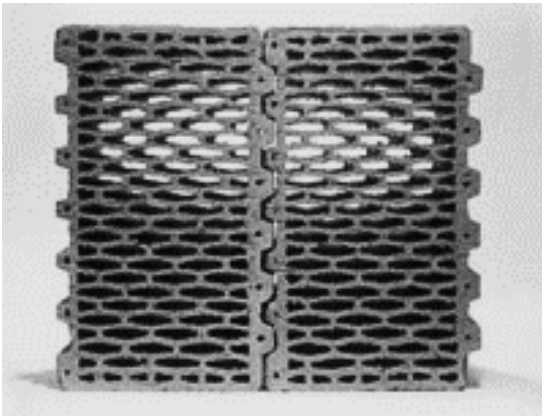


Figure 7.8: Clay brick ceiling surface
(<http://www.wienerberger.com/brands-products/porotherm-bricks-ceiling-system/product-range-porotherm/brick-ceilings>)

Figure 7.9: Porothem clay brick with air cavities
(<http://www.wienerberger.com/brands-products/porotherm-bricks-ceiling-system/product-range-porotherm/brick-ceilings>)

Hydraform clay bricks

For millennia, the elements of fire, water, air and earth have been merged to create a building material of incomparable usefulness and attractiveness. A clay brick.

Replacing clay bricks with hydraform interlocking clay brick blocks eliminates the process of burning wood normally used to bake clay bricks (<http://www.hydraform.com/>). Hydraform interlocking blockmaking machines will be used on site where they hydraulically compress soil that contains a small amount of clay and silt mixed with cement into soil cement blocks. When cured, these can be dry-stacked without mortar (<http://www.hydraform.com/>). A curing time of 7 days is recommended. The machines are also ideal for this application where material from site can be re-used to manufacture clay bricks. One can also utilise skills and labour from the nearby community (<http://www.hydraform.com/>).

The programme will use the excavated clay from the site to manufacture hydraform clay bricks on site. The intention is to use these as infill material where the bricks will form the outer exoskeleton of the building.

Porotherm clay bricks and ceiling bricks

The Porotherm clay bricks and ceiling brick system will be used due to the relevance of clay on site as well as its excellent thermal properties. The ceiling bricks have air pockets which result in a lower product density and hence higher thermal insulation. By using these bricks it will assist in maintaining a comfortable interior temperature without excessive heating or cooling strategies – thus decreasing energy requirements. Precast load-bearing ceiling beams will be positioned and the ceiling tiles will then be manually laid. A geopolymer concrete slab will be cast over the ceiling tiles. The raw nature of the brick will be maintained to form the outer membrane of the building. This clayed texture will also be visible on the ceiling surfaces (http://www.wienerberger.ro/App/Maps/Wb-ro/catalog/EN/pdf/Porotherm_System.pdf).

The programme will use the excavated clay from the site to manufacture porotherm clay blocks. The intention is to use these as infill material with a prefabricated clay and concrete structure.

Steel

Due to the structural strength and properties of steel (Ashby & Johnson, 2002), steel will be used as endoskeleton and framework of the building. As with most things, steel frame buildings come with both advantages and disadvantages.

The advantages include longevity and durability of the material itself. With timber borders one often get rotting or distorting which could be problematic with the parts of the building in the wetland. With any structure there is usually the difficulty that bugs may find their way in. Steel is inorganic and therefore bugs will not nest; thus the functional impairment that pests often render to timber borders will not happen. Due to the nature of the programme, steel will be the more durable option (Ashby & Johnson, 2002).

Disadvantages include the cost of making steel being very high. Insulation is a major difficulty with steel buildings. Steel buildings require added insulation, as steel on its own is not a very good insulator (Ashby & Johnson, 2002). This must be taken into account when designing the structure.

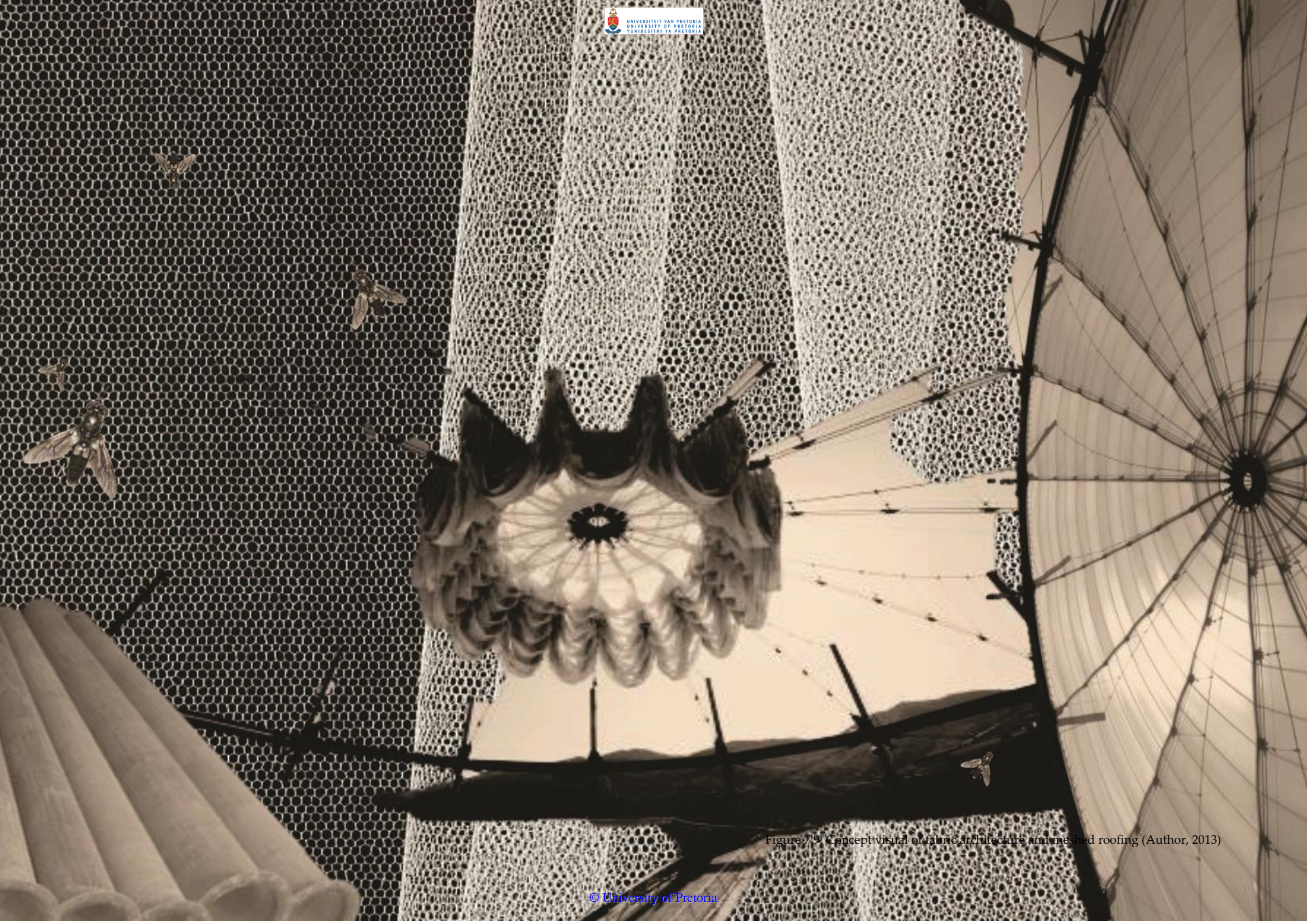


Figure 7.9: Concept visual of fabric architecture and meshed roofing (Author, 2013)

Fibre-reinforced plastic composite panels

Fibre-reinforced plastic (FRP) is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, basalt or aramid, although other fibres such as paper, wood or asbestos have sometimes been used. The polymer is usually an epoxy, vinylester or polyester thermosetting plastic, and phenol formaldehyde resins are still in use. FRPs are commonly used in the aerospace, automotive, marine, and construction industries. (Ashby & Johnson, 2002).

Glass-reinforced plastic (GRP) is composed of strands of silica. Each individual glass fibre is very fine with a small diameter, and they are woven to form a flexible fabric. The fabric is normally placed in a mould and polyester resin is added, followed by a catalyst (to speed up the reaction). The process is repeated so that there are many layers of silica fabric and resin, and allowed to dry/cure. The resulting material is strong and light. Glass-reinforced plastic can be sanded or polished to a smooth finish and painted (Ashby & Johnson, 2002).

Glass-reinforced plastic is lightweight and has good thermal insulation properties. A double 5-mm GRP with 15-mm polyurethane foam core has a U-value of 0,02 (MMS, 2013). It has a high strength-to-weight ratio, making it useful for the production of products such as water tanks, surfboards, canoes, small boat hulls and similar products. The ultimate tensile strength of a freshly drawn, single glass filament (diameter 9-15 microns) is about 3,5 GPa. It is made from readily available materials, it is non-combustible and chemically resistant (Ashby & Johnson, 2002). It is non-porous, durable, easily cleaned, resilient, slip-resistant, non-absorbent to liquids and odours and – most importantly – resistant to microbial growth (Ashby & Johnson, 2002), which makes it an ideal material for laboratory use.

Mesh

Silica and polyester mesh

A silk mesh reinforced with polyester and polyethylene fibres are usually used for insect screening.

Characteristics:

Material: Low and high-density polyethylene (5000S), pure silk stuffing.

Length: 0,5 m – 10 m

Colour: Generally off-white; colours can also be customised.

Weave characteristics: Plain weave, light-weight, beautiful, generous, naisuanjian corrosion, perforated, easily cleaned, and qualitative light.

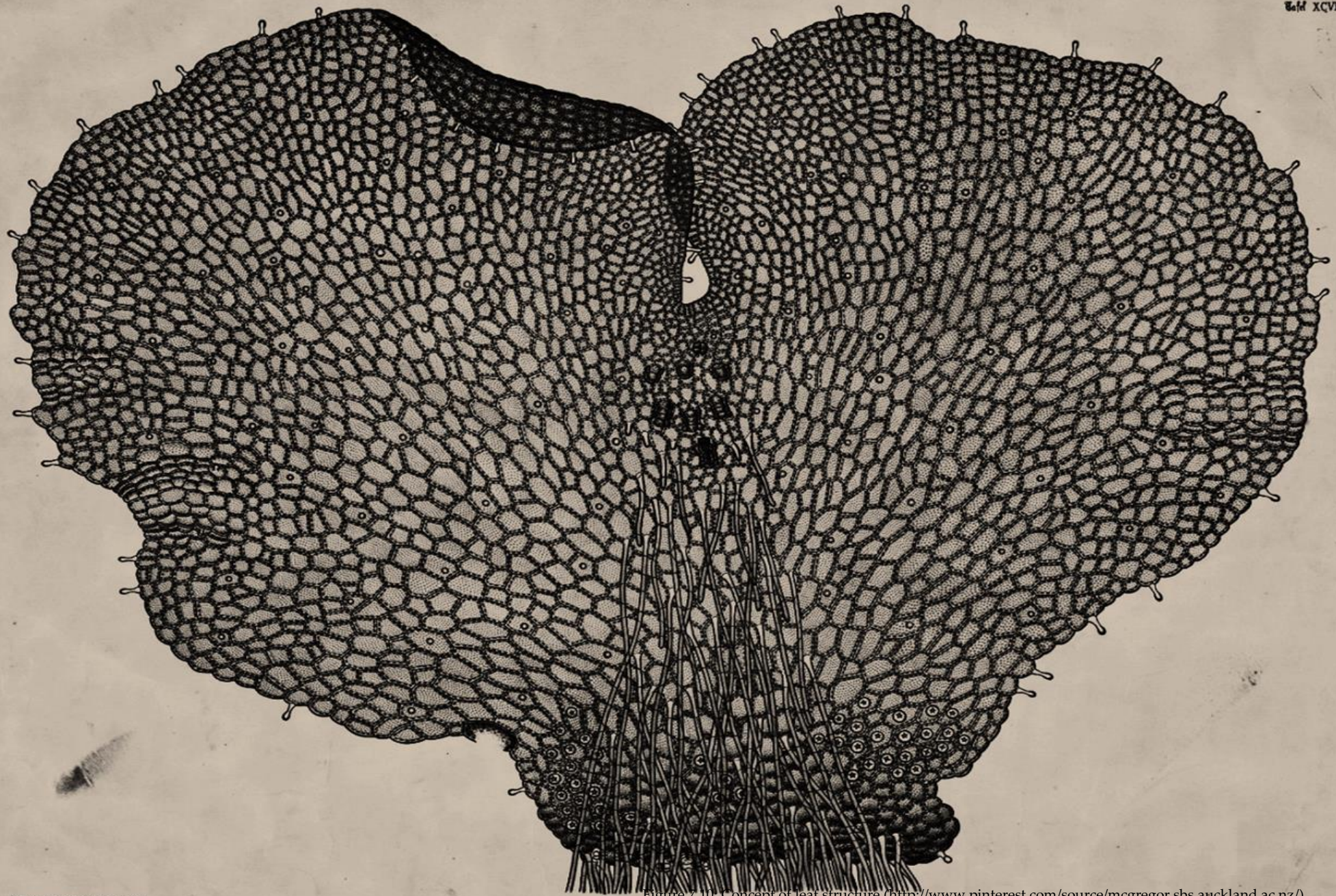
Usage: Locust, grasshopper breeding private networks, mesh and wire diameter has been precisely calculated, the most suitable for locust development and growth. The locust breeding nets produced by our factory, anti-UV, anti-ageing, ventilation, air permeability is good, high rate of grasshopper, and can be used for 3-5 years.

Polyester mesh (Soltis Ferrari)

The Soltis meshed fabric consists of a woven base cloth of high tenacity polyester threads and a vinyl coating. The coating is applied with the membrane under constant tension in both the warp and weft directions throughout the entire manufacturing process. The mesh has a dirt-resistant surface treatment (<http://en.sergeferrari.com/solar-protection/>)

Characteristics:

Soltis composite mesh has high solar protection properties with 35% solar reflection, 65% solar absorption, 3% solar transmission and ejects and absorbs 97% of the heat (<http://en.sergeferrari.com/solar-protection/>). It allows generous amounts of light to filter through and will allow 5-10% of water to diffuse through. 100% recyclable, based on Taxyloop® (<http://www.lunex.no/produkter/screen/screenduk-ferrari-soltis/>). It comes in a variety of colours and can be custom-made to match any pantone colour.



L. Froy et C. Müller auct. et del.

Figure 7.10. Concept of leaf structure (<http://www.pinterest.com/source/mcgregor.sbs.auckland.ac.nz/>)

E. Laue auct. Berlin.

60/13

V. Aschida

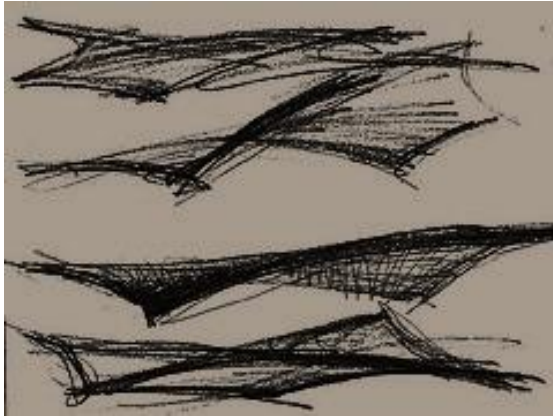


Figure 7.11: Sketch of initial concept of a leaf capturing water as a roof solution (Author, 2013)

Figure 7.12 - 13: Final roof concept (Author, 2013)

SYSTEMS

Rainwater harvesting

The concept of a leaf capturing water has been explored and introduced as well as the idea around the structural integrity of an insect wing. The roof should resemble the fundamental physical characteristics of a wing where the wing achieve maximal strength with as few structural members and materials used. The wing appear fragile yet it serve this major functional purpose of flight and hence survival.

Incorporating biomimicry into environmental design, combine aesthetics, simplicity and function into responsible use. The natural world abounds with examples of simple rainwater harvesting. Lakes, ponds, wetlands and groundwater are excellent large-scale, natural examples of rainwater harvesting, while upturned leaves holding droplets serve as micro examples. Architectural expressions of natural systems for capturing and conveying the rain that falls on our sites can be inspiring and add significant meaning to any design. We are however increasingly cognizant of our abuses of the world's water. By installing rainwater harvesting systems, the water that is industrially treated is reduced, contributing to individual and community water security and maintaining balance in the natural water cycles of surrounding ecosystems. As per the framework response proposal.

Rainwater will be used for irrigation, flushing toilets (which accounts for 30% of indoor water use), mechanical systems, cleaning needs (factory) and even potable drinking water. The basic system will collect rainfall from the roof but also allow a 10% filtered amount for the landscaped portal and planted roof cover. A perforated roof material will serve the required purpose. Roof materials and slope posed the greatest challenge. Metal, clay tiles and slate are generally selected. For the purpose of both capturing a generous amount of water as well as filtering water for the landscape underneath, a fine strong mesh was selected. The roof will have a multi-function role of both harvesting water, allowing light to filter through but also adding another membrane to the building which will protect. The living roof, on ground level will act as a mini-watershed for primary filtration. The water will be stored in underground water tanks. Stored water can be used for potable or other uses. Potable water needs to be filtered or sterilized to meet requirements. Usually rainwater will be filtered down to five microns before sterilization. Possible filters include sand, ceramic and disposable. Once adequately filtered, the water can be sterilized to kill any potential pathogenic bacteria via a UV sterilizer, a chemical sterilizer (such as bleach) or a membrane osmosis system. A trickle filter will be introduced as to filter and oxygenate the water from both the tanks and the wetland.

Passive cooling

Passive cooling systems are particularly appropriate for this part of Africa because, long before humans thought of it, passive cooling was being used by the local termites. Termite mounds include flues which vent through the top and sides, and the mound itself is designed to catch the breeze. As the wind blows, hot air from the main chambers below ground is drawn out of the structure, helped by termites opening or blocking tunnels to control air flow.

Passive cooling works by storing heat in the day and venting it at night as temperatures drop.

- Start of day: The building is cool.
- During the day: Machines and people generate heat, and the sun shines. Heat is absorbed by the fabric of the building, which has a high heat capacity, so that the temperature inside increases but not greatly.
- Evening: Outside temperatures drop. The warm internal air is vented through chimneys, assisted by fans but mainly rising naturally, because it is less dense, and drawing in denser cool air at the bottom of the building.
- Night: This process continues, cold air flowing through cavities in the floor slabs until the building's fabric has reached the ideal temperature to start the next day.

This natural tendency of materials to deliberately store and release heat will be opposed in the laboratories. The laboratories will be manually heated and cooled and in order to use as little energy to do so the laboratories will be insulated.

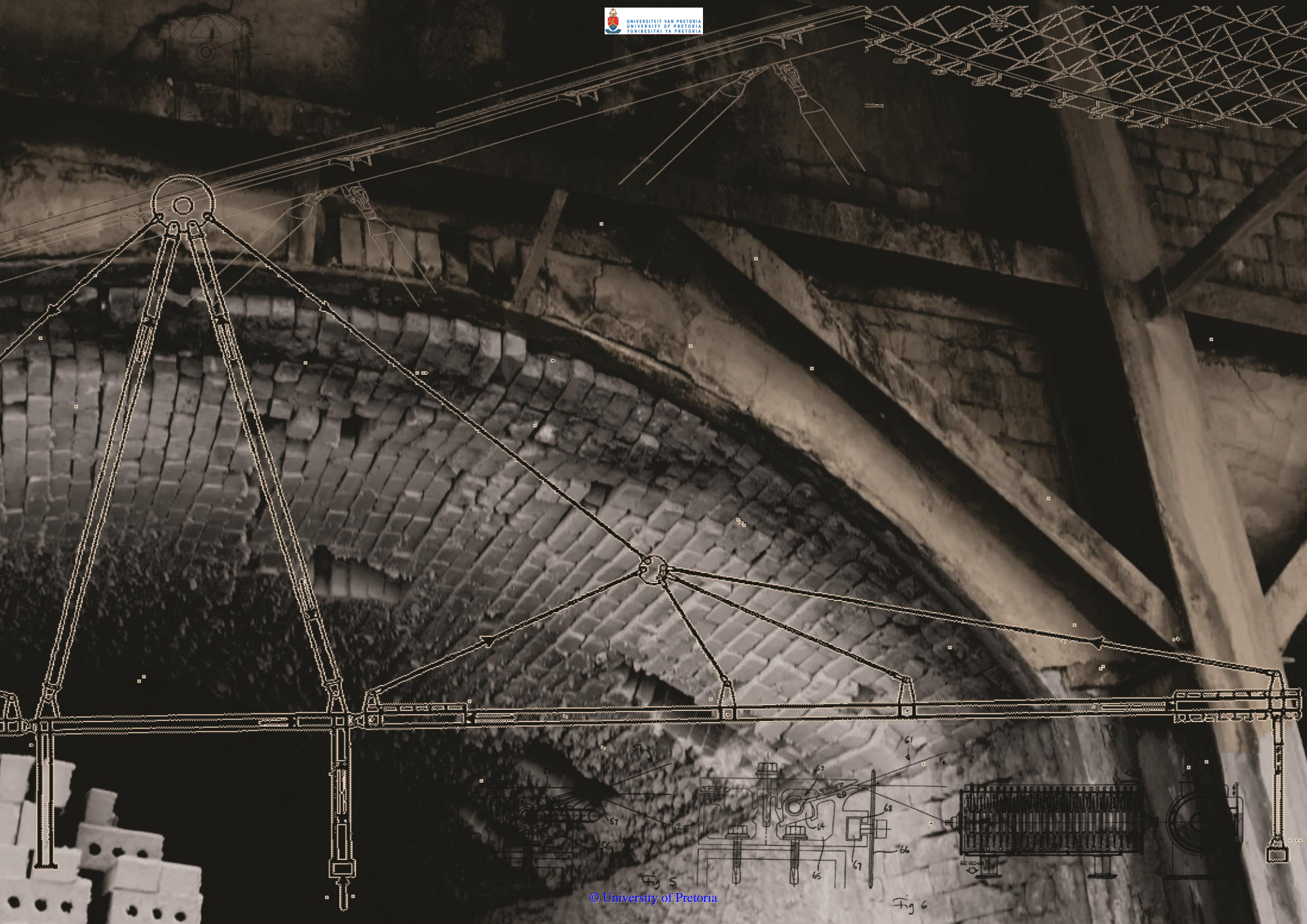


Fig 5

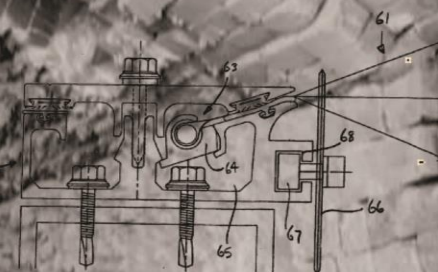
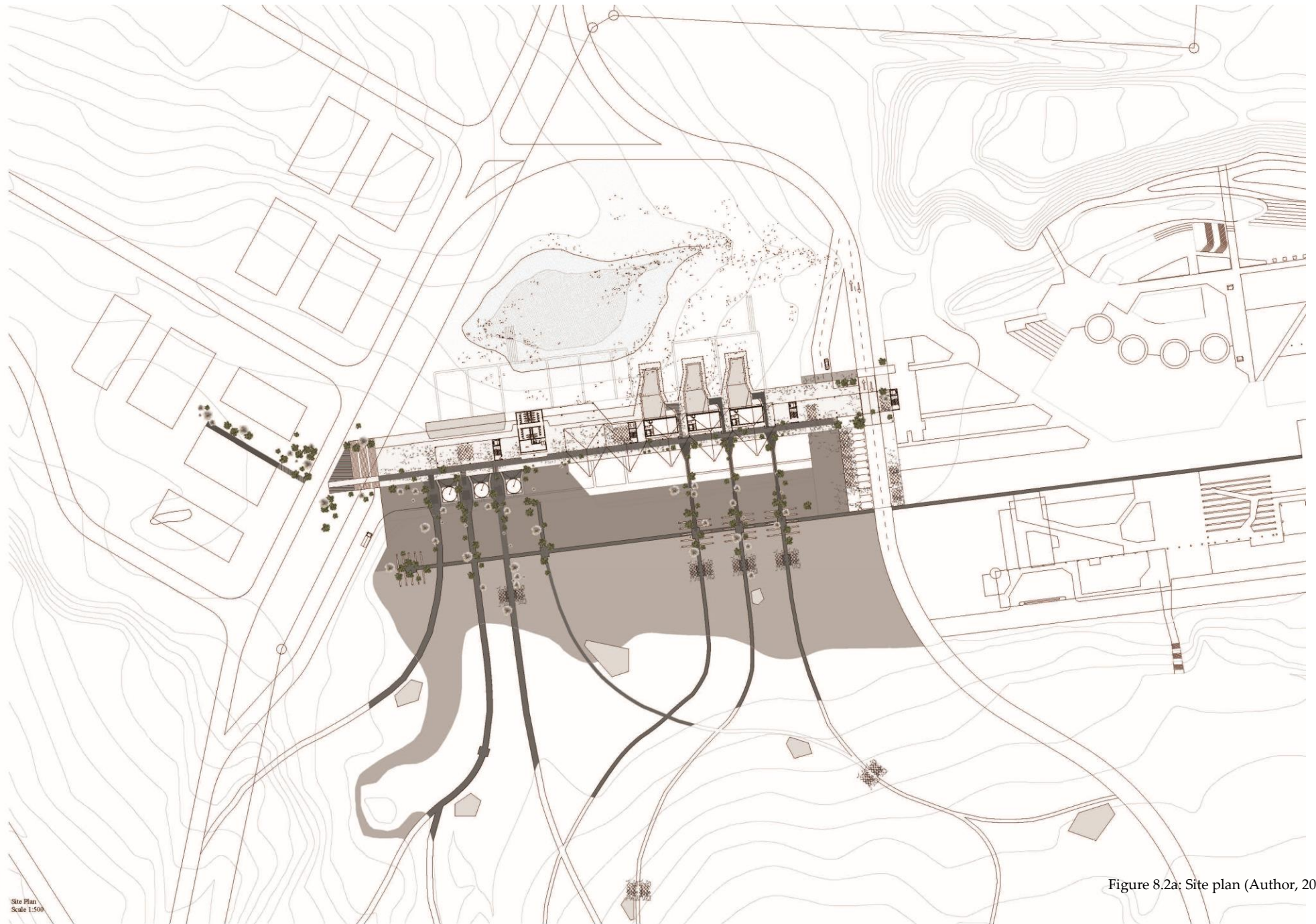


Fig 6

TECHNICAL DOCUMENTATION. Chapter 08



Figure 8.1: Urban framework plan (Silent Industry Group, 2013)



© HARVEST the Insect

Site Plan
Scale 1:500

Figure 8.2a: Site plan (Author, 2013)



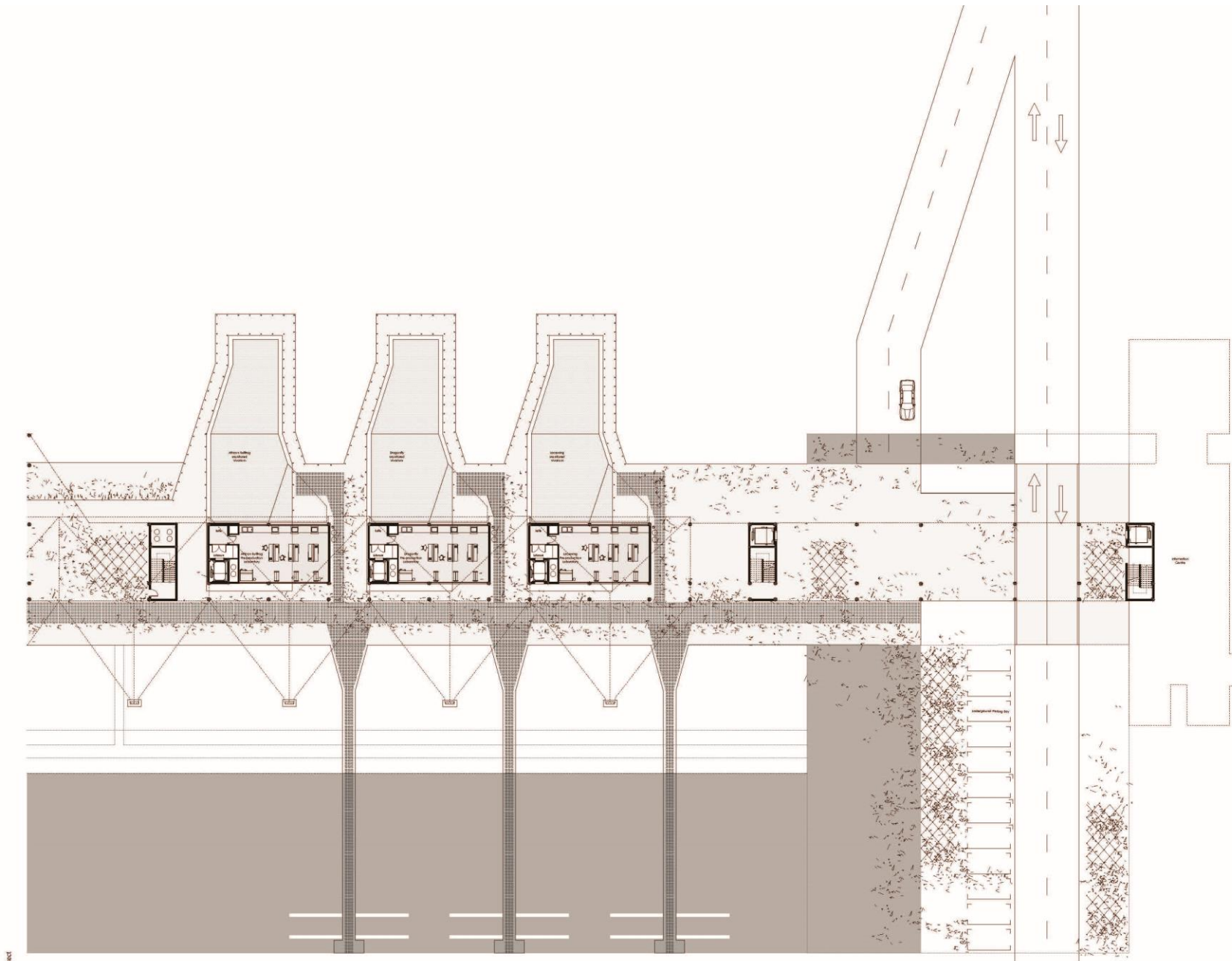


Figure 8.2b: Ground floor plan, "Landscaped Portal" (Author, 2013)

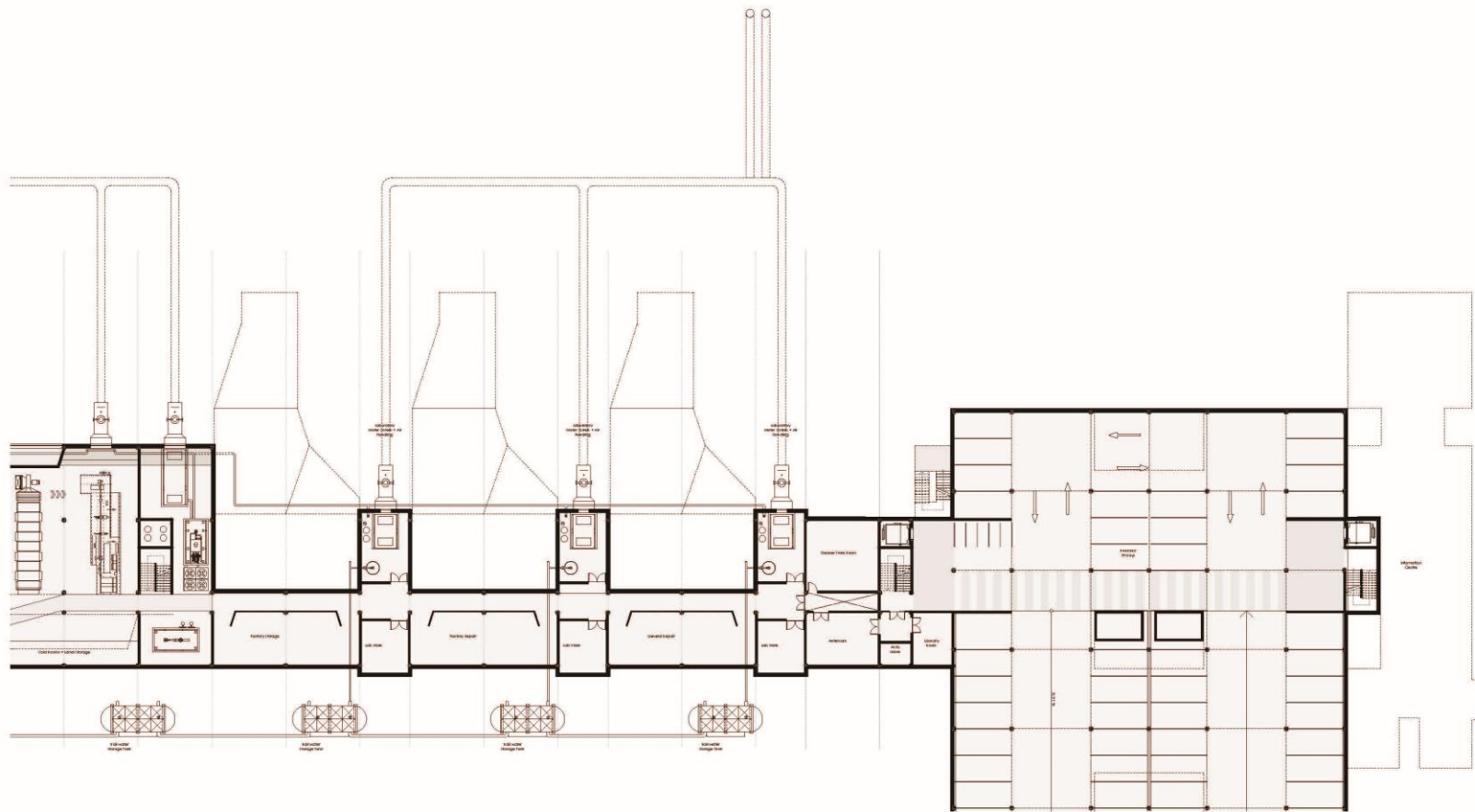


Figure 8.3: Lower basement level, "Fly Factory" (Author, 2013)

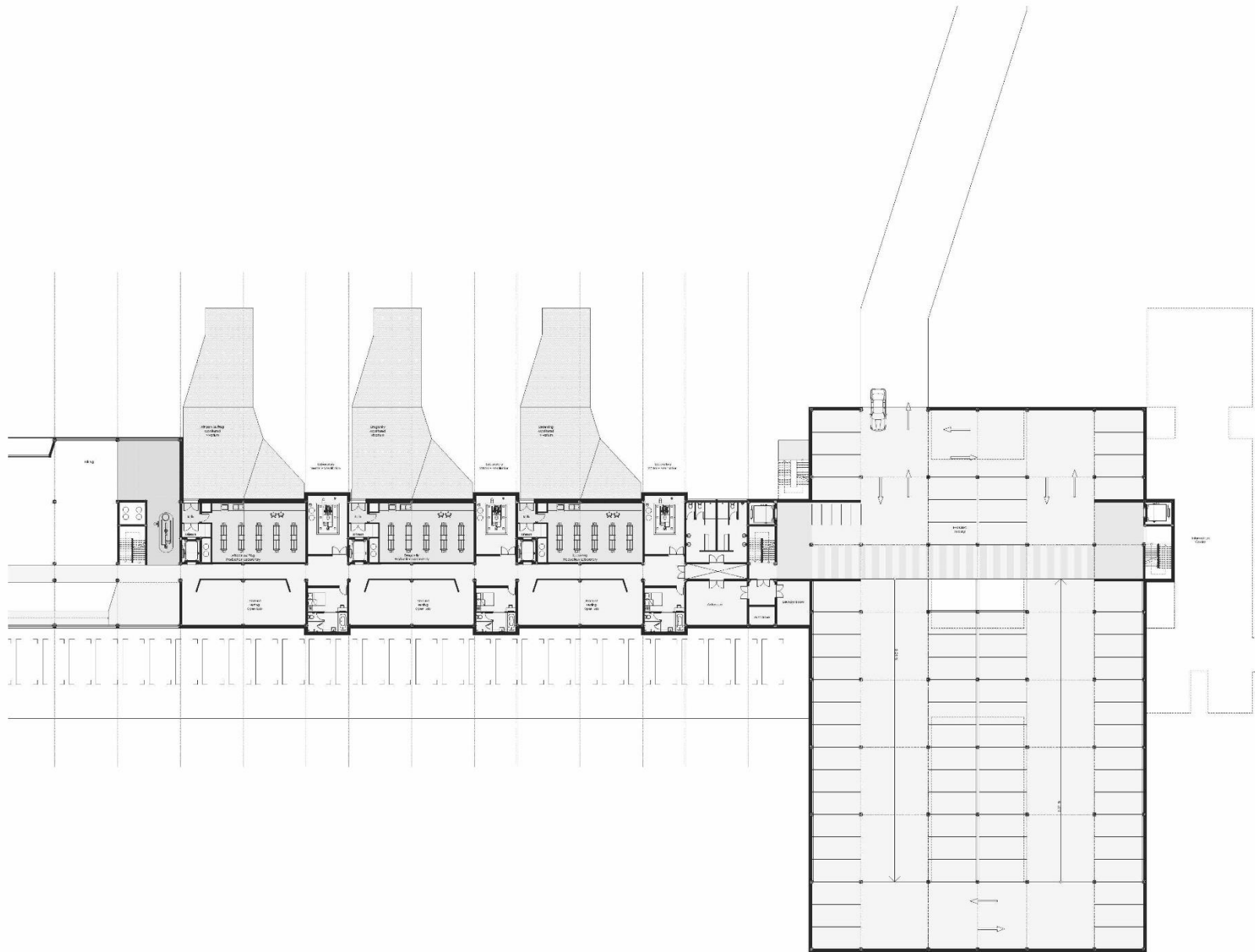
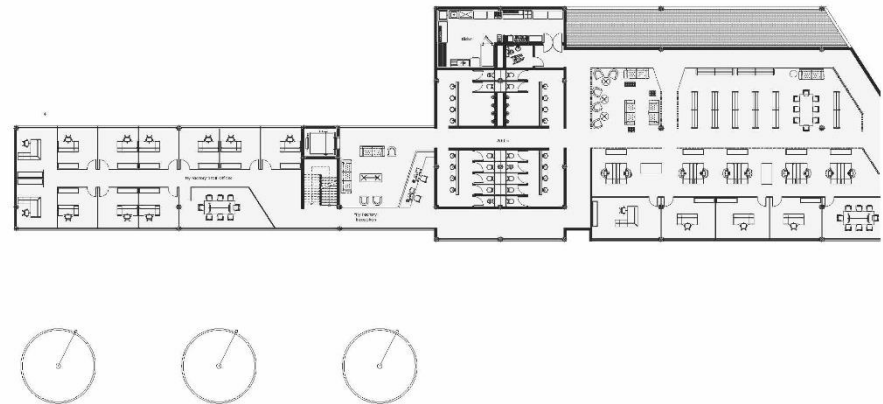
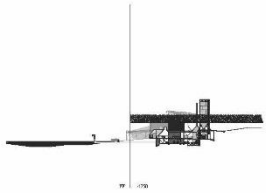


Figure 8.4: Upper basement level, "Fly Factory" (Author, 2013)



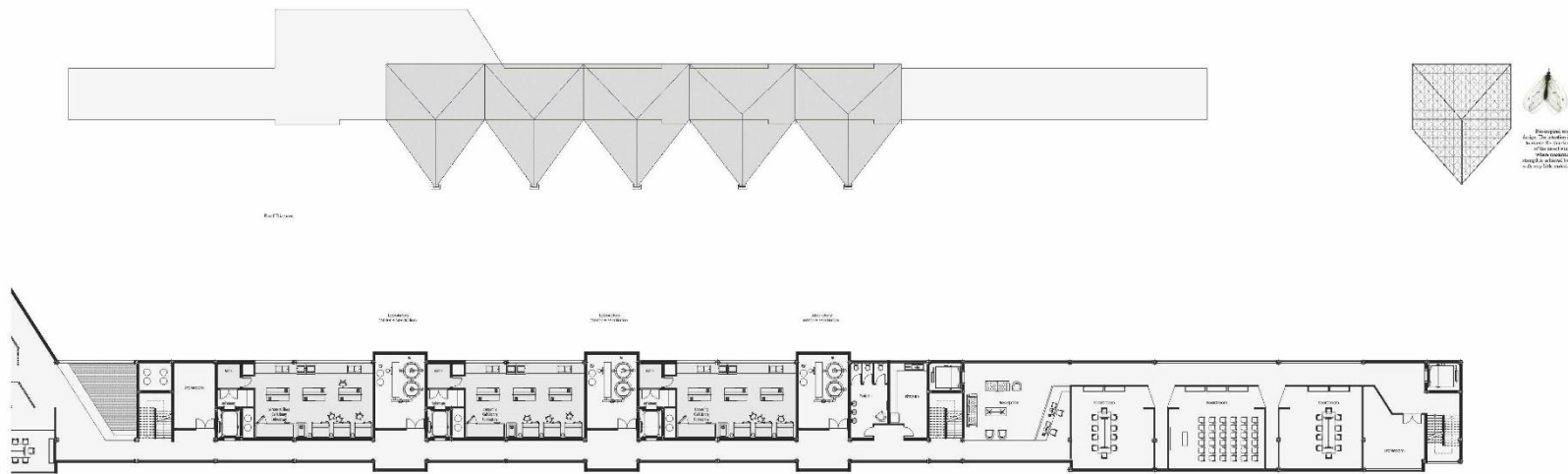
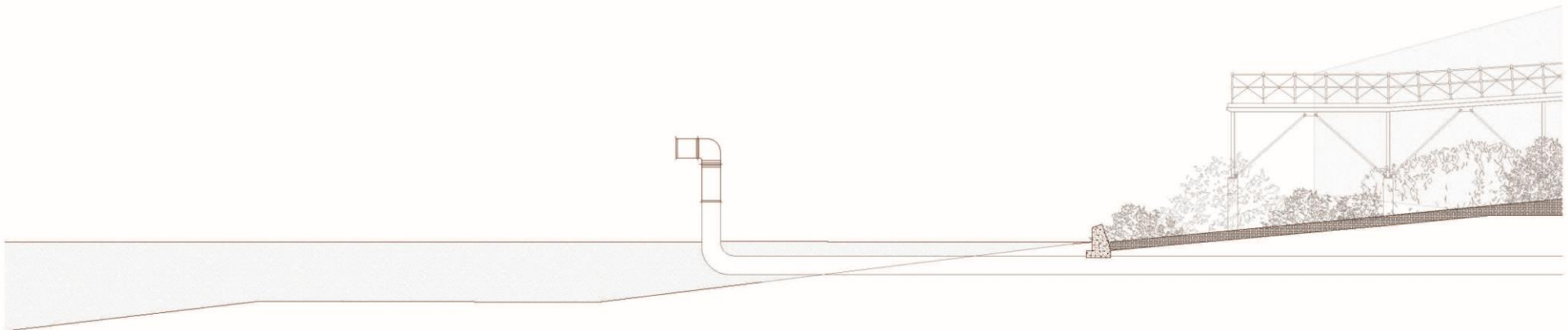
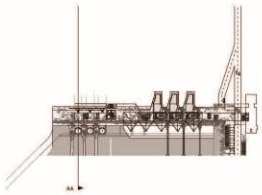


Figure 8.6: Upper level, “Urban research facility and insectary” + Roof Plan (Author, 2013)



HARVEST the Harvest
Building Section AA
Scale 1:50

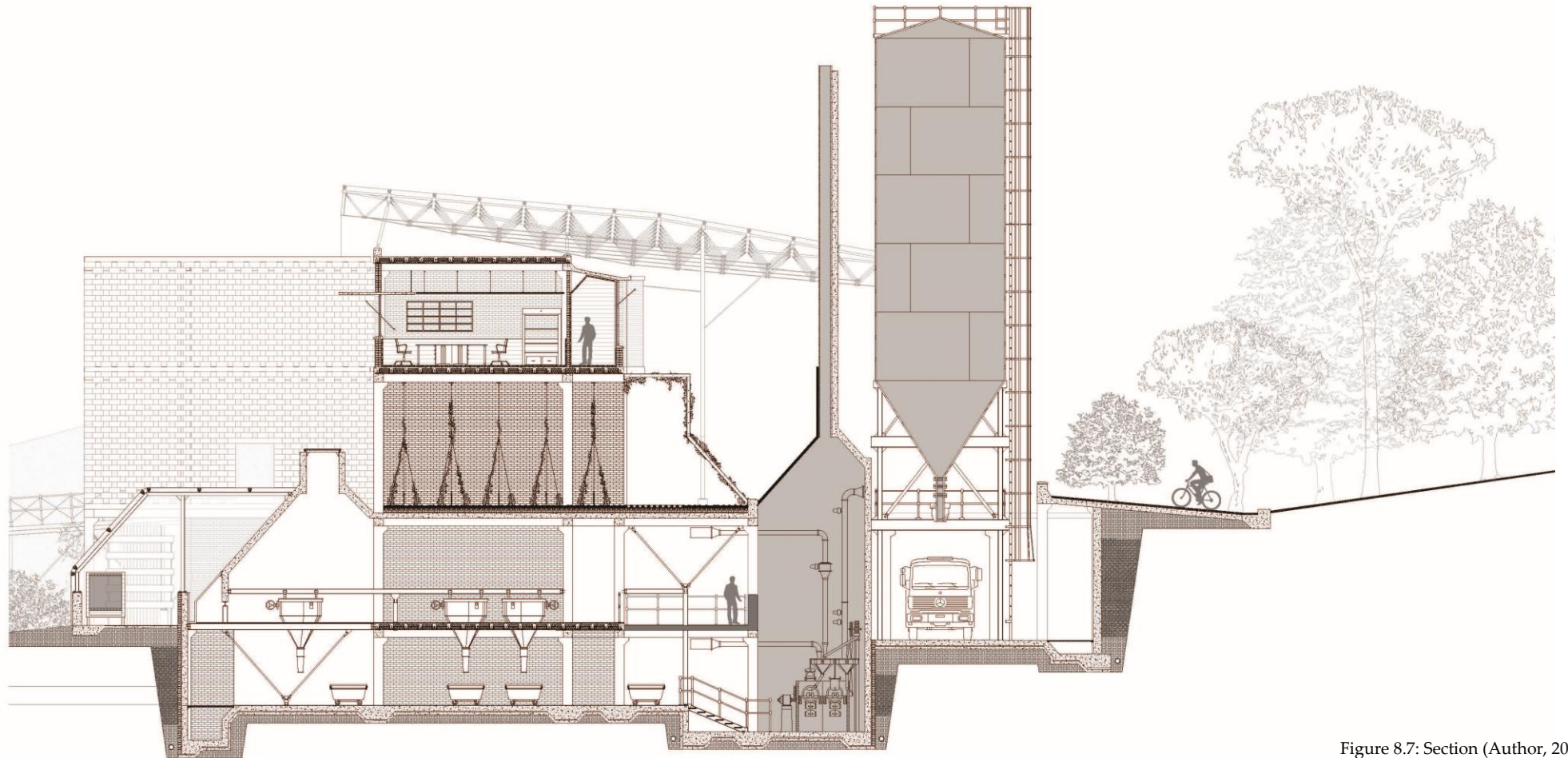
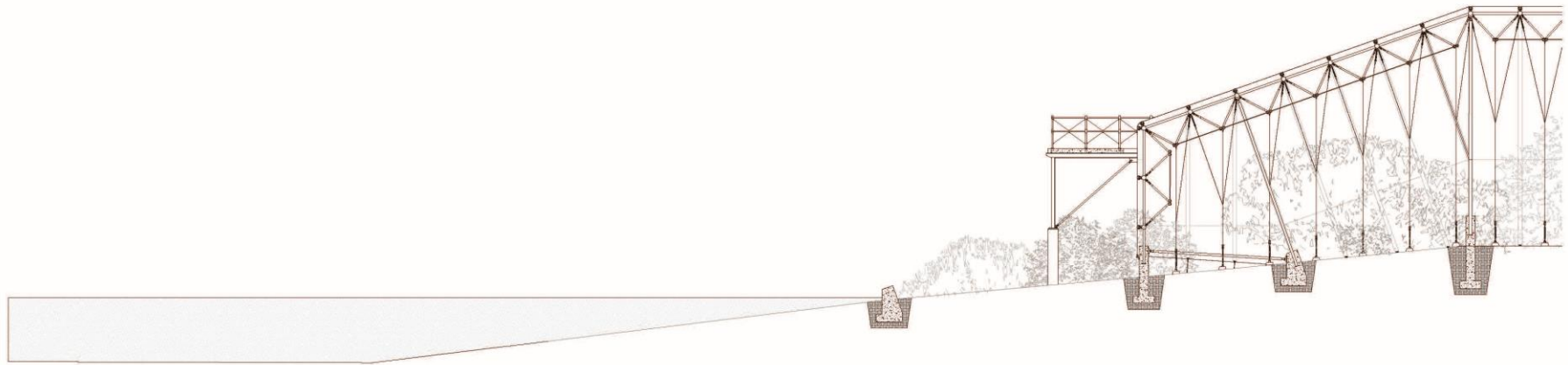
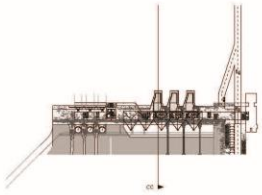


Figure 8.7: Section (Author, 2013)



HARVEST the Insect
Building Section 00
Scale 1:50

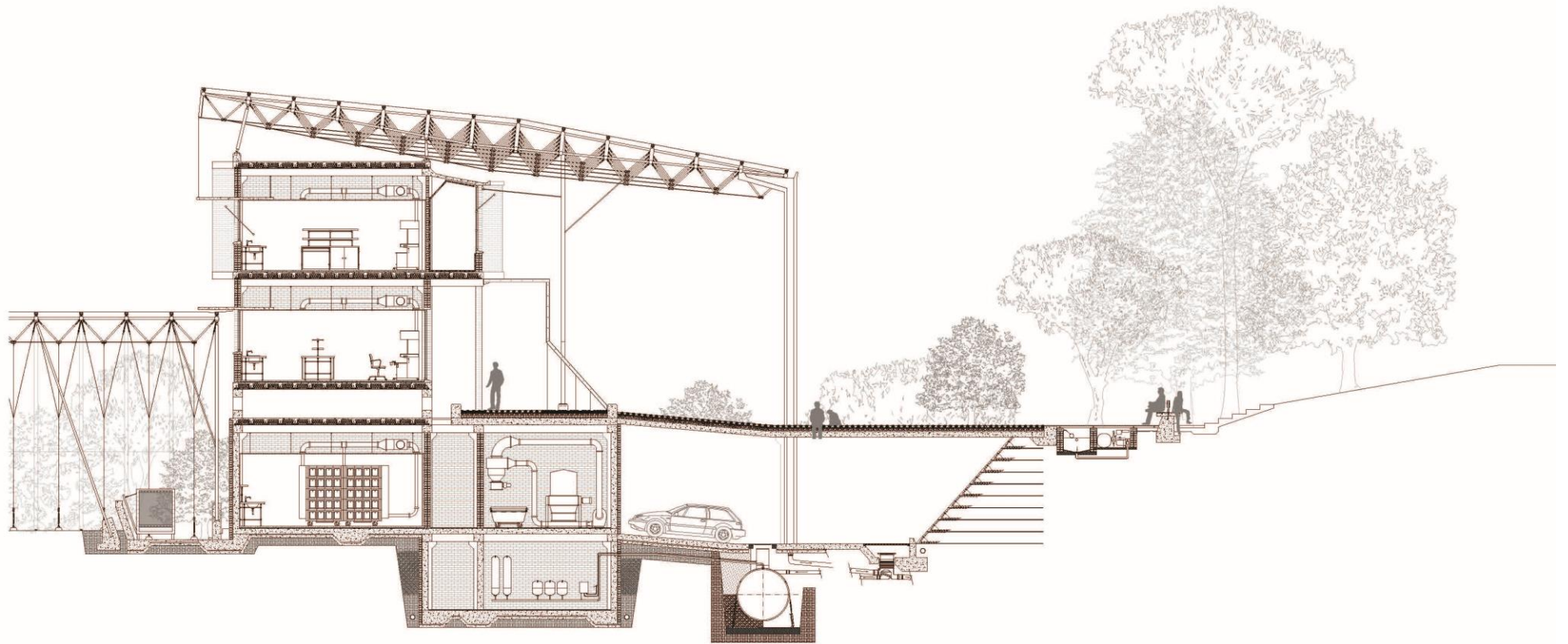
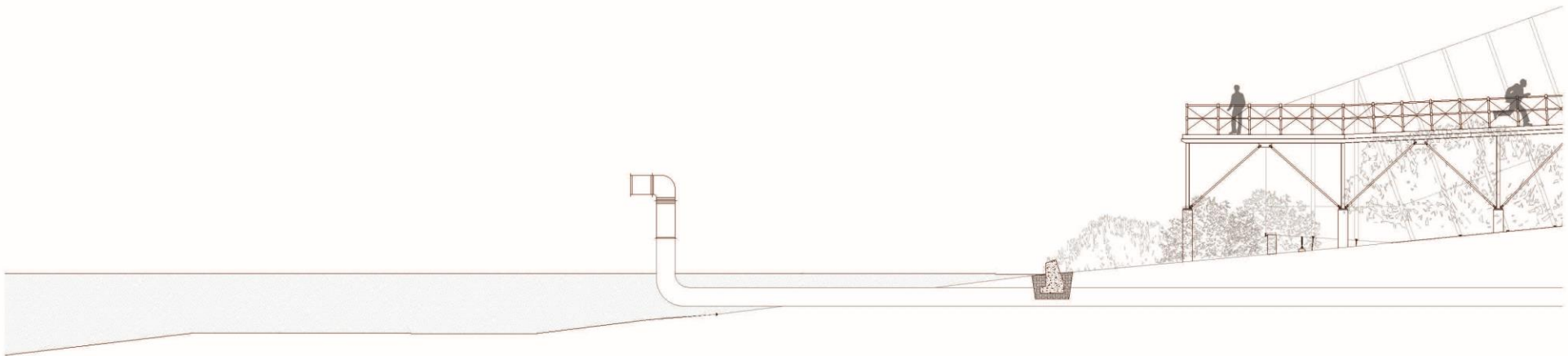
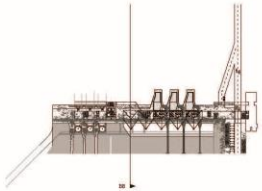
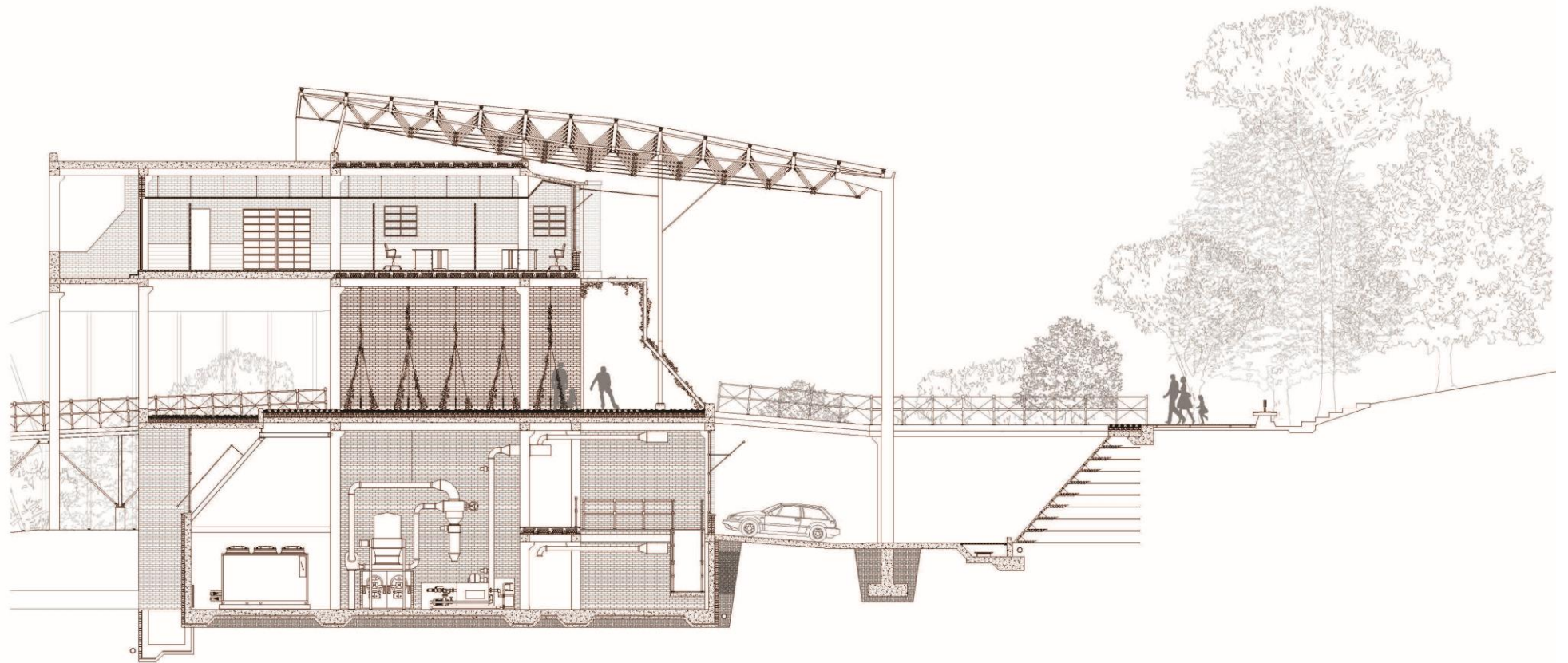


Figure 8.7: Section (Author, 2013)

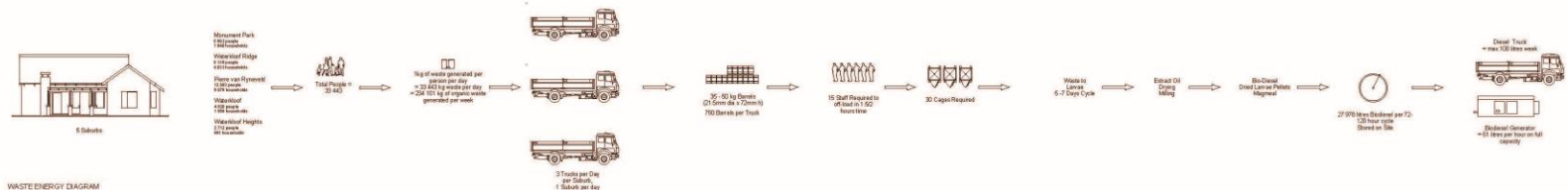
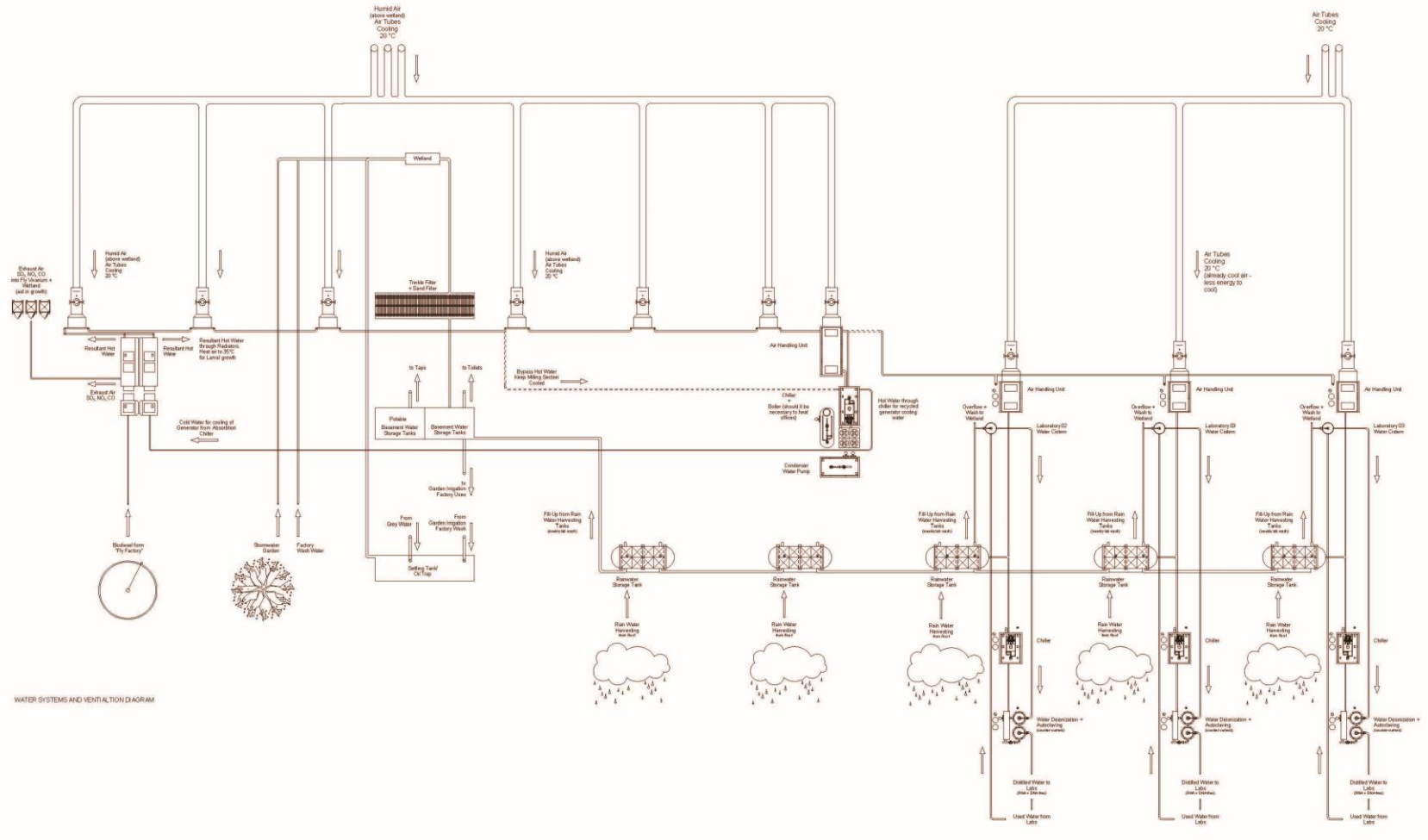


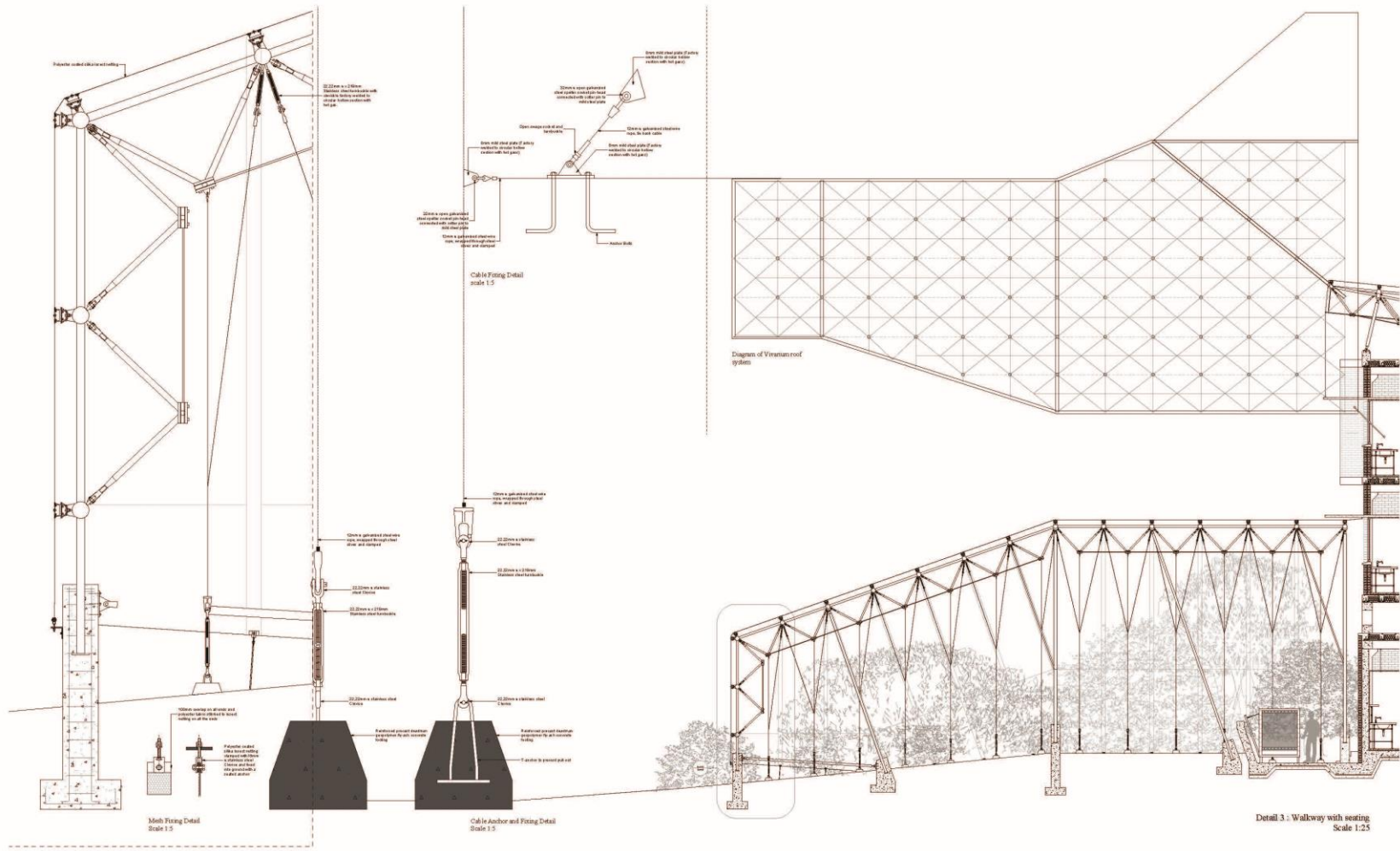
HARVEST the Insect
Building Section BB
Scale 1:50

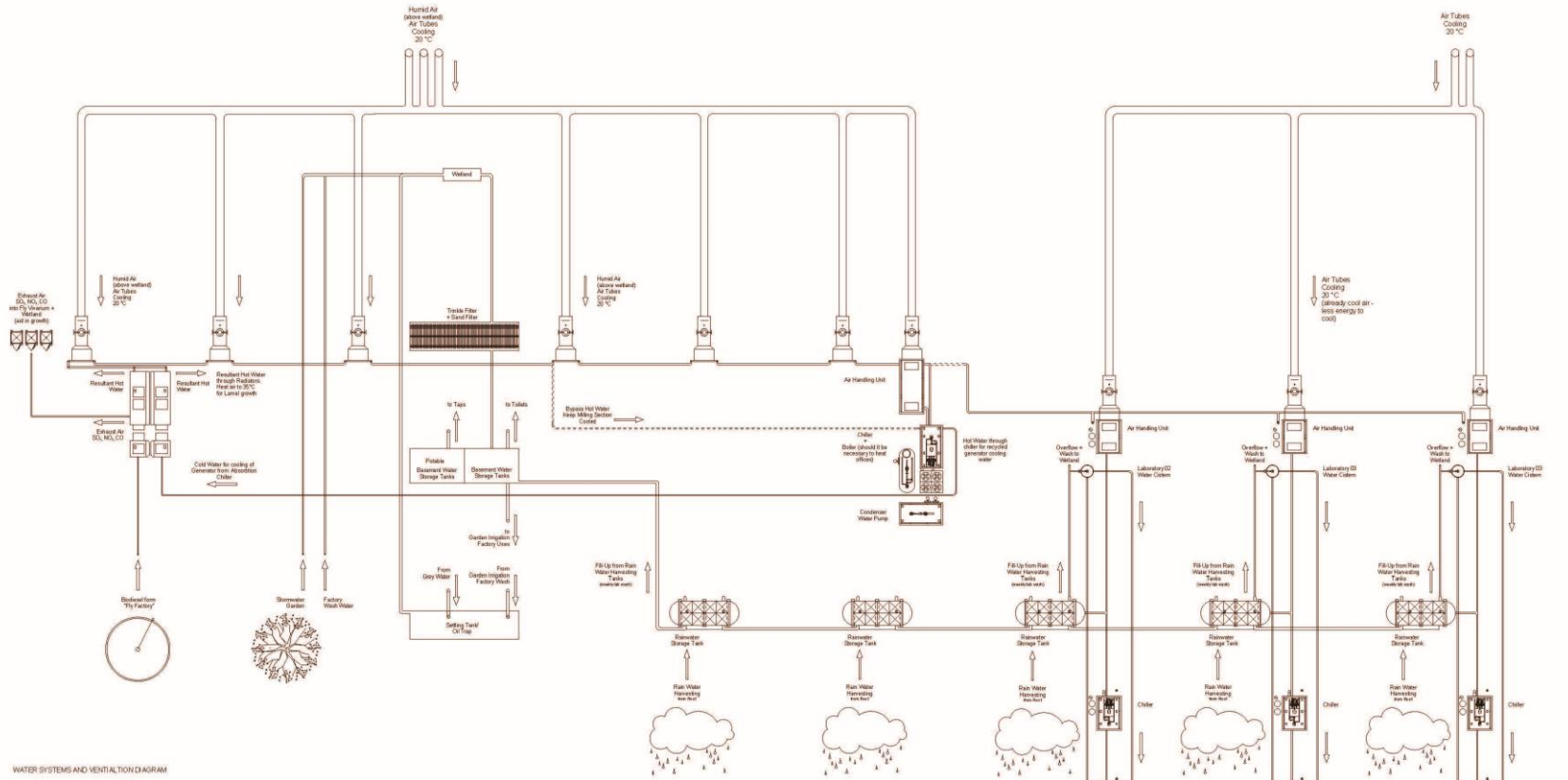


HARVEST the Insect
Building Section BB
Scale 1:50

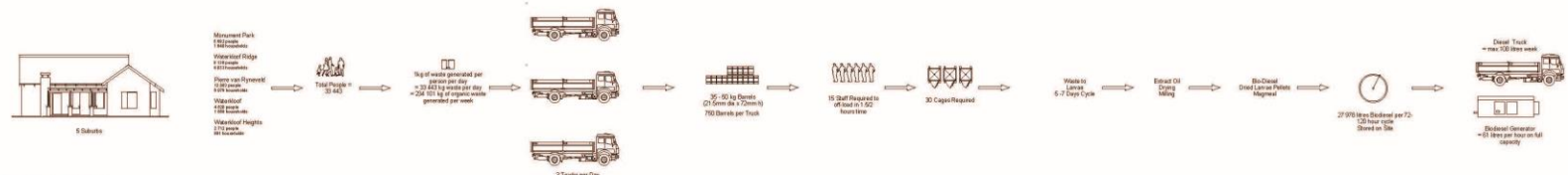
Figure 8.7: Section (Author, 2013)







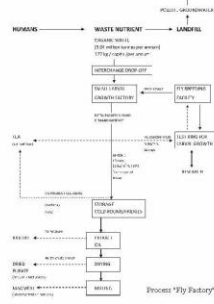
WATER SYSTEMS AND VENTILATION DIAGRAM



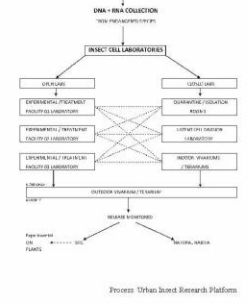
WASTE ENERGY DIAGRAM



Site Analysis and Design Considerations



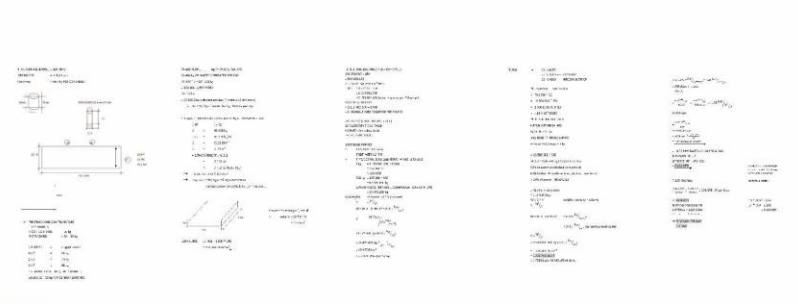
Process 'Fly Factory'



Process 'Urban Insect Research Platform'

Requirements and calculations for breeding facility

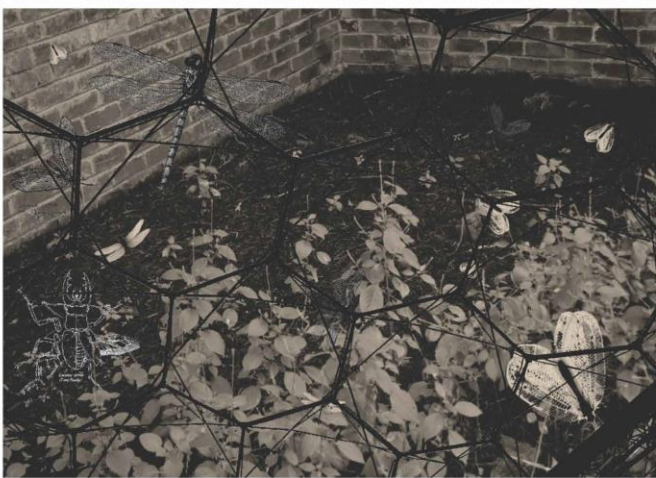
PARAMETER	UNIT	VALUE	REMARKS
1. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
2. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
3. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
4. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
5. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
6. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
7. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
8. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
9. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)
10. BREEDING AREA	m ²	1000	1000 m ² (10m x 100m)





CONCEPT OF MATERIALITY

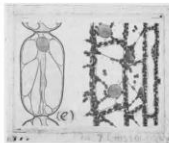
The building is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The building is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.



Materiality and Technology

MATERIALS

The building is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The building is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.



Material	Properties	Applications
Concrete	High strength, durable	Structural elements, walls, floors
Steel	High strength, ductile	Structural elements, beams, columns
Brick	Traditional, aesthetic	Walls, cladding
Wood	Warm, natural	Interior finishes, furniture



Roofing

The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.

Roofing

The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.



Material	Properties	Applications
Concrete	High strength, durable	Structural elements, walls, floors
Steel	High strength, ductile	Structural elements, beams, columns
Brick	Traditional, aesthetic	Walls, cladding
Wood	Warm, natural	Interior finishes, furniture

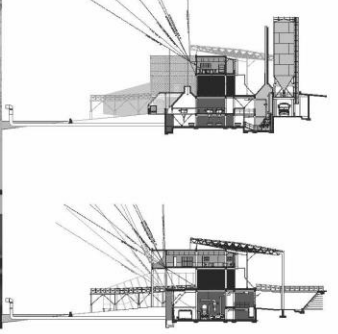
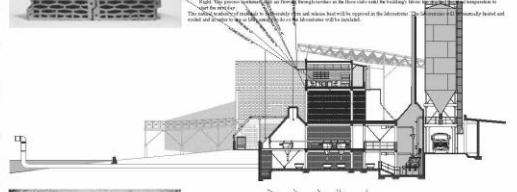


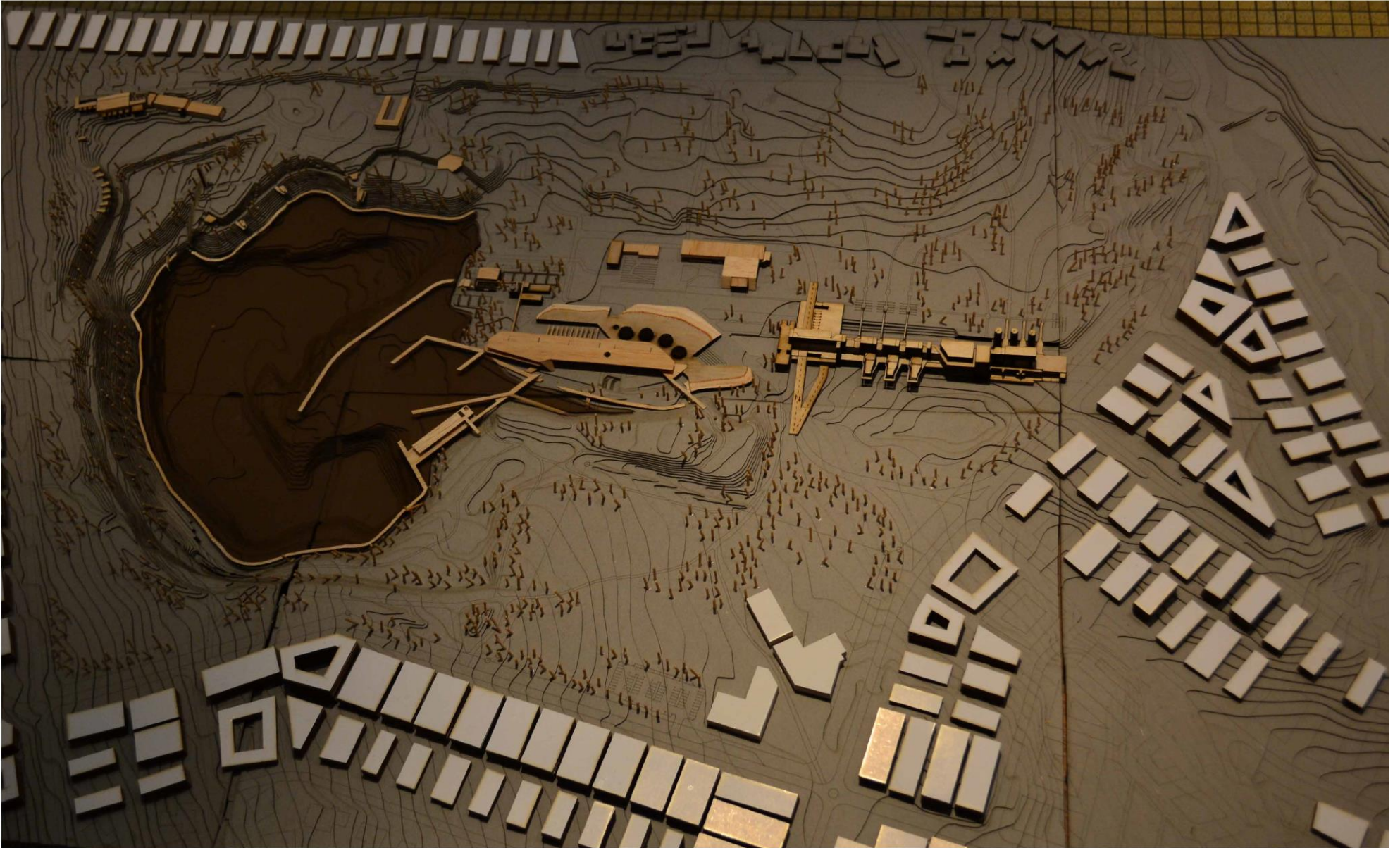
Roofing

The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.

Roofing

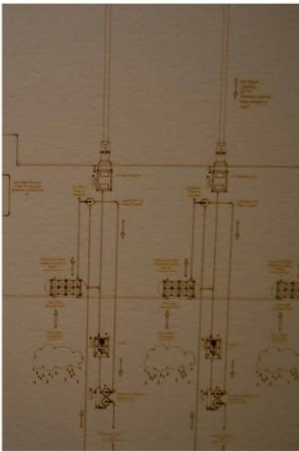
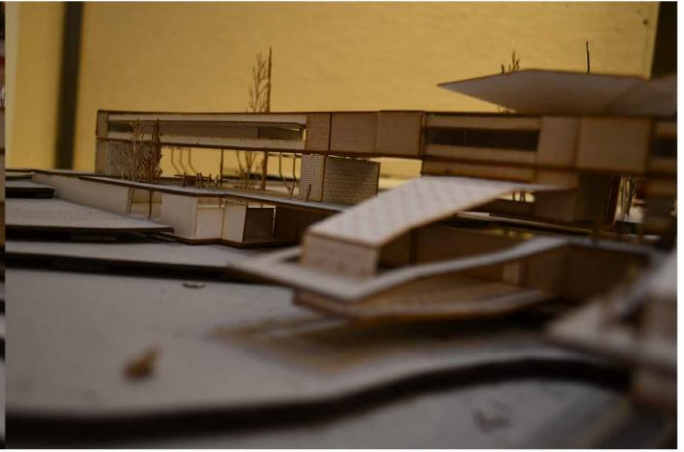
The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background. The roof is a large-scale construction project in a semi-arid environment. The structure is a massive concrete structure with a dome-shaped structure in the background.

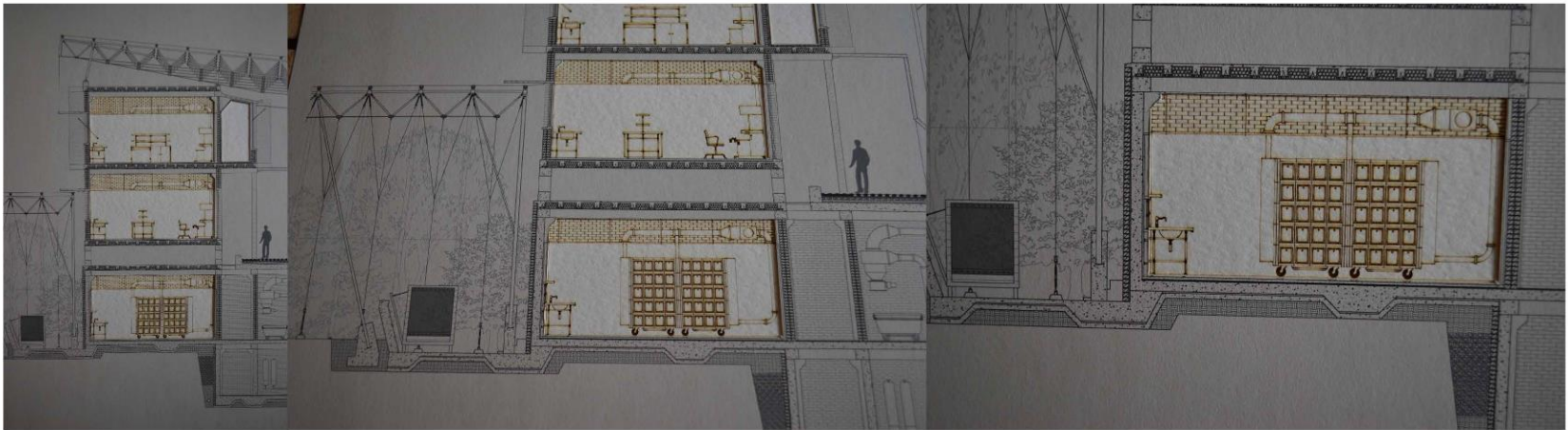
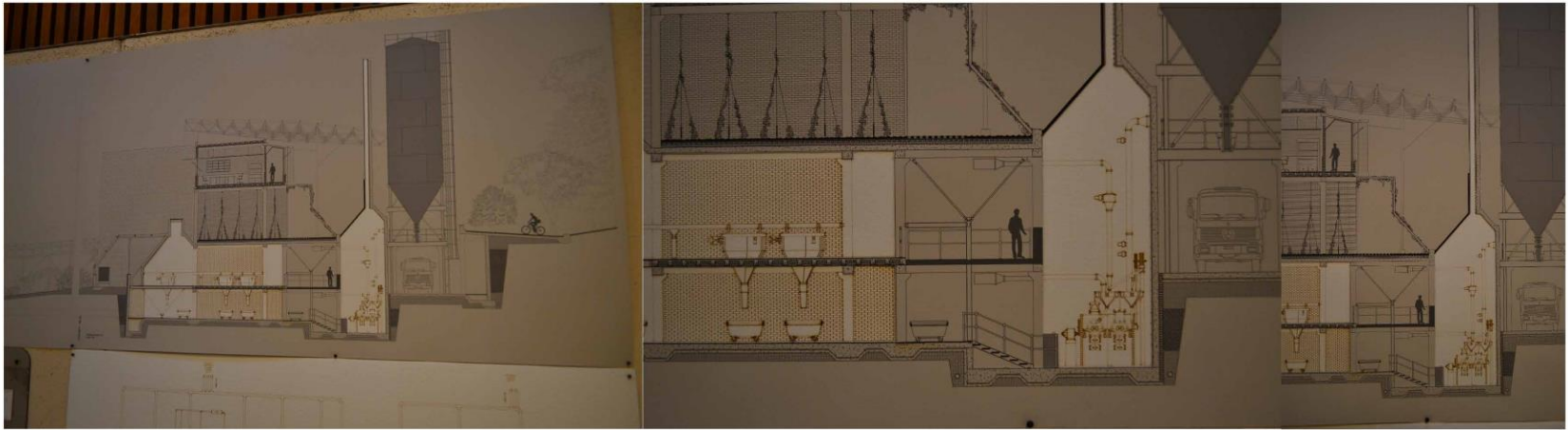




"HARVEST"









BIBLIOGRAPHY and ADDENDUM. Chapter 09

BIBLIOGRAPHY

- ACOCKS, J.P.H. 1988. Veld Types of South Africa. *Memoirs of the Botanical Survey of South Africa*, No.57: 1-146. Botanical Research Institute, Pretoria.
- ADLER, D. 2006. *Metric Handbook: Planning and Design Data*, 2nd ed. Oxford: Elsevier Butterworth-Heinemann.
- ALDERSEY-WILLIAMS, H. & VICTORIA, A.M. 2003. *Zoomorphic: New Animal Architecture*. London: Laurence King Publishing, in Association with Harper Design International.
- ASHBY, M. & JOHNSON, K. 2002. *Materials and Design: The Art and Science of Material Selection in Product Design*. Oxford: Elsevier Butterworth-Heinemann.
- BADARNAH, L. & KNAACK, U. 2008. *Organizational features in leaves for application in shading systems for building envelopes*. Southampton: WIT press. pp. 87-96.
- BADARNAH, L., NACHMAN FARCHI, Y. & KNAACK, U. 2010. Solutions from nature for building envelope thermoregulation. Research Paper. Faculty of Architecture, Delft University of Technology, Netherlands. pp. 251-262.
- BARNES, R.D. 1982. *Invertebrate Zoology*. Philadelphia, PA: Holt-Saunders International. pp. 105-106.
- BENYUS, J.M. 2002. *Biomimicry: Innovation Inspired by Nature*. New York: William Morrow Paperbacks.
- BOOKCHIN, M. 1995. *The Philosophy of Social Ecology*. Montreal: Black Rose Books.
- BREDENKAMP, G.J. & BROWN, L.R. 1998. A vegetation assessment of the northern areas of the Northern Metropolitan Local Council area: Unpublished report, Northern Metropolitan Local Council.
- CALLICOTT, J.B. 1990. *Conservation Ethics: Conservation Biology, Volume 4, Issue 1*. Massachusetts: Blackwell Science, Inc.
- CARROLL, S.P. & FOX, C.W. 2008. *Conservation Biology: Evolution in Action*. New York: Oxford University Press.
- CHINERY, M. 1986. *Living Garden: A practical guide to attracting and conserving garden wildlife*. London: Dorling Kindersley Publishers Ltd.
- CINCOTTA, P.R. & ENGLEMAN, R. 2000. *Human Population: Its Influences on Biological Diversity*. New York: Springer Publishing.
- DREW, A. & JOSEPH, J. 2012. *The Story of the Fly: And how it could save the World*. Cape Town: Cheviot Publishing.
- DREW, D. 2013. Personal interview with Mr. David Drew from Agriprotein. South Africa, 11 March 2013.
- FOX C.W., ROFF, D.A. & FAIRBAIRN, D.J. 2001. *Evolutionary Ecology: Concepts and Case Studies*. New York: Oxford University Press.
- FOX, W. 1995. *Toward a Transpersonal Ecology: Developing New Foundations for Environmentalism*. Albany: State University of New York Press.
- GRUBER, P. 2010. *Biomimetics in Architecture: Architecture of Life and Buildings*, 1st ed. Vienna: Springer Vienna Architecture.

- GRUBER, P. & GOSZTONYI, S. 2010. Skin in architecture: towards bioinspired facades. Article. 1: 503–513.
- HARDJITO, D. & RANGAN, B.V. 2005. Development and Properties of Low-Calcium Fly Ash-based Geopolymer Concrete, Research Report GCI, Faculty of Engineering, Curtin University of Technology, Perth, Western Australia.
- HICKMAN, J.R. ROBERTS, L.S. & LARSON, A. 2001. *Integrated Principles of Zoology*, 11th ed. New York: McGraw-Hill.
- HORNE, P.A., RIDLAND, P.M. & NEW, T.R. 2001. *Micromus tasmaniae: a Key predator on aphids on field crops in Australasia*. Cambridge: Cambridge University Press. pp. 388-394.
- HUTCHEON, N. 1963. Requirements for Exterior Walls-IRC-NRC-CNRC. *Canadian Building Digest*, 48: 55
- JANZEN, D.H. 1999. *How to grow a wildland: the gardenification of nature. Nature and Human Society: The Quest for a Sustainable World*. National Academy of Sciences, Washington D.C: National Academy Press.
- KALKMAN, V.J., CLAUSNITZER, V., DIJKSTRA, K.B., ORR, A.G., PAULSON, D.R. & VAN TOL, J. 2008. Global diversity of dragonflies (Odonata) in freshwater. Freshwater Animal Diversity Assessment.
- KWAK, M. M., VELTEROP, O. & BOERRIGTER, J.M. 1996. Insect diversity and the pollination of rare plant species. London: Academic Press for the Linnean Society London and the International Bee Research Assosiation. pp. 115–124
- LAVER, J., CLIFFORD, D. & VOLLEN, J. 2008. *High performance masonry wall systems: principles derived from natural analogues*. Southampton: WIT press. pp. 243-252.
- LORD, W.D., GOFF, M.L., ADKINS, T.R. & HASKELL, N.H. 1994. The black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) as a potential measure of human postmortem interval: observations and case histories. *Journal of Forensic Sciences*, 1: 215-222.
- MCEWEN, P.K., NEW, T.R. & WHITTINGTON, A.E. 2007. *Lacewings in the crop environment*. Cambridge: Cambridge University Press.
- MCKIBBEN, B. 1990. *The End of Nature*. New York: Random House Inc.
- NAESS, A. 1989. *Ecology, community and lifestyle*. Cambridge: Cambridge University Press. pp. 164-65.
- NAVEH, Z. & LIEBERMAN, A.S. 1990. *Landscape Ecology: Theory and Application*. New York: Springer Publishing.
- NEW, T.R. 1999. Neuroptera and biological control. *Stapfia*, 60: 147-166.
- NEW, T.R. 2002. Prospects for extending the use of Australian lacewings in biological control. *Acta Zoologica Academiae Scientiarum Hungaricae*, 48: 209-216.
- NEWTON, L., SHEPPARD, C., WATSON, D.W., BURTLE, G. & DOVE, R. 2005. Using the black soldier fly, *Hermetia illucens*, as a value-added tool for the management of swine manure. Waste Management Programs. North Carolina State University.
- NORTON, B. 1991. *Toward Unity among Environmentalists*. New York: Oxford University Press
- PAVIA, A. 2007. The Incredible Edible Worm. *Reptiles Magazine*.
- PEARSON, D. 2001. *New Organic Architecture: The Breaking Wave*, 1st ed. Los Angeles: University of California Press.

- PIETERSE, E. 2013. Personal interview with Dr Elsje Pieterse, University of Stellenbosch Researcher from Agriprotein, South Africa. 13 March 2013.
- ROLSTON, H. III. 1994. *Conserving Natural Value*. New York: Columbia University Press.
- RUSSELL, F. 1979. *Art Nouveau Architecture*. London: Academy Editions.
- SAMWAYS, M.J. 1996. *Global Biodiversity Assessment*. *Conserva* 11 (3): 14.
- SAMWAYS, M.J. 2005. *Insect Diversity Conservation*. Cambridge: Cambridge University Press. p. 342.
- SAMWAYS, M.J. & HATTON, M.J. 2000. The third dimension: conservation on hills and mountains. *Palmnut News*.
- SAMWAYS, M.J & TAYLOR, S. 2004. Impacts of invasive alien plants on Red-Listed South African dragonflies (Odonata). *South African Journal of Science*, January/February,
- SAMWAYS, M.J., MCGEOCH, M.A. & NEW, T.R. 2010. *Insect Conservation: A Handbook of Approaches and Methods (Techniques in Ecology and Conservation)*. Oxford: Oxford University Press.
- SAVONEN, C. 2005. Big maggots in your compost. Oregon State University.
- SHEPPARD, D.C. 1992. Large-scale Feed Production from Animal Manures with a Non-Pest Native Fly. *Food Insects Newsletter*.
- SHEPPARD, D.C., TOMBERLIN, J.K., JOYCE, J.A., KISER, B.C. & SUMNER, S.M. 2002. Rearing methods for the black soldier fly (Diptera: Stratiomyidae). *Journal of Medical Entomology* 39: 81
- SUMAJOUW, M.D.J. & RANGAN, B.V. 2006. Low-Calcium Fly Ash-Based Geopolymer Concrete: Reinforced Beams and Columns, Research Report GC3, Faculty of Engineering, Curtin University of Technology, Perth, Western Australia.
- THE AUSTRALIA ICOMOS CHARTER FOR PLACES OF CULTURAL SIGNIFICANCE (The Burra Charter). 1999. Australia ICOMOS.
- THOMSON, S. 2003. *Scoping Report for the proposed Development of remaining Extent of the Farm Waterkloof 428-JR*. Pretoria: Seaton Thomson & Associates cc.
- WALLAH, S.E. & RANGAN, B.V. 2006. Low-Calcium Fly Ash-based Geopolymer Concrete: Long-Term Properties. Research Report GC2, Faculty of Engineering and Computing, Curtin University of Technology, Perth Western Australia
- ZANG, J., HUANG, L. & HE, J. 2013. An artificial light source influences mating and oviposition of black soldier flies, *Hermetia illucens*. *Journal of Insect Science*, 10: 202

INTERNET RESOURCES

DEPARTMENT OF ENVIRONMENTAL AFFAIRS OF SOUTH AFRICA. 2005-2010. *State of the Environment*. [online] Available at: <<http://soer.deat.gov.za/175.html>> [Accessed 12 March 2013]

STATISTICS SOUTH AFRICA. 2011. *Mid-year population estimates, 2011*. [online] Available at: <<http://www.statssa.gov.za/publications/statsdownload.asp?PPN=P0302&SCH=4986>> [Accessed 22 April 2013]

SOUTH AFRICAN INSTITUTE OF STEEL CONSTRUCTION. 2011. Advantages of steel. [online] Available at: <http://saisc.co.za/saisc/about_steel.htm> [Accessed 10 November 2011]

AGRIPROTEIN TECHNOLOGIES. 2013. Organic waste breakdown and magmeal production . [online] Available at: <<http://www.agriprotein.com/>> [Accessed 28 February 2013]

DEPARTMENT OF AGRICULTURE, CONSERVATION, ENVIRONMENT AND LAND AFFAIRS: Development guidelines for ridges. [online] Available at: <<http://stepsa.org/resources/shared-documents/development-guidelines-for-ridges-pdf>>> [Accessed 22 April 2013]
Tshwane RSDF 2013, Region 3. [online] Available at: <<http://www.tshwane.gov.za/AboutTshwane/CityManagement/CityDepartments/City%20Planning,%20Development%20and%20Regional%20Services/Pages/DRAFT-RSDF-2013.aspx>> > [Accessed 22 May 2013]

NCIPMI. 1998. Insect and related pests of man and animals. *North Carolina Integrated Pest Management Information*. [online] Available at: <http://ipm.ncsu.edu/AG369/notes/black_soldier_fly.html> [Accessed 14 July 2013]

REQUIREMENTS FOR INSECT BREEDING. [online] Available at: <<http://www.insectscience.org/10.202/i1536-2442-10-202.pdf>> [Accessed 3 April 2013]

SMITHFIELD PROJECTS. Using the black soldier fly in waste management. 2012. [online] Available at: <http://www.cals.ncsu.edu/waste_mgt/smithfield_projects/phase2report05/cd.web%20files/-A2.pdf> [Accessed 8 April 2013]

CLIMATE TEMPS. Climate for Pretoria. 2013. [online] Available at: <<http://www.pretoria.climatemps.com/>> [Accessed 5 Augustus 2013]

IUCN RED LIST DATA. 2013. [online] Available at: <<http://www.iucnredlist.org/about/summary-statistics>> [Accessed 2 March 2013]

IUCN RED LIST STATISTICS. 2013. For endangered species. 2013. [online] Available at: <http://www.iucnredlist.org/documents/summarystatistics/2013_1_RL_Stats_Table_5.pdf> [Accessed 22 March 2013]

IUCN RED LIST. Summary of statistics. 2013. For extinct species. 2013. [online] Available at: <http://www.iucnredlist.org/documents/summarystatistics/2013_1_RL_Stats_Table_6a.pdf> [Accessed 2 March 2013]

IUCN RED LIST. Data. 2013. [online] Available at: <<http://www.iucnredlist.org>> [Accessed 2 March 2013]

IUCN RED LIST. Summary of statistics. 2013. [online] Available at: <<http://www.iucnredlist.org/about/summary-statistics>> [Accessed 2 March 2013]

IUCN RED LIST SUMMARY. Summary of statistics. 2013. [online] Available at: <http://www.iucnredlist.org/documents/summarystatistics/2012_2_RL_Stats_Table_1.pdf> [Accessed 2 March 2013]

IUCN RED LIST. Wildlife in a changing world. 2013. [online] Available at: <<http://data.iucn.org/dbtw-wpd/edocs/RL-2009-001.pdf>> [Accessed 2 March 2013]

IUCN RED LIST. Ecological restoration for protected areas. 2013. [online] Available at: <<http://data.iucn.org/dbtw-wpd/edocs/PAG-018.pdf>> [Accessed 2 March 2013]

IUCN RED LIST. Caring for the earth: a Strategy for sustainable living. 2013. [online] Available at: <<http://data.iucn.org/dbtw-wpd/edocs/CFE-003.pdf>> [Accessed 2 March 2013]

TSHWANE REGIONAL SPATIAL DEVELOPMENT FRAMEWORK. 2013. [online] 2013- Available at: <<http://www.tshwane.gov.za/AboutTshwane/CityManagement/CityDepartments/City%20Planning,%20Development%20and%20Regional%20Services/Pages/DRAFT-RSD-2013.aspx>> [Accessed 22 April 2013]

BIODIVERSITY SCENARIOS: PROJECTIONS OF 21st CENTURY CHANGE IN BIODIVERSITY AND ASSOCIATED ECOSYSTEM SERVICES. A Technical Report for the Global Biodiversity Outlook 3. 2013. [online] Available at: <<http://www.cbd.int/doc/publications/cbd-ts-50-en.pdf>> [Accessed 24 March 2013]

NOBEL PRIZE. Press release: 2012 winners. 2012. [online] Available at: <http://www.nobelprize.org/nobel_prizes/medicine/laureates/2012/press.htm> [Accessed 7 March 2013]

WIENBERGER. Porotherm clay bricks and clay ceiling blocks. 2013. [online] Available at: <http://www.wienerberger.ro/App/Maps/Wb-ro/catalog/EN/pdf/Porotherm_System.pdf> [Accessed 3 October 2013]

STATISTICS SOUTH AFRICA. Population densities. 2013. [online] Available at: <http://en.wikipedia.org/wiki/File:Tshwane_2001_population_density_map.svg> [Accessed 15 Augustus 2013]

RINCON VITONA INSECTARIES. Lacewing. 2013. [online] Available at: <<http://www.rinconvitova.com/lacewing.htm>> [Accessed 14 Junie 2013]

WIKIPEDIA. Chrysopidae, Lacewing. 2013. [online] Available at: <<http://en.wikipedia.org/wiki/Chrysopidae>> [Accessed 14 Junie 2013]

HORTICULTURE. Beneficial insect species and Dragonflies. 1992. [online] Available at: <http://aggiehorticulture.tamu.edu/galveston/beneficials/beneficial-11_dragonflies.htm> [Accessed 17 Junie 2013]

WIKIPEDIA. Standard lux levels. [online] Available at: <<http://en.wikipedia.org/wiki/Lux>> [Accessed 18 September 2013]

INHABITAT. Passive cooling a termite mound. [online] Available at: <<http://inhabitat.com/building-modelled-on-termites-eastgate-centre-in-zimbabwe/>> [Accessed 22 September 2013]

WIKIPEDIA. Skeleton. [online] Available at: <<http://en.wikipedia.org/wiki/Skeleton>> [Accessed 28 September 2013]

FERRARI SOLTIS. Outdoor meshed fabric. 2013. [online] Available at: <<http://www.lunex.no/produkter/screen/screenduk-ferrari-soltis/>> [Accessed 2 October 2013]

FERRARI SOLTIS. Solar protection fabric. 2013. [online] Available at: <(<http://en.sergeferrari.com/solar-protection/>) > [Accessed 2 October 2013]

INTERNET INSPIRATION RESOURCES

No particular order

<http://www.wksu.org/news/images/32643/MANTIS-PIN.jpg>

<http://blog.insectmuseum.org/?p=1049>

<http://www.johncoulthart.com/feuilleton/wp-content/uploads/2008/04/stamps1.jpg>

<http://www.wksu.org/news/feature/exploradio/32643>

<http://insectmuseum.org/specimens.php>

<http://www.pinterest.com/utourdoctor/endangered-species/>

<http://bioaccumulation.wordpress.com/2013/05/25/crowdsourced-science-notes-from-nature/>

http://www.osborneross.com/src/img/projects/stamps/endangered_insects/endangered_insects_5.jpg

<http://bugsofpopoagie.wordpress.com/category/entomology-general/>

<http://essig.berkeley.edu/endins/emigdon.htm>

<http://savingparadise.wildlifedirect.org/tag/seychelles-sheath-tailed-bat/>

http://the-bulb.com/wp-content/uploads/2011/11/David_Attenborough.jpg

<http://www.listal.com/viewimage/252977>

<http://www.gs.niigata-u.ac.jp/~gsweb/en/Annai/master-p/e-main.html>

<http://www.classicnatureprints.com/pr.PZS%20Fauna/pzs.tadpoles.xenopus.html>

<http://bugguide.net/node/view/184752/bgimage>

<http://www.frogforum.net/african-bullfrogs/3348-fearing-i-too-got-scammed-dwarf-african-bullfrogs-pyxies-sold-giants.html>

http://squamates.blogspot.com/2012_08_01_archive.html

<http://www.cleantick.com/users/alfredolle/projects/mass-rearing-of-black-soldier-fly-hermetia-illucens/20609>

<http://kylejanzen.wordpress.com/category/history/>

<http://modishvintage.blogspot.com/2011/03/insect-prints.html>

<http://www.pinterest.com/source/mcgregor.sbs.auckland.ac.nz/>