Exploring the potential of architecture for ecological regeneration through the design of an eco-awareness and air recycling facility within the South Durban Basin

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Rishek Brijnarain 212504897

07 November 2018 at The University of KwaZulu Natal,

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Abstract

Exploring the potential of architecture for ecological regeneration through the design of an eco-awareness and air recycling facility within the South Durban Basin.

Durban South Basin is an environment in degradation. The land has both residential and industrial zoning. The shared zoning has created many problems within the community, primarily air pollution. This is due to the combined effects of the petrochemical industries, and the transport required for the produced goods.

The problems exist due to past apartheid planning policies known as the group areas act. People of colour were placed in close proximity to industrialized areas, such that they could easily be used for labour.

This dissertation enquires how man can live harmoniously alongside industrialized areas with the aid of regenerative architecture. The dissertation aims to find methods of regenerating community confidence and environmental opulence by an enquiry into architecture and its place/space making principles.

The qualitative study aims to discover solutions through a theoretical framework, literature study, precedent study, and case study with conclusions and recommendations. The research findings present key principles towards a regenerative architecture using a theoretical framework. The theoretical framework provides principles towards an architecture that encourages natural eco-system regeneration through awareness and air recycle facility.

The principles are developed through the exploration of Regenerative Architecture, Ecological Urbanism Place Theory, Systems Theory, Learning & Empowerment in the built environment, and Symbioses where they will ultimately form a systematised method to architecture that will be applied to the design of a Regenerative architecture.

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Conclusion

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1.1.0 Introduction

This Chapter provides an introduction and explanation into the research specified, and includes the background, motivation/ justification for the study, definition of the problem, aims, and objectives then followed by the scope. We will finally explore key concepts and theories relating to the topic.

1.1.1 Background

The South Durban Basin is an area located behind/ south of the Durban harbour. It is an area of low lying geographical contours. The bluff headland is the geographical barrier preventing the ocean from flooding the low lying contours of the basin. Durban International Airport, was previously situated within the South Durban Basin, and was used as a landmark for the area. Nowadays it is known as “cancer valley” absent of landmarks, but rather engulfed by air polluting industries. These industries pollute the air, with minimal governmental policies to regulate air toxicity levels within the area. It is common knowledge and logic to reason that communities should not be living within an environment of high toxicity in a pursuit of good health for themselves and families. However we find that people living within these fenceline communities struggle to leave the area and in most cases are subjected to remain in these areas due to financial constraints or via a place attachment. Although one should not dwell on the past, it is important to note the group areas act and its role in our current society. Environmental Injustice has been a struggle in contemporary South Africa. “Its links to apartheid spatial planning and politics is the cause, and it has left deep social, economic, political, and ecological scars” (Kaplan: 2000).

The people that suffer within the South Durban Basin are the ones that were deemed “black” during the apartheid era. They were forced to live in crowded areas near industrial zones such that cheap labour could be provided to these industries. This maximized profit and exploited “Black” South Africans into

a life of direct exposure to hazardous pollution and socioeconomic hardships. “To this day people who cannot make it out of these areas have to make a living within these areas, subjecting their children to these harsh environments (Niranjan: 2005).”

The scenario of high levels of air pollution within a community is by no means an accident. Researchers around the world are facing problems of air pollution within larger cities such as Beijing in China, and New Delhi in India. Knowledge could be learned from similar cities although the context of South Durban Basin is unique as it is not a city, but rather a neighbourhood and community. Therefore the researcher seeks methods and processes in the built form which aim to help the people of the south Durban basin breathe cleaner air.

1.1.2 Motivation/Justification for study

The South Durban Basin consists of Kwazulu Natals’ largest petrochemical industries. These companies refine petrochemicals and produce fuel from crude oil. The fuel is provided for the country and is used mainly by motor vehicles. However, due to the large import of crude oil through The Port of Durban, it is vital that the petrochemical companies’ are located close to the port. However due to excessive practice of using unsustainable methods by petrochemical companies, the process of refining fuel has subjected the environment to degradation. and with ongoing resource scarcity looming over the country, very few organizations of mankind are focusing on addressing the several health, social, environmental, and economic, problems which arise by partaking in a non-renewable fossil fuel fixation which is degrading communities, habitats, and increasing global mean temperature. Should these practices continue at a rapid pace, and then this will lead to a scenario of severe instability with regards to climatic conditions present for life on earth.

Due to past planning principles of apartheid in South Africa, labelled “the group areas act”, the government positioned non-white racial groups near petrochemical refinement industries, to provide the cheap labour. Fast forward almost a century and city data now indicates that each refinery

belches out more than 17 tons of noxious gases daily (Carnie, 2015). Due to the significant volume of toxic gases being disposed of, numerous people residing within these fenceline communities suffer from respiratory illnesses. Their lack of considerable wealth to treat such ailments, forces them into poverty or crime (Jaggernath, 2010).

One of the major forms of illnesses related to air pollution is lung cancer. Although the industries refuse to take responsibility, we can't ignore the fact that children from the age of 4 years old are dying due to lung cancer (Ivan, 2005). This is because the young have developing lungs, and are the most susceptible to environmental toxicity. This research takes a critical position by postulating that the built environment can play a vital role in addressing the problems associated with air pollution. The research being conducted is designed in faith to provide an eco-awareness and air recycling facility for the community most affected by air toxicity, such that it provides a remedy or solution to the ills facing people and the environment.

1.2.0 Definition of the problem, aims and objectives

1.2.1 Definition of the problem

Mankind's insatiable thirst for oil as the primary source for consistent energy has had a detrimental effect against the planet. Many scientists claim that oil will only last for another 30 years, until the year 2050. What will we do then?

Oil is a non-renewable energy source and its engagement with automobiles has become the normal way of living life. However to maintain this 'normal' way of life a refinement process of crude oil is required. Refinement processes produce tons of noxious gasses which are harmful to the environment and human beings once inhaled. In the case of South Durban Basin, a large community is directly exposed to high

levels of noxious gases daily, ranging from children to pensioners. The sub health, economic, environmental, natural and physical problems which arise from this will be discussed further in detail within the discourse of the dissertation. Therefore we come to the crux of the problem, that large non-renewable energy industries are positioned directly within communities, in a geographical context ill-favoured to the dispersion of air pollutants.

1.2.2 Aims

The researcher aims to unravel the mysteries surrounding architecture and its ability to filter or decompose toxic pollutants of air. Architecture is used as an antidote against toxic air, in effect helping to regenerate a community and acting as a platform for ensuring the present and future sustainability of generations born and yet to be born.

1.2.3 Objectives

The objective of the thesis is to discover an architectural approach to resolving the issue concerning industrial air pollution within the Durban South Basin. The solution needs to be beneficial for the residents, workers, industry, environment, and the biosphere, while ensuring sustainable and cost-efficient building processes.

1.2.3.0 Primary Objective

Due to rapid urbanization, plans to expand non-renewable industrial activity and resource scarcity besieging the planet, it is paramount to determine how architecture and urbanism can assist with the detoxification of hazardous air, and help with the resurgence of a healthy and vibrant community within the Durban south basin.

1.2.4.0 Secondary Objectives

1.2.4.1 To understand the history of the Durban south basin, and the challenges facing the community currently.

1.2.4.2 The utilization of renewable energy to decontaminate air pollutants.

1.2.4.3 To promote community development through built form and architecture.

1.2.4.4 To utilize the correct architectural principles to create a regenerative development.

1.3.0 Setting out the scope

1.3.1 Delimitation of Research Problem

The study aims to confine its limitations to air pollution and its relationship with the built environment. It is understood that the problem has, socio-political, economic and medical characteristics. Although these problems influence the built form, the study of these issues will not be dealt with in detail and is not the point of outcome for the study.

1.3.2 Definition of Terms

Recycle - convert waste into valuable reusable material

Catalyst - something which accelerates or causes change.

Ambient air - The air of the surrounding environment

Baseline - The current and existing condition before any development action

Boundary layer - In terms of the earth's planetary boundary layer is the air layer
near the ground affected by diurnal heat, moisture or momentum to or from the
surface.

Concentration - When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are preceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.

Condensation - The change in the physical state of matter from a gaseous into liquid phase.

Dispersion potential - The potential a pollutant has of being transported from the source of emission by wind or upward diffusion. Dispersion potential is determined by wind velocity, wind direction, height of the mixing layer, atm spheric stability, presence of inversion layers and various other meteorological conditions.

Emission - The rate at which a pollutant is emitted from a source of polllution.

Emission Factor - A representative value, relating the quantity of a pollutant to a specific activity, resulting in the release of the pollutant to the atmosphere.

Evaporation - The opposite of condensation, where a substance's state is

changed from liquid to gas.

Fenceline Communities – Communities which live borderline to pollution cau ing industries.

Inversion - An increase of atmospheric temperature with an increase in height.

Mixing layer - The layer of air within which pollutants are mixed by turbulence. Mixing depth is the height of this layer from the earth's surface.

Oxides of Nitrogen - Refers to NO and NO2. The gas is produced during combination especially at high temperatures.

Particulate matter (PM) - The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed in order to protect the public from exposure to the inhale fractions. PM can be principally characterised as discrete particles spanning several orders of ma nitude in size, with inhalable particles falling into the following general size fractions:

PM10 - generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung.

PM2.5 - also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less).

PM10-2.5 - also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but

equal to or less than a nominal 10 microns); and Ultra-fine particles general ly defined as those less than 0.1 microns.

Precipitation - Ice particles or water droplets large enough to fall at least 100m below the cloud base before evaporating.

Relative Humidity - The vapour content of the air as a percentage of the vapour content needed to saturate air at the same temperature

SDIB - South Durban Industrial Basin

Wastewater treatment plant - An industrial structure designed to remove biological or chemical waste products from water, thereby permitting treated water to be used for other purposes.

Multi-Sensory - a building incorporating our senses throughout the design, visual perception, hearing or auditory design, smelling or olfactory design and touch or tactile design.

Node - a place where social and cultural interactions can occur.

Perception - a way, in which something is regarded, understood or interpreted.

Social Capital - the networks of among people who live or work within a particular society, enabling that society to function effectively.

Social Revitalisation - to give new life, vitality and cohesion to the social lives of all members of society.

VOC's - Volatile Organic Compounds

1.3.3 Stating the Assumptions

It is assumed that the built environment can play a vital role in addressing air pollution. Should the role be properly understood, the insights and knowledge gained would prove helpful to the community of South Durban Basin in formulating strategies to overcome air toxicity issues. It is assumed that these communities feel disadvantaged due to their close proximity to industrial areas. The built environment can help by educating the community regarding ecological regenerative methods to provide clean air. In addition renewable energy practices can also be taught, to achieve a more sustainable built environment, and improve their quality of life.

1.3.4.0 Key Questions

1.3.4.1 Primary Question

1.3.4.1.0 How can architecture help to supply safe inhalable air for the residents of South Durban Basin?

1.3.4.2 Secondary Questions

1.3.4.2.0 What are the current challenges facing residents of the south Durban basin?

1.3.4.2.1 What methods of science and technology are appropriate to decontaminate hazardous air?

1.3.4.2.2 What strategies are required to regenerate community development?

1.3.4.2.3 What architectural principles are required to design a regenerative mixed-use facility that supplies safe inhalable air to members of a community?

1.4.0 Concepts and theories

Introduction

Industrial air pollution and its relevance to the field of architecture have not been significantly explored. Scientists and environmentalists have warned against an attitude, by which the human race separates itself from the environment. This disconnection has resulted in a predominately unaware and irresponsible society which can be associated with the increase in global warming and climate change (Walker, 2007). Therefore the research seeks to connect the human attitude with the environment, through an architectural intervention, with the aim of reducing carbon offsets, and providing clean air to the community. This facility can create ecological awareness, and stand as a symbol against air pollution.

The theoretical and conceptual framework that underpins the research is based on an inquiry into regenerative development, ecological urbanism; the built environment learning and empowerment; living systems theory, permaculture and symbiosis. These theories create a strong framework to demonstrate how architecture can be viewed within a regenerative paradigm, and help uplift a community through the development of built form suited to community needs.

Theory 01: Ecological Urbanism

Ecological Urbanism provides valuable insight to “view the fragility of the planet and its resources as an opportunity for speculative design innovations rather than as a form of technical legitimation for promoting conventional solutions. The problems confronting our cities and regions would then become opportunities to define a new approach. This is the territory of ecological urbanism “(Mostafavi, 2015).This theory propagates the idea that urbanism could impact an environment positively. In order to produce a positive environment one needs to become innovative and inventive, perhaps from using other disciplines, such as science and technology together with architecture. The future is only welcoming more inhabitants to “the city”, and urbanization is predicted to be around 66% of the world population in the year 2050 (United Nations,

2014). Therefore it is vital to understand how architecture can protect and regenerate natural resources in urban environments with increasing demands from an expanding urban population.

This theory is relevant to Air Pollution in the Durban South Basin, due to industries having only looked at developing, and growing their enterprises, without consideration for natural and ecological systems and corridors. Therefore the theory proposes that we develop architecture to suit its climate, economy, context, community and local identity. Ecological Urbanism can be implemented by key strategies, namely; to anticipate, collaborate, curate, sense, interact, produce, incubate, adapt and measure ideas. These methods also bridge the gap between academic theory and practical implementation of thoughtful design in the creation of built form. Architects and visionaries who practice the implementation of thoughtful design towards an environmentally conscious design will be explored further.

Ken Yeang, is an architect who is internationally recognised as the leading proponent of ecological design in architecture. In 2008, he was identified by The Guardian, as one of the “50 people who could save the planet”. He advocates an environmentally responsible approach to design and, incorporates bioclimatic features in high-density building typologies (Hart, 2011). He uses the climate as a generator for design, such that the architectural solution consumes less energy, provides a more humane environment and establishes a unique local cultural identity. Thinkers of such provide valuable insight into pioneering work which aid in the quest for providing an ecologically focused architectural solution.

The research does not merely seek to acquire knowledge pertaining to ecological coexistence within the built environment; but also aims to develop an understanding of how the built environment can perform as a mediation space between industry and community.

Theory 02: Built Environment, Empowerment and Learning

Built Environment Empowerment and Learning focus on sharing knowledge such that the community is educated about their surroundings. Knowledge of the environment and ecosystem allows for a harmonious relationship within the community. The built environment plays a role in environmental and societal degradation. Therefore it is imperative that the solution to social and ecological elevation is addressed through the built form. The built form and environment are the mediums whereby empowerment and learning are communicated.

The adage “Knowledge is power” embodies the essence that if you equip people with knowledge, they become powerful. The iterance of rightful principles learned, produces a society of great intentions. The intentions which drive change within the environment follow principles derived from the concept of urban resilience. Urban resilience is the ability of an urban system to continue to prosper regardless of drastic changes occurring within the system. Educating the community about resilience and regenerative principles promotes residents into becoming major proponents of the concept.

Theory 03: Place Theory

Critical regionalism is a base for routing architecture to place and its connection to nature (Frampton, 1983). Frampton states that the fundamental strategy of critical regionalism, is to mediate the impact of universal civilization with elements derived indirectly from the peculiarity of a particular place (Frampton, 1983) Critical Regionalism forms the basis for bounding architecture to place, its principles mediate the modern world with the vernacular, by weaving together the influences of modernisation and the machine with local hand-made, vernacular craft (Frampton, 1983). Therefore it is essential to understand place, and its inclusive varieties. In an understanding of place, a better design solution can be obtained, which fits within the context.

Place is an important concept. Many scholars believe that it is only in relationship to place that humans experience the intimacy and responsibility

to the living world and find a meaningful identity and role for themselves (Relph, 1976; Sack, 1977; Berry, 1981; Casey, 1996; Malpas, 1999; Cameron, 2002; Cresswell, 2004).The importance of relevance to place is described by Kelly, “Wherever you live, your tiny spot is deeply intertwined within a larger place, embedded fractal like into a whole system called a watershed, which is itself integrated with other watersheds into a tightly interdependent biome. At the ultimate level, your home is a cell in an organism called a planet. All these levels interconnect “(Kelly, 2005). Therefore in order to obtain community revitalisation, it is paramount to understand place, such as the Durban south basin. Understanding place would provide valuable insights into designing relevant and regenerative architecture.

Concepts

Concept 01: Regenerative Development

In 1987, the Bruntland report was issued which stated that “sustainable development is development that meets the needs of present without compromising the ability of future generations to meet their own needs.”
The aim of sustainability is associated with maintenance, as opposed to regeneration. Therefore we require a concept which aims to achieve a net positive, rather than a net zero, the concept of regenerative development “investigates how humans can participate in ecosystems through development, to create optimum health for both human communities (physically, psychologically, socially, culturally and economically) and other living organisms and systems” (Pedison and Jenkin, 2009). “Work that regenerates addresses the unrealized potential inherent in the relationship between a given system and the larger systems within which it is nested. That is, it enables living systems to evolve by expressing their latent potential in the form of new value in the world” (Mang and Haggard 2016). The majority of the world is thinking through a mechanistic paradigm, rather than an interdependent thought paradigm. “We stopped seeing ourselves as physically and spiritually connected to family, clan, and land” (Suzuki, 1998). “We are a part of nature and

we require a profound shift in our values and behaviours. We require new ways of seeing ourselves." (Mang and Haggard, 2016) There are three main principles to regenerative development, co-evolution, place and developmental processes. Co-evolution is a principle which demonstrates that human beings prosper with nature and we need to contribute to the abundance of life. Elizabeth Sahtouris states that "the best life insurance for any species in an ecosystem is to contribute usefully to sustaining the lives of other species, a lesson we only beginning to learn as humans (Sahtouris, 1999)." "Partnering for co-evolution requires a whole-systems reorientation that connects human activities with the evolution of natural systems (Mang and Haggard, 2016)." Place is an important principle and as James Kunstler expresses "Every Place is like no place in particular (Kunstler, 1994)." "The idea of place is a way for people to envision the unity of humans and natural systems in a concrete and specific way. In each place on Earth, natural and cultural systems express themselves uniquely (although often the qualities that differentiate them are masked by the effects of media and the global economy). This means that if we wish to engage in co-evolutionary partnerships with nature, we have to do so place by place, discovering opportunities and solutions that are indigenous to specific locations rather than generic to everywhere" (Mang and Haggard, 2016).Therefore the principle of place must be considered for effective regeneration to occur. Developmental processes are processes which aim to include stakeholder actualizations within community and to discover a collective community vocation or purpose. This is accomplished by including human development in every aspect of a project (Mang and Haggard, 2016). Therefore this is a process of design and an on-going activity. The process engages with local stakeholders. Stakeholders can develop an understanding of their place, and how it works as they contribute as co-designers and on-going stewards (Mang and Haggard, 2016). This process enables everyone to participate and understand their roles within the place and environment. This process is done by engaging in community dialogue. A collective vocation is a vision which the community has together, of what they wish to see progress within the community. "This recalling of vocation

of place keeps people connected to what they most care about" (Mang and Haggard, 2016). This process asks a key question to communities – "What contribution must the community make to enable their children and grandchildren to thrive here? "(Mang and Haggard, 2016)

Concept 02: Urban Resilience

Resilience is associated with the intention to maintain energy usage. This concept is already in effect within Durban as a future masterplan. Resilience is the ability of something to rebound or resume its original shape following exposure to a stressor (Welsch, 2013). Resilience had been conceived as a property of a system that makes it return to an equilibrium or a steady state after a disturbance or 'engineering resilience' (Gunderson, 2000).In contrast 'ecological resilience' defines or measures 'the capacity of a system to absorb disturbance and reorganize while undergoing a change so as to still retain the same function, structure, identity, and feedbacks' (Walker et al, 2004). Resilience is a new concept and is commonly used in the field of environmentalism and development. The reason it is so important is that Durban has adopted a resilience strategy which is being implemented within the city. This affects the future masterplan of the city, and any architecture or built form that is yet to happen. However, resilience does have a drawback if not supervised, whereby one can pose the question; how can resilience relate to a pro-active approach towards environmentally conscious development? The idea is to create architecture and built form which considers the resilient people of Durban South Basin. Resilience also connotes to understanding the symbiotic relationship between man and nature.

The community are the focus of encouragement, to engage with and partake in development, and rejuvenation of their built form and environment. Sustainable development is the organizing principle for meeting human developmental goals, while simultaneously sustaining natural resources and ecosystems. Sustainability allows resources to be continuous and recyclable. Sustainable development is future-oriented in that it aims to ensure that future generations are at least as well off as the current generation (precautionary

principle) (Sutherland, 2017). This idea intends to satisfy sustainable ways in achieving the design of a facility, such that the facility does sustain itself, with a renewable resource, for generations of the present, and future. However the facility can only be sustainable if there is a symbiotic relationship with the community and the facility, and vice versa. This symbiosis and inter-relationship between people and architecture is the catalyst to providing successful solutions.

Concept 3: Symbiosis

Kisho Kurokawa and The Philosophy of Symbiosis symbolises that everything is related to everything, with a sense of non-duality/ symbiosis existing on earth. Hence this concept proposes methods to address the existing disjunctive environment. The philosophy of symbioses explains that the intimate organism to organism interaction is an interaction where the stronger element does not dominate the weaker, but rather an endeavour to determine common rules, without removing the variance between the elements (Kurokawa, 1994). This is relevant to the relationship between industry, environment/nature, people and air quality within the Durban South Basin.

Conclusion

The understanding and correct implementation of the above-mentioned theoretical framework and literature is important because it shapes an architecture, which people within the context of the Durban South Basin can be proud of and associate an identity to. This will lead to greater interest in the area, and could possibly attract eco-tourists and visitors worldwide. Tourists would be able to view the role of nature, as a force to combat the problems created from industrialist and mechanistic thought paradigms.

Currently, there is no research available locally in the field of architecture and urban design, regarding the given issue. The literature and study aim at approaching and analysing the issue of air pollution in the Durban South Basin, through a regenerative Architecture, such that the architecture aims to

prove its advancement in technology effectively and act as a “filter” to industrial air pollution. This proposal could serve as a guideline for the cleansing of toxic air within disadvantaged communities. The utmost essence of formulating the literature is to understand how architecture can decontaminate the air people breathe within communities of close proximity to oil refineries, and regenerate the environment into a healthier ecosystem for inhabitants to live in.

1.5.0 Research Methodology

The research proposes to utilize qualitative and quantitative study methods, as it requires scientific knowledge from a data perspective, and it also aims to understand through interviews and secondary data, the social aspect and problems fabricated from air pollution directly.

Primary Research:

Empirical research is vital to the research, which deals with the impact of industrial air pollution on a specific community in the Durban South Basin. The sources of primary data and methods of data collection are listed below:

Focused Interviews:

Primary data will be accumulated through focused Interviews as well as an investigation into the daily life of people living within the specified site and its surroundings. These interviews would be focused on fenceline community members living within close proximity to industry.

Key Informants:

a) Desmond D’Sa of the South Durban Community Environmental Alliance (SDCEA).

His knowledge of the area is unprecedented, and his dedication to the protection of the community and environment is resolute. Observation studies, dialogues, and interviews would be conducted such that useful information is gathered, such that this thesis could facilitate the right principles to establish

which would serve the community and environment sustainably.

b) Dr. Catherine Sutherland

Dr. Catherine Sutherland is a geographer who specializes in social and environmental systems with the clear focus towards sustainable development. She has taught the author significant knowledge from the module Environmental and Development studies. Her work and knowledge that exists in the Durban South Basin are unparalleled. Her expertise would provide valuable insight towards implementing a sustainable approach towards architecture in the Durban south basin.

Photographic Analysis:

A photographic study will be undertaken such that relative issues can be visually documented. A more accurate study of the location and context would be better expressed visually. This would also form part of the primary research, as photos will be taken during interviews and meetings.

Case Studies:

Petrochemical industrial architecture needs to be examined such that the process of refinement is understood. This would also lead to better knowledge as to how air pollution is created, and thus eventually informing the architectural intervention.

The schools within the areas of Merebank and Merewent will be studied such that a better understanding of how air toxicity affects daily education. The main priority amongst schools is Settlers Primary School, as reports state that this is the most affected school, and contains the highest amount of asthmatic learners. The outcome of this would be to understand what the kids require in their daily lives, such that they have a suitable environment for learning and play.

Indoor Recreational Facilities and its architectural qualities need to be studied carefully, such that the architecture can suit the nature of play, without compromising on air quality.

Site analysis:

The site will be chosen upon rigorous analysis based on topography, wind patterns, and nearby fenceline communities that are most affected. The site would also need to be able to employ clean renewable sources of energy, such as tidal, wave, or wind energy. The site would also need to be in close proximity to schools, such that children could walk or cycle to engage in these clean recreational, activities, without being affected by the toxic chemicals. Therefore the site which addresses all of these requirements needs to be selected carefully.

Research Instruments:

1. Open semi structured interview schedule asking what the community would wish to see developed within the built environment.

Secondary Research:

The author aims to compile a significant amount of secondary research relating to the topic, such that a correct analysis is drawn from the literature review. The aim of the literature review is to analyse theories relating to ecological urbanism, technology appropriate to air pollution recycling, and the spaces and forms required to create a facility which would provide environmental awareness to the people of Durban.

The secondary research information would be gathered from the following sources:

- Books by various authors related to the subject
- Journal articles by various authors,
- Reports, documents and academic papers
- Television Broadcasts
- World Wide Web

Chapter 2

Theoretical Framework

Figure 1:
"Survival Kit for the Ever-Changing Planet" at the Breathe art and multimedia exhibition hosted by The World Health Organization, May 19, 2015, in Geneva, Switzerland. (http://www.coclimate.com/wp-content/uploads/2015/06/Voyage_02.jpg)

Art has and always will be at the forefront for creating different new ideologies which challenge traditional epistemology, and stir human curiosity. Chiu Chih's "Survival Kit for the Ever-Changing Planet" evokes deep awareness of the states of environments human beings are creating and subjected to, in order to cater for mass urbanisation, and world globalization. However these environments that we are creating through un-sustainable processes are contributing to air-pollution.

The air pollution levels are increasing and the artist here depicts a way in which human beings will have to go about their days in the near future if we do not guide the way the majority of the current human civilization creates new built environments, and the method in which we regenerate existing environments.

Figure 2:
“Survival Kit for the Ever-Changing Planet” at the Breathe art and multimedia exhibition hosted by The World Health Organization, May 19, 2015, in Geneva, Switzerland. (https://static.designboom.com/wp-content/uploads/2013/08/chiu-chih-voyage-on-the-planet-designboom01.jpg)

The artist states that “Like warriors bring their family’s photo with them in the war, like spacemen carry air from the Earth to go explore other planets,” he says. “Leave the comfortable home, go further, and explore the exciting world. Humans won’t just stay on Earth in next 5,000 years.”(Alcorn, 2014) Although this work isn’t just about the environment, it’s about the adaptability that humans need to have in order to ensure the resilience it would take to survive now, and in the possible near future.

2.0

Introduction

The world is moving forward and constantly evolving. A major part of the evolution of man deals with his/her ability to engage with built forms. However we have come a long way from cave dwelling and nomadic structures. The built environment has always been developing, and will continue to develop as long as the sun still shines. Architects engineers, town-planners, scientists, and environmentalists, are striving daily to discover solutions which forefront the climate change era. A collective vision of a more sustainable and greener built environment future is starting to gain ground, this is conspicuous, and is what is needed to catapult mankind into abundant life.

The theoretical framework aims to amass theories and concepts which have been developed thus far, that push the boundaries of human, environmental and developmental potential into a new paradigm. The paradigm that is studied situates itself with the overarching concept of Regenerative Development. In order to achieve a Regenerative Architecture, three principles need to be applied. These three principles are namely; co-evolution, understanding place and developmental processes (Mang and Haggard, 2016).

Three theories will be explored within this chapter, and these three theories will be viewed through an applicable principle. Living systems theory would be implemented through the principle of Co-Evolution, Place theory would be implemented through the principle of Understanding Place, and The built environment, development and learning theory would be implemented through the principle of Developmental Processes. This is important to understand because these principles would infinitely be applied to achieve a regenerative architecture. All theories, concepts and principles are viewed as one collective tool in which the author aims to analyse the literature, therefore the Theory of Symbiosis will be applied to unify the relevant theories, concepts and principles discussed.

2.1

Regenerative Architecture

"Throughout history, the really fundamental changes in societies have come not from dictates of governments and the results of battles but through vast numbers of people changing their minds—sometimes by only a little bit. . . . By deliberately changing the internal images of reality, people can change the world" (Harmon, 1990).

The present moment offers the potential, born of crisis, to transform the way humans inhabit the earth (Mang and Haggard, 2016). Never has there been a time that has existed such a time as this. Regenerative development states that social and physical structures are needed, such that any project can generate beneficial impacts that ripple out and contribute to making the world a healthier place (Mang and Haggard, 2016).

The nature of mind is an important subject to initiate a regenerative development. (Mang and Haggard, 2016) state that there is a belief that environmental problems are symptoms of a fractured relationship between people and nature. Therefore the core issue is cultural and psychological. We need to see ourselves as a part of a co-evolutionary whole, inclusive of nature. Therefore intangibles such as motivation, and human will, need to be addressed such that we do not neglect the tangible solutions.

"Regenerative design has many effects. For one, it changes the relationship of people to their places. It can restore the reservoir of practical ecological competence at the local level allowing us to do more for ourselves and for each other—the things that we once did naturally as capable people, good neighbours, and active citizens. It helps ground us by better informing us of where we are and the ecology and energy flows by which we are sustained in a particular place. In a world where any one place has come to look much like any other, we have lost sight of the fine print of our lives and how we are provisioned with food, energy, materials, and spiritual sustenance"(Mang and

Haggard, 2016). “Further, regenerative design should enhance the opportunities for caring, conviviality, celebration, and face-to-face democracy” (Hester, 2006). Due to the amount of regenerative work that is needed to provide a platform for a regenerative community, it only makes sense that the entire community is empowered and brought into participation within the creation of built environments. We must build in the ability to maintain hope and function as a society in emergency (and possibly breakdown) and lay the basis for recovery (Dartnell, 2014).

A summary of what is required of mankind is best described by David Orr in the following paragraph: “The Great Work of our generation is to create a post-fossil-fuel and postconsumer economy that is regenerative, fair, durable, resilient, convivial, and democratic. It must be powered by renewable energy. It must be a circular economy that recycles, reuses, or transforms its wastes. Of necessity it will be much more focused on essentials of food, energy, shelter, clean water, education, the arts, and rootedness in place and bioregion. It will be built by local people who cherish and understand their places and the place of nature in a sustainable economy. But it must also be a political economy, a product of revitalized grassroots capability and vision. If it is to flourish, it must regenerate possibilities and capacities that grow from foresight married to practical ecological competence” (Orr, 2016).

Therefore the author aims to focus and implement 3 key principles that achieve a regenerative architecture. These key principles are identified as Co-Evolution, Understanding Place and Developmental Processes.

Co-Evolution

“We stopped seeing ourselves as physically and spiritually connected to family, clan and land” (Suzuki, 1998). Therefore we require a profound shift in our values, behaviours and the way we view ourselves. Mang and Haggard also state that Human communities have often been able to prosper when they worked in partnership with nature. We are gradually rediscovering this fundamental truth and imagining ways to apply it in the post-industrial age (Mang and Haggard, 2016)

Therefore we notice when we help one another using nature as the binding force, mankind is able to co-evolve. We have been doing this for centuries; however we could not predict that we would also use this technique of co-evolution towards a selfish aim. Selfish aims will not last in the near future, because man would not be able to survive without any natural resources, as the famous Cree Indian Tribe proverb goes “ Only when the last tree has died, and the last river been poisoned and the last fish caught, will we realise we cannot eat money”. Therefore it is essential to understand that “the best life insurance for any species in an ecosystem is to contribute usefully to sustaining the lives of other species, a lesson we only beginning to learn as humans” (Sahtouris, 2015). Each and every living organism is a part of co-evolution on planet earth. Therefore it is important to understand its significance in the designing of built environments. To design for evolution is to design environments that help lay foundations for the on-going evolution of natural and social systems, enabling them to increase in viability and health as the world changes around them (Mang and Haggard, 2016).

An architect by the name of Teddy Cruz stated that in order to design for co-evolution” We need to redefine density, not as a series of objects thrown on the territory but as a series of exchanges. We need to negotiate a new economy and micro-politics between the top-down economics and politics of development and the bottom-up social activism of neighbourhoods, creating out of these dynamics new micro-policies, micro-economies at the level of the neigh-

bourhood. These dynamics need to redefine our tools, our practice. We as artists and architects can be the translators of the intelligence embedded in these communities. We can be the producers of new conceptions of citizenship and the reorganizers of resources and collaborations across jurisdictions and communities. Finally we could be the designers of political processes and alternative economic frameworks" (Cruz, 2010). Therefore architecture of co-evolution cannot be possible without the inclusivity of the architect and other built environment professionals to be amongst the community he/she is designing for.

Understanding Place

"No one can make ecological good sense for the planet. Everyone can make ecological good sense locally, if the affection, the scale, the knowledge, the tools, and the skills are right" (Berry, 1991).

Therefore we need to identify each place exclusively, such that the place can contribute wholly to establish a healthier built environmental collectively. "As an architect, you have to understand the essence of a place and create a building that resonates with that" (Safdie, 2011). Therefore understanding the essence of place is paramount to creating a regenerative architecture. Therefore Mang and Haggard ask the questions "What makes each place unique? What gives it vitality? Viability? What is the source of its potential and, therefore, of its capacity to evolve? With this understanding it becomes possible to tailor sustainable design strategies and processes that are harmonious with the character of a specific place" (Mang and Haggard, 2016). David Orr also states that real communities are those that which the bonds between people and those between people and the natural world create a pattern of connectedness, responsibility, and mutual need.(Orr, 2004)

Developmental Processes

"Where your talents and the needs for the world cross - there lies your vocation" - Aristotle

Mang and Haggard state that "by eliciting a collective vocation, a regenerative project can help a community coalesce around its shared purpose, inspiring will and action; this would then illuminate a path to sustainability suited to the unique character of place" (Mang and Haggard, 2016). Therefore the vocation of place will in essence form new life that will allow both its place and world to evolve. When a community awakens to its uniqueness, it taps into a potency that comes from operating authentically, from the core of which it is. "Within human communities, a collective vocation enables people to work intentionally, independently, and in diverse ways toward a common aim. Put another way, a collective vocation provides a context within which people are able to discover their individual vocations. By eliciting a collective vocation, a regenerative project can help a community coalesce around its shared purpose, inspiring will and action, and illuminating a path to sustainability suited to the unique character of a place" (Mang and Haggard, 2016).

Therefore the aim of developmental processes is to include every member of a community to be responsible for the change of that community. This is the way to creating a holistically sustainable environment, and a holistically situated architecture. The process of deliberation involves all those within the community to engage with the design process. The process encourages the members of community to ask the question, what contribution must the community make to enable their children and grandchildren to thrive here?

2.2

Ecological Urbanism

Ecological Urbanism provides valuable insight in order to “view the fragility of the planet and its resources as an opportunity for speculative design innovations rather than as a form of technical legitimation for promoting conventional solutions. The problems confronting our cities and regions would then become opportunities to define a new approach. This is the territory of ecological urbanism“(Mostafavi, 2015).This theory propagates the idea that urbanism could impact an environment positively, and to do that one needs to become innovative and inventive to apply solutions perhaps from other disciplines, such as science and technology to the field of architecture. The future is only welcoming more inhabitants to “the city”, and urbanization is predicted to be around 66% of the world population in the year 2050 (United Nations, 2014). Therefore what can architecture do to protect and regenerate natural resources in urban environments with increasing demands from an expanding urban population?

This theory is relevant to the cause of Air Pollution within the Durban South Basin, due to industries having only looked at developing, and growing their enterprises, without the consideration for natural and ecological systems and corridors. Therefore the theory proposes that we develop architecture to suit its climate, economy, context, community and local identity. Ecological Urbanism as a concept can be implemented by key strategies, namely; to anticipate, collaborate, curate, sense, interact, produce, incubate, adapt and measure ideas. These methods also bridge the gap between academic theory and practical implementation of thoughtful design in the creation of built form. Architects and visionaries who utilize a practical implementation of thoughtful design towards an environmentally conscious design approach will be explored further.

An environmentally conscious Architect is Ken Yeang, who is internationally recognised as the leading proponent of ecological design in architecture. In 2008, he was identified by The Guardian, as one of the “50 people who could save

the planet". He advocates an environmentally responsible approach to design and incorporates bioclimatic features in high-density building typologies (Hart, 2011). He incorporates the climate as a generator for design, such that the architectural solution consumes less energy, provides a more humane environment and establishes a unique local cultural identity. Thinkers of such provide valuable insight into pioneering work which aid in the quest for providing an ecologically focused architectural solution.

Therefore the research does not just seek for knowledge pertaining to ecological coexistence within the built environment; however, it also aims to develop an understanding of how the built environment can perform as a mediation space for industry and community to engage with each other, such that they can resolve issues through education.

2.3
Living Systems Theory

"Healthy citizens are the greatest asset any country can have."
- Sir Winston Churchill

Living systems theory is a general theory which postulates that every organism on earth is exists, and they exist due to the relationships which are created. As Miller states complex structures which carry out living processes can be categorized into seven hierarchical levels. They are the cell, organ, organism, group, organization, society, and supranational system (Miller, 1978).

Therefore if we consider the relationship between man and place, we can understand how place is seen as a living system. "Each particular place is the continuously evolving expression of a highly complex set of forces–inanimate and living–which become integrated into an organic whole."(Dubos, 1972)

"Living systems are open; they interact and co-evolve (or co-devolve) with their environments. Nestedness implies that there is a mutuality of interest among their different levels, based on the energies they exchange. Although organisms are at once complete, independent, and autonomous, they are also interdependent with other life forms."(Mang and Haggard, 2016)

Therefore when we look at the relation of architecture to place, we witness the great possibility for architecture to affect change by implementing a living system strategy such that the uniqueness of place is designed for and addressed. "The health of human beings, societies, ecosystems and the planetary life support system is fundamentally interconnected and interdependent."(Wahl, 2009) Therefore if the health of human beings isn't well, then this affects the society and ecosystem they living in, in this case pertaining to the community residing within the Durban South Basin. This is the stratum of the theory, should one affects the small, and it inadvertently affects the society.

2.4
Permaculture

“All the world’s problems can be solved in a garden” – Geoff Lawton

Permaculture is a term made up by Bill Mollison and David Holmgren. It is the amalgamation of the words permanent and agriculture – permaculture. Permaculture is firmly grounded in the core fundamentals on the way nature works, and using those fundamentals in the application towards the regenerative process of the environment and global community.

As Mang and Haggard state that “Permaculture is a design system that develops and applies the ability to discern the patterns that are structuring both natural and human systems, and to generate new patterns that weave the human and natural together into a dynamic whole.”(Mang and Haggard, 2016)

2.5

Place Theory

Place is an important concept and many scholars believe that it is only in relationship to place that humans experience the intimacy and responsibility to the living world and find a meaningful identity and role for themselves (Relph, 1976; Sack, 1977; Berry, 1981; Casey, 1996; Malpas, 1999; Cameron, 2002; Cresswell, 2004).The importance of relevance to place is described by Kelly, “Wherever you live, your tiny spot is deeply intertwined within a larger place, embedded fractal like into a whole system called a watershed, which is itself integrated with other watersheds into a tightly interdependent biome. At the ultimate level, your home is a cell in an organism called a planet. All these levels interconnect. “(Kelly, 2005)

Therefore in order to design for a regenerative development for a community revitalisation, it is paramount to understand place, such as the Durban south basin. Understanding place would provide valuable insights into designing architecture of relevance and regeneration.

2.6

Critical Regionalism

Critical regionalism is a base for routing architecture to place and its connection to nature (Frampton, 1983).

Frampton also states that the fundamental strategy of critical regionalism is to mediate the impact of universal civilization with elements derived indirectly from the peculiarity of a particular place (Frampton, 1983) Critical Regionalism forms the basis for bounding architecture to place, its principles mediate the modern world with the vernacular, by weaving together the influences of modernisation and the machine with local hand-made, vernacular craft (Frampton, 1983). Therefore it is essential to understand place, and its inclusive varieties. In an understanding of place, a better design solution can be obtained, which fits within the context, rather than utilizing a universal solution, which clearly demonstrates placelessness.

2.7

Built Environment and Empowerment

Introduction

The built environment and empowerment explores ideas relating the people to the architecture and examining the relationship between them.

When man/women are empowered then they can find the deepest resources within themselves. The people need the knowledge that they can change their circumstances through massive action aimed at right focus. Therefore the relationship that architecture has with people is an important one because it has the ability to empower people.

2.7.1 Individual Empowerment (Maslow's hierarchy of needs)

Maslow's hierarchy of needs states that people act because of certain needs and certain needs takes precedence before others. Each need is described in levels, and there are 5 levels. Once each level is attained then we look forward to achieving the next level.

The 5 stage model can be divided into deficiency needs and growth needs. The first four needs are deficiency needs and the last need is a "being need". Deficiency needs are what motivate people if they are unmet into achieving them. These needs are in the following order;

- Physiological needs (food, water, warmth, rest)
- Safety needs(security, safety)
- Belongingness and love needs(intimate relationships, friends)
- Esteem needs(prestige and feeling of accomplishment)

Each of these needs become stronger if they are unmet. If one is hungry they will become motivated to get food until that hunger is satisfied.

Maslow (1943) initially stated that individuals must satisfy lower level deficit needs before progressing on to meet higher level growth needs. However, he later clarified that satisfaction of a needs is not an “all-or-one” phenomenon, admitting that his earlier statements may have given “the false impression that a need must be satisfied 100percent before the next need emerges” (1987, p69).

Growth needs do not stem from a lack of something, but rather from a desire to grow as a person. Once these “growth” needs have been reasonably satisfied, one may be able to reach the highest level called self-actualization.

Everyone is capable of reaching self-actualization, however many people get stuck in the lower levels back and forth, and fail to achieve the chief aim of life.

On the following page is an image of Maslow’s hierarchy of needs:

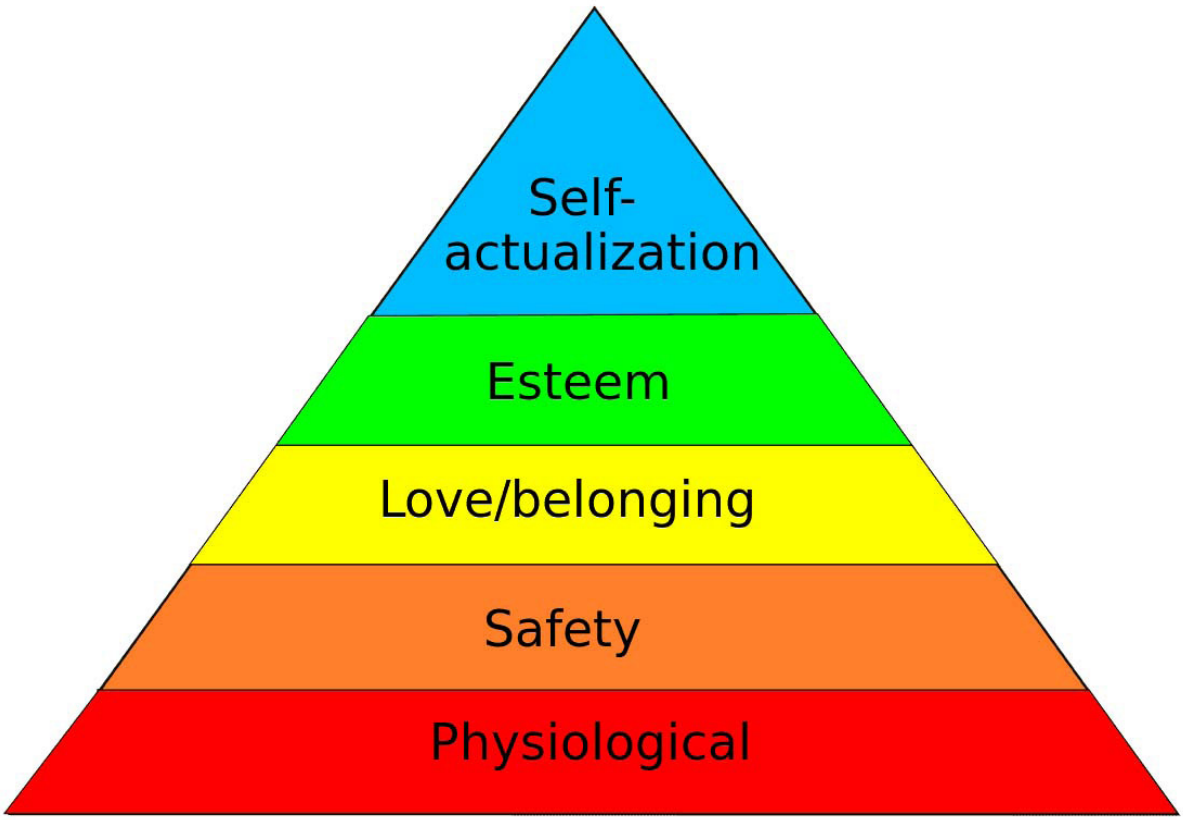


Figure 3: Maslow’s Hierarchy of needs (https://www.simplypsychology.org/maslow-needs.png)

2.1.2 Group Empowerment

Group empowerment is the ability for people to unite in a common cause; this is a great ability of human beings as they can thrive from each other. This is related back to Maslow's hierarchy of needs.

People are stronger in unison. The old maxim holds true: "Birds of feather flock together"

When people of the communities consisting of Durban South Basin (Wentworth, Isipingo, Bluff, and Merewent) come together, then they become a force to reckon with, as they are united by a common cause, to protect their health, children's health and social welfare and quality of life for the people of Durban South Basin.

2.1.3 Conclusion

The empowerment of the people is a powerful thing, as the people of the communities within the Durban South Basin were previously oppressed. Therefore they have become used to the oppression posed onto them by apartheid government. Although South Africa is now a Democracy, this oppressive tendency of the state still looms over the neighbouring communities. This is because the state favours economic gains over quality of life for the people – "Neo-liberal policies promote investor friendly regimes open to international capital and global markets" (Niranjan: 2005). Therefore the solution is to empower the people, and thereafter forces can be set into motion which aid to the dissolution of the hazardous chemicals and substances within the air and environment.

Built Environment and Learning

3.1.0 Introduction

"Built environments include the buildings, sidewalks, streets, play structures and other human-created spaces around us" (Eco Healthy Child Care)

Learning about the environment is an important study. This learning should be about all the surroundings in and around the environment such that students are educated about their surroundings and the relationships of surroundings with their specific buildings.

Knowledge on the environment and ecosystem allows for a perfect relationship for every person in the local community.

"It can therefore be shown that people react to environments globally and affectively before they analyse them and evaluate them in more specific terms. Thus the whole concept of environmental quality is clearly an aspect of this – people like certain urban areas, or housing forms, because of what they mean. Places considered to be industrial, and hence smoky, unhealthy, dark, and dirty are disliked" (Burgess, 1978)

"This applies equally to classrooms, student dormitories, wilderness areas, housing, cities, and recreation areas" (Rapoport, 1977:50)

Therefore the understanding of the built environment and its meaning is important. If the relationship between the two is clearly understood then the creation of better and more climatic conducive environments to aid in study and learning could be provided.

3.1.1 Learning Theories

Humanism Paradigm:

"Humanism is a paradigm/philosophy/pedagogical approach that believes learning is viewed as a personal act to fulfil one's potential" (David L, 2015)

"Humanism, a paradigm that emerged in the 1960s, focuses on the human freedom, dignity, and potential. A central assumption of humanism, according to Huitt (2001), is that people act with intentionality and values (Huitt, 2001). This is in contrast to the behaviourist notion of operant conditioning (which argues that all behaviour is the result of the application of consequences) and the cognitive psychologist belief that the discovering knowledge or constructing meaning is central to learning. Humanists also believe that it is necessary to study the person as a whole, especially as an individual grows and develops over the lifespan. It follows that the study of the self, motivation, and goals are areas of particular interest" (David L, 2015).

"Key proponents of humanism include Carl Rogers and Abraham Maslow.
A primary purpose of humanism could be described as the development of self-actualized, autonomous people (Rogers C & Freiberg, H.J :1994). In humanism, learning is student centred and personalized, and the educator's role is that of a facilitator. Affective and cognitive needs are key, and the goal is to develop self-actualized people in a cooperative, supportive environment (DeCarvalho, R.: 1991)"
(David L, 2015).

Social Learning Theory:

"Bandura's Social Learning Theory posits that people learn from one another, via observation, imitation, and modelling. The theory has often been called a

bridge between behaviourist and cognitive learning theories because it encompasses attention, memory, and motivation" (David L, 2015).

"People learn through observing others' behaviour, attitudes, and outcomes of those behaviours" (Bandura: 1977). "Most human behaviour is learned observationally through modelling: from observing others, one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action." (Bandura: 1977).

"Social learning theory explains human behaviour in terms of continuous reciprocal interaction between cognitive, behavioural, and environmental influences" " (David L, 2015).

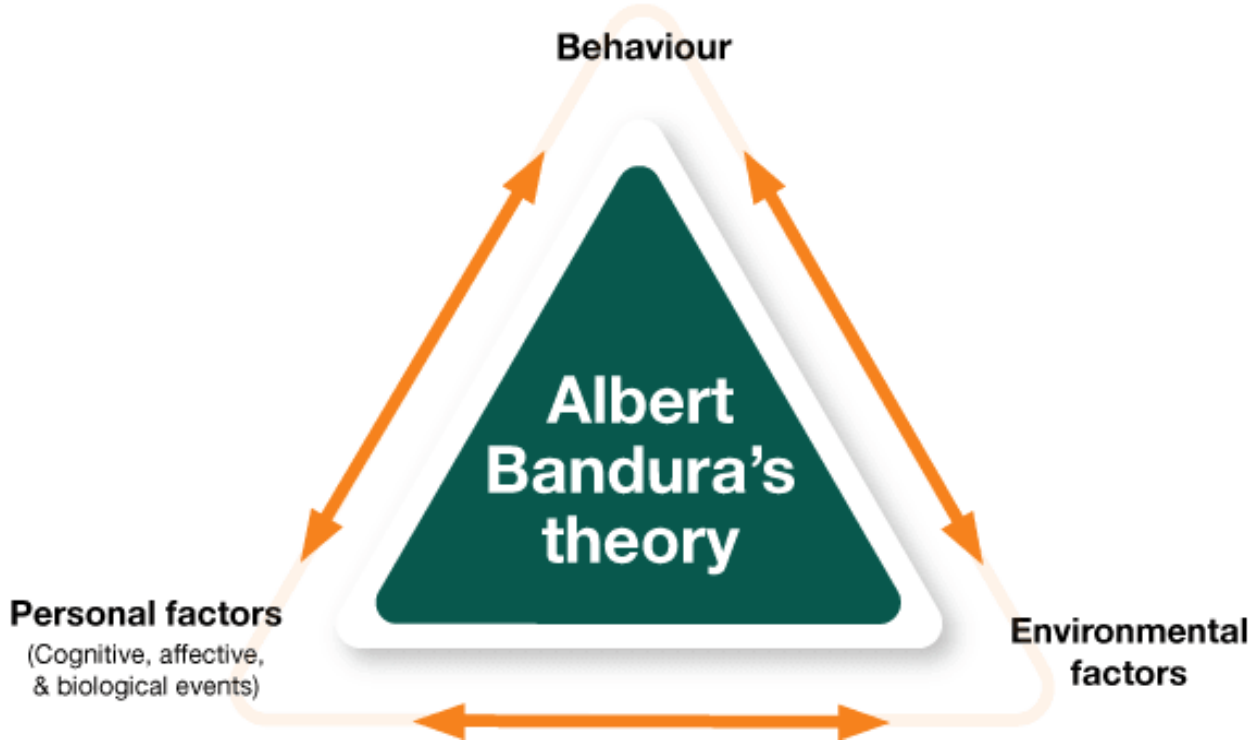


Figure 4: Social Learning Theory (http://3.bp.blogspot.com/Social-Learning-Theory-Albert-Bandura.png)

3.1.2 Conclusion

The built environment is a necessary process which is a part of learning. Learning happens within the built environment. The creation of an environment which is constantly learning and adapting to the requirements and needs of the local community is essential for the future years to come.

Resilience in Durban

4.1.0 Introduction

Resilience is a metaphor that captures the ability of something to rebound or resume its original shape following exposure to a stressor (Welsch: 2013).

Resilience had been conceived as a property of a system that makes it return to an equilibrium or a steady state after a disturbance (or 'engineering resilience'; Gunderson 2000).

In contrast 'ecological resilience' defines or measures 'the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain the same function, structure, identity, and feedbacks' (Walker et al. 2004, 2).

4.1.1 Resilience Strategy for Durban

Durban has been chosen as one of the 100 Resilient Cities in the Rockefeller foundation programme and a framework and strategy has been developed which aims to target Durban's key issues/problems:

Individuals

- Access to basic services
- Access to livelihood opportunities

Communities

- Rebuilding a fractured society
- Promoting active and engaged citizens

Systems

- Environmental issues
- Reliable infrastructure
- Governance
- Finances
- Knowledge systems
- Leadership

It is important to note that the upgraded amendment focuses on the rehabilitation of informal settlements into phase projects. Durban is currently waiting to see if the Resilience strategy would be approved by the Rockefeller Foundation, due to amending the strategies posed by the Rockefeller foundation.

4.1.2 Deliberation and Community participation

A collective exchange, that allows people to transform pre-given opinions into new 'preferences' -on the basis of the exchange (Hajer, 2005).
Knowledge therefore becomes the product of the practice of deliberation and community participation.
Characteristics of deliberation:

Reciprocity: discussions must be conducted through an argumentative exchange, each participant responding to each other's views (Hajer, 2005).

Inclusiveness: debates require that stakeholders are made part of the argumentative exchange, and that everyone with a stake can have a say (Hajer,

2005).

Openness: the way in which the debate is staged and conducted must avoid unnecessary barriers, including that of (professional) language (Hajer, 2005).

Integrity: the debate requires honesty and no double play (Hajer, 2005).

Accountability: those involved are accountable to political bodies and to the public at large, also with regard to the degree to which the rules as laid out have been guaranteed (Hajer, 2005).

Dialogue: learning through an ongoing process in which knowledge is mobilised and enriched through confrontation with a variety of stakeholders and experts (Hajer, 2005).

4.1.3 Conclusion

Deliberation is a complex and political process which requires negotiation in a networked and multi-party setting. Strong rules need to be generated which help resolve conflicts should they arise and these rules should guide expectations. The setting in which deliberation takes place needs to be formalised such that the outcomes of the situation is increasingly democratic. Ultimately there needs to be a more sustainable process of decision making amongst the local community, and this is the best possible way, if done correctly.

Resilience is a new term and is used a lot in the field of environmentalism and development. The reason it is so important is become Durban has adopted a resilient strategy which is being implemented within the city. However resilience does have a negative3 side to it, such that one asks the question; when do we stop being resilient and start being pro-active towards the environment?

Therefore resilience needs to be looked at with sustainable development which is a theme explored in the next chapter.

Figure 5: Displaying Engen Refinery amongst community. (https://sodurba.files.wordpress.com/2016/10/engen.jpg?w=1038&h=576&crop=1)

Sustainability

5.1.0 Introduction

Sustainable development is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend. Sustainability allows for resource to be continuous and recycled.

Ecological Modernisation

This is a fundamental belief that science and technology can solve environmental problems.

Weak EM	Strong EM
Economistic	Ecological
Technological (narrow)	Institutional/systemic (broad)
Instrumental	Communicative
Technocratic/neo-corporatist/closed	Deliberative/democratic/ open
National	International
Unitary (hegemonic)	Diversifying

Figure 6: EM Table (Table 1 Types of Ecological modernization, Christoff, 1996, p 490)

Ulrich Beck (1992, 1995) – we are living in the 'risk society' where we are managing the dangers.

5.1.1 The Origin of the Concept of Sustainability

"UNEP Stockholm Conference on Environment and Development (1972)
The Conference was launching a new liberation movement to free men from the threat of their thralldom to environmental perils of their own making. The movement could succeed only if there was a new commitment to liberation from the destructive forces of mass poverty, racial prejudice, economic injustice, and the technologies of modern warfare. Mankind's whole work and dedication must be towards the ideal of a peaceful, habitable and just planet.
The Conference could not deal with all the ills of the world, but if it successfully accomplished the important work before it, it would establish a new and more hopeful basis for resolving the seemingly intractable problems that divided mankind. It had to be recognized that the physical interdependence of all people required new dimensions of economic, social and political interdependence. Better means would have to be devised for making knowledge available to decision-makers and to those who would be affected by decisions" (Sutherland C, 2017)

Ecological sustainability:

The life support systems of the earth must not be compromised and the regional and local ecosystems upon which development depends must be maintained. The intrinsic value of the natural environment must be recognised and the integrity of natural systems must be protected. Carrying capacity is an important component of ecological sustainability. (Sutherland C, 2017)

Social sustainability:

Relates to the social capital which is created through human endeavour. Social capital includes the built environment, identity and attachment to place,

social networks for survival and for the enhancement of quality of life, responsibility and citizenship that is developed through participation in projects, and the creation of recreational and cultural spaces and activities. Education and empowerment forms an important part of the social capital necessary for improved planning and development. (Sutherland C, 2017)

Economic sustainability:

With the current global economic system which encourages private profit, market expansion, just in time production and low investment in social services, the need for approaches which challenge the inefficient use and unequal distribution of resources is critical. Environmental economics offers some insights into how to cost environmental resources into budgets so as to ensure a more equitable use of resources. (Sutherland C, 2017)

Governance:

Global and local society is no longer managed by hierarchical top down systems where the state controls and plans society. There is a new system of governance where many stakeholders: business, the state, scientific experts and civil society interact to find solutions to challenging problems through partnerships and more democratic decision making. Processes of governance where scientific experts engage with local knowledge and where all actors debate solutions are favoured under sustainability. (Sutherland C, 2017)

Futurity

The stock of both natural and social capital that should be passed on to future generations. Sustainable development is future oriented in that it aims to ensure that future generations are at least as well off as people living now (precautionary principle) .(Sutherland C, 2017)

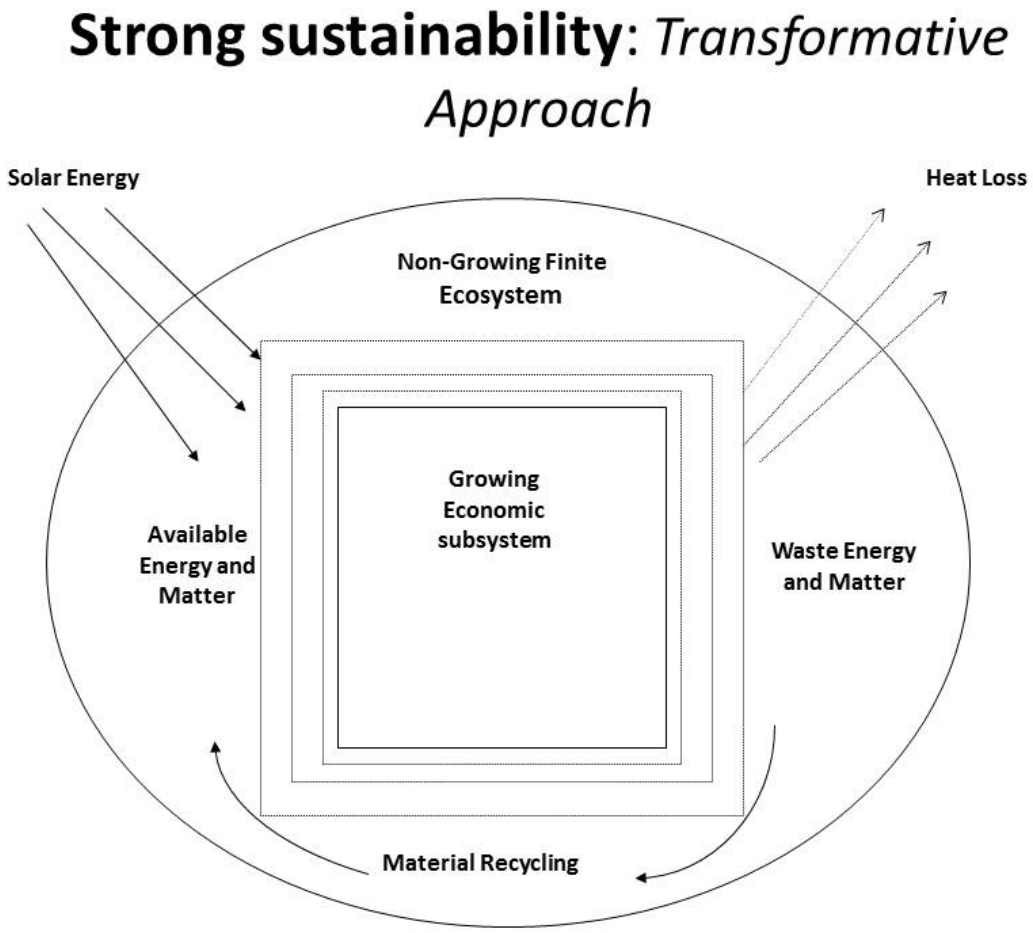


Figure 7: (Image above and below of Strong sustainability from notes: Sutherland C, 2017)

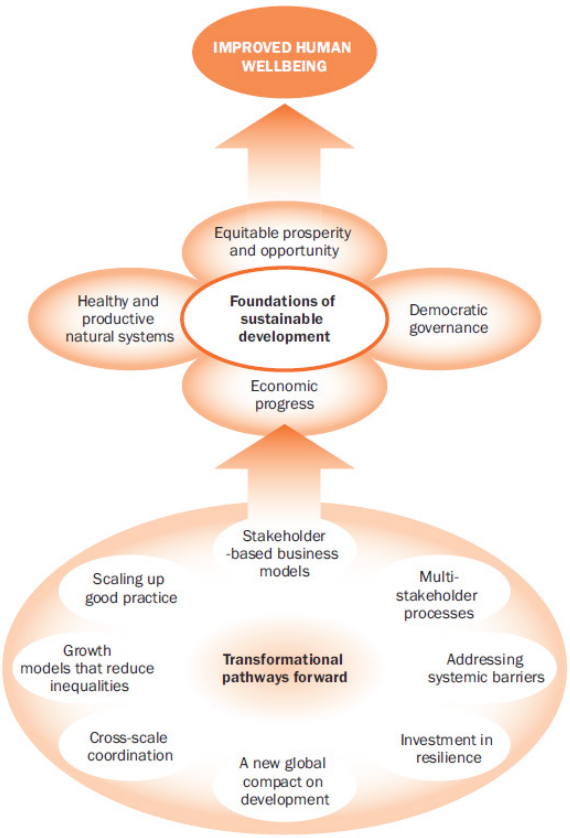


Figure 8: Foundations of a sustainable development ((Image above of sustainable development goals from notes: Sutherland C, 2017)

Figure 9: Sustainable development goals (Image above of sustainable development goals from notes: Sutherland C, 2017)

5.1.2 Conclusion

The concluding statements of this chapter relate to the idea that we need to meet these new sustainable development goals.

If these goals aren't met then we are adding to global warming and contributing to environmental degradation, social degradation and economic degradation.

Therefore key principals mentioned above need to be implemented within the environment of the Durban South Basin such that the area could be revitalized accordingly towards the sustainable development goals (SDG's).

The main cause of environmental pollution is the massive carbon requirement and use of carbon by human beings. Human beings are living in the anthropogenic age and we are the dominant species, therefore if we do not aim to make changes to our lifestyles and the way we consume energy, there will be no planet left for our future generations.

It is only fair that we be kind to such a loving and generous planet – which gives all life and forms sustenance.

Symbiosis

Kisho Kurokawa and The Philosophy of Symbiosis symbolises that everything is related to everything and that there is a sense of non-duality/ symbiosis existing on earth. Hence this theory proposes methods to address the disjunctive environment existing. The philosophy of symbioses explains that the intimate organism to organism interaction is an interaction where the stronger element does not dominate the weaker, but rather an endeavour to determine common rules, without removing the variance between the elements (Kurokawa, 1994). This is relevant to the relationship between industry, environment/nature, people and air quality within the Durban South Basin

Conclusion

The understanding and correct implementation of the above-mentioned theoretical framework and literature is important because it shapes an architecture, which people within the context of the Durban South Basin can be proud of and associate an identity to. This will lead to more interest being taken in on the area, and could possibly attract eco-tourists and visitors from all around the world to come and view how nature has been included as a force to combat the problems created from industrialist and mechanistic thought paradigms.

Currently, there is no research being done in this locality, with the given issue, in the specific field of architecture and urban design. The literature and study aim at approaching and analysing the issue of air pollution in the Durban South Basin, through a regenerative Architecture, such that the architecture aims to prove its advancement in technology effectively and act as a "filter" to industrial air pollution. This proposal could serve as a guideline for the cleansing of toxic air within previously and currently disadvantaged communities. The utmost essence of formulating the literature is to understand how architecture, can decontaminate the air people breathe within communities of close proximity to oil refineries, and regenerate the environment into a healthier ecosystem for inhabitants to live in.

Figure 10: Image displaying the correlation between children playing and Engen refinery in the background.
(http://www.greenpeace.org/eastasia/Global/eastasia/photos/climate-energy/COP%2017/GP03BZK.jpg)

Chapter 3

Regenerating ecology through architecture

Introduction

The literature aims to address the key question: How can architecture help to reduce air toxicity and hence assist in creating clean and safe inhalable air for the residents of South Durban Basin?
The research also identifies 3 key objectives which when achieved, will formulate an approach to answer the primary question and achieve the primary objective. They are as follows;

1. To understand the history of the Durban south basin, and the challenges facing the community currently.
2. The utilization of renewable energy to decontaminate air pollutants.
3. To promote community development through built form and architecture.

This chapter will aim to answer the key question through the principles identified within the theoretical framework. This chapter begins with the enquiry of architecture and co-evolution. It is important to understand that co-evolving relationships exist within nature and the built environment. This chapter will aim to understand the essence of co-evolution within nature, and its role in the built environment by exploring the role of architecture and place, and the challenges facing architecture and place (Durban South Basin).

Understanding place is important when architecture is being developed for a community. Architecture is designed to meet the communities' specific functional and visual needs. Therefore the literature will inform a research towards addressing the uniqueness of place. Finally the interaction between developmental processes and architecture will be addressed, and utilised to identify architecture as a regenerative symbol. In order for architecture to regenerate it requires processes which contain activities that regenerate thought paradigms existing within the community. These developmental processes will oc-

cur simultaneously, daily. Literature informing developmental processes within community, regeneration of environmental quality, and economic quality will be studied.

3.1 Architecture of Co-evolution

3.1.1 Cities and air purification

The air we breathe consists of 21%oxygen, 78%nitrogen and small amounts of carbon dioxide, argon and various other gases. Water vapour is also present within the air to some degree. All other components of air are considered contaminants. This natural equation has been longstanding and even a minimal disruption to the above equation would result in dire consequences. Chlorofluorocarbons (CFC'S) were created by Thomas Midgley, a research scientist who worked for the Frigidaire division of general motors. He was asked to produce an alternative to ammonia, which was a toxic refrigerant. He discovered an alternative gas which is stable and inexpensive, known as CFC's. Today this chemical substance together with volatile organic compounds (VOC), Carbon dioxide, carbon monoxide, methane, nitrogen oxides and surface ozone/ greenhouse gas; are the leading causes of global warming. Studies have shown that the global surface temperature will increase by 1degree Celsius annually (Zaheir, 1996). The exponential rise in temperature will result in a disastrous consequence of events.

Air pollution is caused by gases and solids. Gas particles are lighter than air particles. Solid particles require a low density to become airborne. The combination of gases and solids has a greater likelihood to pollute the air, than gasses or solids individually.

The primary sources of pollution can be divided into two categories, point sources and non-point sources. Non-point sources are emissions from motor vehicles, wood fires, aerosol, or dust. Point sources are fixed sources, such as industrial plants and mines. This thesis focuses on point sources as the source of air pollution, specifically the consequences of petrochemical compa-

nies. Petrochemical reactions produce smog. Smog is formed by the combination of nitrogen oxide (burning of fossil fuels) and hydrocarbons with other forms of VOC's in direct sunlight. This chemical process produces the murky haze which hovers over the city. Smog affects the nose and lungs, produces a putrid odour and creates breathing difficulties (Zaheir, 1996).

Urban migration is rapidly increasing; therefore air pollution must be addressed in order to run efficiently. The purification of air in cities is a topic gaining traction in the contemporary society, as air pollution continues to worsen. The decline in the quality of air can be attributed to the constant burning of fossil fuels in various forms, and construction of built form and infrastructure in unsustainable methods.
Toxic volatile substances emitted in the form of gases from paints, carpets, and fabrics often accumulate in the stagnant circulation zones common to indoor home and office urban environments and further contribute to pollution. (Molhave, 2004).

An ecological approach to addressing air pollution is through living plants. This traditional approach to managing indoor and outdoor air pollution is naturally effective. The capacity of natural air purification using vegetation is limited. According to an estimate, it takes roughly seventy spider-plants to purify an area of 420 square meters of interior environment (Wolverton, McDonald and Watkins, 1984). With the aid of architecture, engineering and human design, the process of growing plants can become time efficient, resulting in more plants filtering air.

Diffusion and Convection are natural processes which use vegetation to filter toxins from air. Toxic gases are absorbed on the exposed surfaces such as leaves, and thereafter degraded through natural metabolic processes (Giesse, Dauranth, Langebartels and Sanderman, 1994). In the mid 1980's NASA researchers approached the problem of air pollution by directing air through plant soil. The root systems in soil contain microorganisms, and provide a

second layer for the metabolic transformation of air. The combination of ventilation with soil filtration led to early prototypes of living filters which were capable of cleaning air (Wolverton, 1988). Despite the efficiency of plant and soil filtration systems for air purification, these systems have a limited capacity compared to Carbon air filters or High Efficiency Particulate Air (HEPA) filters.

Living Air Filter

The constraints surrounding air pollution has been addressed with the design of a living air filter. The living air filter is more efficient regarding mechanics and aesthetics, compared to the NASA designed plan for air filtration. The living air filter was designed by the French designer Mathieu Lehanneur in collaboration with David Edwars for the opening of the centre for experimental art and named Le Laboratoire in central Paris. The project named Bel-Air directs polluted air through the leaves and soil of potted plants. In addition it directs air through a water bath and back into the environment with a speed greater in magnitude than the original design represented by NASA (Edwards, 2013). The competition for technology has resulted in the creation of more efficient designs and approaches to combat the problem of air pollution. Bel-Air won Popular Science Invention of the year award in 2008, MOMA (Museum of Modern Art) New York. This design has been sold commercially under the name Andrea. This design can be reproduced at various scales, making it a desirable and significant strategy in sustainable urban architecture of the near future.

Figure 11: The image displays the device functioning within an exhibition space. This device cleans the air. https://www.amazon.com/s/?field-keywords=ANDREA+Plant-based+Air+Purifier&tag=2016000-20

The above image demonstrates the design of andrea.

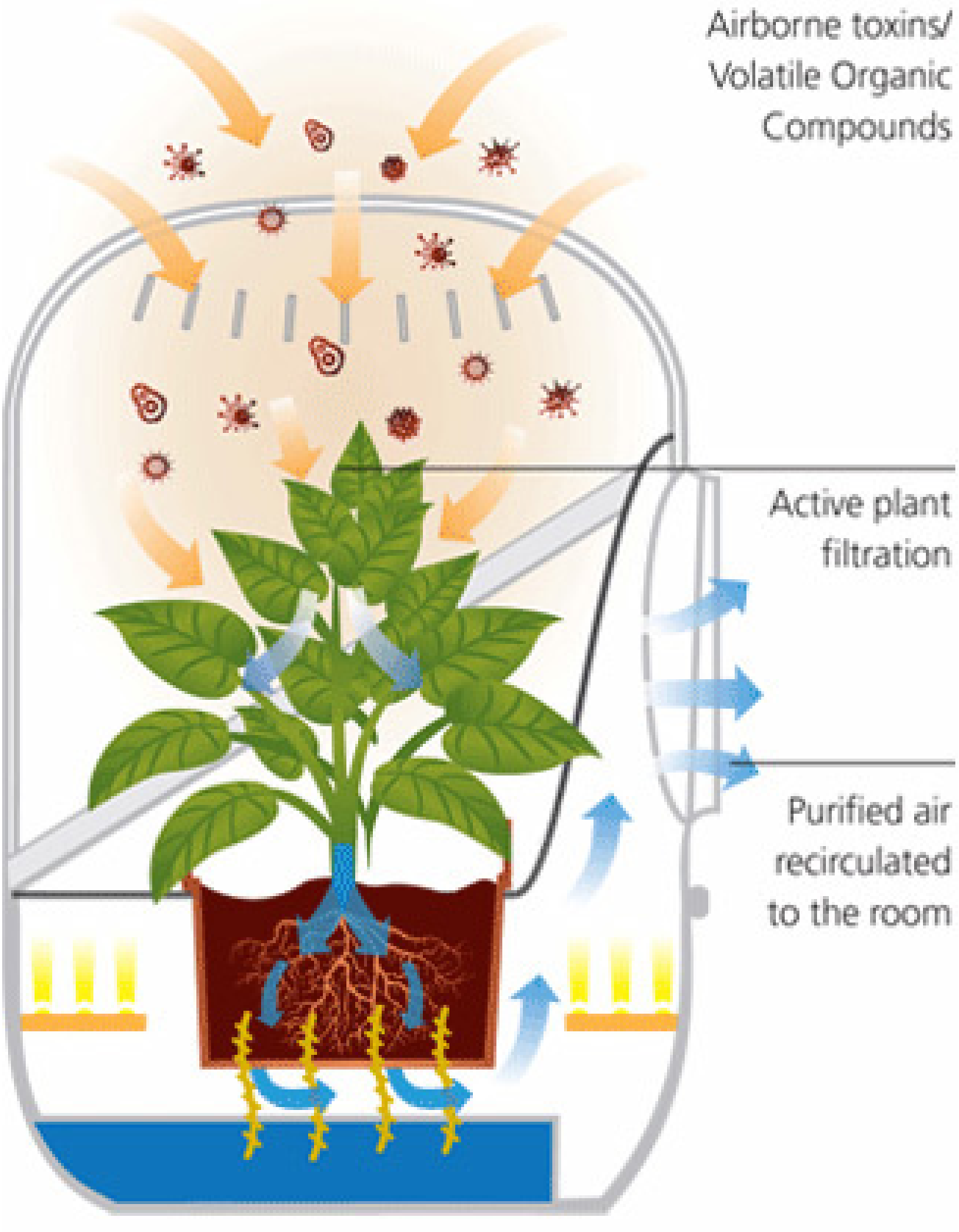


Figure 12: The image displays the device functioning within an exhibition space. This device cleans the air. https://www.amazon.com/s/?field-keywords=ANDREA+Plant-based+Air+Purifier&tag=2016000-20

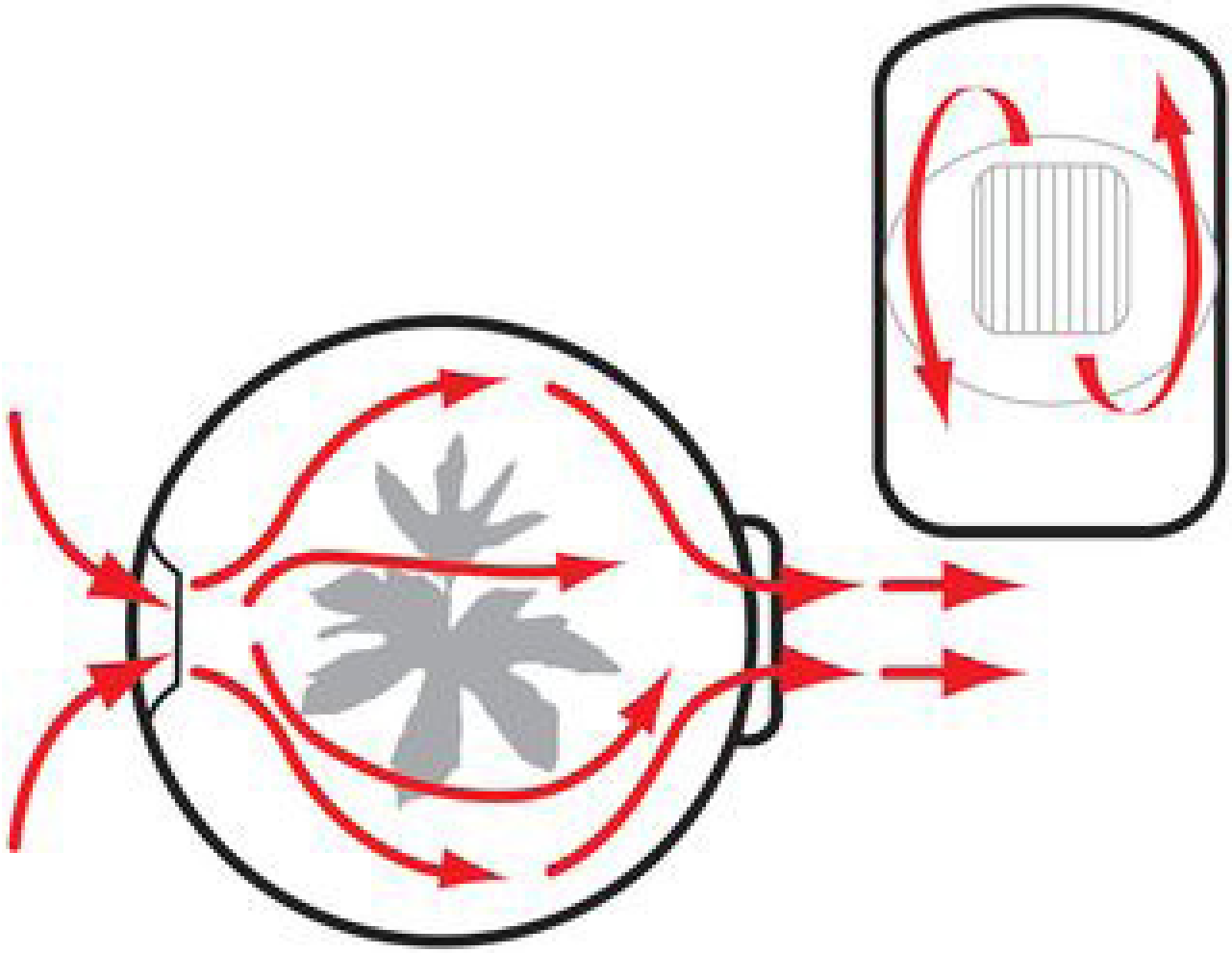


Figure 13: Section diagram illustrating the working process and directional flow of air. (https://www.designboom.com/cms/images/andrea01/andrea11.jpg)

Mathieu LeHanneur and David Edwards built an ultra-efficient filtration system that eliminates toxins using plants. Plants can only purify air which comes into contact with the plant. A container is constructed containing fans which allow air to encircle the plant for maximum effieciency,by circulating air within the container. A fan blows air around leaves, whilst a second fan sucks air through soil and water underneath the soil, this tray of water produces humidity that keeps the plant moist and traps additional toxic molecules. This system then circulates the air to the room. Vents on the side release purified air into the room. (Aaronson, 2008)

Dan Roosegaarde, Air purification Tower

A Dutch designer by the name of Dan Roosegaarde and his firm, studio roosegaarde have come up with a solution to the problem of air pollution. Their creation, The Smog Free Tower is a 7 meter tall aluminium tower using only 1170 watts of electricity and positive ionisation technology. The tower suctions in air through vents on the top, cleans it through ionisation technology techniques, and then releases it through the vents on all six sides. According to the firm, the design is equipped with environment-friendly technology that cleans 30.000 m3 of air pollution per hour.
The Smog free tower provides a local solution for clean air in public spaces such as parks.

Figure 14: An image displaying The Smog free tower surrounded by the industrial context (www.studioroosegaarde.com, 1, 2018

Environmentally conscious architecture

"The precondition of any civilization, old or new, is energy. First wave societies drew their energies from human and animal muscle power, or from the sun, wind and water. Second wave industrial societies began to draw their energy from irreplaceable fossil fuels-oil, coal, and natural gas. This revolutionary shift meant that for the first time a civilization was eating into nature's capital rather than merely living off the interest it provided. Third wave civilization must and will draw on an amazing variety of energy sources-hydrogen, solar, geothermal, tidal, biomass, lightning discharges, perhaps advanced fusion power, as well as other energy sources not yet imagined." - The Third wave, Alvin Toffler, 1980

Environmentally conscious architecture explores landmark principles in general ecology, and socially responsible building design. Environmentally responsible design is currently still in the process of being defined worldwide by pioneering architects, designers, construction consultants, engineers, and the client.

The term sustainability was not favoured by Australian futurist Peter Ellyard, as he states that the word 'sustainability' means survival, where as we should be focusing on thriving. According to Robert Berkebile, each design decision must be an act of restoration and renewal. "Design decisions must be contributing to the social, economic, and environmental vitality of the individual and of the community"(Pederson, 2013).

What is the real impact of our design on those who we intend to serve, on their neighbourhood, community and the planet? When this question is considered and realized, we will find out that our actions echo in the immortal notion of time. If mankind is to survive, we require a significant shift in our thinking. We need to understand that our thought process needs to change. Berkbille states that " the inertia of business-as-usual has created an obsolete governmental policy, land use laws, public safety codes, infrastructure

that aims to overpower natural systems, tax, and economic policy that encourage our short sighted take-use-waste behaviour." He also states that globally, there are increasing examples of these barriers being broken down by great examples of ecological design.

The concept of 'sustainability' was introduced by William McDonough which was provided by the World Commission on Environment and Development (Zeheir, 1998). He published the Hannover principles via a commission by the German Government to create a set of design principles for the EXPO 2000 World's Fair.

The 9 Hannover principles are as follows:

1. "Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition".

2. "Recognize Interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects".

3. "Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness".

4. "Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist".

5. "Create safe objects of long term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes, or standards".

6. "Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems, in

which there is no waste".

7. "Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use".

8." Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled".

9." Seek constant improvement by the sharing of knowledge. Encourage direct and open communications between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity".

The Hannover principles mentioned above should be seen as a living set of principles. These principles are constantly evolving and transforming in relation to our understanding of our interdependence with nature. Therefore these principles should adapt as the world evolves.
How effective are current practices of sustainability in the built environment and do they follow the principles delivered as the Hannover principles? Most sustainable practices of architecture try to use energy and material more efficiently. This is through the paradigm that decoupling material use from economic growth can sustain architecture and industry in the long term. This insight is critical because the World Resources Institute projects that the world's energy use will rise by 300 percent, due to the increase in world population and economic activity over the next 50 years. Therefore if increase in economic activity means more material being used, the equation will not be balanced, as there will be little hope for limiting impacts of human activity on the natural environment. 'If industry can become more efficient, us-

ing less material to provide the goods and services people want, economic growth can be sustained—thus decoupled from resource extraction and environmental harm" (Matthews, Emily, et al.2000).

Some of these techniques helps designers and architects to utilize the closed loop cycles of nature - where there is no waste, one of these techniques is called cradle to cradle design.

Cradle to Cradle design

The current perspective of the marginal population is cradle to grave, which translates to product to waste. Cradle to cradle is a process whereby there is no waste, and designs can embody these principles because they already exist within nature. "By modeling designs on these regenerative cycles, cradle-to-cradle design seeks, from the start, to create buildings, communities and systems that generate wholly positive effects on human and environmental health. Not less waste and fewer negative effects, but more positive effects. Imagine, for instance, buildings that make oxygen, sequester carbon, fix nitrogen, distill water, provide habitat for thousands of species, accrue solar energy as fuel, build soil, create microclimate, change with the seasons, and are beautiful" (Braungart and McDonough, 2003).

Cradle to cradle design is not just a wishful design concept. It is based on ecological intelligence. "In the natural world - a grand, evolving system based on hundreds of millions of years of research and development - the processes of each organism contribute to the health of the whole. One organism's waste is food for another, and nutrients and energy flow perpetually in closed-loop cycles of growth, decay and rebirth. Waste equals food. Understanding natural systems allows architects and designers to recognize that all materials can be seen as nutrients that flow in natural or designed metabolisms. By specifying safe, healthful ingredients, designers and architects can create and use materials within cradle-to-cradle cycles. Materials designed as biological nutrients, such as textiles for draperies, wall coverings and uphol-

stery, can be designed to biodegrade safely and restore soil after use, generating more positive effects, not fewer negative ones. Materials designed as technical nutrients, such as infinitely recyclable textiles, can provide high-quality, high-tech ingredients for generation after generation of synthetic products. And buildings constructed with these nutritious materials, and designed to respond to local energy flows and cultural settings, encourage patterns of human settlement that are restorative and regenerative." (Braungart and McDonough, 2003).

De-materialization to re-materialization

The term re-materialization refers to a process of chemical recycling that creates more value to materials, and allows products to be reused. Examples include a re-thread of a motor vehicle tyre or nylon fibres from certain clothe products.

"The model is changing real-world business. Shaw Industries, for example, has examined the material chemistry of its carpet fibre and backing to assess the healthfulness of its dyes, pigments, finishes and auxiliaries—everything that goes into carpet tile. Out of this rigorous process has come the promise of a fully optimized technical nutrient. Shaw now guarantees that all its nylon 6 carpet fibre will be taken back and returned to nylon 6 fibre, and it's safe polyolefin backing returned to safe polyolefin backing" (Braungart and McDonough, 2003). This process infers that existing material could become new material. This is one of the most sustainable methods in producing materials. Carpet is a material which acts good as a sound damper within spaces of design.

Cradle-to-cradle building design is the process of discovering useful ways for humans to inhabit the landscape. "In every landscape, nature is our guide. We study landforms, hydrology, vegetation and climate, trying to understand all the natural systems at play. We investigate environmental and cultural history; study local energy flows; and explore the cycles of sunlight, shade

and water. Out of these investigations comes an “essay of clues,” a map for developing healthy and creatively interactive relationships between our designs and the natural world” (Braungart and McDonough, 2003).

When sunlight shines upon the earth, biology flourishes and we celebrate its increase—the growth of trees, plants, food, and biodiversity. We can create buildings that make the energy of the sun a part of our metabolism, allowing us to maximise our natural resources and apply architecture to positive purpose. Intelligent design can enhance buildings, communities, cities and nations that honour human ingenuity and harmony with nature. When that becomes the hallmark of good design, we will have entered a moment in human history when the things we make will truly become a regenerative force.

Renewable Resourced Architecture

“Designers are recognizing their positions as leaders in society. If we understand that design leads to the manifestation of human intention, and if what we make must not only rise from the ground but return to it, soil to soil, water to water, so that everything that is received from the earth can be freely given back to the earth without causing harm to any living system, then this is good design and ecology” (Braungart and McDonough, 2003).

“Most buildings are connected to the grid and get their power from coal, nuclear or natural gas-powered plants, with the possible exception of certain buildings being powered by hydro-electricity. Ideally a green building would not just get its daylight and heat, but also its electricity from the sun or other renewable energy sources “- (Rocky Mountain Institute Primer on sustainable building, 1995)

The dissertation will investigate various types of relevant renewable energy sources. Building professionals and property owners should be educated on renewable energy sources. These individuals are responsible for making decisions concerning fuel sources, and their actions have a significant impact on the local, national and global ecosystem.

Solar Energy

The sun delivers 5million quads of energy each year to the Earth, which is 16000 times greater than the current energy use of the entire planet. The sun is a continuous renewable resource of energy. The sun is responsible for life on Earth. The sun is our only form of light and heat. Since the introduction of structures, architects and builders have tried to gain the maximum orientation to favour the sun's rays. "Solar energy systems contribute to the health and psychological well-being of the occupants. Like a living organism, the living building continuously seeks the path of the sun. The building becomes a skin that orients its occupants to a universal calendar. The hours of the day and the seasons of the year synchronise the comfort and beauty of the natural world with the occupants inside "(Zeheir, 1998).

Passive Solar Heating

Solar energy can be obtained by various methods with the purposes of heating, cooling and lighting. Passive solar refers to systems that absorb, store and distribute the suns energy without relying on mechanical devices such as pumps and fans which require additional energy.

Glass is used because of its transparent qualities as a material. Glass allows light to pass through the skin of a building without being absorbed or reflected. However, it reflects or absorbs longer-wave length, infrared radiation in the form of heat. In a greenhouse the sunlight enters through grooves and walls, and the solar energy is absorbed by the plants within. The generated heat is converted by plants into radiation. Radiation does not escape through the glass, but rather keeps the air within the greenhouse warm.

Thermal masses such as concrete, brick, stone, water and rock are good at storing heat energy. These masses retain heat during the day, and release it at night when temperatures decrease.

Solar Cooling

Passive solar technology can also be used for cooling buildings. These systems function by either shielding buildings from direct heat gain or by transferring excess heat outdoors. Design elements such as overhangs, awnings, and eaves shade windows from the warmer summer altitudes. The low angle winter sun can pass through these design elements, allowing for greater heat transfer to buildings. Heat loss is also passed through elements such as the roof or floor, and insulation can be installed such that this heat energy does not escape. These elements are known as radiant heat barriers. Water evaporation is another method to cool buildings, since water absorbs a large amount of heat from its surroundings, when it changes from a liquid (water) to a gas (vapour). Design features such as fountains, and pools help to cool the surroundings. Natural elements such as trees help to cool the environment from heat energy produced by the sun. The chemical process known as transpiration is the release of water vapour from the pores of plants. This process can reduce air temperature by up to 10 degrees Celsius (Zeheir, 1998).

The planting of deciduous trees in the Northern orientation has multiple advantages. During summer they can reduce heating effects within the building, whilst during winter trees shed leaves, and allow heat energy to enter the building. A final approach is the method of using earth cooling tubes. These pipes are underground, with one end outside and the other end inside the building. Fans then draw air from outside, through the pipes. The air then transfers energy to the soil, resulting in cooler air. Soil remains at moderate temperatures all year round. This soil-cooled air then enters the building and is circulated. However due to air toxicity, this air will need to be passed through wet pads. The evaporation of the water from the air then cools the air, and acts as a filter to purify air.

Daylighting

As the cost of electricity increases, resource scarcity and load shedding occurs, one searches for an alternative to non-renewable electricity. Currently, South Africa uses coal as its primary source of electricity. This form of energy is not renewable, and to utilize this as a sole source of energy for newly built architectural projects, demonstrates ignorance from the architect's standpoint. Therefore day lighting is an important aspect when one considers the lifespan of a project, and its dependence on impermanent sources of energy. Solar lighting reduces the energy demand of the building in reference to lighting. Light reflecting panels can reflect sunlight into the building by tracking the suns path. These panels allow for light to be directed into the building without necessarily facing the best orientation to the sun.

Photo sensor systems can be used as an alternative energy saving feature. Sensors can sense when day lighting quality is good, and in effect shuts off artificial lighting.

In warmer climates day lighting can affect the thermal comfort of the building owed to the large amount of heat absorbed through the glass. Fortunately there is a solution, low emissivity coatings on windows (low-e). Low-e glass can be used to block out particular light wavelengths, control overall lighting levels, or redirect light into a building interior (Zeheir, 1998). Low-e glass is an effective way to deal with daylight and heat in South Africa; however this glass isn't as cheap as normal glass.

Photovoltaic Energy conversion

Photovoltaic technology (PV) is an efficient form of solar technology. Antoine-Cesar Becquerel discovered Photovoltaics in 1839, when he was conducting an experiment by working on an electrolytic cell consisting of an electrolyte and two electrodes. He discovered that if you shine a light on this cell, it produces a current. During the 1870s, a German scientist Heinrich Hertz observed the photovoltaic effect in solids, and built the first Photovoltaic cell using selenium (primarily salt). The early selenium cells only converted 1 to 2% of energy into electricity. This proved too complex and

expensive to be used as a source of power, where readily there were readily available cheap available fossil fuels (Zeheir, 1998). This technology has since developed, and now due to the material silicone, PV's are cheaper, more efficient and useful.

Wind Energy

Wind energy was previously the primary energy source globally. Wind energy transported goods, people, grains and pumped water via windmills. Wind energy fuelled the ships on the river Nile 5000 years ago. Windmills were used in India, China and Persia over 2000 years ago. Wind power was the first source of energy to generate electric power in Denmark. According to sources, Denmark reached 150 to 200megawatts of electricity using wind, and this provided a quarter of the energy used in Denmark (Zeheir, 1998).

The advancement in technology has created an evolution of wind turbines since. It has become more affordable for cities, governments and people to install wind turbines. According to a Department of energy report in 1990, "Wind turbines create zero emissions, consume no fuel, and are manufactured from commonly used materials like steel and fiberglass. Wind turbines operating in California reduced emissions of carbon dioxide by about 2.7billion pounds during 1911. The use of wind power instead of fossil fuels in California avoided emissions of about 16million pounds of other pollutants like sulphur dioxide and nitrogen oxides. These chemical gases produce acid rain and smog (Zeheir, 1998).

Although the installation and operation of wind turbines generally has a minor effect on the environment, there are negative consequences which must be considered. When installing wind turbines the site and habitat may be affected by soil grading, road building and foundation pouring. The spinning function of turbines can be dangerous to bird life, therefore wind turbines should not be set up in naturally sensitive areas where endangered or threatened species exist. The technology is considered land invasive, as these turbines

need to be situated at a distance from one another. Wind turbines also produce noise pollution. Noise pollution can affect residential or commercial areas. However a study conducted by the University of California determined that people are accepting to wind farms being close to their homes, more so than biomass, nuclear and fossil fuel facilities. Respondents suggested that they would not mind a wind turbine at a distance of 3 to 8 kilometres from their homes.

Conclusion

Architecture of co-evolution explores techniques and methods of approaching the built form from the standpoint of a renewable energy source; such that man, structure and nature can evolve together without having to rely on depleting resources. In order to achieve an architecture that co-evolves with man and nature, we need to identify the uniqueness of place, and the intrinsic characteristics identifiable to the Durban South Basin. Therefore this chapter concludes with an understanding that in order to have architecture of co-evolution, the architecture needs to be ecologically sensitive, whilst obtaining its energy from renewable resources. Some examples have been illustrated showing how man is dealing with the problem of air toxicity. The smog free tower, and Andrea represent ecologically conscious principles within design. These principles need to engage with a sense of place to become a regenerative force of architecture.

The following sub chapter will aim to understand a sense of place, the meaning of place attachment, and its role in the community existing within the Durban south basin. In order to co-evolve, ones senses need to be in balance. The research aims to discover smells that exist within the Durban south basin, and its relevance to air toxicity.

3.2 Place and Architecture (sense)

3.2.1 Finding a Sense of place

The phenomenological literature is the earliest available evidence which explores the nature of people's relationships with places. A general viewpoint to phenomenology and sense of place is defined as a return to things (Husserl, 1983). In the context of architecture studies, Manzo expressed that in phenomenology of place experience is the most important element in perception (Manzo, 2003). The creation and experience if architecture is a factor that can change every environment to a place. Phenomenology in architecture explores ontological character of humankind and considers 'being-in-theworld' as an indispensable part of continuation (Manzo, 2003). Phenomenology at this point, is an integral ontological structure which is essential for psychological existence and well-being (Tuan, 1975).

It is important to note that phenomenologists argue that the concept of 'existential space' is imperative to architecture (Sime, 1986). Christian Norberg Schulz explained that changing a space to place is the existential purpose of architecture. Therefore, a conscious effort to discover the meanings within an environment must be sought. (Schulz, 1985). Place affects the physical and mental wellbeing of an individual. Planning must use a sensitive hand and eye to identify the meanings within the environment. According to Relph, place is a fusion of human and natural order, owing to place being the centre of our immediate experience. All that exists is the now, and being in the now allows us to experience any place fully. Place is also a part of the environment that has been experienced via our senses (Relph, 1976).

The research objectives state that architecture should be able to address the challenges facing the community, one of these challenges are concerned with the majority of people living within the Durban South Basin remaining there despite opportunities to relocate. One perspective can be viewed using phenomenology and sense of place. The term 'Topophilia meaning 'love

of place'. This term was used by Tuan to describe the existing remarkable bonds between people and the physical settings. People tend to remain rooted to place because of bonds that exist between them and the environment. He defined Topophilia as a strong and impressive relationship between people and places. Spirit of place relates to the exclusive aspects of a place (Tuan, 1977). Therefore in order to regenerate an environment, sense of place is an important issue that can strengthen the relationship between human and place. A sense of place is influenced by people's beliefs, values and behaviour. Place makes us feel secure and pleasure causes the attachment to place (Steele, 1981). Grussow states that there are three stages to a sense of place. Stage 1 is when people do not pay particular attention to the place itself and their experience of place is superficial. These individuals do not develop an attachment to place. Stage 2 is when people become familiar with place. Their experience is perceived unconsciously. It is collective, social and cultural, rather than personal. Individuals in stage 2, have a great participation toward place. Stage 3 is associated with profound familiarity with place. It involves the 'existential insideness' of a person and is experienced unconsciously. In this level a person is integrated with place (Relph, 1976). According to environmental psychologists, architects and designers should consider both emotional and functional qualities of places. In this regard, they elaborated that the purpose of designing places is not only is facilitating everyday activities but providing symbolic and affective qualities. The overall quality of environments is measured in terms of the richness of their psychological and socio-cultural meaning. Physical comfort, safety, and performance criteria are also used in determining the quality of an environment. (Stokols & Shumaker, 1981). The experience of place is the most important aspect when designing to create a sense of place. When people experience feelings of excitement and happiness when experiencing a place, this suggests an example of design achieving a sense of place. Place is not just an object, but part of a larger whole that is experienced through meaningful events. The experience is completely sensual and determined by all five senses (sight, hearing, smell, taste, and touch),(Shamai, 1991).

Lynch states that a sense of place creates a good relationship between human and place. He reasoned that a place should have an identity to construct the sense of place leading to place attachment (Lynch, 1998).A sense of place can also be defined as a combination of three elements i.e. location, landscape, and personal involvement (Shamai, 2005). According to Shamai, there are also 3 levels of Place. Belonging to a place is the first level, the second level is attachment to a place, and the third is commitment to a place which is the highest phase. Shamai also discusses that for having a better life individuals, need to be connected emotionally and spiritually to their living places. They satisfy their needs through emotional relationships and identification with their living place. This remarkable emotional connection is called sense of place (Shamai, 1991).

3.2.2 Place Attachment

During the course of a person's lifetime, they become attached to many things. Place is one of them. The communities that live within the south Durban basin are attached to their place. Their place means something to them; it is unique, one of a kind. The situation will worsen, because industries are competing against global competition. What will happen to the people that live there? Who will take care of them? Greed intoxicated minds in society are willing to hurt themselves in favour of more money.

Attachment to things need to be stopped, however there is a deeper understanding in association to this phenomena.Low & Altman defined place attachment as an emotional connection between people and their surroundings. They asserted that place attachment comprises of interactions between affect and emotions, knowledge and beliefs, behaviours and actions (Altman& Low, 1992). People hold certain beliefs or memories in place. People also act in certain ways in different places (Hummon, 1992).

People living within these communities subjected to air toxicity, experience place attachment. Studies have shown that they have sentiment for place. Therefore the solution to this issue is to use place attachment as an oppor-

tunity for local community members to engage the issues facing them. Therefore spaces of engagement need to be included within the research design to allow for active community participation. One of the many factors that make up the uniqueness of a place is the particular smell of a place. The Durban south basin has a distinct smell. This odour comes from gases being emitted from various types of industries, motor cars, trucks and buses

3.2.3 The nose and the city

The ideal world is presented to us as a clean and deodorized environment. It is usually represented through visual and auditory senses as shiny white surfaces, deodorized bodies, white walls and clean streets. However Tolaas argues that this should not be the case. He states that “the hygienic rhetoric” dominates the collective imagination of people, and it is widely believed that to be clean and shiny is to present or represent (Tolaas, 2009).

“However our sanitized cities are depriving us of the chance to use our noses for navigation and information” (Drobnick, 2006). Therefore Tolaas poses the question; what would happen if the nose played an equal role to those of the eyes and ears in the process of navigation, perception, and communication? (Tolaas, 2009)

Human beings are genetically equipped to encounter smells. We, therefore have the potential to respond appropriately to smells when encountered. However these need to be learned, because human beings are classified as generalists. We do not possess the ability to respond to particular smells such as the specialists ie; predators and prey. Human beings require associative learning in order to hardwire the catalogue of dangerous smells into our memory and perception (Drobnick, 2006). Human beings associate a smell to the circumstances in which they first experienced that particular smell. Smells are associated to identity, and people tend to like or dislike people based on their smell. “Smell repulsions and preferences are deeply rooted into the human brain, therefore to manipulate these is to efficient-

ly achieve effective results be it in the political, social or individual realm. Nothing is more powerful than the manipulation of people's feelings through the use of smell. This is happening in the commercial world, as well as the industrial world. There is a strong relationship between smells, power and society (Claasen, Howes & Synnott, 1994). Mankind needs to adapt to different smells and accept each other's smell, as this would shift perceptions of smell amongst people and could possibly change the world states Tolaas (Tolaas, 2009). So how do we use smell as a tool to act against air toxicity? Smell could be the guage to measure whether gases are present in the air.

Locating different smells

Places may be characterized by their smells. Smells surround us all the time. "The nose never sleeps, with each breath taken in; we inhale molecules which give us information on a micro level of our surroundings" (Tolaas, 2009). In cities we operate through three zones of smells; the industrial, the public, and the private. Each zone has its own acceptance and tolerance to smells. Human beings operate with many boundaries, and prejudices. Industrial zones are associated with foul smells, and our nose develops a higher tolerance. The private space is linked to a greater sensitivity, and a lower tolerance. This is important to understand when dealing with air toxicity. In an industrial zone almost all smells are accepted, however if smells enter our private space it becomes problematic. In the Durban south basin, these smells penetrate individuals' private space. This is attributed to the close proximity of refineries and big industries to people's homes.

Tolaas asks the question; can we train ourselves to go beyond acceptance of these smells and learn to navigate the urban terrain through their unique smells? He states that a more comfortable approach to smells brings about a more optimistic attitude towards environmental issues (Tolaas, 2009) He also states that people tend to become challenged when asked to use their nose other than to breathe in and out. However if people use their noses

to track smells they may rediscover their surroundings. People can rediscover people, place and city though smell. He states that people need to discuss how we can use the hidden smell codes of the city to unite people instead of separating them. A project in Mexico City called the 'Talking Nose' depicts smell as a source of information and communication. Two hundred neighbourhoods were identified through their smell molecules. Smells are a chemical signal from our environment and if a smell source is localized enough in space and time, its position becomes fixed or localised. However air movement can lead to delocalization as air inertia can delay smell detection (Tolaas, 2009). In this project, participants were selected based on the familiarity with their areas, and were asked to walk through specified areas. Participants were asked to focus on their smell sensations and use full gestures when encountering a smell. These descriptions were then analysed, developed, compared and matched to the electronic analysis. The result was a movie that displayed the participant's gestures when encountering a smell, as well as the audio expression and the location of each smell. This study of urban smells provided an alternative dimension to the understanding of the city. "It enriched our sensual experience and provided input for urban design and architecture. The invisible city can communicate and be understood") Tolaas, 2009).

Conclusion

There are many dimensions which constitute the makeup of place. This chapter explored a sense of place, and what it requires to create a sense of place. However this chapter also discovered that the place attachment could be used as a solution to the problems facing the community with regards to air toxicity. As those that are attached to place, are more likely to act out against environmental degradation and air toxicity. Residents that live within the Durban south basin experience foul smells, largely because of the major industrial zone situated in-between residential zones. Smells could be mapped out by residents and this map could perform as a guide to dwellers of that area. Information gained could help people deal with air pollution effectively. The next chapter explores how residents could become the agent for change within an environment, and the processes which constitute ecologically conscious architecture.

3.3 Developmental processes and architecture (interact)

3.3.1 User generated urbanism

This is the urbanism of the tactician, those devising temporal and interim uses, seeking voids, niches, and loopholes in the socio-spatial fabric (Rebar, 2012).

Rebar developed the parking project. The project entails transforming a metered parking lot into a temporary park. This intervention was used as a social media meme, coupled with a free how to build manual. The project sparked a global event called 'parking' day. People can now claim a vacant parking space as a site for social expression, activism, and public participatory art (Mostafavi, 2012). The firm rebar have also explained that they've retransformed spaces with recycled items, and anyone can sign up to use the space to perform dance, music or theatre.

Mostafavi explains that two future scenarios are seen for an ecological city. " In one scenario, a global greening movement which consolidates power in the hands of corporate multinationals, who further erode public and civil liberties under the rubric of resource efficiency, which ultimately results in resource scarcity. Another option is to move towards a dynamic, decentralized, pluralistic and cooperative social ecology which will ultimately result in future of sustainable abundance" (Mostafavi, 2012).

A decentralized approach is efficient when trying to affect change within an environment. The Durban south basin can acquire a decentralized approach to develop a user generated urbanism, whereby residents start to inflict change to their environments towards a more ecological future for the city of Durban.

3.3.2 Situating ecological experiments

Urban environments are poorly understood in ecological terms. It is critical to develop ecological strategies in order to prevent ecological degradation. Therefore in order to increase ecological research, experiments need to be formulated within the built environment. “Such research requires innovative methods that extend beyond the discipline of ecology, and suggests that we reformulate design approaches to relationships between nature and culture within cities” (Felson & Pollak, 2012).

The degradation of ecosystems in urban areas reflects that the design of cities “has tended to prioritize human activities, including vehicular circulation, public use, and safety over other living systems” (Felson & Pollak, 2012). They also state that this reduces habitats and connectivity – blocking soil processes and increasing storm water runoff. However there isn’t adequate research available currently to determine how ecological processes in cities actually work (Felson & Pollak, 2012). Challenges such as dealing with constraints, political complexity, adjacent land uses, setbacks, and public or private entities prove to be difficult, yet not impossible. “Designers can fruitfully collaborate with ecologists to integrate ecological experiments into urban spaces” (Felson & Pollak, 2012). Collaboration can happen at different scales – from an individual building to neighbourhood projects to regional planning. The key is to identify and develop experimental sites. Once this issue has been resolved then the site can be viewed as a multifunctional dynamic zone, serving both the outside and inside of the site. The educational and demonstration component of experiments prove to be integral to the social and cultural program of situating experiments within cities.

” It is the connection of telling people what is going on in the context of place that would allow the existence of an experiment in the shared space of a city to make sense. The design of public places as research environments may be understood as a hybrid practice, providing opportunities to influence cities in new ways, to monitor, evolve and adapt to changing urban

ecological conditions" (Felson & Pollak, 2012).

Therefore utilising urban experiments as an approach to designing improved environments is important. Urban experiments can prevent ecological disruption by modifying previous approaches to a site associated with ecological degradation. Architecture can be in a form of an experiment which continually adapts to natural changes in the environment.

3.3.3 Principles concerning ecological experiments

The process of creating ecologically conscious architecture

The thinking that underlies the ecological paradigm is less a linear Cartesian model but rather of the mode that can be better envisioned through chaos theory or by the hologram, embodying ceaseless mutual causality and interdependence."

- Dr John Todd, Biologist

"When designers are assigned a problem, they usually consider three basic criteria: cost, performance and aesthetics. Designers and architects must also ask whether a material or system is ecologically intelligent and socially just. Can something really be beautiful if it destroys the earth, or is unfair?" States architect William McDonough. Today architects work with environmentalists and develop environmental criteria affecting the site. An example of this would be an Environmental Impact Assessment (EIA)." This is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse" (Convention on biological diversity, 2018).

Environmental Objectives need to be set out before the start of a project, and an example of these objectives would be the Hannover principles discussed in Chapter 3, section 3.1.2. The following factors need to be considered for site selection and design process; climate, topography, vegetation, wildlife, capacity/ density, visual character, natural hazards, cultural context, energy and utilities, site access, and assessing existing toxins on site.

Climate

The climatic conditions of the site is important, because an architect can adjust the building to suit those conditions unique to climate. Durban is a sub-tropical climate. The winters are warm, hot summers, rainy springs, and windy autumn seasons. Characteristics of a design should be considered such

that facilities can be located to maximize human comfort, protection of the site resources and building facilities.

Direction of prevailing wind conditions should be studied such that the building can take advantage of passive cooling techniques including as cross air ventilation. The annual rain fall could assist in the decision making of water storage facilities, and drainage mechanisms. Climate informs and situates design to place. The architecture is not invasive but rather responsive to the environment.

Topography

Durban south basin, is positioned on flat land. The primary concern is to protect the soil and vegetation from erosion. Reducing the building footprint, eliminating parking spaces for cars, elevating walkways, using point footings for structures and keeping soil disturbance to a minimum are good practices to observe as they incur less damage to the site.

Vegetation

Retaining natural native vegetation to a site ensures the integrity of the site. Sensitive plant species need to be identified and protected. “Existing vegetation should be maintained to encourage biodiversity and to protect the nutrients held within the green canopy” (Zeheir, 1996). Natural vegetation protects wildlife habitats, soils, offers acoustic and visual privacy. Plants provide natural shade and can be used as a food source. The protection of natural plants, and environments is an important aspect to creating environmentally sensitive architecture.

Wildlife

Wildlife Habitats should be kept as natural as possible. Wildlife is encouraged to remain nearby to human activity. The creation of artificial habitats can have a negative effect on the natural eco-system.

Capacity and Density

Each site has its own level of capacity for development, density and human activity. This capacity should be based on resources available to the site and the lands ability to regenerate itself." The siting of facilities should be very careful to weigh the merits of concentration of built form versus the disposal of built form" (Zeheir, 1996). According to Zeheir, natural landscapes are easier to maintain if facilities are carefully dispersed, or contrarily the concentration of facilities leaves more undisturbed natural areas. Therefore a balance of concentration and dispersion should be applied should it suit the site constraints.

Visual Character

The protection of natural views and perspectives should be preserved. Unnecessary site intrusions such as roads should be avoided. When a designer works with the topography and locates small footprint structures within existing vegetation, then the visual character will represent the natural and historic character of the site. "The existing landscape can be protected by coordinating construction methods and access around vegetation. This can save money in landscaping costs" (Zeheir, 1996).

Natural Hazards

Natural hazards that exists in nature such as dangerous topography, dangerous plants, animals or water should have controlled access should it be required to be a part of the design. The site does contain a canal and access will be controlled to this hazard.

Cultural Context

Local history and people provide a context which allows for sustainable design. Community activities such as farming, fishing or agriculture can be included within the design approach. There are churches and temples within the local context, and these places of worship provide a sense of well-being to the people.

Energy and Utilities

Most architectural projects will require systems that provide running water, power and basic sanitary waste management. These systems need to be planned within the architectural project. Noise from mechanical systems can be buffered by location or plants. Natural vegetation and soil depressions provide great channels for draining storm water runoff. Night lights should enhance features of the site considerably. Fixtures also should be kept close to ground such that glare and obstructions to the site are minimized (Zeheir, 1996).

Site Access

Access to site for construction should be considered such that large machinery and equipment are limited to protect the natural vegetation and soils. Prior to construction temporary power, vehicular access, and storage should be considered in the planning process.

Assessing Existing Toxins on the site

The site should be assessed for toxic chemicals within the soil or site. Toxins can be encapsulated and removed. The soil, water and air should be tested for radon, asbestos, lead, mercury and other poisonous VOS's and particulate matter.

Indoor air quality

"Indoor air pollutants accumulate from four sources: outside air, building materials, HVAC Equipment and people" (Interiors, 1995). Pollution becomes a problem when many chemicals become concentrated and buildings with inadequate ventilation suffer more from air pollution. Air pollution in low concentrations cause eye and skin irritation, in high concentrations it leads to asthma or lung cancer." A study by NASA shows that placing a plant every 100 square feet, toxic substances responsible for indoor air pollution can be reduced by 87%" (Zeheir, 1998).

Water conservation and rain water collection

Water makes life possible. The earliest civilisations of man built near rivers, wells and springs. The earth, like the human body consists of two thirds water. Water is essential to our survival. Ecological design “should diligently respect water sources. Water conservation should be promoted by specifying low-use water fixtures, appliances and by water recycling systems. Water conservation includes water that is of lower quality than drinking water, for toilet cisterns, irrigation for vegetation or grey water (Zeheir, 1996).

Ecologically conscious design collects water through a system of gutters connected to tanks that can store the water. Water can be stored in catchments that look like ponds. The water can be used for landscape maintenance. Gravity storage of water is an important possibility because the water can use gravity to attain the correct release pressure of water from a tap. Water storage is an important part to creating an ecologically conscious design.

Conclusion

In this chapter the literature explored how co-evolution is related to a sense of place. This relationship can lead to designing environments of experimentation and user generated spaces. In the quest to save the planet from rapid global mean surface temperature increase, professionals and non-professionals from all around the globe are participating in developmental processes to ensure a greener future for the generations yet to arrive. The literature formulated an approach to design through the following paradigm: Architecture as a regenerative paradigm for harmonious living between nature, community and industry. This paradigm is used to analyse the precedents which continue in the following chapter.

Chapter 4

Precedent Study

4.1.0 Introduction

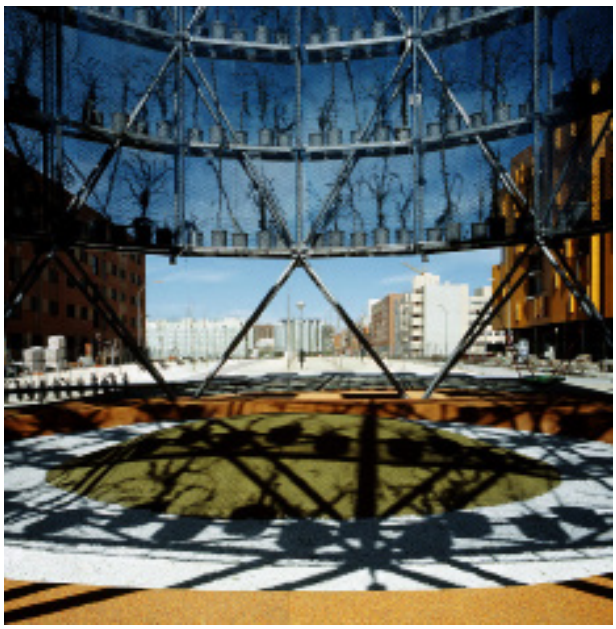
This chapter will explore four precedent studies in using the themes highlighted within the literature review of this thesis. The precedent studies are located beyond South African boundaries with emphasis on sustainable development, community empowerment, social empowerment and air purification. All precedent studies will be relevant towards the design of an eco-awareness and air recycling facility as it takes into consideration the conceptual drivers of each project, the spatial planning and structural systems used within each project.

4.2.0 Eco Boulevard, Ecosistema Urbano, Madrid

Figure 15: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/500ffb-7828ba0d42220001c1-eco-boulevard-in-vallecas-ecosistema-urbano-image (Accessed :01 June 2018)

The Suburban Development of Vallecas in Madrid, is a poor to middle income community which suffered from the lack of good public space due to poor urban planning. The redevelopment of public space was opened out to competition. The winning proposal is the precedent discussed here. The main objectives of the design was to generate activity (social characteristic) and the bioclimatic adaptation of the structure to the site to create healthy outdoor space (environmental characteristic).

“Public spaces belong to everyone and they should act as supports for a number of activities and events, beyond what can be planned, spaces where citizens can act in freedom and spontaneously” (Ecosistema Urbano, 2008). Ecosistema Urbano make an attempt to make up for the total lack of activity due to irresponsible planning, the prototype aims to serve as a device which encourages plant growth, as the architects believe that trees are the best natural element to enhance public place. Therefore, this facility aims to position itself as a tree, however when the trees grow to a bigger height within the following 15 to 20 years, this structure could be removed such that it leaves an open space in between tree canopies. The architects concentrated these structures such that higher climatic comfort was achieved and thus offering thermal comfort was the seed of a public space regenerating process. “We do not think a building is necessary, but a place for people whose shape is defined by the very activity developed in it at a given time “ (Ecosistema Urbano, 2008).



Left Figure 16: Eco Boulevard Source:
Ecosistema Urbano Available-at: https://www.archdaily.com/6303/

Right Figure 17: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/Accessed :01 June 2018)

Co-Evolution

Three pavilions or “trees of air” are all open to cater for different functions. This allows the functionality of the pavillion to adapt to the user. The architects state that once the necessary time has elapsed, these devices should be taken down and the old premises should remain as clearings within tree canopies (Ecosistema Urbano, 2008). It is important to note that the planted trees help to reduce air pollution present within the air nearby to the pavillion. These plants are grown for members of the community and help promote environmental, social, regeneration. The solar energy captured can be sold back to the grid and essentially pay of its own construction and running costs.

Left Figure 18: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily. com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/Accessed :01 June 2018)

Right Figure 19: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/ eco-boulevard-in-vallecas-ecosistema-urbano/ (Accessed :01 June 2018)

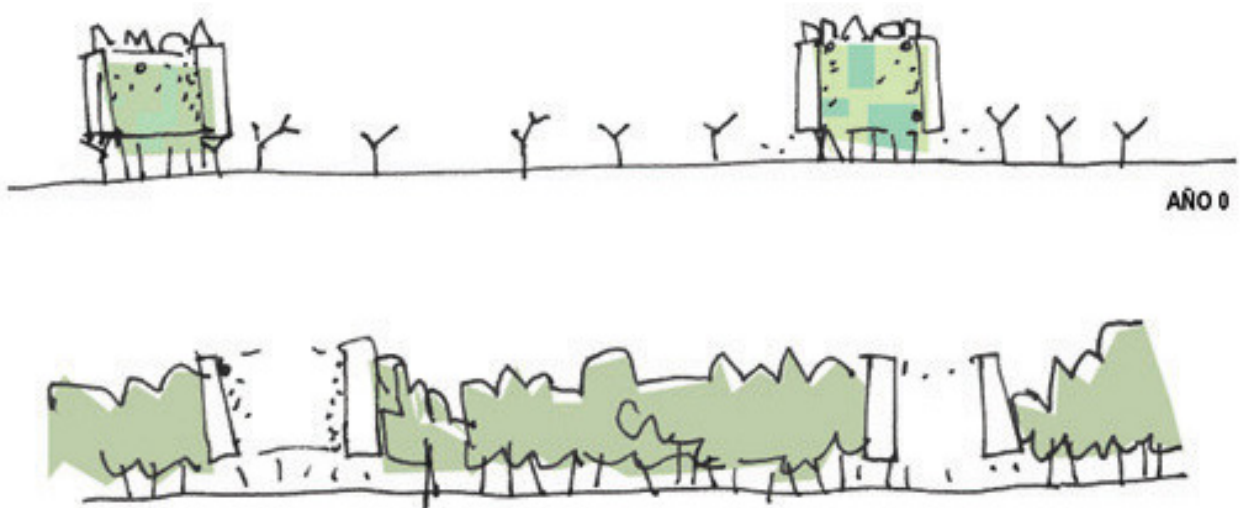
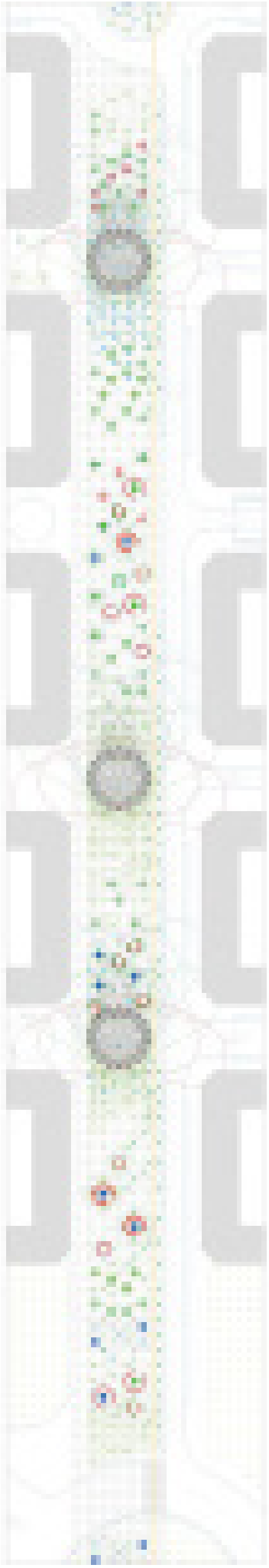


Figure 20: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/ Accessed :01 June 2018)

Processes

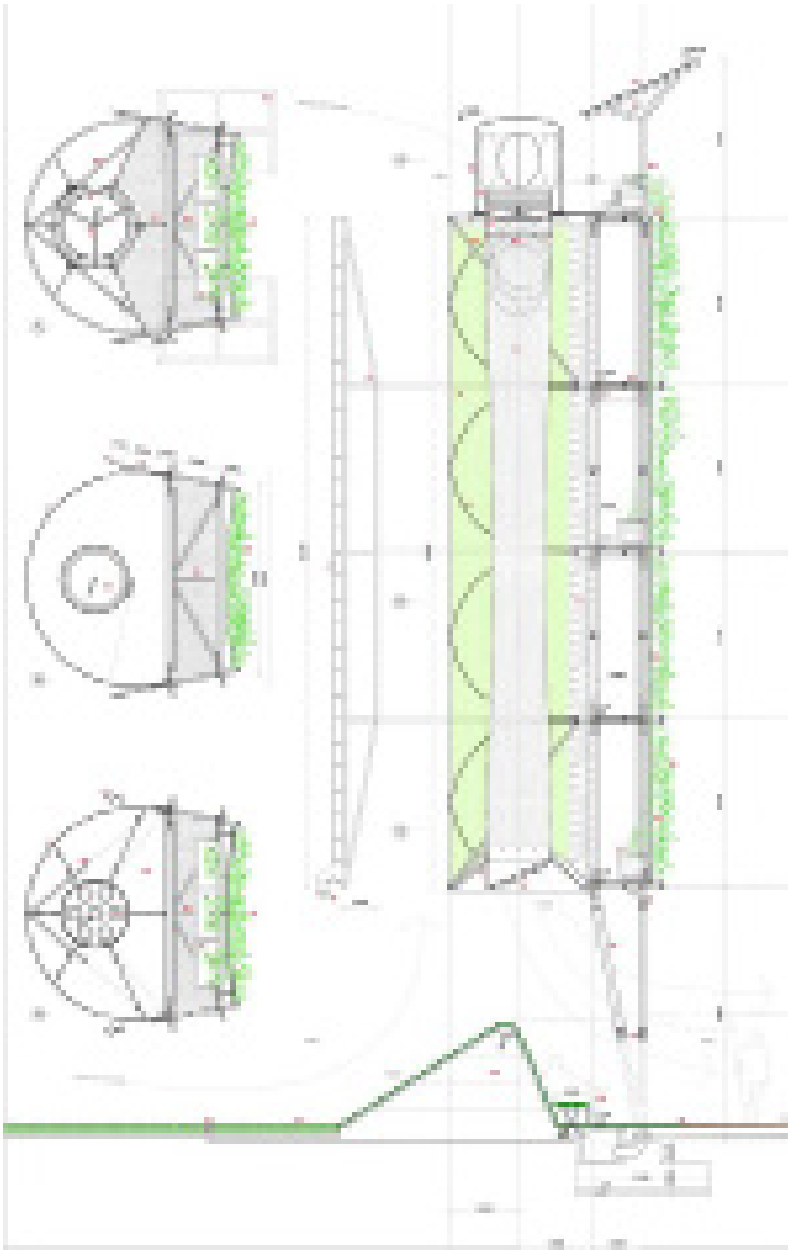
The architects call the structure “Air Trees”. These “air trees” completely run on solar power Selling this energy to the power network generates savings on money and could possibly be reinvested in the maintenance of the structure itself. “This is just a model for the management of resources on a project in the course of time” (Ecosistema Urbano, 2008).

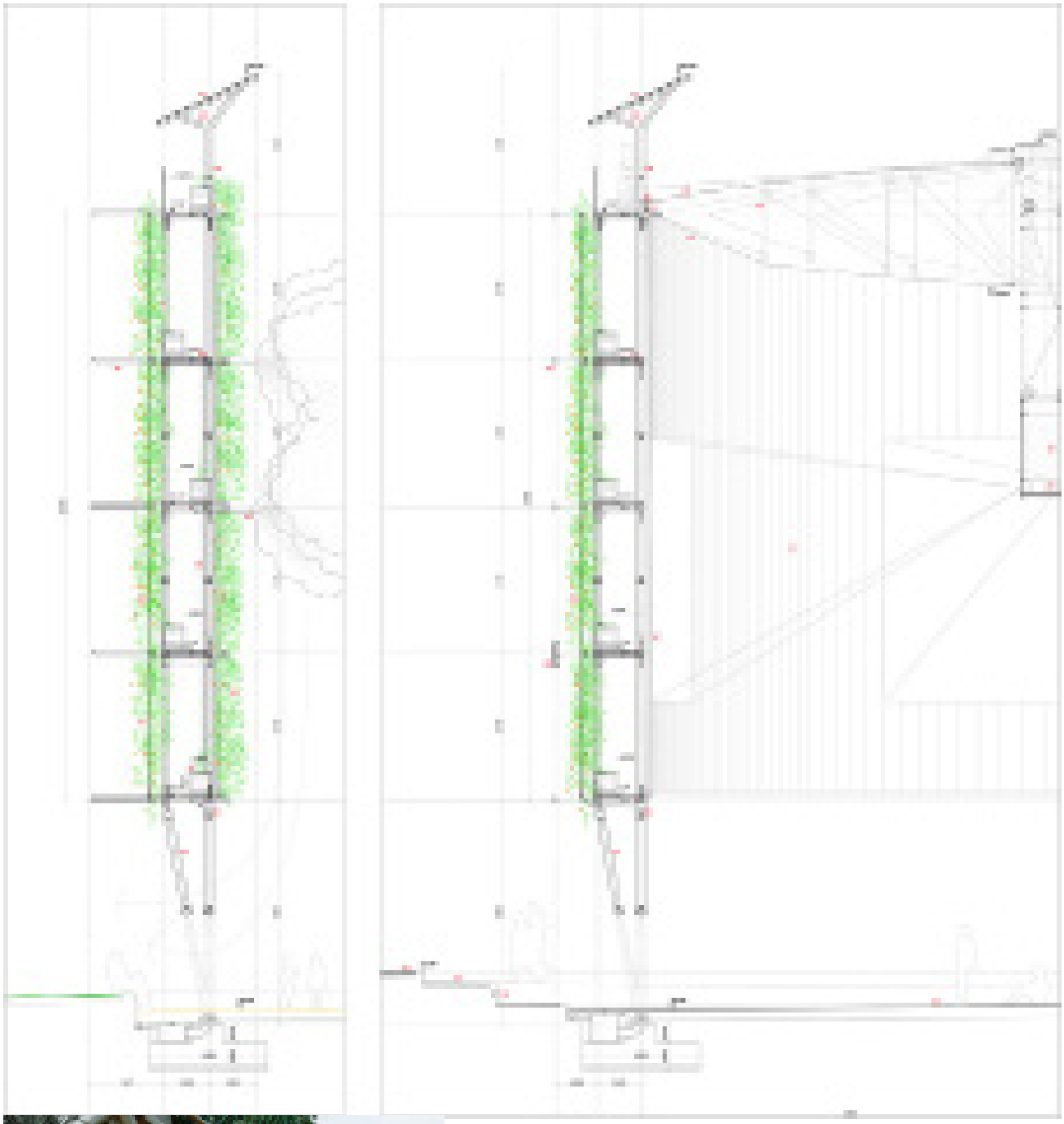
Technology is important to the project, and this build adapts technology used from farming techniques, such as evapotranspiration into the built form, such that plants do not lose moisture within the air but rather this moisture is captivated and used to cool down the air temperature.



Left Figure 21: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/

Below Figure 22: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-vallecas-ecosistema-urbano/





Above Figure 23: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/eco-boulevard-in-valle-cas-ecosistema-urbano/ Accessed :01 June 2018)

Left Figure 24: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily. com/6303/eco-boulevard-in-valle-cas-ecosistema-urbano/Accessed :01 June 2018)

Place

“The goal of this project is to create an atmosphere that invites and promotes activity in an urban public space that is “sick” due to “bad planning” (Ecosistema Urbano, 2008).

The simple climatic adaptation systems installed in the “trees of air” are of the evapo-transpirative type, which is a system often used in the design of greenhouses. This project aims to reactivate the public space by creating climatically adapted environments (8ºC-10ºC cooler than the rest of the street in summer) where citizens can now become active participants in public spaces again.

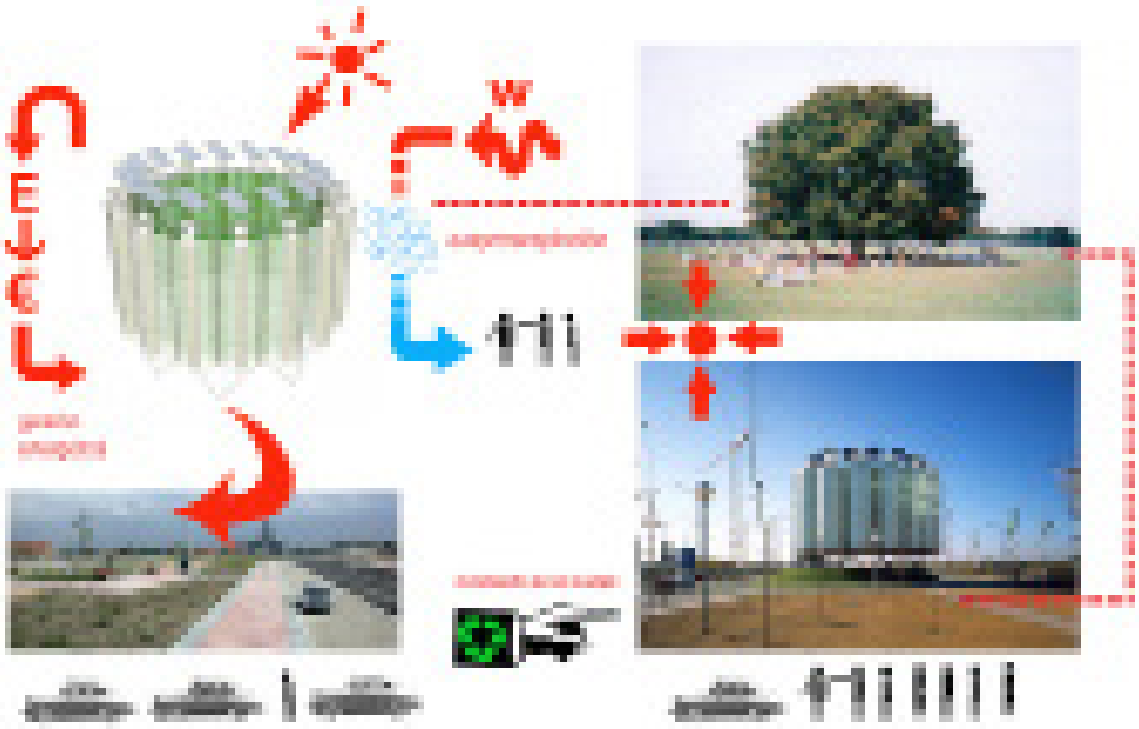


Figure 25: Eco Boulevard Source: Ecosistema Urbano Available-at: https://www.archdaily.com/6303/ eco-boulevard-in-valle

4.3.0 Mexico City Hospital Facade, Elegant Embellishments, Mexico

Figure 26: Mexico City Hospital Source: http://www.elegantembellishments.net, Online, Accessed 09-09-18

Architects Allison Dring and Daniel Schwaag of Elegant Embellishments have created a facade that reduces air pollution. Approximately 20 years ago, Mexico's metropolis was the world's capital of air pollution. Therefore this is a significant precedent to study, as we can learn from Mexico on how they respond to reducing air pollution statistics via the built environment.

Clean air campaigns like "Pro-Aire" have eliminated environmentally-damaging vehicles and modernized public transport. Green rooftop gardens, which were a strategy for reducing air pollution is merely a drop in the ocean when the number of vehicles keeps increasing by 200,000 cars every year. Therefore Mexico City administrators are desperate for solutions to the nitrogen oxide (NOx) crisis and welcome architectural resolution such as a smog-eating hospital,

or rather the hospitals affixed facade which contains titanium dioxide pigments, which possibly neutralizes the emissions of an “impressive 8750 vehicles per day” within its surrounding area (Stone, 2013).

Co-Evolution

The facade of the Hospital General Dr. Manuel Gea González on busy Avenida Calzada de Tlalpan resembles a giant slice of “Swiss cheese”, dotted as it is with holes and gaps. Daniel Schwaag appreciates the comparison. According to the Berlin architect, “these are quasi-crystalline, non-repeating structures”. The resulting pattern generates ever-new images from just a few basic shapes. Their arrangement is regular, yet ramified.

At the same time, these interwoven patterns represent a large surface across a compact space.” The module by Elegant Embellishments is designed to transform a maximum of noxious airborne NOx into harmless water, carbon dioxide, and calcium nitrate” (Wolfson, 2013).

“A field test in Manila produced phenomenal results: Each square meter of the module removed 0.26 grams of NOx per day” (Wolfson. 2013). The module’s unusual structure, which captures light from all angles, plays a major role – as does the use of titanium dioxide. Maximum surface area = large amounts of smog absorption. Schwaag explains that while it would be possible to spray the catalyst onto existing buildings, it would not have the same effect.

“In both cases, geometry determines the outcome. To this end, the convoluted, multi-angular surface of their “prosolve module“ is not optimized for a particular solar angle, but instead facilitates NOx scrubbing via light energy throughout the day”
(Wolfson, 2013).
In theory, such facades could be spun to infinity. Or moved indoors, as ceiling sculptures, at long as the device is within the path of direct or reflected

sunlight.

Process

The age of intelligent facades.

Right now, the facade of the Hospital Dr. Manuel Gea González remains a reference project, an acupuncture needle in the behemoth of a body that is Mexico's capital. Yet the structure herald the start of something new: an age of intelligent facades that promise to make life in some cities more liveable.

For Mexico City – and its smog problem – is everywhere. It's in La Paz, Manila, Hong Kong, or New Delhi. The "functional ornament," according to Daniel Schwaag, helps to make invisible technologies tangible. Even when the reactions are relegated to the nano sphere, the new structure clearly shows that it takes a will and idea to effect urban change. He adds that, "some technologies are only interesting on an urban scale" (Wolfson, 2013).

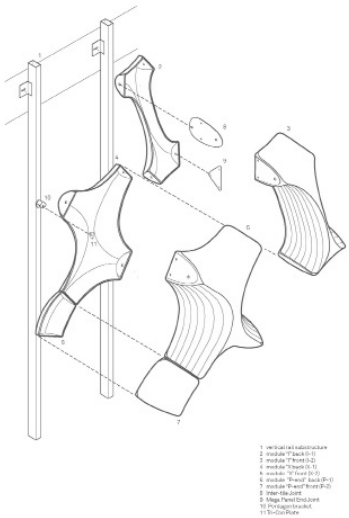
The architects claim that the building will help reduce a small fraction of that pollution. The key to the smog-fighting powers of the hospital building's façade is in its paint, made from a titanium dioxide-based pigment. "According to the designers, when ultraviolet rays of sunlight reach the titanium dioxide on the tiles, it triggers a chemical reaction between the tiles and the smog in the air (mono-nitrogen oxides). The smog therafter decomposes into safer chemicals, such as water, carbon dioxide, and calcium nitrate" (Wolfson, 2013).

Place

In 1992, Mexico City's levels of sulphur dioxide, suspended particulate matter, carbon monoxide, ozone, lead, and nitrogen dioxide all exceeded the World Health Organization's health protection guidelines which is the current scenario in the South Durban Basin. At the time, researchers hypothesized that the pollution was causing about 35,000 hospitalizations and 1,000 deaths every year. It's generally thought that Mexico City's pollution problems stem from an unfortunate combination of an explosion in industrialization, layout planning which includes many far-flung situated neighborhoods, and geography whereby

the high altitude and encircling mountains trap the polluted air as though in a bowl. This scenario is closely linked to the scenario experienced within the South Durban Basin as the geography also traps pollution within the basin, and does not allow for smooth air flow.

In addition, the innovative lattice-like design of the tile shapes “slow wind speeds and create turbulence, for better distribution of pollutants across the active surfaces,” said Elegant Embellishments co-founder Alison Drin. According to Stone from Fast Company “The omni-directionality of the quasicrystalline geometry is especially suitable to catch things from all directions.” The design has additional environmental benefits, as well. “The façade produces shadows in the inside of the building, helping to keep it fresh and cool,” said Josue Hoil Basto, who works for the construction firm that built the innovative building. “That way the amount of air conditioning needed to cool it is kept at its lowest possible level, helping save electric energy” (Stone, 2013).



Left Figure 27: Mexico City Hospital
Source: http://www.elegantembellishments.net, Online, Accessed 09-09-18

Right Figure 28:Mexico City Hospital Source: http://www.elegantembellishments.net, Online, Accessed 09-09-18

4.3.0 Air purification tower, Daan Roosegaarde, Beijing

Figure 29.1:Smog Free Tower Source: https://www.studioroosegaarde.net, Online, Accessed 08-06-1

In Beijing, which is one of the world's most polluted cities, there's a "futuristic tower that sucks up smog, turns it into clean air, and filters out the smog particles so they can be turned into diamonds" (Reismann, 2017).

Children in Beijing suffer from various lung diseases, such as lung cancer, and asthma. Life expectancy within Beijing is noted to decrease by 15-16 years according to Reismann (Reismann, 2017). Within the South Durban Basin, we notice people suffer with similar health concerns, and perhaps this solution proposed by Daan Roosegaarde is an effort to help relieve people from the injury suffered from breathing in toxic air.

"This is not the bright future we envision," Roosegaarde says. "This is the horror"
(Reismann, 2017).

The tower they built, which has been used in Rotterdam, Beijing, Tianjin and Dalian, sucks up 30,000 cubic meters of polluted air per hour, cleans it at the nano level – the PM2.5, PM10 particles – and then releases the clean air back into the city. The tower is powered by solar energy.

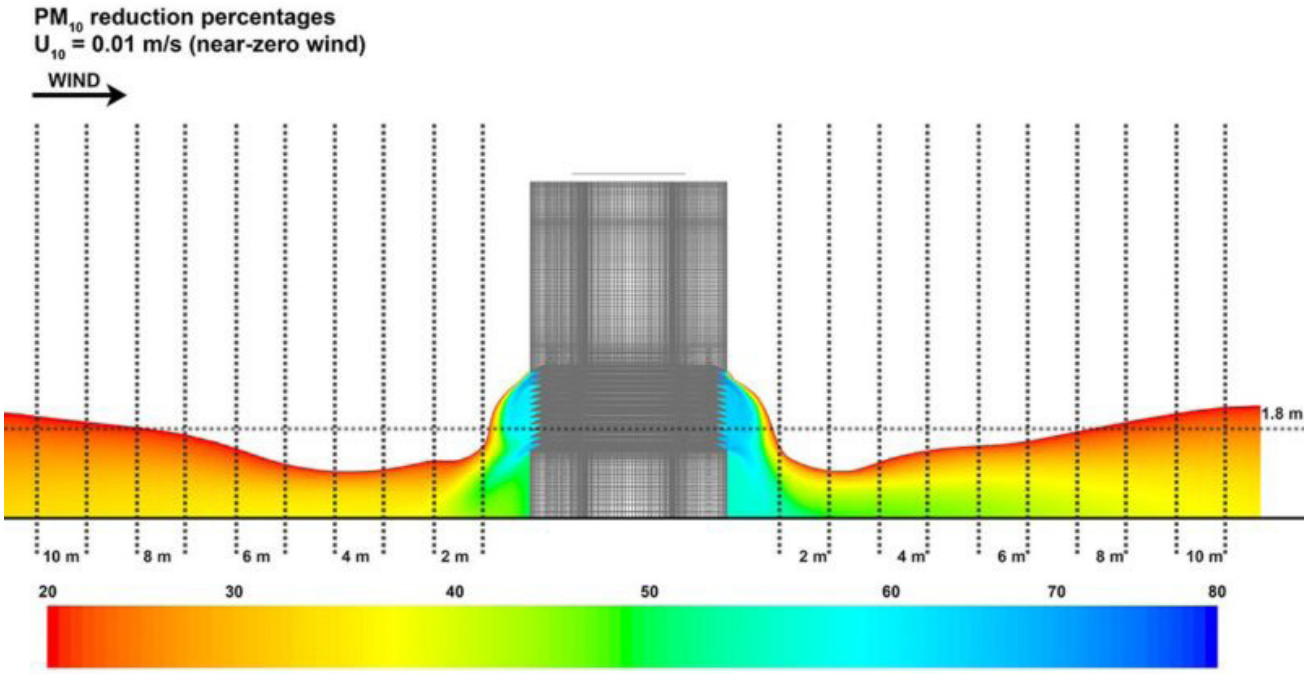


Figure 29.2: Smog Free Tower Source: https://www.studioroosegaarde.net, Online, Accessed 08-06-18

Reduction in PM10 concentration (in percentage) by the SFT in near-zero wind conditions, up to distance of 10 m from the tower (Photo: Eindhoven University of Technology).

Co-Evolution

The Design idea started via a “Kickstarter campaign” and received approximately

$175 000. This allowed the design to be built and positioned within Beijing. This also proved that people are interested in air quality, so much so that individuals donated money to the cause of air purification. This is a form of co-evolution whereby the community grows and funds a project themselves. This design works for the community. The smog particles filtered by the tower are compressed for 30 minutes and turned into dark, boxy gems. The

“diamonds” are then used for rings and cufflinks, each representing 1,000 cubic meters of pollution. So therefore it is implied that if you purchase a smog ring, then you donate 1000 cubic meters of clean air to the city.

Process

The idea was tested to see if there were any truths to the claims of providing clean air and the findings of Prof. Blocken, a renowned scientist in the field of urban physics, are based on measurements conducted by a team of experts and they confirm the effects of the Smog Free Tower.

“The tower works in simple way, it sucks in dirty air like a giant vacuum cleaner. Ion technology then filters it,before returning smog free air through the towers vents. By creating a field of ions, all the particles on the nano scale gets positively charged, therefore when the ground is negatively charged, they are dragged to the ground, and 75% more clean air is obtained. The technology is safe and in one hour it can purify 30,000 cubic meters of air and with consumption of power of 30 watts which is around the light bulb consumption. This technology manages to capture ultra-fine smog particles which regular filter systems fail to do. The tower was first tested at Rotterdam, Netherlands and after that in Beijing, China it was used for 41 days and significant reduction was seen in the smog around the place. The tower is also planned to be placed in Paris, Mexico, Los Angeles, New Zealand and Japan” (Gayki et al, 2018).

“The Smog Free Tower works with the proven ENS technology of positive ionization to remove large fractions of particulate matter from the air in its immediate surroundings. Both the technology and the Smog Free Tower itself have been successfully evaluated with both field measurements and numerical simulations with Computational Fluid Dynamics. The results confirm that the tower captures and removes up to 70% of the ingested PM10 and up to 50% of the ingested PM2.5. For a tower in an open field in calm weather, this provides PM10 reductions up to 45% and PM2.5 reductions up to

25% in a circle with diameter of more than 20 m around the tower. When the tower is applied in semi-enclosed or enclosed courtyards, the beneficial effects can be much larger." (Prof. dr. Bert Blocken, Eindhoven University of Technology, the Netherlands and KU Leuven, Belgium)

Place

Although the design is not unique in the sense that each unit will be different. The unit does aim to create place making, by the mere fact that the design will provide clean air to its surroundings. "The Smog free tower can be very useful in the area where the air pollution is at very high rate. Such towers can be provided in open public places such as gardens and green areas where people gather for getting fresh air. The carbon which is absorbed by the tower can be used to make the crystals of diamond. It works on less power consumption so no need for any special arrangements for its power source" (Gayki et al, 2018).

The design is a good example of an initiative which could be developed by a community, to reduce smog and air pollution.

Figure 29.2: Smog Free Tower Source: https://www.studioroose gaarde.net, Online, Accessed 08-06-18

Figure 30:Smog Free Tower Source: https://www.studioroose gaarde.net, Online, Accessed 08-06-18

Conclusion

This chapter has set out to analyse the precedents using the principles developed through the literature, Co-evolution, Process and Place were explored with respect to each precedent in order to understand ways in which a regenerative architecture could be achieved The way in which these precedents have achieved a regenerative architecture starts to form the basis for the recommendations in chapter six. Although each of the three precedents studied differed in scale, form and function. The precedents succeeded in capturing modern technology, tectonics, and materials
which helped purify, supply and deliver clean air to people.

Eco Boulevard, Ecosistema Urbano, Madrid responded to the local climate more appropriately through the use of materials and construction methods that limited the buildings impact on the natural environment and provided thermal comfort. Due to the climate and context, Eco Boulevard is a more appropriate precedent for an environmental awareness and air recycling facility which aims to be developed on an urban scale.
Mexico City Hospital attempted to capture air pollution and break down particles into benign substances. The design of the facade was optimized such that maximum sunlight engaged with the titanium dioxide coating. This design proved to be valuable in its engagement with process and co-evolutionary materials. The material or coating could be applied to numerous buildings within an urban scale such that the overall air pollution within the specific area is reduced cumulatively.
The smog free tower is the most appropriate in process to an environmental awareness and air recycling facility, as it can reduce the pollution caused by industries and provide clean air. It can also utilize crowd building and funding, whereby this process becomes a part of the community, and people can then start to respect and care for the architecture they have helped to create.

A regenerative architecture needs to be contextually bound to place, yet at the same time behave as a prototype . Therefore the area of study, being South Durban Basin, needs to be explored in greater detail. The Durban South Basin will be explored in the same manner in which the precedents were analysed. This way
the Eco-awareness and Air recycling facility may respond to the topography of the site, the processes that occur on site socially and naturally and the natural
environment of the area in relation to the built environment.

Figure 31: Site Study Source: Author

Chapter 5

Case Study of Merebank, Durban South Basin: The forgotten people

4.1.0 Introduction

The key research question formulated reads as:

How can architecture help to supply safe inhalable air for the residents of South Durban Basin?

The question leads to the investigation that architecture could help supply safe inhalable air for the residents of the south basin in Durban. However to understand the process of achieving clean air for the community, various aspects of the South Durban Basin need to be explored in detail. The context of South Durban Basin will then be analysed and discussed, both the industrial and residential zoning of the area. This is crucial so that the spirit of the south Durban Basin and context may be understood.

These elements identified from the authors research in Merewent, Durban South Africa, will be used to identify the spaces needed within the environment. Informed decisions on the accessibility to locate the building in relationship to its context. The materials and methods that will be used in the construction of the building. The type of landscape that the building will need to respond to as well as the climatic response. The accommodation of the varying user groups of the area will be identified so that they are recognised in the spatial planning and movement through the site and building.

Location of Merebank, Merewent, Wentworth, Durban South Basin, South Africa

Figure 32: Global Map Source:www.wikimedia.org, Online, Accessed 10-08-18

Above Figure 33: South African Map Source:www.wikimedia.org, Online, Accessed 10-08-18

Below Figure 34: Durban South Basin Map Source: www.durban.gov.za, Online, Accessed 25-05-18

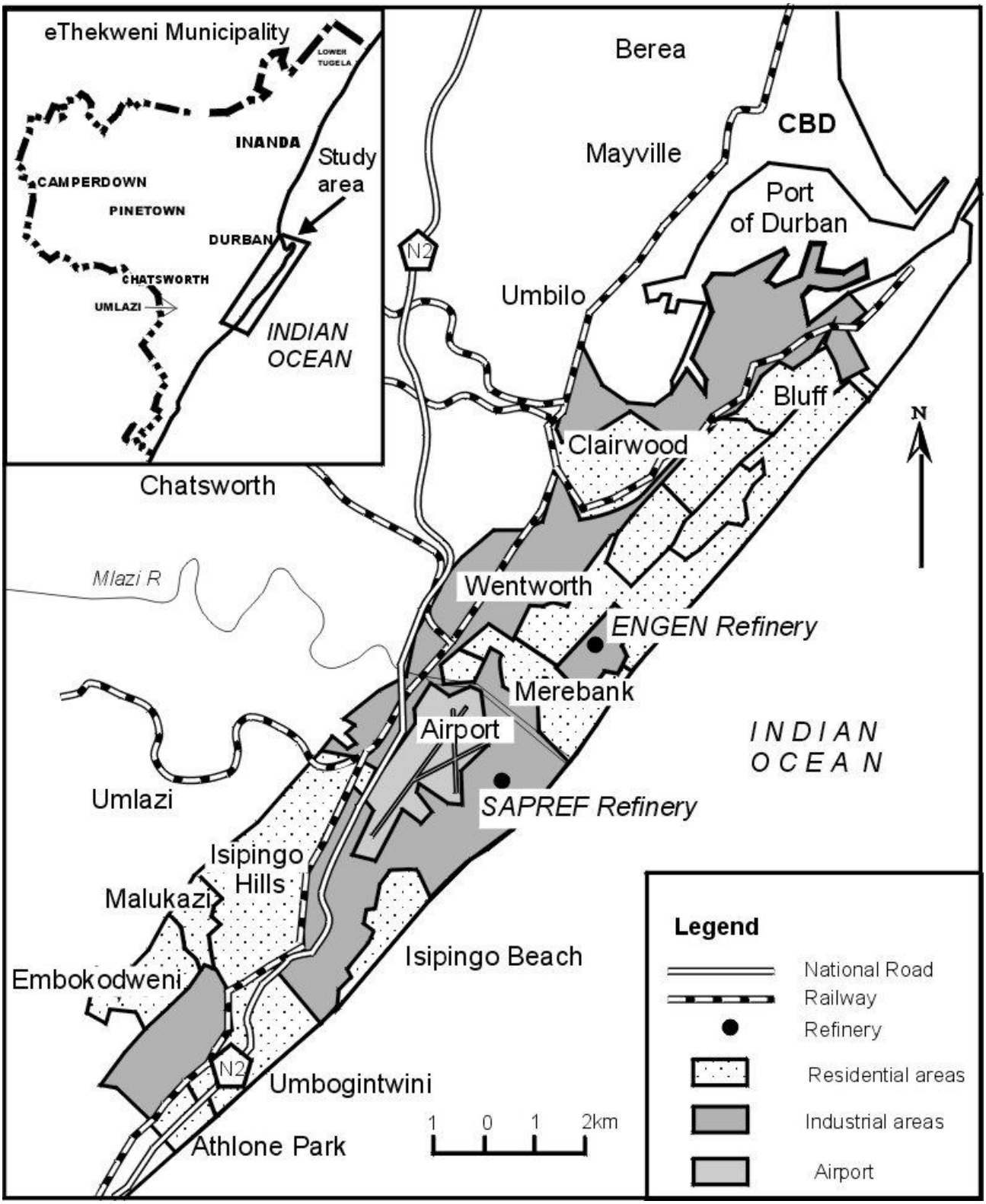


Figure 35: Site Figure Ground Source: Author

The following Maps illustrate the location of Merebank within the South Durban Basin. It is situated adjacent to the old Durban International Airport., Wentworth and the Engen Oil Refinery. The context of Merebank meets the Indian Ocean via “cuttings” or the canal of umlazi river. The water flowing from the canal is highly polluted and all waste from large industries are flushed out to the ocean via this canal. Residents however fish at the mouth of the river and ocean. The fish that they catch are in most cases toxic. The figure ground analysis represents built form and the relationship between industry and residents.

Accessibility of Merebank, Durban South Basin

Merbank is easily accessible via the M4 Freeway or N2 freeway. Taxis and Buses travel to the area on a continuous basis, and there are plans to include the area within the "GO Durban Strategy". Badulla drive is the main road whereby the site is accessed. Badulla drive is accessible directly via an offramp from the M4 Freeway. The M4 Freeway is linked to the CBD of Durban and is a major arterial link of Durban. The site is easily accessible, and this is because of the oil refineries and their need for easy accessibility due to the movement of trucks to and from the Durban Harbour. Thus it is paramount to understand how architecture could supply safe inhalable air, such that architecture can become the voice in which people can liberate themselves towards the struggle of attaining a healthier society on the level of the physical, mental and spiritual. Architecture positioned within easily accessible space has the potential to influence positive change within an environmental, social, and economical context that is on the verge of entropy.

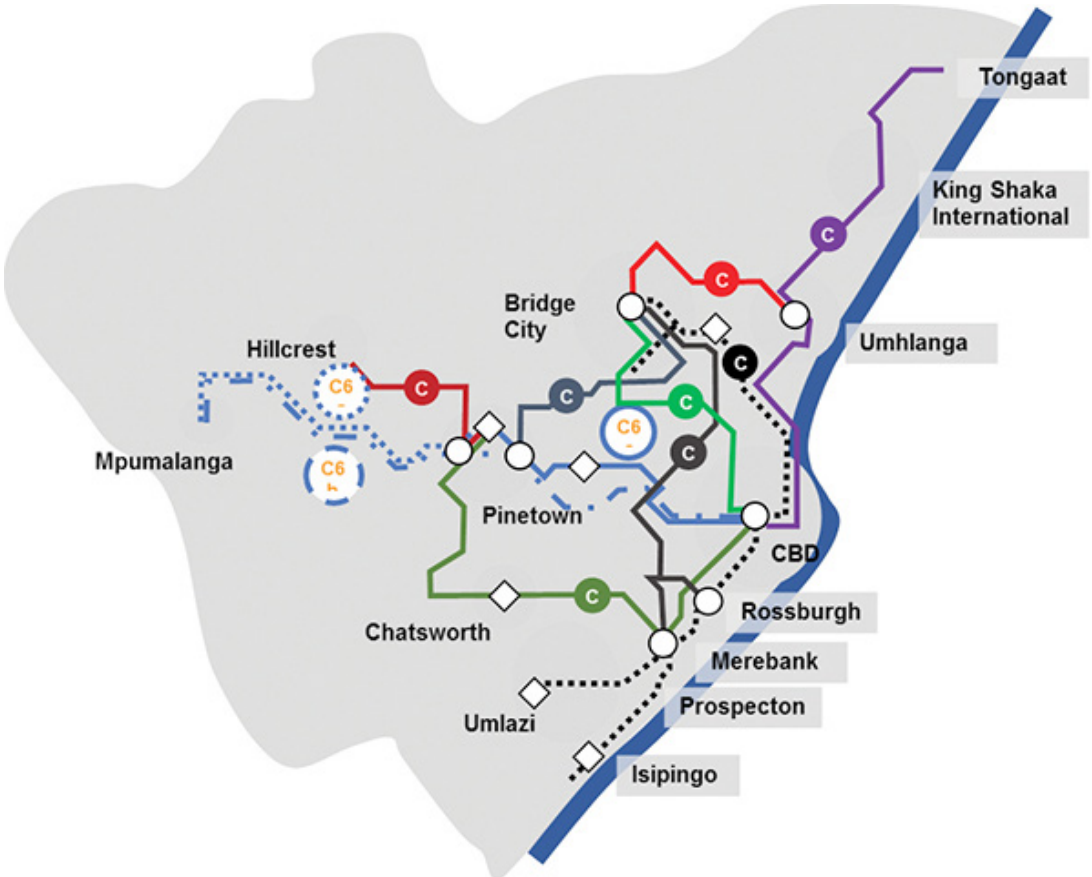


Figure 36: Durban South Basin Map Source: www.durban.gov.za, Online, Accessed 25-05-18

Co-Evolution in Merebank, Durban South Basin

"We are at a point in human evolution when human solidarity on a global scale is absolutely vital for the survival of the human species. That means understanding that we are all co-inhabitants of this planet" - Petra Kelly (1947-1992)

Context and Scale of Merebank, Durban South Basin

Merebank is a community of people living directly in-between two of the largest petrochemical refineries. A large paper mill is also situated adjacent to Merebank. The people that reside within the south Durban basin, were forced to stay within the context, and are now subjugated to environmental racism. The homes were provided by the apartheid government of South Africa and were of the project housing standard. The urban planners and architects under apartheid government created plots around industry and on these plots were shared semi-detached homes, and low-rise flats with a singular vertical access. Numerous amounts of negative space was created. Spaces of low visibility, and small areas were created, this was done such that the maximum amount of units were created. In certain blocks of flats, sunlight is restricted and this proves to be unhealthy as sunlight is needed for a healthy space and environment. This is also not good for any energy concern as more ambient light is required, which increases energy load on an already tight budgeted household.

The arrangement of allocated plots within the immediate context are formed in unision with the linear nature of Badulla drive. Badulla Drive is the key access link to the chosen site of intervention, therefore it is presumed logical that an architectural solution be realized on a site of high accessibility as well as in-between community households such that the architectural solution is easy to arrive at via foot, car, bus or train.

Figure 37: Site Study Badulla Drive Source: Author

Figure 38: Site Study Negative spaces Source: Author

Figure 39: Site Study Semi Detached homes Source: Author

Figure 40: Site Study Govermental issued Flats Source: Author

Figure 41: Site Study Badula Drive Source: Author

Figure 42: Site Study Badula Drive Source: Author

There is abundant vegetation on site and this vegetation could be utilized within the architectural solution. The site was previously used as a soccer grounds, with a disused parking lot which is now a dangerous space. Various accounts of people within the area claim that the disused parking space is used to trade drugs. The author personally experienced vehicles enter and leave the disused parking spot in quick succession numerous amounts of time. These types of spaces are not good for communities, as they facilitate degenerative behaviour rather than regenerative behaviour. The way out of hell is not to engage in more hellish activities, but rather standing up for positivity and fighting for justice. The disused parking space has the potential to transform itself through some of the principles derived from this research. Hence we notice that an attitude of faith in place can be the driver for positive change. People that live within the basin believe in God, and positivity. They have already been successful in surviving hardships, therefore there is not a doubt that this community will stand together to see social, environmental and economical problems change for the better. The people that live here are resilient and many claim that they cannot smell the air pollution as their sense of smell has been degenerating and they have become accustomed to the daily toxic air. This is quite marvelous yet disgusting that a human being should adapt to these kinds of situations on the dailty. Perhaps Darwin was correct when he stated that " it is the one that is most responsive to change that survives" (Darwin, 1859).

We notice some of the people of the basin surviving through air pollution and many dying because of it. This cycle of life and death in the basin is mediated by a public hospital, named Wentworth Hospital. Questioning the hospitals adequacy is perhaps a dissertation itself. However the hospital is approximately 2.5 kms from the proposed site, and is far to reach by foot, therefore we see the importance for more healthcare facilities or "spaces of clean air" within the immediate context. The health problems associated to massive amounts of air pollution do not give much time to the diseased, either to get healthcare, or to live a full life. It is important to note that

these statements discussed above are written in the context of time, and in order to engage any change, one needs to act immediately, now.

The next section will examine some of the materials used in construction and alterations to residential and industrial architecture within the context.

Figure 43: Site Study Wentworth Hospital Source: Author

Tectonics and Materiality of Merebank, Durban South Basin

The tectonics of Merebank, Durban south basin is varying. Some people have adapted their homes to the 21st century in numerous ways and others live in what was given to them with minimal adaptability. People living in semi-detached homes ammend their homes to give it a unique colour, shape, or characteristic. These changes could be from changing windows and doors to actually extending their homes to create more interior space. Some homes have carports, and awnings. Some have built garages. The idea of evolution is ever present here, because we notice people take whats given to them and evolve it. This idea is of renovation is organic and results in each home being completely unique. The scale of construction is small compared to modern day high rise and low rise residential. However there are exceptions to the norm, as some people live in either very small houses or rather large homes uphill from the chosen site (those that purchased two or more properties which are adjacent to each other).

Discovered methods of construction are concrete, brick and mortar, with timber trusses and clay or ceramic roof tiles. We also notice that certain construction techniques consisted of cement/concrete blocks built up to timber trusses, asbestos roof tiles, gutters and rainwater downpipes.

The materials that were used to construct the residential architecture of Merebank in the Durban south basin is mainly materials that exist within Durban. Sand is sourced locally, as well as common bricks, certain facebricks, blocks and timber. Clay and ceramic tiles are also manufactured in Kwa-Zulu Natal. Steel sections, corrugated or IBR roof sheetings are manufactured within KZN. Plastics, PVC, Polycarbonate and Insulations could differ in availability, however there are companies which produce these materials within KZN. Paint is also manufactured in KZN Jacobs. Therefore it is fair to state that the majority of materials used in the alteration, construction and extension of homes can be sourced locally depending on availability of the material.

Figure 44: Site Study Materiality Source: Author

Figure 45: Site Study Materiality Source: Author

Kwa-Zulu Natal has cement quarries and this provides a consistant source of cement for the construction industry. The scale at which these residential units exist also utilize very little energy in the fabrication of the home. People adaptively reuse their properties for different functions, and the home changes continuously according to the need and function of the user.

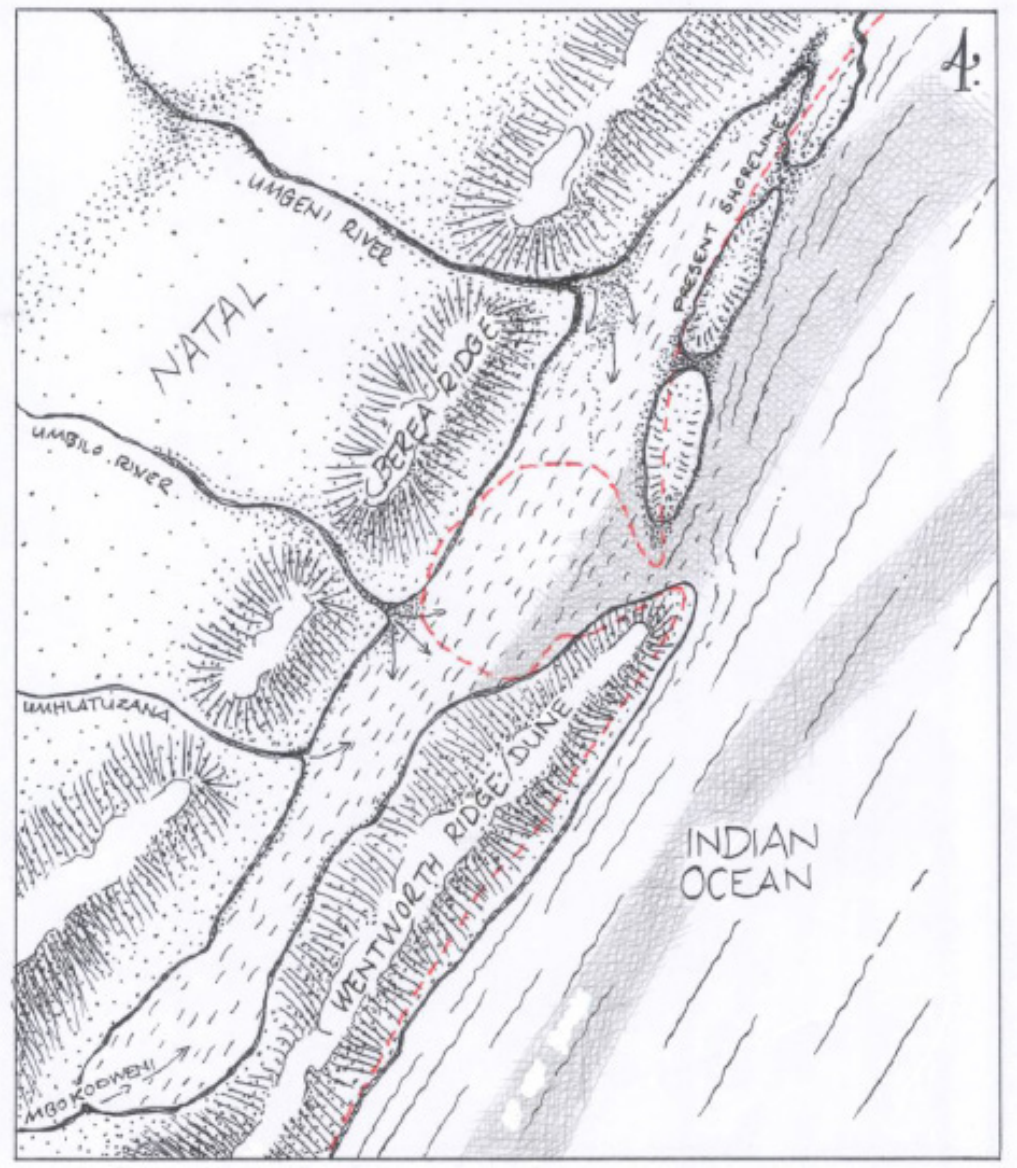
There are people with the knowledge of typical “brick/block, plaster cement, timber roof structure and ceramic roof tile construction” within the area of study. There are also people with the knowledge of steel fabrication construction techniques (steel beams, steel/concrete columns, trusses, and roof sheetings). Therefore it would be important to construct the architectural solution with the knowledge of construction techniques existent amongst members of the community. This would be true deliberation, and the entire community can have a sense of ownership to the architecture. In this way the architecture becomes cared for because they have the knowledge of maintaining materials they are used to engaging with. However it is also important to note that training in construction techniques can also take place, such that people who require skill sets can now become capable of learning these skill sets. As the adage goes:
“Give a man a fish, feed him for the day. Teach a man to fish, feed him for life”.

In the following section the topography of Durban will be discussed. This is important to identify because in order to build for the future, we require knowledge of the lands topography and how it was formed settled. The section will also discuss how humans have disrupted and changed the topography concerning Durban.

Topography and Geology of Merebank, Durban South Basin

The land of what is now known as Durban, seemed to look very different in the past, before humans settled here. Mankind has divided the land up into zones according to functionality, the CBD is central and everything revolves around it. However the Topography of Durban is unique, especially in the sense that it has a “natural” port. The port of Durban was formed by nature and man has merely adjusted it to suit modern demands of shipping and trade regulations. The port is consistantly dredged and is ever changing with activity. What is unique about this is that the natural harbour existed where the chosen site of study is located.

Figure 46: Site Study of where the harbour used to be previously Source: https://grahamlesliemccallum.wordpress.com, Online, Accessed 02-10-18



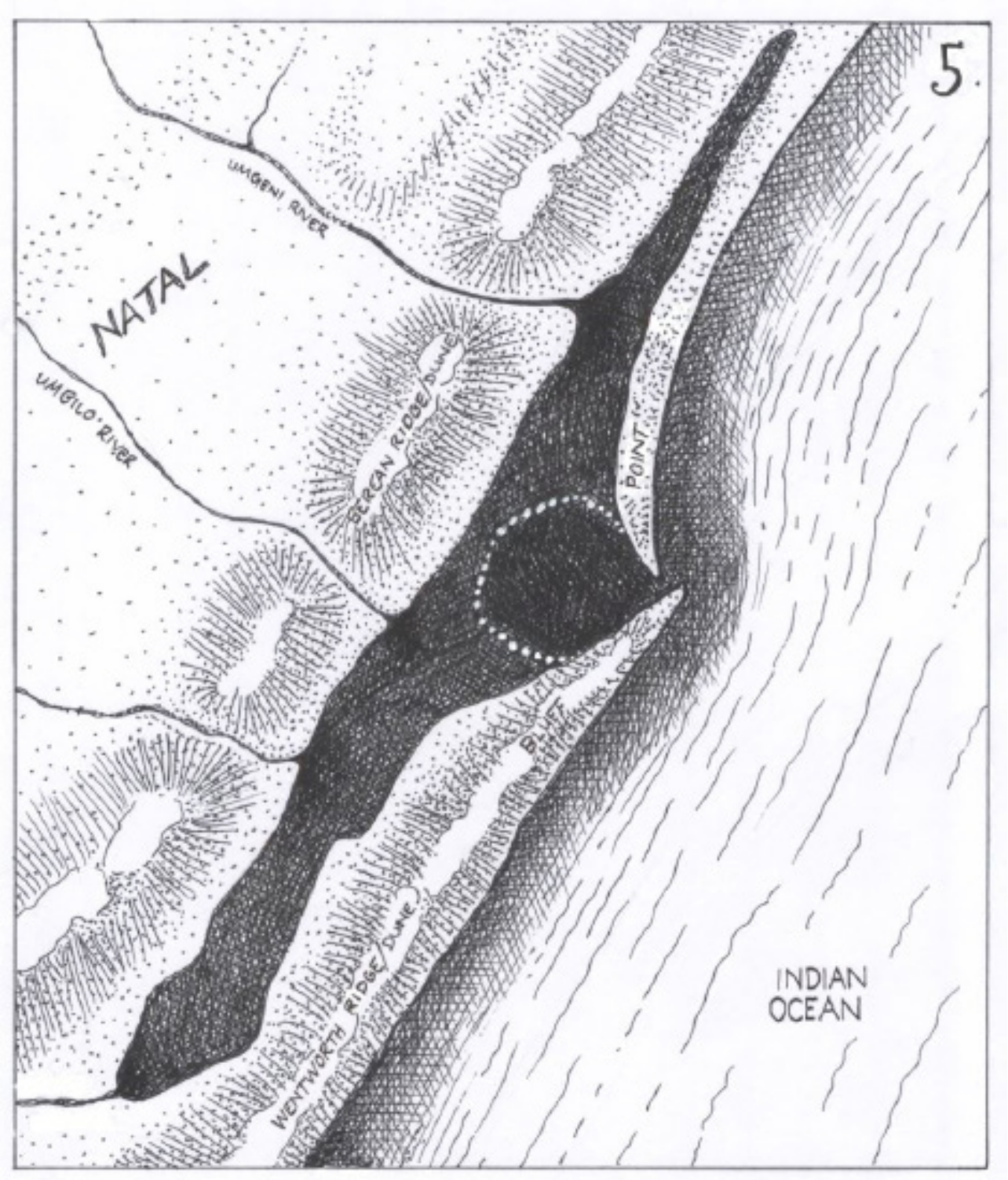


Figure 47: Site Study of where the harbour used to be previously Source: https://grahamlesliemccallum.wordpress.com, Online, Accessed 02-10-18

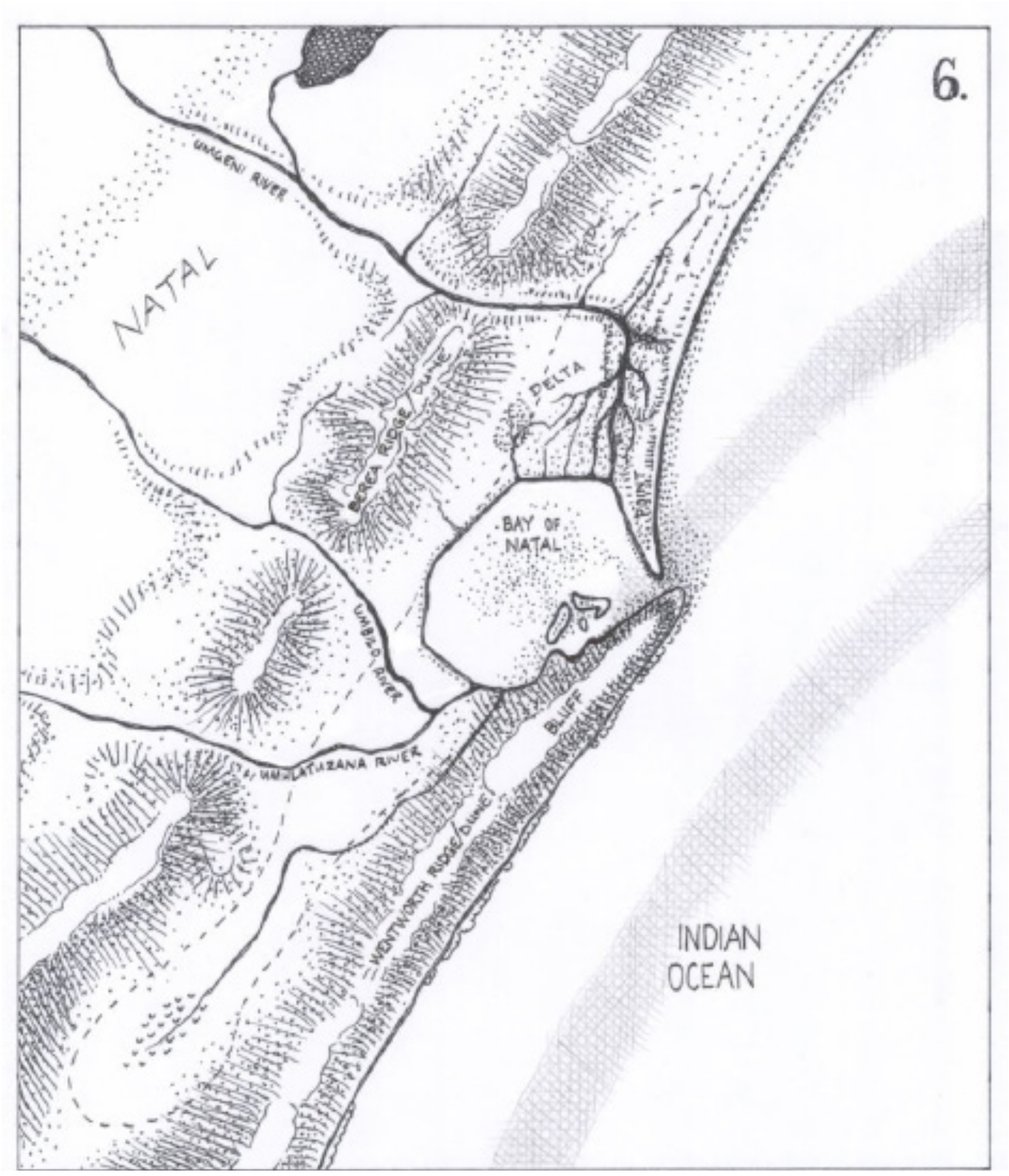
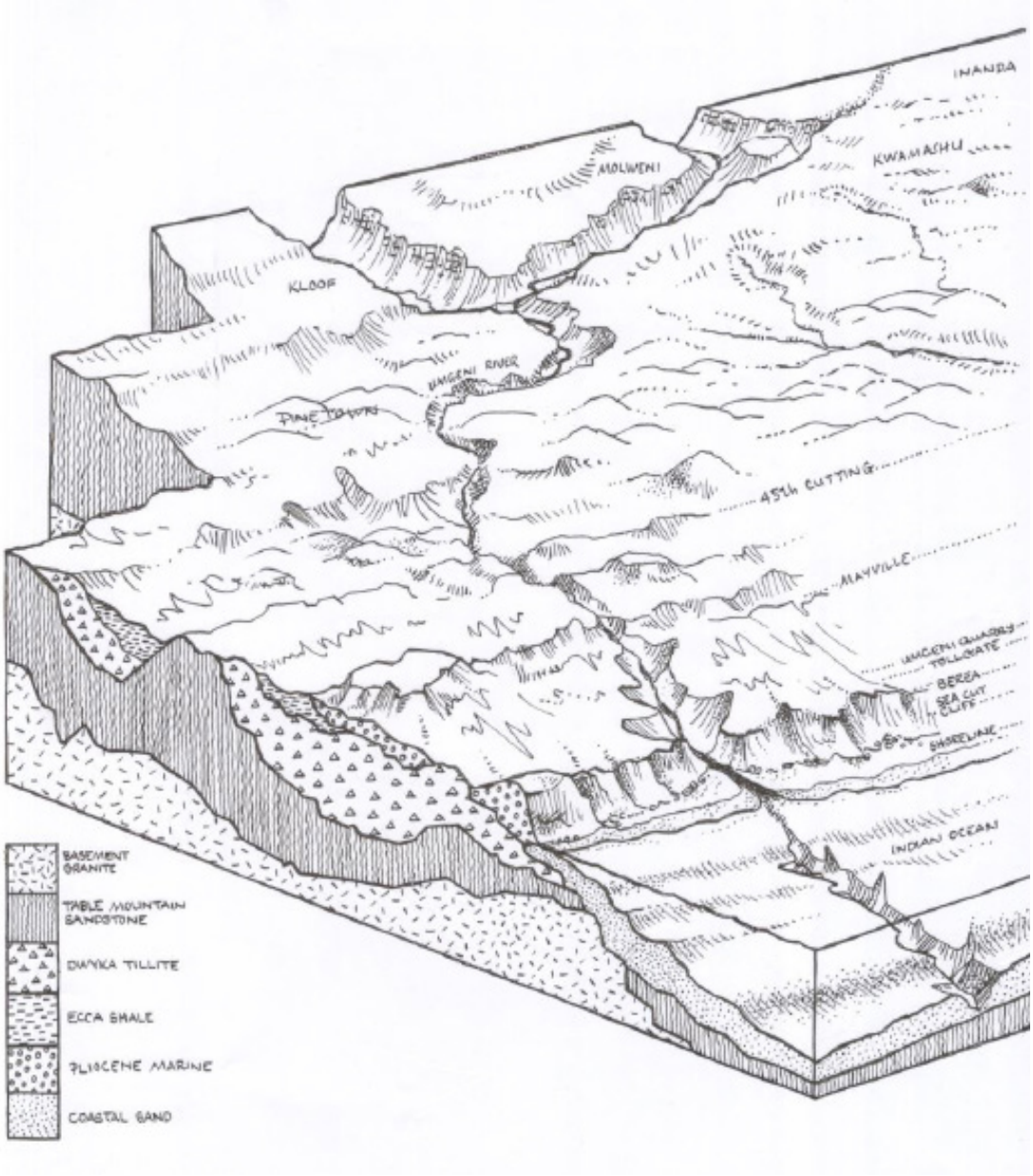


Figure 48: Image of where the harbour is currently Source: https://graham-lesliemccallum.wordpress.com, Online, Accessed 02-10-18

Figure 49: Site Study of a topographical section Source: https://grahamlesliem-ccallum.wordpress.com, Online, Accessed 02-10-18


INANDA
KWAMASHU
MOLWENI
KLOOF
UMGENI RIVER
PINETOWN
45th CUTTING
MAYVILLE
UMGENI QUARRY TOLLGATE
BEREA
SEA CUT CLIFF
SHORELINE
INDIAN OCEAN
BASEMENT GRANITE
TABLE MOUNTAIN SANDSTONE
DWYKA TILLITE
ECCA SHALE
PLIOCENE MARINE
COASTAL SAND

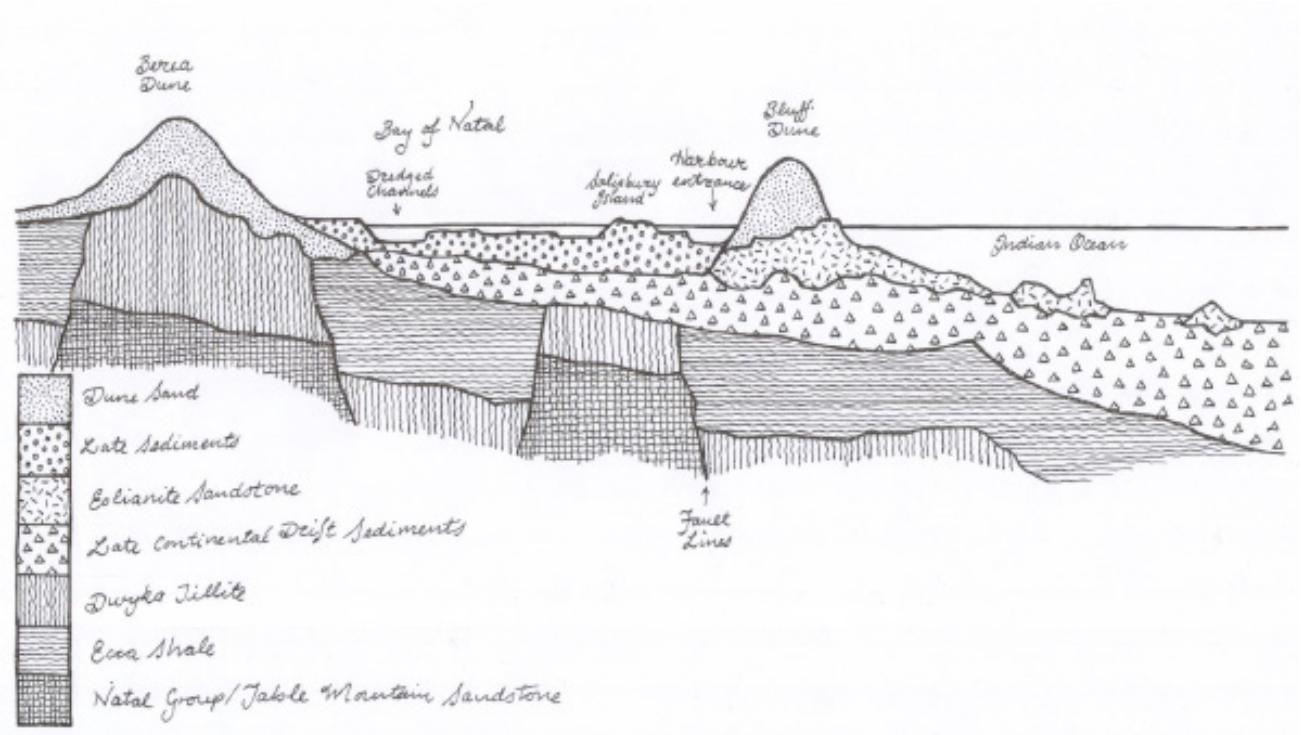

Berea Dune
Bay of Natal
Bluff Dune
Dredged Channels
Salisbury Island
Harbour entrance
Indian Ocean
Dune Sand
Late Sediments
Eolianite Sandstone
Late Continental Drift Sediments
Dwyka Tillite
Ecca Shale
Natal Group/Table Mountain Sandstone
Fault Line

Figure 50: Site Study of a topographical section Source: https://grahamlesliem-ccallum.wordpress.com, Online, Accessed 02-10-18

The Bluff and Wentworth dune consists of “dune sand” and “late sediments”, which arent too stable for building, therefore we see homes positioned on these dunes requiring a strong pile foundation such that the home does not come sliding down the dune. Whereas on the lower contours of the chosen site there exist much stronger soil such as “late sediments” and “late continental drift sediments”. “Ecca Shale” is prevalent just underneath the layers of “late continental drift sediments”. Therefore should a highrise building be built upon the soil of the south basin, it would require a pile foundation driven into the “ecca shale” layer such that the foundation is strong enough, and the building will not erode away when there are movements in the soil due to excessive flooding.

Therefore it is important to note that the chosen site of study will require piles, however the structure should keep to the scale of the local residential architecture, such that it blends in rather than be obtrusive to context. The building should ideally be on a pile foundation and stilts, such that when the land is flooded with increased sea level rise, the floor plates above ground level is secure, and items within are safe. This would allow the structure to continue providing clean air regardless of any risk of floods.

Place

“ Some people look for a beautiful place, others make a place beautiful” (Inayat Khan, 1976)

It seems that the people that live within the South Basin are a part of the latter of Inayat Khans’ statement. In the SDIB people have no choice but to make place beautiful, and those that cannot afford it architecturally, may do so in whatever form fit for themselves.

However the SDIB is occupied by workers, residents, environmentalists or conservationists. Tourism within the SDIB is not a major draw card, because tourism favors the people that look for a beautiful paradisal place. However it is important to note that the people that live within the SDIB, workers, and environmentalist or conservationists will be the key user groups for the architectural solutions provided.

The architectural solution should be able to welcome tourists and people from all nationalities. This will heighten environmental awareness and spread the message of change. Therefore the architecture should represent spaces that will be utilised by fulfilling the functions required by various user groups within the SDIB.

Local Community Members

Members of the community that live within the SDIB rely on the environment even though it is toxic. The local access to the beach is fished daily, by people making a living of fishing. The people plant their own crops even though soil conditions are not the most conducive for healthy vegetables or fruit. Man has really polluted this environment and it is in the basic instinct of his brothers and sisters, to survive with what is left for them. Therefore it is essential to highlight the plight of these people by allowing them space to grow their own crops and shared farming amongst an architectural solution. Plants could be facilitated indoors via a hydroponic system, or positioned outdoors under better air quality conditions. However what is important is that the architectural space provided creates and supplies clean air, such that the spaces within and without are healthier than the rest of the surroundings. This would encourage the locals to take ownership of the architecture and vacant land which existed before. This would become the starting point for ecological, social, environmental, economical and physical regeneration of a community which is in constant distress.

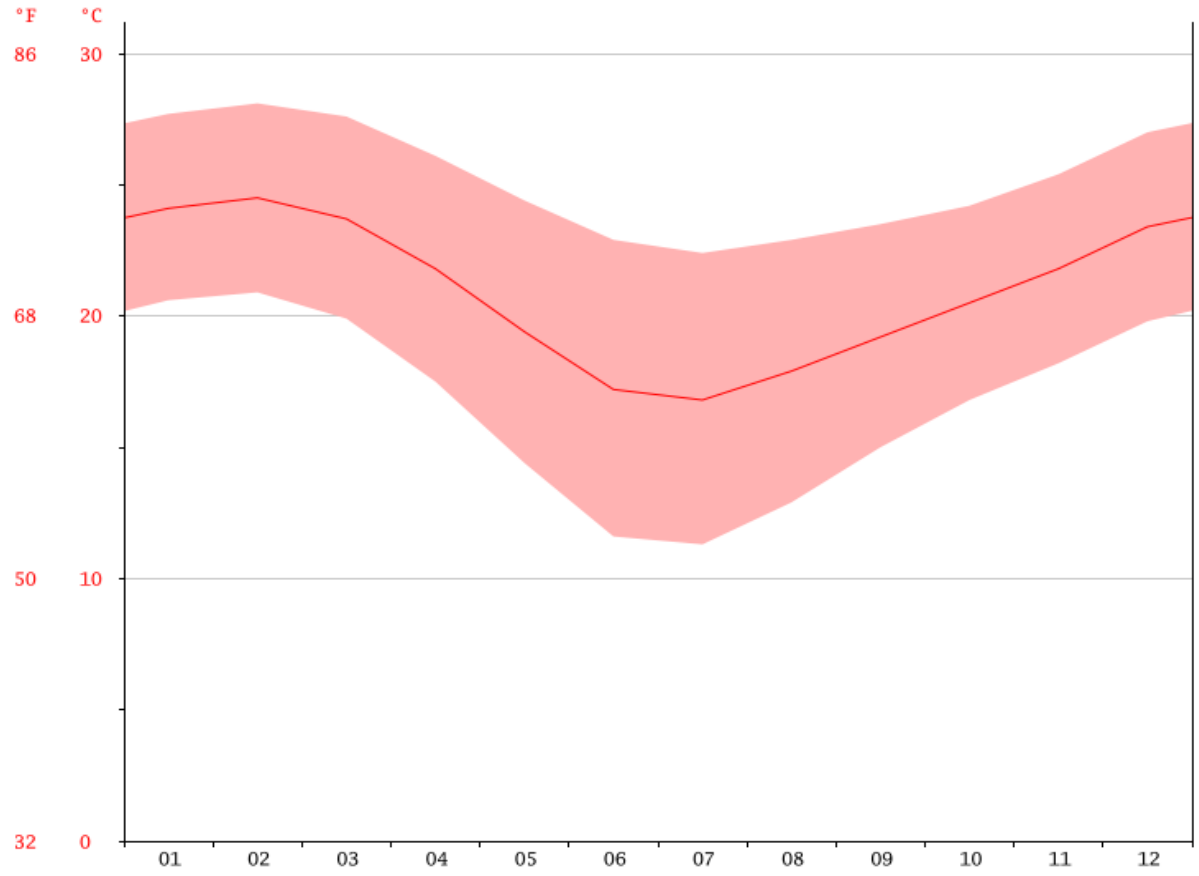
Local Entrepreneurs

There are plenty of people making a living within the SDIB via entrepreneural efforts. People either turn their homes into a place of residence and work, or they set up stalls along Badulla drive or Tara Road to sell vegetables and fruits. We notice professionals running their business from home, and this is a good thing, because entrepreneural activities create jobs for more people. Existing within the area are small contracting companies, spaza shops, tea rooms, and tuck shops. The Merebank market or “mall” also exists in close proximity to the chosen site of study. This is a key economical and cultural node and this node provides people with various goods and services required.

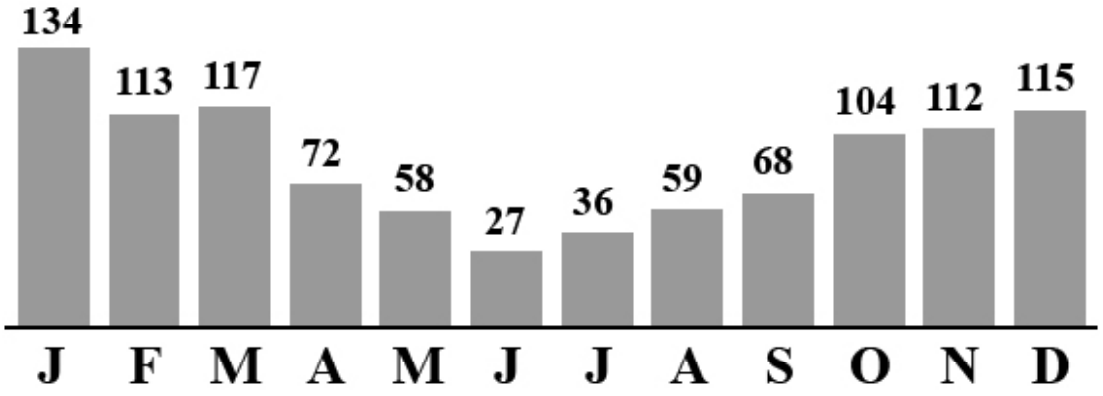
Environmental Conditions

The climate of Durban is a sub-tropical climate. This means that Durban experiences hot summers and cool winters. The mean annual temperature of Durban is around 24.5 degrees celcius in summer and 17.5 degrees celcius in winter.

Figure 51: Average mean temperature for Durban Source: https://en.climate-data.org, Online, Accessed 09-07-18



The majority of rain and precipitation occur during the summer months. The winter months have little rainfall.



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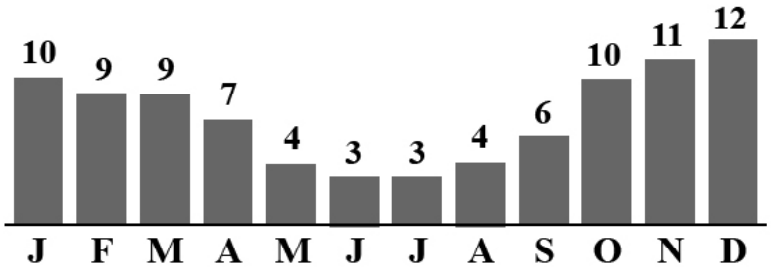
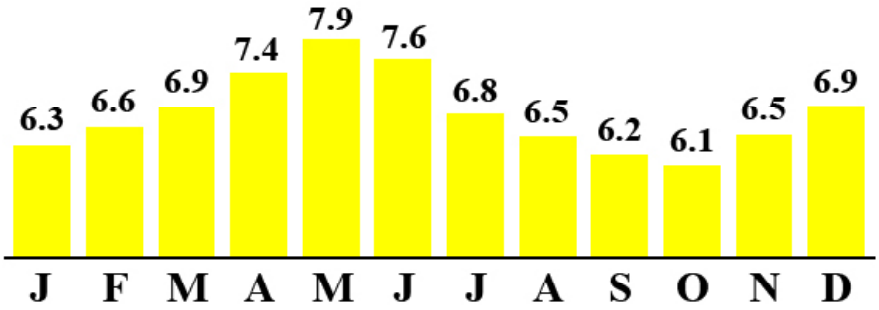
for Durban Source:
https://en.climate-data.org,
Online, Accessed 09-07-18



Right Figure 53: Days of
rain per month Source:
https://en.climate-data.o
Online,
Accessed 09-07-18



Above Figure 54:
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Source: https://
en.climate-data.org,
Online, Accessed
09-07-18

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DMOSS
Site Study Source:
gis.durban.gov.za,
Online, Accessed
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Environmentalist Groups within Merebank, Durban South Basin

The SDCEA, or South Durban Community Environmental Alliance is one of the notable environmental groups which exist within the basin. Groundwork is another organisation which fights for environmental justice. However the researcher has worked with members of SDCEA including Mr Desmond D'Sa who is a tower figure to the people of the SDIB. He is a community leader with iron determination and the organisation fights for the health and welfare of the people. They are funded by donations. The organisation works extensively to arrange petitions, protests and rallies in favor of good health and living circumstances. They campaign against pollution, health, and the exploration of oil and gas offshore the coast of South Africa. They aim to help generate community development and sustainable development. The organisation fights for renewable energy and for the end of fossil fuels. The organisation also aims to provide the community with knowledge on environmental factors such as air pollution, gas leaks, flares, and oil spills. Without organisations like the above mentioned, the DSIB would be a very hostile place to live and work in.

The process of built form in the natural environment

Bluff nature reserve exists within the SDIB and it is approximately 2km from badulla drive. The above section on topography demonstrated the flow of rivers into the bay of natal. Hence the basin is rather flat, because it was the bay or in earlier times a lagoon. Much of the old Greyville racecourse is still a marsh wetland. On the chosen site, a wetland is also prevalent. However we notice that man is infinging on these wet lands by placing warehouses and industrial buildings on these wetland sites. The intereference caused to the natural eco-system only creates more problems for people depending on natural methods of growing vegetables and fruits. This is because when any toxic chemical leaks into the wetland, it usually surfaces around other wetlands. Hence all the wetlands are still connected in some way although the rivers have been diverted of their course.

This is an important notion, because when designing any architectural proposal for the SDIB , the architect must respond to these natural challenges. Therefore the best method of construction to sites of this calibre requires for the conservation and replenishment of nature. In order to do that, the foundation should touch the earth lightly and utlilize techniques of water harvesting such that the water collected could be initiated back into the water table to encourage plant growth.

It is also worthy to mention that the procedure industry follows when erecting built form is not conducive to preserving and sustaining ecological systems. One could argue that industry should lead by example, however the majority of industries around the world do not maintain good architectural practice. In order for mankind to prosper, we as human beings need to implement techniques in construction which capture and store energy without hurting others in the process of achieving this result.

Conclusion

The case study has laid the foundation for achieving an ecologically regenerative architecture which is based on the co-evolution, place-making and processes used in Merebank, Durban South Basin. The context of Merebank represents a unique sense of place and the community spirit is strong. People are continuously co-evolving, with nature and industry. One can notice the changes made to individual homes, this is proof of resilience as well as constant evolution. In the face of environmental toxicity, dwellers are still hopeful for life. This is the true spirit of mankind. The dwellers push on and do not give up. This is the spirit that architecture represents.

The developmental processes which exist within the SDIB are intertwined within the code of nature. Matter is always seeking expansion and growth, or it subjected to decay and entropy. Even though the environment is toxic, people somehow grow, and some are subjugated to entropy. However this is a design informant for an eco-awareness and air recycling facility because not everyone can withstand the environmental toxicity. It is a crime to pollute the air on such a massive scale. Therefore the research proposes for a design of an architectural propotype which multiplied on an urban scale - could produce a significant change to air pollution levels. The functionality of each prototype could be adapted to users needs.

The building needs to connect with the ecosystem existing, such that it could regenerate and replenish the environment. The adaptability of the functionality proves useful because as needs change over the course of time, the spaces created can adapt to these changes. This is the idea of regeneration, whereby the concepts of co-evolution, place, and developmental processes intersect such that they assist one another.

Chapter 6

Conclusions Recommendations and findings

Introduction

The research, analysis and synthesis carried out in the theoretical framework, literature review, precedent studies and case studies aim to address the problem statement:

Mankind's insatiable thirst for oil as the primary source for consistent energy has had a detrimental effect against the planet. Many scientists claim that oil would last for another 30 years, until the year 2050. What will we do then? Oil is a non-renewable energy source and its engagement with automobiles has become the normal way of living life. However to produce this 'normal' way of life a refinement process of crude oil is required. These refinement processes produce tons of noxious gasses which are harmful to the environment and human beings once inhaled consistently. In the case of South Durban Basin, a large community is directly exposed to these high levels of noxious gases every day, including children and old age pensioners. The sub health, economic, environmental, natural and physical problems which arise are directly linked to the massive amounts of air pollution existing in the SDIB.

The theoretical framework, review of the literature, precedent studies and case study all form a part of the analysis which aims to satisfy the main objective:

This research positions itself along the brink of great realization - that oil reserves are not permanent. Therefore the researcher aims to unravel the mysteries surrounding architecture and its ability to filter or decompose toxic pollutants of air, such that architecture is now seen as a place of refuge, health, welfare, collaboration, integration, and community. Architecture here aims to be an antidote against toxic air, in effect helping with the regeneration of a community. Architecture should act as a platform for ensuring that

present needs are met without jeopardizing the needs of generations born and yet to be born.
Thus the findings and recommendations represented on the following pages attempt to synthesize key architectural principles which address the key research question:

How can architecture help to supply safe inhalable air for the residents of South Durban Basin?

This chapter culminates and outlines the findings of the research formulated through the literature review, precedent studies and the case study. The chapter also displays the data gathered from sporadic conversational interviews with community memembers present at an SDCEA community meeting, as well as a semi-structured interview with Mr Desmond D'Sa of the SDCEA.

The recommendations introduced generate the design principles which formulate the design of the eco-awareness and air recycling facility for the South Durban Basin.

Recommendations and Findings

The environment which exists within the South Durban Basin is not conducive to sustain a healthy living. This is due to "top-down" philosophy which refer to the government as figurative top, and the citizens as figurative down.

Nature is subjugated to harsh levels of pollution and the environment is suffering from rapid decay. Peope of all races and all genders were interviewed via random conversation - they remain anonymous. Desmond D'Sa was interviewed semi-structurally.

The objectives developed within the first chapter have been achieved by answering the sub-questions in the chapters following the first chapter. These sub questions were answered by the three principles aiming to achieve ar-

chitecture that is regenerative. They are namely; co-evolution, sense of place, and developmental process/process. It is important to note that these principles was also used to analyse the precedent and case studies. Architecture which respects co-evolution, place, and process in effect creates regeneration. This was the overarching concept to the research, because in an environment facing rapid degeneration, the polar opposite is required for the transformation of the precinct. This will create environmental awareness through the bottom up approach, citizens as the figurative bottom, and governemental institutions at the figurative top. After all, everything in nature principally grows from small to large (seed to tree), or from the bottom up (roots to branch).

The First Chapter aimed at answering the first sub question:
1. What are the current challenges facing residents of the south Durban Basin? It was established that the main problem facing the residents is air pollution, however many other problems such as crime, poverty, violence and a lack of community confidence exists in direct relation to the air pollution.

Chapter 2 initiated a theoretical and conceptual framework that allowed the author to gather the relevant principles necessary toward achieving an ecologically regenerative architecture.

The Third Chapter explored the literature based on the theoretical framework, such that it could answer the following sub-questions:
2. What methods of science and technology are appropriate to decontaminate hazardous air?
It was discovered that science and technology do play an important role in decontaminating hazardous air, as there are technologies such as ionisation of air, titanium dioxyde and air filters. Therefore science and technology should be incorporated within architecture such that the air becomes cleaner, the environment becomes more conducive for living in and the health of the community rises.

3. What strategies are required to regenerate community development?
Community development within the SDIB exists currently and there are people working together to administer relief to people suffering. They exist in the forms of environmental organizations and healthcare organizations. This chapter discovers that architecture has the power to regenerate community and therefore some of the strategies used to engage community development are borrowed from architecture and vice versa. It was discovered that by promoting sustainability through community driven projects and creating jobs through employment opportunities and skills development training people can alleviate themselves through poverty and unemployement.

4. What architectural principles are required to design a regenerative mixed-use facility that supplies safe inhalable air to members of a community?
Architecture may be able to supply safe inhalable air to members of a community by the adapting of architecture to an area or site, incorporating the principles driven to achieve a regenerative architecture, and facilitating the relevant air cleaning technology within the architectural mainframe.

The Fourth Chapter tests the principles of regeneration discussed in the literature review against the architectural precedents. This framework of principles was the lens through which Merewent was analysed. This was done because the proposed eco-awareness and air recycling facility needed to regenerate the environment sensitive built form.

The Fifth Chapter explored Merewent and the greater South Durban Basin precinct such that a site responsive architectural prototype could be developed.
The research concluded that the disadvantaged communities of the south basin rely on natural resources to survive, such as planting and fishing. The community also relies on basic healthcare services provided. The community required architectural solutions that can provide clean air. Certain members of the community displayed knowledge of basic construction methods, materials

and ideologies.

The recommendations presented in the Sixth Chapter are based on the literature studied, precedents analysed, the interviews conducted, and the observations done in Merewent. The intensive exploration of Merewent was vital such that the context informed the eco-awareness and air recycling facility.

Recommendations

The design principles that are developed are generated for an ecologically regenerative architecture which situates itself in the context of high air pollution and urban decay. It is important to note that this context is shared between industry and residents. The principles were developed through the exploration of the literature, precedent studies, and a case study that included semi-structured interviews and on site observations.

The conceptual and theoretical framework lead the research to establish the architectural design concept of **Architecture as a regenerative paradigm for harmonious living between nature, community and industry.**

The architectural concept implies that architecture should regenerate the relationship between nature, community and industry. In doing so architecture aims at providing clean air for memebers of the community, situate itself within place, and provide developmental processes such that members of the community have an opportunity to learn skills, and gain employement. This facility aims at enhancing sustainability and resilience amongst the community.

Co-evolution in Architecture

The principle of co-evolution is influenced by natural biological processes. This principle allows the architecture to impact positively on the natural environment. It also suggests that an architectural prototype can be viewed as a cell, and as nature multiplies one cell to create the organism, architecture can be multiplied interdependently such that an organism can be created - an organism which cleans the air, abides to place, and regenerate community

development.

- Co-evolution fundamentally implies that no one may benefit over another. People and industry need to co-exist, and co-evolve such that there is a mutual beneficial arrangement between them and nature.

- The proposed architectural solutioin needs to provide clean air within the community without consuming more energy than it can give back. Achieving a net positive energy coefficient implies that sustainability and resilience is promoted through natural processes and renewable energies.

- The building requires natural lighting, air purification systems to clean the air within the building and supply clean air around the buildings perimeter. Studies show that PM2.5 is cleaned up to 50 % at an exterior radius of 10-15 meters with minimum wind present.

- The co-evolution implies that architecture, people, industry, and the natural environment require each other to function healthily such that the entire system of life is improved within the SDIB

Place in Architecture

Place in architecture refers to the development of architecture with respect to the place in which it will exist.

- To capture the sense of place for the design of an eco-awareness and air recycling facility, the surrounding natural and built context should be inspiring the materiality and tectonics of the architectural facility.

- The facility should be able to be built by members of the local community, therefore it is important to consider their skills and should it be lacking, then the education needs to be provided such that members of the commu-

nity can develop a new skill set.

- The materials that make the building need to be locally sourced such that the architecture becomes rooted to place. This will reduce the cost of transportation and limit carbon emissions for the transfer of these materials.

- The use of local materials allow for the architecture to be maintained. This is easier to do if the local members of the community know how to maintain the materials used. It only makes ecological sense that the architecture should blend in with place. The architecture will also be understood by the community because they are familiar with the materials used.

- The building needs to respond to the local topography of the south Durban basin, such that the low lying contours are respected. The area is infamous for flooding especially after the Wentworth Ridge was blasted to make way for the newly channeled Umlazi River Canal. The architecture requires to be positioned on pile foundation and stilts such that flooding cannot affect the building.

- The architecture needs to adapt to the sites continuous changes. The architecture needs to correspond with climate change and create a good air quality present within the immediate area.

The principle of respecting place before commiting to the design of architecture is vital to the ecology of the area, and for the creation of ecologically regenerative architecture.

Developmental Process in Architecture

Developmental process in architecture refers to the relationship between architecture and community development. In order for the eco-awareness and air recycling facility to approach design from the ground-up. In summary architec-

ture needs to develop people, the community and the environment.

- Architecture needs to provide jobs for the local people of the south basin. The facility therefore requires local participants such that the facility is cared for and loved by the people that surround the facility.

- The functionalities of the facilities need to be able to adapt to what the user requires. Therefore the social activities present within the area need to correspond with the architectural facility.

- Sustainability and resilience are key ideas which drive forth the notion that architecture should minimize its impact on the natural environment, yet providing maximum impact to provide clean air. The cost of the construction needs to be minimized such that the carbon footprint is reduced. Solar energy needs to supply electricity and water tanks need to harvest water.

These principles for architecture mentioned above formulate an architecture that respects people, the environment, and industry.

Conclusion

In conclusion, the proposed eco-awareness and air recycling facility for the Durban South Basin incorporates key regenerative principles. The context is in rapid degradation, and it requires an immediate architectural response that could alleviate the problems associated to massive air pollution. The facility aims to provide clean air, root itself within place, yet be flexible enough to adapt to functionality and position. The facility aims to create awareness to the issues concerning environmental degradation and environmental racism. It also aims to provide education about permaculture such that people can learn how to grow plants that clean indoor air within their homes. Therefore the project aims to provide clean air, and promote social bonding within the context of the South Durban Basin.

"Further Research is needed"

There is further research that is needed within the South Durban Basin. One such research gap is the study of architecture and spaces of play in the south basin. There is a large amount of cases that exist whererby women and child abuse is reported and no available literature on howmany abuses are not reported. There is a study done to show the correlation between air pollution and green criminology, the title of the study is: "The Urgency of a "Green Criminology": A Case Study of Air Pollution, Criminal Activity and Environmental Perception in the South Durban Basin (South Africa) and the author named Ludovica Serafini. This study that has been done has an effect on architecture, because the built environment has multiple negative spaces. These negative spaces are places of crime, abuse, drugs, and prostitution. Architecture needs to assist people in the south basin as there are many ills caused by poorly planned architecture and urban planning. There are no buffer zones between industry and community. The research has touched on this lightly but was not the key focus. There exists the possibility to help one another and situations will change for the better as we exist in an era of infinite possibility.

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Interview and Discussions D'Sa, D. (2018) An interview on determining an ecologically responsive architecture for the South Durban Basin.(Interview at SDCEA Offices) Personal Communication. 17 October 2018

Appendix A

Interview Schedule: The interviews were semi-structured, and occured randomly over different days. The interview followed the style of a conversation, and it was a relaxed atmosphere. An interview took place at the Austerville Community hall whereby a community meeting was held. The participants were calm and collected, and responded in an honest manner.

Below is a copy of the Interview Schedule

To elders/adults within the Durban South Basin community

1. How long have you been living within the Durban South Basin?

2. How have these living conditions affected your life?

3. How many people live in your home?

4. How many have jobs from your household?

5. Do any of your family members work for the petrochemical companies?

6. Do any of the family members suffer from respiratory illnesses, and how old are they?

7. What types of respiratory illnesses are you and your family affected by?

8. How would the supply of clean air to your community help?

9. How has crime/poverty affected your safety?

10. Are you satisfied with your environment?

11. Can you and your family afford medical aid?

12. Which schools do your children attend?

13. Have the young adults found jobs within the area, or out of the area?

14. What do you require to help you develop your skills and earn money?

15. What is your common mode of transport?

To major industries

1. Has your business been progressing each year?

2. Do you notice that the processes the company employs are polluting the environment significantly?

3. Are you aware that children are being affected by these toxic gases prevalent in the air?

4. Have you monitored the waste output of the company, and its carbon footprint on the environment?

5. Is the company you work for South African?

6. What benefits do you provide the community with?

7. What is the role of the company within the economy?

8. What sustainable technologies does the company utilize?