

# [RE]Claiming Vigour

Designing an Urban Industrial Complex in Mamelodi

Human Settlements and Urbanism  
Study Leader: Jan Hugo

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M Arch (Prof)  
at the University of Pretoria

2017

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## Words of Thanks

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I would like to thank my **Mom and Dad**, for your boundless love and support. Thank you for being patient with me through all the sleepless nights, and for understanding all the deadlines and models and messes that went with this dissertation

And lastly I would like to thank **Cari, JG** and **Salome**, for keeping me sane when the going really got tough. You inspired me and I will cherish the moments we had together. Thank you for your advice, support and friendship.



## Abstract

Mamelodi still remains captive in the spatial legacy of Apartheid. With long travel times and virtually no employment opportunities in Mamelodi, the status quo is difficult for inhabitants to deal with. Economic theory suggests that industrial programmes employ the largest number of people, and are the most effective ways to grow the economy. Additionally, workers for industrial jobs rarely require intricate training or education, creating the ideal platform for entry level jobs.

A theoretical investigation looked at the validity of functionalism for an industrial programme, but found it lacking. Critics charged functionalism with not considering all the functions a building serves unintentionally, which led to an additional layer of theory being added to the process. This was critical regionalism, selected for being contextually sensitive and appropriate whilst remaining grounded and practical about modernity. Precedents looked at the spaces Industries in Mamelodi used and the spaces international industries use, taking lessons from that. A site was chosen and analysed, and all the research was distilled into four drivers: Industry, Railway link, Level Change, and Modularity. This is quickly developed into a concept of creating an energy conduit, as a means to transfer the vigorous energy of Mamelodi to the outside world.

And this finally led to a design. Located on a steep hillside, the design negotiates some steep conditions and staggers a bunch of separate buildings over the site. Breaking the monolith, these buildings also create intimate public spaces in-between, that become populated with the happenings of everyday life. Four chimney towers serve as beacons, and create small thermally comfortable spots in the public spaces. Shading devices extend indoor programs into the public realm, trying to blur the threshold between them.

The building is adaptable, allowing materials to be re-used on a new location, and follows a strict grid and modular. This allows for the easy expansion and changing of spaces, as businesses should require. Further, pooling resources together allows the industries far greater access to services, systems and resources than they would be capable of acquiring on their own. And lastly, the central location with the railway and road links the industries not only with their employees but also to potential markets, allowing for greater profit and more sustainable economic empowerment.

This dissertation shows a method for bringing economic empowerment to Mamelodi, using industrial programmes that share resources. It is possible to do this in a contextually sensitive way, without compromising on the quality of the spaces.

## Project Summary

Title: **[RE]Claiming Vigour - Designing an Urban Industrial Complex in Mamelodi**

Programme: **Various Industries and Supporting Functions**

Adress: **Eerste Fabrieke Station, Eerste Fabrieke St, Mamelodi, Gauteng, South Africa**

GPS Coordinates: **25°43'19.2"S 28°21'26.9"E**

Research Field: **Human Settlements and Urbanism**

Clients: **Various Stakeholders on and around the site, as identified through mapping.**

Theoretical Premise: **Economic Empowerment of Mamelodi can be achieved by grouping industries together to share space, resources and capacity for growth.**

Keywords: **Industry, Mamelodi, Wood Workshop, Metal Workshop, Brick Makers, Weavers, Economic Empowerment, Apartheid Spatial Legacy, Functionalism, Modularity, Adaptability.**



## Contents

Introduction	2	Final Design	32
Industry as Catalyst	6	Site	32
Mamelodi	7	Overall 3D	34
Economic Empowerment	8	Plans	36
Theory	8	Elevations	42
Precedents	11	Perspective Section	44
Site selection and Analysis	11	Sections	46
Programme	12	Perspectives	50
Project Drivers	12	Model	54
Conclusions	13	Technification	56
Concept	16	Exploded Isometric	56
Conceptual Development	16	Access and Routes	58
Finalised Concept	17	Section	60
Concept Diagrams	19	Strip Section	62
Monolith Site	22	Details	63
Design Development	22	Services	66
Criticism of Prior Designs	22	Chimneys	68
Ordering Spine	23	Daylighting	70
Mixed-Use Station	24	Shading Devices	72
Concrete Chimneys	25	Adaptability	73
Daylight Scoops	26	Conclusions	75
Technical Concept	28	References	76
Adaptability	28	Appendices	81
Independence of Function	28	Functionalism Criticisms	81
Replaceability of Parts	28	Additional Site Mapping	82
Disassembly	28	Stakeholders	84
Materiality	29	Precedents	86
		Mamelodi Climate	91
		Thermal Comfort	91

# Introduction

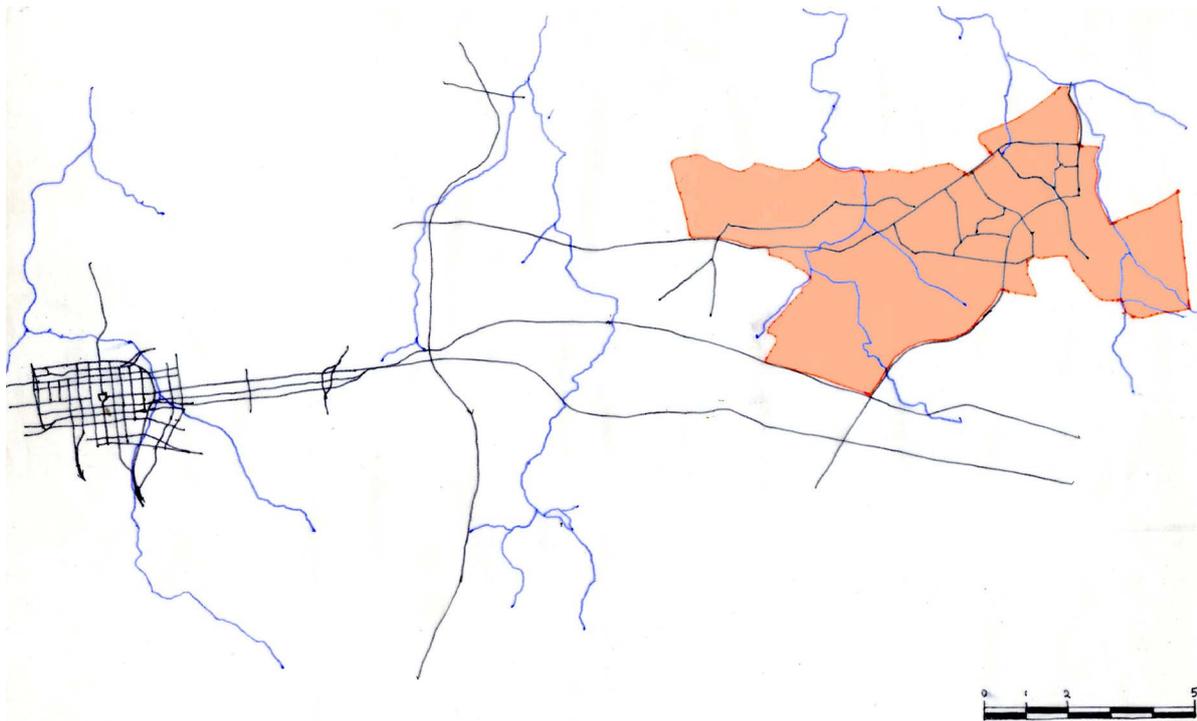


Figure 1-01: Mamelodi as related to Pretoria, 2017

Twenty three years after the first democratic elections in South Africa, very strong spatial legacies remain of Apartheid (Findley & Ogbu, 2011). This is primarily due to very strict town planning rules, which segregated people by racial identity (Krige & Donalson, 1999). The apartheid city planning for Pretoria was also segregated along these lines (see figure 1-02).

The spatial legacy created conditions that leave previously black neighbourhoods impoverished and dependent on their parent cities for goods, services, and employment. It creates a host of problems, reinforcing a commuter culture (which wastes money and time for average citizens), side-lining the lack of basic amenities, and downplaying the value of community investment. Furthermore, self-reliant commercial activities are still discouraged, reinforcing the status quo left over from the Apartheid era.

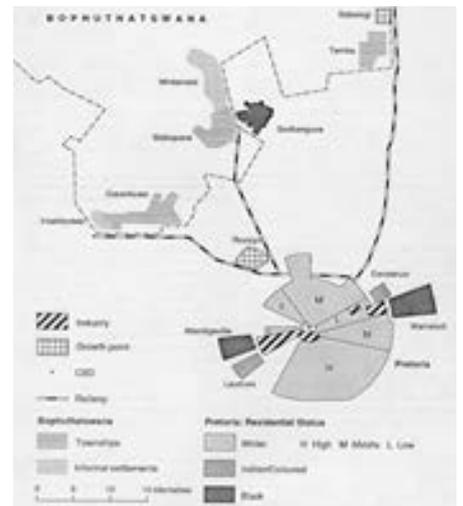


Figure 1-02: [SN], Pretoria and surrounding dormitory settlements in the former Bophuthatswana, [Sa]



Figure 1-03: Pofadder Apartheid Planning, Northern Cape, 2017



Figure 1-04: Ermelo Apartheid Planning, Mpumalanga, 2017



Figure 1-05: Kleinmond Apartheid Planning, Western Cape, 2017

This leads to the formation of a research question:

**How can economic empowerment be brought to Mamelodi, without disturbing the current urban fabric?**

This study focuses on answering this very question, and follows a strict method to arrive at an answer.

In order to understand the issues as well as to propose solutions for Mamelodi, the information was succinctly composed into

an article. After investigating the history of Mamelodi, the article looks at density, commerce and industry, and transportation networks. Relating this to economic theory paves the way for precedents and architectural theory to be drawn in as topics of investigation. Finally, a site is selected and analysed for the implementation of a viable design that deals with the identified issues.

The analysis of Mamelodi was done by means of mapping and graphical interpretation. Understanding the information diagrammatically makes it accessible, and allows for patterns and points of interest to be identified with ease.

In order to guide the overall direction that the study should take, economic theories were consulted to formulate a method of solving the economic problems faced by Mamelodi. This was distilled into a theory of economic empowerment, which highlighted the economic problems faced in Mamelodi and how they could be solved. The theoretical investigation looked at the history of architectural theory to identify the most appropriate theory to use in the general context of Mamelodi and of the general programme. Being that the general programme is industrial, and the simplicity common to Mamelodi, the theory chosen as a starting point was functionalism. The various iterations and criticisms are explored in order to adapt the theory to be contextually appropriate.



Figure 1-06: Mamelodi Population Density, 2017

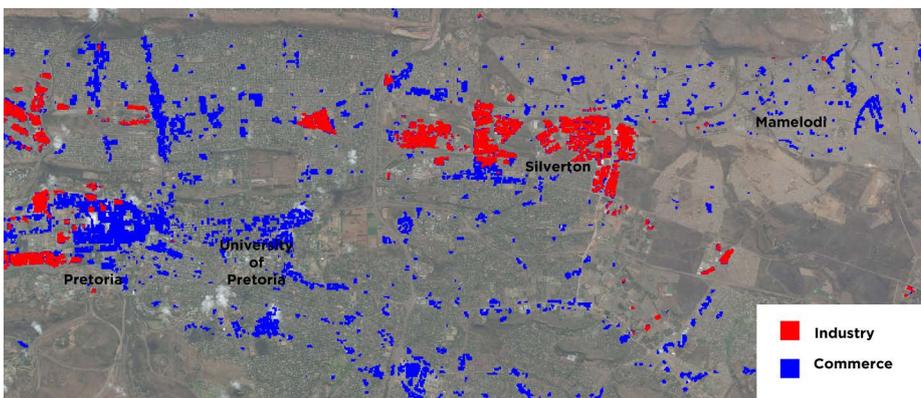


Figure 1-07: Mamelodi Industry and Commerce Land Cover, 2017

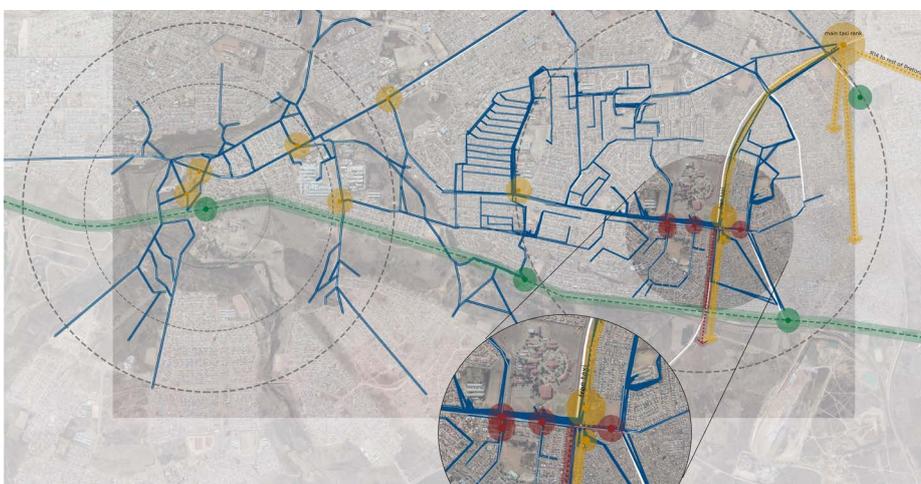


Figure 1-08: Mamelodi Transportation Network, 2017

The precedent analysis follows a method set out in *Precedents in Architecture* (Clark & Pause, 1996:3-7). This method calls for the plans, sections, and elevations of specific buildings to be diagrammatically analysed, according to a theme. The themes chosen for this analysis are based on the general programme and the theoretical background. They are as follows:

- Circulation to use space
- Unit to whole
- Symmetry
- Structure
- Massing
- Plan to section/elevation

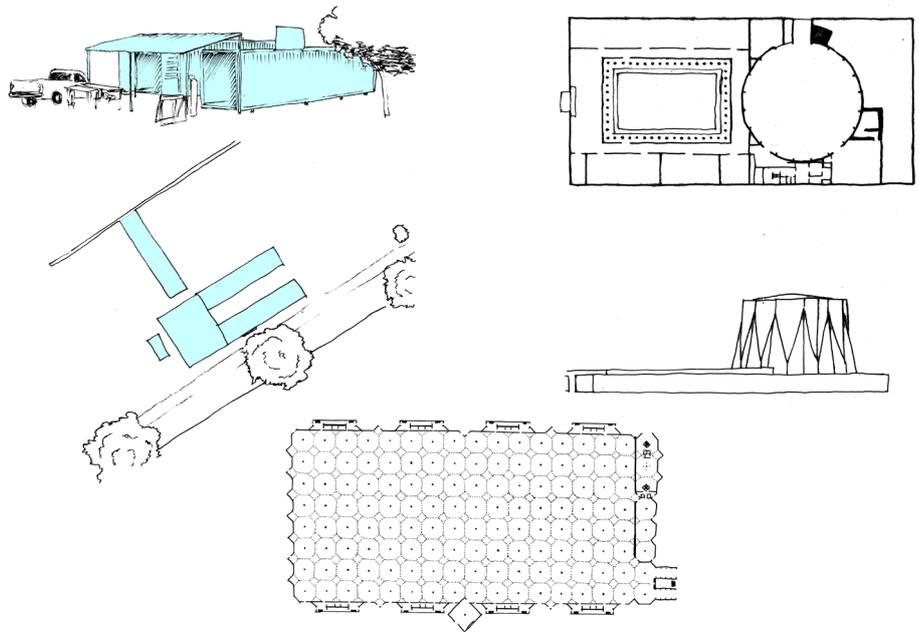


Figure 1-09: Various Contextual and International Precedents, 2017

The selection of the site draws from the research completed up to that point, and sets out the criteria for choosing a site. The site needs to be central, be a geographic boundary with an infrastructure connection, and have enough undeveloped land for ample expansion. Therefore only six sites were deemed vi-

able, and the final site was selected from these. This final site was analysed for physical, social, and intangible factors, in order to choose the best placement for the building.

Finally, the stakeholders of the site were mapped, providing the basis from which the pro-

gramme was developed. This allowed not only for the extant stakeholders to grow their industries with better infrastructure and shared resources, but also avoids external programmes from coming in and creating unnecessary conflict within the context.

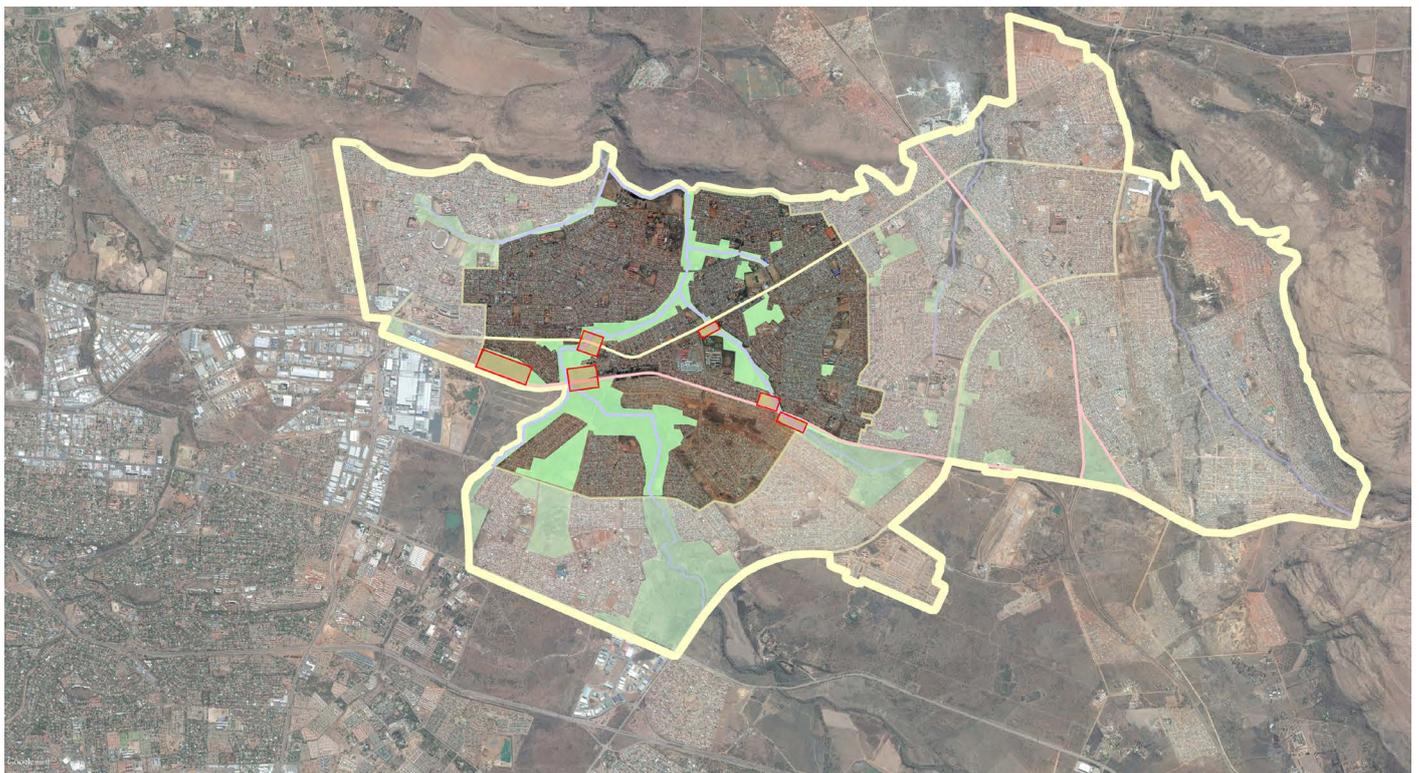


Figure 1-10: Viable Site Choices, 2017

By understanding the macro and micro scale of Mamelodi, the primary drivers of the site, namely the conditions that most influence and inform decision making, could be identified and established. The drivers are identified as being the industrial programme, the railway link, the level change, and the modularity of the system. These four issues drive the design decisions.

The essence of these drivers must be caught in a single idea and is thus used to generate an appropriate concept. From the concept, the first designs immediately develop spatially. The diagrammatic analysis and representation of the concept become the primary informants in terms of space- and form making.

Several sketches from the process of design development are provided, and illustrate not only the various ideas that the

designs tried to translate into built form, but also the reaction to criticisms of previous iterations. This shows the consistent process of improvement that has been followed through the duration of the year.

In order to develop the final design, several conceptual decisions were required concerning the technification of the building. These decisions looked at materiality, connections, and various other factors concerning construction, and formulated conceptual positions for these.

The final design is showcased last. The design is discussed in detail, with notes on the various plans, sections, and elevations explaining design decisions. Furthermore, the analyses and technical details are also discussed in depth, to explain some of the reasons certain choices have been made.

Lastly, following all the prior information, conclusions could be reached that summarise all the lessons learnt and the contributions this dissertation makes to the field of Architecture.

This will be followed by the references, and the appendices, to clarify any further queries.

**Thus, this study contributes to the field of architecture by proposing a viable industrial complex that is contextually appropriate to the neighbourhood of Mamelodi, and by understanding the limitations of modularity.**



Figure 1-11: Final Design Overall 3D, 2017



Cornelis Rudolf van Schalkwyk

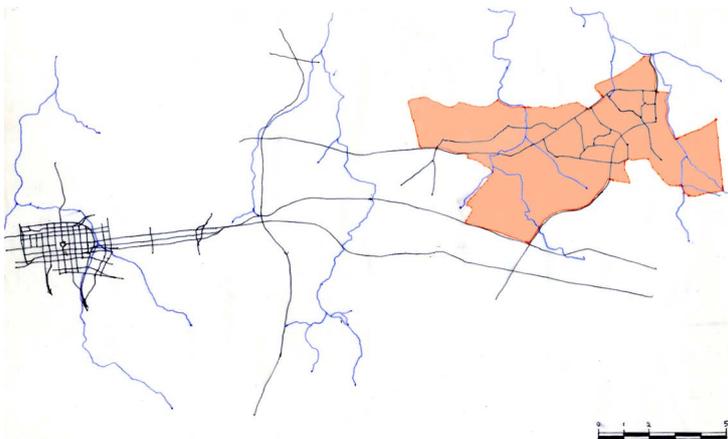
# Industry as Catalyst



*Industry presents an overlooked opportunity for economic growth in urban areas. Mamelodi (with its unique culture, history and opportunity) provides a place where industry could make a major difference.*

*By analysing the general situation in Mamelodi, it becomes clear that several problems exist. A look at economic theory indicates that an industrial intervention may be the most appropriate programme. A theory is chosen to match, and precedents of industrial buildings are investigated for possible morphology.*

*Once those aspects are established, a site could be chosen, and a fitting programme established. This leads to the final conclusions, and a motivation for the construction of an industrial building in the urban area of Mamelodi.*



**Fig. 01.** Above; Mamelodi, in relation to central Pretoria (Author, 2017)

Twenty three years after the first democratic elections in South Africa, very strong spatial legacies remain of apartheid (Findley & Ogbu, 2011). This is primarily due to very strict town planning rules, which segregated people by racial identity (Krige & Donaldson, 1999). The apartheid city planning for Pretoria was also segregated along these lines (Fig. 02).

This spatial legacy creates conditions that leave previously black neighbourhoods impoverished and dependent on their parent cities for goods, services and employment. This creates a multitude of problems, such as commuter cultures (wasting money and time on travelling), lack of basic amenities, lack of a local identity, little to no community investment, and a lack of self reliant commercial activities.

This dissertation will look specifically at the conditions present in Mamelodi. Problems will be identified, and a process of mapping, analysis, and reflection will propose a solution to these problems. This will be developed into a workable design.

Following a rough analysis of the history and origin of Mamelodi, an effort will be made to understand the identified problems and the theory behind their possible resolution. This will inform the general programme of the building, which allows for contextual and international precedent studies to take place. These precedent studies directly influence and inform the theory that will inform the building, and is thus a crucial interim step. Once the theory has been established and a rough method fixed for the creation of the building, the

site could be specified, and the programme fixed according to an analysis and understanding of that site. The programme must follow the site analysis in the case that no specific client is provided, in order to ensure that any chosen programme does not conflict with the conditions of the site.

By understanding the macro and micro scale of Mamelodi, the primary drivers of the site, namely the conditions that most influence and inform decision making, could be identified and established.

However, the essence of these drivers will be used to generate a single, appropriate concept. The concept becomes the first stage of design, and the diagrammatic analysis and representation of the concept becomes the primary informants in terms of space- and form making.

Several sketches from the process of design development are provided. They illustrate not only the various ideas that the designs tried to translate into built form, but also the reaction to criticisms of previous iterations. This shows the consistent process of improvement that has been followed through the duration of the year.

The final design will be showcased last, along with the technical resolution of systems, details and spatial problems. This will lead to the conclusions of this dissertation, summarising the lessons learnt and the contributions this dissertation makes to the field of Architecture.

Being enforced since 1950s (Krige, 1999), these segregated neighbourhoods have well-established urban cultural identities, often completely disparate from one another (Findley & Ogbu, 2011). This disparity was intentionally encouraged by the policies of the apartheid government (Krige et al, 1999). One of the remaining aspects of the apartheid spatial legacy is the lack of substantial employment in the previously black settlements. Throughout South Africa, it was a common occurrence for a town to have a 'servant town' (without employment opportunities) placed adjacent industrial areas (Krige et al, 1999).

It is imperative for the growth and development of these previously called "servant towns" to become independent of the towns and cities to which they are attached, so as to move towards the deconstruction of the apartheid spatial legacy. However, this has to done in a mind-

ful and careful manner while being sensitive to the genius loci of the area. Jane Jacobs (1961: 112-140) points out that a possible side effect of development is gentrification, which may destroy the character of a place by displacing original inhabitants. A method of avoiding this is to properly research an area and to include such information as informants before starting with the design (Levy, Comey, Padilla, 2006:76-82).

### Mamelodi

Mamelodi is situated approximately 40km east of the centre of Pretoria. It served Pretoria by providing cheap housing for black labourers during the apartheid era, and has not developed any industry or commercial nodes of its own.

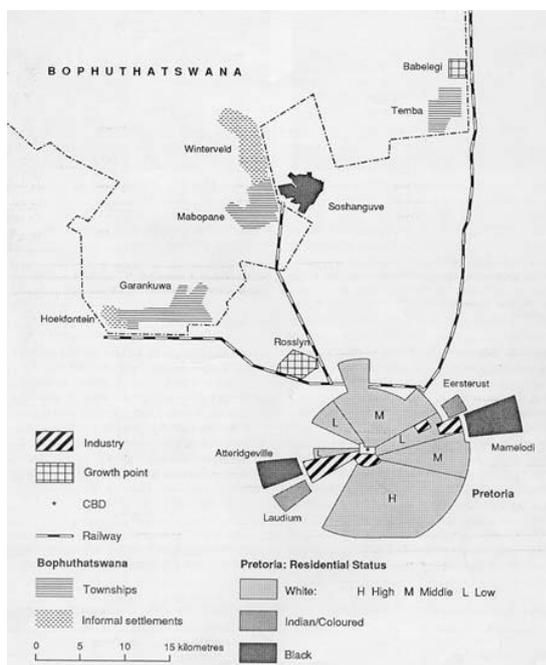
tion density of Mamelodi is nearly 7 times higher than that of the suburbs of Pretoria. The distribution of this population density can be seen in Fig. 03.

The light areas within the urban fabric are most often open pieces of land, schools, and hospitals. However, these spaces do not provide opportunities for development, as they tend to serve crucial functions for the community.

### Commerce & Industry

The economic opportunities for residents in Mamelodi remain limited, and are another manifestation of the spatial legacy of apartheid. No large industrial or commercial areas exist in Mamelodi, and residents must seek employment some distance away.

Fig. 02. Below; Apartheid Plan for Pretoria (Smith, 1990)  
Fig. 03. Right; Population Density of Mamelodi (Author, 2017)



Mamelodi was established in 1953 with the erection of 16 houses (Mashabela, 1988:104). It continued to grow in the interim decades (Mashabela, 1988:104), and today has a population of 330 000 (Census 2011).

### Population Density

Whilst Pretoria has an average of 1079 persons/km<sup>2</sup>, the population density of Mamelodi is 7403 persons/km<sup>2</sup> (Census 2011). The popula-

### Transportation network

The transportation network of Mamelodi is another manifestation of the spatial legacy of apartheid, with a heavy reliance on taxi and bus transportation. The train line also provides an opportunity to connect Mamelodi not only to Pretoria, but also to the rest of South Africa. There is the opportunity, close to the railway line, for industrial and commercial development.

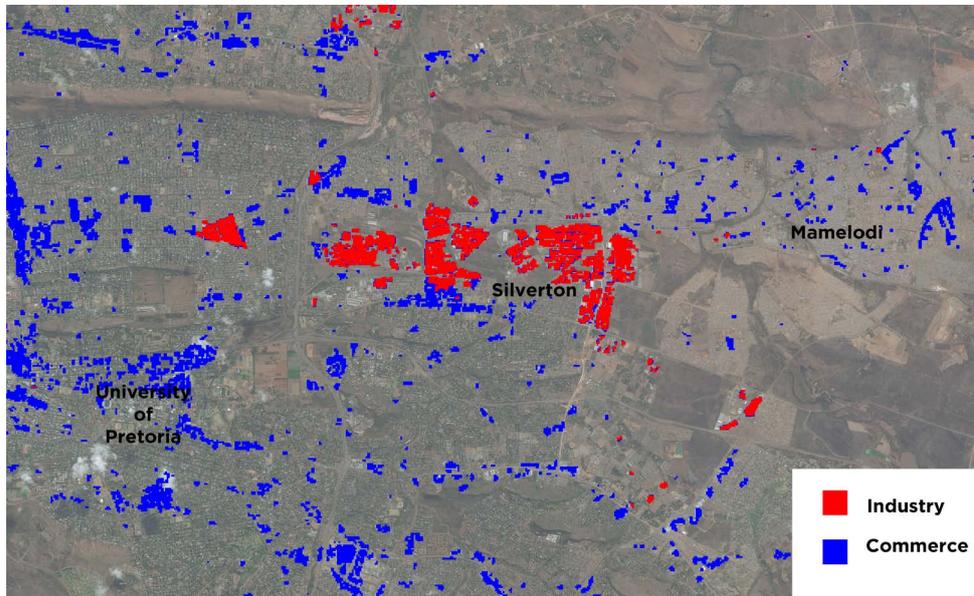


Fig. 04. Left; Industrial and Commercial Land Coverage, from MapAble™ (MapAble™, 2017)  
Fig. 05. Opposite Top Right; Local Precedent (Author, 2017)

Fig. 06. Opposite Bottom Right; International Precedent, Ceramic Factory, Hassan Fathy, 1952 (Author, 2017)

### Economic Empowerment

Mamelodi suffers from a similar problem as the rest of South Africa, in that too few jobs are available to a growing population (Cawker & Whiteford, 1993:37). Economic empowerment could be encouraged by promoting and growing small scale industry, because it is operated by lower-income groups and tends to be labour intensive (Cawker & Whiteford, 1993:53).

Hawkins suggests that by developing a multifaceted manufacturing sector, a country shows itself capable of supporting a higher income level (1986:279). Thus, developing industry in Mamelodi would not only foster local job creation and further investment, but would help the nation as a whole in presenting a model of economic empowerment that may resolve the spatial legacy of apartheid.

However, industries in Mamelodi face certain problems, which tend to discourage growth and investment. These issues are linked to the spatial legacy of apartheid, and could be encapsulated in the following points:

- **Lack of Capacity for Growth** – Small scale industries tend to be operated from containers, backyards, and garages. These spaces are generally fixed and inflexible, offering only limited opportunity for expansion. Small scale industries do not generate enough profit to erect large facilities in order to manage growth. Additionally, any expansions are inflexible and place-specific.

- **Lack of Centrality** – The industries in Mamelodi aren't focused on any particular area, and do not interact much. This means that the onus is on the client to find and go to the industry they may wish to visit. Furthermore, these small-scale industries are located far from transport nodes and opportunities, limiting the accessibility the industries have to the market.

### - Lack of Supportive Infrastructure

– Being operated from the side of the road or in backyards, the industries are only able to access limited amenities. The cost of providing the infrastructure required by all industries to grow is too significant, curbing expansion.

In order for the building to address the spatial legacy of apartheid, and to foster economic empowerment within the community of Mamelodi, a program that addresses the above-mentioned points is required.

From initial understandings, this would best be achieved with a mixed-use industrial building, located centrally in Mamelodi, in proximity to supportive infrastructure.

### Theory

Vitruvius (Morgan, Warren, 1914:17) opened the dialogue of architectural theory by stating the three aspects which defined architecture, namely the qualities of **Firmitas** (structural soundness), **Utilitas** (usefulness), and finally, **Venustas** (beauty). Whilst structural soundness is inherently bound to the craft of architecture, a conflict has existed throughout the dialogue of architectural theory as to whether usefulness or beauty has greater importance (Kruft, 1986). The goal of the argument has not been to declare the other aspect worthless, but rather to define the steps an architect should take when making a building. Should one first focus on making something beautiful, and then alter it into a useful structure, or should the converse take place?

From the precedents in Mamelodi it is clear that the spaces should first and foremost be useful before any thought could be directed towards the aesthetic. Thus, the logical theory to use would be

the most recent theory that emphasizes the usefulness of the building.

After rough analysis of the history of architectural theory (Kruft, 1986), it is clear that this logical starting point for such an argument is the theory of functionalism. This theory focuses of the function and use of a building, as opposed to the aesthetic qualities (Davies & Jokiniemi, 2008:164). Drawing from the vast reservoir of history, various forms of this theory have existed (Kruft, 1986).

### Functionalism Defined

Functionalism is not described by any particular manifesto, but can rather be encapsulated by a series of texts that convey a similar message throughout history: lose ornament and focus on the function of the building. Thus, this theory is best represented by the texts that have brought about its existence throughout the ages.

### A History of Functionalism

Leon Battista Alberti stated in his 10 books on Architecture (1755:654) that a necessary aspect of beauty is harmony. He defines harmony as anything consisting of parts fitted together in such a way and with such proportion that adding, removing, enlarging, diminishing, altering, or moving any of those parts would result in beauty being lost. In essence, he defines beauty as a state when nothing can be added, taken away, or altered, or else it would become inferior.

In the 18th century, Étienne-Louis Boullée (Arnheim, 1977:257) drew a different but related conclusion. He stated that the visual form of a building should have an analogy to the use of the building (Kruft, 1986:159), equating it to the images evoked by poetry. In a sense, he sees the function of the building as an opportunity to provide a poetic beauty

to its form. This is not strictly functionalism, but is most definitely a unique approach to the subject of form making.

In the 19th century, the skyscraper finally made its debut, with Louis H. Sullivan leading the charge (Kruft, 1986:356-357). He recognised that this new form of building could not follow historical conventions, and in *The Tall Office Building Artistically Considered* (Sullivan, 1886:403-409) he makes it clear that a skyscraper should NOT be a stack of horizontal buildings. He argues that as it is a vertical edifice, its vertical lines should be celebrated and the tallness of the building properly expressed. It was Sullivan who coined the term "form follows function" (Sullivan, 1886:408), an axiom adopted by successive generations.

By the 20th century, Adolf Loos regarded ornament and decoration of any kind as a crime (Loos, 1913:19-24). Loos makes the substantial leap of bringing morality into architecture, and regards the removal of ornament and decoration as signs of a moral, modern man. Although the moral implications of Loos's arguments are vague and more a point of sensation than an actual argument, he provides sufficient reasoning to justify a removal of ornament. The argument (Loos, 1913:22-23) he presents is that ornament is an unnecessary expedient. When two objects, one ornamented and one plain, are sold for the same price, the plain object will generate a greater income for the maker. It will also require less time to make, and so allow greater productivity and even greater wealth for the maker. Loos rejects the use of ornament purely for the sake of ornament (Loos, 1913:24).

The Bauhaus Manifesto (Gropius, 1919) was written to explain a method of reconciling new technologies with the sentiments of art (Kruft, 1986:383). Gropius had long considered the problem of mass production, and saw

it as an opportunity to introduce good design to the general public. The Manifesto (Gropius, 1919) outlined a method to base design education on the physical experience of craftsmanship. While movements such as Art Nouveau and arts and crafts were attempting to re-establish trades and craftsmen (Kruft, 1986:384), the Bauhaus embraced industrial processes, focusing on making functional objects and architecture beautiful. This, in essence, defined the points sought by the school of functionalism.

Le Corbusier challenges many preconceptions in his book, *Vers une Architecture* (1931). He not only postulates the beauty of austerity, but takes an unusual route in not discarding the classical temples of antiquity as irrelevant. He displays them alongside images of motor cars, and asks us to find both beautiful (Le Corbusier, 1931:134-135). He explores the beauty of austere and plain forms, such as the grain silos in the Americas (Le Corbusier, 1931:21-29), and finds the play of light on the masses to be beautiful in the sublime and abstract. He not only challenges the architect to see this beauty, but to disregard style completely (Le Corbusier, 1931:23).

Furthermore, Le Corbusier praises the engineer for being inspired by economy and ruled by mathematics (Le Corbusier, 1931:11). He presents a lesson to be learned from the airplane in the logic which governed the statement of problem and its realisation (Le Corbusier, 1931:105-127).

Relating to Sullivan's statement of "form follows function" (Sullivan, 1886:408), Le Corbusier views the plan, namely the organisational use of space, as the generator of form (Le Corbusier, 1931:43-64). Although he advocates the use of sculptural elements to express this form, the basis of the design lies in its functionality. Le Corbusier sees his methods as a complete synthesis between idealism and functionalism

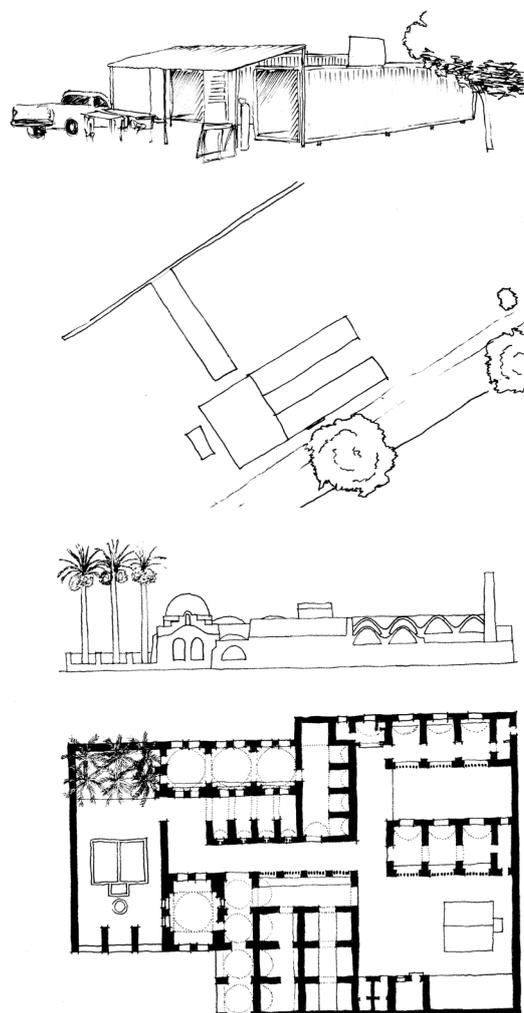
(Kruft, 1986:397), in that they harmonise the mathematical logic of the Universe with the beauty of art, and therewith bring art into harmony with the Universe (Kruft, 1986:398).

#### Criticisms of Functionalism

Functionalism reached its peak after the Second World War, with a need for cheap, quickly constructed buildings (Kruft, 1986:434-435). It was easily adopted as reparations for being shunned and marginalised by the National Socialist German Workers Party in Germany (Kruft, 1986:435). This was pushed by the United States, where the main proponents of functionalism resided, but without offering any new theory in the decade after the war (Kruft, 1986:435). The quick succession of deaths of the proponents of functionalism during the 1960s also left a gap of thinking, with the passing of Le Corbusier (†1965), Gropius (†1969), Van der Rohe (†1969), Neutra (†1970) and Frank Lloyd Wright (†1959) (Curtis, 1985). This gap and the lack

of development of functionalism gave rise to sentiments that argued against functionalism. A great variety of arguments arose, but few had substance and no unified refutation of functionalism came (Kruft, 1986:444). This collection of arguments has been collectively termed the 'post-modern' (Kruft, 1986:444).

Arguments were levied against "hierarchy", the "disconnect between beauty and use", the "lack of aesthetic drive", the "capitalist drivers of functionalism", the "lack of symbolism", and the "disregard for the human experience and ownership" (Kruft, 1986). Although the arguments are valid, none provide a solid and logical refutation of functionalism (see Appendix, Pg.81-82), except for the theories of Rudolf Arnheim (Kruft, 1986:442). Arnheim argued that although functionalism was based on catering to the functions a building would serve, the previous interpretations had disregarded many of the secondary



or even tertiary functions the building serves, including cultural, symbolic, psychological and political aspects (1977). He grounds his argument in the fact that though these factors may not have been considered previously, they remain relevant and contribute to the experience of buildings regardless (Arnheim, 1977).

Kruft (1986:442) himself argues that the symbolism and meanings used in the past cannot be merely transplanted. He argues that this would see historical models treated superficially and without engagement. He describes these reasons as the fundamental objection to postmodernism.

Due to the rationality of functionalism, and the emotionally driven criticisms against it (Kruft, 1986:442), the apparent conclusion is that functionalism on its own is not sufficient as a theory to create architectural form. However, none of the aforementioned critics have delivered any compelling arguments except for Rudolf Arnheim, in that functionalism has not properly considered ALL the functions a building must fulfil (1977).

To address the shortcomings, namely those of cultural, psychological, emotional, and identity of place, the theory of critical regionalism will be investigated. This theory was selected, as it provides a framework for dealing with the intangible qualities of a site, and so may provide a better solution than pure functionalism.

Secondary Theory - Critical Regionalism  
Kenneth Frampton wrote an essay, termed *Towards a Critical Regionalism: Six Points for an Architecture of Resistance* in 1981. Within, he posed the arguments that architecture was being polarised between "high tech" buildings and buildings with a compensatory façade, to hide the truth of its structure. This polarisation is the result of two elements, namely freeways and freestanding high-rises. The reasons for building have become clouded by incomplete arguments, which do not have an end goal in mind (Frampton, 1981:17). Without that end goal, Hannah Arendt argues that utility used to generate meaning results only in meaninglessness (Frampton, 1981:17).

The only sustainable path for architecture to take is to distance itself both from the high-tech practises, and from inefficient pre-industrial forms. It should rather look critically at elements of both, before adopting either. This would cultivate an identity giving culture, which is reconciled with the global civilisation (Frampton, 1981:20). The success of critical regionalism is de-

pendent on incorporating the peculiarities of the site (such as climate, lighting, and topography) into the identity of the building. Although local vernacular should be investigated for solutions, it would play into the hand of populism to try and evoke emotions associated with the vernacular. It would result in an unreconciled building that tries to evoke cheap emotions. Critical regionalism represents not only a method of maintaining identity, but also of bringing civilisation to cultural elements (Frampton, 1981:21)

Hamilton Harwell Harris (Frampton, 1981:22) argues that regionalism may either exist by restricting world culture, or by liberating a regional culture from too many restrictions.

In his 1954 essay, *Building, Dwelling, Thinking*, Martin Heidegger (Frampton, 1981:24) argues that the experience of a place is dependent on its physical boundaries. He explains that the Greeks had understood a boundary not at which a place stops being, but rather from which it starts to exist. Heidegger further argues that the act of "being" can only take place in a domain with well-defined boundaries.

The peculiarities of site, such as topography, light, climate, and the tectonics of buildings in the region, all act as informants to create an identity for a building. This identity, combined with the developments of "high-tech" civilisation, could result in a building that is competitive and has a sense of identity (Frampton, 1981:26-27). Furthermore, by engaging senses of perception other than the visual, a richer and more unique experience is presented to the user. Engaging with the tactile rather than purely scenographic elements, the architecture becomes richer to the user, and thus densifies its objecthood (Frampton, 1981:28-29).

Practical Conclusions for Application  
Vitruvius wrote that architecture consists of three parts, namely beauty, strength and usefulness (Morgan, Warren, 1914:17). All buildings require strength, and the debate of theory has been whether usefulness or beauty are the next most important aspects (Kruft, 1986). An industrial program will work best with a theory that promotes the usefulness of the building first. Thus, the most recent theory to exemplify this is functionalism, which prioritises the function of the building over aesthetic qualities (Davies & Jokiniemi, 2008:164).

Although various proponents of functionalism argue for its superiority, there are many criticisms as well. However,

Kruft notes that few of these criticisms had any substance, and no united front was provided against functionalism (1986:444). The theories developed from these criticisms are known as the 'post-modern' (Kruft, 1986:444).

The most substantial argument, posed by Rudolf Arnheim, states that functionalism disregards the multiple intangible and unmeasurable functions of architecture, and that in order to properly adapt, functionalism must address these functions and respond appropriately (1977). Because the criticism most commonly heard about functionalism is that it lacks a sense of identity and place, the secondary theory of critical regionalism was chosen to address the shortcomings experienced by functionalism. Kenneth Frampton explains that critical regionalism tries to find a middle ground between high tech (functionalist) and pre-industrial, cultural (vernacular) solutions, by distancing itself from both (1981:20). Critical regionalism on the other hand compares both sides of the argument and only makes a choice after careful and critical consideration. This helps to cultivate an identity-giving culture, which could be reconciled with global civilisation (Frampton, 1981:20).

In order to understand how this theory is going to impact the creation of architecture, it becomes necessary to know the method by which it would be applied. To synthesise these two different but related theories, the following method is proposed.

Firstly, every decision made would have to comply with two sets of theoretical questioning.

1. Is the decision beneficial to the function and usefulness of the building? (functionalism)
2. Does the decision complement the context of the building, namely does it respond to climate, topography, location, cultural or social conditions of the context?

Any decision that fulfils the first requirement would be sufficient, but fulfilling the second to some degree would be preferable. In fact, when faced with two choices, the one that allows the second aspect to be fulfilled to the greatest degree would be chosen. An additional thought in terms of form making would be to lay out the spaces on plan according to functionalist theory, and to address the sections and elevations through means of critical regionalism.

This would result in a building which is functional and contextually relevant.

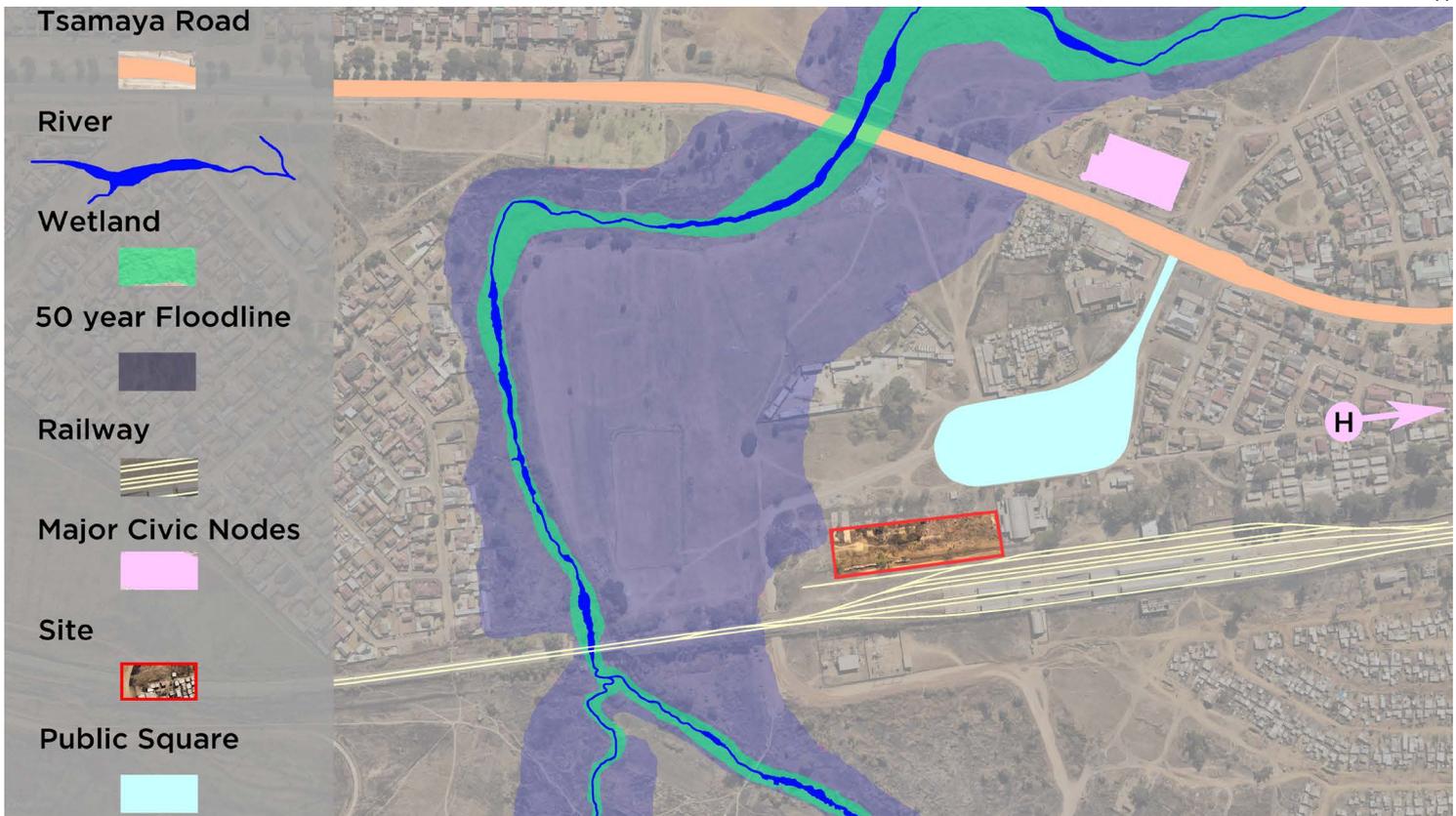


Fig. 07. Above; Chosen Site, and Rough Analysis (Author, 2017)

### Precedents

Several precedents were studied. These included contextual as well as programmatic precedents (see Appendix, Pg. 86-88).

Precedents in either category were identified, sketched and then analysed according to the method set out in Precedents in Architecture (Clark & Pause, 1996:3-7). The themes chosen for analysis are:

- Circulation to use space
- Unit to whole
- Symmetry
- Structure
- Massing
- Plan to section/elevation

These themes were chosen specifically for their relevance to an industrial programme. Three contextual precedents were selected and analysed in depth.

The international precedents show very little correlation and relation (see Appendix, Pg. 88-90). Only individual aspects could be analysed and interpreted, and the most relevant aspects are as follows:

- Functions may be separated.
- Modularity allows for easy expansion and addition.
- Spaces may be tailored to specific functions.
- Important features may be dissociated from the rest of the building to highlight importance.

These aspects are valid to consider in designing an industrial building. However, as the benefits are unclear, these aspects should be critically considered when applied to design.

From the analysis of the precedents, several points could be highlighted to take forward into design. These have been distilled from both the contextual and international precedents.

1. Functions may be separated.
2. Important features may be completely dissociated from the rest of the building to highlight its importance.
3. Industries tend to be located on pedestrian routes, or attached to a house.
4. Modularity allows for easy expansion and addition.
5. Shipping containers (modular units) tend to be serve as storage and support spaces, but may contain entire industries.
6. Spaces may be tailored to specific functions.
7. Workspaces tend to be covered by a freestanding roof, of which the depth and the vertical supports are as minimal as possible.

Applying these points would not only aid in finding architectural form, but in resolving the construction of the building.

### Site selection and Analysis

For the site to comply with the theory of economic empowerment, it must fulfil the following criteria.

- **Centrality**, within the broader city of Mamelodi. An intervention along edge conditions would have either limited exposure, or would shift the focus and energy of Mamelodi, which is not conducive to maintaining a sense of place and identity.
- **Geographical boundedness**, in order to properly define the space in which investment and development should take place. This would ensure that the residential urban fabric of the rest of Mamelodi remains undisturbed, preserving the identity of Mamelodi. This includes **Infrastructure connections**, to the benefit of an industrial programme. This would greatly increase the viability of the building and its industrial functions, by easing access to the national market.
- **Undeveloped and open land**, with the intention that any land unused by the initial development would spur additional investment and development in the area.

Through mapping, these conditions were identified and overlaid (see Appendix, Pg. 82), to show sites where all the conditions were met. Six sites were identified and two were chosen for additional analysis, due to the multiple advantages the two sites hold.

The analysis of these sites looked at the physical features, such as topography, rivers, wetlands and trees, roads, paths, and buildings. It also mapped the locations and nature of the stakeholders of the site.

This brought forth a variety of information, including aspects such as where the site would be optimally located, and which programme would be best suited to this location.

The chosen area has a railway running through it, as well as the four lane Tsamaya Road. Additionally, the area has a river, with wetlands and a large floodplain (bounded by the 50-year flood line). Some civic buildings are also present, with a magistrate's court under construction against Tsamaya Road. Lastly, the possibility of a well-defined public square exists next to the existing station.

#### Stakeholders on and around the site

The stakeholders on and around the site are the people and groups who own, use, or have made land around this site their own. They are a part of the intangible culture of this site, and provide a unique insight into what the site is capable of.

This analysis is crucial, for the point that these stakeholders directly inform the programme the building would use, because the presence of these stakeholders (particularly commercial ones) show that they are viable industries. Thus, the building would benefit from their established presence and they would benefit from the spatial qualities of the building. Furthermore, by incorporating existing industries, conflict is avoided that may have occurred with the introduction of a foreign programme.

#### **Programme**

The programme of medium industry, or Moderate Risk Industrial – D2 as it is classified in SANS10400 Part A20, has a few programme specific stipulations set out in SANS10400. These include Part O: Lighting and Ventilation, Part T: Fire Protection, and SANS204. These were analysed, and interpreted for easy access.

Furthermore, the programme developed from the stakeholders and assets available on the site, to best fit in with the needs of the context without creating conflict (see Appendix, Pg. 84-85). The general programme is as follows:

1. Communal functions
2. Admin & security office
3. Storage space
4. Bathrooms
5. Rainwater treatment plant
6. Cafeteria
7. Spaza shop
8. Wood workshop
9. Metal workshop
10. Painter's workshop
11. Weaver's Studio
12. Urban agriculture
13. Brick maker's studio
14. Micro-Mechanic

These programmes would best be served by an adaptable modular. A grid based on such a modular unit has several benefits:

- It promotes standardisation across the site, which not only brings costs down but also allows damaged or weakened parts to be replaced easily and efficiently.
- It allows for easy adaptation and expansion, by providing an obvious unit with which to expand, which would allow future development to take place unhindered by the past and the present.
- It eases construction, by providing a template that the construction crew could easily memorise and adapt to every condition. This would speed up construction time without sacrificing quality.

For the purposes of this project, a modular unit of 3400mm x 3400mm x 3400mm has been chosen.

#### **Project Drivers**

From these various headings several primary drivers, namely the primary factors that would influence decision making on the particular site, have been identified. These drivers not only inform design decisions, but could be used to find and define a concept.

#### Industry

The industrial programme of the site is by far the largest driver of design. Because economic empowerment is such an important driver for this project, industry is crucial to achieving that goal. Industry creates employment, and sustainable employment creates wealth, and therewith independence. Industry would also foster investment by second-

ary entities, by empowering employees and creating a node for industrial development.

Furthermore, the products and services carried out here add to the pride and identity of Mamelodi, especially if the product could be shipped nationwide. This identity is crucial to space making, and would encourage other investors to consider Mamelodi as a place of investment.

Lastly, this building does not aim to become a large industry in and of itself. Restrictions would be put in place to limit growth, encouraging growing industries to invest in their own facilities. This would not only foster additional investment in Mamelodi, but would allow a new, small scale industry to take over the old space and undergo its own process of growth.

#### Railway

The second most important driver is the railway. It adds to the usability and appropriateness of the programme, and provides a link to both the city and Mamelodi. Currently, it is being underutilised, and growth is not only essential but imminent, as can be evidenced by the upgrading of the line.

Currently the railway is monofunctional, carrying only commuters. This was not always the case, as it had originally been built to create a freight link to Maputo, and served the first factories of Pretoria at Eerste Fabrieken. This industrial freight heritage could and should be reclaimed, for the benefit of Mamelodi.

#### Level Change

A direct result of the railway line, the man-made level change not only presents a boundary, but rather an opportunity for bounding both the space of Mamelodi and the railway line within. It creates a transition that is currently not navigated, but could be with the proper design.

#### Modularity

The modularity of the building would aim to achieve several goals.

Firstly, it should speed up and ease construction and assembly. Secondly, it should allow for replaceability and the possibility of upgrading certain elements. Thirdly, it should allow for adaptability, with the site being altered and elements moved around with relative ease.

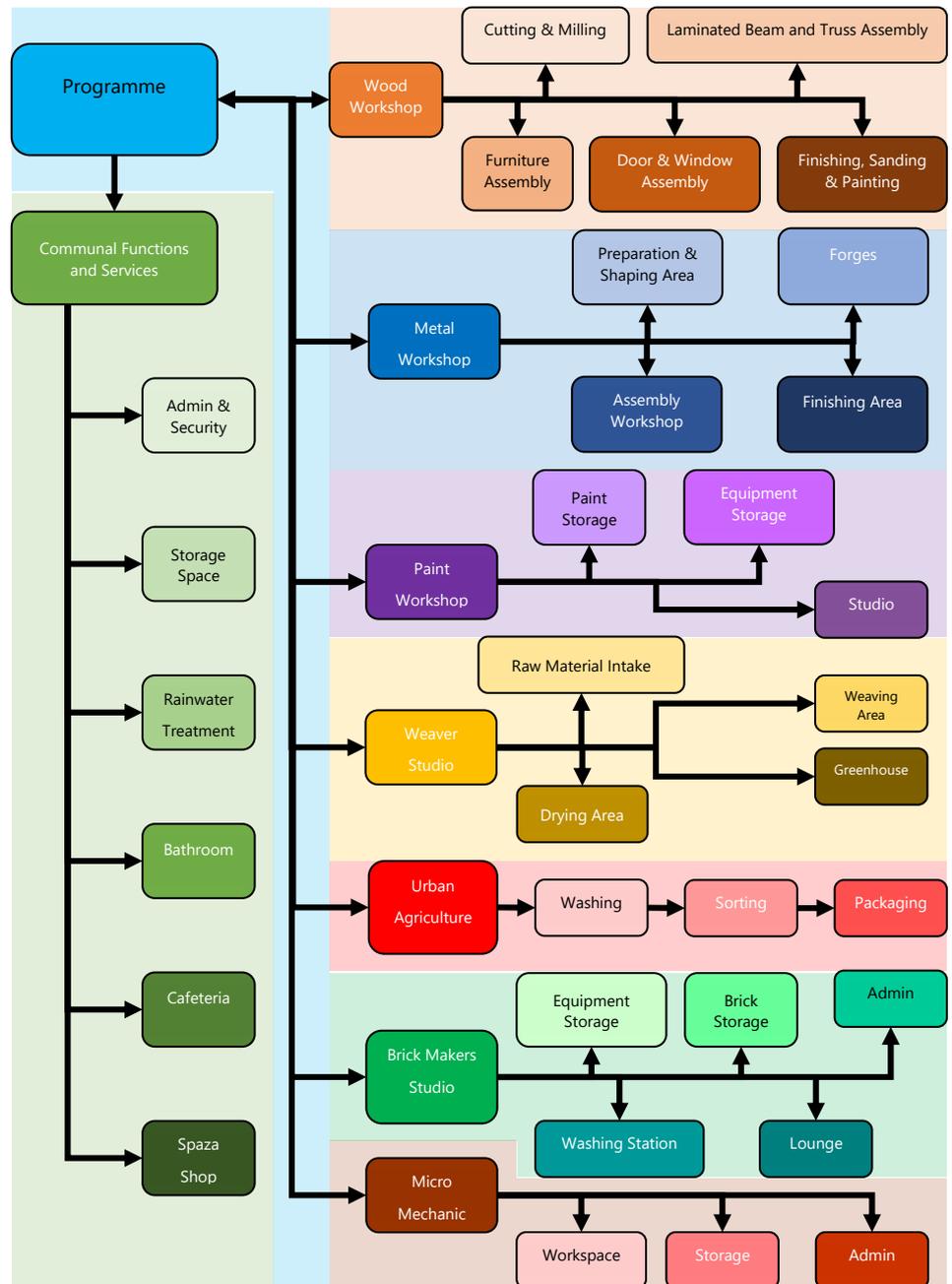


Fig. 08. Right; Programme, expressed diagrammatically (Author, 2017)

## Conclusions

This research document has explored how an industrial building in Mamelodi, interfacing with the railway, may begin to solve some of Mamelodi's problems.

This substantiation can be summarised in the contributions this document has provided.

Firstly this document has provided an approach to **interpreting functionalism and critical regionalism**, inspired by contextually appropriate forms.

Secondly, this document has shown not only the need for, but a viable method to create, **grow, and foster small scale industry** in Mamelodi.

Thirdly, the document proposes a radical solution to an otherwise **wasted edge space** and utilises available resources to a maximum.

Lastly, this document provides a basis for **densifying the site**, and therewith maintaining the integrity of the majority of Mamelodi.

Thus, this document has substantiated the need for an industrial building in Mamelodi.



**Fig. 09. Opposite Top; Site Selection criteria composite, showing appropriate sites (Author, 2017)**

**Fig. 10. Opposite Bottom; Stakeholders around and on selected site (Author, 2017)**

## References

- Alberti, LB, 1485, *The Ten Books on Architecture*, as printed by Owen, E, 1755, London: 654
- Arnheim, R, 1977, *The Dynamics of Architectural Form*, Los Angeles, University of California Press, Publisher: 254-257
- Cawker, G & Whiteford, A, 1993, *Confronting Unemployment in South Africa*, Pretoria, Human resources council: 8; 37; 47; 53; 106;
- Davies, N & Jokiniemi, E, 2008, *Dictionary of Architecture and Building Construction*, Oxford, United Kingdom, Elsevier: 184
- Findley L, Ogbu L, 2011, *South Africa: From Township to Town*, Places Journal, November - accessed 03/04/2017 at <https://placesjournal.org/article/south-africa-from-township-to-town/>
- Frampton, K, 1981, *Towards a Critical Regionalism: Six Points for an Architecture of resistance*, in *The Anti-Aesthetic: Essays of the Postmodern*, editor Foster, H, 1983, Seattle, Bay Press: 16-30
- Gildenhuys B, Badenhorst W, du Toit J 2017. *MapAble™, Dataset: Industrial and commercial Land Coverage* - accessed 23/02/2017 <http://map.mapable.co.za/>
- Gropius, W, 1919, *Bauhaus Manifesto and Program*, Staatliche Bauhaus, Weimar
- Hawkins, AM, 1986, *Small-scale industry*, edited by Berg, RJ, & Whitaker, JS, *Strategies for African Development*, Los Angeles, University of California Press: 279-315
- Jacobs, J. 1961, *The Death and Life of Great American Cities*, Random House, New York
- Krige S, Donalson R, 2000, *Spatial Transformation in the Post-Apartheid Era – South Africa: a Website course in Social Economic and Political Geography – An International Educational Project*, Ministry of the Flemish government Department of Education - accessed 06/03/2017 at [https://www.impulscentrum.be/south\\_africa/mod3\\_city/theo3.asp](https://www.impulscentrum.be/south_africa/mod3_city/theo3.asp)
- Kruff, HW, 1985;1994 Translated by Taylor R, Callander E, Wood A, *A History of Architectural Theory: from Vitruvius to the Present*, Phillip Wilson Publishers, London
- Le Corbusier, S.A, Ed. 13, *Towards a New Architecture*, translated by Etchells, F, 1931, London, Rodker Publishers: 11, 21-29, 43-64, 105-127, 134-135
- Levy DK, Comey J, Padilla S 2006, *IN THE FACE OF GENTRIFICATION: Case Studies of Local Efforts to Mitigate Displacement*, Washington DC, Urban Institute. Pg. 1-2 - accessed 15/01/2017 at <http://www.urban.org/sites/default/files/alfresco/publicationpdfs/411294-In-the-Face-of-Gentrification.PDF>
- Loos, A, 1913, *Ornament and Crime*, Cahiers d'aujourd'hui (5):19-24
- Mashabela, H, 1988, *Townships of the PWV*, South African Institute of Race Relations, Braamfontein:104-109
- Smith, DM, 1992, *The Apartheid City and Beyond: Urbanization and Social Change in South Africa*, Wits University Press, Johannesburg
- Statistics South Africa, 2011, *National Census*, Statistics South Africa, Pretoria: Dataset - *Population density: Mamelodi* - accessed 24/09/2017 at [http://www.statssa.gov.za/?page\\_id=4286&id=11377](http://www.statssa.gov.za/?page_id=4286&id=11377)
- Statistics South Africa, 2011, *National Census*, Statistics South Africa, Pretoria: Dataset - *Population density: Pretoria* - accessed 24/09/2017 at [http://www.statssa.gov.za/?page\\_id=4286&id=11366](http://www.statssa.gov.za/?page_id=4286&id=11366)
- Sullivan, LH, 1896, *The Tall Office Building Artistically Considered*, Lippincott's Magazine, JB Lippincott Co, Philadelphia, Pg. 403-409
- Vitruvius, S.A, *The Ten Books On Architecture*, translated by Morgan, MH, Warren, HL, 1914, Boston, Harvard University Press: 17

## Concept

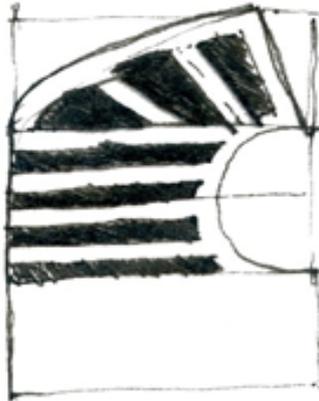


Figure 3-01: Site Definition Concept



Figure 3-02: Hexagon Concept

The concept of a building is the primary idea that informs decision making (Farely, 2007:156). In order to find an appropriate concept, it must be directly related to the project drivers.

### Conceptual Development

The previous conceptual ideas were generated haphazardly and without due process. These diagrams show the conceptual thinking that explored various options, but resulted in few usable ideas.

These diagrams try to articulate a public square, and show the various ways to use an enormous site without constructing a monolithic building. Furthermore, an exploration into modularity shows how the site may be approached.

An additional idea looked at woven reed matts, and how various functions could be related on a grid. This was interpreted in a final diagram. The idea was that each direction of strand would represent an aspect of the building, with overlaps representing mixed-use nodes and hubs.

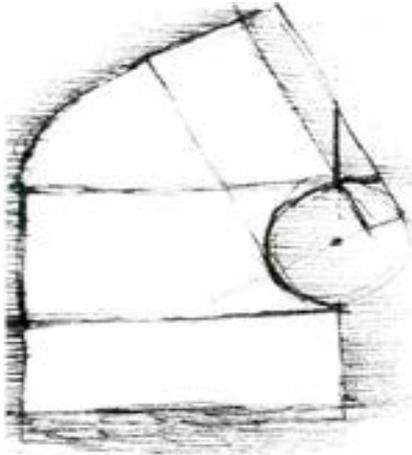


Figure 3-03: Subdivision Geometry

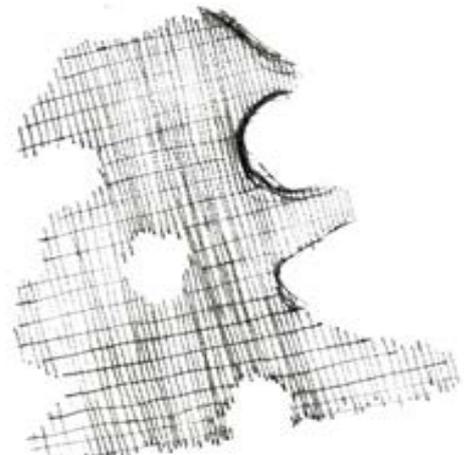


Figure 3-04: Weaving Concept

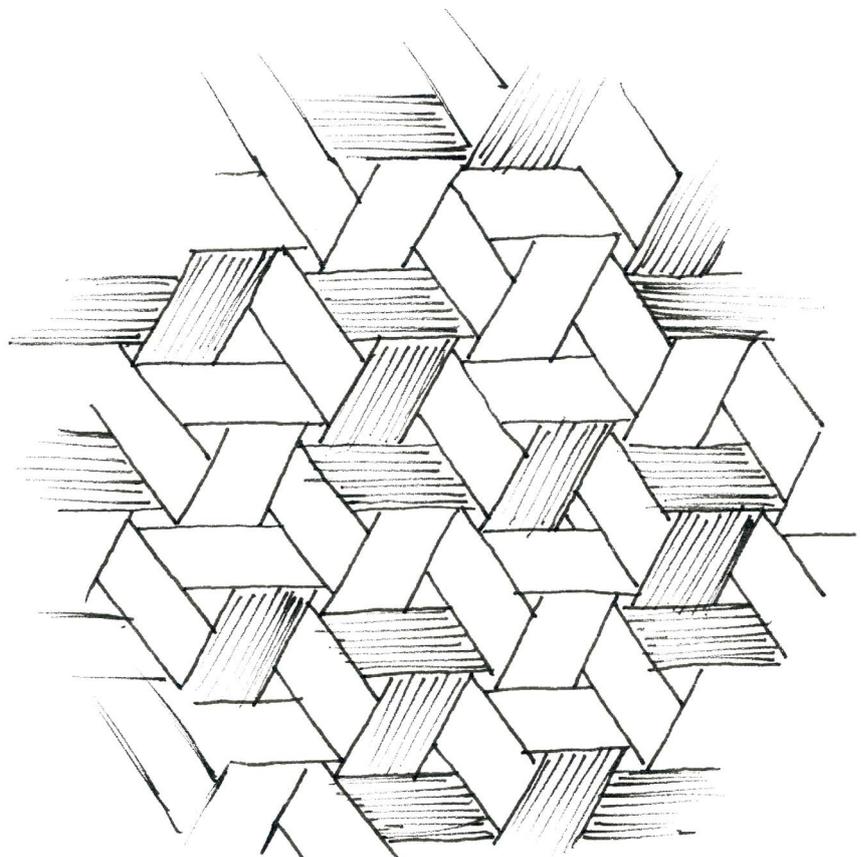


Figure 3-05: Triangulated Weaving Concept

## Finalised Concept

Following the research undertaken, an effort was made to identify and understand the primary drivers of this project, with four being identified. These were:

1. **Industry:** Being the primary driver of the plan and the shape of the architecture, this is directly linked with the programme (see Page 12) and thus the entire purpose of the building.
2. **Railway:** Being the secondary driver, the railway line provides the advantage to an industrial building (Mathabatha, 2005:20) that competitors would not have. It increases viability and ensures the continued success of the building. It provides the unique opportunity for small and medium size industries (see Page 8) to use the railway frequently and efficiently.
3. **Level Change:** Being a condition of the site (see Appendix Pg 84), the man made level change presents a boundary condition that could be traversed by means of a building. The boundary has thus far been too steep to develop, and therefore this building has the opportunity to make a "useless" site very valuable.
4. **Modularity:** and by association, adaptability (see page 8). By using standardised parts and a fixed grid, this building must be able to withstand and adapt to change. Parts should be reusable and should foster adaptation and growth in the occupant industries.

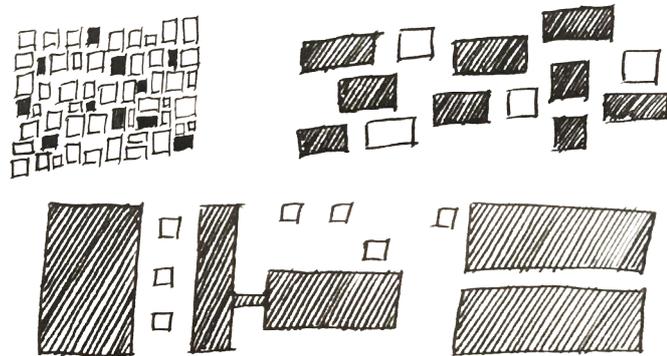


Figure 3-06: Various scales of Industry within an urban fabric

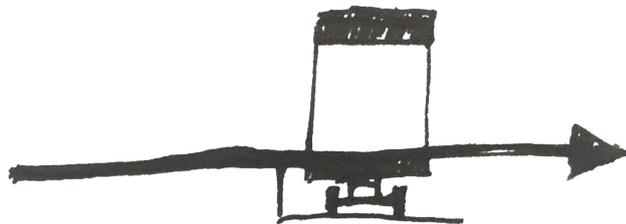


Figure 3-07: Railway Interface

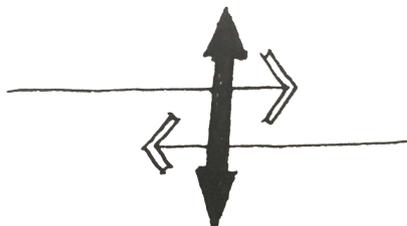


Figure 3-08: Level Change Diagram

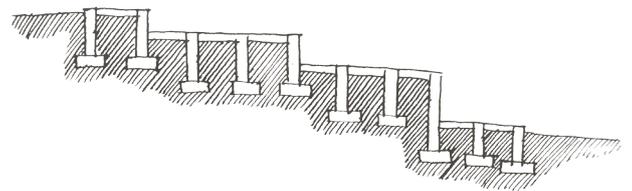


Figure 3-09: Modular base on the level change

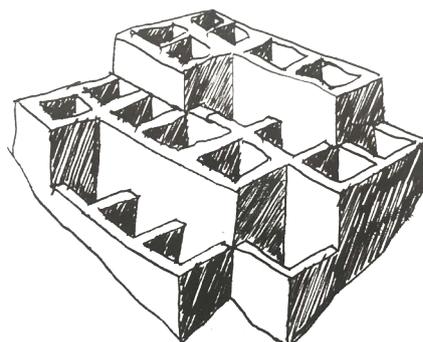


Figure 3-10: Modular Base

Using the four drivers of industry, railway, level change, and modularity, a concept could be chosen. However, in order to avoid a haphazard method as before, a much more structured approach has been devised.

Due to the nature of a concept, it should be as simple and plain as possible (Davies & Jokiniemi, 2008:89). As such, a concept should be a single word or phrase that could be used to create form. Thus, a list of words have been compiled that are associated with Mamelodi, even in a very abstract sense. These have been graded by how appropriately each word/phrase conveys the essence of each driver.

The grade was given out of 5 for each driver, with 5 being very appropriate and 1 being very inappropriate. The grades were then added up at the end and converted to a percentage, in order to easily gauge which

concept would be most fitting. It is worth noting that the concept of **Intertwine/Weave**, which had been used as a previous concept, was only deemed 40% appropriate by this method.

Furthermore, the concepts of **Industry as Identity** and **Robust/Adaptable** scored very high, but not sufficiently so to become the primary concepts.

Ultimately, the concept that was deemed most appropriate in relation to all the drivers, was that of **Energy Conduit**. This concept refers specifically to the energy of Mamelodi, and how it needs to be carried into the rest of Tshwane and Preto-

ria in a useful and manageable form. This building would aim to be a conduit for that energy, by converting the vigour and passion of the Mamelodi community into industrial products and services. These could then be distributed around the country, and may add to the identity of Mamelodi by fostering the idea of Mamelodi as a hub of creation.

This may even encourage further investment by external entities, upon recognising the vigour and spirit the community of Mamelodi possesses.

Conceptual Term or Phrase	Drivers Scored out of 5				Score out of 20	Percentile Score
	Level Change	Railway Interface	Industry	Modularity		
Crossing	4	3	1	3	11	55%
Threshold	4	4	1	1	10	50%
Fabric/Material	3	1	2	3	9	45%
Intertwine/Weave	2	3	1	2	8	40%
Generative	2	4	3	1	10	50%
Penetrate	3	3	3	1	10	50%
Catalyst	2	4	4	3	13	65%
Confluences	3	4	3	1	11	55%
Assemblage	1	2	4	5	12	60%
Commun/ality/ity	1	4	3	4	12	60%
Robust/Adaptable	2	3	4	5	14	70%
Industry as Identity	2	3	5	4	14	70%
Timeless	2	2	1	2	7	35%
Temporary/Fleeting	2	4	1	3	10	50%
Bottleneck (Destinations)	3	5	4	1	13	65%
A Mark on the Timeline	3	3	2	3	11	55%
[RE]focus Potential Energy	3	4	4	2	13	65%
<b>Energy Conduit</b>	4	4	4	3	<b>15</b>	<b>75%</b>

Table 3-01: Concept Grading table, related to the appropriateness towards the project drivers

### Concept Diagrams

Concept diagrams are an important method of interpreting the concept in terms of form and space. It serves as an intermediate step between the theoretical (see Page 8-10) and practical (see Pages 32 - 73) stages.

#### Flow of energy

The flow of energy on the site refers to how the energy of Mamelodi could potentially be directed.

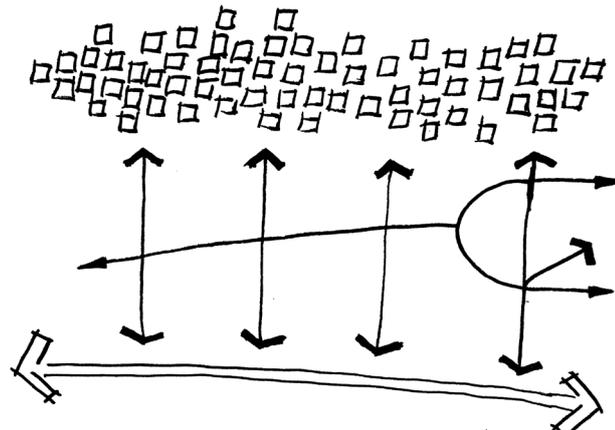


Figure 3-11: Flow of Energy

#### Energy Absorption and Redistribution

The site would absorb energy from the city and transform it into a useful state. Only thereafter would it be radiated to the rest of the city and country through the railway.

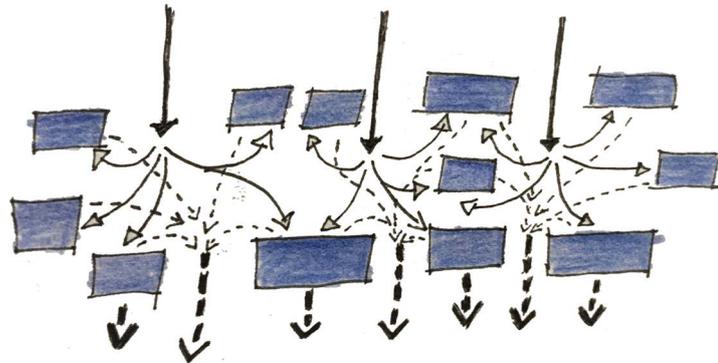


Figure 3-12: Energy Absorption & Distribution

#### Relation to the Station

The station, presents an edge towards the site, and could be seen as a constituent building that defines the spaces on the site.

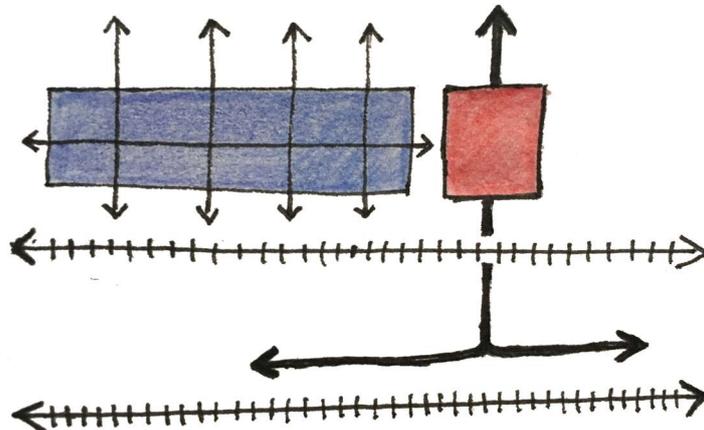


Figure 3-13: Relation to the station

#### Separation of Buildings

The buildings are separated, following the precedent set by the Ceramic Factory by Hassan Fathy (see Appendix, Pg. 88). Each function of the building is contained in a single unit, and is separated to further emphasise this division.

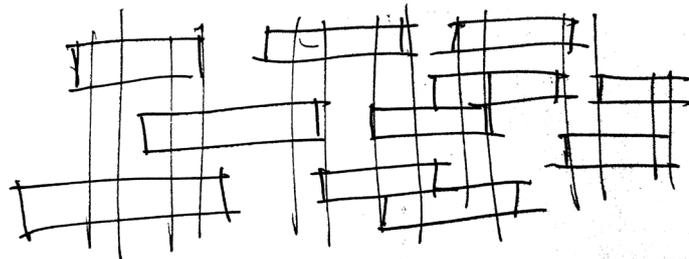


Figure 3-14: Separation of Buildings

Furthermore, the division of functions breaks the monolith and allows the building to blend better with the context of Mamelodi (see Page 7).

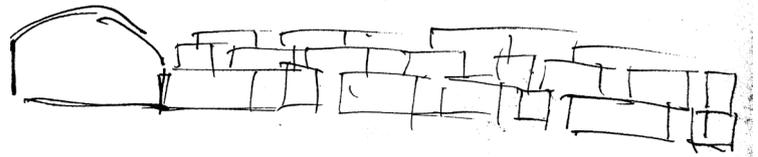


Figure 3-15: Separation of Buildings Elevation

### Hierarchy of Divisions

The linear site is subdivided by the cross routes, and their interaction with the central route along the site. At each crossing of these paths, a public square is located (see Page 59). The various buildings of the site must conform to these. Additionally, the subdivisions are arranged hierarchically, with the off centre A division representing the most important area.

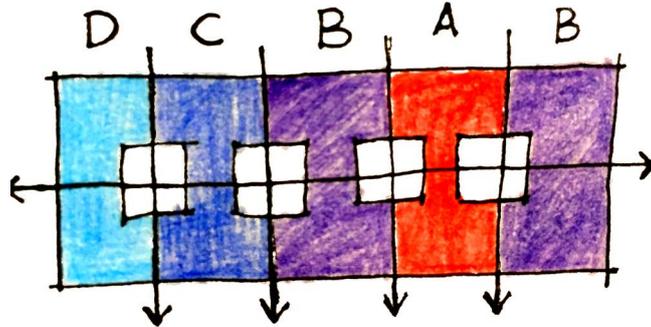


Figure 3-16: Hierarchy of Divisions

### Roof Coverages

The roof coverage of the site, is arranged in a manner that has the densest coverage over the division that is the most important in the hierarchy. Further out, the roof dissolves into individual structures.

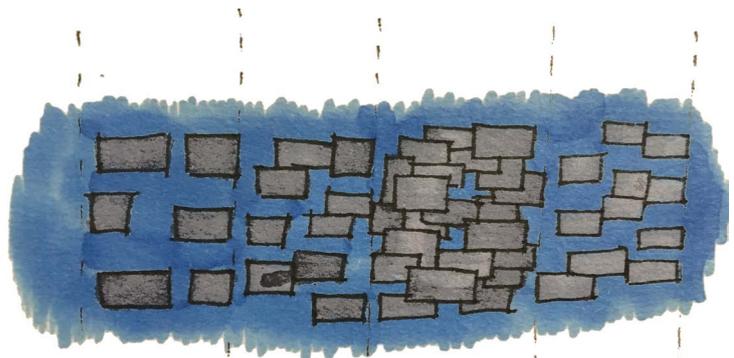


Figure 3-17: Roof Coverages

### Level Change

The level change cannot be negotiated in one step, and requires multiple, smaller steps to make the site useful and user friendly. Cutting and filling, with retaining walls resting on the cut and fill of the preceding level would be the most viable method to negotiate this.

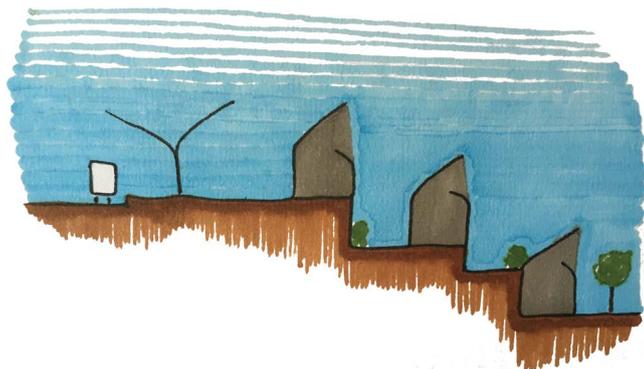


Figure 3-18: Level Change

### Variable Roof Pitches

The roof pitches are varied and unrelated, save for all being monopitch and rectangular. The general height of the building and the added pitch of the roof would aid vertical circulation of air.

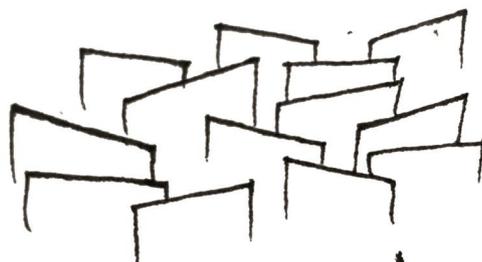


Figure 3-19: Variable Roof Pitches

### Alignment to the Grid

The buildings are aligned to the grid, and the structure would be aligned along centrelines. Skin would thus be attached to the exterior of such a structure.

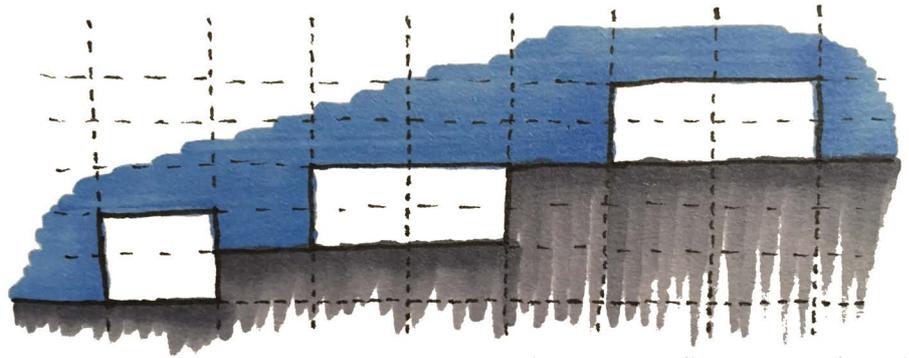


Figure 3-20: Alignment to the Grid

### Breaking the Monolith

The building cannot function as a monolithic entity, as it would not allow for adaptability (see Page 8). With a monolithic structure the site would become more about the process of production rather than the interaction between various industries and the advantages that may be derived from such a non-monolithic arrangement. Scale becomes a very important feature, and may be used to highlight certain elements.

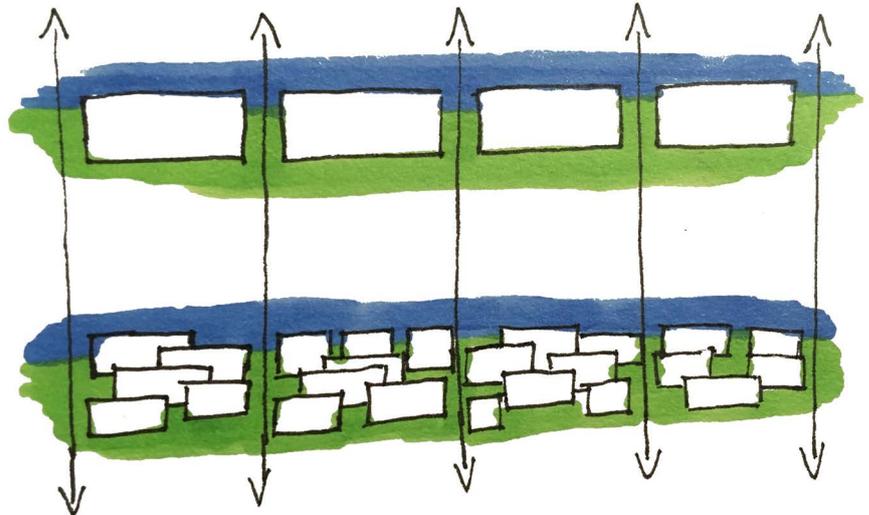


Figure 3-21: Breaking the Monolith

### Ventilation Towers

The towers form an aesthetic ordering device within the façade of the building, and would be used to identify the public squares. This makes it easier for users to orient themselves on the site.

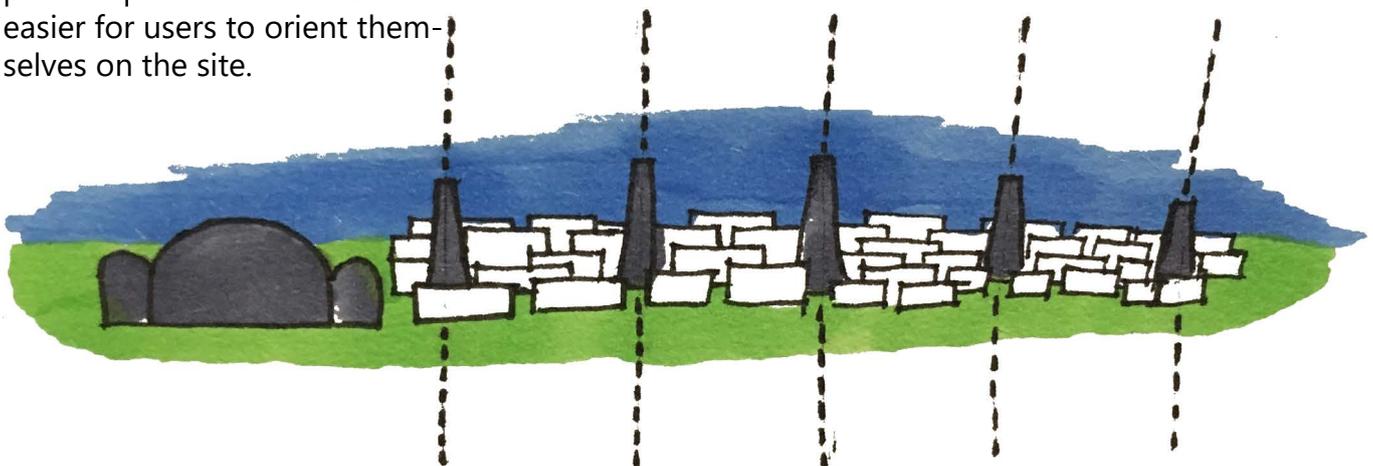


Figure 3-22: Ventilation Towers

# Design Development

## Critique of previous designs

The previous design iterations were varied, and were developed by reacting to general As such, it is not relevant to delve into each iteration in depth, but rather to look at the finalised version of each iteration, with a short summary of the major informing decisions.

## Design 1 - Monolithic Site

The large site was chosen for various reasons. It would deal with all the various edges, such as the flood line, the railway, Tsamaya road, and the public square.

Various methods of dealing with the large site were considered, but none were deemed appropriate. These included hexagonal blocks, rectangular blocks interspersed with courtyards and covering the entire site

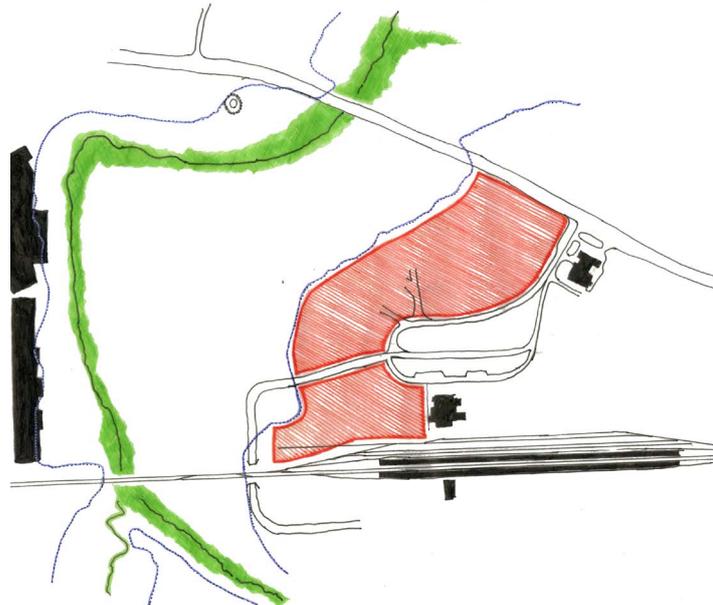


Figure 4-01: Large Rough Site Analysis

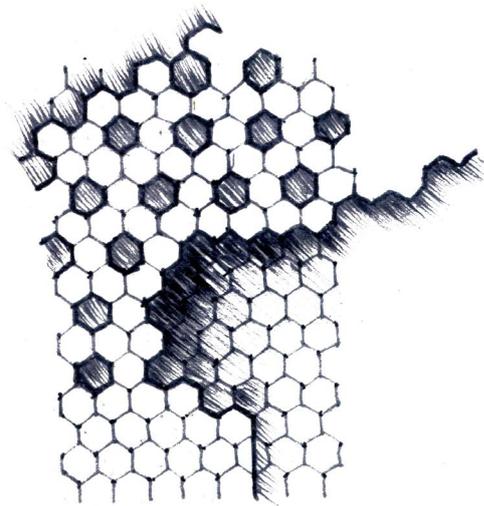


Figure 4-02: Hexagonal blocks around Public Square

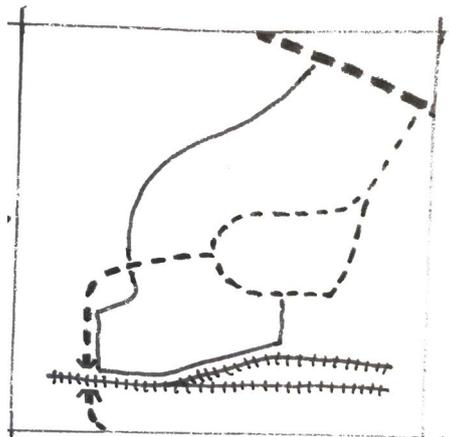


Figure 4-03: Diagram Site Plan

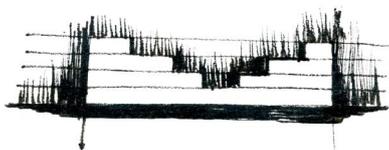


Figure 4-04: Concept Section

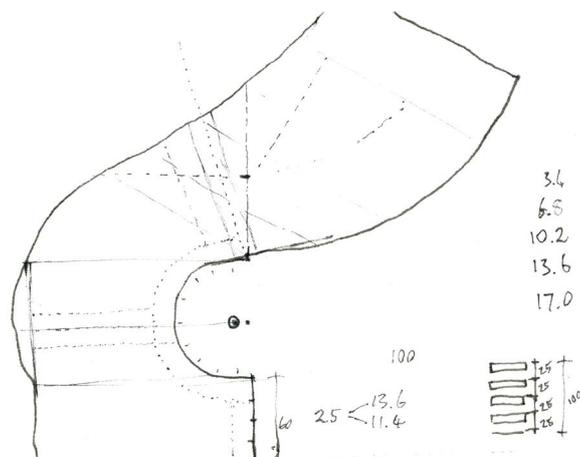


Figure 4-05: Possible Site Geometry

## Design 2 - Oversized Spine

This design is noteworthy for trying to draw focus to a single, monolithic element as a means of organising the site (see Page 21). All functions either branch from or go through this spine, with a railway station punching a large entrance through the monolith.

Industrial functions in this building would have been organised in an organic and informal manner (see Page 7), had the idea been developed further. The monolith spine was compared to the Plan Obus for Algiers by Le Corbusier, 1933 (Lamprakos, 1992:185).

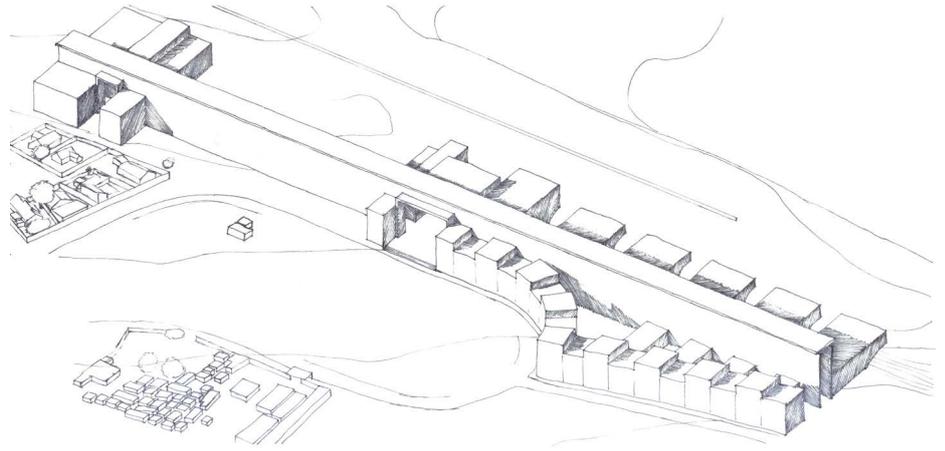


Figure 4-06: Design iteration 2, showing monolithic spine to which functions are attached.

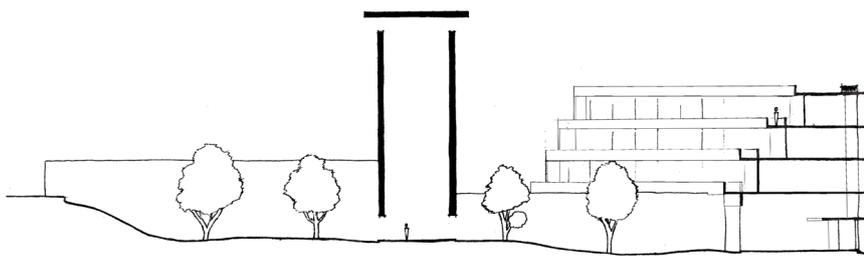


Figure 4-07: Hexagonal blocks around Public Square



Figure 4-08: Plan Obus for Algiers, Algeria, Le Corbusier, 1933, from Lamprakos, 1992:185

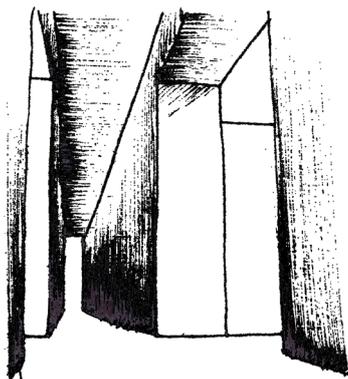


Figure 4-10: Perspective

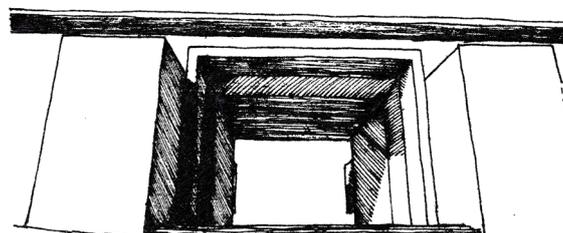


Figure 4-11: Perspective of Entrance

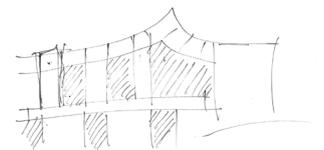


Figure 4-12: Sketch Plan

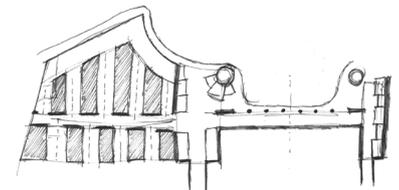


Figure 4-13: Rough layout

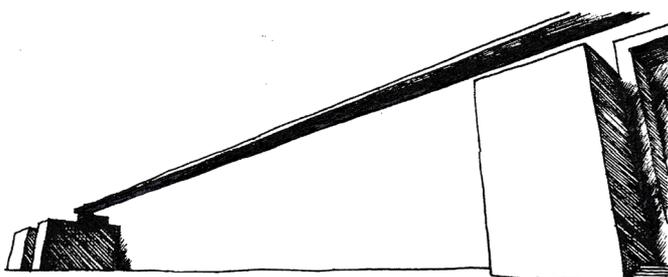


Figure 4-14: Monolith Spine Perspective



Figure 4-15: Rough Program

### Design 3 - Mixed use, Central road with detailed residences

The third design iteration focused on combining various different programs into a single building, in order to create a mixed-use programme. Based on the theories of Jane Jacobs (1961:151-177), mixed-use buildings and functions help to activate spaces and to maintain vitality more thoroughly. One of the criticisms levied against this design was its vastness, and the monolithic nature of the residential block (see Page 21). However, this design had worked to invert the monolith spine of the previous design into an internal access road.

Another aspect that arose in this design was that the design focus was placed on a concentrated strip of industry. This would become very relevant in later iterations of the design.



Figure 4-16: Plans showing the ground floor layout and the residential units in-situ, with the concentrated industrial area highlighted

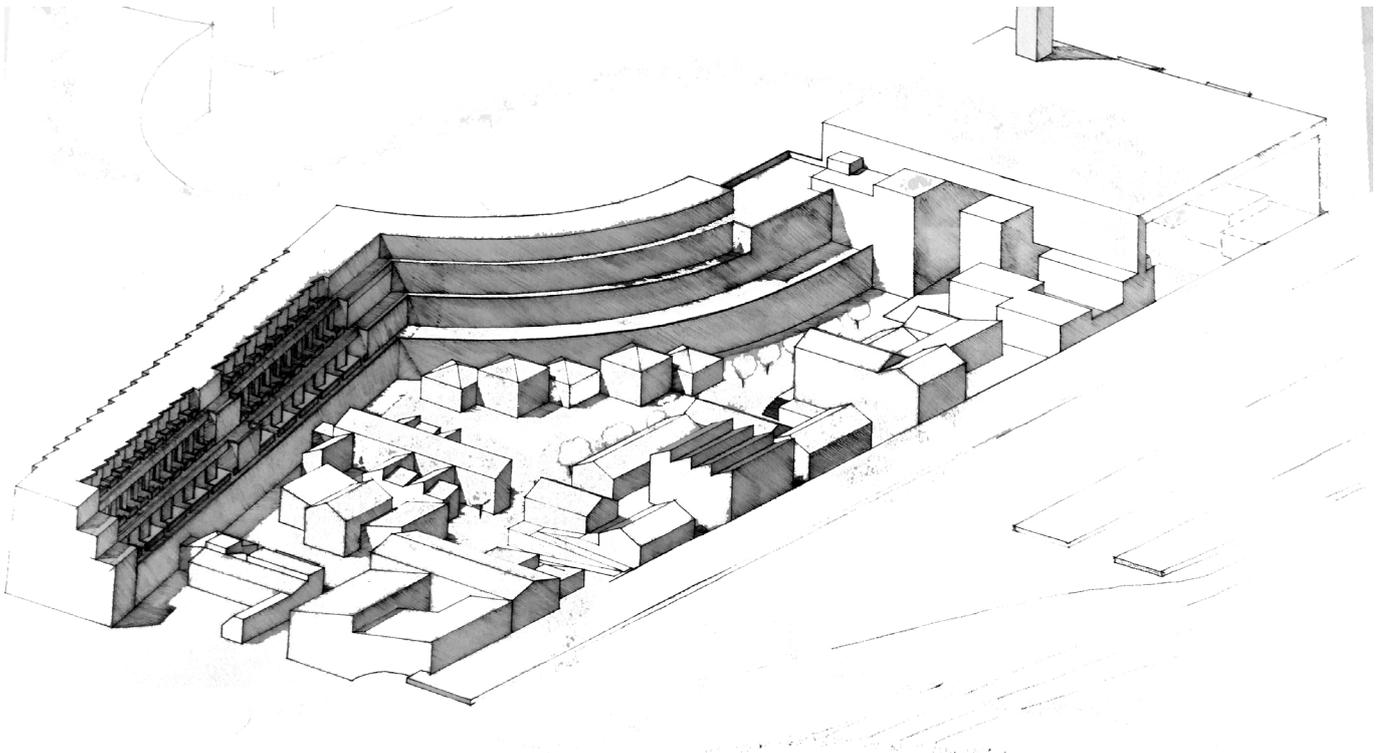


Figure 4-17: 3D view, mixed use complex, with industrial park behind residential units, with commercial frontage to the street.

## Design 4 - Concrete, Neoclassical Ventilation Stacks

The primary focus of this design was the use of concrete ventilation stacks as the primary ordering and bracing devices. The idea was that a reinforced concrete bay would act as the cross bracing for the entire structure. One of the criticisms levied against these stacks was that they had a neo-classical appearance (see page 8).

Furthermore, the plan of this iteration inspired several later decisions, such as the separation of functions into separate buildings (see page 21). A section of the plan used these separations to inform several public spaces, which would be intimate but public.

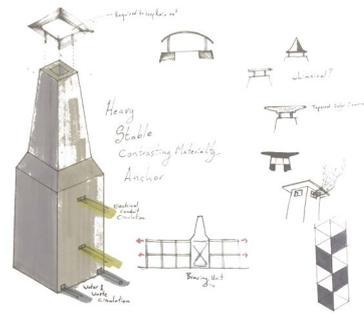


Figure 4-18: Concrete Stacks



Figure 4-19: Roof Plan

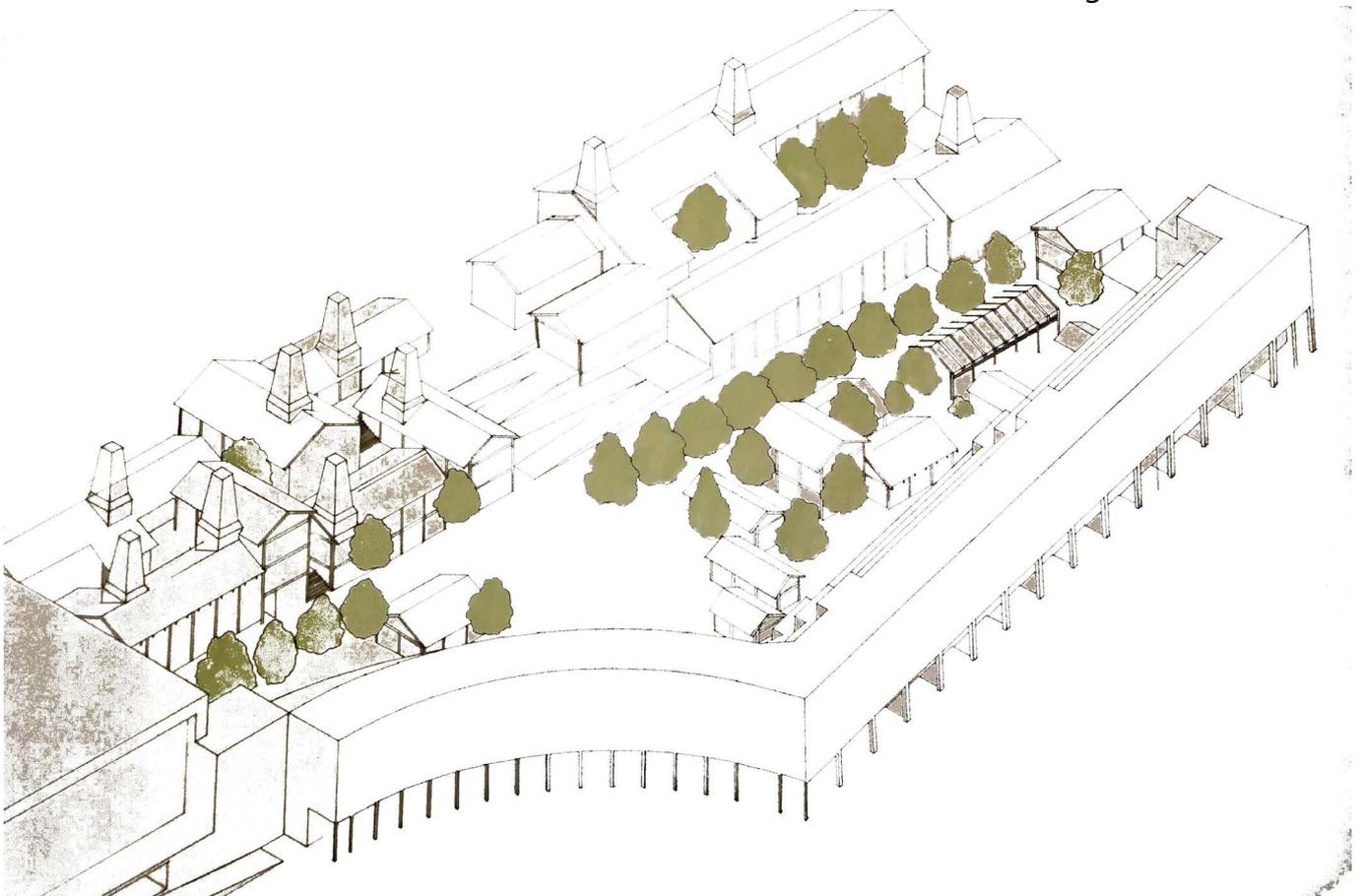


Figure 4-20: Neoclassical stacks displayed. Note that all roofs have been made into hip roofs, in order to create a language of spatial articulation.

## Design 5 - Daylight Scoops

This design focused on the design of a modular steel roof, and whether it could be designed in a way that allowed it to serve multiple functions. This roof was intended to allow in light, and provide ample height for passive air circulation to be encouraged (Smegal, 2017).

This design also started to explore materiality of the skin, and how this could be articulated. The result was a corrugated sheeting skin, which would wrap around the edges and corners to try and present a seamless façade.

This design was eventually abandoned in favour of a more contextually appropriate design (see page 11). The floor plan has remained very nearly identical though, and thus will not be discussed here.

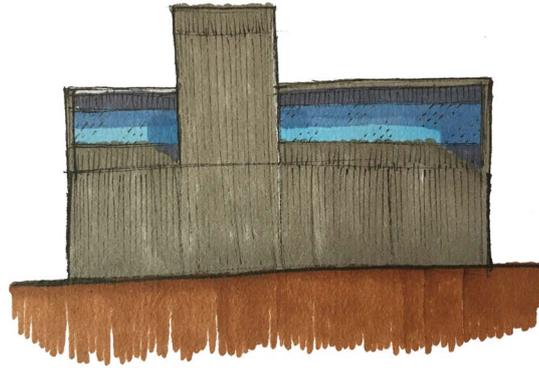


Figure 4-21: Initial Materiality Exploration



Figure 4-22: Light Scoop Section

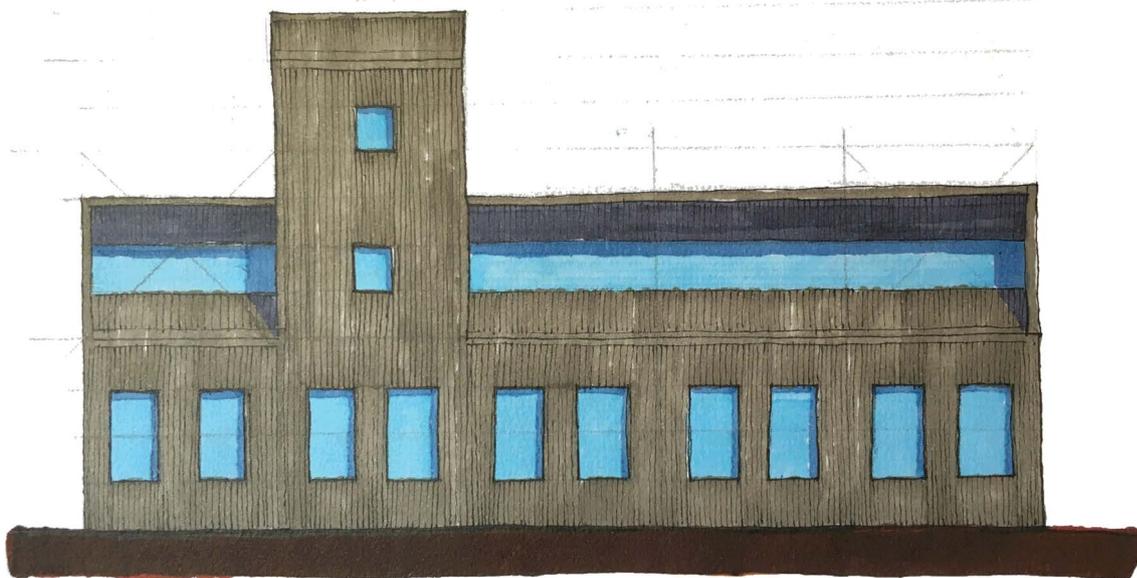


Figure 4-23: Façade materiality exploration

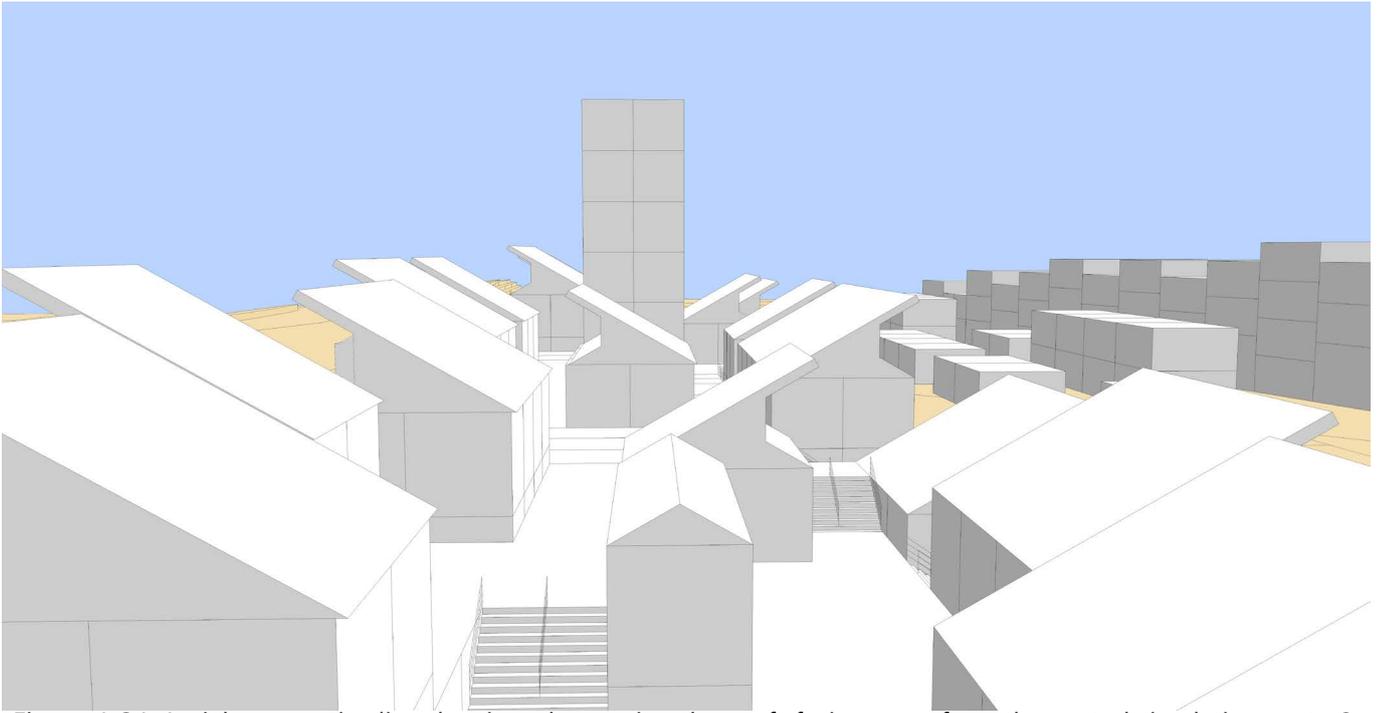


Figure 4-24: Aerial perspective line drawing, showcasing the roofs facing away from the central circulation route & public Spaces.



Figure 4-25: Perspective section, showcasing some aspects of the final materiality.

## Technical Concept

The technical concept relates to the conceptual thinking processes around the idea of construction and the assembly of materials. It has greater bearing on the final design than previous iterations, as it explains the thoughts and ideas behind the final design's construction.

Here follow the various conceptual ideas that guide decisions on materiality and the assembly of the building.

### **Adaptability**

Related to the principle driver of industry (see page 12) and the problems faced in Mamelodi, the lack of capacity for growth (see page 8) could be solved by addressing the factors that limit growth, namely space and adaptability.

Being adaptable, the building would expose functionalism by conforming directly, and changing to the changing functions of the building. As expressed in the word of Sullivan, "form follows function" (1886:403-409) This is an ex-

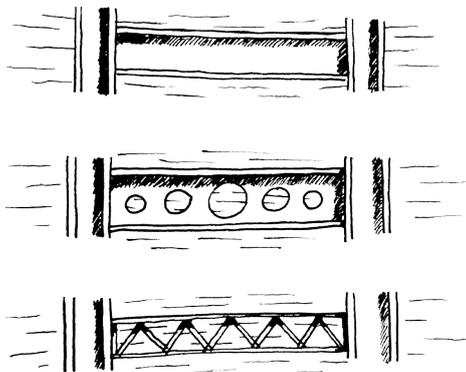


Figure 5-01: Site Replaceability of Parts

treme expression of functionalism, by showing that the usefulness of the building remains much more important than the beauty that a particular layout has provided, as expressed by Le Corbusier (1931:23).

With ample space being provided on site, the adaptability becomes directly linked to the modular unit of the site and how parts could be used, replaced, and moved to a new location (see page 12).

### **Independence of Function**

In order to have a building that could be disassembled, parts should be replaceable. This contrasts with the writings of Alberti (1755:654), but remains in line with what other writers have expressed about functionalism.

However, the building should not come tumbling down the moment one element is removed. Thus, each part should be able to function independently, with any interactions between them being regarded as a bonus to the overall strength and stability of the structure. Any part should be able to function with all dependent parts removed. Furthermore, this epitomises the theory of functionalism. With the focus of each part on its specific function, the architecture is created (Loos, 1913:22-23). Everything that is not necessary, may be removed.

Additionally, Le Corbusier stated that there is beauty in austerity, comparing automobiles with classical Greek temples (Le Corbusier, 1931:134-135).

### **Replaceability of Parts**

Parts should be replaceable, and thus consist of standardised materials. Any future upgrades or retrofits would merely have to conform to the parameters of the previous part, and could be inserted without disrupting the rest of the structure.

However, this does create the condition that some parts would be more permanent than others. For example, the concrete retaining walls would be permanent, and would define the base of the site. However, steel columns would be less permanent, in order to allow for their movement along the intersections of the gridlines. Certain internal finishes will be designed for easy and regular replacement, should the programme require it.

### **Disassembly**

Connections would favour disassembly, for the parts that could be assembled in such a way. The idea is that parts may be removed, or moved to new locations without losing any strength or integrity. As discussed in the steel category of the materials section, a focus would be given on bolting parts together. This would protect the galvanising of the steel, and would help in the disassembly of the building

## Materiality

The materiality of the building has been conceptually considered for adaptability and re-use. However, some materials cannot be adaptable, and serve more permanent functions.

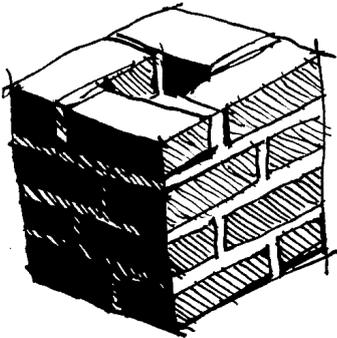


Figure 5-02: Masonry

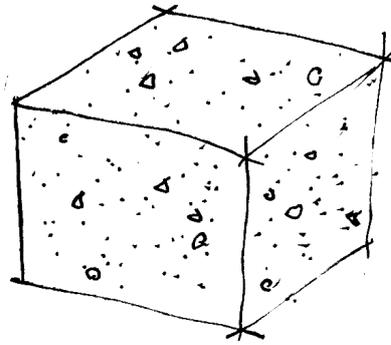


Figure 5-03: Concrete

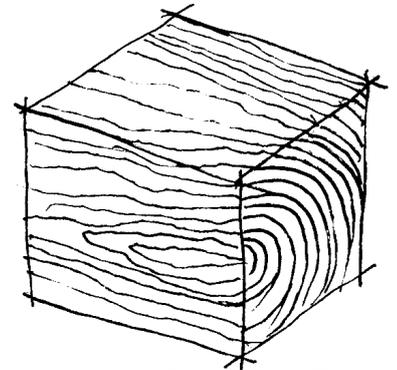


Figure 5-04: Timber

1. **Masonry** – Masonry would be used for more permanent vertical surfaces, and would be aligned to the grid where possible. The masonry, instead of the concrete retaining walls, will bear the load of the structure. This allows the retaining walls to be fixed into position, and to remain permanent, whereas the masonry may be demolished. Additionally, masonry would be used to pave the external surfaces of the site, to ease access to the soil for any planting or earthworks.
2. **Concrete** – Concrete would be used for the retaining walls, as well as the floors. The retaining walls would be L-shaped, and serve additionally as a foundation for any structure above. The floors would have a finished thickness of 170mm, including screed, for any ground floor levels. Suspended floors would be supported by permanent shuttering, spanning 3400mm from beam to beam. Service channels would be cast into the floors in order to convey the necessary services.
3. **Timber** – Timber would be used as an adaptable interior skin of the buildings. Fire retardant plywood would be used, and the plywood itself would aid in increasing the insulation of the building. The primary reason is that the plywood could be drilled into and have items, shelves, and objects attached, while still maintaining its structural integrity. This would allow industries to customise the interior of their workshops with the tools and equipment needed to function. Furthermore, these panels are easily replaced, and would be bolted into position, allowing quick and efficient replacement.

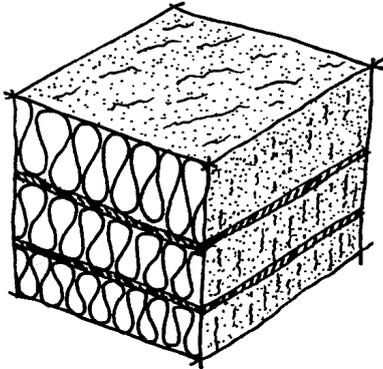


Figure 5-05: Insulation

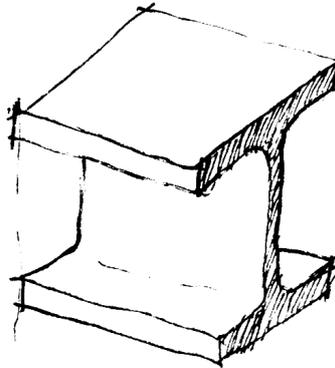


Figure 5-06: Steel

**4. Insulation** – Insulation would be hidden away behind internal panelling and the external skin, and would be as permanent as possible. However, provision would be made for its removal during disassembly, preferably intact.

**5. Steel** – Steel would be the most versatile material used on the site, serving multiple functions. It would be galvanized where possible, off-site, and would be bolted to ensure it is not damaged. Primarily, steel would serve as the structural element of the site, both serving as the columns in the form of H-sections and as beams in terms of I-sections. Roof beams would also consist of steel, as would the top-hat purlins. Steel Klip-Lok™ sheeting would be used on the skin and the roof of the building, with insulation inside to protect it. Furthermore, the permanent shuttering supporting the concrete suspended floors would be made of steel. They would be welded to each other on site, but would be bolted on all other connections. Various angles would support this shuttering at the connection

to the beams. Additionally, the shading devices would consist entirely of steel, including the structure, the shading slats, and the stay cables. Although the shading device itself would be welded into one piece, all other connections would be bolted. Lastly, steel would be used for all the bolted connections, and would also be used as rebar, which would not be galvanized.

**6. Paints and Finishes** – The building would be left as natural as possible, and materials would be allowed to retain their original colour, unless a specific industry would like to paint their building surfaces. The floor may be coated should the industry desire, but this would be left for each industry to decide.



## Final Design

The final design was developed concurrently with the technical resolution of the building to ensure that they remain harmonious.

### Site

The building is located adjacent to the Eerste Fabrieke Station. To the north is a public square and an area for proposed future development.

To the west of the site lies a floodplain, bounded by the Pienaars River. A soccer field and several industries (such as a brick maker) make use of the vast open space.

The Pienaars River, according to the *State of Rivers Report* (River Health Program, 2005:25), is of marginal to low ecological importance and sensitivity. The same report describes the water quality as fair, with few nutrients. Floods erode significant amounts of the river bank, and fish and macro-invertebrates are absent. There are significant amounts of invasive vegetation, which further reduces the river's quality.

Tsamaya Road passes close by the site, and is a significant road in Mamelodi. A number of services and businesses are situated on Tsamaya Road, making it a major route for goods and people.



Figure 6-01: Site plan and features



river

Brick Makers

Tsamaya Road

Magistrate Court

Proposed Future Development

Proposed Future Development

Fuel Station

Public Square

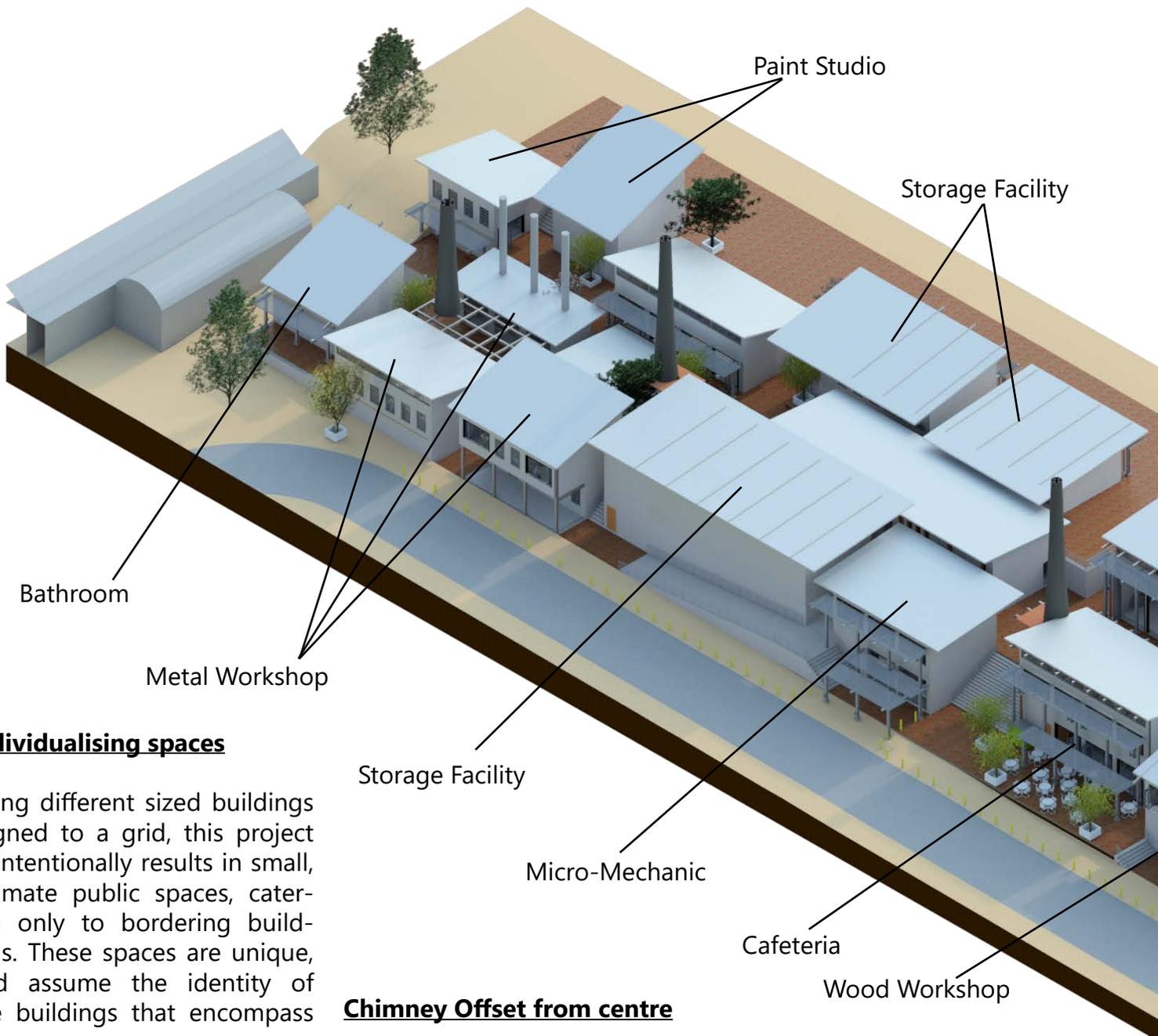
Eerste Fabrieke Station

Substation

N

0 10 50 100 150 200 250

## Overall 3D



### Individualising spaces

Using different sized buildings aligned to a grid, this project unintentionally results in small, intimate public spaces, catering only to bordering buildings. These spaces are unique, and assume the identity of the buildings that encompass them.

### Breaking of the Monolith

The aesthetic motivation for separating all the individual functions, was to use it as a method of breaking the monolith (see page 21). A large, single building would not fit appropriately into the context of Mamelodi (see page 11), and so a less intrusive design was more appropriate.

### Chimney Offset from centre

The chimneys, although effective in reducing the temperature directly below them, serve as ordering devices and visual landmarks (see page 21). Made from welded steel plates, each chimney would be coloured through an initial coat of paint, identifying them by different shades. This would allow for easy navigation on site, as they are located off centre on each public square.

By placing the chimney off centre, the square remains useful. Placing the chimney in the centre of the square renders the middle of the square inaccessible to tall items and goods. This draws more from the medieval and renaissance town squares, with an offset bell or watch tower (Kostof, 2004:296), than from the placement of an obelisk as the terminus of a road, as in Rome (Kostof, 1991:500).

### **Paved Public Spaces**

The public spaces are paved over, allowing for easy access below ground. When buildings are moved, the slab and top sections of the foundation wall is removed and replaced by paving. The slab is re-used as aggregate for the new slab.

### **Extension of Usable Space**

Separate shading devices, constructed from steel, are located in front of various doors and windows. They are inspired by the precedents set by Mamelodi industries (see page 11), where the primary working space is located beneath a single shading plane. Thus, the shading devices aim to extend the usable space of the industries, and to provide an interface between the public and the industrial programmes.

### **Public to Industry**

By opening up to the public spaces, the industries are provided not only with a visual connection (Jacobs, 1961:36), but also with a social connection (Jacobs, 1961:36) to the other industries and users of the site. This would result in more chance encounters, and a possibility for the cross pollination of ideas and resources (Glaeser, 2011:5). This openness would create unique opportunities for innovation and additional development.

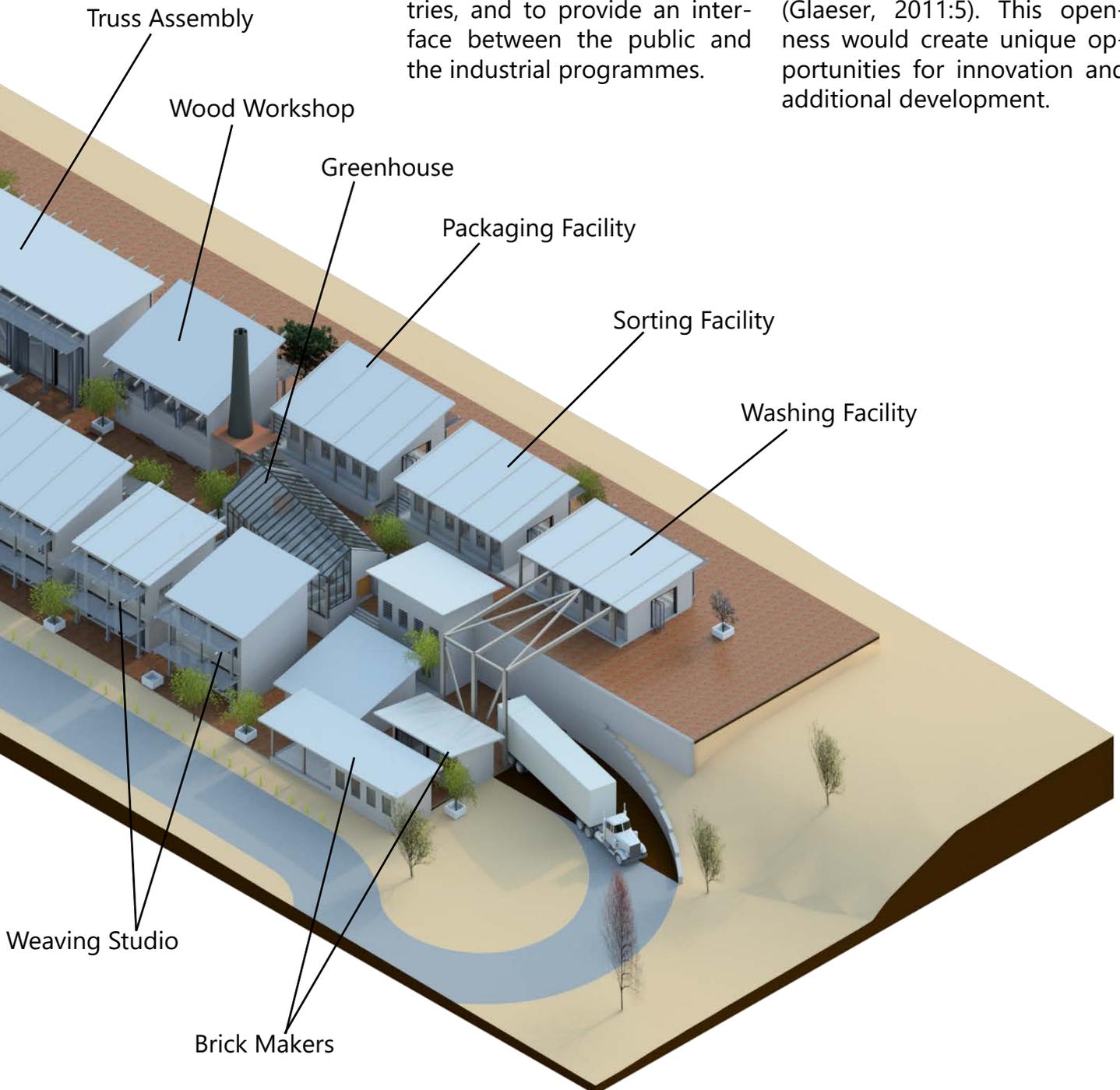


Figure 6-02: Overall 3D

## **Plans**

### **Ground Floor Plan** **Levels 0000 - 1700**

#### **Brick Makers**

Brick Makers are an extant industry on the site, using sand and water from the Pienaars River to make cement, sun-dried bricks. Facilities would be provided for administration and tool storage, as well as a relaxation lounge.

#### **Rainwater Treatment**

Rainwater caught by the storm water system is carried by gravity to the western end of the site, where it would be caught in sumps. From there it would be pumped to the treatment facility and used as grey water.

#### **Grocery Store**

There are small goods stands in and around the site, selling sweets, snacks, and small household items. This facility could potentially absorb one or more of these.

#### **Cafeteria**

Several food vendors and informal eateries are extant on the site, but there is no cafeteria. The provided facilities include a kitchen and washing area, a serving space, and a seating area.

#### **Micro Mechanic**

Several industries advertise automotive repairs near the site. This facility includes some workshop space and two bays for working on cars.

#### **Bathrooms**

Communal bathrooms are provided on the site according to SANS 10400 Part P. These are spread across the site at three locations. The central facility contains showers for the workers of the site to use.

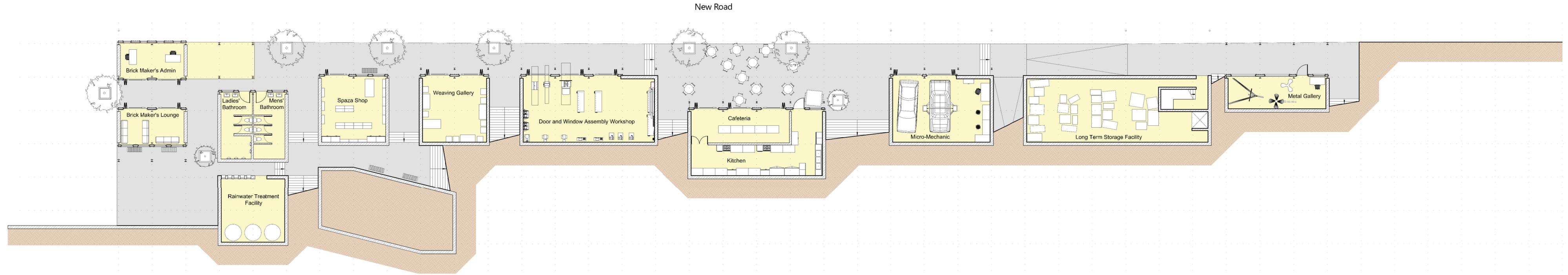


Figure 6-03: Lower Floor Plan - Scale 1:200

## **Mid Floor Plan** **Levels 2550-4250**

### **Weavers**

There is no extant weaving industry on or near the site. However, the industry would potentially use reeds from the nearby wetland. By eliminating invasive plants and promoting the growth of indigenous reeds, this industry could sustainably rehabilitate the wetlands in the vicinity. A weaving studio with drying facilities is provided, as well as a display gallery. A greenhouse is provided for the propagation of stems and seedlings, for planting in the wetland.

### **Wood Workshop**

Only aerial evidence exists of an extant wood workshop near the site. The provided facilities would include a large space for the assembly of trusses and beams, a space for door and window assembly, a timber preparation area, and a space dedicated to furniture making and finishing the products.

### **Lounge**

A lounge and conference facility is provided for conducting more formal affairs and meetings, and may be used by the senior staff of each industry for relaxation.

### **Administration and Security**

This facility serves as the administrative and security hub of the site, overseeing and looking after all the various communal facilities.

### **Metal Workshop**

Several manufacturers of metal gates are extant in Mamelodi. The programme has been expanded somewhat, to provide a solid metalworking workshop. The facilities provided include forges, a preparation and sizing area, and assembly floor, and a finishing space. Additionally, a gallery is provided for the display and sale of certain items and art.

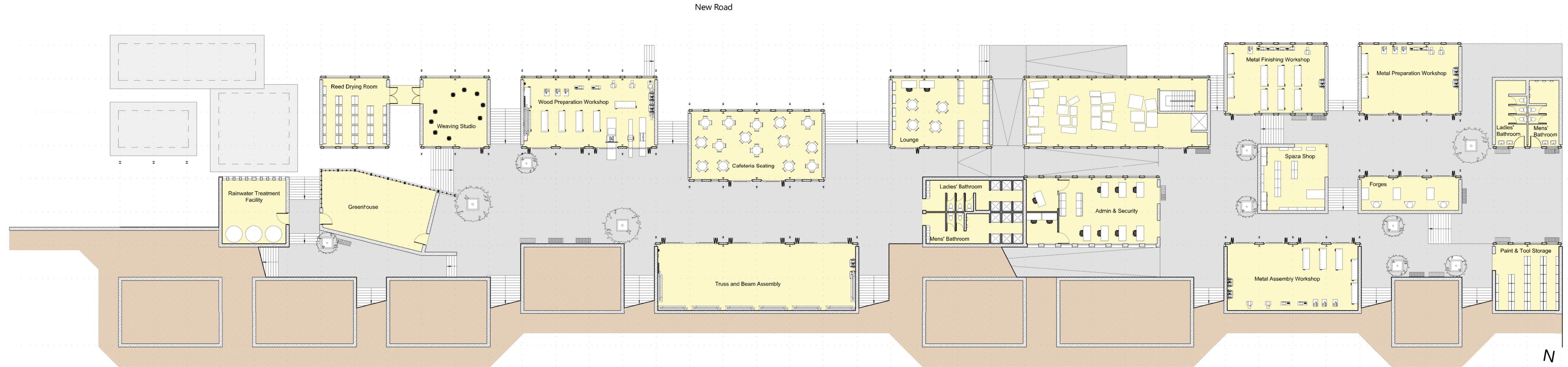


Figure 6-04: Mid Floor Plan - Scale 1:200



## **Upper Floor Plan** **Levels 5100-5950**

### **Urban Agriculture**

This is a hidden industry at present, with no visible signs of existence. There is a massive potential for this industry, however. Adjacent to the site, a massive floodplain extends, on which any buildings and developments are prohibited for safety reasons. This space would be ideally used for an activity such as urban agriculture, especially considering the near constant water supply nearby. The proposed facilities include a washing area, a sorting area, and a packaging area.

### **Storage Facilities**

Communal storage facilities for either raw materials, finished products, or tools are provided. Certain facilities are more secure than others, and are ideal for storing valuable goods. However, as with the site, a size limit exists. This is in the hopes of fostering industrial independence of self-sustaining industries.

### **Painter Studio**

While no extant paint shop or studios exist on the site, several painters advertise their services in the vicinity. The provided facilities include paint and equipment storage, and a studio gallery with large, south facing windows.

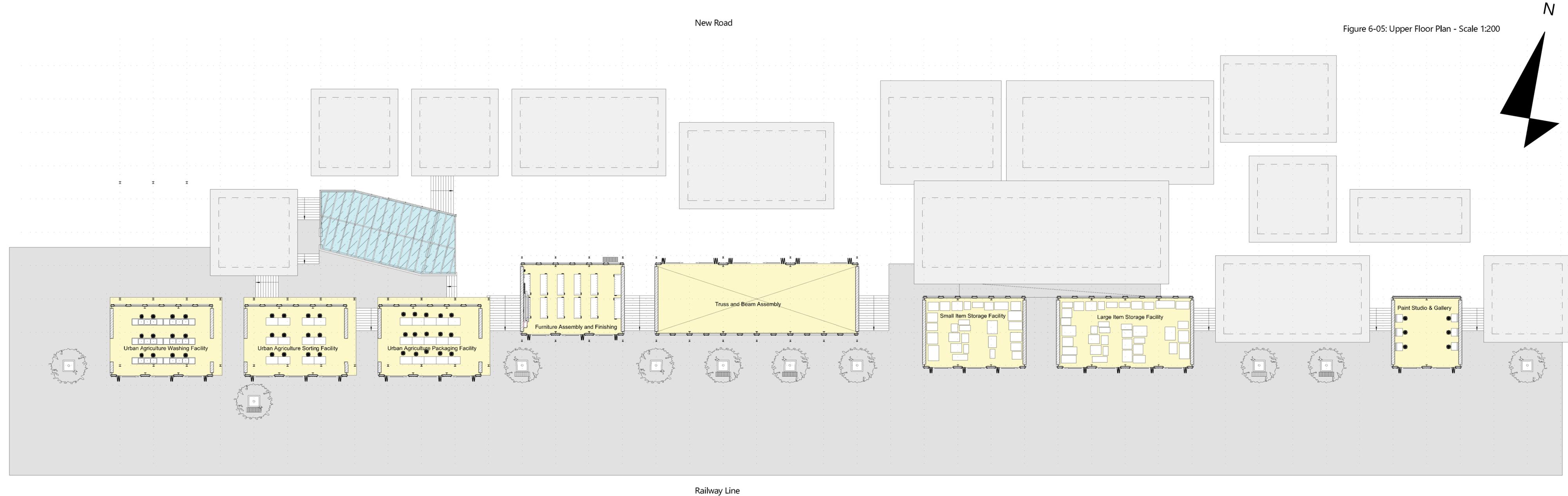


Figure 6-05: Upper Floor Plan - Scale 1:200



## Elevations

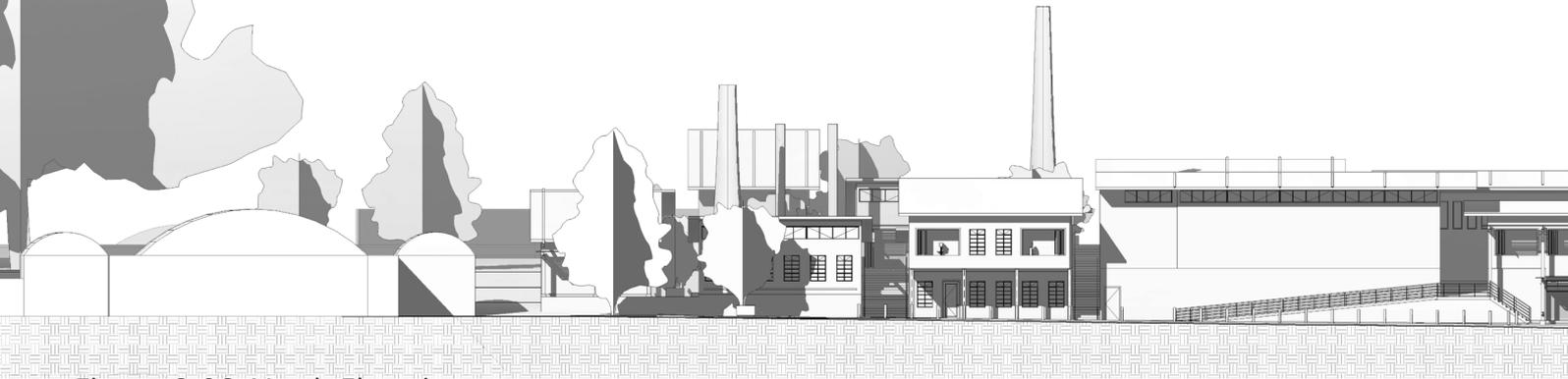


Figure 6-06: North Elevation

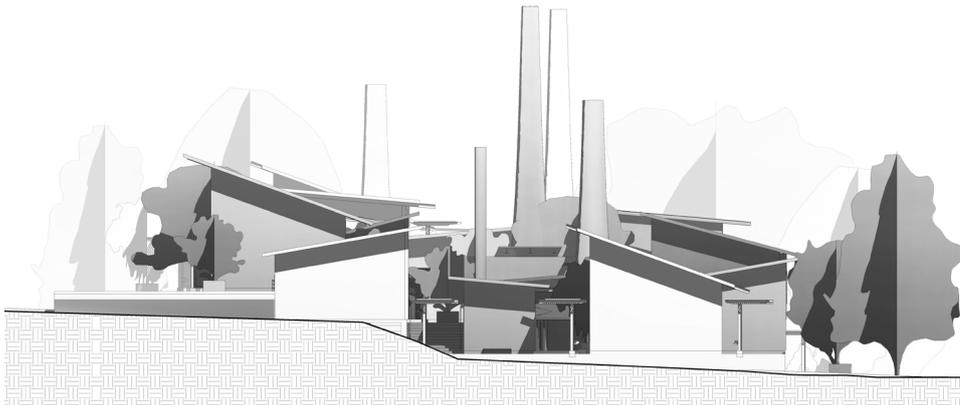


Figure 6-07: East Elevation

Figure 6-08: South Elevation



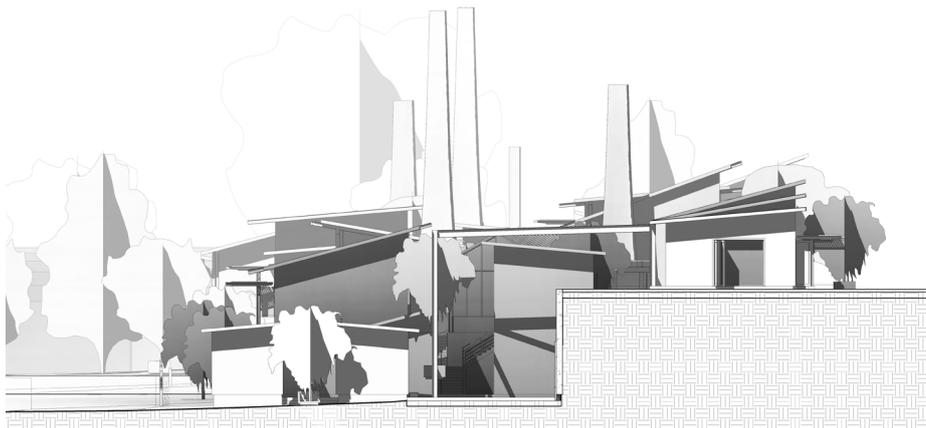
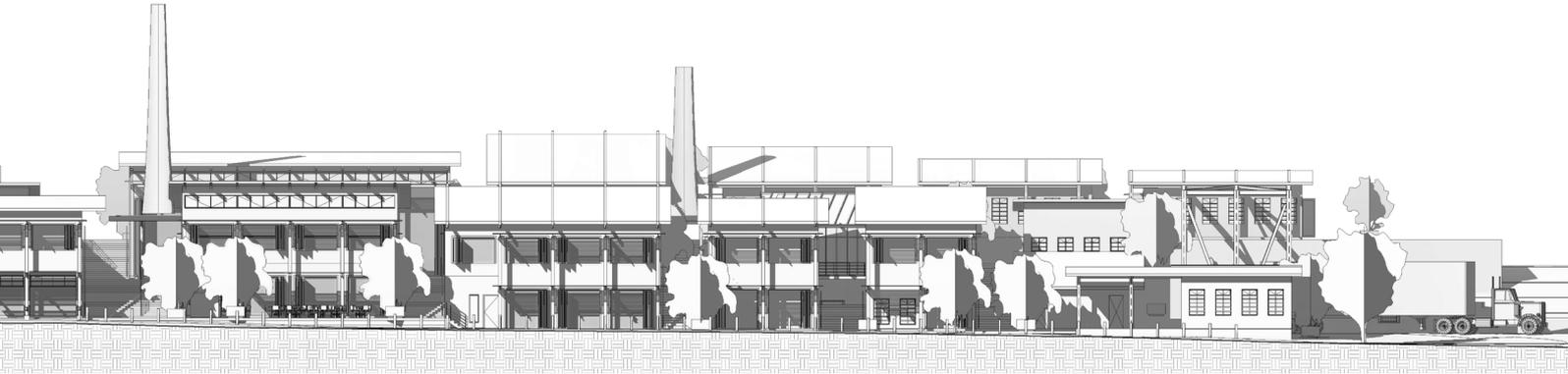


Figure 6-09: West Elevation



## Perspective Section



### **Infrastructure as Growth Limiter**

Some of the infrastructure of the site is completely immovable, such as the ramps and retaining walls. This makes it impossible for any one industry to

grow beyond a certain size, and encourages investment by such an industry in its own buildings and structures. Furthermore, it protects some of the small-

er industries from losing all of their space to larger competitors. They are able to maintain autonomy due to the layout of the site.



Figure 6-10: Perspective Section

## **Organising Space**

By stating that all buildings must have at least one bay of separation, the site becomes automatically populated by various cross routes and public

spaces formed by the buildings on the site. It creates spaces on a human scale, rather than trying to impose larger spaces on the users.

**Sections**

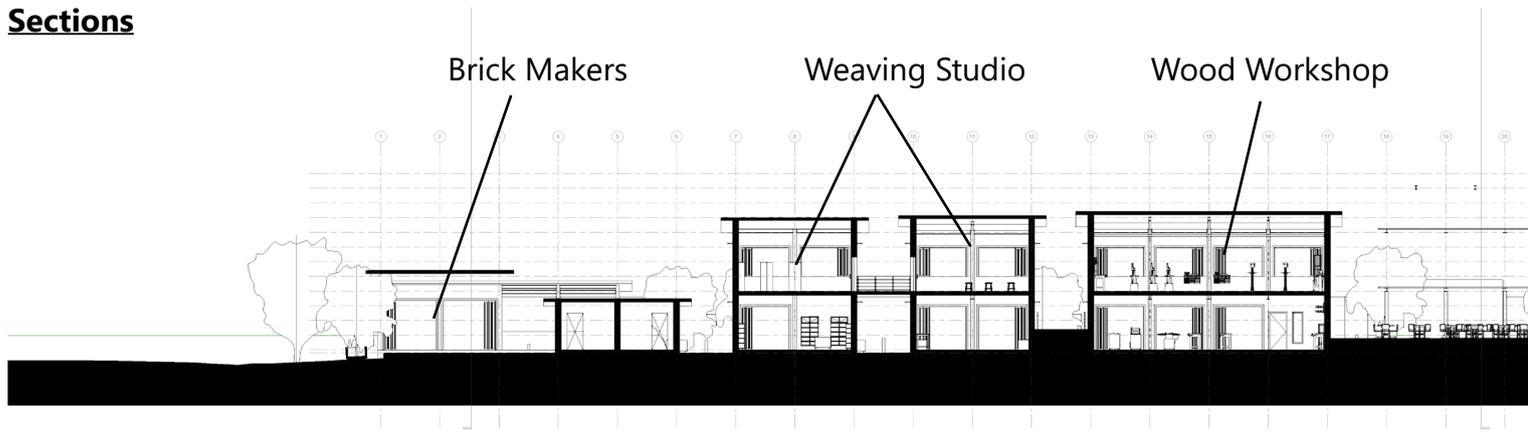


Figure 6-11: Long Section

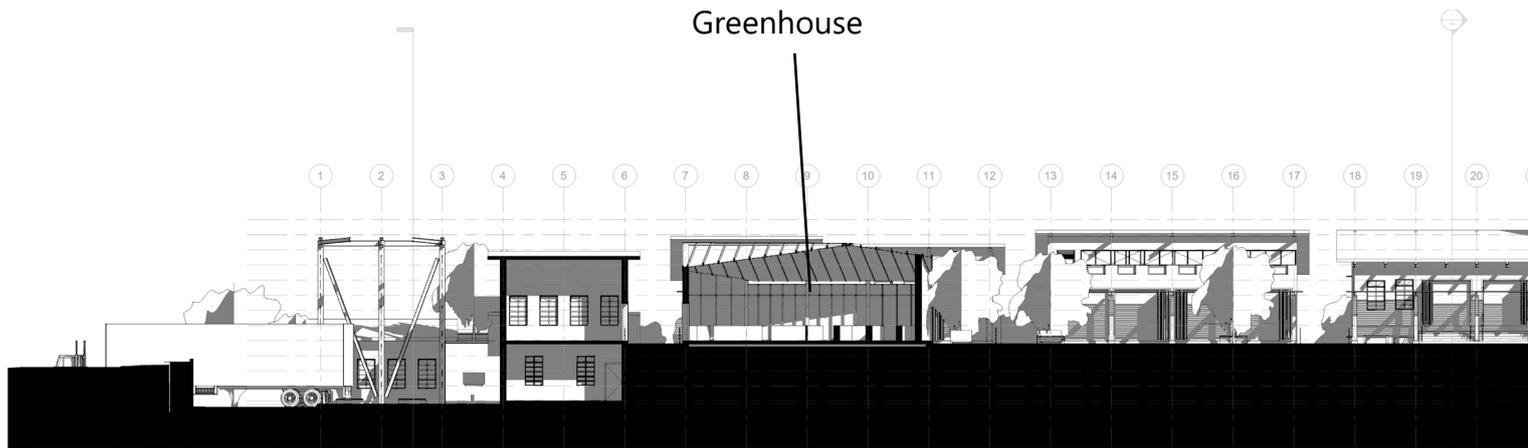


Figure 6-12: Long Section

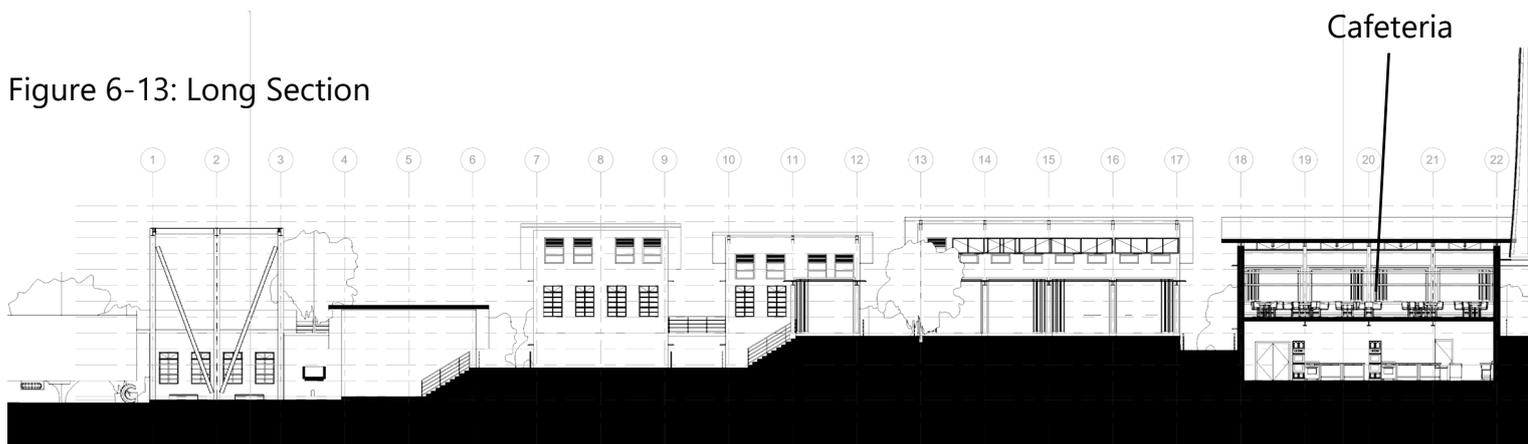


Figure 6-13: Long Section

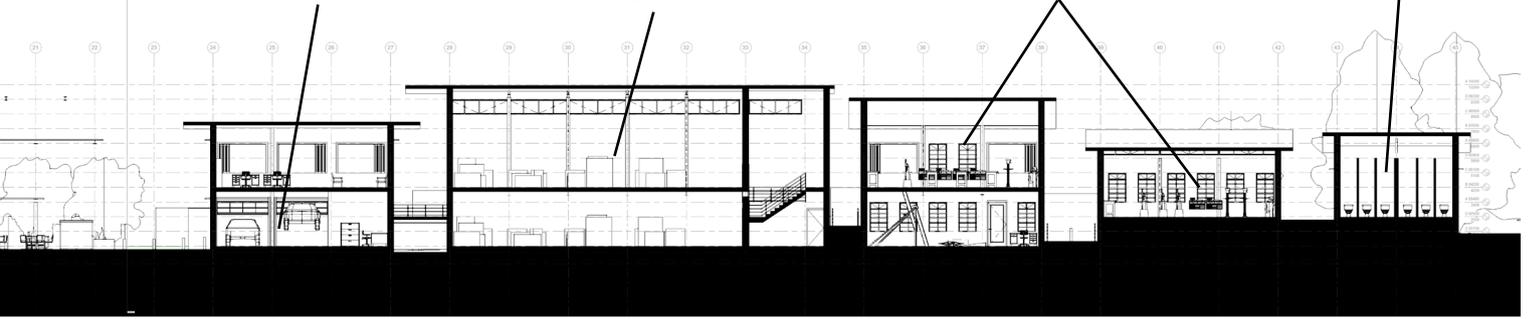


Micro-Mechanic

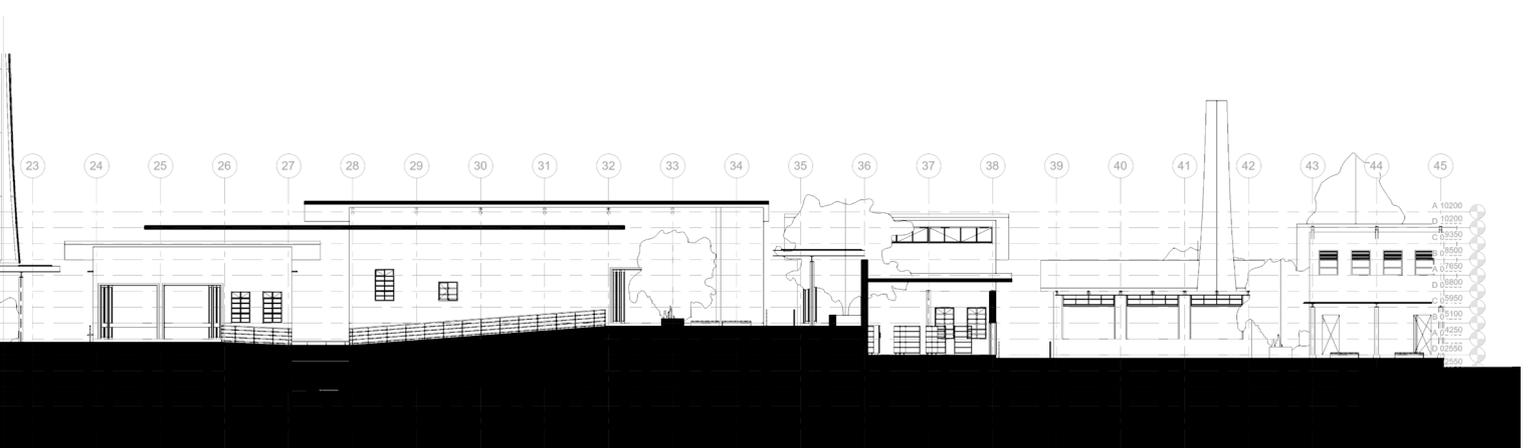
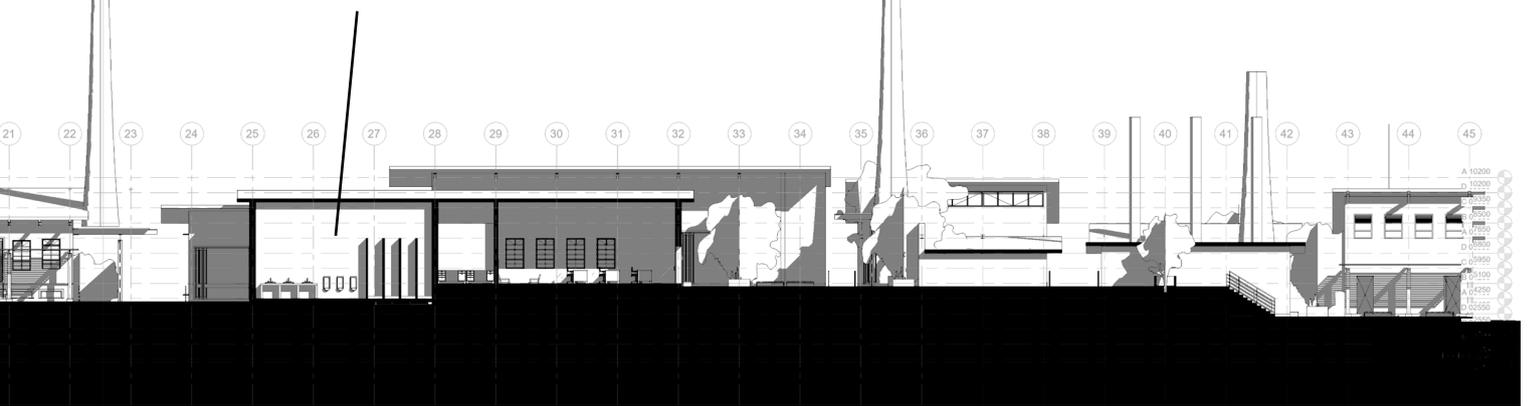
Storage Facility

Metal Workshop

Bathroom



Bathroom



**Sections**

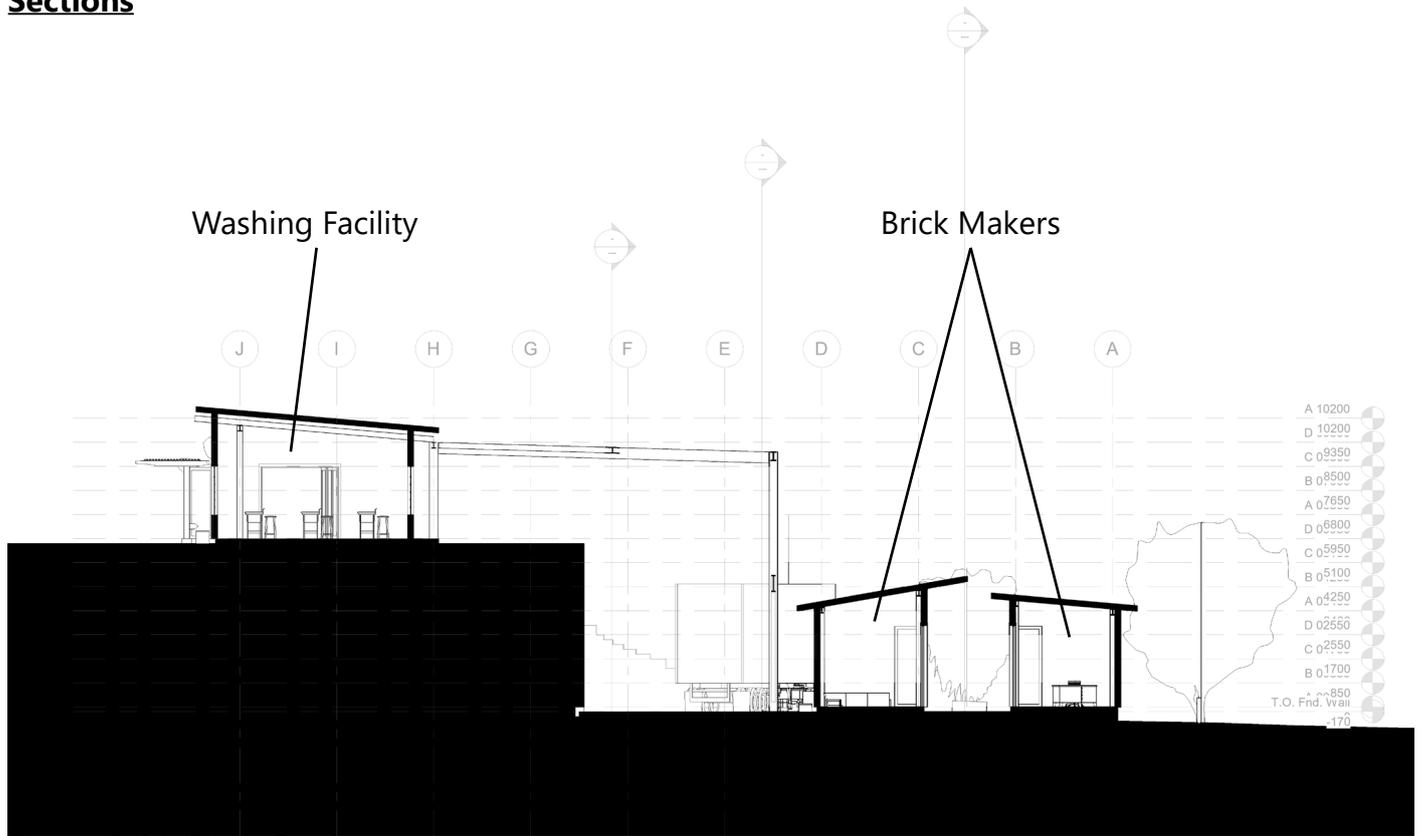


Figure 6-14: Short Section

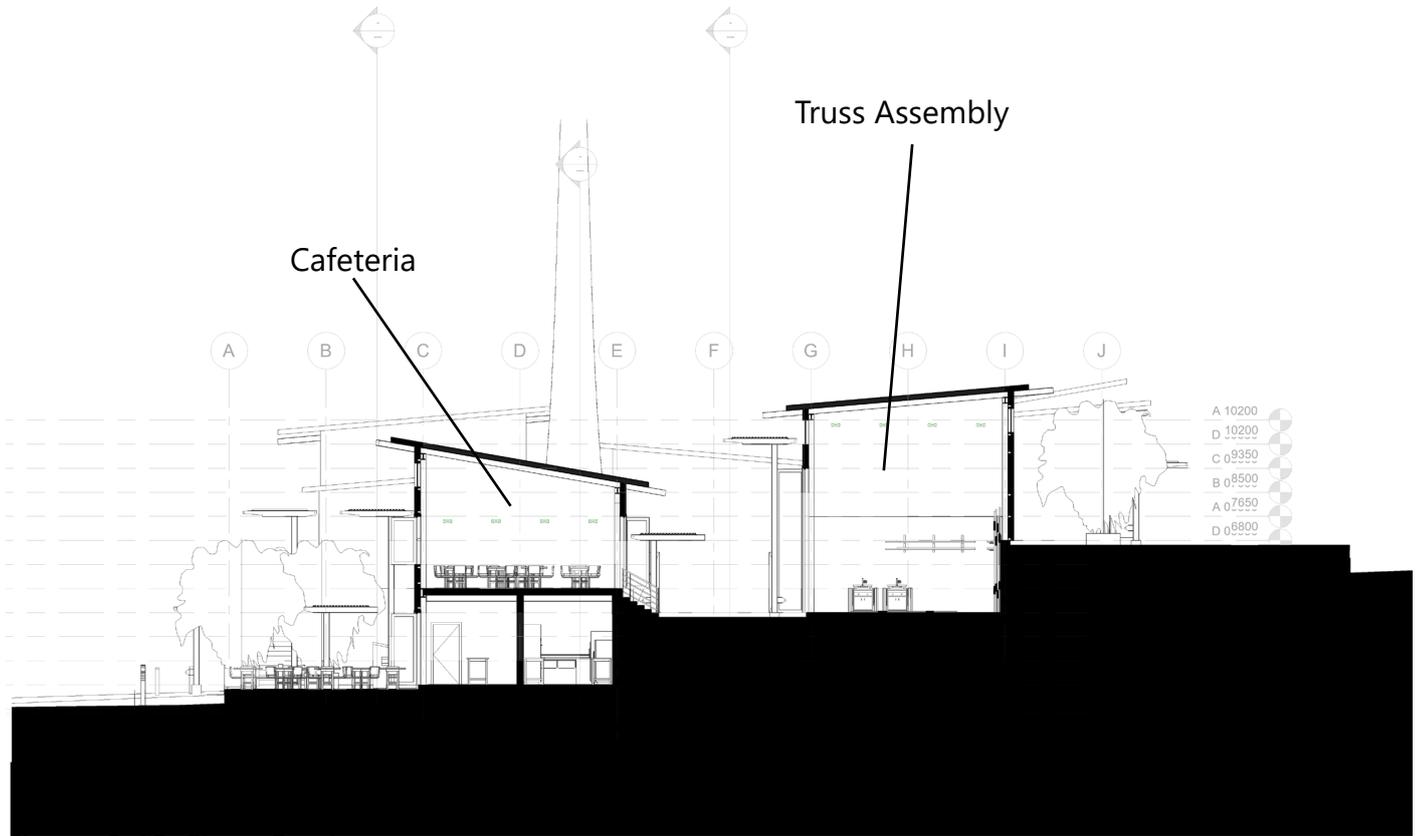


Figure 6-15: Short Section

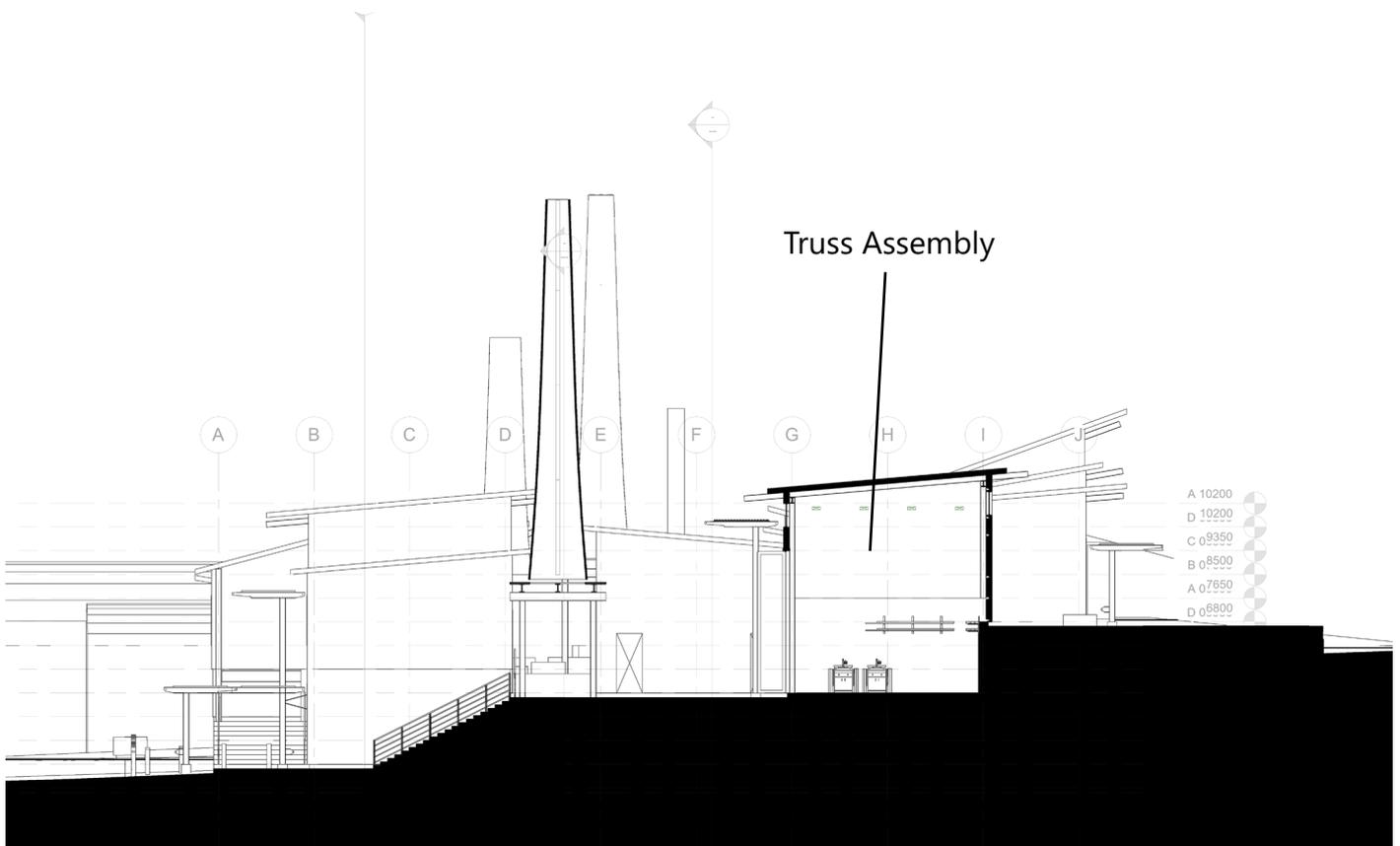


Figure 6-16: Short Section

**Perspectives**



Figure 6-17: Loading Platform Perspective



Figure 6-18: Greenhouse Square Perspective



Figure 6-19: Woodworking Square Perspective



Figure 6-20: External Perspective from NE



Figure 6-21: Birds Eye External Perspective from NE



Figure 6-22: Cafeteria Square Perspective



Figure 6-23: External Perspective from NW



Figure 6-24: North Perspective



Figure 6-25: Platform Perspective



Figure 6-26: East Square Perspective

## **Model**

The model consists of 3D printed buildings on a laser-cut base of timber board.



Figure 6-27: Model View



Figure 6-28: Model View



Figure 6-29: Model View



Figure 6-30: Model View



Figure 6-31: Model View

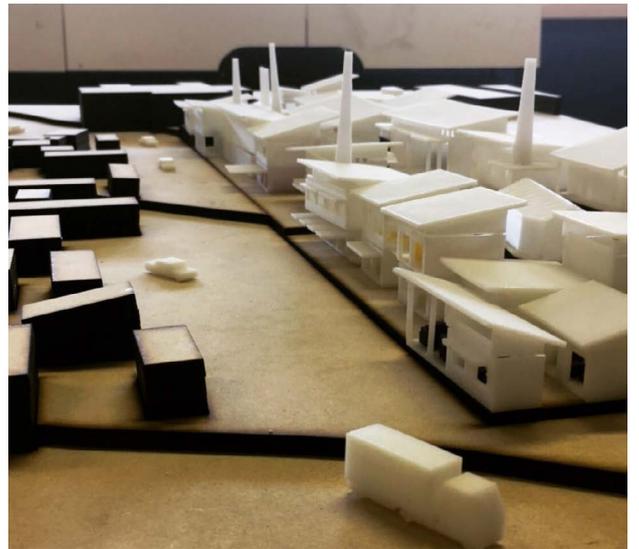


Figure 6-32: Model View



Figure 6-33: Model View



Figure 6-34: Model View

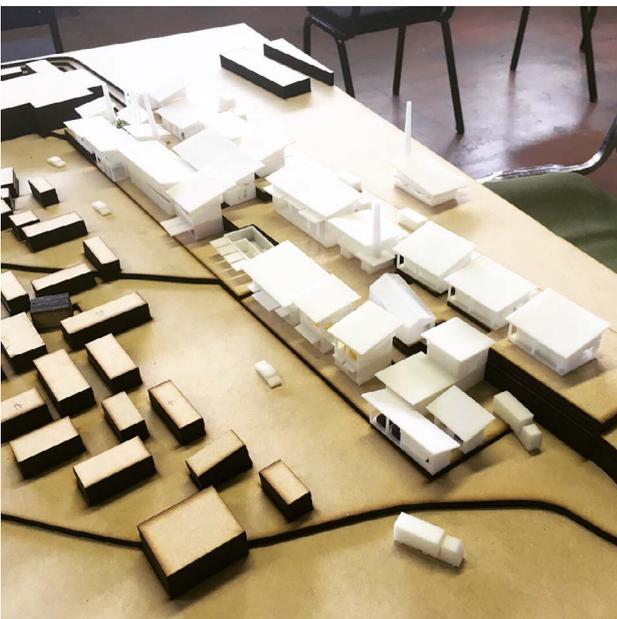


Figure 6-35: Model View



Figure 6-36: Model View

## Technification

The technical resolution of the building was directly developed from the technical concept, and was developed concurrently with the final design. This helped the technical resolution and spatial decisions to remain harmonious throughout.

In order to show the efficacy of the technical resolution of the building, several aspects are investigated.

These include aspects that affect only certain parts of the building, or the whole site. Furthermore, certain parts are investigated and shown in detail, to explain their function and purpose.

### **Exploded Isometric**

#### **Roofs**

The roofs used in this building are inspired by the precedents from Mamelodi (see page 11). Several of these industries have their primary work area located underneath a floating plane, a single rectangular covering to shield from the sun and the rain (see page 20). This inspired the use of monopitch roofs, which not only pay homage to the context but also break the size (see page 21) and monolith of the site with varying pitches from roof to roof.

Although the Mamelodi precedents minimise the amount of structure (see page 11), these roofs are supported by a clear structural system, with rafters protruding beyond the edges of the roof. These are profiled at both ends, with the possibility of supporting the weight of shading devices. These are discussed in detail later.

#### **Skin**

The skin of the building discussed here is the non-structural, and merely provides the covering for the building through which most of the doors and windows are placed. The skin is a composite construction, with Klip-Lok™ sheeting, insulation, top-hat profiles and plywood sheeting making up the primary elements. The idea is that the skin of the building is re-usable (see page 28), and could be taken apart as needed. Thus, it is bolted together and bolted to the structure from the inside of the building.

#### **Structure**

The structure is primarily a lintel and beam construction made from steel. All the connections are bolted, and provide the opportunity for re-use, adaptation, and relocation (see page 28). Bracing is strategically located so as not to interfere with openings or circulation. It comes in two forms. Firstly, the traditional cross brace made of steel triangulates between members. Secondly, the ends of buildings are completely filled with concrete end walls, butting up against the structural members.

#### **Foundations**

The foundation system of the building is twofold. Firstly, some retaining walls also act as foundations, so as not to require duplicate material. Secondly, foundations according to the engineer's specifications would be provided everywhere else, and has been envisioned as a strip foundation in this case.

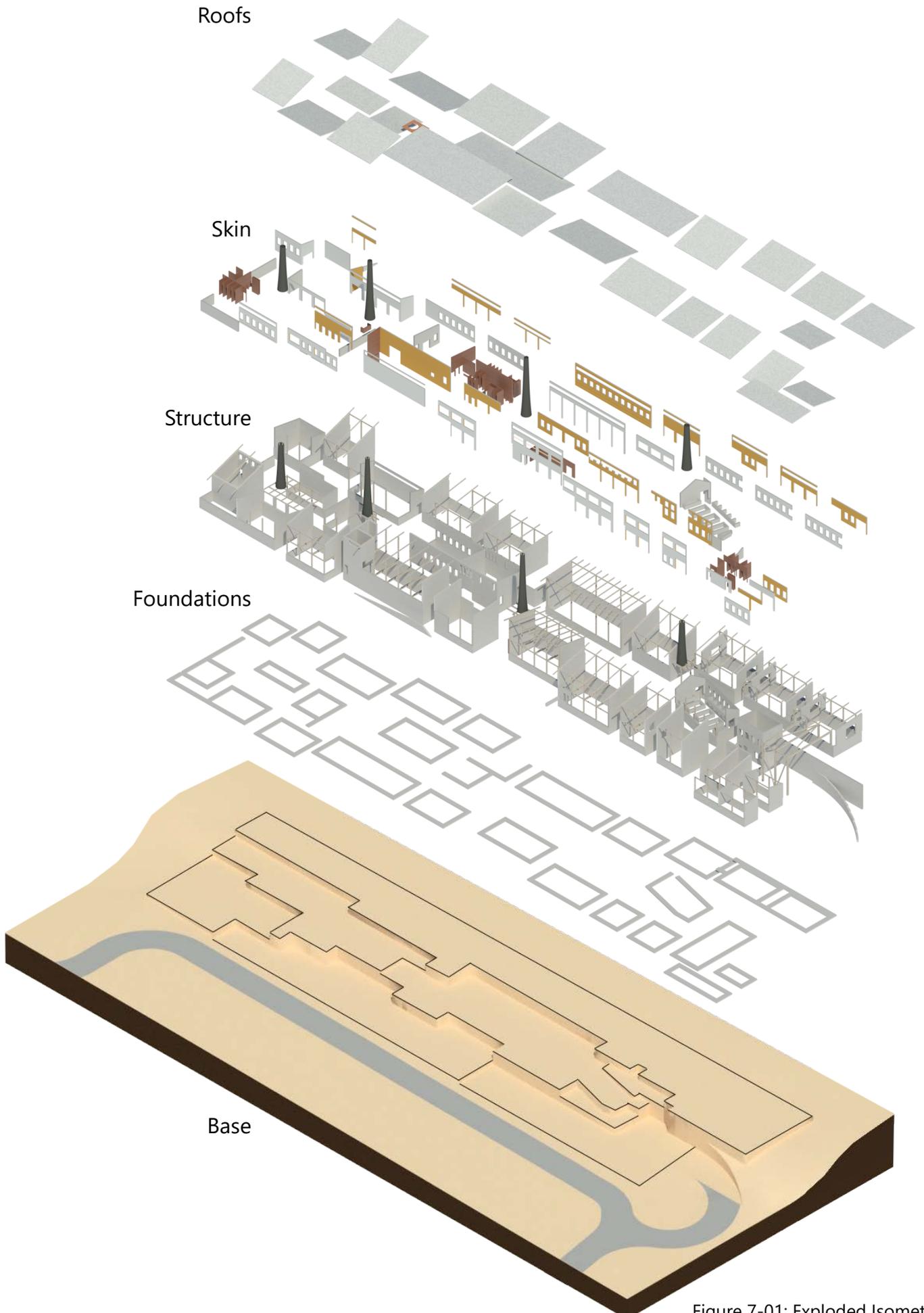


Figure 7-01: Exploded Isometric

## Access and Routes

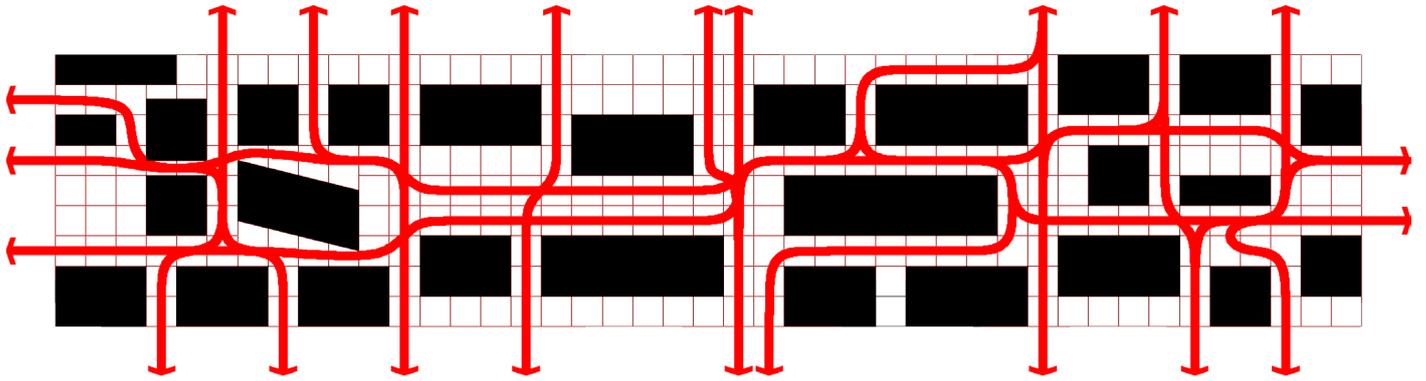


Figure 7-02: General Routes

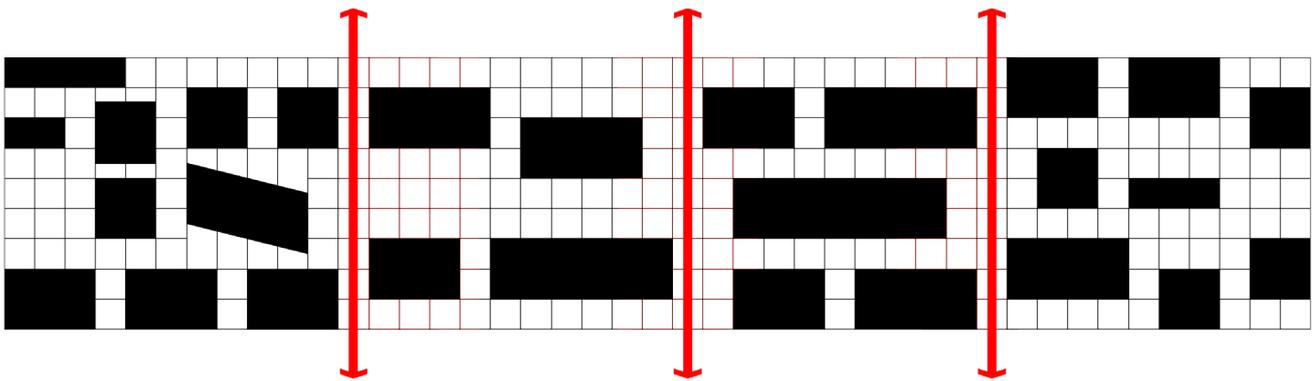


Figure 7-03: Cross Routes

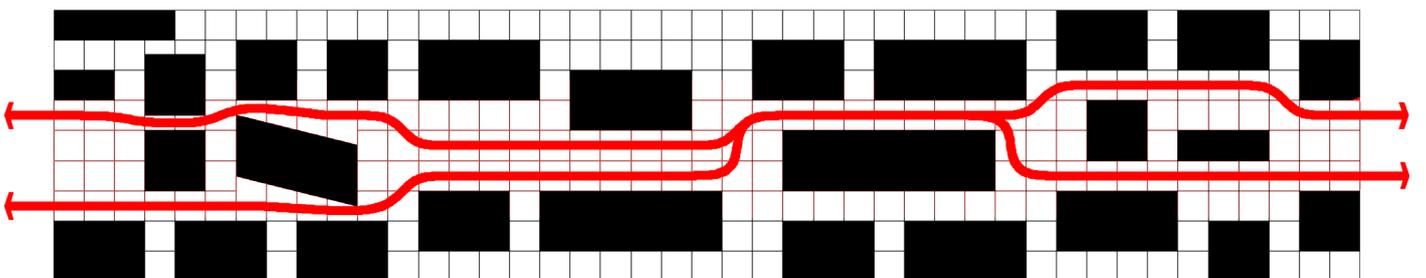


Figure 7-04: Lateral Routes

### **General Routes**

Most of the pedestrian movement would happen through the shorter routes of the site. Only persons visiting multiple industries would use the lateral routes. This means that people would usually walk less than 50m from the road to the industry itself.

### **Access Control**

Access control on the site would not be as tightly monitored as in regular industrial areas (Honeywell, SA:XI). With all the industries opening up to the public realm, community surveillance (Jacobs, 1961:36) would be integrated into the functioning of the site. At night, access gates would be locked on the most distant access routes, with the primary cross routes remaining open till a later hour.

### **Material Routes**

Due to the nature of the industrial programme (namely catering to light and medium industry) most materials and goods would not be too bulky or heavy, and could be carried by hand up the various stairs. Almost all buildings have short access routes to the road or the station, allowing for the easy transport of light and small materials and goods.

For bulky or heavy items, a ramp way is provided. A forklift could navigate the ramp way, but the bulkiest items would purposely not fit (see page 44). This is to encourage industries that are making larger items to move into more appropriate facilities.

### **Emergency Access**

#### **How do people get out?**

The nature of the site allows any person to get out of any building within seconds (Levine & Norenzayan, 1999:190). Furthermore, the site has multiple routes for avoiding any area, which means that evacuation is an easy process.

#### **How do emergency personnel get in?**

Fire hydrants are provided at five points on the street side of the site, and two additional ones on the platform side. Additionally, the general access routes provide access for any medical and security personnel, while patients and equipment could be brought up via the ramp (see page 44).

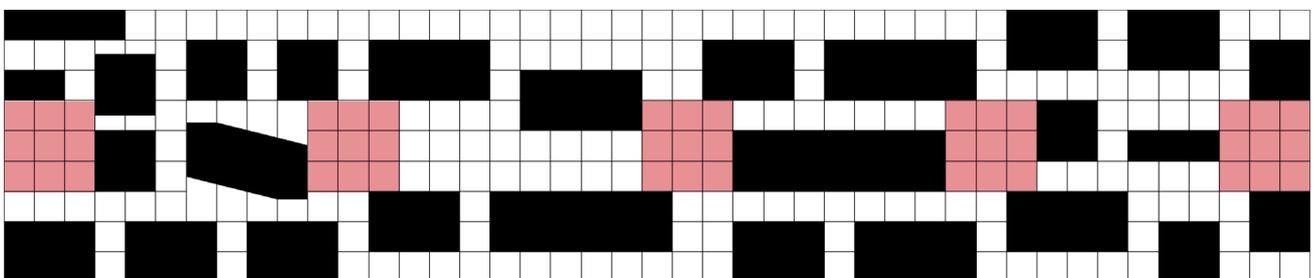


Figure 7-05: Public Squares on Plan

### **Fire Safety**

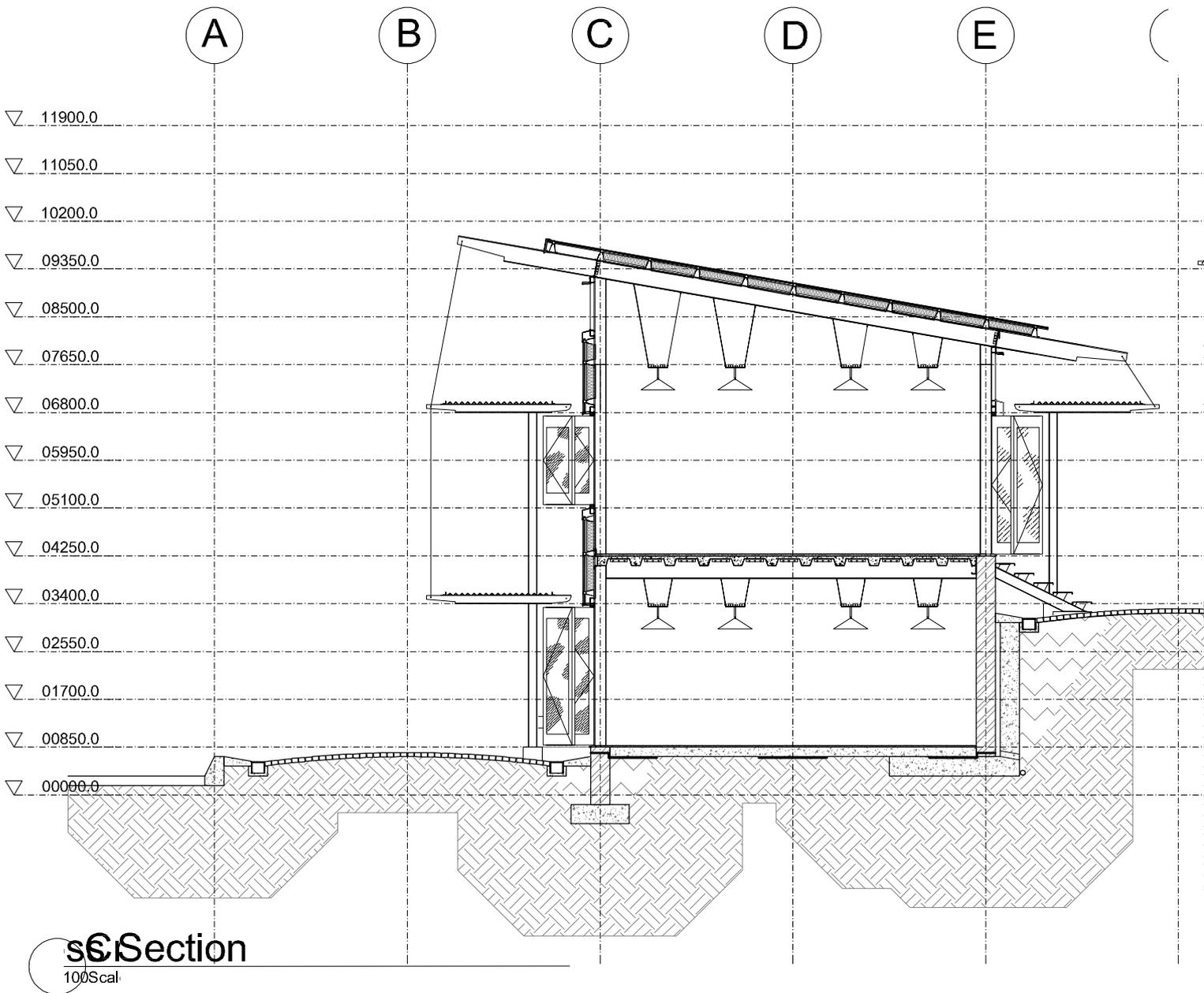
The separations of the buildings aids fire fighting. This is because each building is self contained and unconnected to any adjacent buildings, while providing circulation and access for emergency crews all around. No part of the building is cut off from emergency access.

### **Public Squares**

The public squares have a base size of 3 by 3 modular units. This reinforces the idea of the Cardo and Decumanus (Kostof, 1991:191-192), usually running through the central square of the 3. Furthermore, it relates to the forum, being defined as a square set about the interaction of the two roads (Kostof, 1991:192).

By maintaining these squares, without people building on them, the site has to develop more naturally, with buildings ending on or running past the corners of the square. This relates back to the aesthetic rule of breaking the monolith (see page 21). It creates a non-regular layout for the buildings, and provides an exciting user experience.

## Section



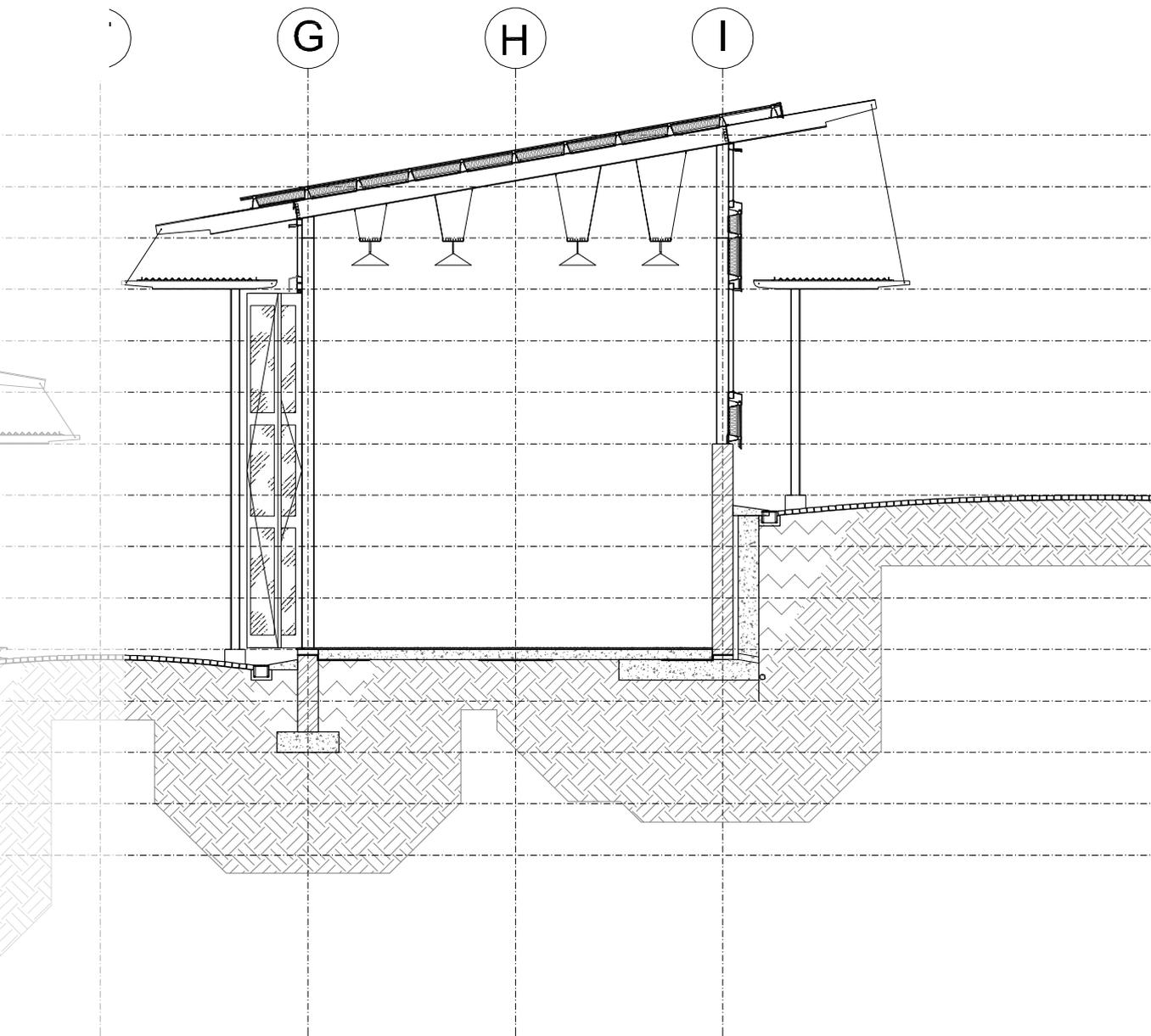
### Roof Plane

The roof plane itself is derived from the industrial precedents in Mamelodi (see page 11). It presents a plain, simplistic plane as a covering feature, and covers the main working area of that part of the industry.

### Profiled Rafters

Profiled rafters stick out beyond the edges of the roof plane, and serve several functions. Firstly, they provide for the possibility of the roof plane being expanded, should the programme require it. Secondly, they provide a connection point from which to suspend some of

the weight of the additional shading devices. Thirdly, they provide an ordering aesthetic, by being located at regular intervals (see page 21). They are aligned to the grid and provide a clear, external expression thereof. The columns are almost always hidden on the interior, and don't express the grid externally.



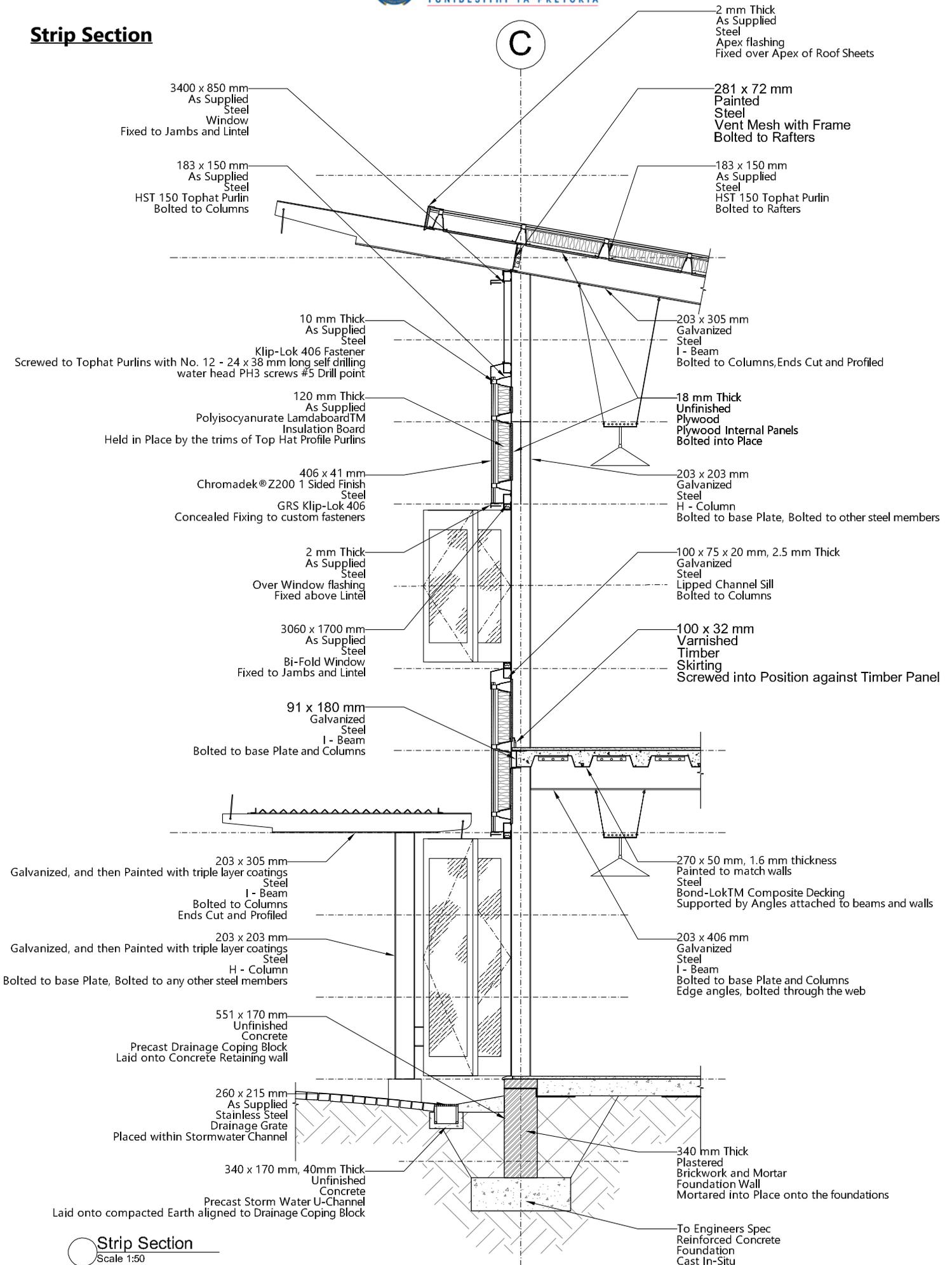
### **Modular Stair Units**

The stairs are constructed from steel, and are bolted into position. Should a building adapt or move, the staircase could come with it.

The steps are consistently 170mm high. With level separations every 850mm, 5 risers are located between each level. This also relates back to the modular units.



# Strip Section



Strip Section  
Scale 1:50

Figure 7-07: Perimeter Section

## Details

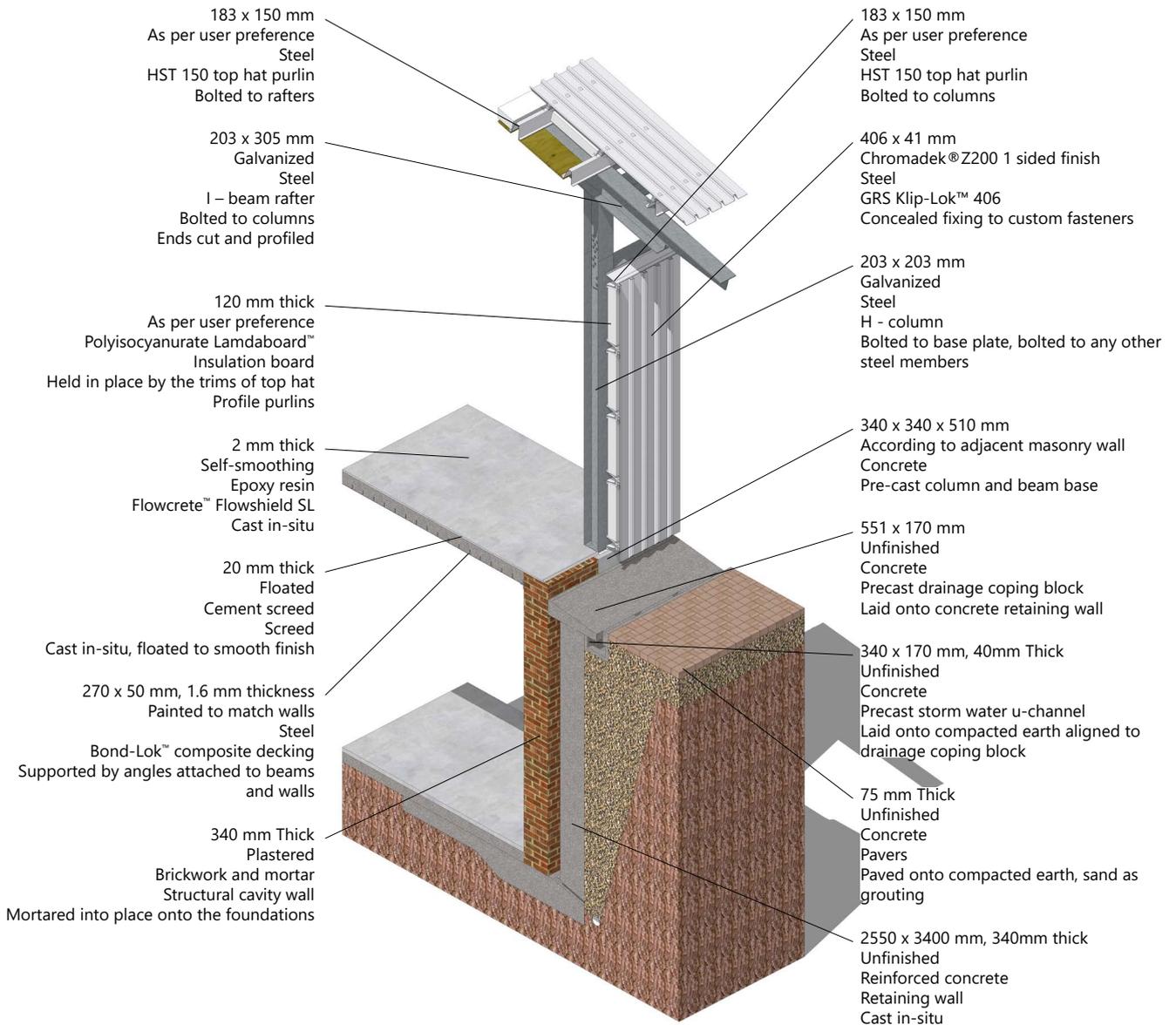


Figure 7-08: Detail Strip Section 3D

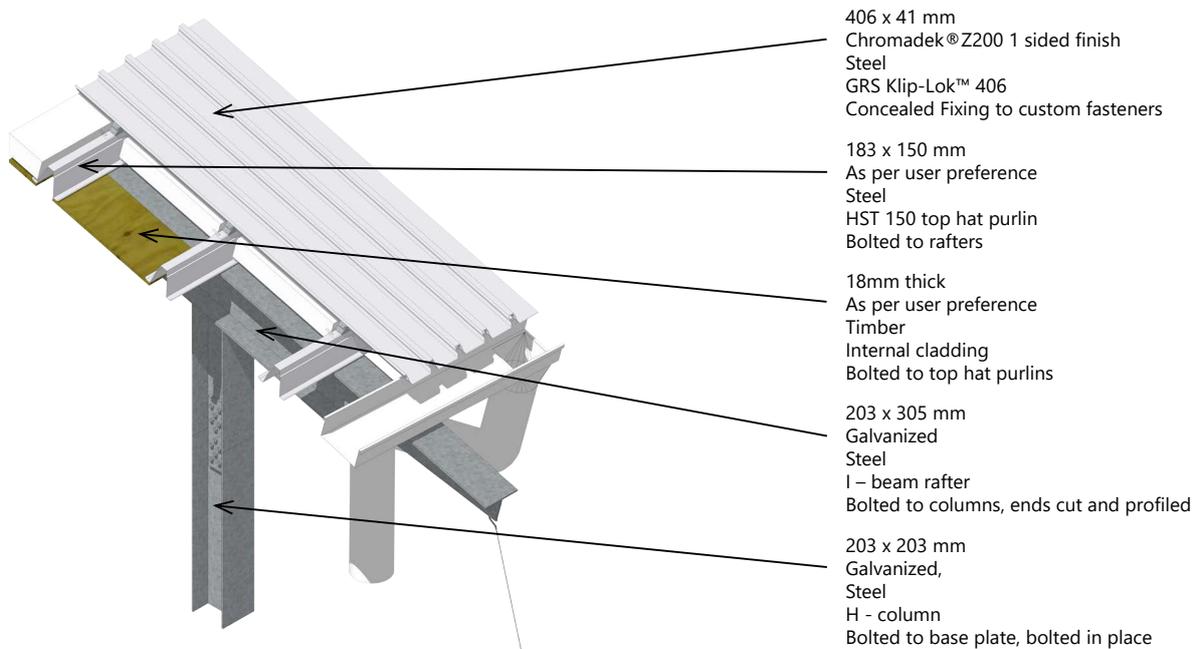


Figure 7-09: Rafter and Column Connection 3D

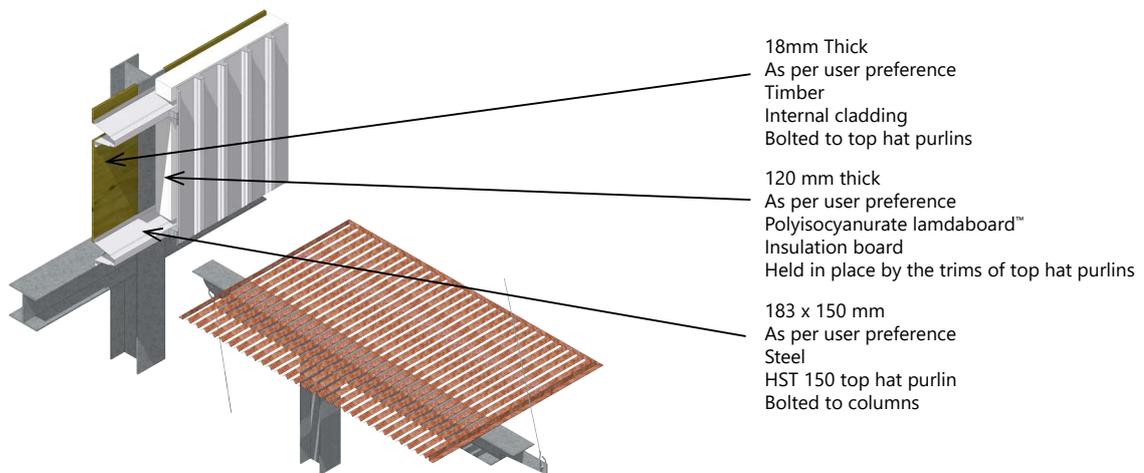


Figure 7-10: Shader and Lintel 3D

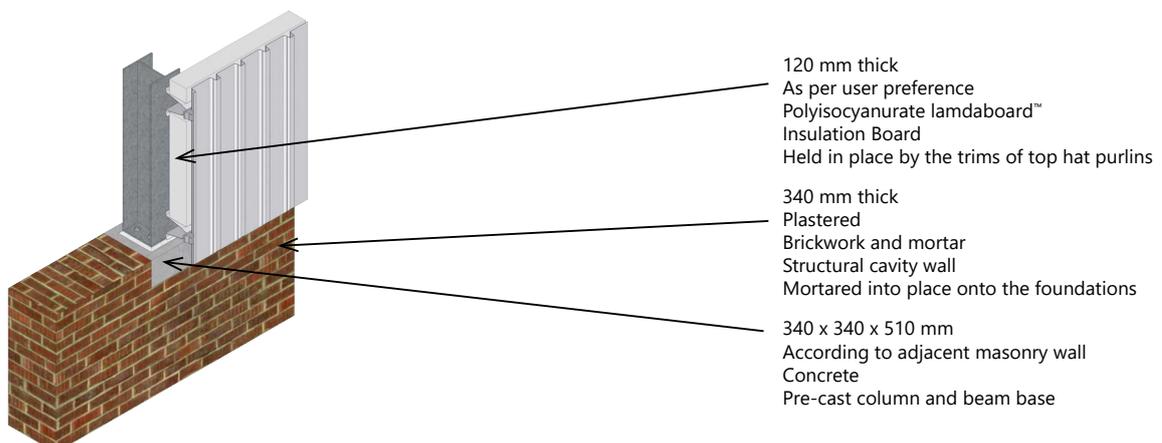


Figure 7-11: Column Base Connection 3D

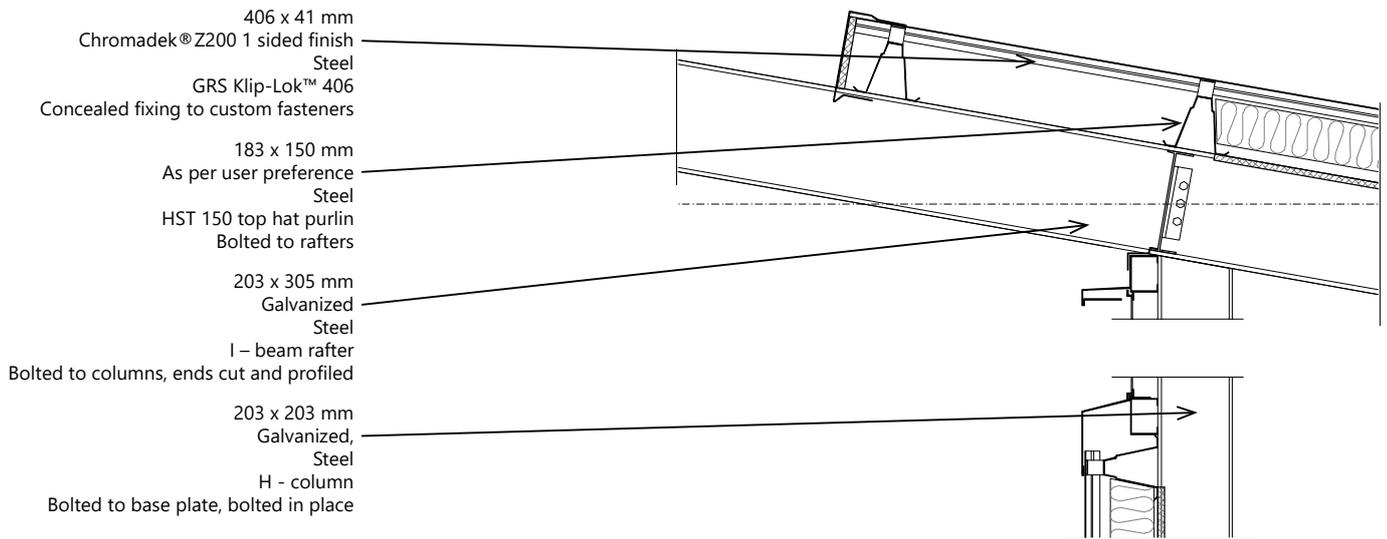


Figure 7-12: Rafter and Column Connection 2D

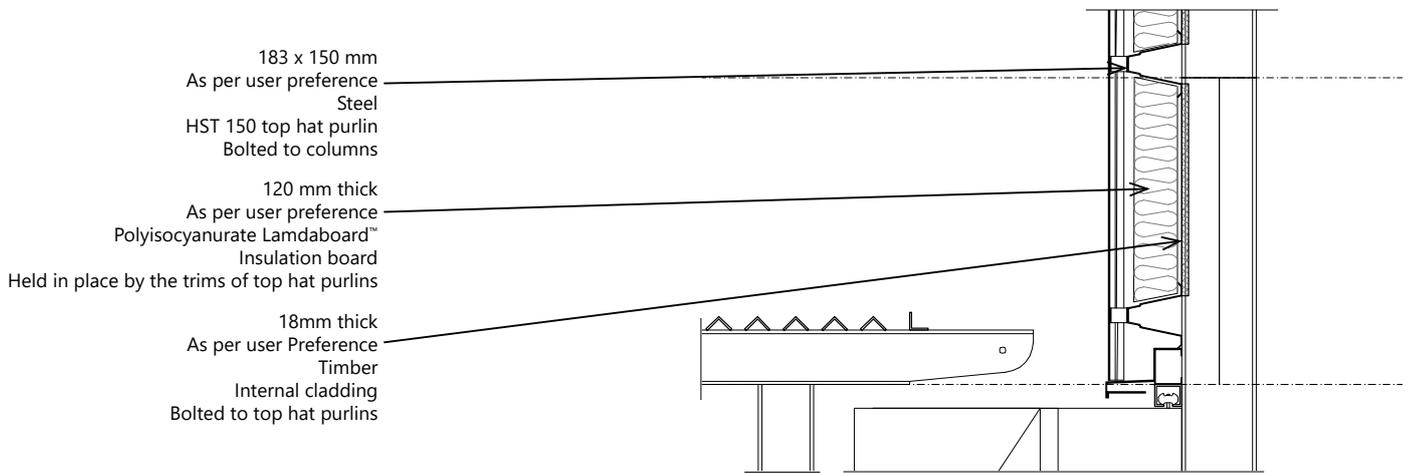


Figure 7-13: Shader and Lintel 2D

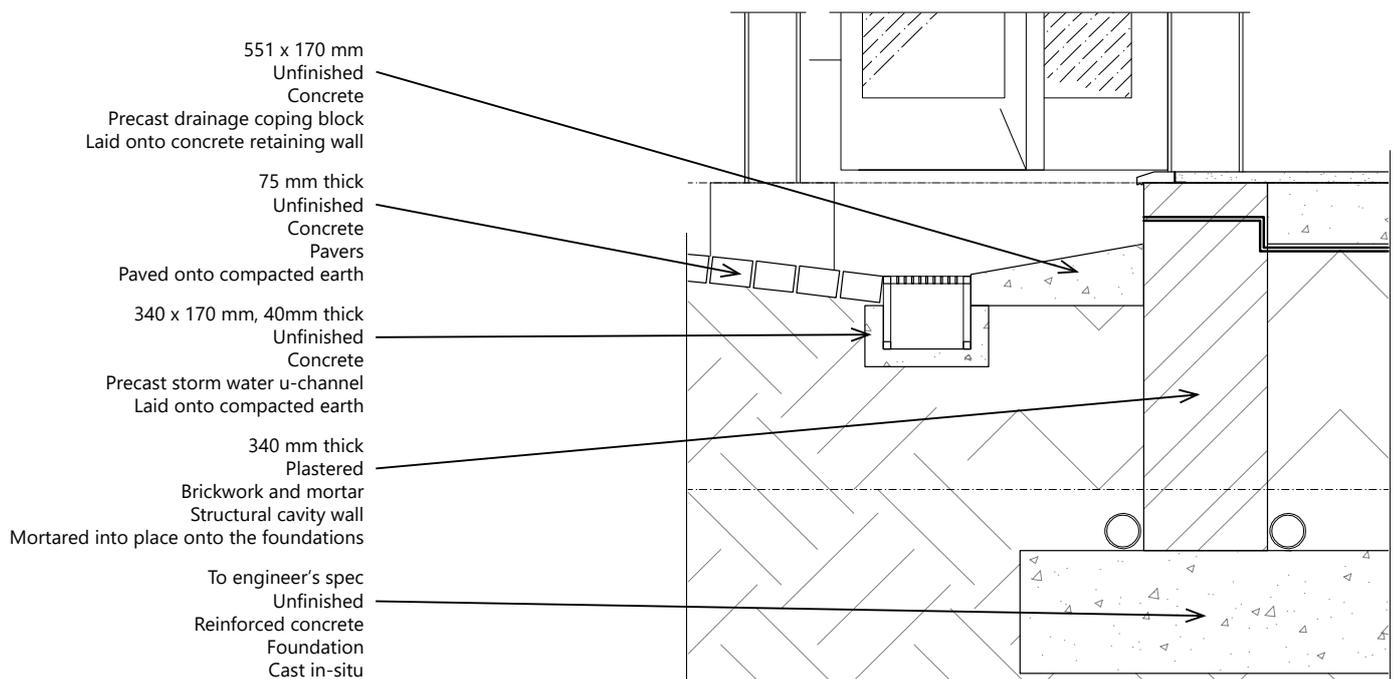


Figure 7-14: Column Base Connection 2D

## Services

The services are designed to function with a high degree of redundancy and resilience (see page 28). There are 9 separate runs running along the 9 grids lengthwise on the site, with each acting independently of the others. This redundancy in turn fosters resilience. Should any run experience a catastrophic failure, all the other runs remain functional (see page 28).

Furthermore, seeing as most buildings span over two bays, no building is left completely incapacitated by a catastrophic failure in a single run.

The black water sewerage lines do not follow the general runs of the site, because they are isolated to the three bathroom structures on the site. In so doing, the rest of the runs may go underneath buildings, subject to SANS10400 Part P-2, subsection (2a). It states that the regulations will be deemed to be satisfied if the system is subject to an acceptable rational design by an professional engineer or approved competent person.

However, in order to ensure the system could remain functional in constrained conditions, the services are designed for much larger loads. This would ensure that the systems would have ample capacity beyond the design load.

To further decrease the likelihood of maintenance, the systems would use high quality materials and systems through-

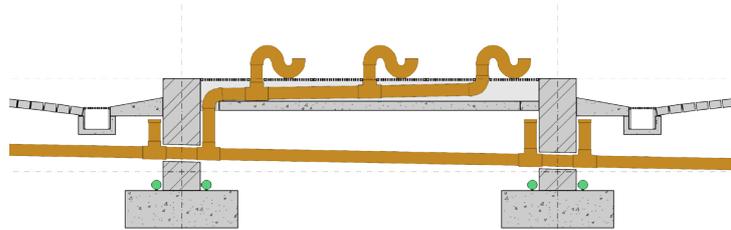


Figure 7-15: Gray Water Sewerage Drainage and Runs

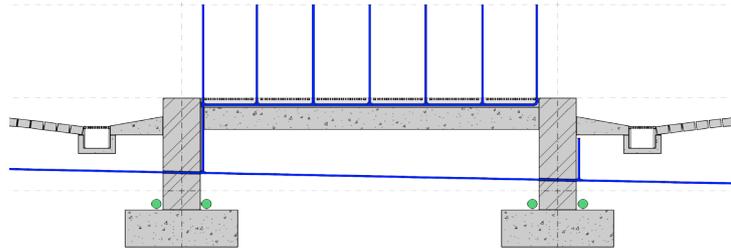


Figure 7-16: Water Supply and Runs

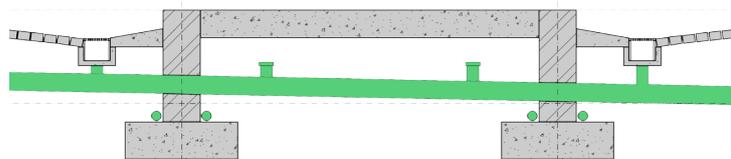


Figure 7-17: Storm Water Drainage and Runs

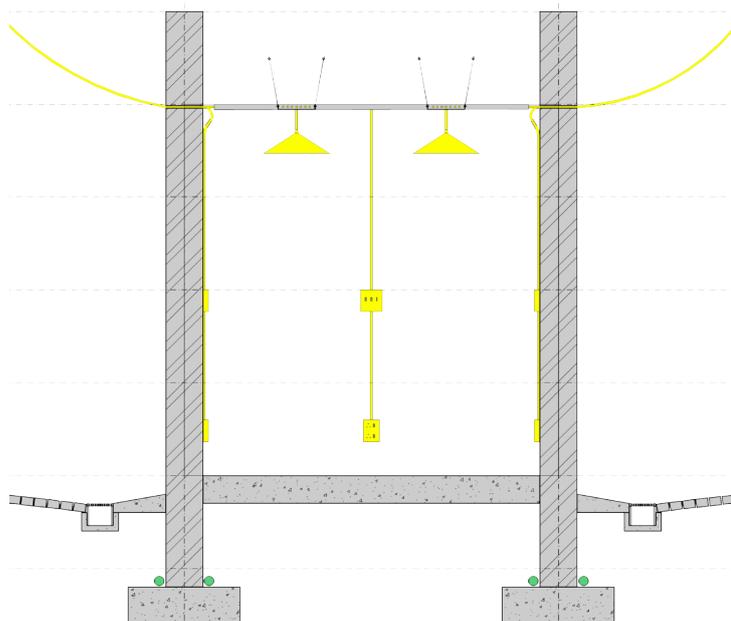


Figure 7-18: Electrical Conduits and Runs

out, especially where services are inaccessible. This decreases the chances of the systems requiring maintenance that would require the demolition of built works

Unused services must be available for future expansion and development. This translates into capping or covering unused connections for a later date.

Each service is conveyed into and through the buildings by different means. Electrical cables as well as lighting and telephone lines would make use of cable trays. Fire suppression systems would be suspended from the rafters separately, while other water supply systems would either make use of floor channels or walls. Gray water sewerage would also make use of floor channels, for quick and easy access, with stainless steel grates as coverings.

This system thus allows the buildings and site to adapt. Every location has all the services available, making the site much more versatile.

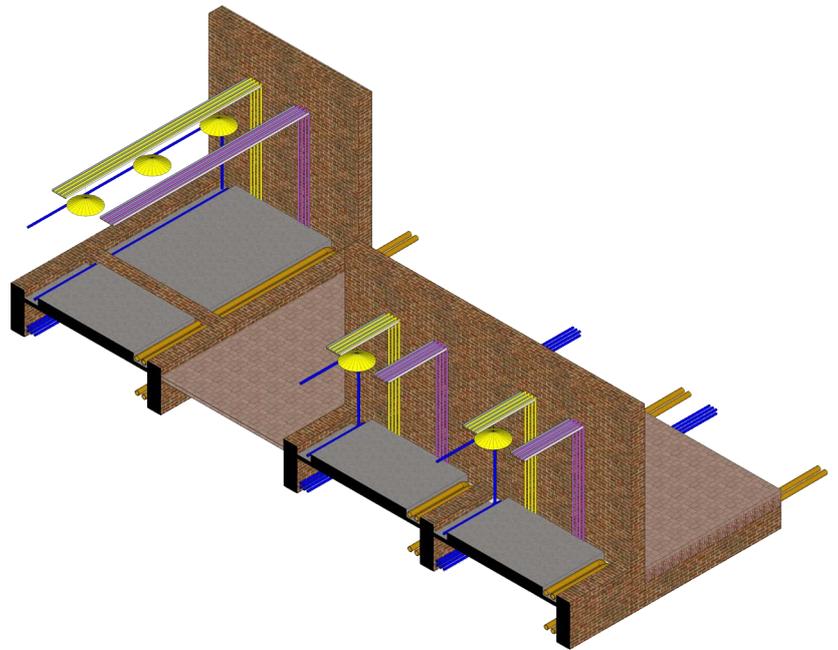


Figure 7-19: Conceptual Service Run 3D

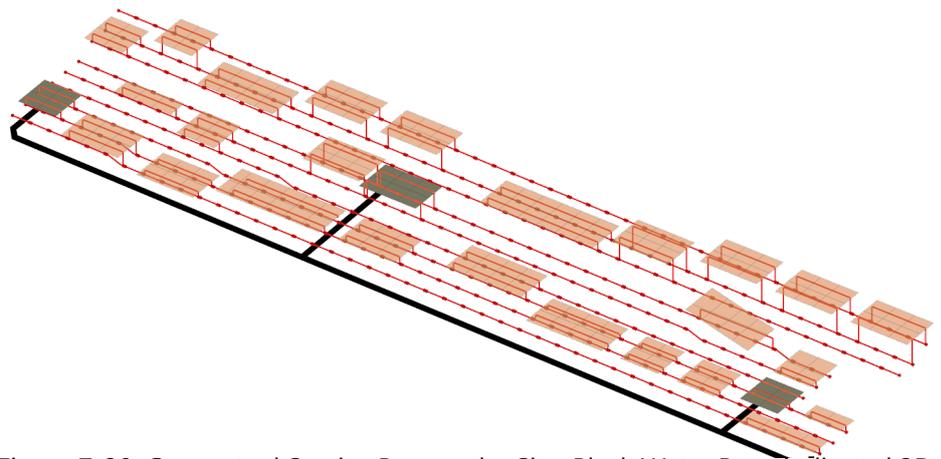


Figure 7-20: Conceptual Service Run on the Site, Black Water Runs indicated 3D

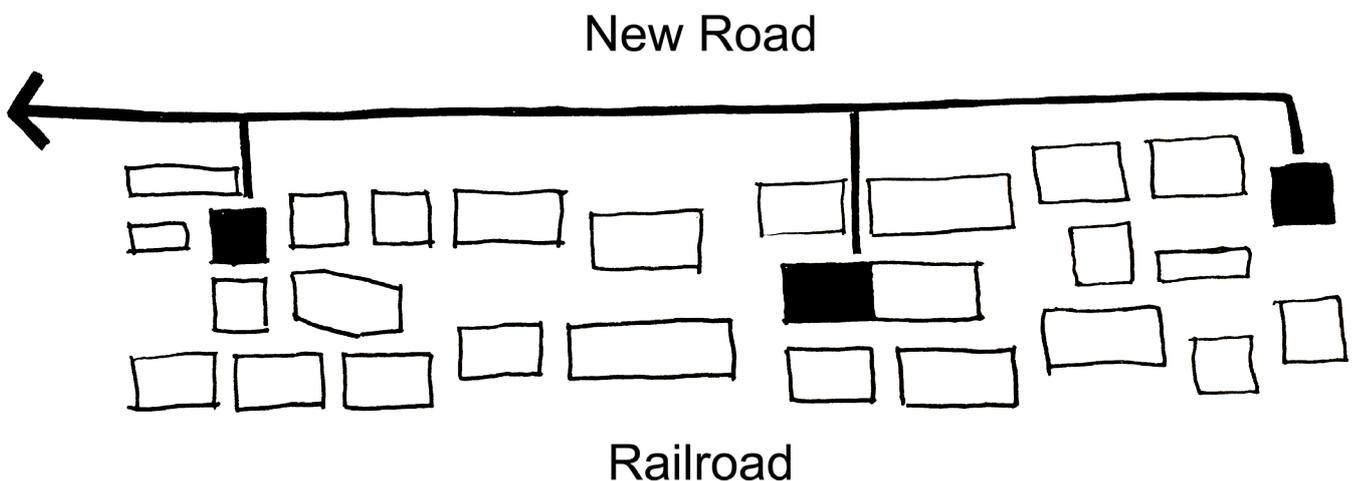


Figure 7-21: Black Water Sewerage Runs Diagram

## Chimneys

Situated on four of the five public squares, the chimneys are inserted to create thermally comfortable (see page 91) points by encouraging airflow. The efficiency of such a chimney determines the size of this comfort point. As a secondary benefit, the chimneys serve as landmarks and aesthetic ordering devices. They mark the location of the public squares and aid on-site navigation.

The chimneys are tall compared to nearby features. They stand at 13600mm and 17000mm above relative ground level. The structural base consists of an I-beam curved into a circle with a centre to centre diameter of 2000mm. Bolted to this, four I-beams extend upwards, tapering so that their tips are 800mm apart, centre to centre. Steel sheeting is riveted to the flanges of these near vertical I-beams. Where the sheets overlap, they are welded together, creating large seams visible from ground level. Each chimney would be manufactured from a different grade or colour steel, in order to identify them better.

This chimney would be supported on a bed of I-beams, all of which are bolted to a structure for lateral strength and support. This would help with any wind-shear the chimney may experience, but would require an engineer to secure it properly.

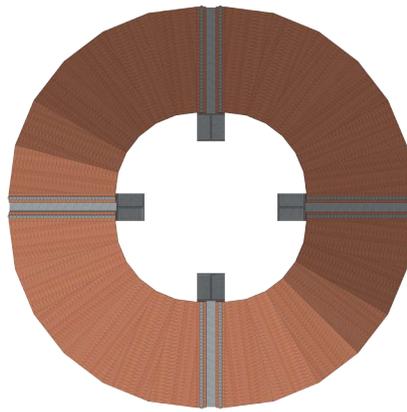


Figure 7-22: Plan

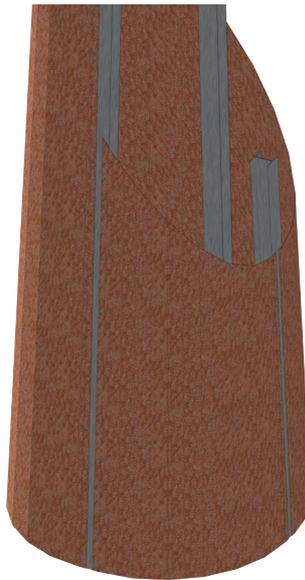


Figure 7-23: Cut Through Detail

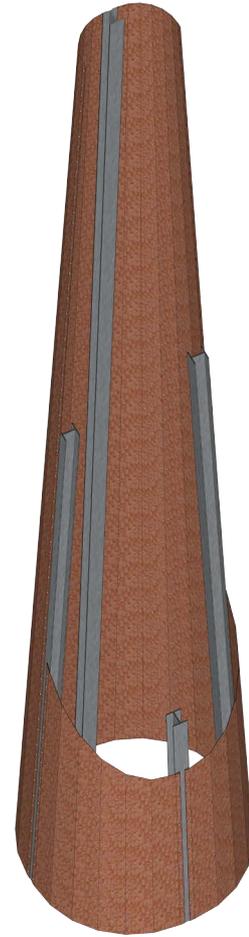


Figure 7-24: Cut through Overall

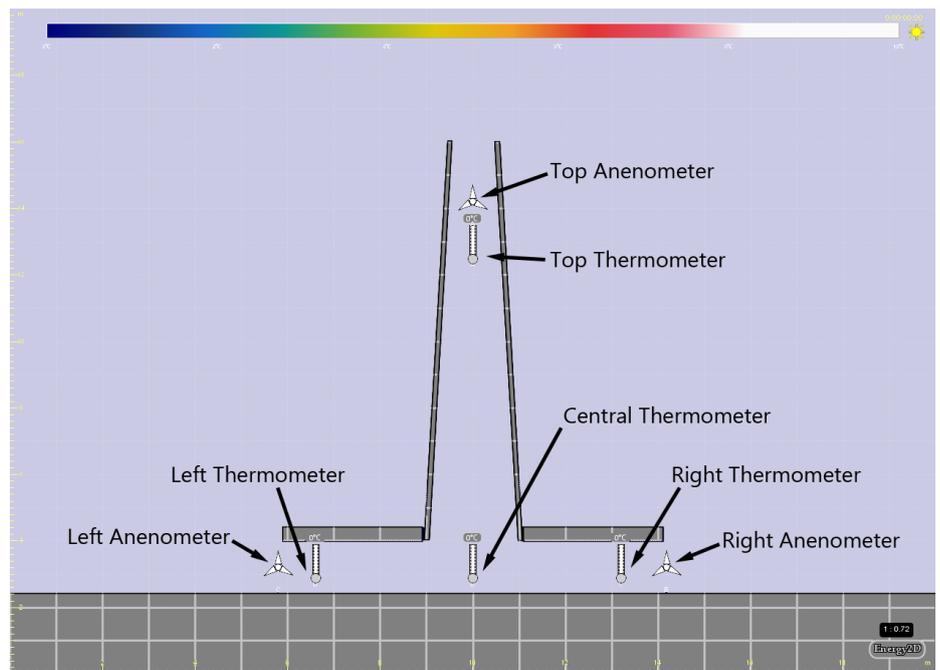


Figure 7-25: Analysis Model Setup

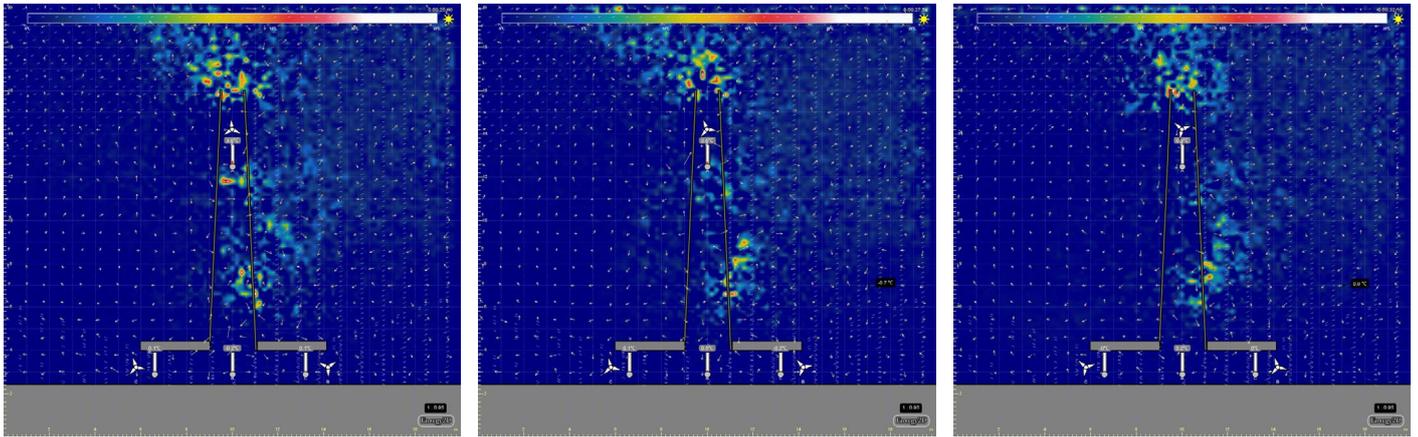


Figure 7-26: Chimney Model at 3 Different Timestamps

Efficiency is maximised through the tallness (Smegal, 2017) of the chimneys and the choice of materials. A taller chimney creates a larger differential between the hot air at the top and the cool air below. Furthermore, the steel sheeting would heat up in the sun due to solar exposure, and would maximise the flow of air.

The chimneys were modelled in the programme Energy2D™ to simulate their efficacy. Although the actual efficiency could not be determined, it was determined that hot air would flow through the chimney. Further simulation and analysis would be required by a specialist to streamline the design.

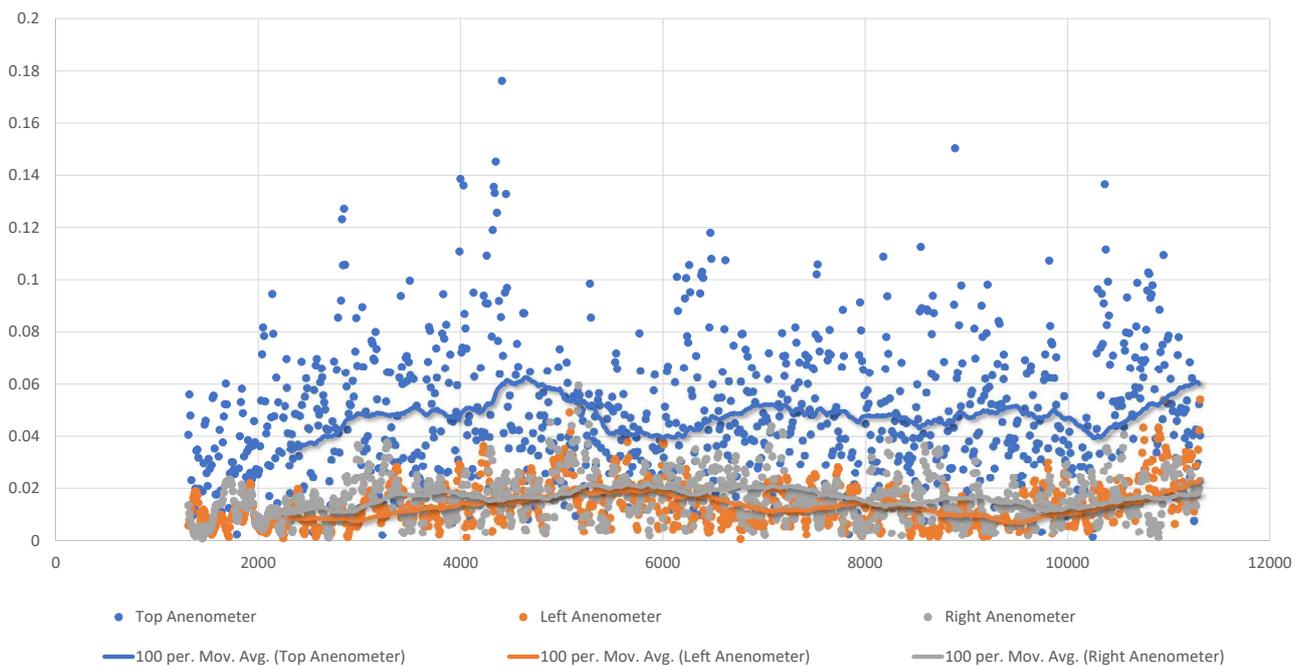


Figure 7-27: Charted Data

## Daylighting

The comfort and usability of an industrial building tends to be simplistic, in that most industries have very high thermal loads (Pinto, 2015:5006).

Comfort in an industrial building is primarily driven by ventilation and daylighting of the building (see page 91). This is because industrial processes and functions often carry a high mechanical heat energy load from machinery, equipment, and tools (Pinto, 2015:5006). This cannot be factored into an adaptable building, and so must be disregarded.

Furthermore, a look at the climate of Mamelodi shows that the ambient temperature is comfortably between 19°C and 28°C for most of the daytime working hours (see page 91). With such a high energy load, the focus for thermal comfort would focus on cooling and shading.

Additionally, by maximising cross ventilation and reducing the solar heat gain through glazed surfaces, the building would remain optimised for industrial processes throughout the year. These must be done while maintaining sufficient daylighting on the usable floor areas.

The buildings aim to remove the need for active ventilation through large doors and window openings as well as vents throughout. Although no current industry requires ventilation, it may be required in the future. This would have to be provided, installed, and maintained by that industry.

To avoid glare and solar heat gain through glazed surfaces, overhangs are provided. 850mm tall windows are provided at the tops of most north and south facing walls, butting up against the roof. Thus, the overhangs directly affect the solar exposure of these windows, and are calculated

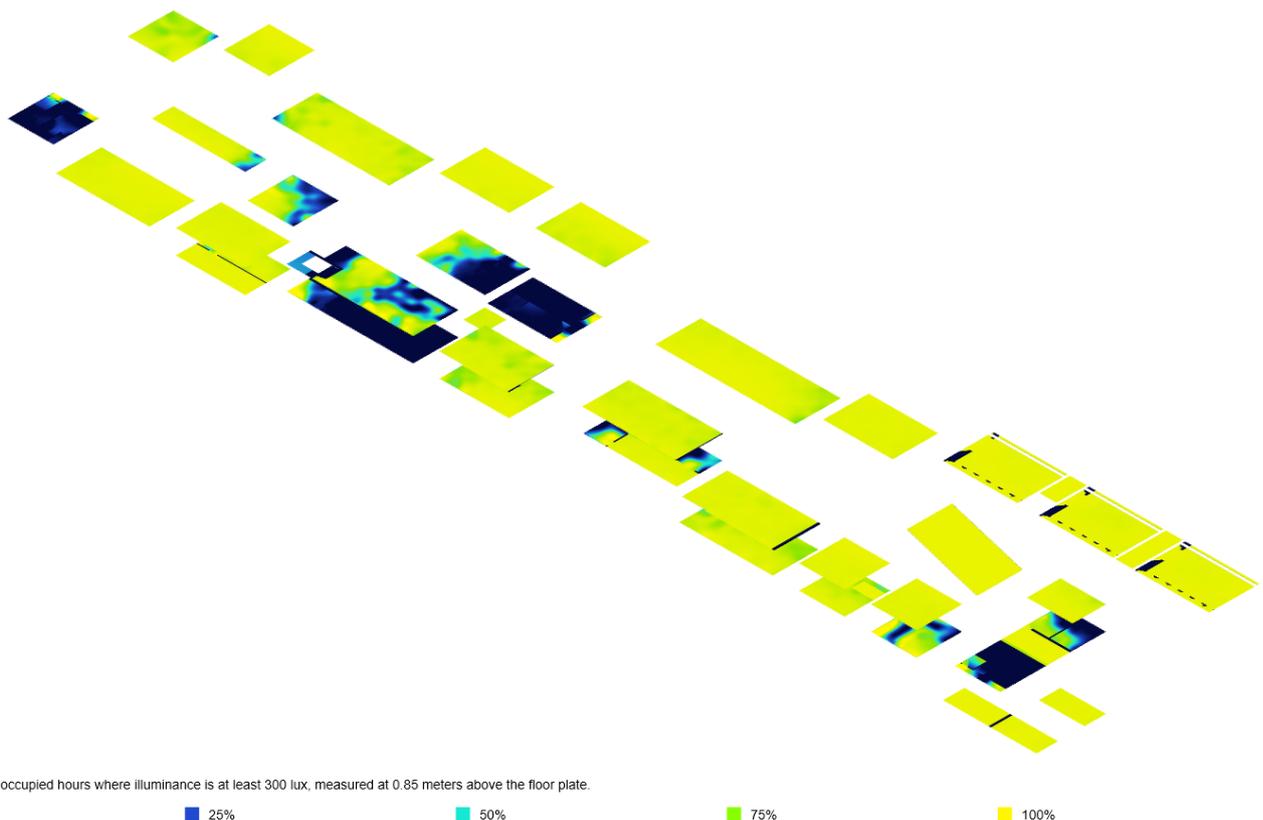


Figure 7-28: Daylighting Analysis from Sefaira™

to cover them optimally. The overhangs extend a total of 850 mm from the outside edge of the walls (but some overhangs may vary according to the specific locations). This would be sufficient in keeping the solar heat gain to a minimum for the majority of the year (see figure 10-29).

Modular shading devices are provided over several doors and windows as well. The devices are discussed in detail later on. In essence, they extend the usable floor area of the workshops into the public space, blurring the threshold between industry and public space.

To verify that all the industrial buildings are properly lit by means of daylighting, the building has been modelled and tested in Sefaira™, an energy and daylighting simulation plug-in for Revit™ and Sketch-up™. When measuring the percentage of working hours that the industrial buildings are properly lit (see figure 10-28), shows that the vast majority of buildings would be well lit for more than 90% of daytime working hours.

This not only showcases the success of the design, but how appropriately it is designed to the climate of Mamelodi.

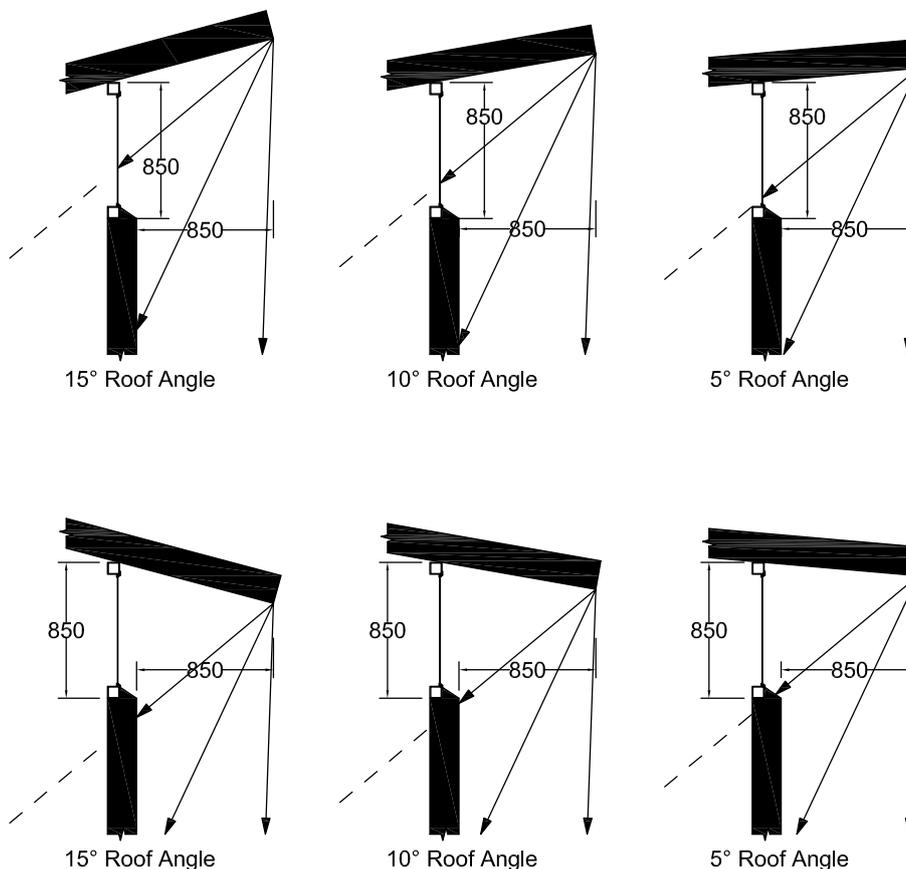


Figure 7-29: Mamelodi Sun Angles for Various Roof Pitches

## Shading Devices

Constructed of steel, the shading devices are allowed to garner a layer of patina. The upright column and horizontal beam (see figure 7-30) serve as a single anchored part, to which the shading screens are connected. The beam is bolted to the column, and the rear is counter anchored to a part attached near the base of the column. The anterior tip of the beam is supported by connecting it with a cable to the rafters of the building, aligned overhead.

The shading slats consist of angle irons mounted inside an angle iron frame. This screen is mounted to the supporting anchors, and spans over a single and sometimes a double bay. The screens are bolted to the supporting anchors.

These designs are fairly material heavy, but would be slimmed down with the input of a structural engineer for a sleeker design.

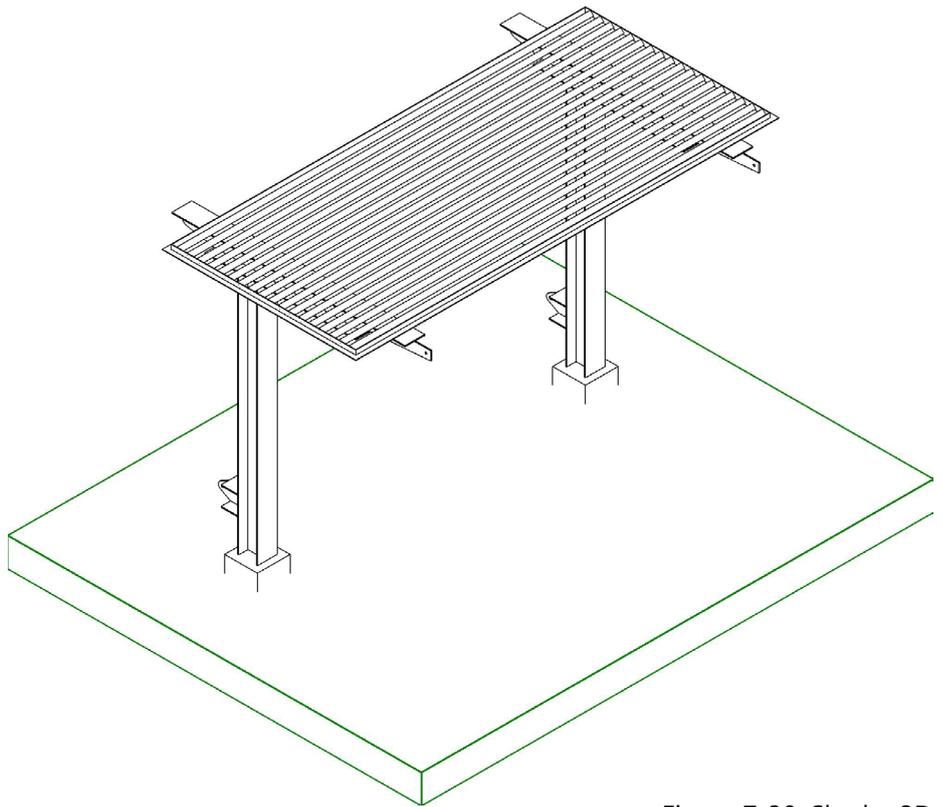


Figure 7-30: Shader 3D

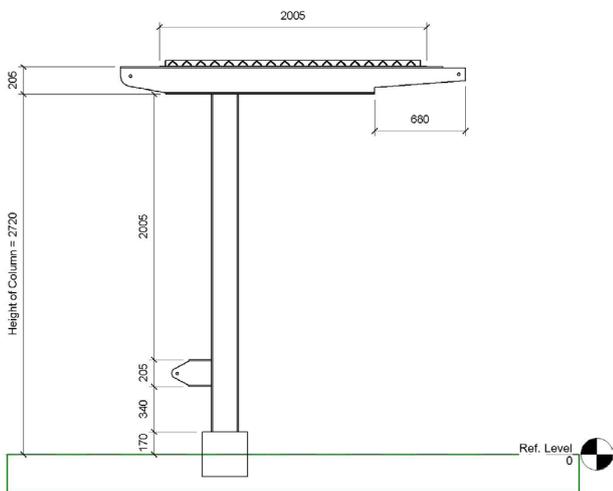


Figure 7-31: Shader Side Elevation

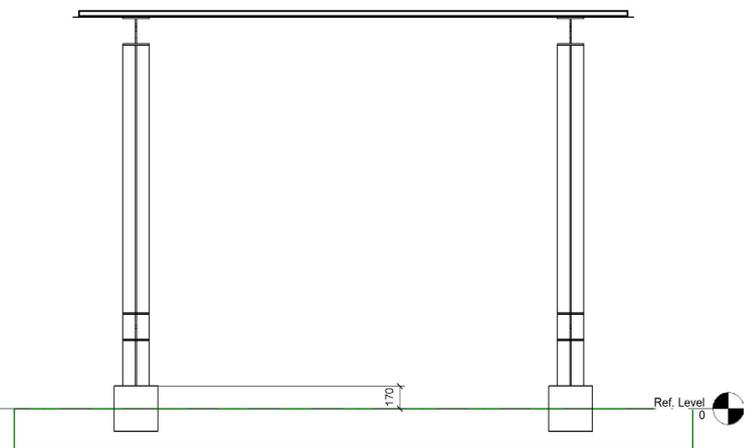


Figure 7-32: Shader Front Elevation

**Adaptability**

The adaptability of the site addresses an issue identified in Mamelodi, namely, the lack of capacity for growth (see page 8). Without space or easy ways to expand, industries are limited and do not grow.

The site provides rules and guidelines for expansion, along which buildings may be expanded. This ensures that all expansion is modular and easily adaptable to the needs of the users.

The expansion following a modular also means that buildings use the same materials. Should another building be disassembled at the same time as construction is happening, the same materials may be utilised.

This brings the site in line with the theory of functionalism (see page 9), in that the form of the building is a direct result of its function.

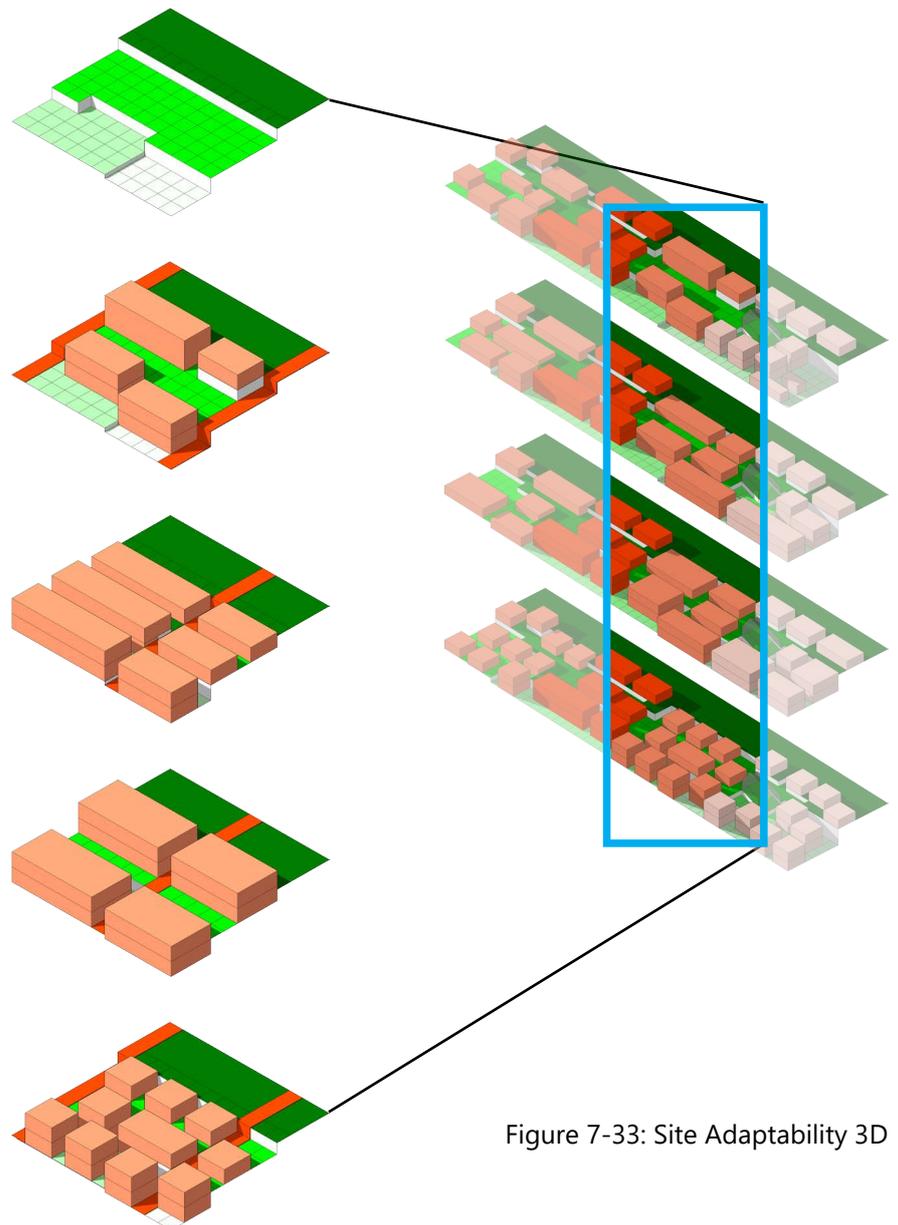


Figure 7-33: Site Adaptability 3D

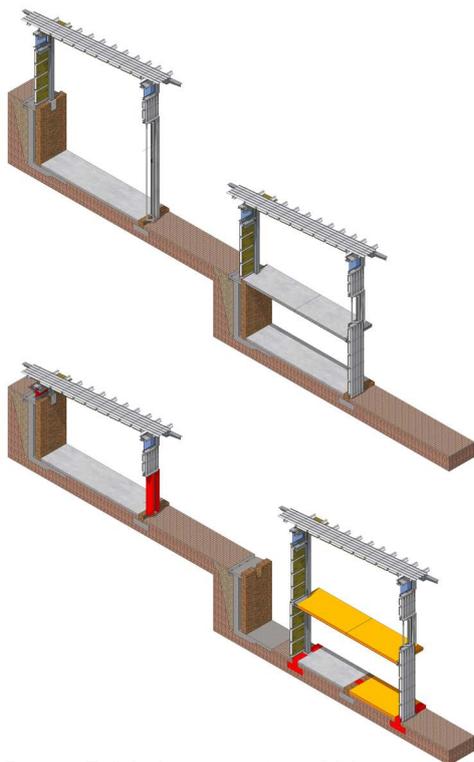


Figure 7-34: Adaptability of Materials 3D

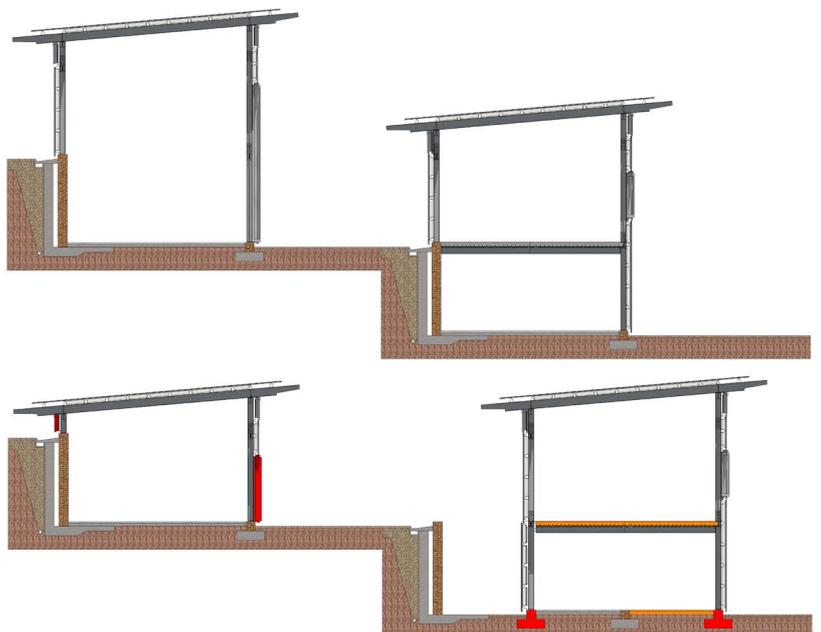


Figure 7-35: Adaptability of Materials 2D



## Conclusions

The spatial conclusions that become apparent in this is that the spaces between the buildings become as, if not more, important than the buildings themselves. The interaction between public and private is an opportunity, either to emphasise or blur the edge.

Furthermore, the most successful spaces on the site are those that engage with an active public square. Note should be given to ensure that less important spaces are further away from such nodes. However, one way to solve this as well is to have multiple, smaller public spaces, rather than focusing all the energy on a large singular space.

In terms of solving the problem posed by the lack economic opportunities, this building would be successful. However, some shortcomings would definitely be that it is very labour intensive to adapt a space to a new configuration, but that the savings would come from not needing new materials. Furthermore, it is rather easy to change or adapt spaces on a whim should the need arise for the industry.

The space does however create intimate yet robust spaces that small businesses could use as they require, and the centrality and adjacency to the station would connect any tenant much better to resources and markets.

Lastly, the shared communal spaces and functions would allow these industries to have better facilities at a lower cost and upkeep, increasing profitability and competitiveness. The buildings themselves would be functional, but contain no exceptional or unusual features that may confuse builders or future tenants, and the parts are easily replaceable, by comparison to other structures.

The services would have a large redundancy score, but would also ensure that should a problem occur along one line, no other lines would be adversely affected. Thus, even a catastrophic failure of one line of services would not disrupt work in any space not directly linked to that line.

Additionally, the modular nature of the services make them easy to connect to or disconnect from, as well as to replace. This complex of buildings would be ideally suited for multiple, medium industries, and would remain resilient in a plethora of challenges.

Thus, the building achieves solutions to the challenges Mamelodi industries face. It has the capacity for industries to grow. It groups and shares otherwise costly resources to the benefit of the industries. It provides a central and connected location, with a railway and road link, to the benefit of the industries. All these provisions will aid in the growth of industries and therewith the economic empowerment of the residents of Mamelodi.

## References

- Adobe® Indesign® CS6, Version 8.0, 2012
- Adobe® Photoshop® CS4, Version 11.0, 2008
- Autodesk® AutoCAD® 2018, Version O.49.0.0, 2017
- Autodesk® Revit® 2018, Version 18.1.0.92, 2017
- Alberti, LB, 1485, *The Ten Books on Architecture*, as printed by Owen, E, 1755, London: 654
- Arnheim, R, 1977, *The Dynamics of Architectural Form*, Los Angeles, University of California Press, Publisher: 254-257
- Awan, N, Schneider, T. & Till, J., 2011. *Spatial agency: other ways of doing architecture*, London: Routledge.
- Bekker HD, Biermann SM, Stiff JS, Vosloo L, Wolhuter KM 2005. *Guidelines for Human Settlement Planning and Design*, Council for Scientific and Industrial Research, Captur Press, Pretoria, Ch. 5.5, Pg. 10-13
- Berg, RJ, & Whitaker, JS, 1986, *Strategies for African Development*, Los Angeles, University of California Press: 279-315
- Burger, M, 2010, *Bibliographic Style & referencing techniques*, Pretoria, UNISA Press: 29-96
- Cawker, G & Whiteford, A, 1993, *Confronting Unemployment in South Africa*, Pretoria, Human resources council: 8; 37; 47; 53; 106;
- Climatemps.com , 2017, *Pretoria Climate & Temperature*, <http://www.pretoria.climatemps.com/> Accessed 19/12/2017
- Curtis, WJR, 1996, Ed. 3, *Modern Architecture since 1900*, London, Phiadon Press.
- Davies, N & Jokiniemi, E, 2008, *Dictionary of Architecture and Building Construction*, Oxford, United Kingdom, Elsevier: 184
- Xie, C, 2017, *Energy2D®*, Version 2.9.6, Boston, Massachusetts Institute of Technology

- Dobbs, R & Remes, J, 2011, *What's the biggest limit on city growth? (Hint: it's not steel or cement)*, [SL]: Mckinsey & Company. (Accessed 2017/04/07 <http://www.mckinsey.com/global-themes/urbanization/whats-the-biggest-limit-on-city-growth>)
- Farelly, L, 2007, *The Fundamentals of Architecture*, Switzerland, AVA Publishing SA: 156
- Findley L, Ogbu L, 2011, South Africa: From Township to Town, in *Places Journal*, November. <https://placesjournal.org/article/south-africa-from-township-to-town/> [Accessed 03/04/2017]
- Frampton, K, 1981, Towards a Critical Regionalism: Six Points for an Architecture of resistance, in *The Anti-Aesthetic: Essays of the Postmodern*, editor Foster, H, 1983, Seattle, Bay Press: 16-30
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: Census 2011 population and household totals per SAL, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: COMBINED SCHOOLS, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: Clinics2014, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: Gauteng Public Health Facilities 2014, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: Healthcentres2014, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: INDUSTRIAL AND COMMERCIAL LAND COVERAGE, <http://map.mapable.co.za/> , [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: INTERMEDIATE SCHOOLS, <http://map.mapable.co.za/> [Accessed 2017/02/23]

- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: PubHospitals2014, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: PRIMARY SCHOOLS, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: PubHospitals2014, <http://map.mapable.co.za/> [Accessed 2017/02/23]
- Gildenhuis B, Badenhorst W, du Toit J 2017. *MapAble™*, Dataset: SECONDARY SCHOOLS, <http://map.mapable.co.za/> , [Accessed 2017/02/23]
- *Google Earth® Pro 7.1.2.2041*, Program Published 2013, Imagery Date 29/08/2016
- Gropius, W, 1919, *Bauhaus Manifesto and Program*, Staatliche Bauhaus, Weimar
- Honeywell, SA, *Honeywell Security Catalog*, Honeywell, Pg. XI-XII
- Hofstee, E, 2000, *Constructing a Good Dissertation: A Practical Guide to Finishing a Master's, MBA or PHD on Schedule*, Johannesburg, EPE
- Howard, E. 1902;1906 2nd Ed. *Garden Cities of To-Morrow*, Swan Sonnenschein & Co, London, Pg. 126-140
- Jacobs, J. 1961, *The Death and Life of Great American Cities*, Random House, New York
- Krige S, Donalson R, 2000, *Spatial Transformation in the Post-Apartheid Era – South Africa: a Website course in Social Economic and Political Geography – An International Educational Project*, Ministry of the Flemish government Department of Education, [https://www.impulscentrum.be/south\\_africa/mod3\\_city/theo3.asp](https://www.impulscentrum.be/south_africa/mod3_city/theo3.asp) [Accessed 2017/03/06]

- Krufft, HW, 1985, *A History of Architectural Theory: from Vitruvius to the Present*, 1994, Translated by Taylor R, Callander E, Wood A, Phillip Wilson Publishers, London
- Lamprakos, M, 1992, *Le Corbusier and Algiers*, in *Forms of Dominance*, AlSayyad, N, Sydney, Avebury: 183- 210
- Le Corbusier, S.A, Ed. 13, *Towards a New Architecture*, translated by Etchells, F, 1931, London, Rodker Publishers: 11, 21-29, 43-64, 105-127, 134-135
- Levine RV, Norenzayan A, 1999, The Pace of Life in 31 Countries, in *Journal of Cross Cultural Psychology*, Washington State, Western Washinton University, (30-2):190
- Levy DK, Comey J, Padilla S 2006, *IN THE FACE OF GENTRIFICATION: Case Studies of Local Efforts to Mitigate Displacement*, Washington DC, Urban Institute. Pg. 1-2. Sourced from <http://www.urban.org/sites/default/files/alfresco/publication-pdfs/411294-In-the-Face-of-Gentrification.PDF> [Accessed 2017/01/15]
- Loos, A, 1913, Ornament and Crime, *Cahiers d'aujourd'hui* (5):19-24
- Lynch, K., 1960, *The Image of the City*, Cambridge, MA: The MIT Press.
- Manzano-Agugliaro F, Montoya FG, Sabio-Ortega A, Garcia-Cruz A, 2015, Review of bioclimatic architecture strategies for achieving thermal comfort, in *Renewable and Sustainable Energy Reviews*, Spain, Department of Engineering, University of Almeria, (49):736-755
- Mashabela, H, 1988, *Townships of the PWV*, Johannesburg, SA Institute of Race Relations: 104-109
- Pinto NDM, Xavier AADP, Hatakeyama K, 2015, Thermal comfort in industrial environment: conditions and parameters, at *6th International Conference on Applied Human Factors and Ergonomics*: 4999-5006

- River Health Programme, 2005, *State-of-Rivers Report: Monitoring and Managing the Ecological State of Rivers in the Crocodile (West) Marico Water Management Area*, Pretoria, Department of Environmental Affairs and Tourism: 25 [http://www.dwa.gov.za/IWQS/rhp/state\\_of\\_rivers/crocwestmarico\\_05/crocwestmarico\\_05\\_a4.pdf](http://www.dwa.gov.za/IWQS/rhp/state_of_rivers/crocwestmarico_05/crocwestmarico_05_a4.pdf) Accessed 2017/02/16
- Scott, G, 1914, *The Architecture of Humanism*, Boston, Houghton Mifflin Company: 37-209
- SHIFT, 2005, *Brickfields & Legae*, Project Review Series, 6, <http://www.jhc.co.za/sites/default/uploads/files/file/Project%20Review%20Series%20-%20Brickfields%20%26%20Legae%20SHF%20%26%20SHIFT%20Issue%206%202005.pdf> [Accessed 2017/03/03]
- Smegal, J, 2017, *Understanding Stack Effect*, ProRemodeler, <https://www.proremodeler.com/understanding-stack-effect> Accessed 13/09/2017
- Smith, DM, 1992, *The Apartheid City and Beyond*, London: Routledge.
- Steyn, P. G. 2005. *Patterns for people-friendly neighbourhoods in Mamelodi*, South Africa. World Congress on Housing, Pg. 27-30.
- Sullivan, LH, 1896, *The Tall Office Building Artistically Considered*, Lippincott's Magazine, JB Lippincott Co, Philadelphia, Pg. 403-409
- Turok, I ,2012, *Urbanisation and Development in South Africa: Economic Imperatives, Spatial Distortions and Strategic Responses, Urbanization and Emerging Population Issues Paper 8*, International Institute for Environment and Development, London. Pg. 21-24 [http://www.delog.org/cms/upload/pdf-africa/Urbanisation\\_and\\_Development\\_in\\_South\\_Africa\\_-\\_Economic\\_Imperatives\\_Spatial\\_Distortions\\_and\\_Strategic\\_Responses.pdf](http://www.delog.org/cms/upload/pdf-africa/Urbanisation_and_Development_in_South_Africa_-_Economic_Imperatives_Spatial_Distortions_and_Strategic_Responses.pdf) Accessed 20/03/2017
- Vitruvius, S.A, *The Ten Books On Architecture*, translated by Morgan, MH, Warren, HL, 1914, Boston, Harvard University Press: 17

## Appendices

### **Functionalism Criticisms**

One of the earliest sources the post-modernists used to refute functionalism was *The Architecture of Humanism* by Geoffrey Scott, published in 1914 (Kruft, 1986:438). Scott argues that there are 6 fallacies, or false but logical sounding arguments, for architectural form (Scott, 1914:1-14). He presents these fallacies as external values applied to architecture, in the context of the reviving renaissance architecture (Kruft, 1986:343-344). In keeping with post-modernist tendencies, some Post-modernists reverted to this pre-functionalist text to refute the validity of functionalism (Kruft, 1986:438), although the success of their attempts are questionable.

Of the 6 fallacies, the one that is cast against Functionalism is the Biological Fallacy (Scott, 1914:165-182).

The Biological fallacy The nature of biology, as understood by Scott, is that there is no superfluous part or aspect in a biological organism, and so all parts are equally important. This is the argument to which the post-modernists attached themselves. There are two aspects of this fallacy, namely the continuation of an organic tradition, and the creation of architecture without hierarchy (Scott, 1914:165-185).

The aspect of organic tradition argues that style is the result of a continuous development, and that any interruption is unfounded and without basis. Scott attacked the architects who promoted the Gothic style as wishing to return to the Pre-renaissance, because it would return them to the "organic" path that was interrupted by the renaissance. Scott argues, however, that this fallacy does not consider that the values and traditions of the gothic era have been lost, and so it would be improper (Scott, 1914:165-182). An interesting aspect of this fallacy is that Scott also falls into it, by advocating a return to the renaissance traditions after being interrupted by neo-gothic and eclectic.

Furthermore, Scott argues that mere survival is not enough reason to call an organism beautiful (Scott, 1914:182). Although used for another argument, the Post-modernists interpreted this as meaning that Architecture cannot be beautiful merely because it fulfils its functions. Architecture needs to be informed by aesthetic, rather than external values (Kruft, 1986:344).

The biological fallacy has informed many arguments presented by the post-modernists (Kruft, 1986:438), although no united front has been presented. Instead, various versions,

interpretations, and opinions tried to push the Post-Modernist movement into a direction that suited the authors. Kruft discusses some of these theories, and finds almost the only common thread to be a rejection of functionalism (1986:434-446)

Whereas Philip Johnson argued that there was no connection between use and beauty (Kruft, 1986:438), Louis J. Kahn worked towards achieving a synthesis of functionalism and an expressive, almost symbolic language (Kruft, 1986:438).

Bruce Goff argued for an emphasis on the aesthetic, and reversed Sullivan's axiom to "Function follows Form" (Kruft, 1986:439). An anonymous architecture composed of natural forms and materials with a vehemently anti-functionalist message, tried to establish itself, but remained a fringe subject (Kruft, 1986:439-440).

Ernest Bloch (440) also wrote a devastating attack on functionalism, equating it with an ice world for robots, and blaming consumer culture for its proliferation (Kruft, 1986:440). It is difficult to separate his criticisms from his political beliefs, as he identified as a dissident Marxist.

Robert Venturi argued in

favour of applying symbolism and decoration to buildings (Kruft, 1986:440-441). His argument for a “decorated shed” is that mankind requires a new language of symbolism. He also presents “fun” as a serious architectural quality, and a proper motivation for copying buildings from past era’s and cultures. Many of his opinions based on observations in Las Vegas, Nevada.

Charles Moore presents the argument that functionalism disregards the human experience. He states that the human ex-

perience should be as present in a house as in a civic building, and hints at the notion of ownership (Kruft, 1986:442). However, his theories and their execution are very far apart, with the Piazza d’Italia in New Orleans being described as pop culture masquerading as art (Kruft, 1986:442).

The final critic of functionalism worth noting is Rudolf Arnheim, who wrote a logical refutation of functionalism (Kruft, 1986:442). In his book, *The Dynamics of Architectural Form* (1977), Arnheim argues

that architecture needs Symbolism, and has psychological, cultural and various other intangible functions. He argues that any building must aim to also fulfil those functions, and that the traditional functionalism disregarded these ‘crucial’ functions, and therefore was insufficient as an architectural solution.

### **Additional Site Mapping**



Figure 10-01: Boundaries for Site Selection

Physical boundaries in Mamelodi, showing railways and highways as built boundaries. Mountains and rivers make up natural boundaries.



Figure 10-02: Centrality for Site Selection

Centrality, showing the most central area and the various subregions radiating outwards. This disregards historical layers, and uses current conditions.



Figure 10-03: Green/Open Spaces for Site Selection

Green/Open Spaces, so as to not destroy existing urban fabric. This also allows for future expansion to be considered.

Nolli Map, showing the accessibility of the site to the general public.



Figure 10-04: Nolli Map - Publicly Accessible Spaces

Pathways, showing the footpaths on soft earth and grassland as could be identified from aerial photography.



Figure 10-05: Pedestrian Pathways

Shrubs and trees, showing concentrations around the railway, Tsamaya road and the Pienaars River.



Figure 10-06: Trees and Vegetation

Roads, showing the asphalt and dirt roads as could be identified from aerial photography.



Figure 10-07: Asphalt and Dirt Roads

Contours, showing the general fall and lay of the site. The station and railway are located on a man made hill.



Figure 10-08: Contours





Figure 10-10

**Train Station:** This is by far the most prominent asset of the site, and allows the opportunity for both passengers and freight to be engaged.



Figure 10-11

**Waste Recycling:** A small number of persons were spotted on an informal rubbish dump collecting and sorting waste.



Figure 10-12

**Open Air Church:** A circle of white stones around a tree identifies the meeting point of an open-air church.



Figure 10-13

**Residential Areas:** There are various residential area types, ranging from the very informal to the very formal. Some informal settlers would require relocation, due to the danger of their current location.

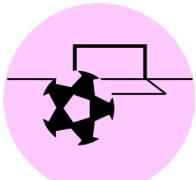


Figure 10-14

**Soccer Field:** A communal, informal Soccer field is present within the 50-year flood plain.



Figure 10-15

**Bus and Taxi Transportation:** Areas for stopping and unloading passengers at the station entrance. The layout of roads in the public square accommodate drop-offs and turn arounds.



Figure 10-16

**Wetland:** The wetland provides several opportunities, and the architectural intervention may address the water quality as an issue.



Figure 10-17

**Truss Maker:** Located nearby the site, in a backyard extension. This seems to be a private enterprise, with no clear signage.



Figure 10-18

**Reed Weaving:** Not currently extant, but the invasive reeds (River Health Programme 2005:25) allow for the opportunity to expand into this sector in order to manage the river ecology.



Figure 10-19

**Pap and other food:** Smaller sellers also at the station entrance, and sparsely dotted around the site.



Figure 10-20

**Automotive Mechanic:** Located on the public square adjacent to the station, this industry is also surrounded by residences.



Figure 10-21

**Driving School and Road Worthiness Testing:** Located on Tsamaya Road, this was identified by a painted advert on a wall.

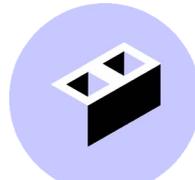


Figure 10-22

**Brick Maker:** The brick makers have a production area, consisting of old bricks, a mixing area, heaps of sand and cement, near the river. This is specifically for the freely available water.



Figure 10-23

**Chesa Nyama:** Located at the entrance to the train station, and a café at the exit from Tsamaya Road.



Figure 10-24

## Precedents

Several precedents were studied, and these included contextual, as well as programmatic precedents.

Precedents in either category were identified, sketched and then analysed according to the method set out in Precedents in Architecture (Clark & Pause, 1996:3-7). The themes chosen for analysis are:

- Circulation to Use Space
- Unit to Whole
- Symmetry
- Structure
- Massing
- Plan to Section/Elevation

These themes were chosen specifically for their relevance to an industrial programme.

Three contextual Precedents were selected, and were analysed as follows:

### Roadside Industry 1 – Welding and Automotive Repair

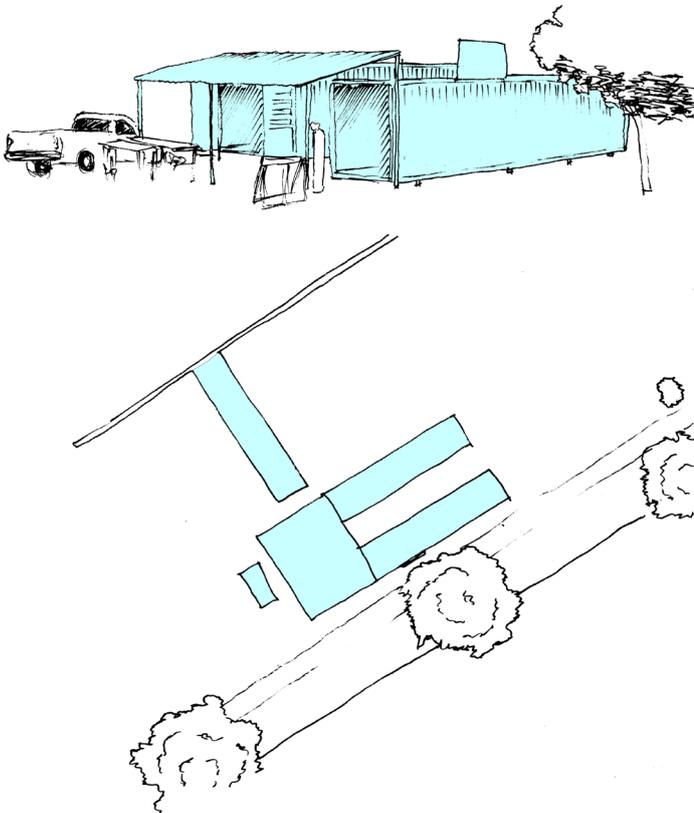


Figure 10-25: Sketch of Welding and Automotive Repair Industry in Mamelodi, by Author

This Industry is located on a roadside in Mamelodi, between a sidewalk and a fence. Portable welding equipment and workbenches are displayed under an open roof, with storage and additional spaces in containers. The central roof is as light, and as lightly supported as possible. This is indicative of the mild weather in Mamelodi.

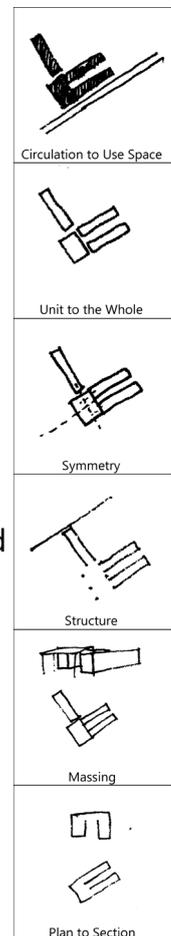


Figure 10-26: Diagrammatic Analysis

### Roadside Industry 2 – Tyre and Wheel Replacement and Repair

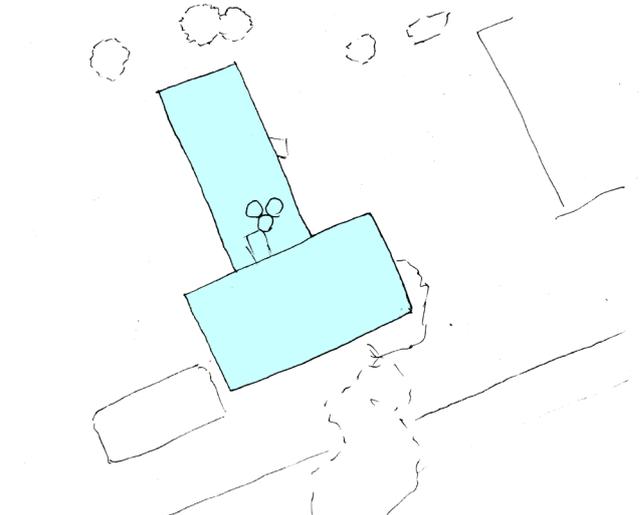
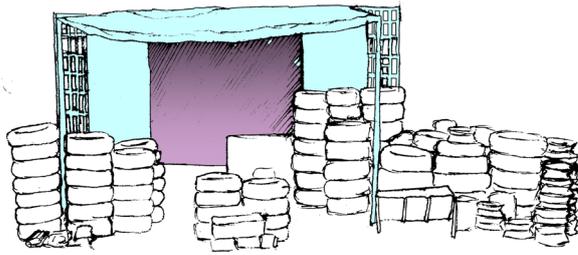


Figure 10-27: Sketch of Tyre and Wheel Replacement and Repair

This Industry is located on a roadside in Mamelodi, adjacent to a sidewalk. A Shipping container defines the rear storage space, while a Roof with fencing defines the front, and primary workspace. Tyres are displayed out front, and convey the nature of the industry plainly. They are stored within the container and the fenced area at night.

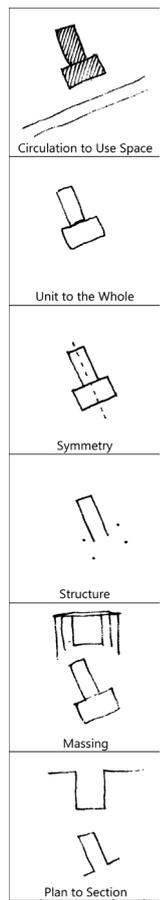


Figure 10-28: Diagrammatic Analysis

### Roadside Industry 3 – Sales and Social Gathering Pergola

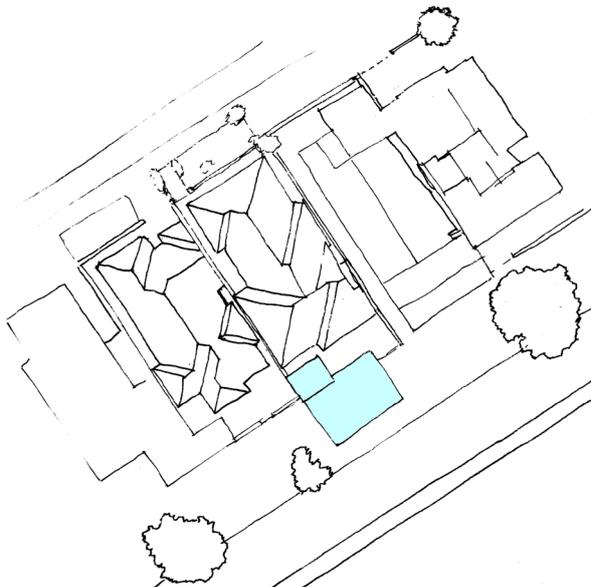
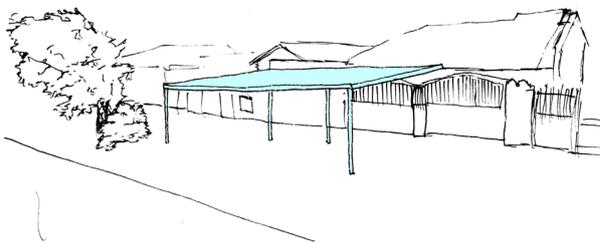


Figure 10-29: Sketch of a Sales and Social Gathering Pergola

This Industry is located on a roadside in Mamelodi, attached to a house. An expansive roof defines the space, and has a small building attached. Although the nature of the industry is unclear, a fair guess may be made that the space can host social gatherings, and that the attached building is for the sale of beverages and food/snacks. This further attest to the good weather Mamelodi.

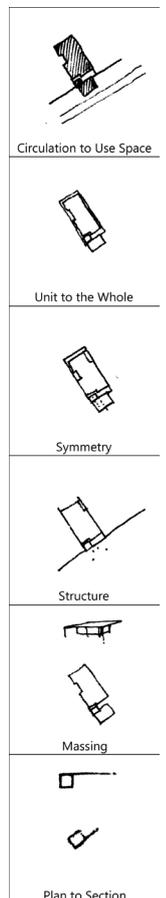


Figure 10-30: Diagrammatic Analysis

## International Precedents

From the analysis of the contextual precedents, certain patterns are revealed.

- Workspaces tend to be covered by a freestanding roof, of which the depth and the vertical supports are as minimal as possible.
- Shipping Containers tend to be serve as storage and support spaces, but may contain entire industries.
- Industries tend to be located on pedestrian routes, or attached to a house.

To further understand the role of architecture in industrial buildings, a series of industrial buildings have been chosen from around the globe, designed by selected architects from the past century. This would not only provide an insight into how these industrial spaces may all be related, but would allow for an understanding of architecture in Industry to be developed

The three international examples were analysed as follows:

### Ceramic Factory, Egypt – Hassan Fathy

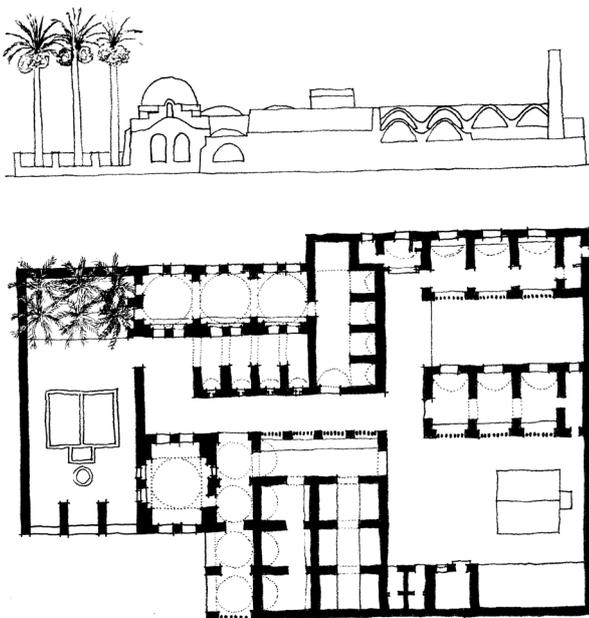


Figure 10-31: Sketch of Ceramic Factory, Egypt, Hassan Fathy, 1950

The ceramics factory was commissioned by a Jesuit Mission as a Community-Oriented Project in Qina, Egypt. The various functions are grouped together, whilst being separate and independent. All the various functions are connected across courtyards and use circulation space to link them. This activates the courtyard spaces with energy.

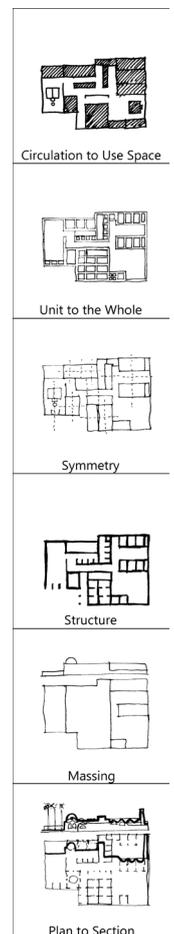


Figure 10-32: Diagrammatic Analysis

Olivetti-Underwood Factory, Pennsylvania, USA – Louis Kahn

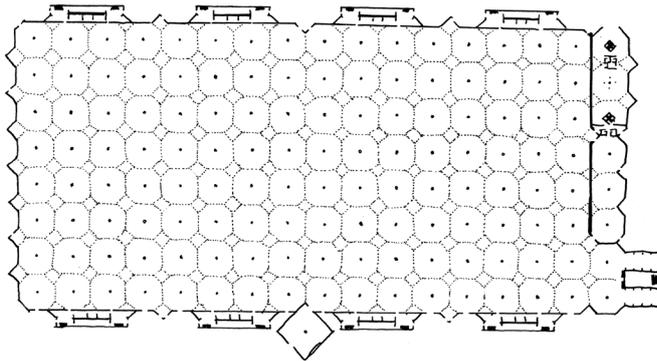
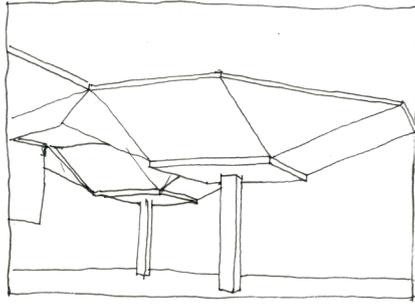


Figure 10-33: Sketch of Olivetti-Underwood Factory, USA, Louis Kahn, 1970

The Olivetti-Underwood factory was designed for the manufacture of typewriters and other products. Kahn designed a concrete unit, supported by a central column, and laid out in a grid of 8x9. With an octagonal coverage, the units join together in lateral support, and the filleted corners of four units support Roof glazing for daylighting. The modularity of the building allows for easy expansion.

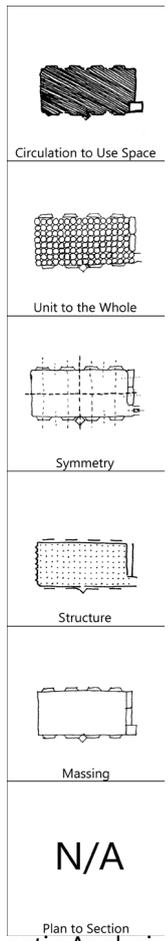


Figure 10-34: Diagrammatic Analysis

Fargus Factory, Germany – Walter Gropius

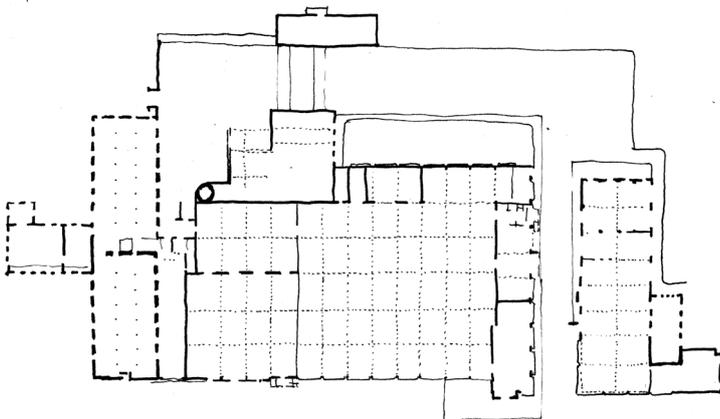


Figure 10-35: Sketch of Fargus Factory, Germany, Walter Gropius, 1913

The Fargus factory in Germany was designed in the international style by Walter Gropius. It consists of various buildings, each hosting a certain function necessary for the production of goods. A grid is visible, but is often broken, altered, or disrespected around the periphery of the complex.

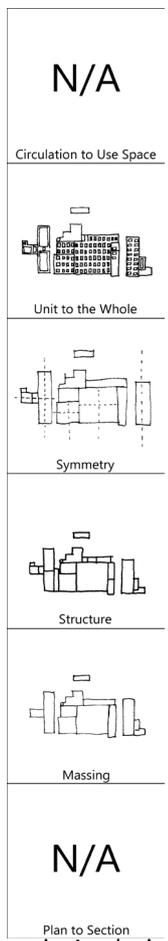


Figure 10-36: Diagrammatic Analysis

The international precedents show very little correlation and relation. Only individual aspects could be analysed and interpreted, and the most relevant aspects are as follows

- Functions may be separated.
- Modularity allows for easy expansion and addition.
- Spaces may be tailored to specific functions.
- Important features may be completely dissociated from the rest of the building to highlight its importance.

These aspects are valid to consider in designing an industrial building. However, as the benefits are unclear, these aspects should be critically considered when applied to design.

From the analysis of the precedents, several points are highlighted to take forward into design. These have been distilled from both the contextual and international precedents.

1. Functions may be separated.
2. Important features may be completely dissociated from the rest of the building to highlight its importance.
3. Industries tend to be located on pedestrian routes, or attached to a house.
4. Modularity allows for easy expansion and addition.
5. Shipping Containers (Modular Units) tend to be serve as storage and support spaces, but may contain entire industries.
6. Spaces may be tailored to specific functions.
7. Workspaces tend to be covered by a freestanding roof, of which the depth and the vertical supports are as minimal as possible.

Applying these points would not only aid in finding architectural form, but in negotiating the technological resolution of the building.

## Mamelodi Climate

The following data represents the climate in Pretoria (climatemps.com, 2017)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Max Temp (°C)	27	27	26	24	21	19	19	22	25	27	27	28
Avg Temp (°C)	22	22	20	17	13	11	11	14	17	20	21	22
Avg Min Temp (°C)	16	16	14	10	5	3	3	6	9	13	14	15
Humidity (%)	67	68	69	66	62	58	54	49	47	53	60	62
Avg Daylight Hours	13h 32'	13h 00'	12h 17'	11h 30'	10h 52'	10h 32'	10h 41'	11h 14'	11h 59''	12h 23'	13h 23'	13h 42'

Table 10-01: Climate Date for Pretoria

## Thermal Comfort

The psychrometric chart is the most widely used tool for understanding comfort levels and the strategies to deal with uncomfortable conditions (Manzano-Agugliaro et al, 2015:738).

Plotting the climate of Mamelodi, the following strategies are required for creating a thermally comfortable environment:

- Passive Solar heating
- Heating Internal Gains
- Solar Protection
- Cooling High Thermal Mass

Only the Average and maximum average temperature was used, because the building would only be occupied during daytime hours.

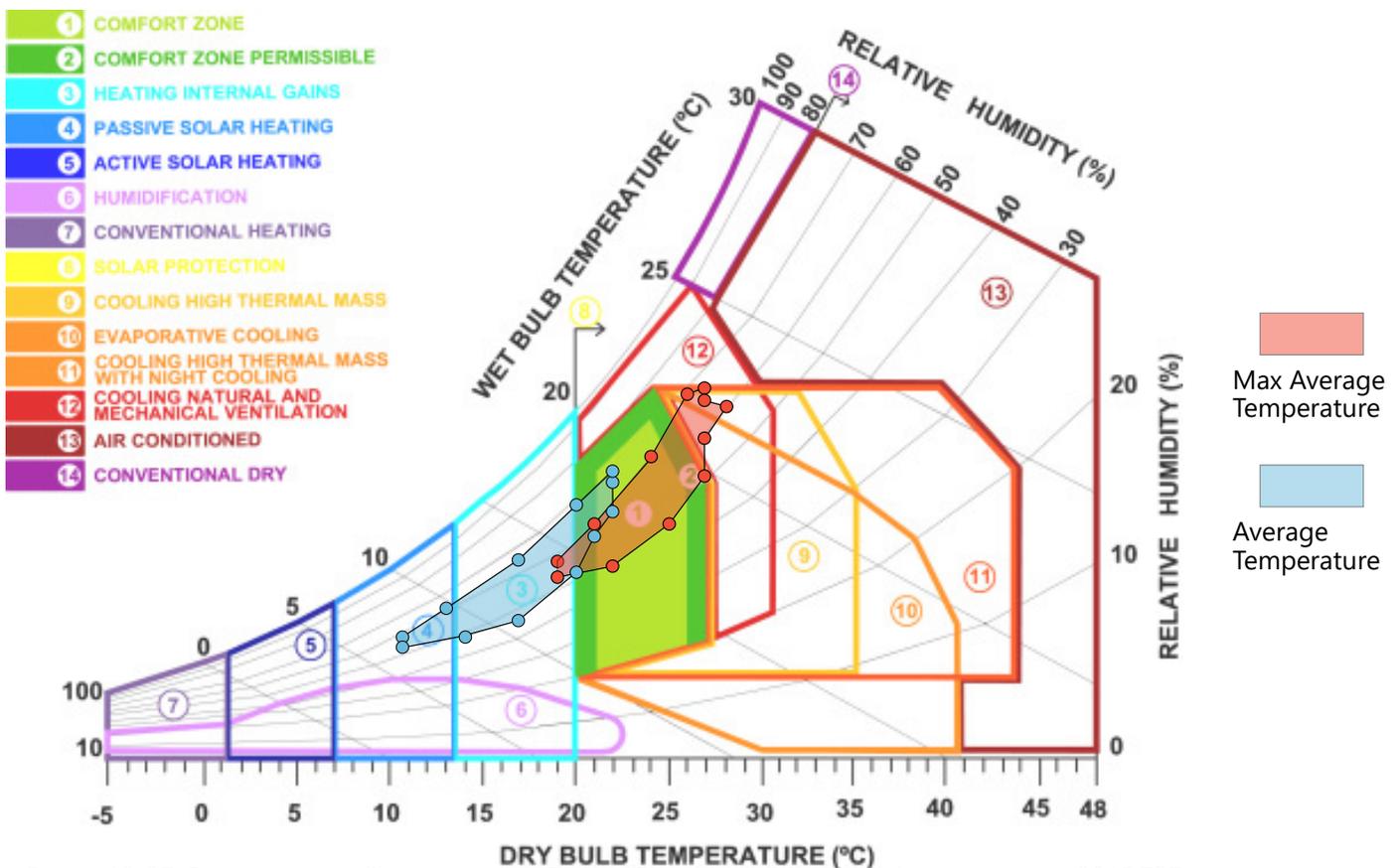


Figure 10-37: Psychrometric Chart including Design Responses, Manzano-Agugliaro et al, 2015:737