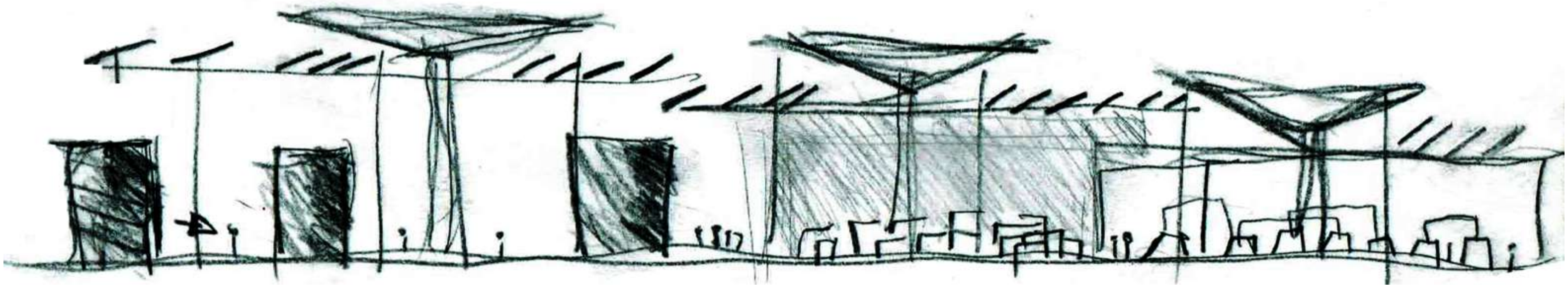

Parti-cul-late

An education and research workshop for off-site manufacturing
by Jan-Adriaan van Rooyen
Submitted in fulfillment of part of the requirements
for the degree Master of Architecture (Professional)
in the Faculty of Engineering, Built Environment and
Information Technology University of Pretoria
November 2019

Hypothesis:

A building can become more than just a building if it carries meaning within the composition of its parts. The efficiencies imposed by the Fourth Industrial Revolution will enable individuals, with the aid of professionals, to create this meaning- social meaning, economic meaning and ecological meaning.

Fig.1: Final Urban proposal Sept 2019(superimposed building by Author Sept 2019, Original context image by Google maps 2019)

Abstract:
This dissertation deals with the makings of a multidisciplinary off-site manufacturing(OSM) education and research facility, focused on the development and use of Computer Aided Drafting (CAD) and Computer Aided Manufacturing (CAM) techniques, to design, manufacture and assemble buildings. Post-industrial revolution, construction, manufacturing and architectural professions have been developing CAD/CAM techniques within many facets of the built environment - some more successful than others. Lately the value and intention of these OSM elements in general have become obscured. Dall and Smith(2019) argue that any mass produced elements that are being reproduced and shipped all across the world, is inherently meaningless, because the sense of effort exerted on its creation is lost. The trend of moving back towards craft "everything" at the onset of the 21st century is directly linked to this meaningless feeling created by mass production. In a phenomenological sense this puts architecture in danger...: As it is the implied bias of architecture to create meaning via the design and construction of spaces. This disconnect between the built environment professions within the development of off-site elements, is what this dissertation will address. In order to restart this artisanal dialect, the intention is to design a multidisciplinary research, manufacture and education facility, that could aid the off-site manufacturing processes related to precast concrete, steel structures and timber computer numeric controlled (CNC) fabrication.

Focus of dissertation:

- The possibilities of using OSM as recursive to regain a sense of craft in architecture via artisanal dialect.

- The possibility of OSM to empower semi-skilled and low skilled labour sectors.

- Restarting the dialect between manufacturers, contractors, the labour force and design professionals, with the intention of breaking the hierarchy.

- The possibilities of using OSM to aid in the creation of meaningful spaces.

Project information:

Course coordinator:
Prof Arthur Baker

Study leader:
Abre Crafford

Research Field:
Environment Potential (EP)

Dissertation title:
Particulate: an education, manufacturing and research facility for off-site manufacturing

Program:
Education, manufacturing and research facility

Address:
erf 149 Koedoespoort, Nico Smit Street, Pretoria Moot, Gauteng.

GPS Coordinates:
25°43’02.0”S 28°14’45.1”E

Client(s):
Particulate Pty Ltd.- a proposed constituent company of the Concrete Society of Southern Africa, the Institute for Timber Construction South Africa and the South African institute of Steel Construction.

Keywords:
Off-site manufacturing, Building Information Management,
Sustainable economies,
Assembly architecture, Open Architecture,
Systems Architecture, disentanglement,
Computer Aided Draughting, Computer Aided Manufacturing.

Theoretical Premise:
Investigating the role of Computer Aided Draughting and Manufacturing within a socio-economic context.

Architectural Approach:
Finding meaning in the creation of things with the aid of computers.

Word of Thanks

Please allow me the opportunity to express my heart felt gratitude to a few people who were critical to the success of this Master’s dissertation:

Prof Arthur Baker your guidance to the class of 2019 as Studio Master is much appreciated and respected. My mentor, **Abre Crafford** - for the long and insightful conversations about Architecture, the challenges of construction in our context and the inviting and welcoming attitude toward any topic, even though not related to Architecture, but critical to my own narrative as an Architect in the making.

André Eksteen and Braam de Villiers - for guiding my architectural thinking over the past six years. Your contribution and support are invaluable.

Service providers and factories in my field of research - thank you for accommodating me by opening up your doors for my visits and for engaging with me in so many informative and valuable conversations. Any friendly and patient pair of ears who listened as I clarified my intentions and needed a soundboard to run my ideas by.

My parents, **Jan and Louise van Rooyen** - for food and support during that long week of draughting whilst my wife was visiting Namaqualand and for raising and inquisitive spirit.

Mieke van Rooyen - the most valuable member of my support team, my wife. Thank you for standing by my side in support, as I tried to understand and make meaning from complex idea and turn them into simplified principles. Your calm and loving approach helped guide and tame my sometimes perplexed though chains.

This dissertation has taught me about the value of knowledgeable and strong people in your team.

DECLARATION

In accordance with Regulation 4(c) of the General Regulations (G.57) for dissertations and theses, I declare that this thesis, which I hereby submit for the degree Master of Architecture (Professional) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution. I further state that no part of my thesis has already been, or is currently being, submitted for any such degree, diploma or other qualification. I further declare that this thesis is substantially my own work. Where reference is made to the works of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references.

Jan-Adriaan van Rooyen

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Problem statement

Problem 1:
Phenomenological sympathy

The use of off-site manufacturing techniques (OSM) is a modernist ideal routed in the paradigm of the Industrial Revolution. At the onset of the 21st century technological advances aiding production in the latter sense have come full circle. The benefits of these advances however, are still being tailored as a unilateral capital gain toward the main stream building industry manufacturer. Creating ambiguity in the benefits of OSM for civil society.
This ambiguity is not created by the notion of unilateral capital gain, but by repetitive and anti-contextual elements consequentially specified by architects and developers. In stark contrast. Kammeyer(2019) reflects on the notion that one can experience the creation of space, when moving through the dining hall of the Future Africa complex designed by Eksteen(Fig 1-Z:), because the elements indirectly imply craft even though it is not handmade. In essence this building's superstructure is constructed with plywood sheet puzzle pieces that can be assembled on site by hand.

Problem 2:
Sustainable building and manufacturing/economy systems

Osman(2019) refers to the flexibility of systems in relation to the other systems that could aid in the sustainable positioning and management of buildings. She (Osman 2019), references the notions of disentanglement and separation of building systems. The inherent implication is that these 'open building systems' needs to be designed in a project-specific sense and cannot rely on mass manufactured systems. Eksteen(2019) refers to the mass production built environment model as a building industry informed by corporate companies. He argues that these types of buildings overcapitalize on imported, technologically advanced, "sustainable" systems of the highest standards, resulting in wasted capital on fixed systems that could have been spent on developing local systems, economies and trades. New technologies like Building Information Management (BIM) and CAM have the ability to program flexibility, or at least manipulate its input in a coherent fashion. We should harness this. Alazzaz(2014), found a direct link between the influx of productivity and ownership of projects by employees, in the utilization of OSM and CAD/CAM compared to traditional construction methods. South Africa, being a culturally dynamic society, with a low employment rate, could greatly benefit from the use of OSM to actuate micro informal economies. This dissertation will aim to investigate hidden potential of using OSM as a mediator in reconciling the latter deficits.

Fig.3: Mass housing scheme in Dadun China (China foto press. 2013)

Fig.2: Future Africa Dining hall built from CNC parts(Eksteen 2019.Earthworld architects .2019)

Delimitations & Inquiry

At the onset of this dissertation a delineation and exclusion between mass produced OSM and Custom computer aided off-site manufactured elements, need to be made. Mass produced elements such as Aluminum window profiles, roof sheeting/gutters, tiles or other finishing elements will not be the focus of this dissertation. The focus will be on custom concrete, steel and timber elements, produced off-site in a project specific sense, using CAM. This delimitation, toward manipulating raw material using CAM, will be made in order to focus the dissertation on the shortfalls of CAM, OSM and BIM knowledge in an architectural sense. It would also aid in the intentions of using OSM to reconcile the polarized built environment economy in South Africa.

As a dialectic precursor, I would like to cast light on my personal architectural endeavours for the past 5 years, where I gained practical experience that lead to my stance regarding OSM and the state of the built environment supply chain. Under the supervision of André Eksteen and Braam de Villiers, co-founders of Earthwold Architects. I have been involved -and witness to- multiple projects that probe the practicalities of OSM. What I perceived during these years is that the natural impetus of the capitalist models of off-site construction is used to advance specific technology to stay on top of the market and inversely staying on top of the market in order to have capital to develop specific technology. This model gives very little or no time for big manufacturers to develop custom project-specific parts. The contribution of the latter model in a local sociological and economical sense, is what gives me food for thought. In contrast, my experience of designing and constructing loose part OSM buildings at Earthworld Architects, is that it is a complex process hampered by lack of design knowledge by contractors, manufacturers and even architects. Although the language of CNC manufacturing is not a very difficult one to learn and control, contractors do not want to take responsibility to translate or manage it. It leaves the Architect to design and resolve most of the complicated time constraint details on his own. If the digital and physical language that is spoken between architects, manufacturers and assemblers can be developed in a coherent fashion, each party can focus on doing what it does best, whether it is architectural design, structural design or programming the production and assembly of the parts. Eksteen(2019) argues that empowering local unskilled and semi-skilled labour to produce and erect buildings using CAD and OSM, would be more sustainable in an urban developmental sense. The possibility of semi-skilled and unskilled labour force to fill the gaps of OSM in a managerial and programmatic sense via the implementation of BIM must be investigated.

In essence, the dialectic between the creation of meaningful space -or 'Architecture'- and the construction of its loose parts is what is disconnected. Piroozfar(2013) argues a holistic approach to understanding all the complex attributes of design is needed to unravel the true potential of OSM. Goulding(2015) points out that the lack of research that could possibly integrate BIM and OSM is what creates this loose connection. Perhaps refocusing the possibilities of CAM and OSM in a coherent project specific, architectural sense is needed? To this end a humble stance of developing simplistic construction detailing of raw materials(Concrete, Steel and Timber) in the CAM and OSM idiom could be a means to redefine what OSM is capable of.

Delimitations

Fig.4: Metaphorical illustration of delimitations to Concrete timber and steel. (by author 2019. Original images by Kuka 2019)

Role players

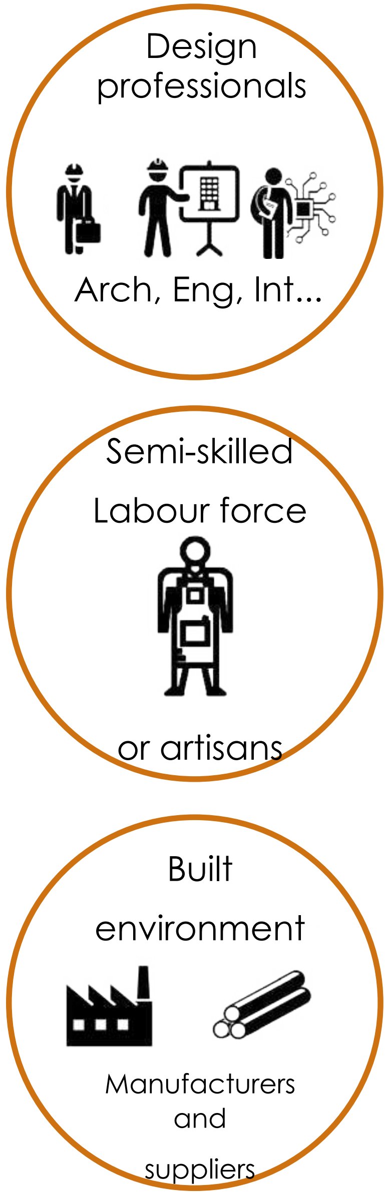
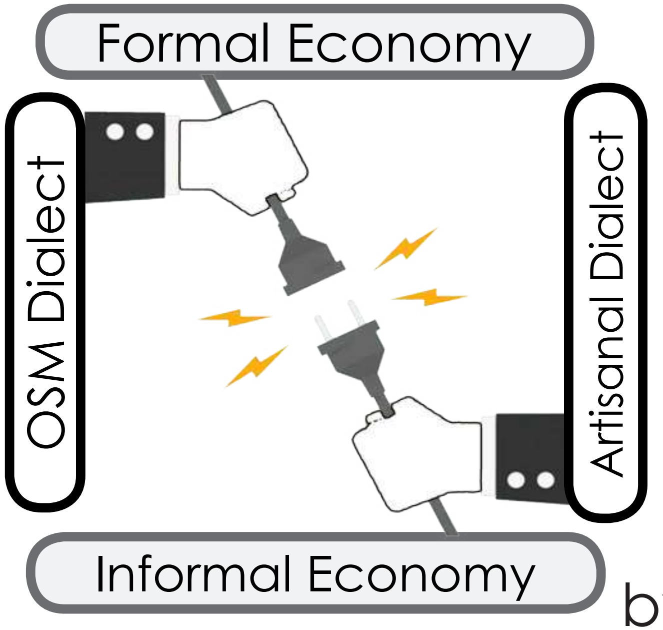


Fig.5: Diagram of role players (Author 2019)

What could

and **should**

OSM do?



by Re-positioning

Architects

as orchestrators of ideas...
in order to create **meaning**

Fig.6: Diagram of the economic disconnect. (Author. 2019)

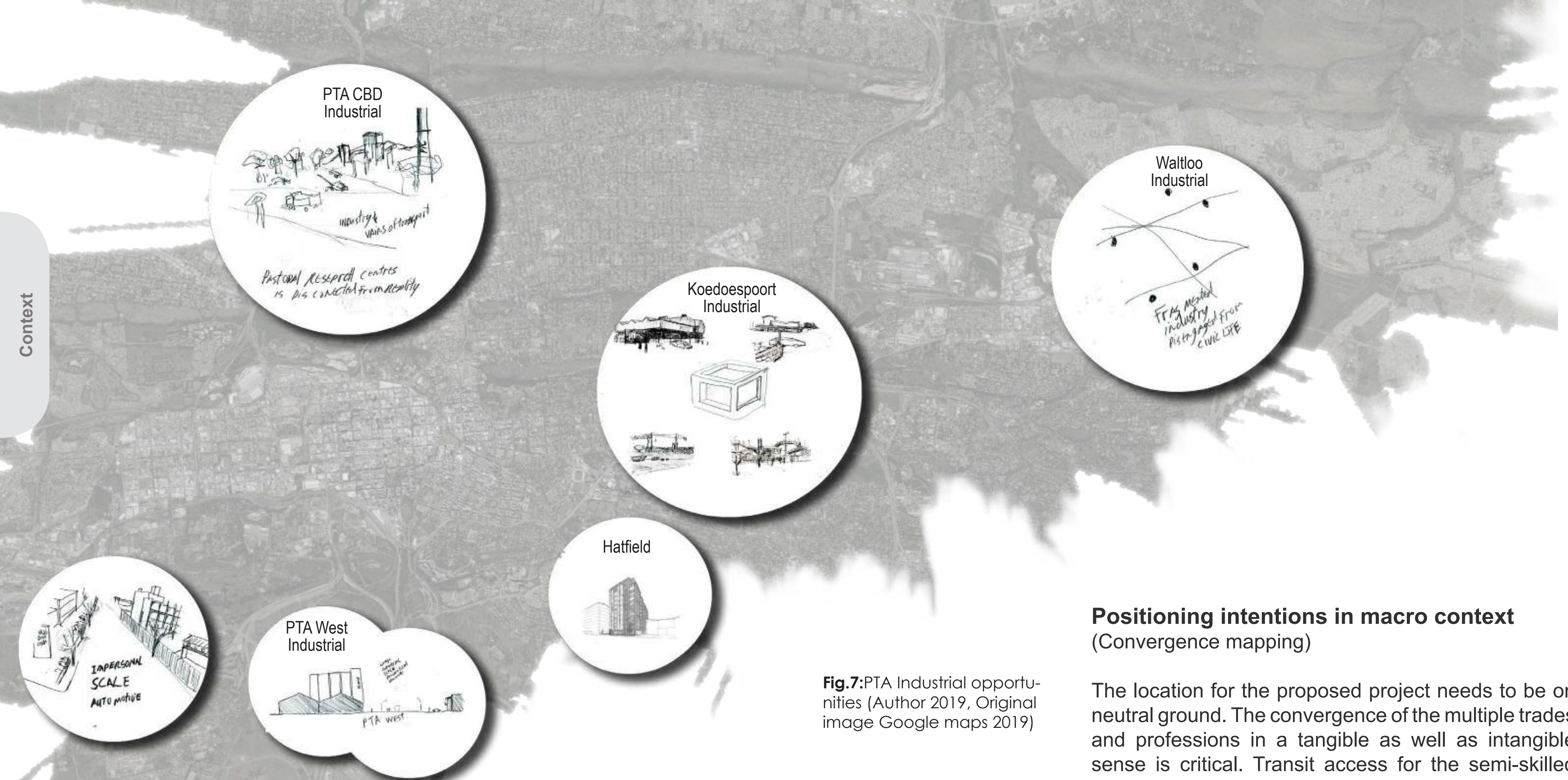


Fig.7:PTA Industrial opportunities (Author 2019, Original image Google maps 2019)

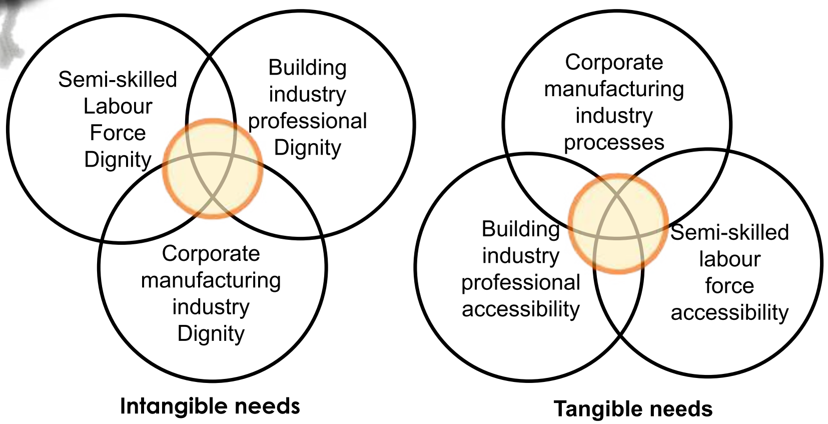


Fig.8: Tangible and intangable needs diagram of users (by Author 2019)

Positioning intentions in macro context

(Convergence mapping)

The location for the proposed project needs to be on neutral ground. The convergence of the multiple trades and professions in a tangible as well as intangible sense is critical. Transit access for the semi-skilled labourers, access for both light industrial and small vehicles should be considered.

In an intangible sense the location should adhere to the needs of students to feel connected to educational nodes. Professionals taking part in the programs of the multidisciplinary facility, should have easy access to and from their individual practices to aid in effective participation. The facility should also be able to act as a catalyst within its context, projecting the ethical stance that it embodies, in order to appropriately locate the facility in a larger context. The relevant role playing factors within Pretoria were documented to investigate the possible positioning of the facility.

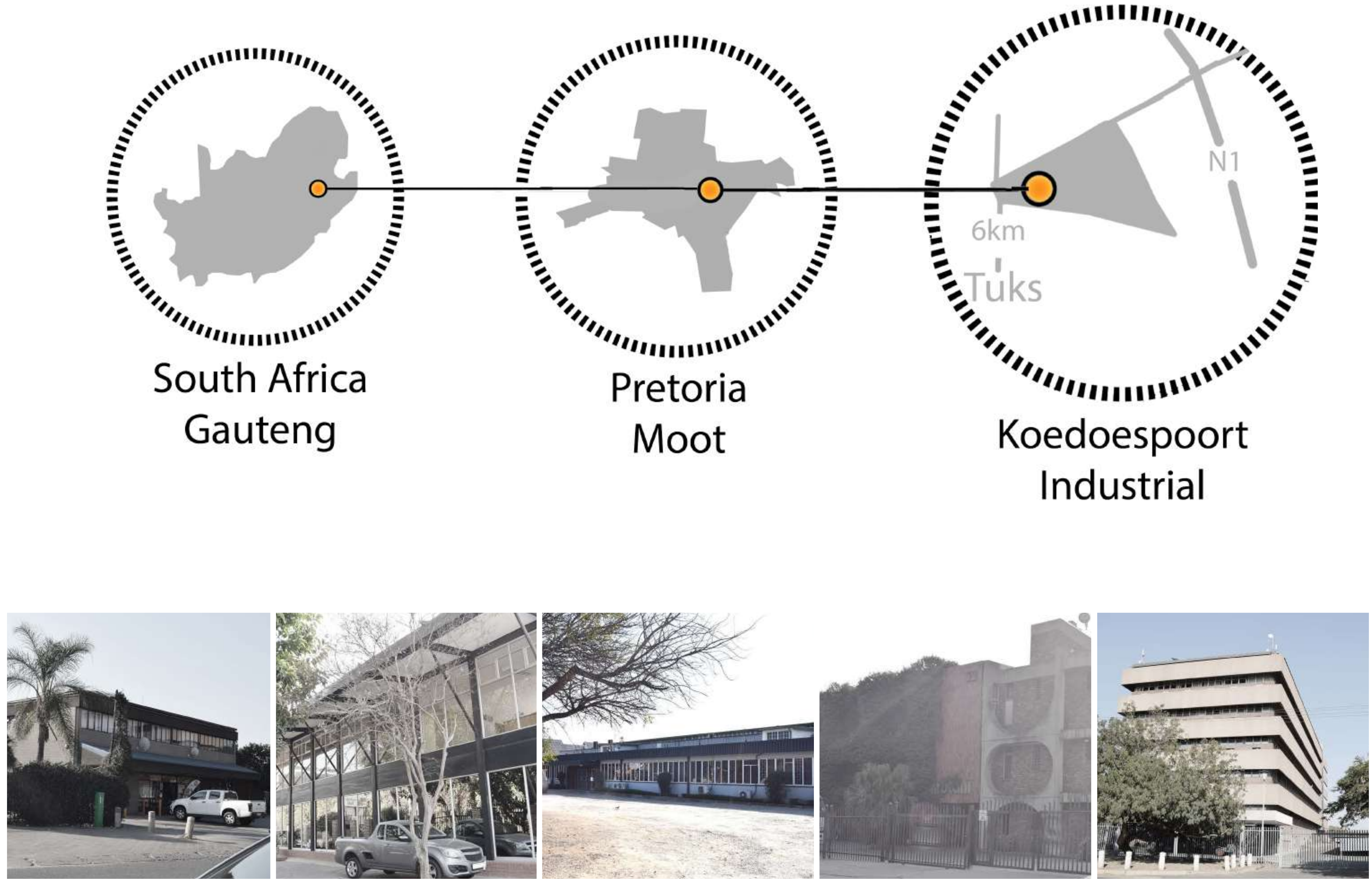
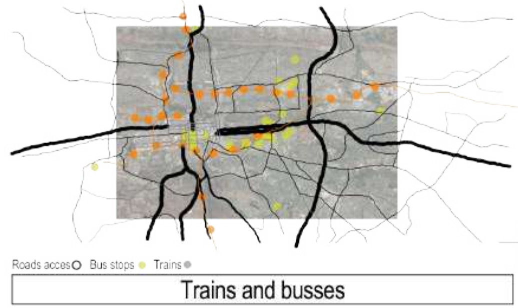
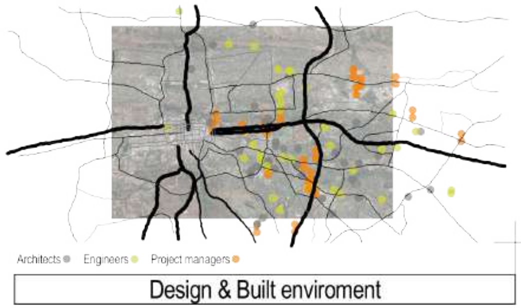


Fig.9: Koedoespoort atmosphere and location diagram (by Author 2019)





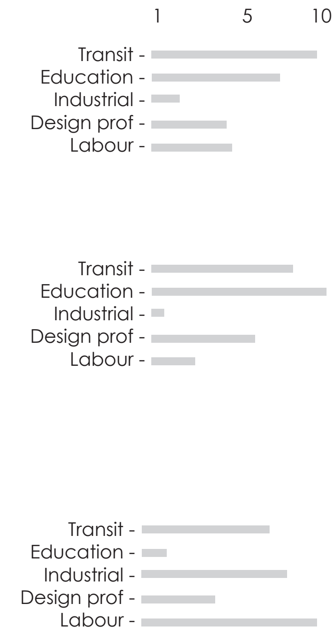
Possible site/areas in Pretoria

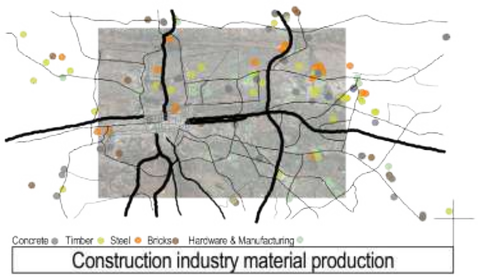
1_Pretoria CBD:
Too far from Built Environment professionals.
Low level light industrial activity.
Movement for light industrial vehicles limited.

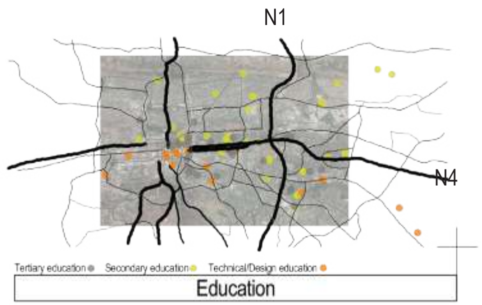
2_Hatfield:
Too congested for semi-industrial activity.
High flow of educational facilities.
Low level of Built Environment professionals.
Too congested for light industrial vehicles.

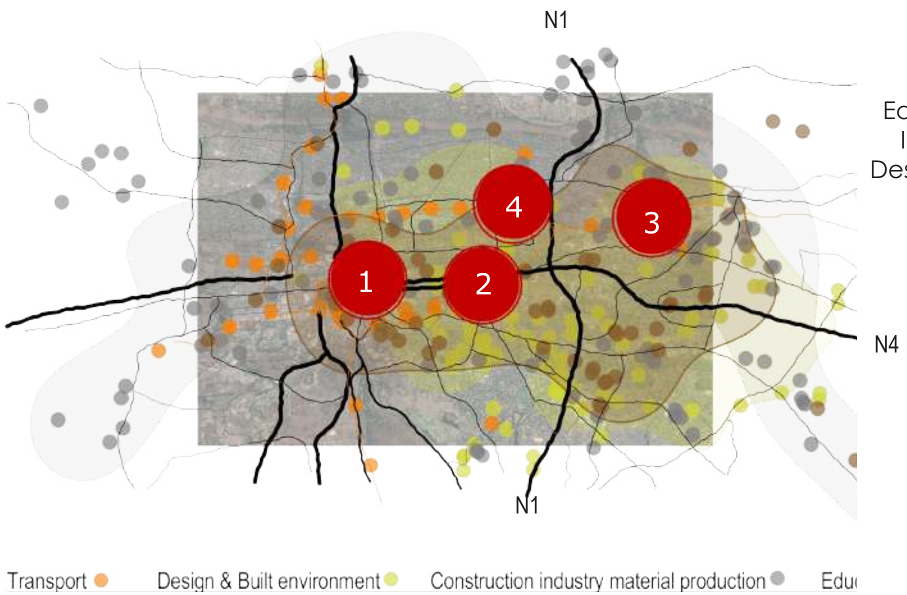
3_Waltloo industrial:
Too industrial for educational facilities.
Low opportunity for corporate business environment.
Vast expanded industrial activity.

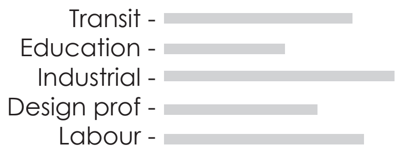
Connectivity=Convergence











4_Koedoespoort Industrial:
Close link to semi-skilled labour areas: Mamelodi

Easy access to broader industrial northern band.

Design and Built Environment in close proximity.

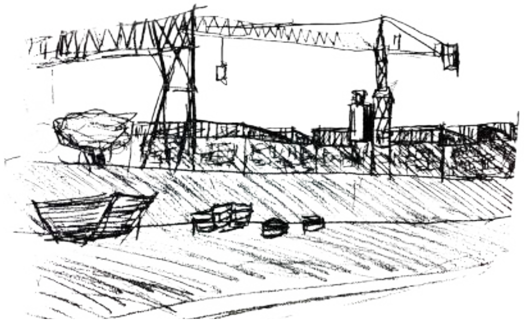
Easy access to freeways for light industrial vehicles.

Next to successful confined light industrial area.

Secondary and primary education facilities in proximity.

Close to railway and bus stops.

Fig.10: Ref to all image/stats on page, Greater Pretoria context mapping Deductions (maps from Google maps. 2019, Stats from Author 2019)

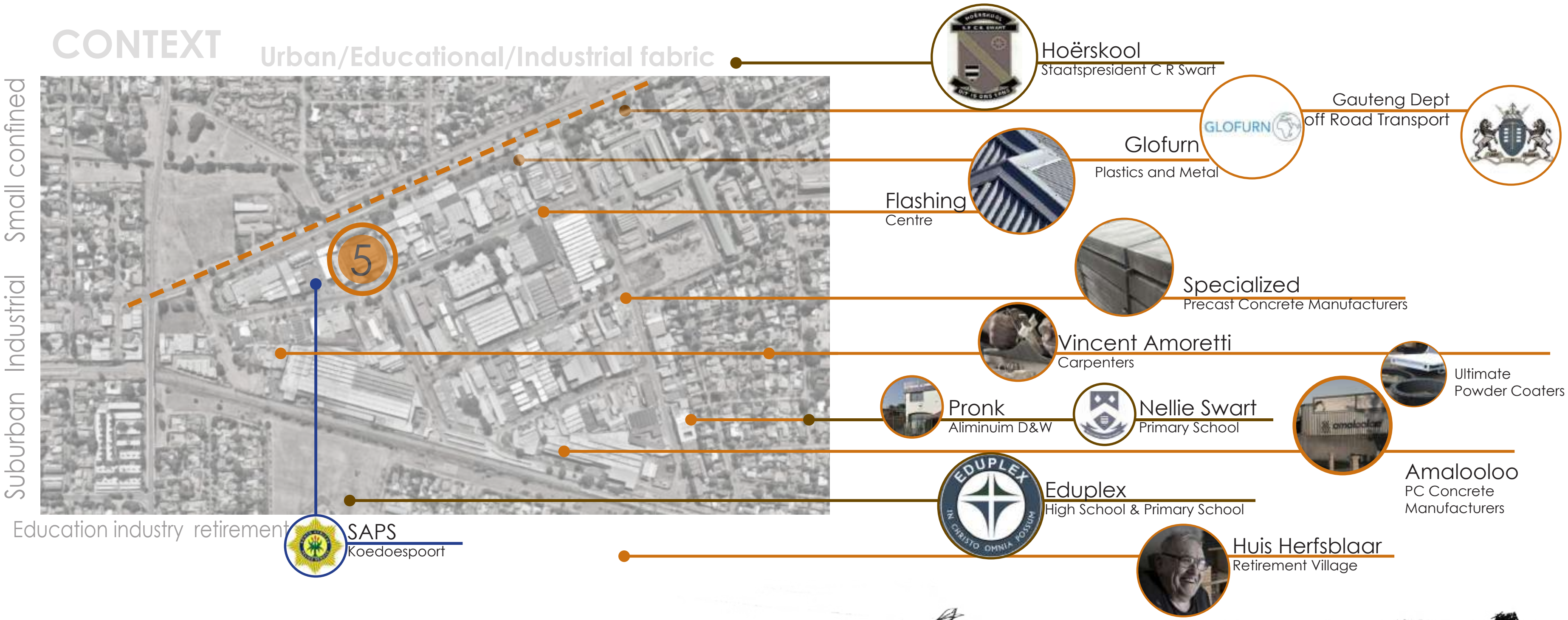


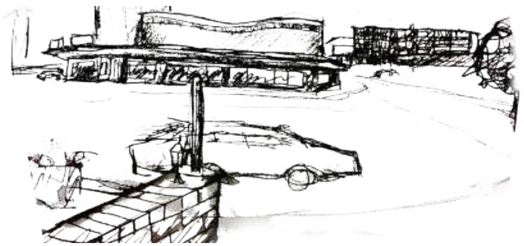
Koedoespoort Industrial

Messo context

Koedoespoort was identified as the point of most probable convergence. It is a very successful confined urban industrial area with a railway confining its Southern boundary and Nico Smit St, the Northern boundary, linking it to the N1 freeway. It is well connected to the Northern Band of Construction Industry Material Producers of Pretoria. It has access to public transport via multiple bus routes and the Queenswood railway station.

The area boasts manufacturing and production on all scales, from plastics mass production to large scale pre-cast concrete elements, with a very prevalent representation of building industry manufacturers. 'Specialised Precast Concrete', 'Amalooloo Pre Cast', Pronk Aluminium, 'Vincent Amoretti Carpenters' and 'Shop Fitting Studio's' are a few of the main constituents. see(fig 1... PTA). Five possible sites within Koedoespoort were identified and analysed.





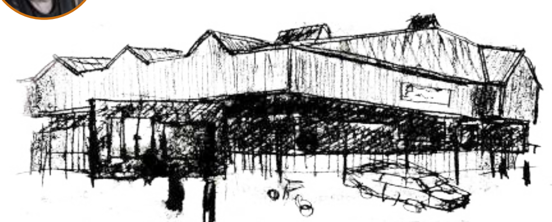
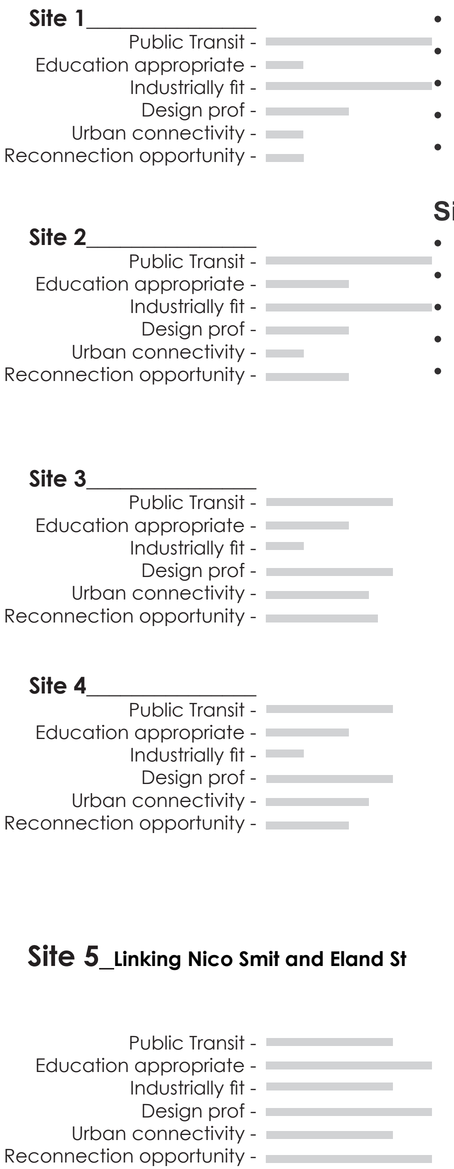


Fig.11: Ref all imigas on page: Industrial, informal and suburban pallet of Koedoespoort (Map image Tshwane GIS. 2019, Diagrams and sketches Author 2019)

Micro context
(Opportunities and considerations)



Connectivity=Convergence

Fig.12: Chart of connectivity in small scale. (Author. 2019)

Site 1_ C/O Nico Smit and Gordon Str

- Low connectivity to urban functions
- Vast vacant land across road
- Train bridge creates hard edges
- On direct route to freeway
- No offices in proximity

Site 2_Vacant lot in Blesbok Ave

- Low connectivity to urban functions
- Perhaps too big
- Semi connection with kiosk
- Connection with PC fabrication yard
- Offices in proximity

Site 3_C/O Nico Smit and Grant Ave

- Low connectivity to urban functions
- Open and vast urban scale
- Offices in proximity
- On direct route to Highway
- Confined to corner.

Site 4_C/O Grant and Lawrence Str

- Zoning may be limiting
- No offices in proximity
- In close proximity to Industrial opportunity for reconnecting multi use
- Intimate scale urban

Site 5_C/O Linking Nico Smit and Eland St

- In close proximity to Industrial
- Opportunity for reconnect to Suburb
- Connected to multiple entry ways
- Have to demolish a few buildings.

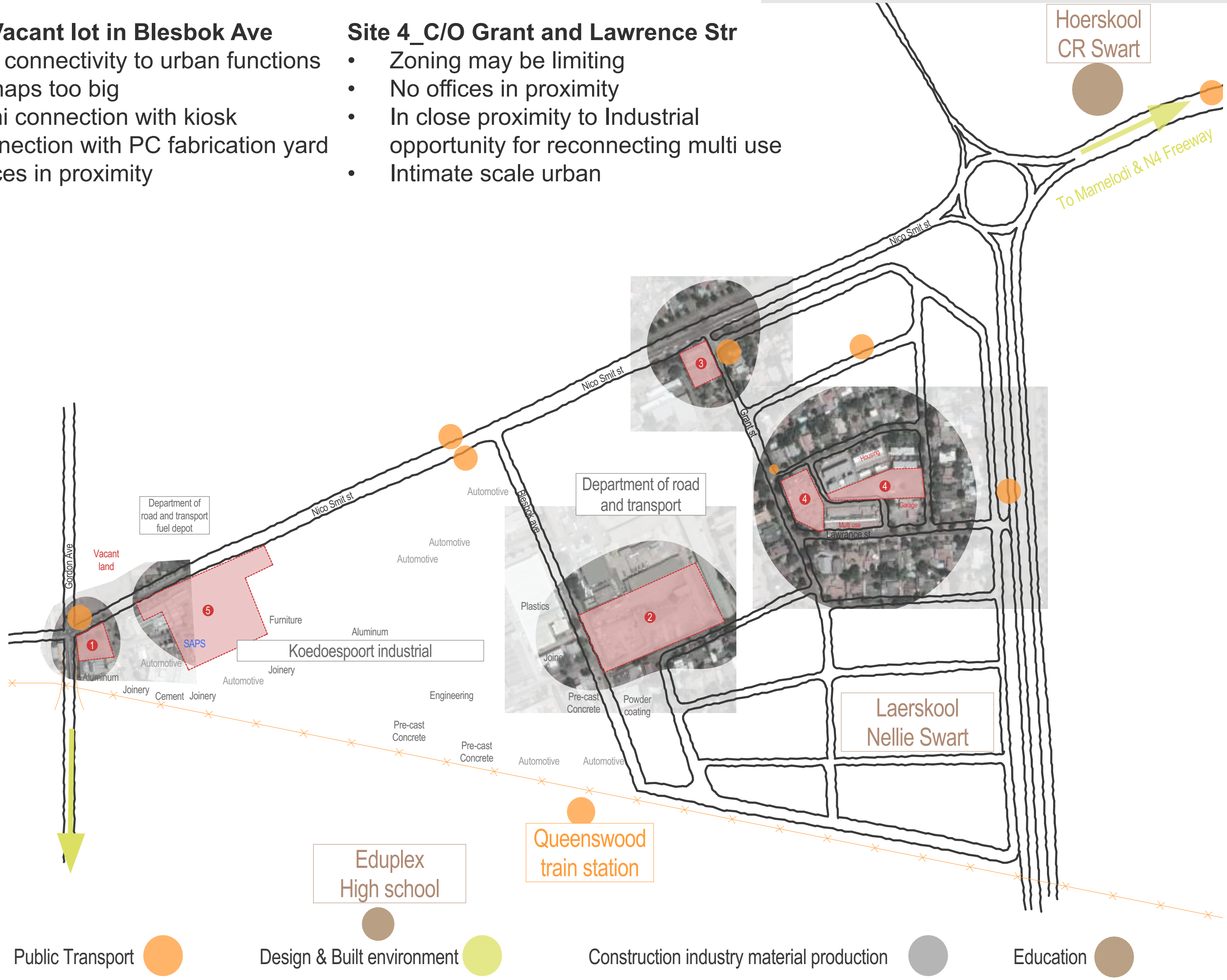


Fig.13: Koedoespoort mapping. (Author. 2019)

Site 1_ C/O Nico Smit and Gordon Str

Site 2_Vacant lot in Blesbok Ave

Site 3_C/O Nico Smit and Grant Ave

Site 4_C/O Grant and Lawrence

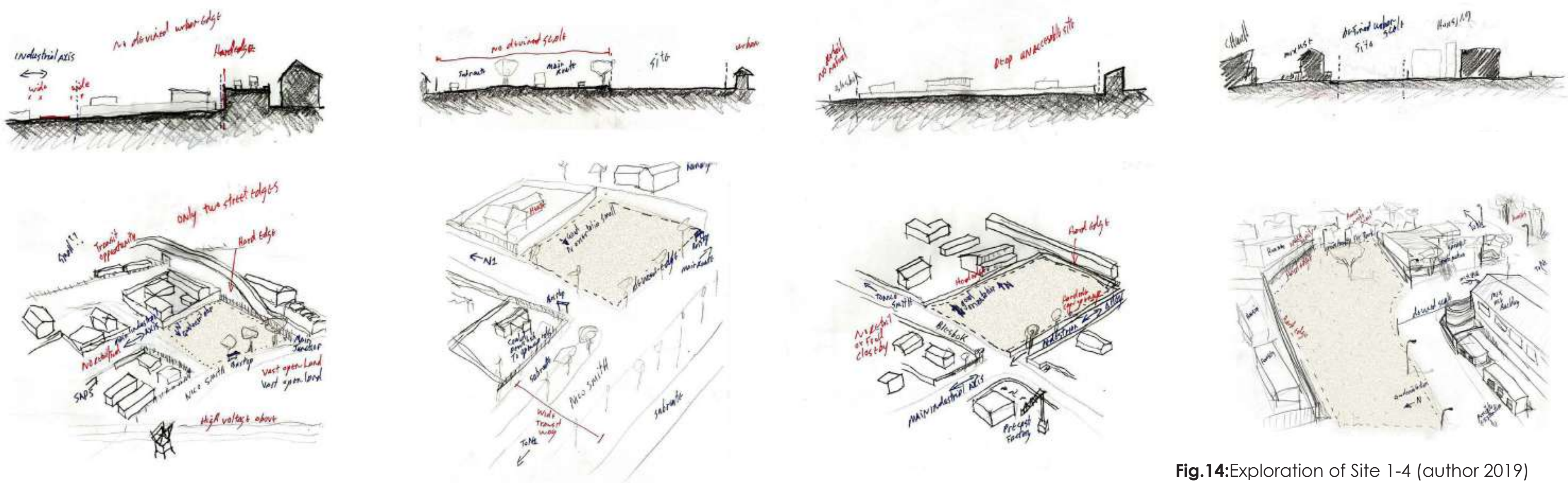


Fig.14: Exploration of Site 1-4 (author 2019)

Micro Context

Positioning the OSM facility in an urban context has to take a few considerations into account. A few critical factors relating to both the pragmatic and normative stance of the facility is listed below, in no specific order.

-Transport and access for both semi- industrial and public vehicles

-Noise levels of semi-industrial CNC and other machinery

-Acting as catalyst for civic and social activities

-Acting as catalyst for the ethos the facility will embody

-Possibilities of re-programming the urban context to enhance urban scale and connectivity.

-Connectivity between the main functions of the facility (Administration, Education, prototyping and production)

Fig.15: Exploration of possibilities on Site 4 (Author 2019)

Socio-economic context
(Urban findings and Normative position)

Within the proximity of Koedoespoort and Mamelodi more specifically open air craftsmanship and trade is a daily sight. Street vendors and small scale entrepreneurs practice their daily routines of fixing shoes, changing car tires and cutting hair. These activities usually happen on the side walks within distance of formalized retail or civic activity - creating an informal economy outside of the formal. Although primitive, the shelters for this informal economy are often able to be transformed into storage for stock during the night and protection from rain and wind. Some of the stalls are also the semi permanent dwellings of the owners. The ability of these informal spatial interventions to adapt to environmental conditions within the public realm, is sometimes overlooked. Paradoxically the environmental flexibility of small scale entrepreneurs within an unsustainable social context is not embraced by the formal economies. Allen(2001) argues that sustainable designed systems should be grounded by three main overlapping criteria. If the elemental sensitivity of these formal economies can transposed in the design of the Machine craft facility to, firstly connect designers to the elements during the proses of education and research and secondly to gradually introduce the informal economies into the formal economy in a semiotic sense. It could have the ability to gradually transform the local state of unemployment.

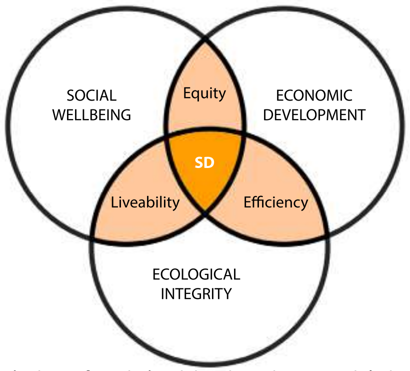


Fig.16: 3 circles of sustainable development (Alan 2001)

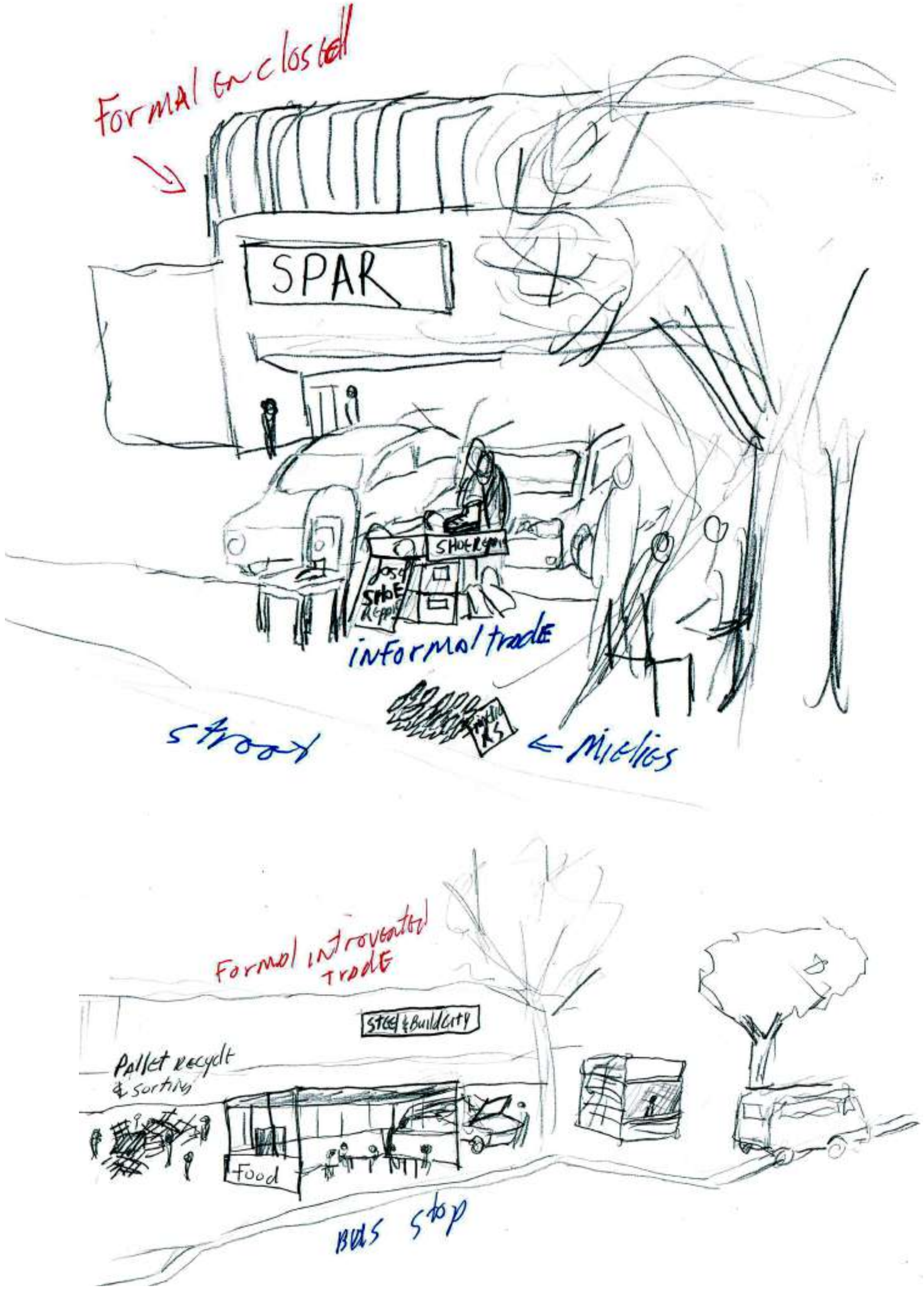


Fig.17: Informal economies in Koedoespoort and Silverton(Author 2019)

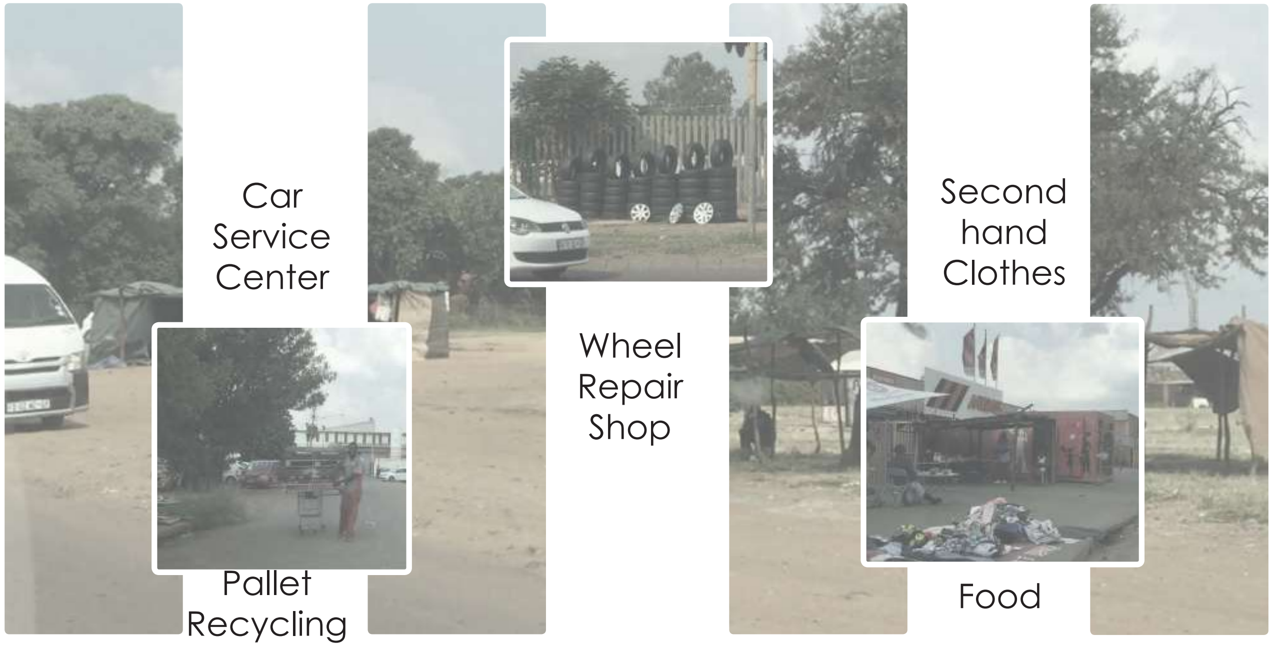


Fig.18: Informal economies in Koedoespoort and Silverton(Author 2019)

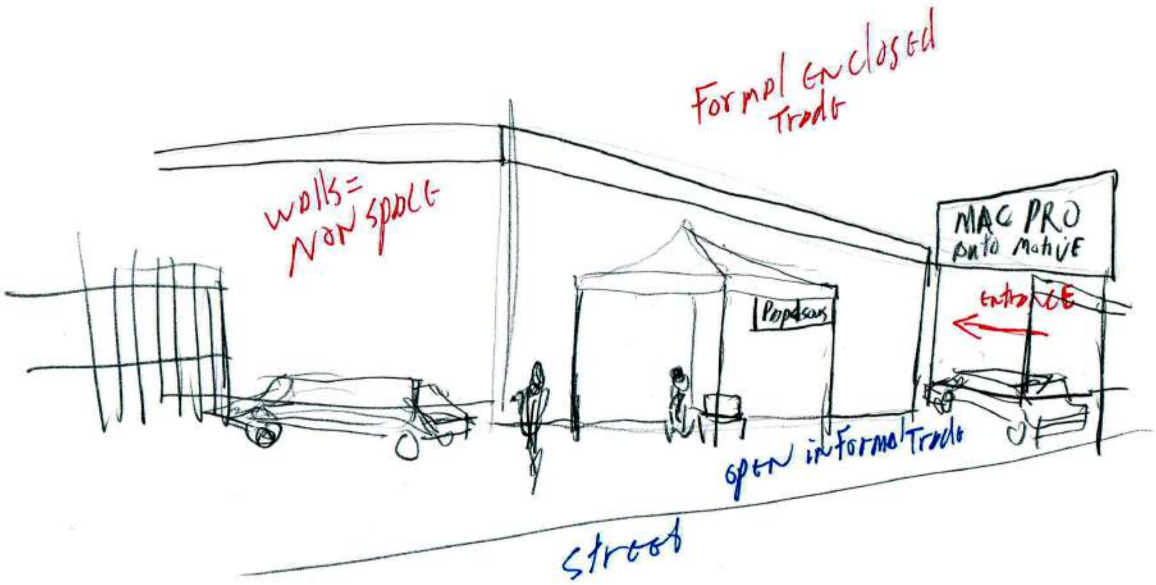


Fig.19: Informal economies in Koedoespoort and Silverton(Author 2019)

Correspondingly Bijoy Jain(2012) argues that his workshop: "Studio Mumbai", is a social interaction between craftsmanship the environment and the creation of architecture. He implies that a direct link to nature -when working in an essentially open shed in a rural plantation- gives an intrinsic value of what is created in an environmental and epistemological sense. What is being created is useful and environmentally, and architecturally sound. Good ecological design principals are the resultant of this system. The remoteness of this model could be critiqued and inversely questioned in an economical and sociological sustainable sense. I argue that this model can and should be implemented in urban contexts. Although Pretoria has high diurnal temperature fluctuation, it is has very little wind storms yearly. Resolving these temperature fluctuations is an Architectural issue.

This dissertation will investigate the possibilities of finding a middle ground between ecologically/ environmentally informed design, sociologically sensitive development and economically viable systems design.

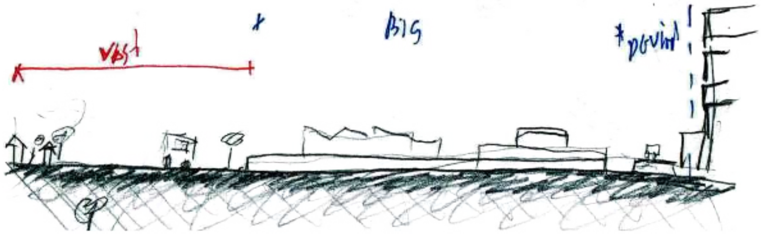
Fig.20: Bijoy Jain Artisan complex exhibition (Architectural Review. 2018)

Urban development
Opportunities and site development

Considering the urban normative position, as described on the previous page, the possibilities of placing the OSM facility in a neighbourhood became redundant. There was little to no opportunity to connect the facility to any civic or social contexts, that would have the benefit of acting as a catalyst to a greater economic area.

A decision was taken to focus on Site 5. The proposed site is situated next to Nico Smit street between two intersections. The distance between the two intersections is more than seven hundred meters without any entrances to the Koedoespoort industrial precinct. This gives opportunity for the site to link the industrial area to the broader public by activating the visual and physical axis into the industrial area. Some existing buildings in the proposed site will be demolished and others re-appropriated in order to develop a social conducive urban plan. To the south-west of the site the Koedoespoort police station is situated. The opportunity to create a more direct link from the police station to Nico Smit street must be used. On an urban scale the surrounding industrial buildings are all one to two storeys high, with offices on the street edges and warehouses behind it. To the south-east there is a six storey office building in the Brutalist late 1960's century Pretoria vernacular.

a Few iterations experimenting with the positioning of the main functions of the facility, education, administration, workshops in regard to practicality and climate design were done. The possibility of catering for residential needs - of both students and retired provetionals- that could activate dialect, and the positioning there-of, was explored. The possibility of elevating the educational spaces to create visuals on of the workshop floors was conceptualized. This opened up the ground floor to enable visual connectivity throughout the site due to the inherent open floor typology of workshop areas.



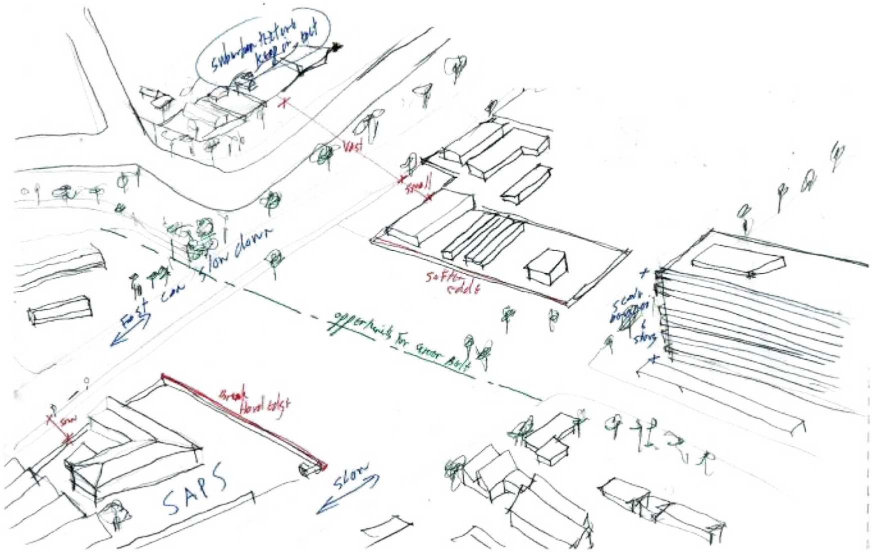


Fig.21: Analysis small Site 5_Linking Nico Smit and Eland Str (Author. 2019)

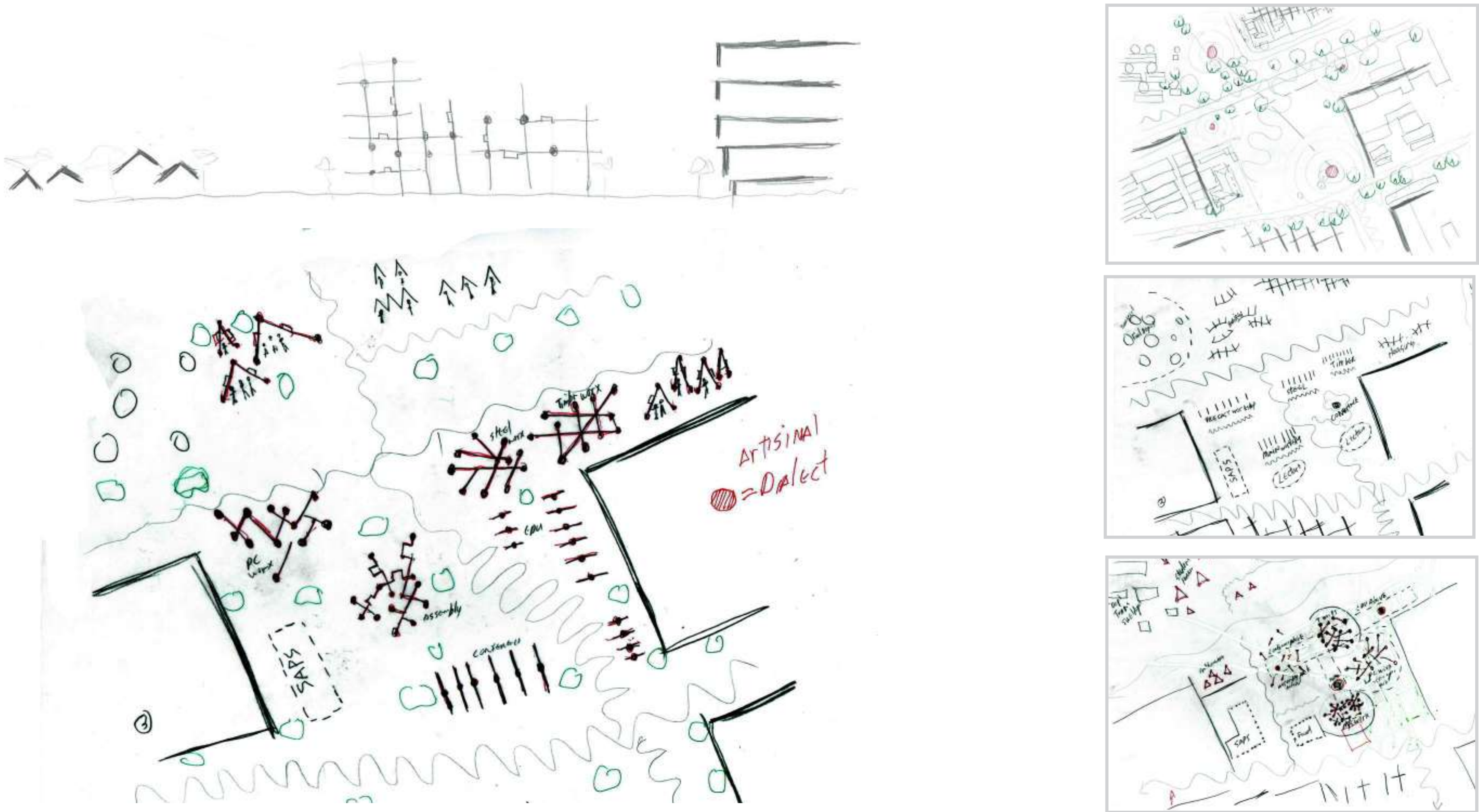


Fig.22: Analysis of possibilities of Site 5_Linking Nico Smit and Eland St (Author. 2019)

Fig.23: Architectural typologies within Koedoespoort(Author 2019)

Fig.24:Buildings to be demolished (March Author. 2019)

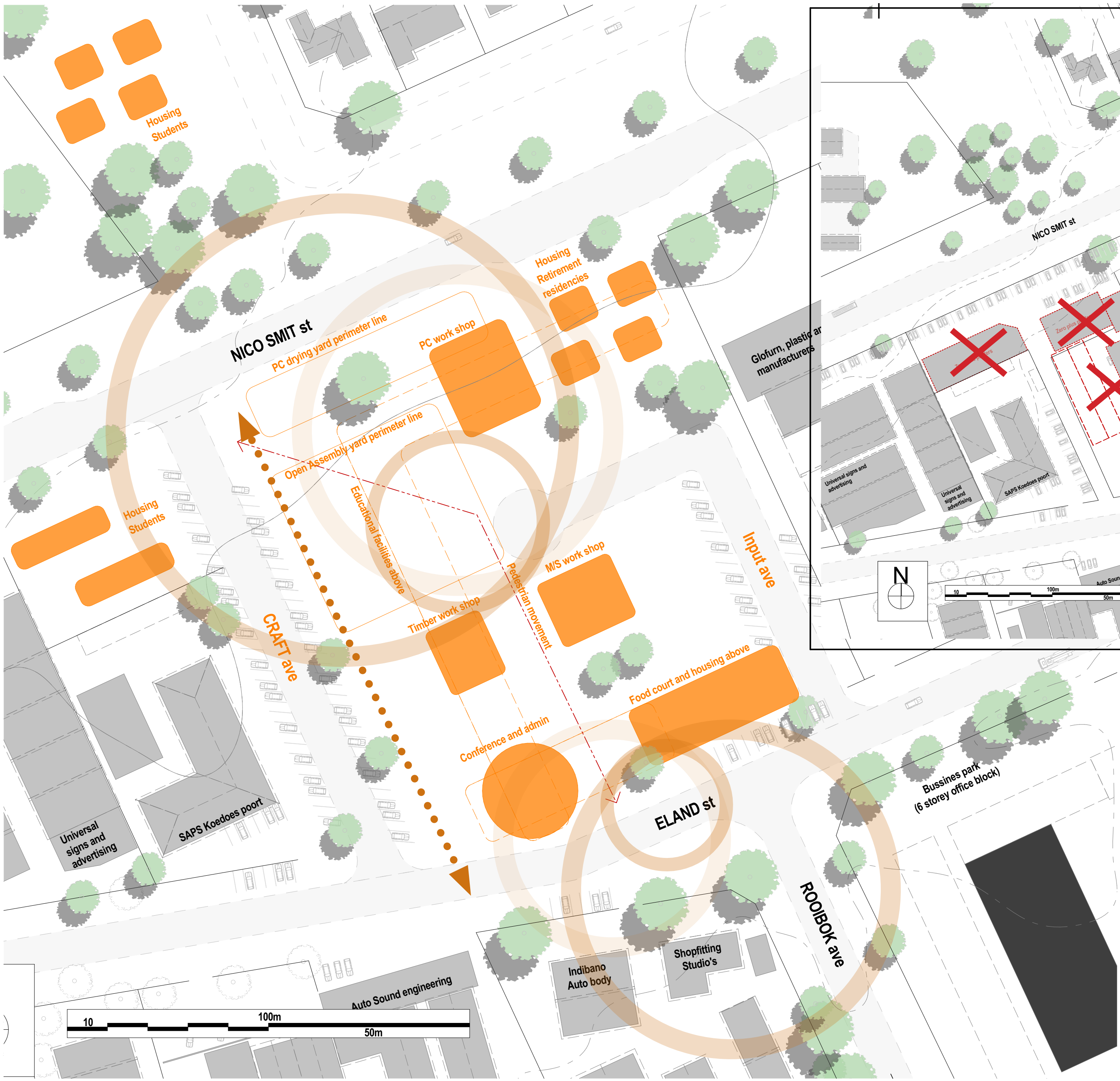
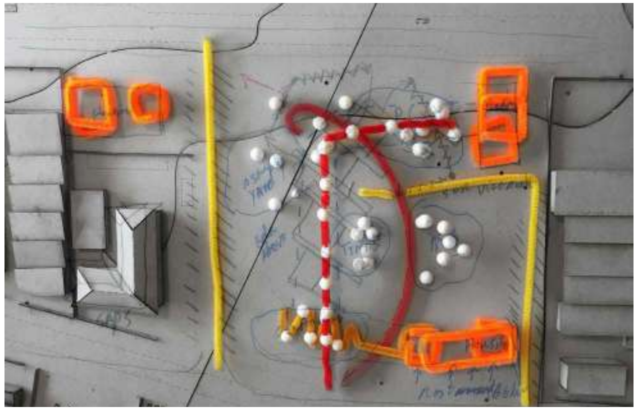
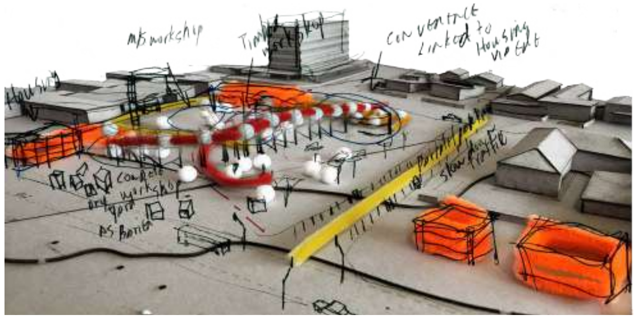


Fig.25:Initial urban proposal. March 2019 (Author. 2019)

Initial Proposal

The re-appropriation of some of the warehouses and buildings was taken into consideration. The printing works and AJs plastics will be relocated within in the Koedoespoort compound. The buildings will be demolished to create a clean slate for an urban development that can connect the OSM precinct to Nico Smit street. The steel and other elements that can be re used will be recycled and used in the new development. The buildings of the Chicken management services and Sams place, will be re-appropriated.





Knowledge exchange
physical workshops or education

Housing
Students, residents or professionals

Pedestrian movement
either within buildings or open air

Public movement
Main traffic routes or service routes

Admin and Conference
Main traffic routes or service routes

Fig.26: Initial urban proposal model. March 2019 (Author. 2019)

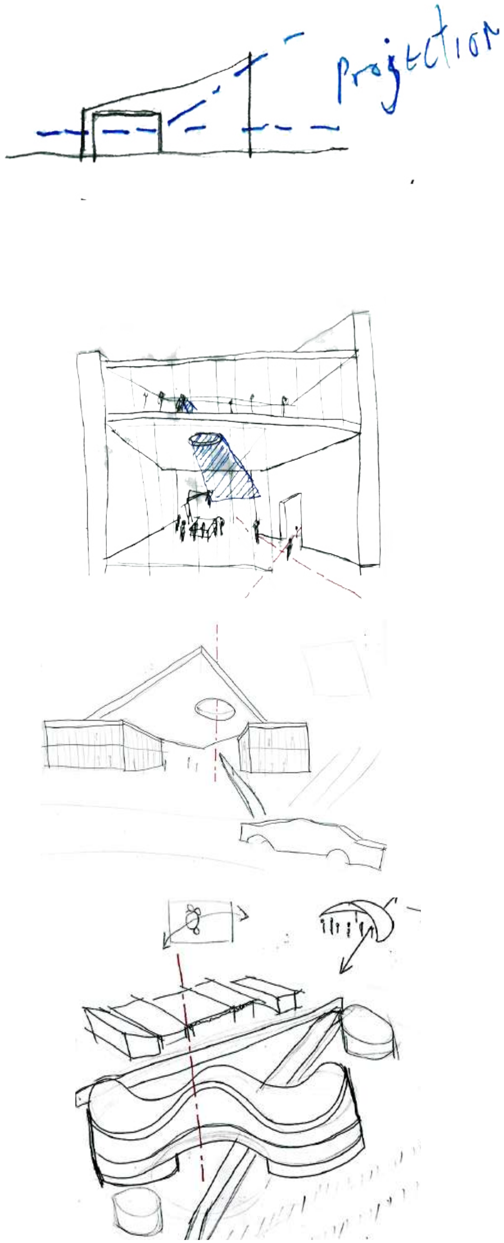


Fig.27: Conceptual Urban intentions March 2019 (Author. 2019)

Theoretical approach

At the core of the OSM facility the reason for its existence must be questioned. How the facility would be creating change or contributing to the continuum of architectural knowledge, as well as contribute to its imminent surroundings in a socio-ecological and economic sense, is critical. With the site firmly established in a relevant context. A brief historic overlook and the thoughts of a few philosophical as well as directly architectural thinkers will be critically reviewed and amalgamated in the following chapter. It is important to not think of the references as a hierarchical build up to a normative position for the OSM facility. The aspects looked at is a scattered array of thoughts found relevant, or indicative of the changes in the attitude needed to establish a premise for the OSM.

Historical background

Since Classic Antiquity Architecture and the creation of space was an art practiced in guilds separated from academies in the pre-medieval ages(Celanie. 2012). During the Middle Ages Architecture was still not considered a liberal/'science' art such as maths, logic, grammar and even music. It was only during the Renaissance period that a shift from artisanal knowledge transfer to scientific based knowledge transfer took place(Celanie.2012). This was made possible via the discovery that discussion of drawings and literal theories has scientific value. Role players such as Alberti, Leonardo and Brunelleschi acted as key agents for this transition. What this shift in thinking indirectly manifested into, was a move away from the direct/tacit ontological dialectic of the technological improvements that happened in workshops or on site. All the complexities and impacts that enlightenment had on the built environment need not be discussed in detail in this dissertation. A relevant outcome that needs to be discussed is the fragmentation of trades/responsibilities that individuals had on a building site. I believe that it is the fragmentation of these age old traditions that is depriving us from the necessary tacit knowledge to create meaningful architecture on all scales. The advantages of this shift to the scientific mode of creating/talking about architecture, is that advances in a 'theoretical' sense could be tested and discussed, away from the tedious labours of working in a workshop. What this shift during the Renaissance also created in the long term was focus on developing clear splits between individual professions with individual responsibilities in the built environment conundrum. I find the development of individual professions beneficial.

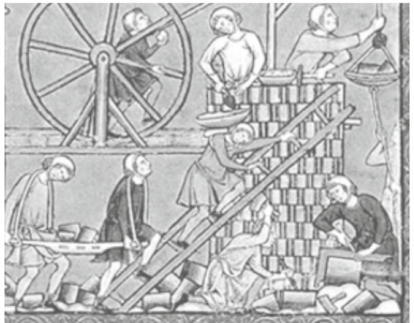
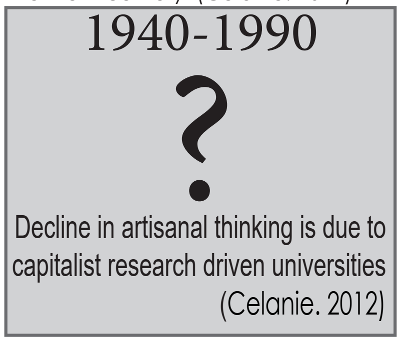


Fig.28: Medieval guilds (Celanie. 2012)

Fig.29: Diagram of split in thinking of enlightenment(Author. 2019)

Fig.30: Bauhaus workshop in the early twentieth century (Celanie. 2012)



It is the romantic attitudes toward the limitations of constituent professions of the built environment, due to the fragmentation of industries, which are problematic. The loss of artisanal dialect on construction sites, with contextual materials and contextual social structures, is what causes this romantic attitude.

Philosophical review

The psychology of matter, material and form being manipulated into usable objects or buildings is very relevant to this subject at hand. The creation of matter, forms, objects, buildings and even cities for the most part of the last 200 years has been happening within factories. The essence of this though is that the matter is being displaced from one area to the next. In the broad spectrum, it causes specific material from one context to be implemented in another context for a specific use, without consideration that there could have been a material within the context appropriated for the same purpose. Pisig(1974) alludes to the empirical problem of the material driven culture of the modern era. He (Pisig. 1974) contributes that the meaninglessness of material/objects in all forms and sizes is due to obscurely romanticized processes of its creation, a industrialized process, predicated on economy. In short what his arguments in his seminal book *'The art of motorcycle maintenance'*, are concerned with is successive theoretical/ scientific knowledge that does not re-evaluate the onset of its own existence: A romantic mode of information transfer that perpetuates mistakes or contradictions. The qualitative aspects of creation is being lost in this mode of thinking. Surely this could also leave room for errors in an ecological sense that would be hard to revert. At this stage reference to Pissig's work should be seen as a broad stroke toward realizing the problems this thinking could generate in the built environment industry. The focus on the industrial processes, like the assembly line that at the core of its thinking is an 'economical process' should be re-evaluated. Not specifically in connection with architecture, but in connection with the meaning that the elements that are mass produced creates.

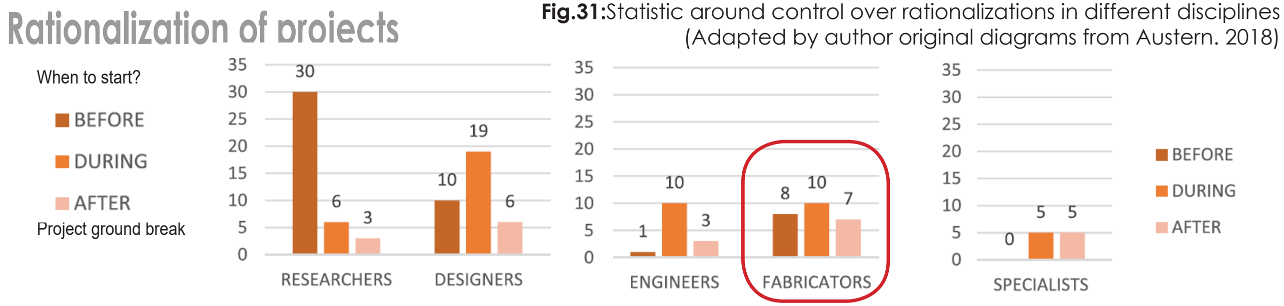


Fig.31: Statistic around control over rationalizations in different disciplines (Adapted by author original diagrams from Austern. 2018)

To contextualize Pisig's argument within the 21st century, as well as understand my outlook towards these matters, the philosophical/psychological writings of Jordan.B Peterson were referenced. Peterson(*Maps of Meaning*. 1999) describes the influx of information on all levels of study as an epistemic crisis, that leads man to thinking that he knows enough of the world and that it is not needed to re-evaluate every instance of ontological knowledge. We might merely reference it from Google or a book and transfer it into any context. This is the general process of building arguments and 'projects'. This may account for the multitude of meaningless copy and paste housing development all around the world. Naming only one atrocity that is beckoning an excuse for capitalists to apprise themselves for contributing to only one of the crisis in our time, housing shortage. Disregarding the long term physiological impact these repetitive soulless interventions would have on both individuals and society. Perhaps it is not developers, architects, politicians or entrepreneurs that should 'save' the world. Perhaps it is the duty of these professionals to re-evaluate their respective vocations, in order to enable societies to help themselves achieve more than previous generations. That is the only way that new, relevant knowledge can be produced. Knowledge that could automatically stabilize societies during shifts in natural, political and economic crisis.

Celanie(2012) refers to '*École de Beaux Arts in Paris*', late 19th century, and the '*Bauhaus in Weimar*', early 20th century, as attempts to recapture this artisanal dialect. In its essence the structure of Bauhaus was a novel attempt. It was based on an apprenticeship model, with a Design Master and a Crafts Master in each workshop (Bauhaus Dessau Foundation 2011). Celanie(2012) found that most schools formed pre-World War two, with similar artisanal aspirations to the Bauhaus, disseminated into universities that thrived on the creation of literal/scientific content to gain respectability after the war. A vast gap in artisanal thinking in academic fields can be found during the second half of the 20th century. At the turn of the 20th-21st century, rapid prototyping labs have become common place in Architectural schools within two decades (Oxman 2010).

Architecturally relevant movements

The influx of self assembly and craft, educating oneself to build anything from google and similar endeavours is an un -precedented phenomenon sparked by the arrival of the Age of Information. Although the notion, of using computer technology in education, is not a direct indication of artisanal dialect as perceived in medieval workshops, the value of this phenomenon as a possible metaphysical call for a return to artisanal dialect is greatly misunderstood and overlooked. The aspirations of up scaling these technologies to become relevant in the built environment are a well-researched topic. Celanie(2012) found that the origins of this phenomenon is due to Mitchell and McCullough of MIT, who have been experimenting with industrial techniques, such as CNC machining and injection moulding in academic laboratories, as early as 1990. During my research, I found that the documentation of CAD/CAM techniques in non-Architectural disciplines of the 1990's, was easy to find. That is not to say that was not happening in Architectural practice or even in industrial manufacturing of architectural elements. These types of technological advances are almost always born from a need to develop specific resolutions in real life scenarios. Frank Gehry has been developing and testing with CNC machines in practice since 1994(Shelden. 2002). Lindsey (2001) documented the process that Gehry had undertaken to practically achieve the free forms of his designs with the use of complex computer numeric geometrical from finding, and termed it rationalization. 'Rationalization' is key to understanding that CAD/CAM technologies are an aid to realizing new advances. Not only in the CAD/CAM field but also

Fig.32: Molenvliet report 1982 (DE DRAGER. YouTube 2019)

in the OSM field. It is the rationalization process and the positioning there-of within a multi-disciplinary continuum that could strengthen economies and social structures in an equitable way, if structured correctly. Austern(2018) researched multiple academic papers on rationalization of architecture from 1990-2018. He(Austern.2018), found the disconnect between the focus of rationalization process practice and academia is evident and alarming. Fig: 31, makes it evident that researchers are the only parties, involved in CAD/CAM continuum, that over-romanticize the pre-rationalization process. It is good that these rationalizations happen in the academic realm. It is also clear that it stays in the academic/romantic realm which is not good. Fabricators seem to be the only discipline that has found a balance approach toward the rationalization of projects with complex nature. We should learn from fabricators in order to extract the benefit from relevant processes for OSM projects. The value in using these advances to aid civic transformation in value chain flows should be investigated. Historically fabricator/manufacturers took materials and capitalised on the manipulation of it by imploring the use of mechanical machines. There is a great possibility that individuals with the aid of professionals can use the efficiencies of CAD/CAM to empower themselves and cut out the middle man.

Habraken's open Architecture theories acknowledges the mode of thinking that welcomes individuals to get creative with architecture. He opposes the notion of modernist architecture to work in styles that could be representative of cultural or architectural 'greatness'. Habraken does not shy away from the reality that people will personalize every aspect of their lives/ homes, because it represents their identity. What is left for Architects to design then? is the critical question he is concerned with. The interfaces between these fluctuating elements; the 'interstitial space'; the permanent spaces or elements that adds value to the temporal spaces; the design of doorways, thresholds, foyers, entrances, entranceway's etc; programming the layout for specific use but leaving it open to interpretation as well -That is what he alludes to. In social housing complexes for example, he concluded that the personalities of the inhabitants can, and should, be expressed at the entrances. Providing the user with the opportunity to do so became important. In the Molenvliet report of 1982, (Fig 32), that reported on Habrakens theories on social housing design. It is described how Habraken and his team sat countless hours with clients guiding them to design and iterate their intentions until each home owner was satisfied that the outcomes represented their personality best. These individual interventions happened in set thresholds or 'entry ways' designed by the architect (Fig 32). In urban design the notion of flexibility can be expressed by specifically designing the elevation parameters of the streets only, to enable individual architect/designers to customize each building. The only parameters taken into consideration was the human scale. This limitation was designed, in order to create continuity of the place as a phenomenological pedestrian intervention. The direct implication is that the individual identities of the buildings, is what would create the identity of the greater context, without much control from a 'master' architect. Each building could have its own barcode as Sjoerd Sutters describes it. (*De Drager,* YouTube, 2019)

The OSM facility taking shape

The possibility of the OSM facility to act as a catalyst in the personalization of buildings from urban to residential scale should not be overlooked at this stage. The architect's role in the facility would be to guide clients, manufacturers, artisans etc. in the superficial understanding of the forms and materiality in the design created by the OSM facility. In the same way engineers would also be able to be directly involved in the creation of the structure and form of the building. And lastly, manufacturers could guide the design professionals on the economic and practical limitations of their intentions. A deeper understanding of OSM would thus be possible. In most part, because it creates an environment for the pre-rationalisation of buildings by all the relevant parties and secondly because it will advance technology and knowledge of previously disconnected enterprises.

The intention of the OSM facility within its context should be clear. This intention should be expressed within the design and expression of the buildings/ precinct. An overall approach would be embodying the notion of interstitial space programmed with the specific intentions of enabling evaluation of the projects being created at the facility. In the larger context two theoretical premises should become visible. Firstly the notion of an alternative means of movement and connectivity between the separate entities and secondly, the notion of the OSM facilty to be a regenerative-personification catalyst. Zooming in on more specific areas the pathways between internal and external assembly areas/workshop will be designed to express movement and visibility. The steel structures of the existing precinct will be re-used to express the notion of regenerative-personification. Interventions embodying the OSM idiom would be expressed on these structures. Moving mechanisms, static shadowing devices or purely functional seating will be designed with the specific intention of being exemplar elements to the ideologies of the facility. The covert aspirations of the OSM facility to not exhaust its own ideology within the design of the facilities will be expressed by creating clear cut differentiation between existing traditional factory/warehousing and the interstitial spaces. To express the development of self-evident interstitial spaces, would be the main concern of this dissertation. Based on the theoretical study this expression, if developed correctly, is key to a contribution to the continuum of architectural discourse.

FORM ? Architectural MECHANISM

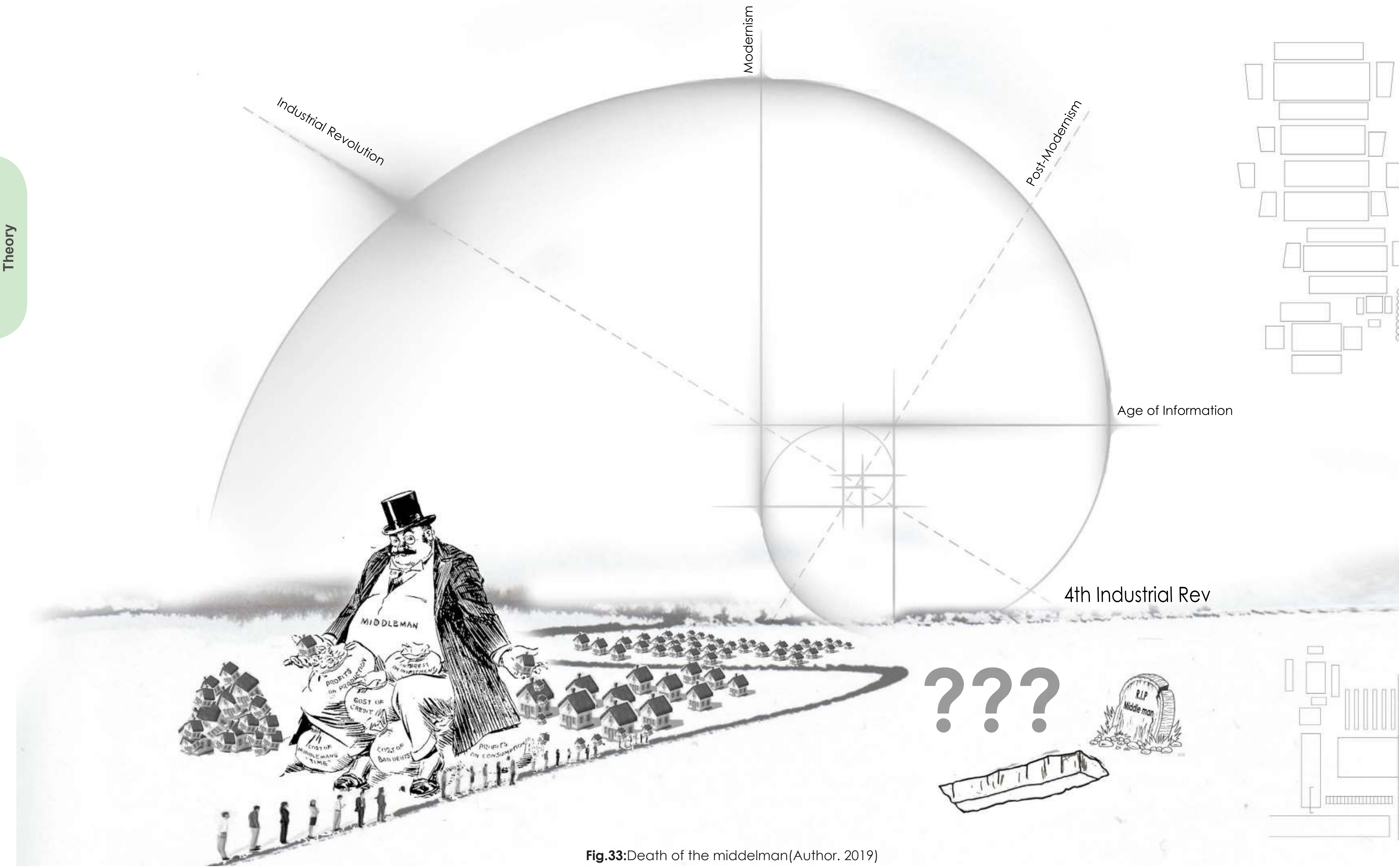
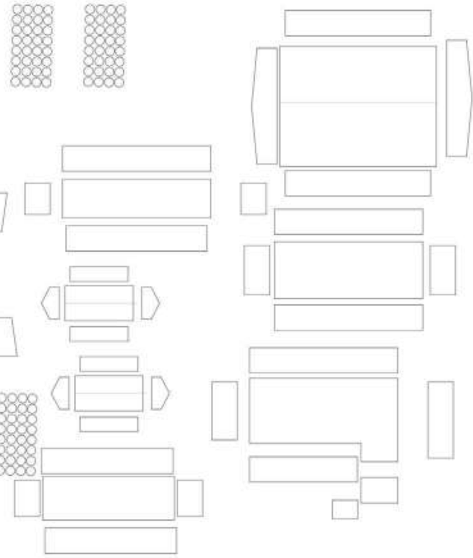
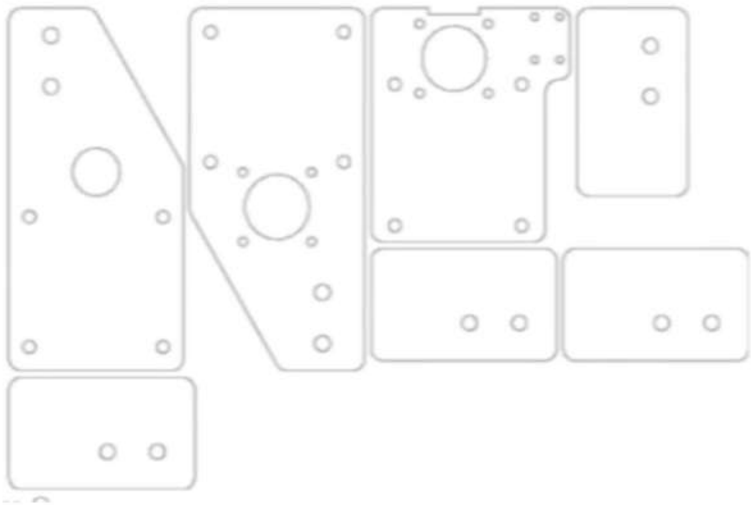
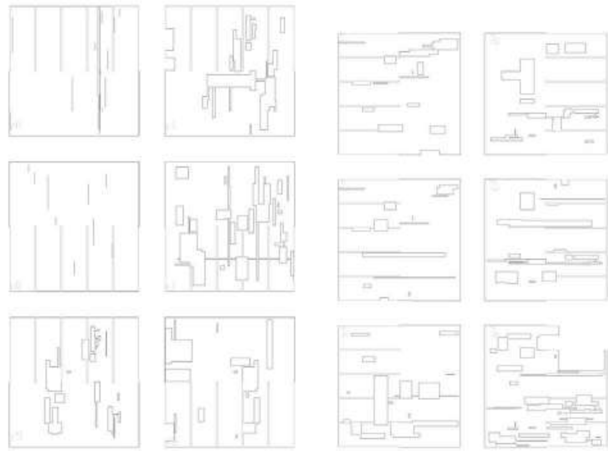
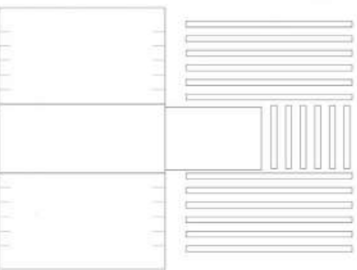
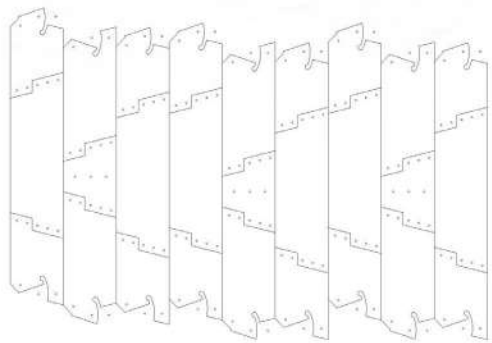
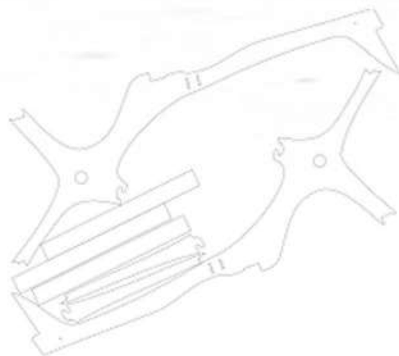


Fig.33: Death of the middelman(Author. 2019)

What could and **should** an **OSM FACILITY do?**

Fig.34: Kunlé Adeyemi's floating shool in Nigeria
(Origional image Iwan Baan. 2019)

Existing artisinal programs in South Africa
(a critical reflection on local opportunities)

The following chapter will deal with the structuring of the client as well as structuring an accommodation list for the OSM facility. Various articles relevant to context and disciplines as delineated were reviewed and will be discussed in a non-hierarchical sense. Funding for the facility and ownership of the facility is an important aspect to its success. Governmental, private or even NGO structuring is possible scenarios. Financial structures aiding both artisans and the private sector in development are in place within South Africa in multiple forms.

South African artisan opportunities

Marope et al(2015) argues that Technical and Vocational Educational and Training (TVET) is quintessential to sustainable development because it encompasses the training of individuals in a holistic real live scenario. The outcomes of these essential artisan programs, are citizens that have a more realistic outlook on their role to play within the micro economies of the individual trades. The question is: Why has the South African artisanal dialect been decaying in the past few decades? In the 'National Artisan Development Program' Expenditure Performance Review 'The Governmental Technical Advisory Center' reported that the decline of artisan training has been a very surreal challenge in the past few decades. In1985 as much as 33000 artisans qualified per year, where-as in 2005 it had an all time low of 4500.

The Skills Development Act of 1998 that introduced learnerships condensed into one year was one of the largest factors contributing to this decline. Since this decline, government has been active in structuring funding for programs focused on aiding the training of artisans. TVET, Accelerated Artisan Programme (AAP) a model and formal apprenticeship training encompassing National Accredited Technical Education Diploma (NATED), to name a few key programs, are all structured to help artisans fund their training. The success rate of the latter funding programs are demoralizing, with only 56% of all participants completing the full program. The main contributing factor to this low output is complicated funding structures. Each phase of an artisan's training is funded by a different constituent. In simple terms, theoretical training is funded by the government, practical training is funded in collaboration with governmental grants and private sector donors and lastly work place training is funded by employers with small grants from government. A coherent outlook in the funding administration system of artisans during the three phases of training (theory, practical and workplace experience) is needed to address these deficits. (GTAC 2017)

The latter scenario although based on the technical sector of South Africa in a very broad sense is an indication that joint initiatives from government and private sector are not successful in contributing to the artisanal dialect of South Africa. Taking the latter arguments in regard it was decided that the OSM Facility should be developed by constituents with interest in the materials relating to OSM facility as delineated in this thesis. The Concrete Society of Southern Africa(CSSA), The South African Institute of Steel Construction(SAISC) and The Institute for Timber Construction South Africa(ITCSA), will be the three parties that will fund, build and manage the MCA.)

Relevant artisanal programs
(Literature review)

The structuring of a curriculum for education combined with the aspects of creating real working opportunities and projects, is a challenge that the OSM facility will face. Examples of international education models that focus on artisan training have been sought out and reviewed. It was found that very few design schools directly imply that they train in the artisan idiom. The New School (TSN) is a design school in New York that has a program focusing on developing partnerships between design professionals, possible investors and artisans. Lawson (2010) states that the standard tertiary educational model, with semester terms and exam outcomes at the end there-of, keeps universities too busy to connect learners with opportunities that could further their personal careers. To this end TSN tailored a course “The New School Collaborates’ as a project that would be focused on project based outcomes without semester driven timeframes.

The first project was structured around the idea that design students teach entrepreneurship programs to a group of Mayan women in Guatemala. That would enable them to upscale and export their weaving craft products via pre-established partners in America. In this program Lawson(2010) adopted ‘The Collective Leadership Partnership Cycle (Fig.35) with some success. The program was essentially a partnership initiated by NTS’s students, driven by the women from Guatamala and funded by CARE (a global humanitarian NGO). Lawson found that the most critical aspect of running multinational and multidisciplinary projects with the aspirations of empowering unskilled and semi-skilled labour is clarifying goals and identifying resources(fig.35). The greatest setback of the project was that the summer educational programs, which ran over a course of two years, inherently fragmented the focus of individuals.

The initial intention was to break from the idea that a single member of the Mayan women society take charge and have all the answers to carry the project forward by teaching the same material to all. What this lead to, was a miss calculation of resources and the intentions of the resources. Within a few months after the summer school, the project almost folded. On return the following year it was decided to first establish the role that individuals want to take within the Mayan weaving community before educating them on specific aspects that would ad value to their own intentions within the project. This re-established resources, as well as structure the processes of the project in a way that clearly define outcomes. The women also felt that they had more freedom to contribute by being able to share specific knowledge in a synergistic model. The feedback loops created in the later approach is explained in fig.36. The non-linear processes and semi-hierarchy of the system must be acknowledged at this stage.

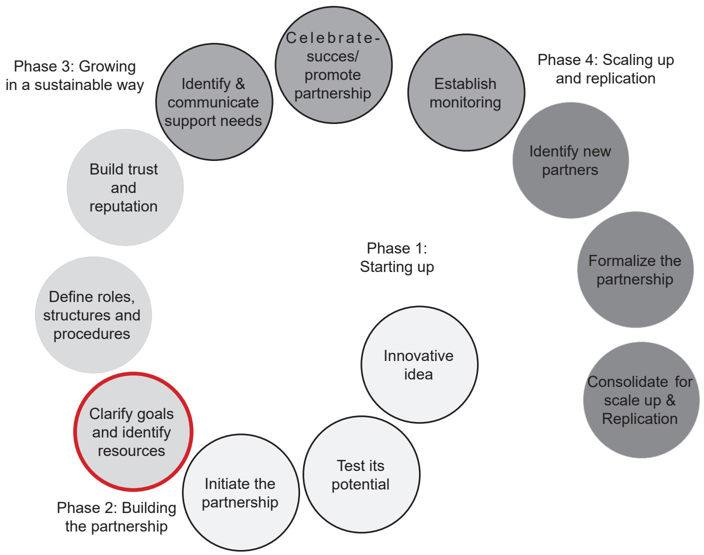


Fig.35: Multidisciplinary partnership projects process cycles (Margolin, 2007.)

Linear processes

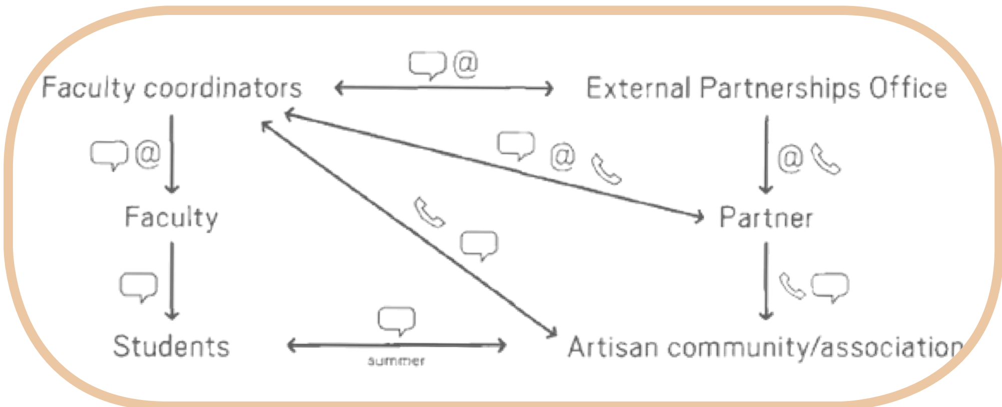


Fig.36: Adaptation of partnership cycle by TNS (Lawson, 2010)

Reciprocal/non-linear processes

'Particulate' as client

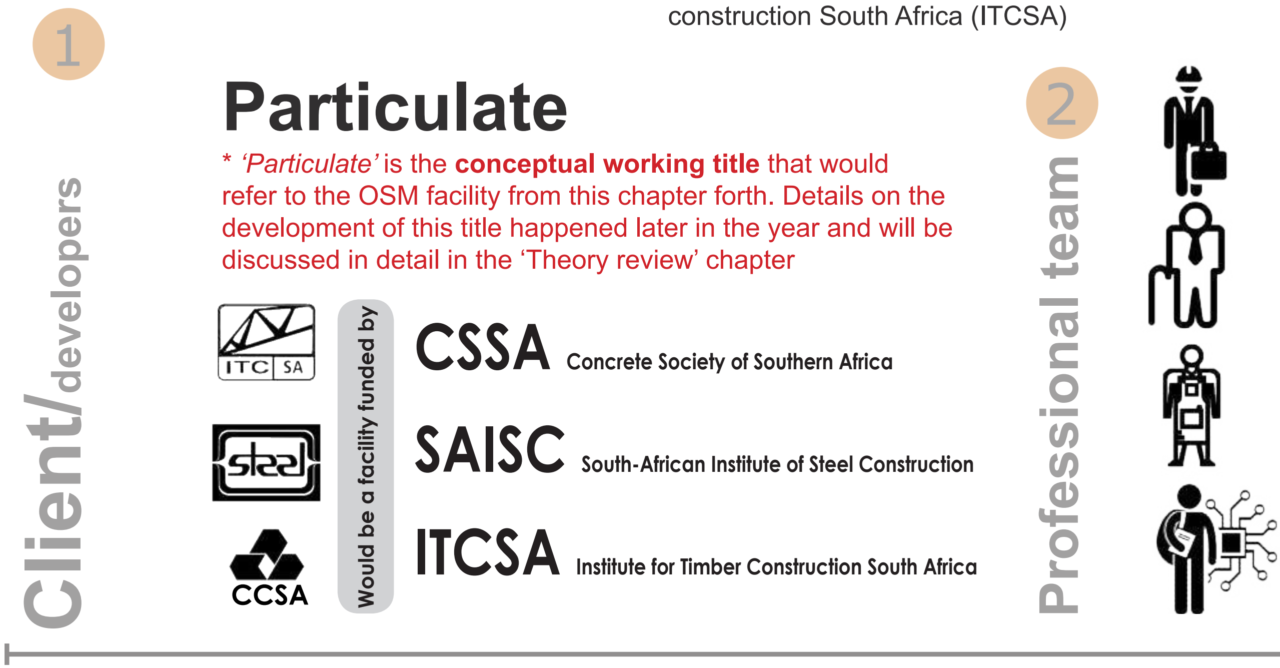
(Client and Program development)

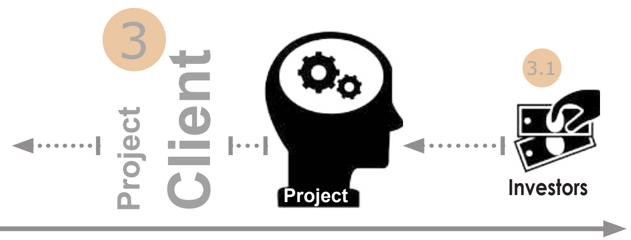
Taking all factors discussed in this chapter thus far into regard, the structuring of financial as well as physical entities of the OSM facility, hence forth ***'*Particulate'*** will be developed in the following pages. Particulate will focus on the structuring of artisanal programs that could benefit multiple parties via the exchange of knowledge and other commodities in a reciprocal manner. The 'client' is structured out of four semi-hierarchical parties/role-players.

The main role-player is a corporate entity responsible for the administration of education programs offered, the maintenance of the facilities and responsible for the success of all projects produced *'Particulate'*. In a real world scenario the facility could be funded and actualized by constituents with interest in the development of the three main raw materials that the OSM facility will focus on: Concrete Society of Southern Africa (CSSA), South African Institute of Steel Construction (SAISC) and Institute for Timber construction South Africa (ITCSA)

The second role-player is the professional and artisan team assembled and appointed by the corporate entity/ Particulate to conceptualize, develop and produce projects. This team is compiled on a project term base and may be altered once after the conceptual phase has been approved by the project client. Parallel to assembling a professional team, '*Particulate*' approaches private clients -the third role player- that wants to use the unique ability of the facility to develop specific projects in the OSM idiom. A project is then initiated and handed over to a professional team.

The third role player will mainly be centred around a project client that has an idea or specific project/ product to be developed. An additional third role-player may be added in the process with the approval of the main project client. This additional third role-player may be material suppliers, manufacturers or corporate artisan sponsors. These role-players may invest money in projects as social investment with the added benefit to incur possible tax breaks for South African companies and sharing in profits. The founding members of *'Particulate'*(SAISC, SAISC and ITCSA) will also focus on acquiring social investment grants from international constituents of their respective trades to fund research and individual artisans. The profit will be split amongst all parties partaking in the project via block chain.





Accommodation development

In an attempt to express the ability of Particulate to redefine interstitial spaces, the development of a formal program or accommodation list will focus on creating space that will enable reciprocal knowledge trade between the role players of the MCA as well as the imminent industrial community of Koedoespoort. The reason for the split in 'Romantic' and 'Logical' elements within the complex can be read in the theoretical chapter of the dissertation. For now, the accommodation makes it clear that the complex should be divided into two parts. A northern flank, that would have all the factories necessary to upscale the prototyped projects of the MCA. The main building (southern flank) that would house all the educational, administration and prototyping as well as link into the Housing of the Artisans. This flank also becomes the most social part of the complex that directly links with Koedoespoort. Ramsey(youtube. 2019) argues that the layout of a workshop should consider the static and flexible elements in balance. The most static elements should be placed strategically against a wall. Within the whole facility compound the positioning of static and flexible elements should be clearly legible. For this reason the focus of the dissertation will be to design the most social interface of the building. The unorthodox challenge of designing prototyping facilities, housing and educational facilities as a socially visible interaction, is key to developing a building that can represent this new model of thinking about OSM .

MCA_ Accommodation schedule

Program	Sub functions	Qty	approx area needed	total area	Static <----------------> temporal index
Timber workshop	CNC machine	4 units	16 m^2	64 m^2	
	Temp storage area	7 units	6 m^2	42 m^2	
	6-axis robotic arms	2 units	12 m^2	24 m^2	
	Lamination press	1	12 m^2	12 m^2	
	Add 70% for movement/circulation area	142	0.7 m^2	99.4 m^2	
			Sub total	241.4 m^2	
Steel workshop	Temp storage area	2 units	25 m^2	50 m^2	
	Plate cutting machine	2 units	16 m^2	32 m^2	
	Plate bending machine	2 units	16 m^2	32 m^2	
	Plate roller(Big and small)	2 units	16 m^2	32 m^2	
	Plasma CNC	2 units	20 m^2	40 m^2	
	Wellding area	2	50 m^2	100 m^2	
	Add 70% for movement/circulation area	286	0.7 m^2	200.2 m^2	
			Sub total	486.2 m^2	
Concrete workshop	Form work manufacturing	3 units	50 m^2	150	
	Form work assembly	3 units	50 m^2	150	
	Custom casting area	3 units	50 m^2	150	
	Production line cating strips	2 units	100 m^2	200	
	Additive manufacturing plant (3DCPrinting)	1 units	80 m^2	80	
	Rebar procesing area	1 units	50 m^2	50	
	Concrete bacthing plant inside/outside	1 units	50 m^2	50	
	Add 70% for movement/circulation area	630	0.7 m^2	441	
			Sub total	1271	
Assembly Warehouse	Storage of fabricated loose parts	3 units	100 m^2	300	
	Assembly spaces/lines	8 units	50 m^2	400	
	Storage of assembled products	3 units	100 m^2	300	
	Process offices	2 units	12 m^2	24	
	Workshops/public Bathrooms	1 units	80	80	
	Add 50% for movement/circulation area	1104	0.5 m^2	552	
			Sub total	1656	
	Housing big conferences	1000 people	1 m^2	1000	
Bulk storage warehouse	Steel storage	1 units	100 m^2	100 m^2	
	Timber storage	1 units	100 m^2	100 m^2	
	Cement storage (perhaps out door)	1 units	100 m^2	100 m^2	
	Hardware storage	1	40 m^2	40 m^2	
	Admin offices	1	10 m^2	10 m^2	
	Add 40% for movement/circulation area	340	0.4 m^2	136	
			Sub total	486 m^2	
Main Building	Foyer	1 units	20 m^2	20 m^2	
	Reception area	1 units	10 m^2	10 m^2	
	General admin	4 units	12 m^2	48 m^2	
	Educators open offices	1 units	80 m^2	80 m^2	
	Education room conversational/boardroom	8 units	10 m^2	80 m^2	
	Education room informational (lecture)	2 units	80 m^2	160 m^2	
	Library	1 units	60 m^2	60 m^2	
	Bathrooms	3 units	20 m^2	60 m^2	
	Virtual proto typing area	1 units	80 m^2	80 m^2	
	Tactile proto typing room	1 units	30 m^2	30 m^2	
	Conference(Small)	1 units	80 m^2	80 m^2	
	Student Studios (Open office areas)	4 units	30 m^2	120 m^2	
	Add 20% for movement/circulation area	828 m^2	0.2	165.6	
			Sub total	993.6 m^2	
Proto typing annex	Laser cutter	2 units	8 m^2	16 m^2	
	6-axis robot for polystirene molding	1 units	12 m^2	12 m^2	
	3D printer	1 units	8 m^2	8 m^2	
	Small CNC machine	1 units	8 m^2	8 m^2	
	Assembly area	2 units	20 m^2	40 m^2	
	MaterialStorage/Sample room	1 units	20 m^2	20 m^2	
	Add 70% for movement area	104 m^2	0.7	72.8 m^2	
			Sub total	176.8 m^2	
Housing	Students: 2student for each 30m^2 of Main building and annex capacity Each student is allocated 25 m^2 of housing	1170.4 m^2	78.0267 units	1950.66667 m^2	
	Permanent Staff: 2 Staff members can have housing for each 500m^2 of the complex	5311 m^2	10.622 units	21.244 m^2	
	Residency staff: 4 Residents can have housing for each 400m^2 of the complex	5311 m^2	13.2775 units	53.11 m^2	
	Add 20% for movement/service area	2025.0207 m^2	0.2	405.004133 m^2	
			Sub total	2430.0248 m^2	
Parking	Workshops/warehousing	4140.6 m^2	1.5 /100m^2	62.109 bays	
	Housing	88.648667 units	1 per 3 units	29.5495556 bays	
	Main building/Offices	1170.4 m^2	4 /100m^2	46.816 bays	
			Sub total	138.474556 bays	

Total for MCA		
	Workshops/warehousing	4140.6 m^2
	Housing	2430.02 m^2
	Main building/Offices	1170.4 m^2
	Sub total	**7741 m^2**
	Erf size	18640 m^2

Fig.37: Accommodation schedule (Author, 2019)

Program, theory and form finding

The amalgamation of the theory regarding attitudes toward artistisanal dialect of the previous chapter and the theories as laid out in the program chapter is attempted(Fig.38). The distinction between the two schools of thought and how they should influence space-making should be prevalent at this stage, as it is the intention of this dissertation to bring forward architectural forms/typologies that could aid in the continuum of the architectural discourse. When considering Habraken's theories -of designing interstitial space and leaving the rest open for interpretation by the user- it can be clearly seen that the split between Romantic and Logical thought greatly influences the architectural forms housing the day to day activities within the proposed facility. This gives the opportunity to start developing specific links between the programs and positioning functions of the facility strategical to benefit the needed reciprocal attitude of the OSM facility.

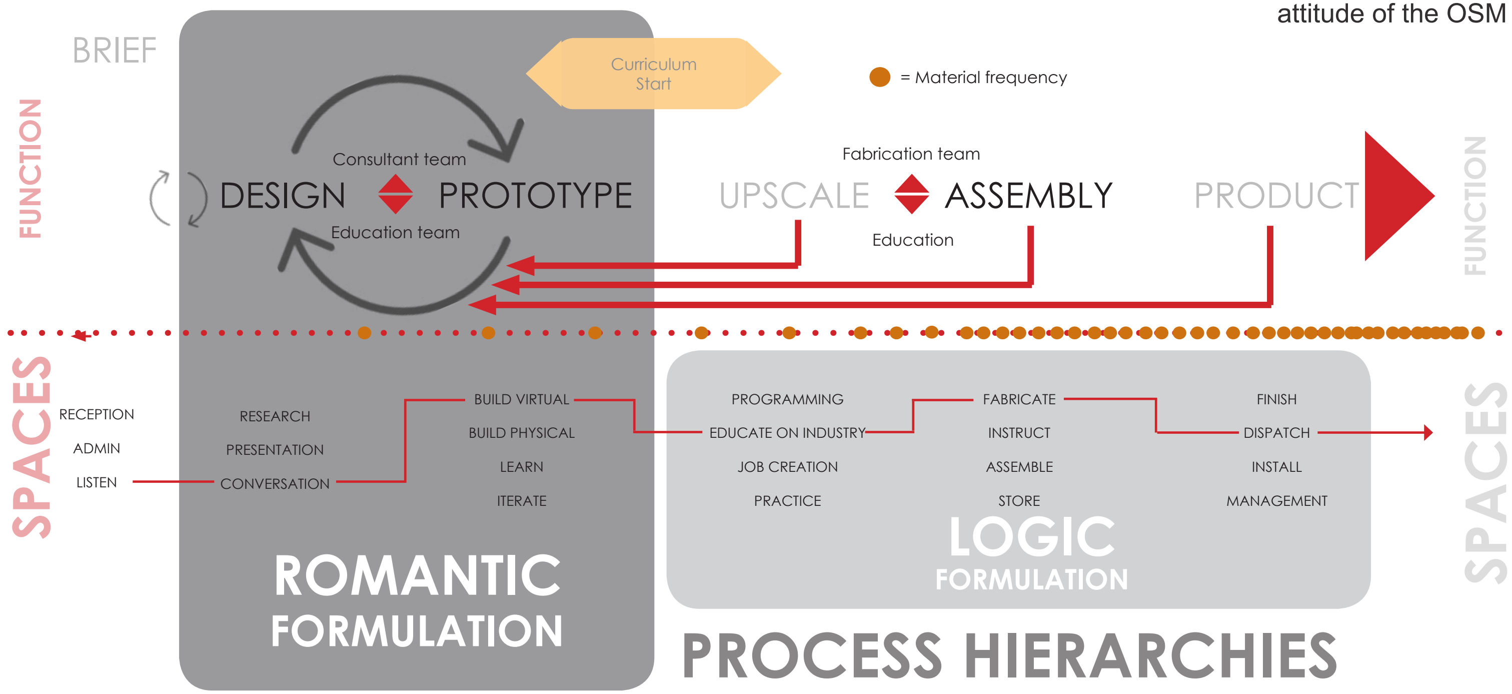


Fig.38: Diagrammatic representation of theory and program intentions (Author, 2019)

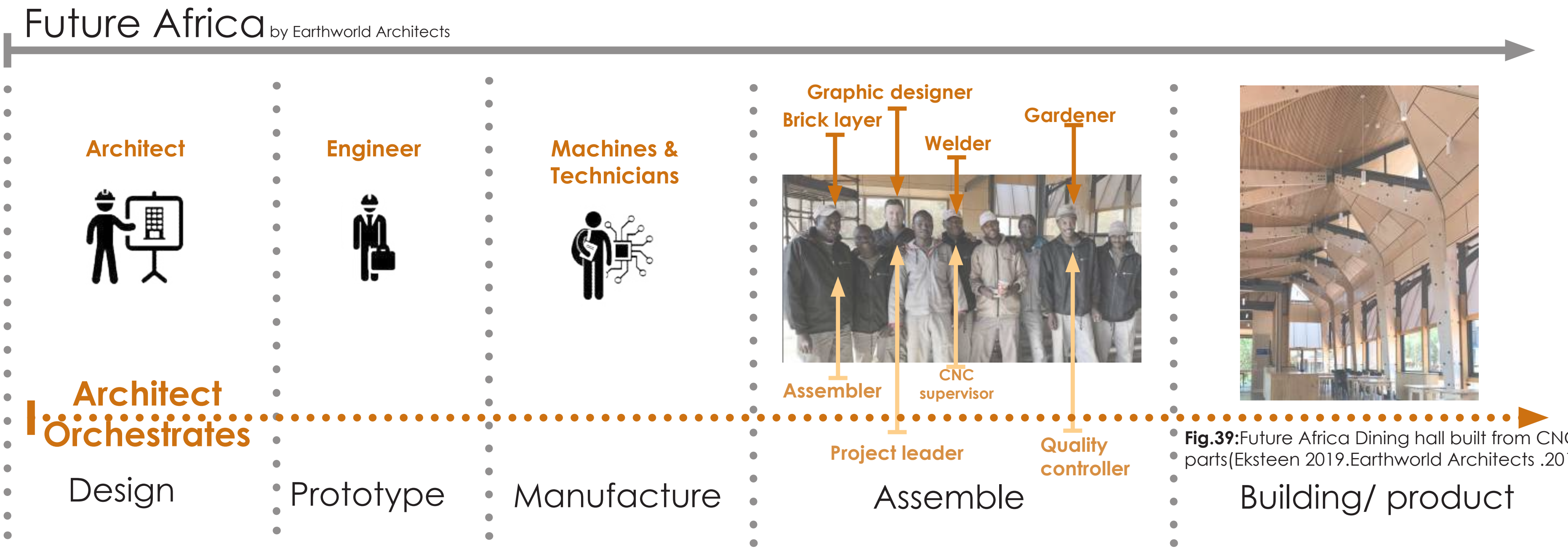


Fig.39: Future Africa Dining hall built from CNC parts(Eksteen 2019.Earthworld Architects .2019)

Fig.40: Diagram of OSM process (Author. 2019)

Contextual precedent

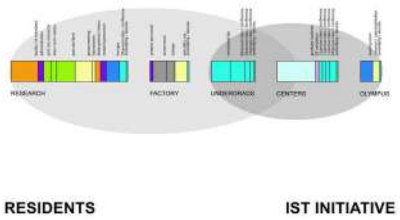
As a contextual precedent Eksteen's Dining Hall (Fig.2 and Fig 39) at the Future Africa campus was researched. Here CAD/CAM technologies enabled the architect to design the timber portal structure, test the prototype with engineers, manufacture the parts and assemble them on site. The development of the structure took approximately 6 months. The assembly of the structure on site took approximately 1 month. What is important to mention is that the same techniques and lessons learned were transposed by Earthworld Architects and the manufacturers, in the development of the adjacent building(The Future Africa Conference Centre); with a one month design/development time and an assembly time on site of less than a month. The key ingredient in both the structures was to create portals out of LVL(Laminate veneer lumber) puzzle pieces no larger than 3meters. Eksteen(2019) claims that a sense of community, pride and upliftment was tacit during and after the project, due to the achievement of building such a large structure with minimal machinery on site. Only hands and a small telehandler were used and a lot of new skills relating to project management and non-conventional construction was transferred to semi-skilled labourers.

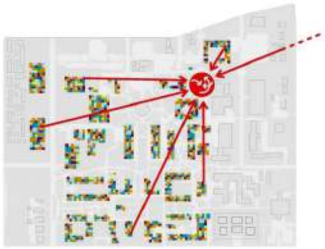
Fig.41: OSM Landscape (Author. 2019)

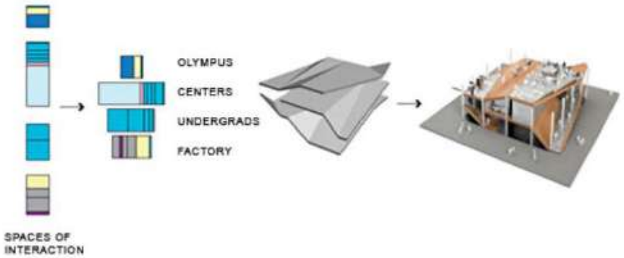
Functional precedent

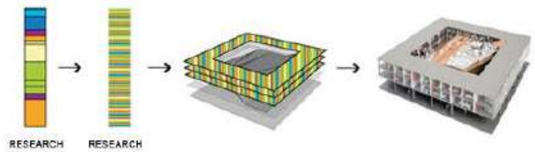
It is clear that a distinct mechanism should be implored to actualize the overt intentions, marrying the Romantic and Logic attitudes, of the OSM facility,as described in the theory chapter. In order to develop an Architectural mechanism a relevant precedent, that explores the idea of threading together such multidisciplinary faculties, was investigated.

Information centres are not usually social spaces. It is a place where one waits to get served and then move along. The intention of the Anneberg information Centre is the inverse. Interaction between science and technology departments is becoming critical in the 21st century. A mechanism that would emphasize this phenomenological movement in an architectural form was developed by REX. A multi-functional core that was to become a social space that one had to move through before entering their different departments within the building was developed. This core housing an amphitheatre/chill space, coffee shops and information boards, scoops up the user from the landscape in a semi-circular motion. This creates an Axis-mundi that reconfirms the location as a gathering place within the urban context. A rim, using light technologically advanced materials, floating around the core anchors the latter notion.









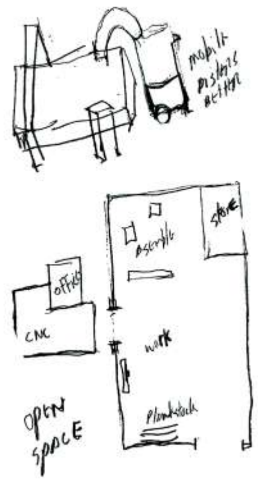
Joshua Ramus/REX_

California USA_concept 2006
Annenberg Centre for Information Science and Technology II

Fig.42: Annenberg Center for Information Science and Technology II(all images by REX. 2019)

Practical precedents

Visits to three relevant factories were made. Long discussions with the founders and workers of the factories translated into knowledge that cannot be put to paper with a few simple words. Summaries of the atmospheres and practical ordering systems relevant to each material were made.



Funkt Woodwork (Factory visit 19.05.24)

354 Derdepoort Rd,
Silverton, Pretoria, 0081
Gauteng - South Africa

Owner: Stefan Hefer (for 10 years)
Occupation: Carpenter, previous occupation Senor Architectural Technologist)
Specialty: Fabrication custom commercial cabinetry and wood works

Findings:

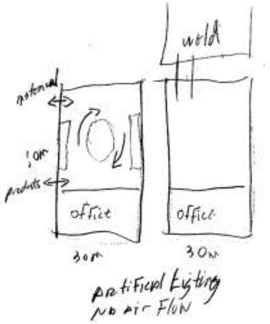
- Small teams work more effectively. For custom work. Small factories also more effective.
- Sawdust can become highly flammable so rooms must be naturally ventilated and dust controlled.
- Mobile duster much more effective than big static dusters.
- Storage does not take up much space. Depending on sizes of boards.
- When painting with polyurethane paint extractors need to be up-stream from paint fumes.
- Custom projects take up a lot of administration time that could be spent on developing craft.

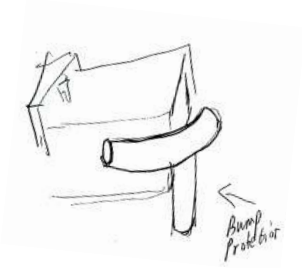
-15 Staff. approx 3 are for administration/management. 12 carpenters/installers

Precedent

All images from care website(Kare. 2019)

No photos or drawing were allowed during factory visit due to confidential project on floor





Sunbake (Zero house)

un-authorized material
Bad factory conditions

Kare Sheet Metal (Factory visit 19.04.31)

355 Moot St,
Hermanstad, Pretoria, 0082
Gauteng - South Africa

Owner: Uli Retter(2nd Generation_Circa 1971) represented by Louis Koekemoer
Occupation: Metal workor and entrepenuer
Specialty: Sheet metal works, cutting, bending & welding. Small to large scale

Findings:

- Factory big. 60x30m. 3 off. two for cutting and bending and one for welding.
- No big cranes needed. Only more effective when cutting 16mm plus sheets
- Departments need to be split. Cutting area, bending area, rolling area and welding/assembly.
- Lots of open space needed for movement. protect machinery with bump guards.
- Shelves to organize cut parts, very beneficial close to cutting machines.
- Low levels of staff on cutting floor, more on welding and bending.
- 150 Staff. approx 30% are for administration/management. . 20% for machinery and 50% laborers/welders.

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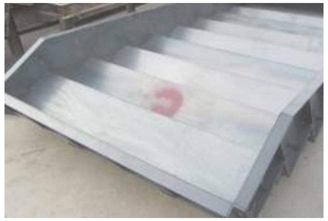
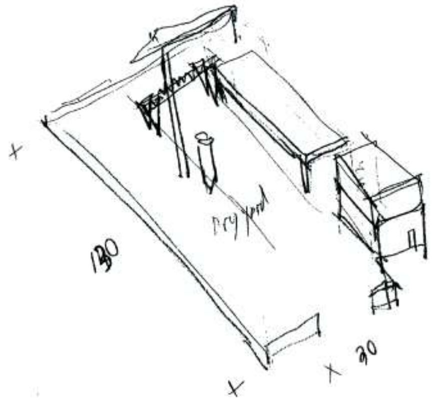






Specialised Precast Elements (Factory visit 19.04.24)

11 Blesbok Av Koedoespoort Industrial
0186 Pretoria
Gauteng - South Africa

Owner: Paul van Rooyen (for 20 years_40 years in pre-cast industry)
Occupation: Structural engineer
Specialty: Design/Fabrication of pre-cast custom structural elements

Findings:

- Long narrow yard. 130mx30m, efficient for moving elements. only 20% of area under roofs. Office small 10x10m(two storeys)
- Timber moulds used very seldom, can possibly increase if skills in close proximity
- Gantry crane for heavy loads 10 tons +, Boom crane fast for loads below 7 tons.
- Setting up on-site casting facilities is difficult due to lack of specialized knowledge
- 70mm temp slab(permanent shuttering) can span 11m, 100mm(plus) in-situ concrete strengthens to full potential effective neat hybrid solution.

-UHPC(ultra high performance concrete) can strengthen up to150mpa in S.A. depending on mixtures. Self-tensioning without re-bar

-40 Staff. approx 10 are for administration/management. 30 labourers/welders/riggers etc.

Urban developments

The precedents and research set the scene to start further development of the 'Particulate' complex within its context. Multiple iterations at exploring form and expression of the ephemeral intentions of the facility lead to a few unexpected discoveries.

-The site has large opportunity to react as a social catalyst on 3 fronts, north, west and south.

- The re-use of the three existing buildings enables a new landscape to be formed between the SAPS and the facility. This will be an important link to develop.

- Projecting the intentions of the OSM facility to the greater context by means of forms should be very specific and carefully thought through.

Fig.43: Legend for all concepts(Author 2019).

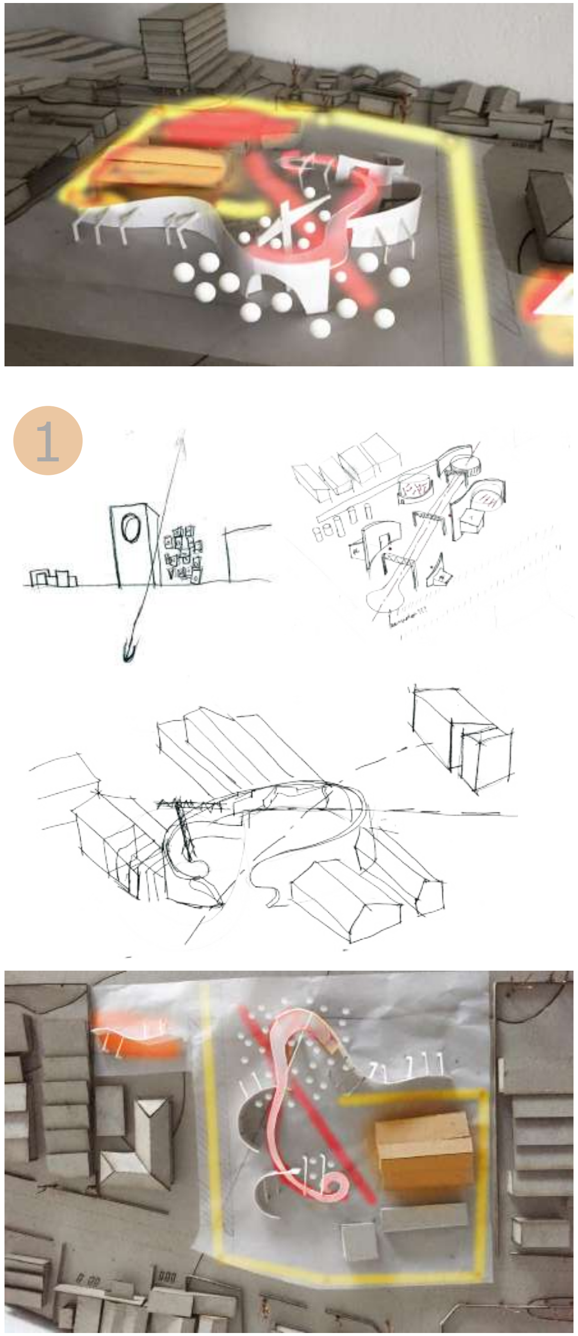


Fig.44: Concept development 1, free form, March 2019 (Author 2019).

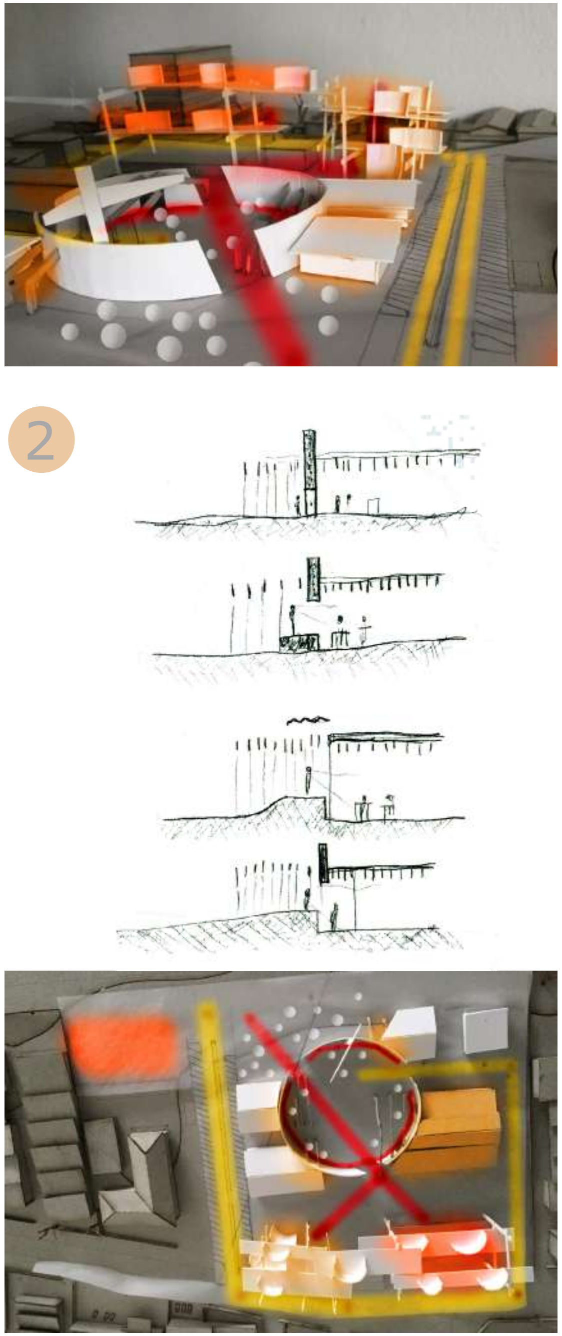


Fig.45: Concept development 2, Centralized yard, March 2019(Author 2019).

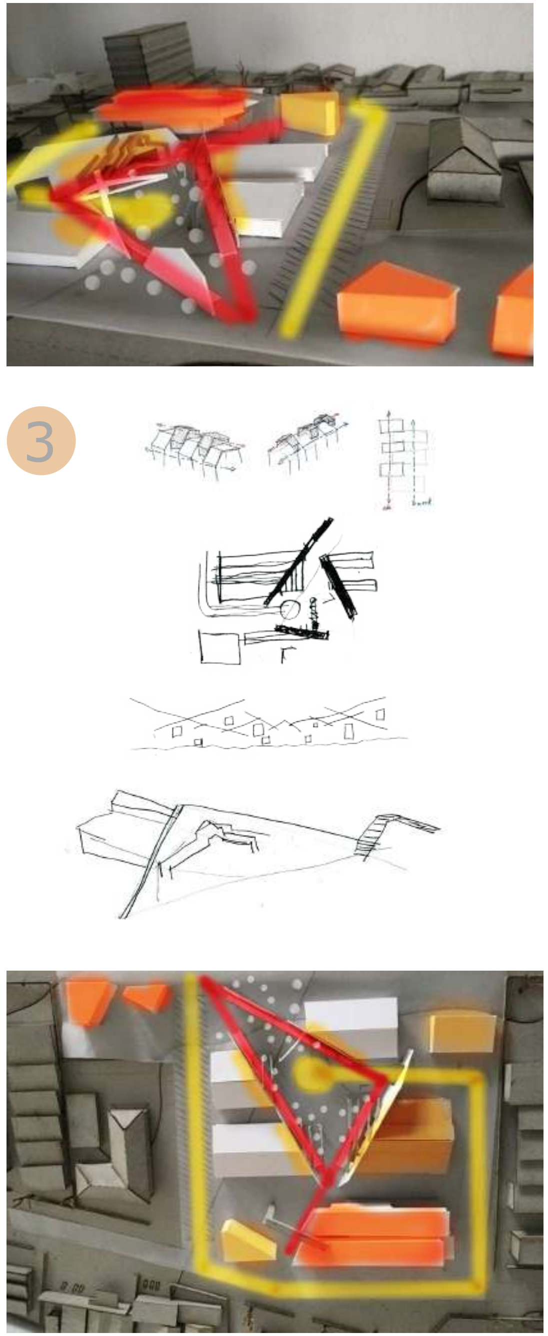
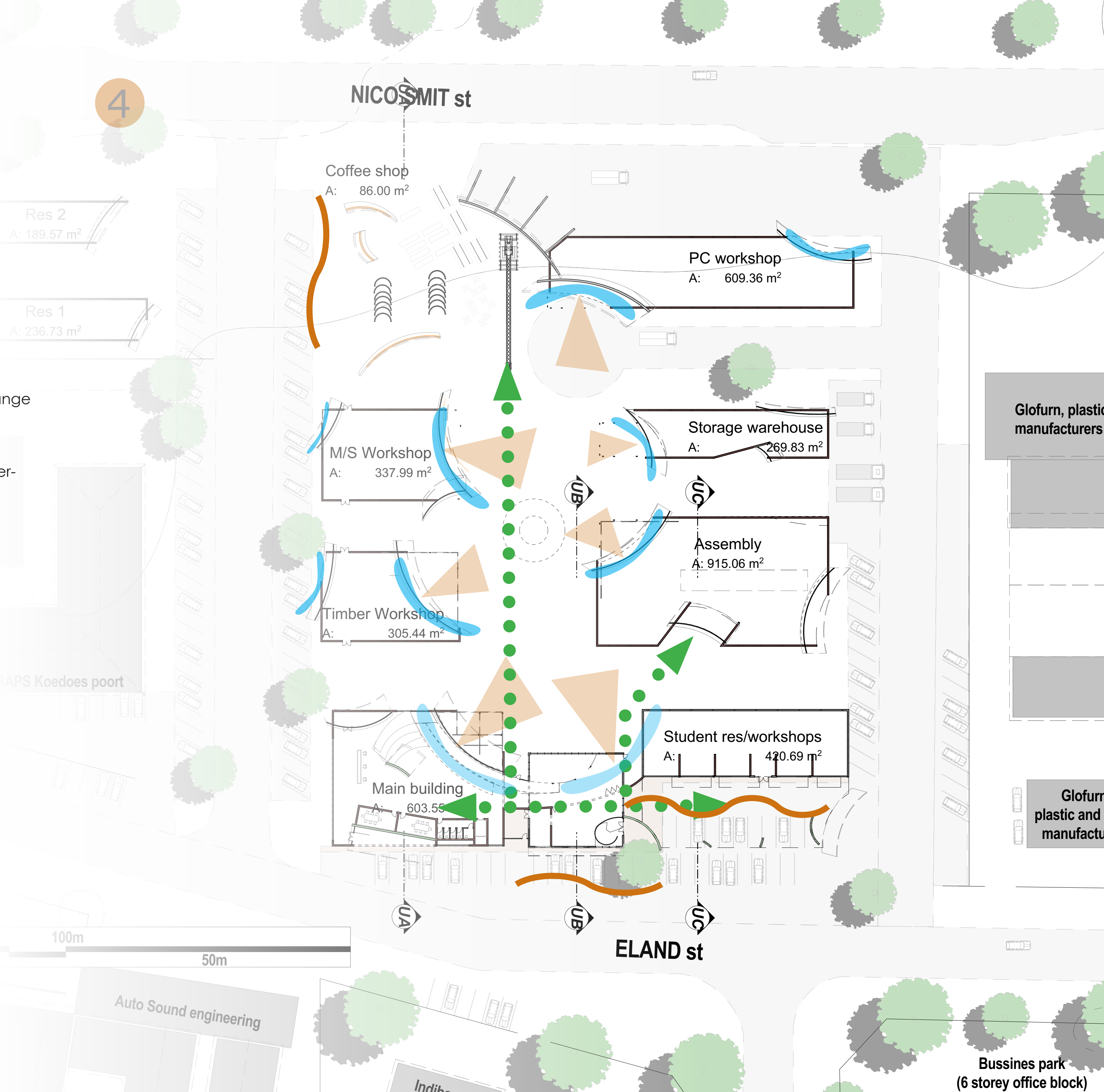


Fig.46: Concept development 3, Linear object/directional cues March 2019(Author 2019).



Elements resembling a change from traditional thought

Designing critical social inter-action around yard

Visual/physical access to greater complex

Interaction with imminent/greater public

Fig.47: Concept development 4, urban plan March 2019(Author 2019).

4

In the development of the latter three concepts it was noted that the rigidity of large landscape elements make it difficult to direct intentions in the micro scale. The aspect of materiality and structure of the elements also come into play, when elements are so big the logical solution will be to cast it in concrete. This self-evident solution would be detrimental to the ethical stance of the OSM facility as it is too permanent. The forth iteration of the concept development explores fragmented shells that can be manipulated in each individual facade. The idea is that the energy that will be created from the inputs and outputs of the OSM facility is projected from a central core (the open assembly yard) to the surrounding buildings. This energy then explodes in a circular motion, bursting through the façades and exposing the structures, now left bare for interpretation. The shells will be developed as light floating elements that would resemble its flexibility and temporal nature. These semi oculus shapes can also be interpreted as lenses between the individual factories and the open assembly yard. The material of the buildings on the other side of the exposed structures will be technologically advanced but still stereotomic, in order to resemble the traditional typologies of factories. The notion of movement and constant progression in technology will also be expressed via these floating elements.

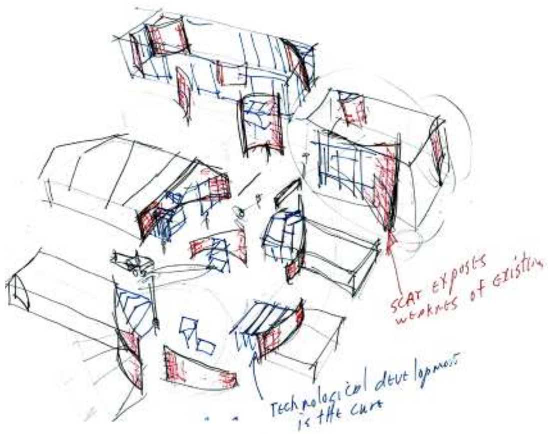
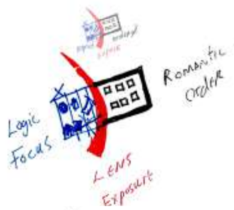
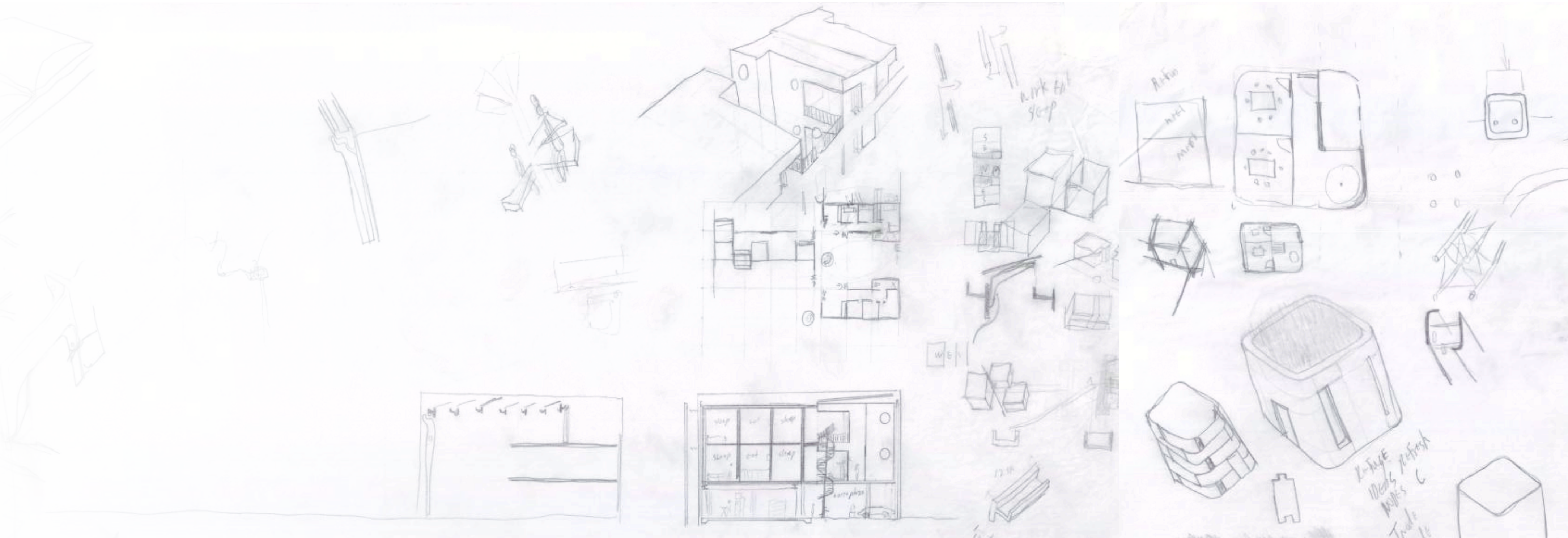


Fig.48: Concept development 4, urban implication March 2019 (Author 2019).





"One should never indulge in sketching out utopian projects because evolution can only result from practical experience." Jean Prove(in Gossel,P. 2006)

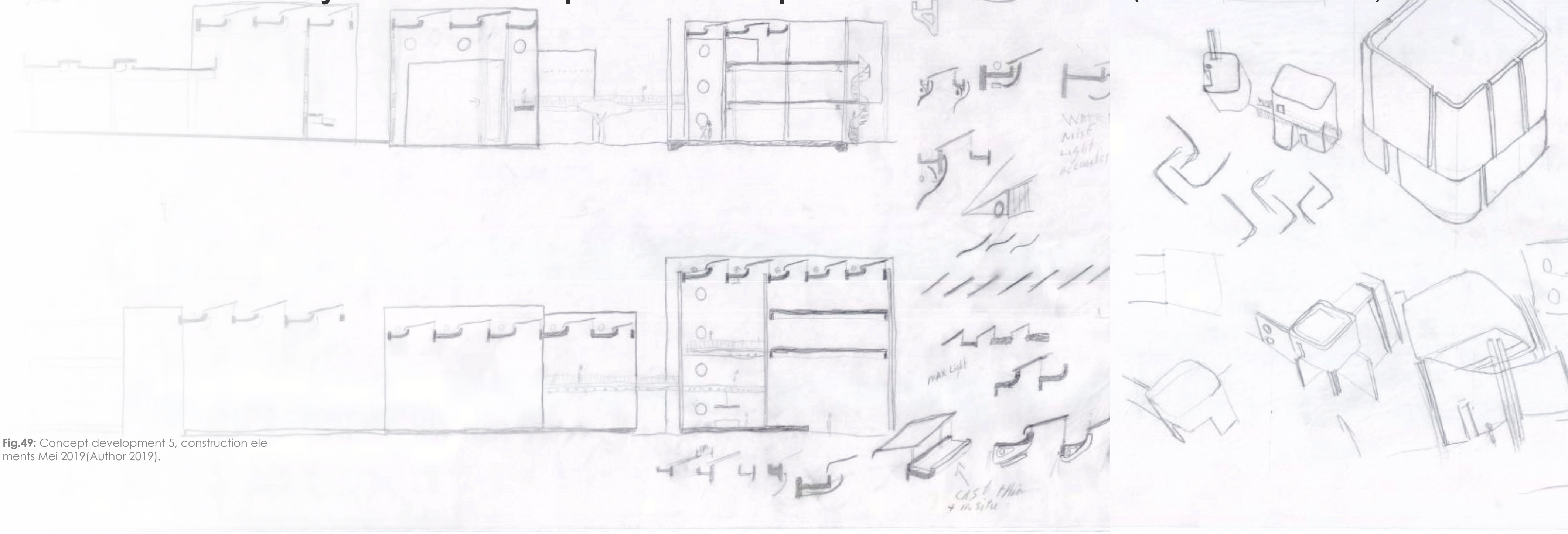
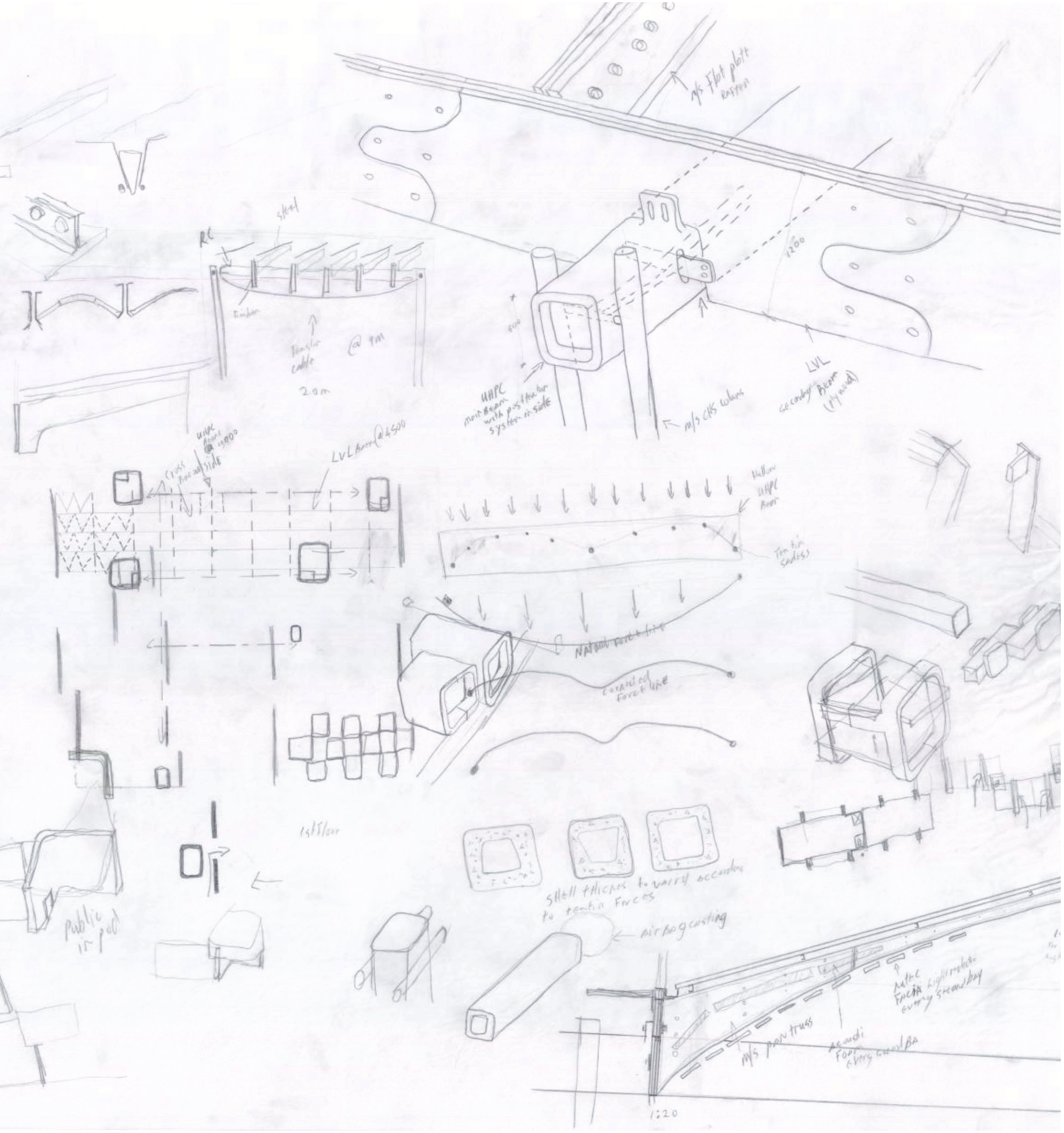


Fig.49: Concept development 5, construction elements Mei 2019(Author 2019).

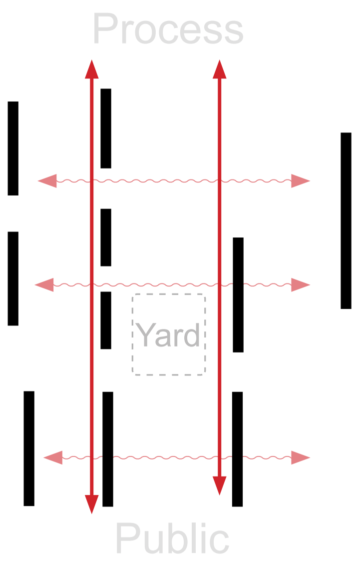


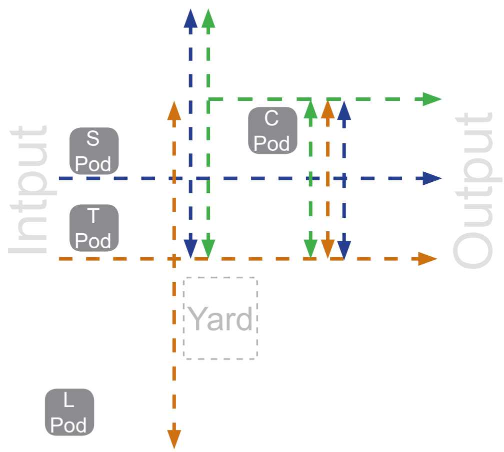
This chapter deals with the concepts of the schemes developed hitherto June 2019.

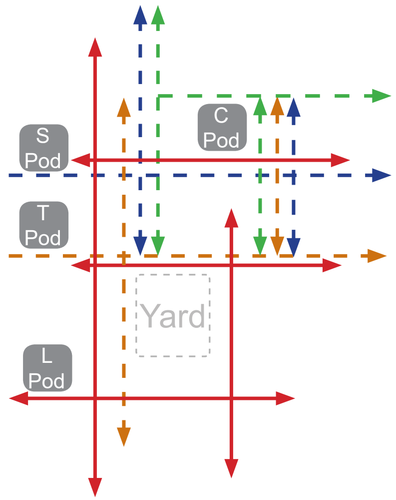
Scheme Proposal

After interrogation it was decided that the pedestrian routes, the roof and its construction as well as the walls and the materiality there of, were chosen as possible elements to work with and be explored. Walls can be used in many ways to say something other than being a boundary and that is what needed to be developed in this complex. How you use materiality of walls as directional cues and express an ulterior construction notion at the same time were explored on multiple levels. Large masonry walls, running in a north-south orientation with flexible infill construction between, enhance the pedestrian flow of the site from south to north. At the south side the most safe public functions like small scale prototyping is placed, and at the north the most dangerous processes like loading heavy concrete pre-cast elements is placed.

Distinctive pods of conversations should be housed within each facility. These pods must be linked on multiple levels where the user always has the option to elevate himself above factory floors with save transition between facilities. The roof was identified as an element that would not be able to be altered by the user. It is here that a clear distinction between traditional building materials and the new proposed means of assembling should be made. Before delving into the detailed development of these systems, it should be emphasised that the final proposed layout of the complex should be one that attempts to be clear in its intention to create connectivity between factories via multi architectural/programmatic interventions.





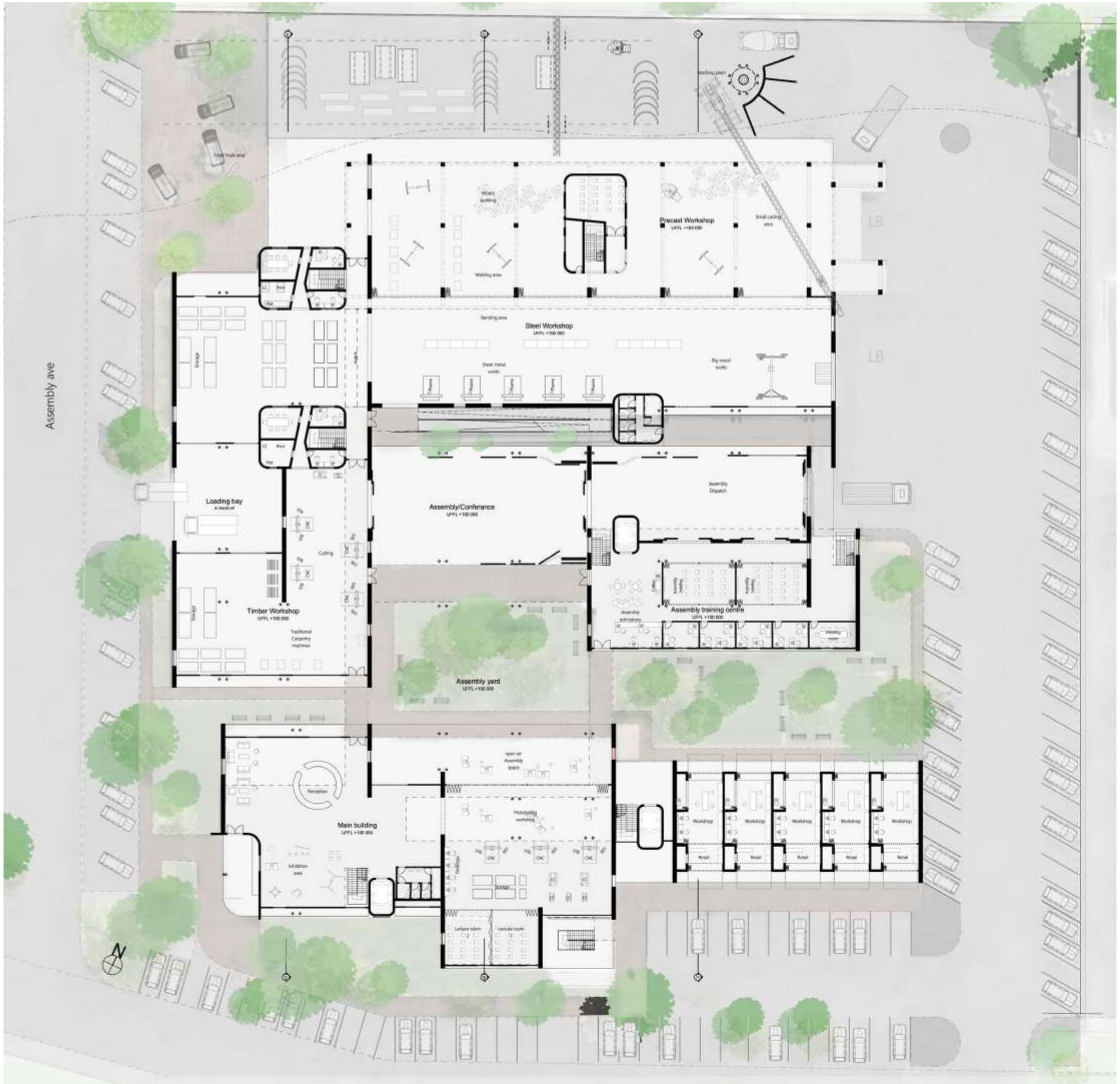


Pedestrian flow

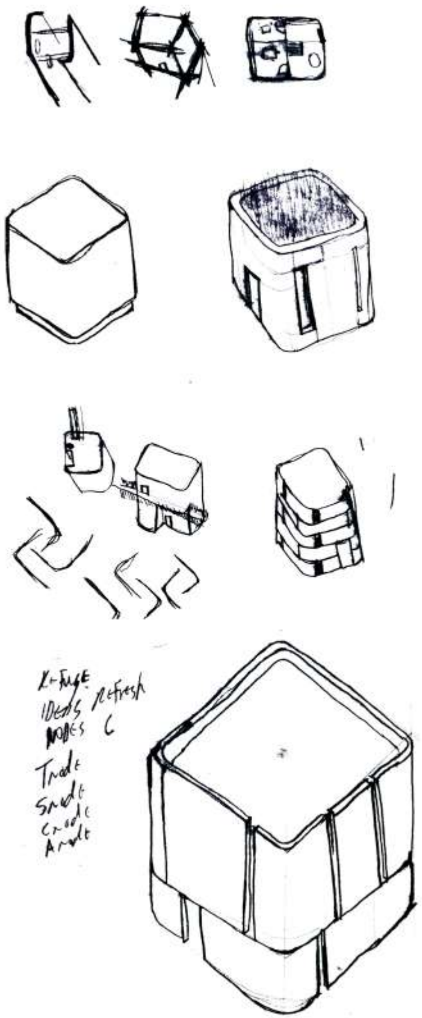
Timber material flow

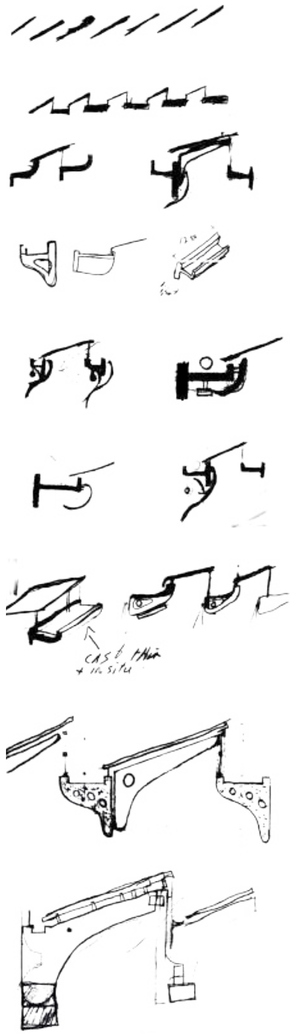
Steel material flow

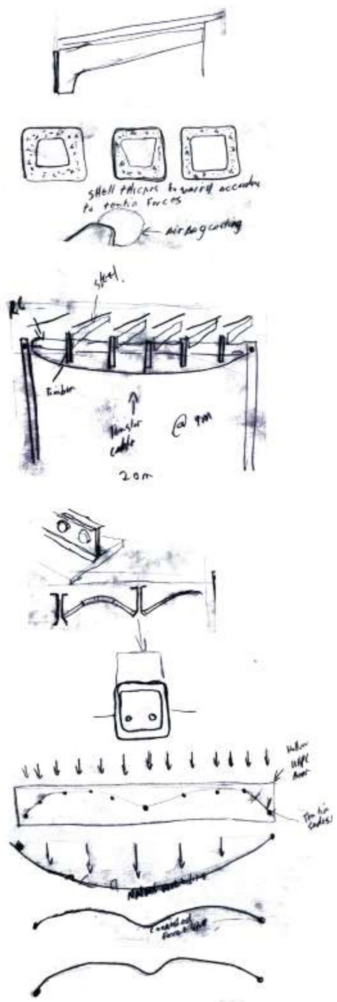
Concrete material flow


Assembly ave
Precast Workshop
Steel Workshop
LB
LB
Loading bay
Assembly/Conference
Timber Workshop
Assembly training centre
Assembly yard
Main building
N

June 2019

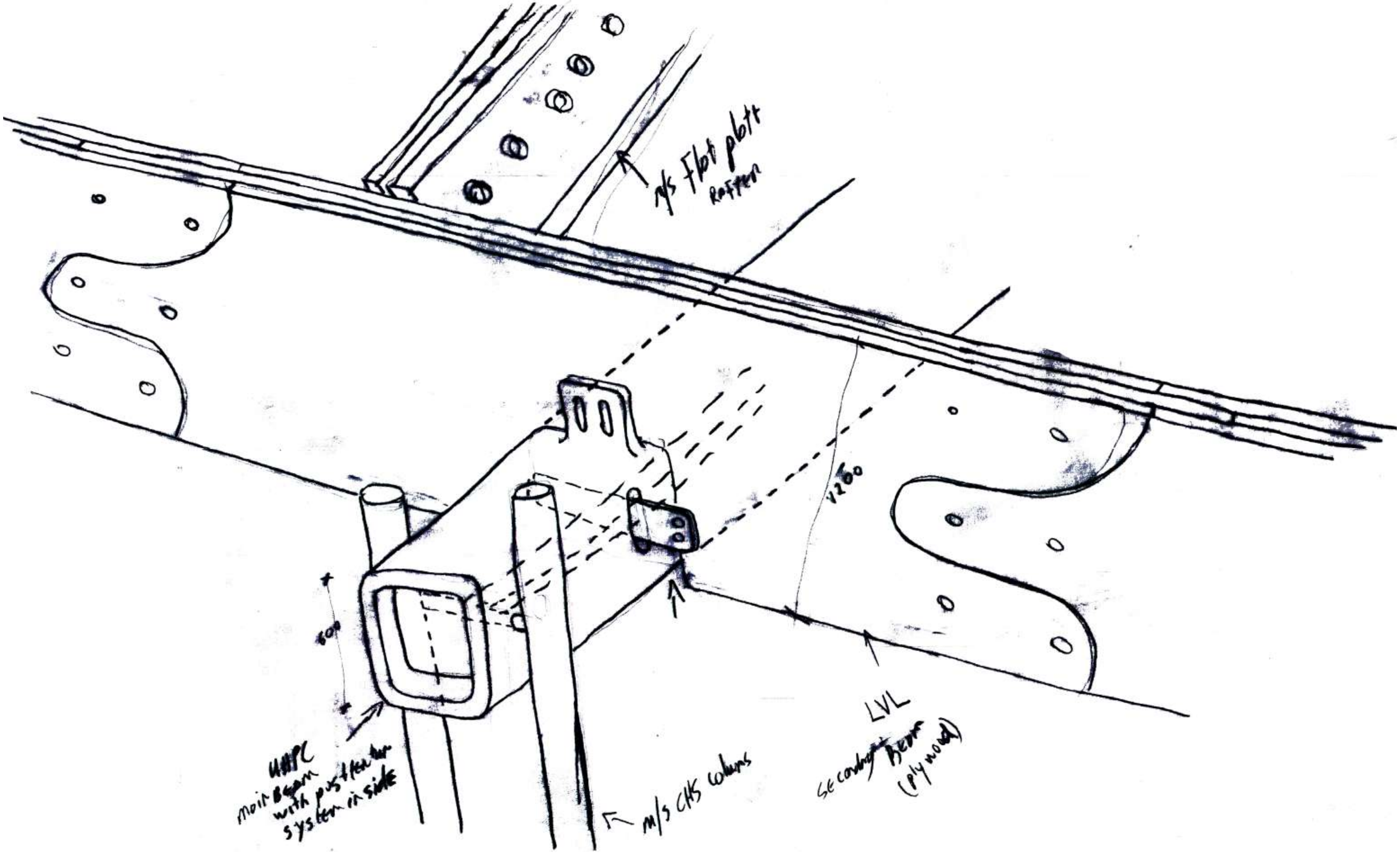


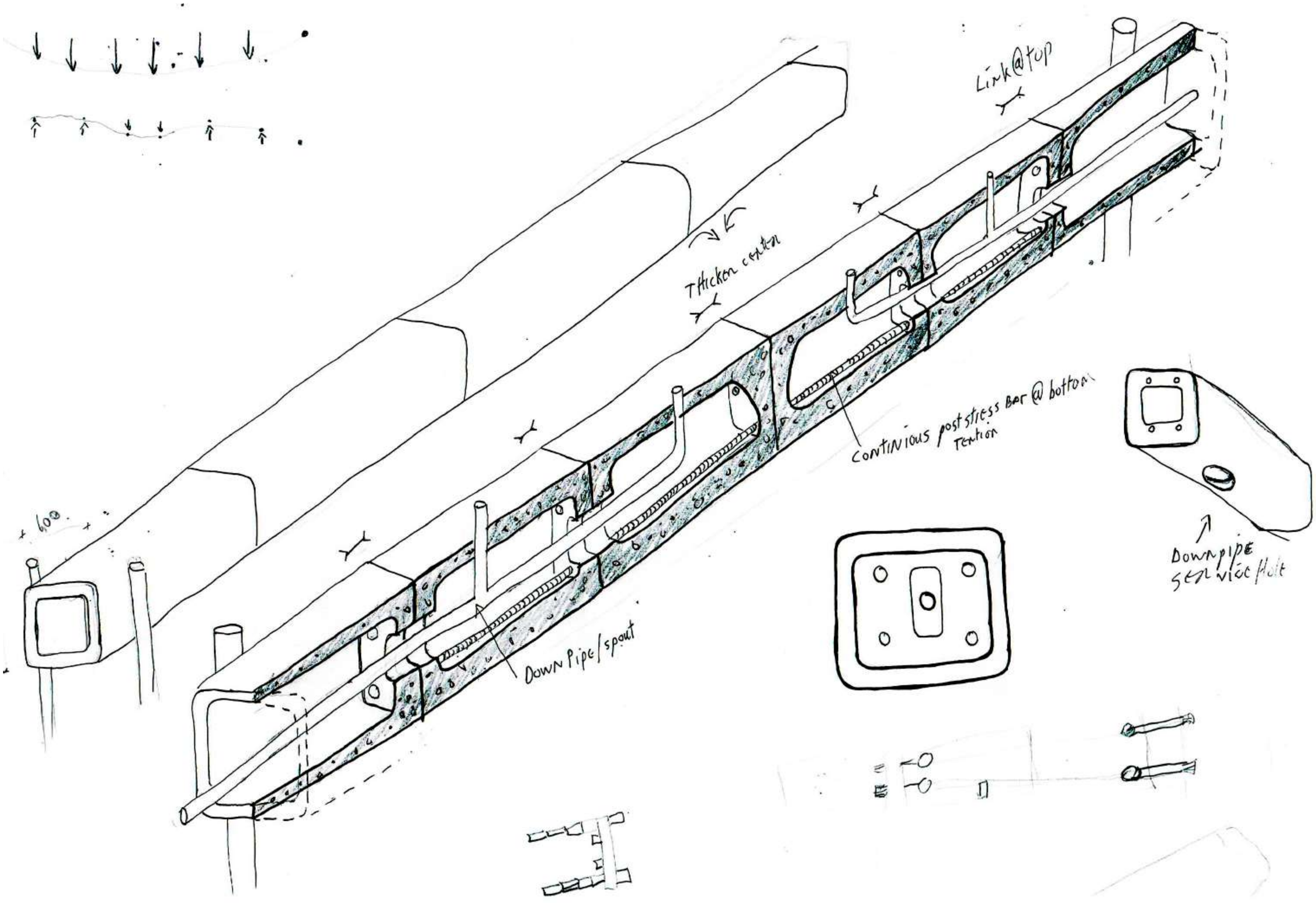




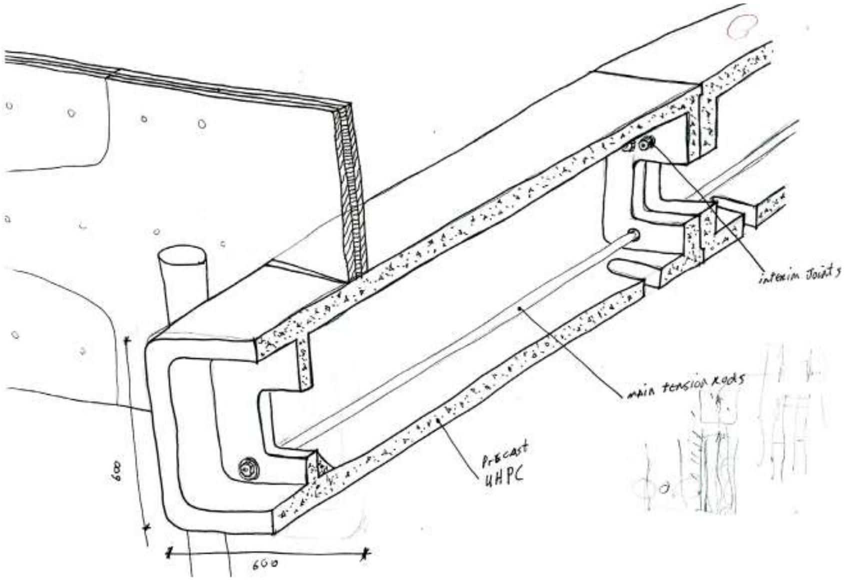
Construction proposal

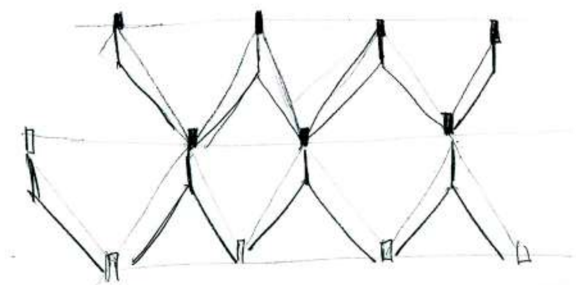
As stated, a construction method that is visibly flexible or able to be dissembled, should be perceived in between the linear masonry walls. Multiple iteration was done in developing a roofing system that would be able to cater for this need, as well as the essential needs of southern lighting acoustics and structural stability. The first intention was to keep the spans of heavy concrete beams in a east-west(from wall to wall) direction that would enable optimal open facade systems without any structural columns. It became clear that the spans and practical implications of spanning the PC beams in the long length of the buildings and using these pre-cast elements for gutters became too heavy. The concrete beams were then placed on the short span of the buildings. The long-span main beam was replaced with a timber laminated rafter. This would be a lighter solution where the roofs can rest upon. Between the rafters, a light weight pan truss can support the purlins. This leaves the areas between the rafters open for interventions needed for mechanical ventilation, acoustic treatment and even lighting. There is now also the possibility to cut holes in the pan trusses for services.

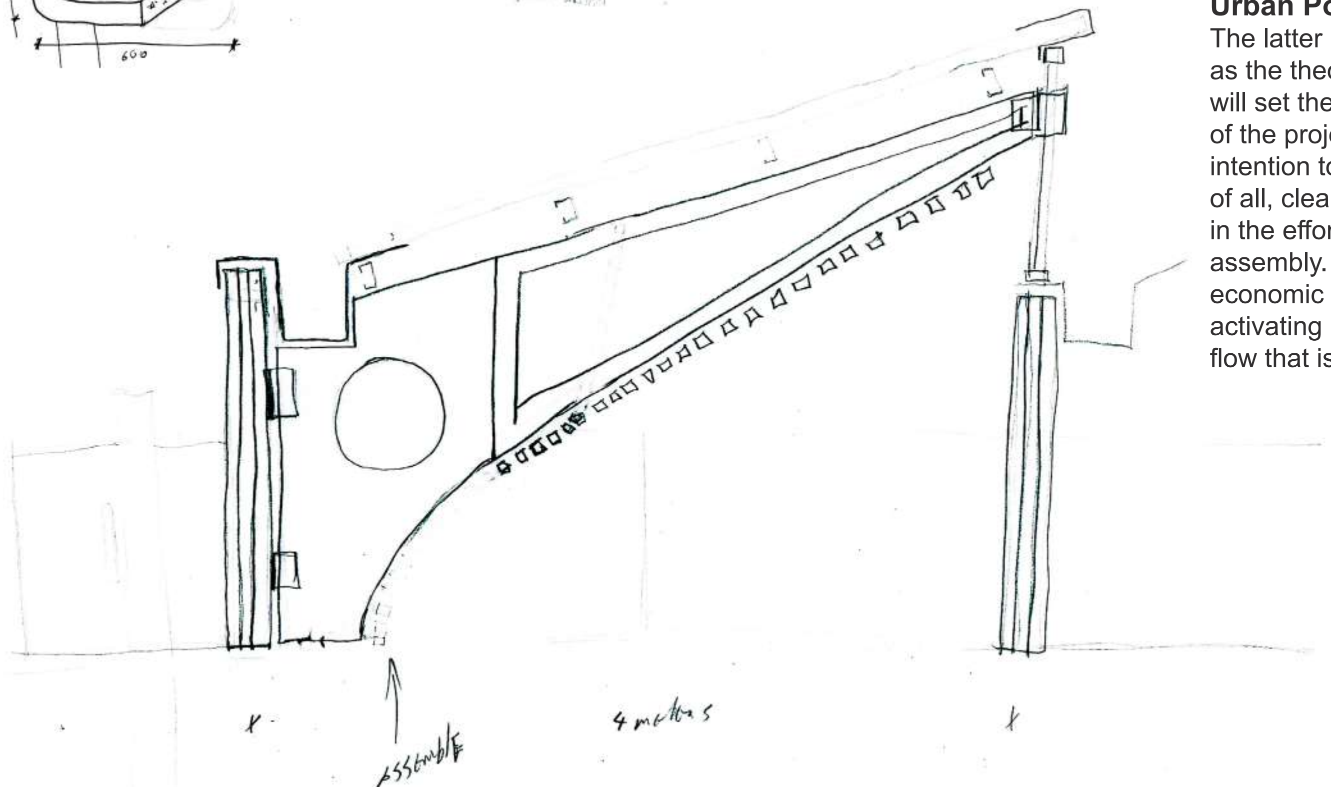

M/S Flat plate Rafter
UHPC main Beam with post tension system inside
M/S CHS columns
LVL Secondary Beam (plywood)



Link@top
Thicken center
Continious post stress Bar @ bottom
Tention
Down Pipe/spout







Urban Possibilities

The latter immature construction principals, as well as the theoretical discoveries made in this paper, will set the scene for further technical development of the project. A project that should be clear in its intention to be dissembled at any moment, but most of all, clear in the way that it has created meaning in the efforts exerted in its design, development and assembly. Efforts that is not only beneficial in an economic sense but contributes to a community by activating new chains of material and knowledge flow that is manageable by civilians.

Steel Office/Lecture Pod

Functions

- Lectures
- Meetings
- CAD/CAM processing

Practical/Technical

- Noise levels.................................Insulated
- Mechanical lifting...............................none
- Dangerous machinery.........................None

Steel workshop

Functions

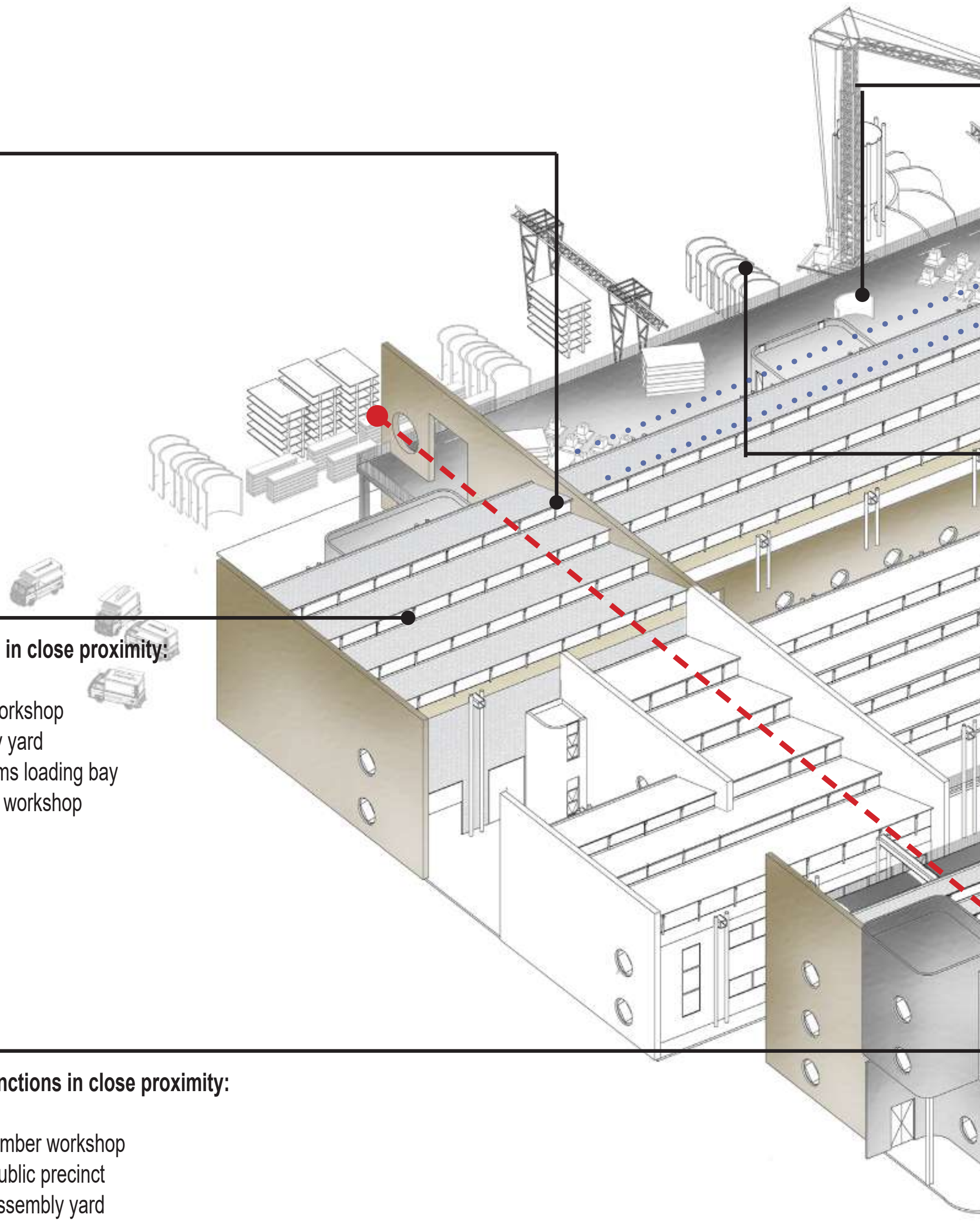
- Steel storage(sheets and profiles)
- Steel processing CAD/CAM
- Traditional steel processing

Practical/Technical

- Noise levels...High
- Dust levels..................................Moderate
- Mechanical lifting.........................Moderate
- Dangerous machinery.........................High

Functions in close proximity:

- Timber workshop
- Assembly yard
- Small items loading bay
- Concrete workshop



Main building

Functions

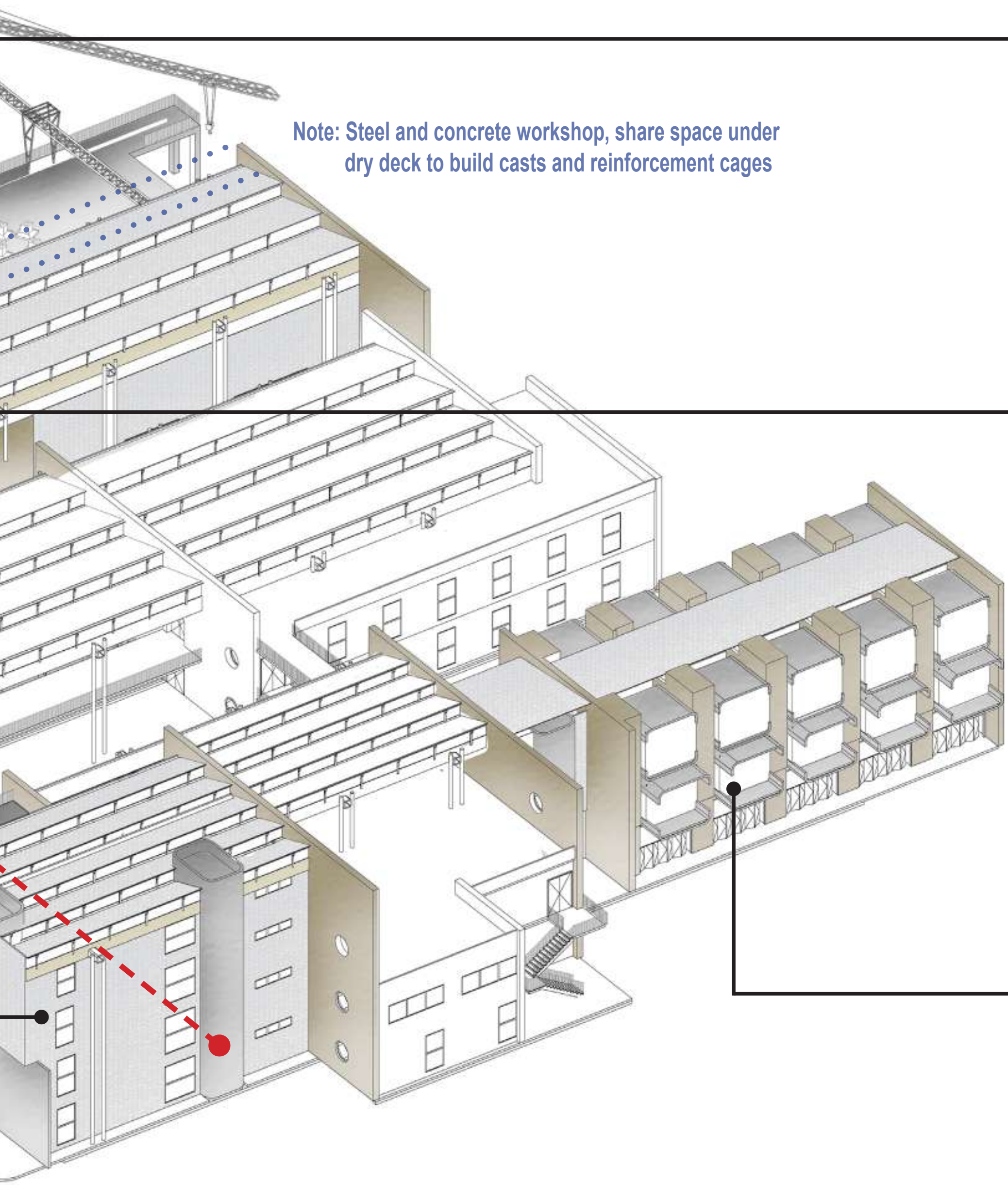
- Reception
- Exhibition space
- Virtual prototyping
- Administration offices
-Small conferences

Practical/Technical

- Noise levels...None
- Dust levels..None
- Mechanical lifting.................................Not needed
- Dangerous machinery..........................Not needed

Functions in close proximity:

- Timber workshop
- Public precinct
- Assembly yard
- Prototyping yard



Concrete Office/Lecture Pod

Functions

- Lectures
- Meetings
- CAD/CAM processing

Practical/Technical

- Noise levels................................Insulated
- Mechanical lifting................................none
- Dangerous machinery.........................None

Concrete workshop

Functions

- Concrete batching
- Concrete casting
- Concrete drying

Practical/Technical

- Noise levels..............................High
- Dust levels................................Moderate
- Mechanical lifting.......................High
- Dangerous machinery.................High

Functions in close proximity:

- Steel workshop
- Assembly yard
- Big items loading bay
- Main access route(Theatrical cranes)

Student housing

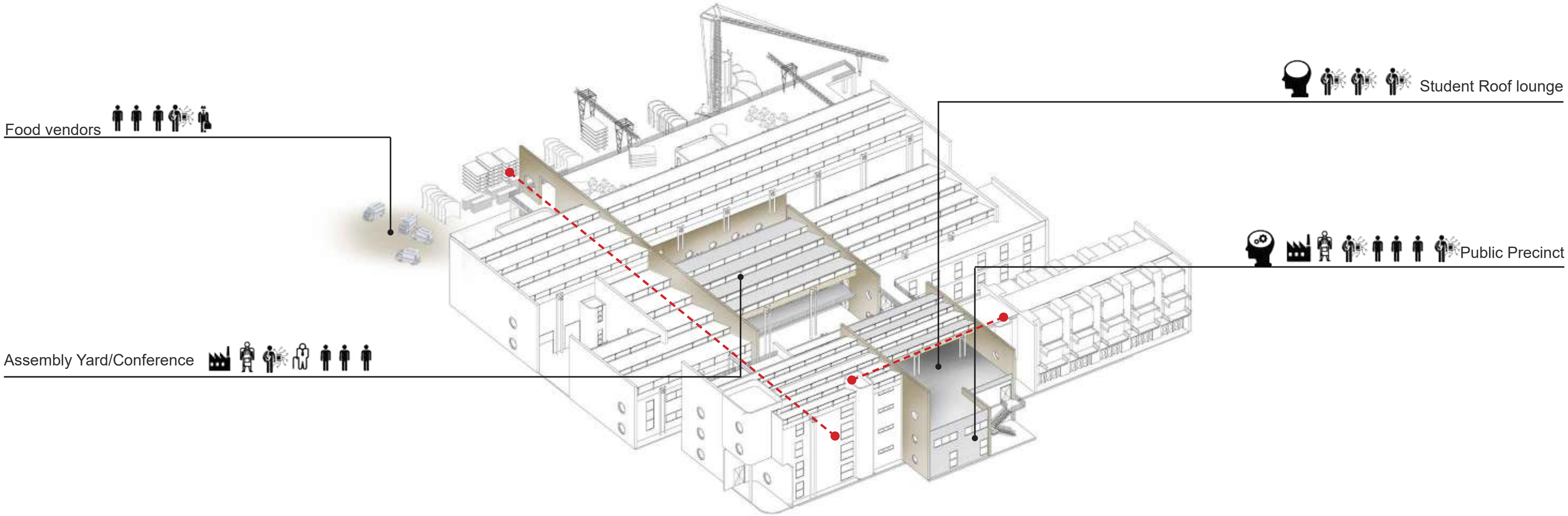
Functions

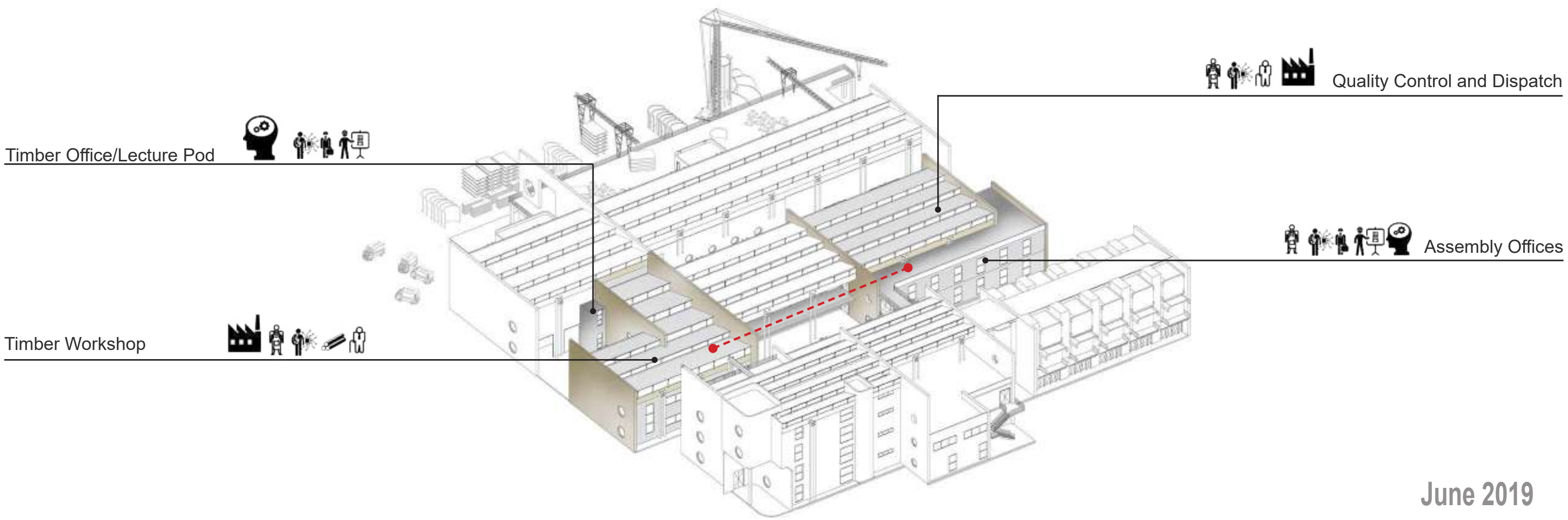
- Housing approx 60 Students

Functions in close proximity:

- Assembly yard
- Prototyping yard
- Main building
- Public precinct

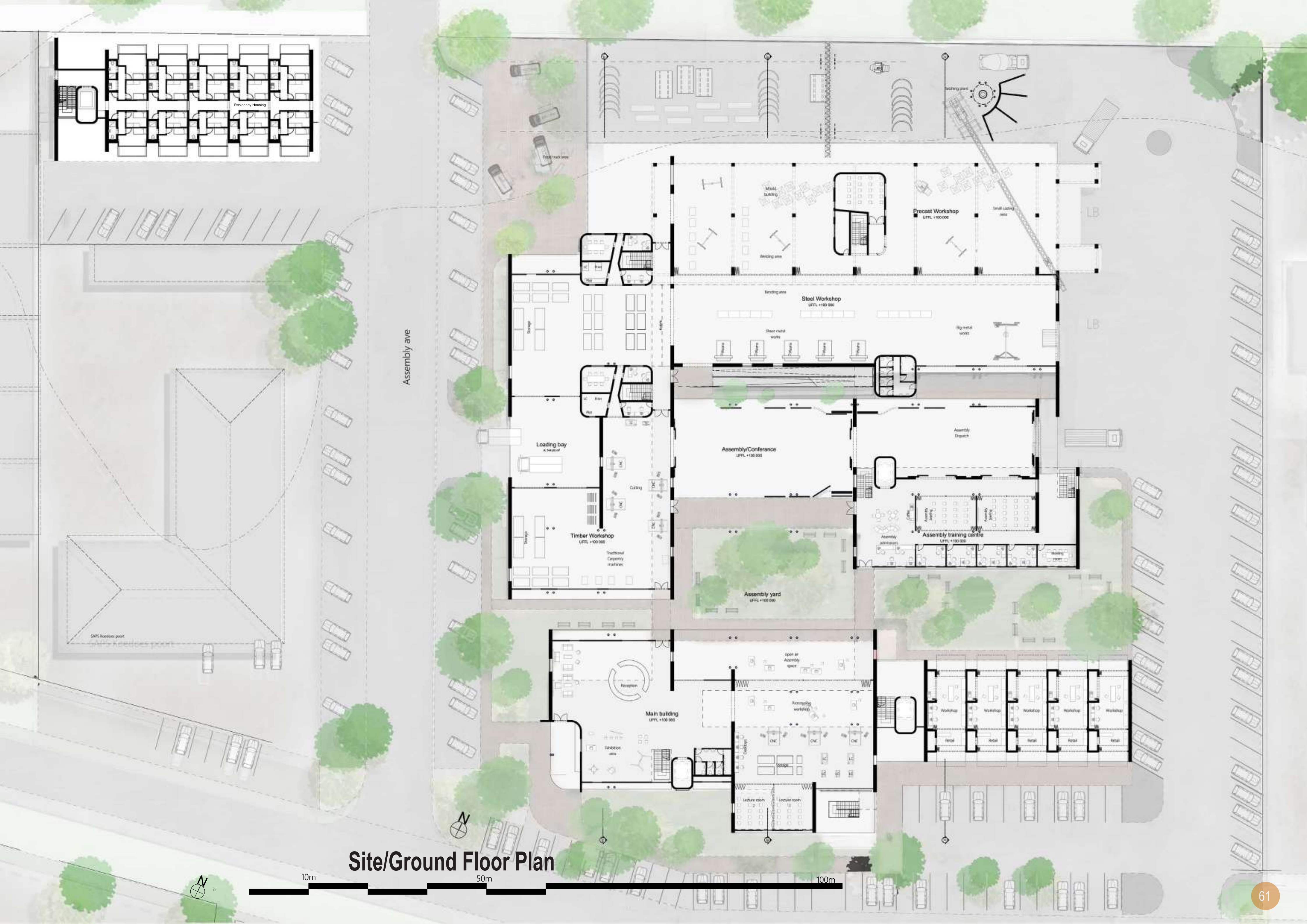
1st Phase public interaction





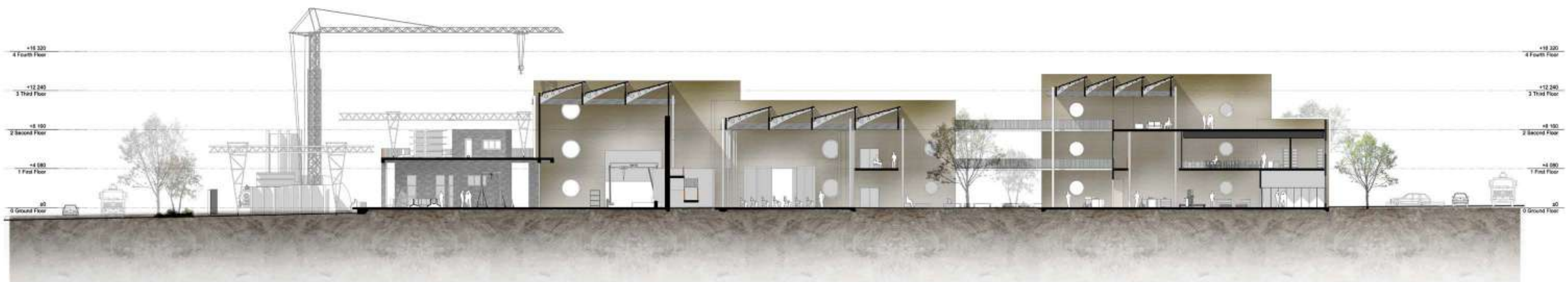
June 2019

2nd Phase public interaction

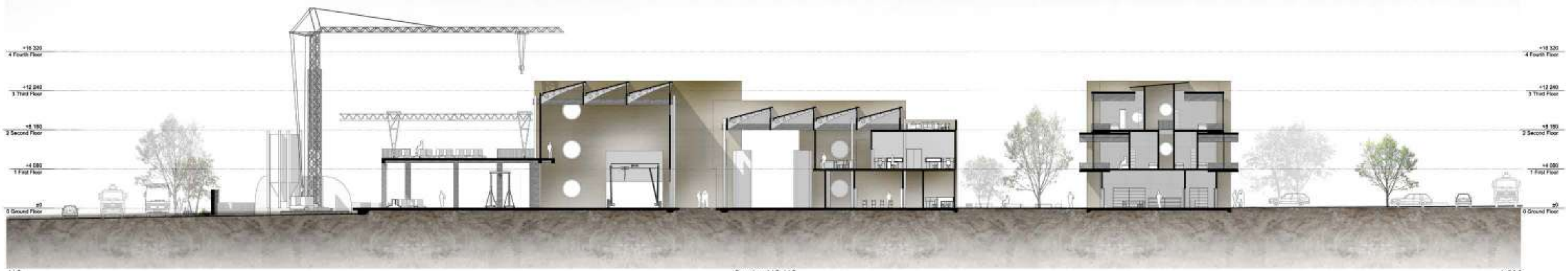


Site/Ground Floor Plan

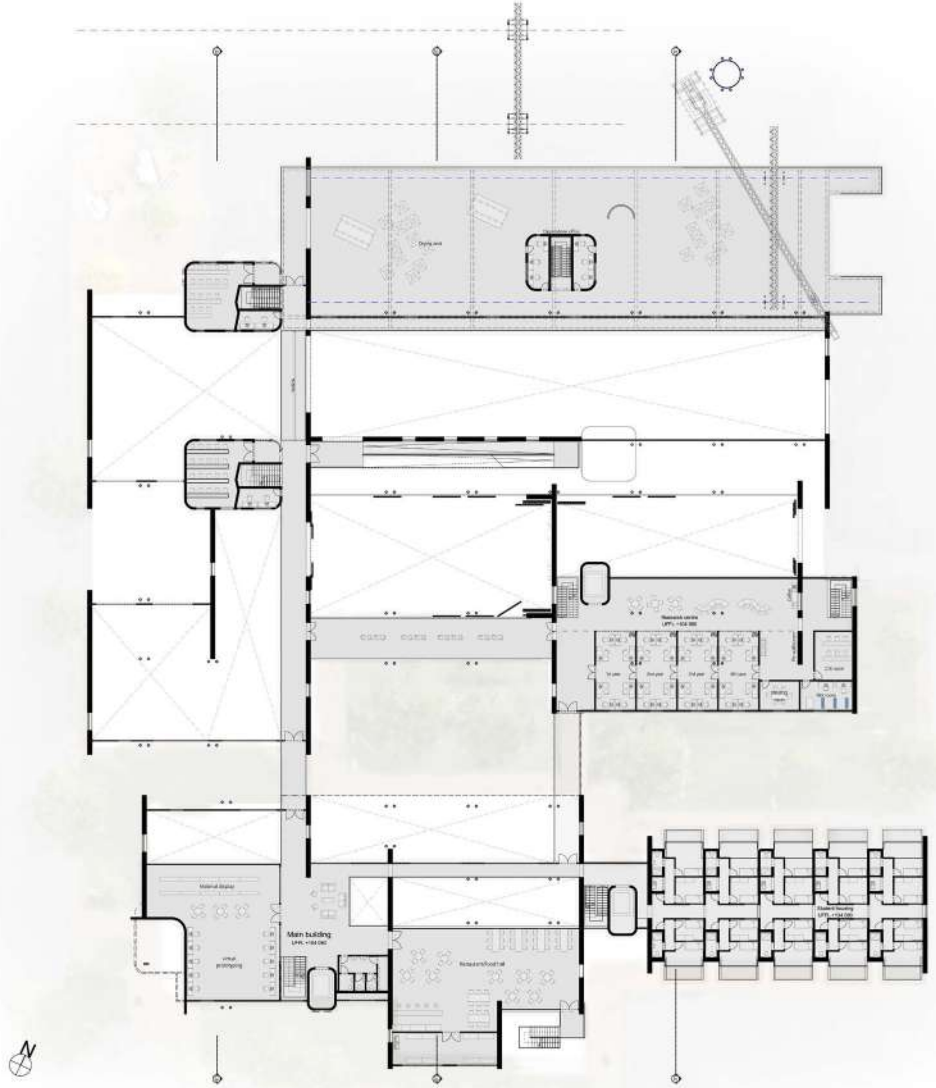
UA Section UA-UA 1:200



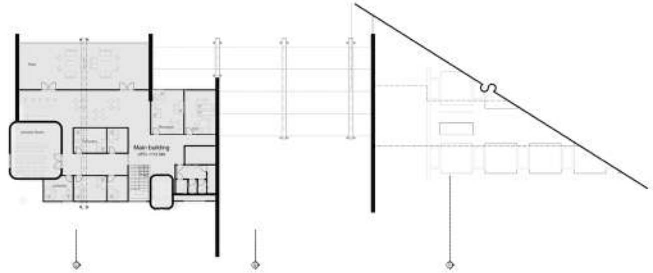
UB Section UB-UB 1:200



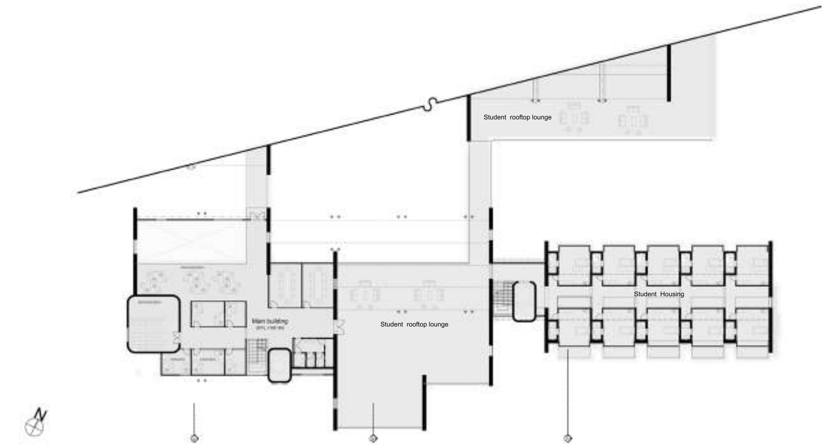
UC Section UC-UC 1:200



1. First Floor 1:250



3. Third Floor

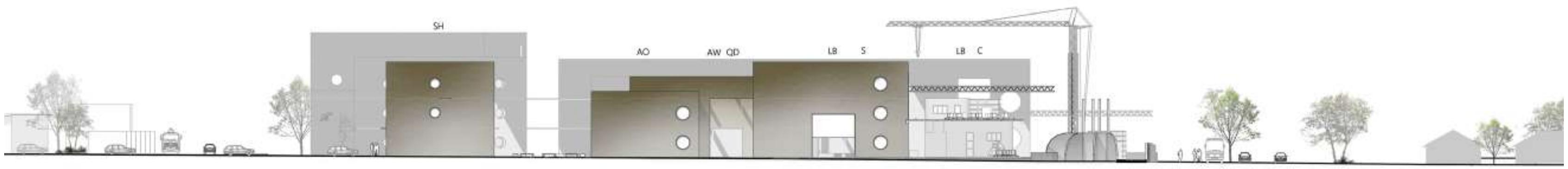


2. Second Floor

Food Vendors_FV_
Quality control and Dispatch_ QD_
Assembly Offices_ AO_
Assembly Warehouse_ AW_
Student Housing_ SH_
Student and public precinct_ SP_
Main Building_ MB_
Small materials Loading bay_ SB_
Large materials Loading bay_ LB_
Timber_T_
Steel_S_
Concrete_C_

Northern Elevation

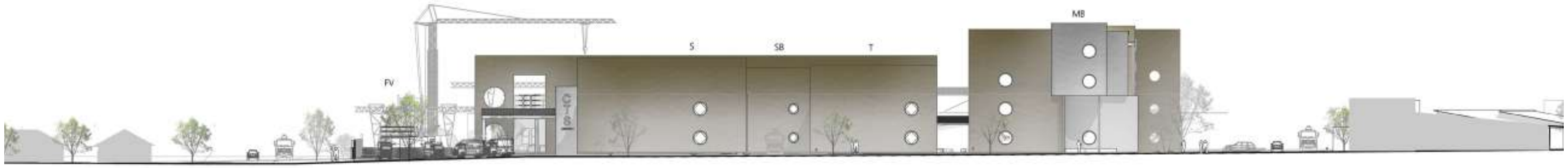
_FV_Food Vendors
_QD_Quality control and Dispatch
_ AO_Assembly Offices
_ AW_Assembly Warehouse
_ SH_Student Housing
_ SP_Student and public precinct
_ MB_Main Building
_ SB_Small materials Loading bay
_ LB_Large materials Loading bay
_T_Timber
_S_Steel
_C_Concrete



Eastern Elevation

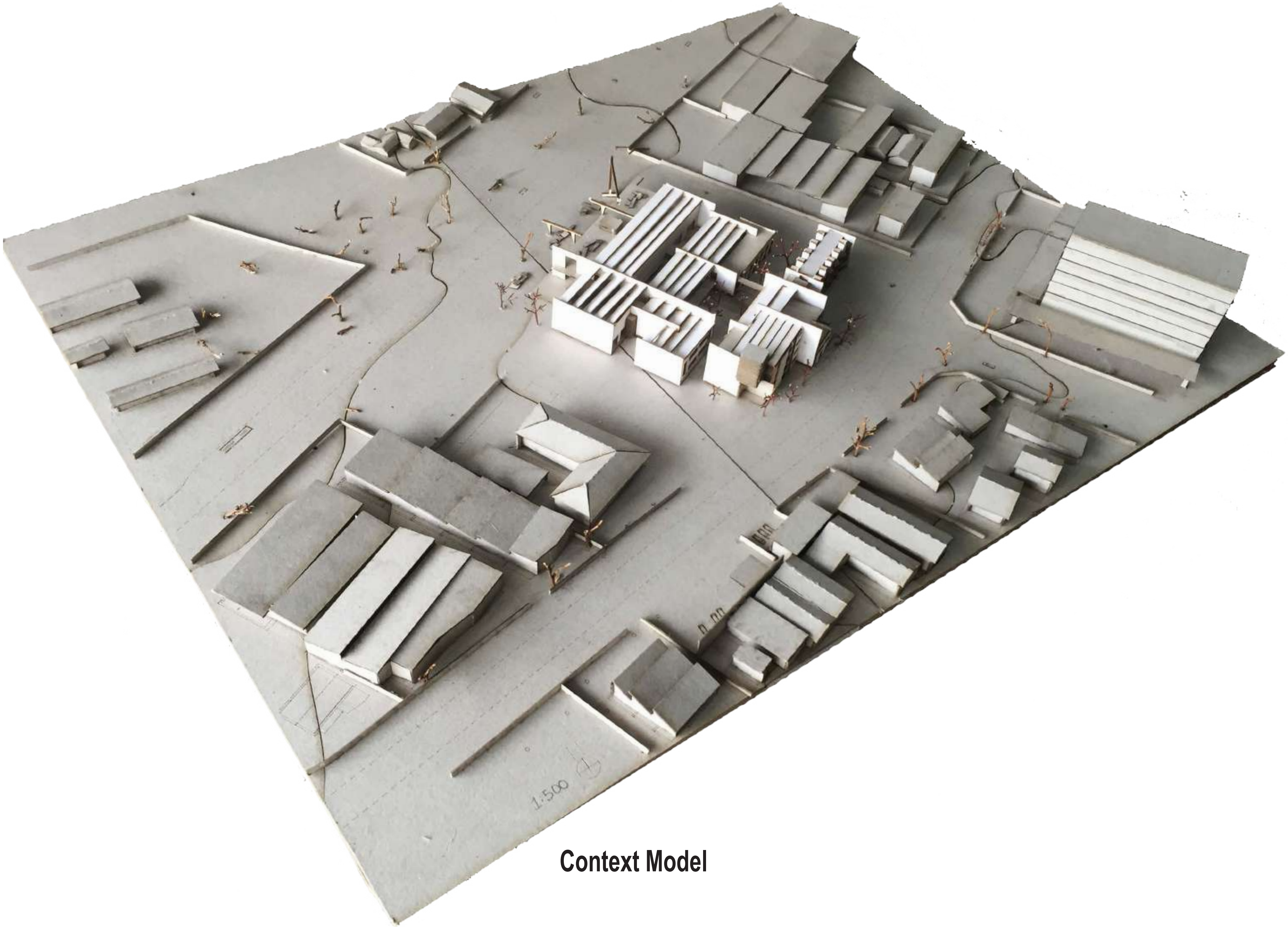
Food Vendors_FV_
Quality control and Dispatch_ QD_
Assembly Offices_ AO_
Assembly Warehouse_ AW_
Student Housing_ SH_
Student and public precinct_ SP_
Main Building_ MB_
Small materials Loading bay_ SB_
Large materials Loading bay_ LB_
Timber_T_
Steel_S_
Concrete_C_

Southern Elevation

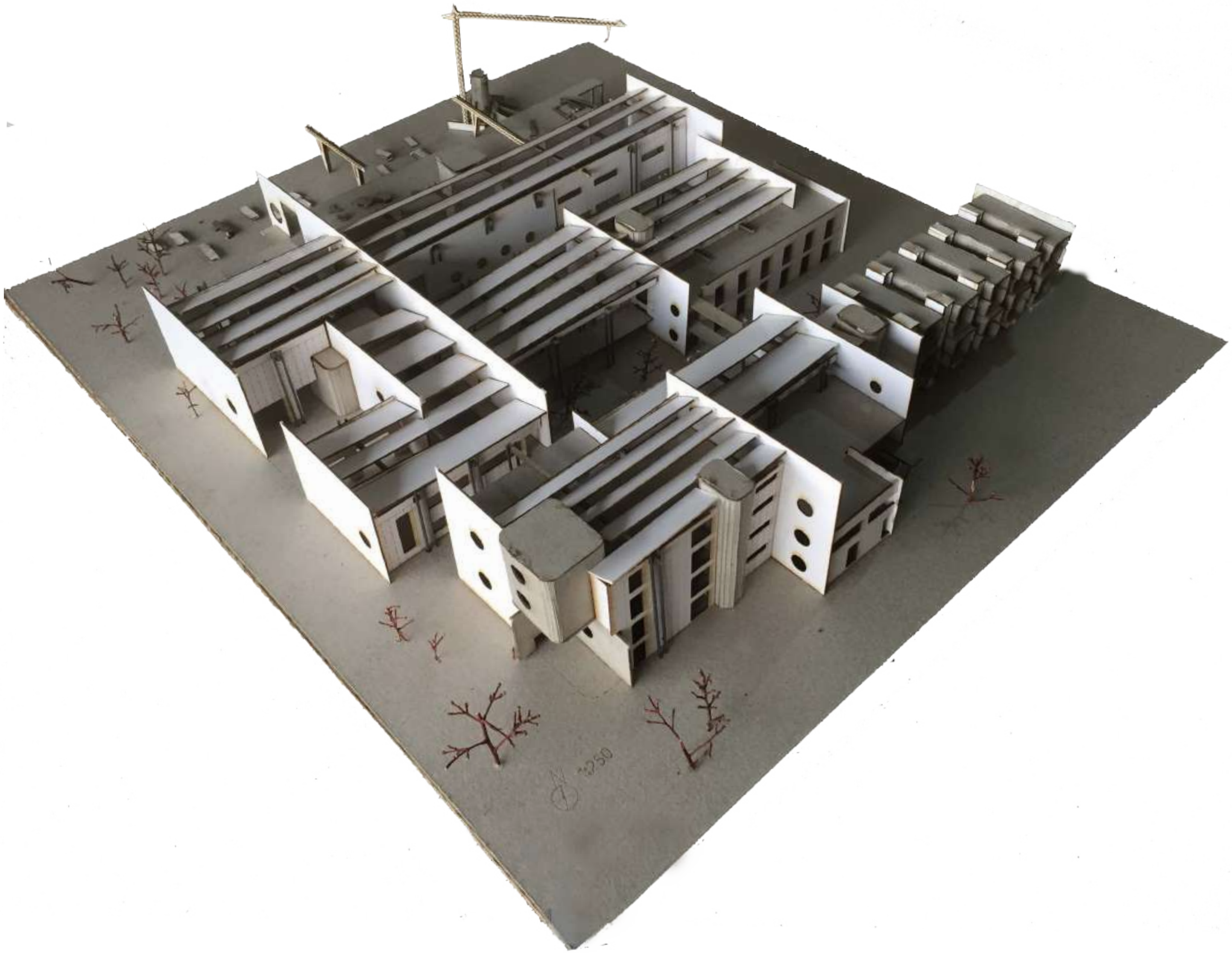


Western Elevation

_FV_Food Vendors
_QD_Quality control and Dispatch
_ AO_Assembly Offices
_ AW_Assembly Warehouse
_ SH_Student Housing
_ SP_Student and public precinct
_ MB_Main Building
_ SB_Small materials Loading bay
_ LB_Large materials Loading bay
_T_Timber
_S_Steel
_C_Concrete



Context Model

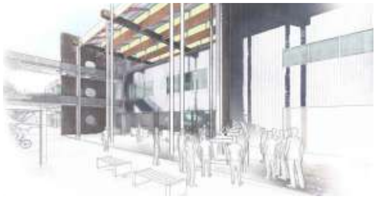


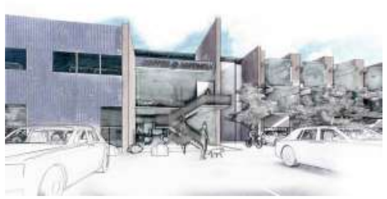
June 2019


T


S


C






CTS

Theoretical review

Parti-cul-ate
Parti-cul-ate
Parti-cul-ate
Parti-cul-ate

The theories explored in the readings during my Master's year must all lead to somewhere or something a personal revelation or hypothesis as it my be. I will now try to summarize/focus my thoughts and findings before resolving my thesis building further. The begging question is, how will CAD/CAM technologies and off-site manufacturing enable Architecture to achieve in future? A step backwards to look at what computers have achieved in the past 50 years is needed. The phenomenology of space and place relative to this evolution is what is important. The creation of an image that references/symbolizes an object comes to mind. At the start of the computer age dots, square or pixels were used to generate images that can represent ideas. Not only represent them, but send them around the world via electronic mail. A two-dimensional information exchange. This made communication, transfer and implementation of ideas easier. It enabled 'architecture' to be disproportionately copied and pasted by architects/developers all in an effort to create meaning. As previously stated the loss of meaning is precisely because they are referencing two-dimensional imagery -plotting generic copies of ideas with only capital gain in mind. I agree this is good for economical development. I reprimand its value to the growth of societies in a physiological or spiritual sense.

Parti-cul-ate
Parti-cul-ate Parti-cul-ate
Parti-cul-ate

In the design of his Lego building Ingles(2017) refers to the aspect of building an environment out of blocks/lego's. Boxilation he (Ingles. 2017) terms it. This translates into a three-dimensional space that is still representational, but more spatial. This same representational reality can be perceived when playing multi-player interactive games on line such as 'Mine Craft'. These games use boxilation to populate three dimensional space in a virtual realm. This establishes a fantasy world that cannot only be experienced, but created by the user. Note, that this creation is without consequence but alarmingly real: in its essence it enables the user to create a meaningful experience/environment all by him/her self (user autonomy). I feel CAD/CAM and off-site manufacturing will enable us to start entry into a new exponential dimension -a 6th dimension I would like to term *'Particulation'.*

This means of creation would not be representational nor without consequence. It will enable a semi-skilled labourer to appropriate materials for himself or for others with the help of CAD/CAM. With the aid of professionals, placed in the key position of being orchestrator of these public intentions, it could translate into an architecture with meaning. It would cut out the capitalist notion of contractor/mainstream manufacturers, to use the efficiencies of CAD/CAM and OSM for their own gain only, and revert to a artisanal means of creating architecture. Architecture with meaning imposed by the clear effort that went into the creation and assembly of its parts

Parti-cul-ate
Parti-cul-ate

2

3

Parti-cul-ate

Pixelate

2D-Representational

Boxilate

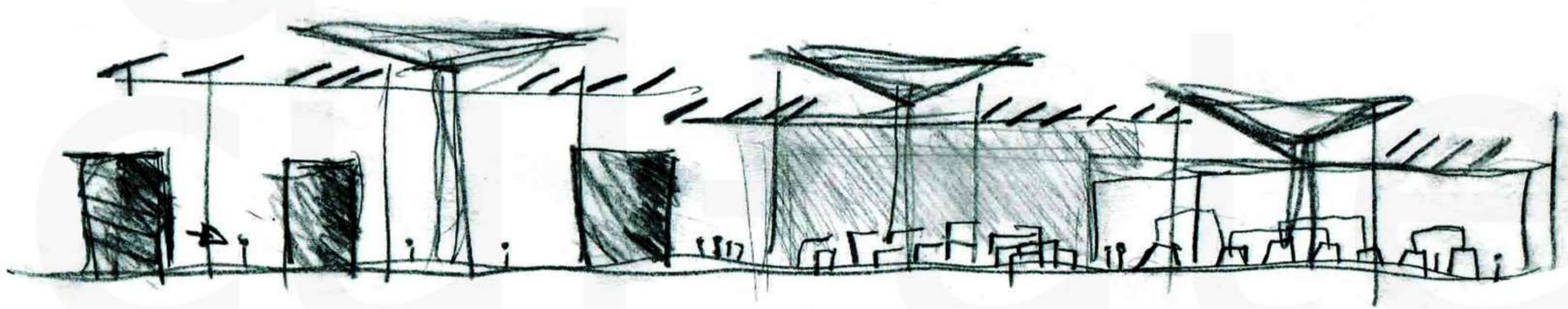
3D-Occupational

Parts Parti Grain
Form Function Scale
Substance Essence

Culture
Utility Animate
Articulate

Latent Assemble
Meaning
Action Dis-assemble

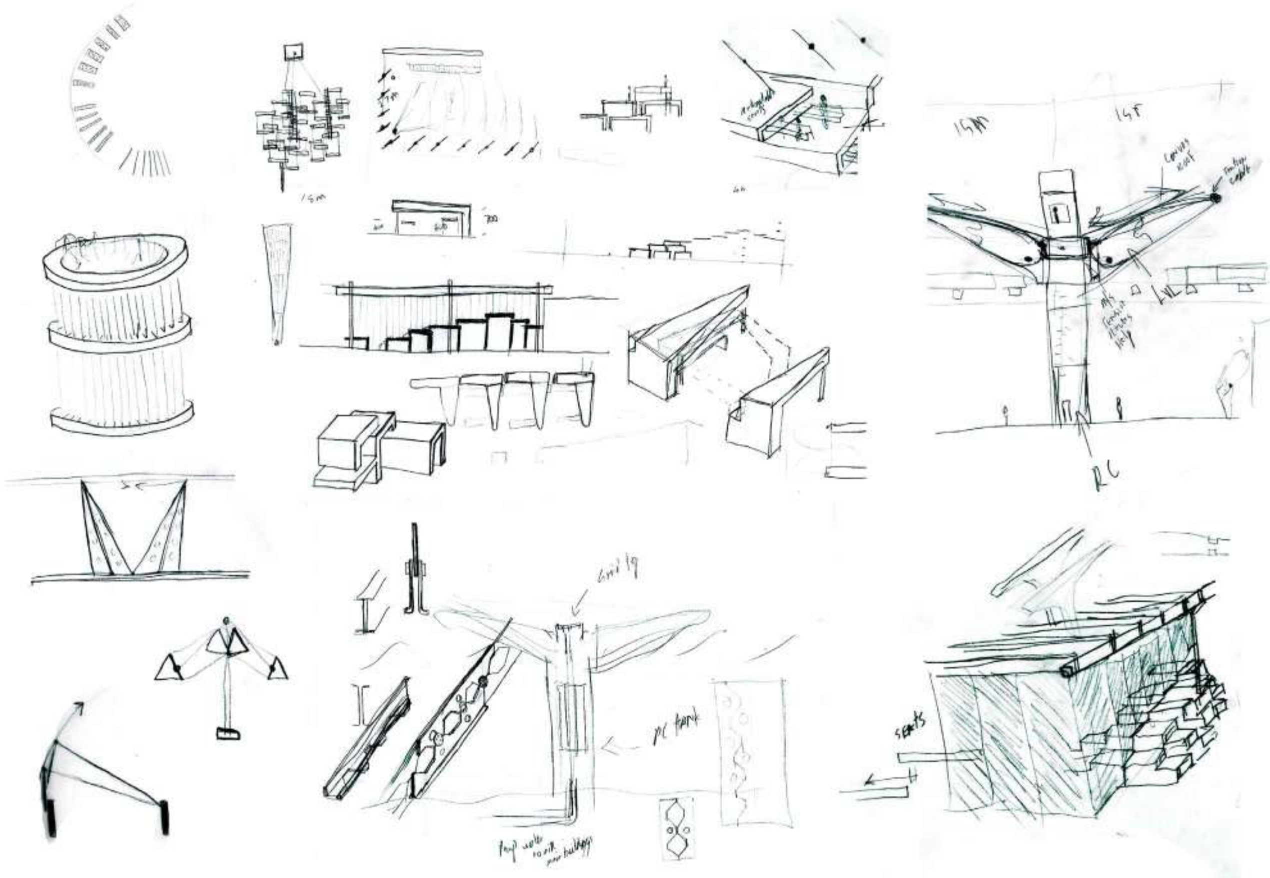
6

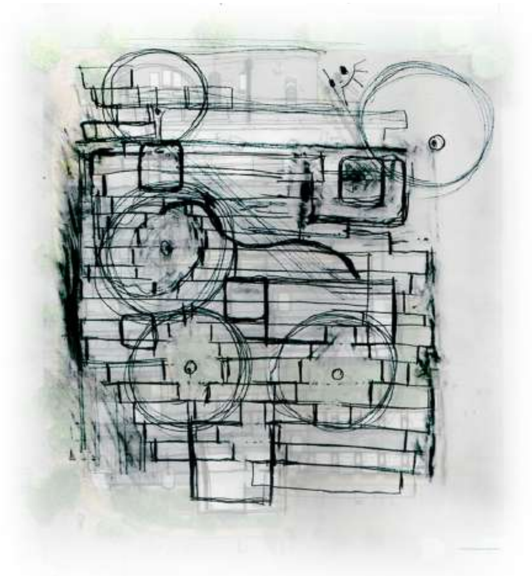


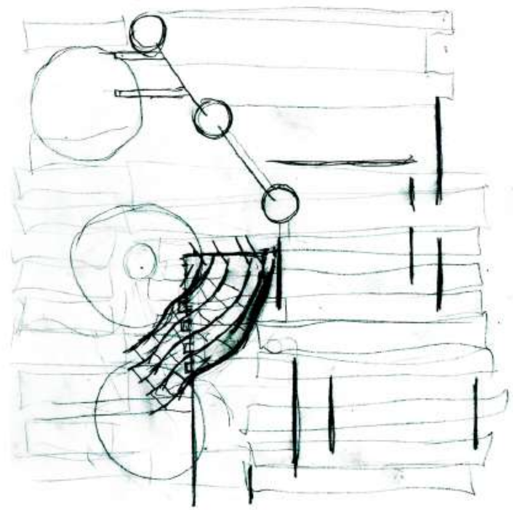
'Particulating' the periphery

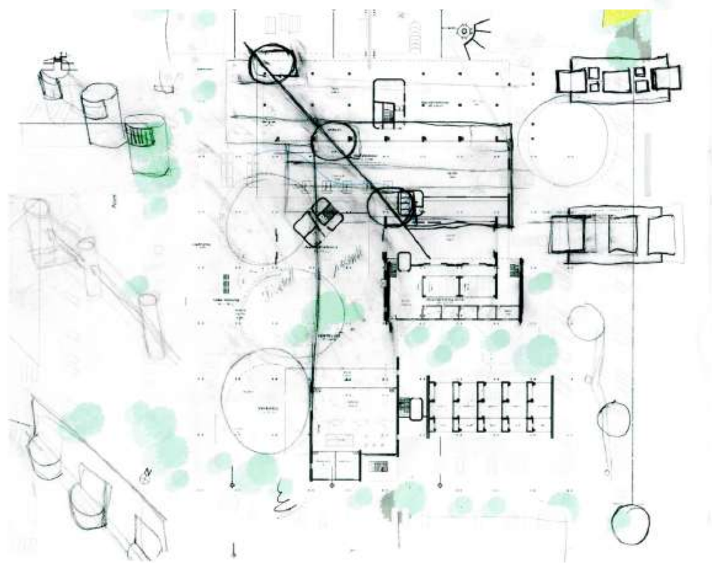
The further development of the site and all the functional elements of the off-site manufacturing facility were focused on both the integration of the larger public into the facility as well as the aesthetic/ functional ethos that the facility should embody. Form and structure finding with the limitations of CNC timber, plasma cut sheet metal and pre-cast concrete elements that can be assembled and dissembled were proprietary to this ethos.

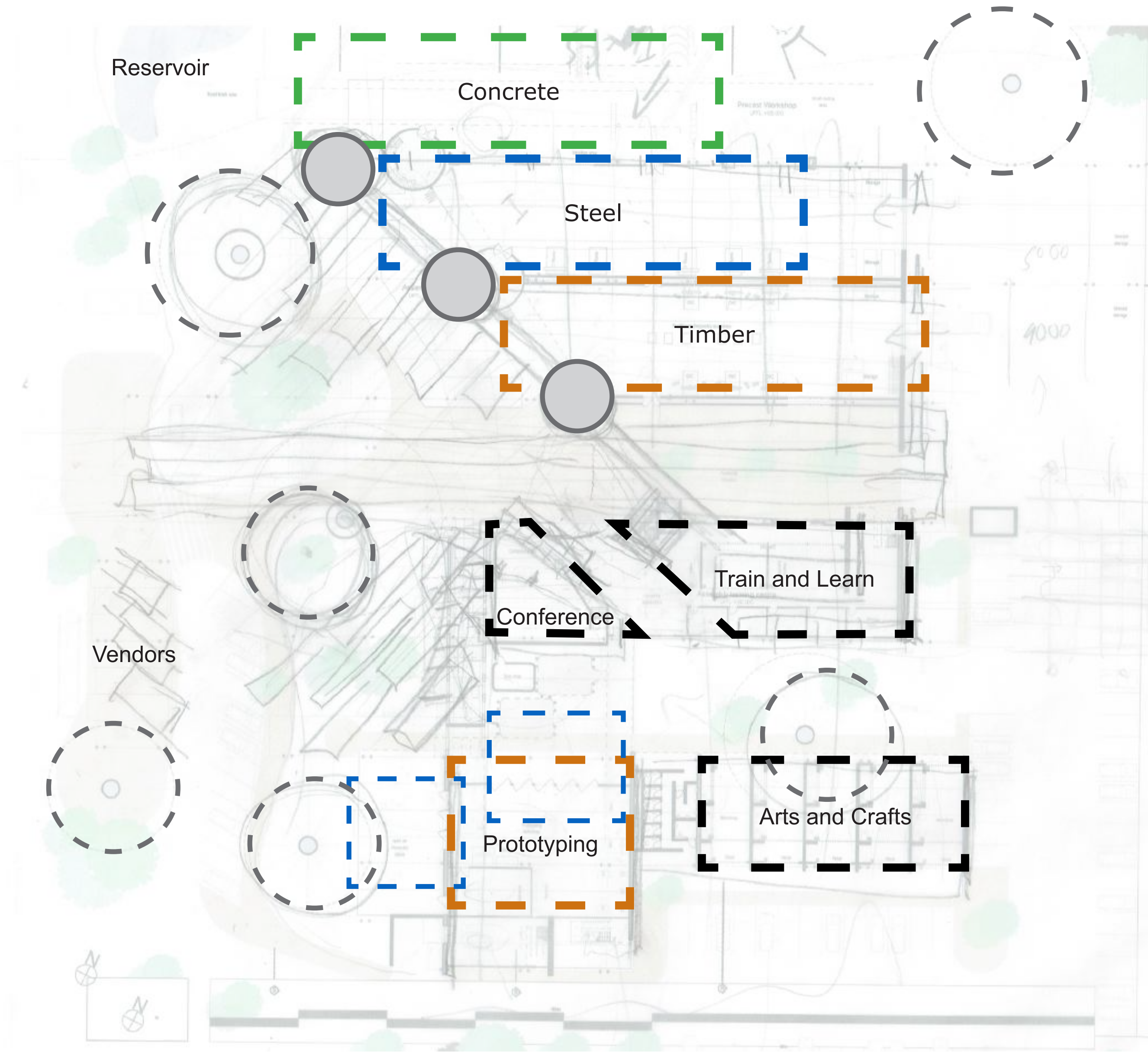
Getting rid of the static north to south masonry walls of the concept developed for the June examination, enabled direct access to the facility both visually and physically. To cater for the large amount of water, that a concrete casting plant needs, rain water harvesting was investigated. The development of a "tree" that could catch water, store it, as well as act as nodes of gathering, was explored.



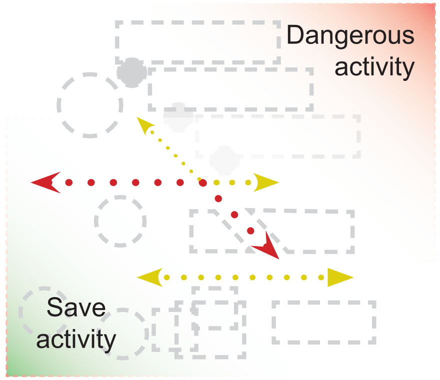




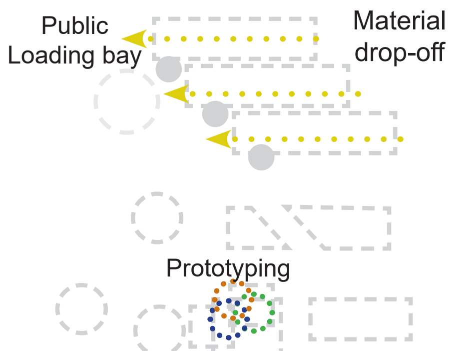




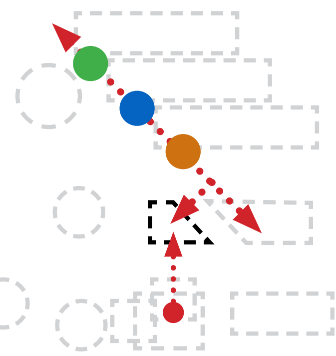
Site plan



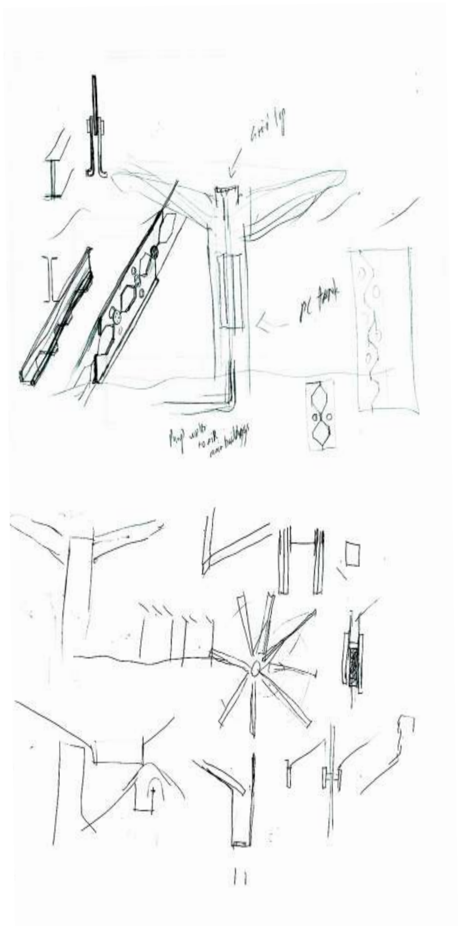
Pedestrian flow

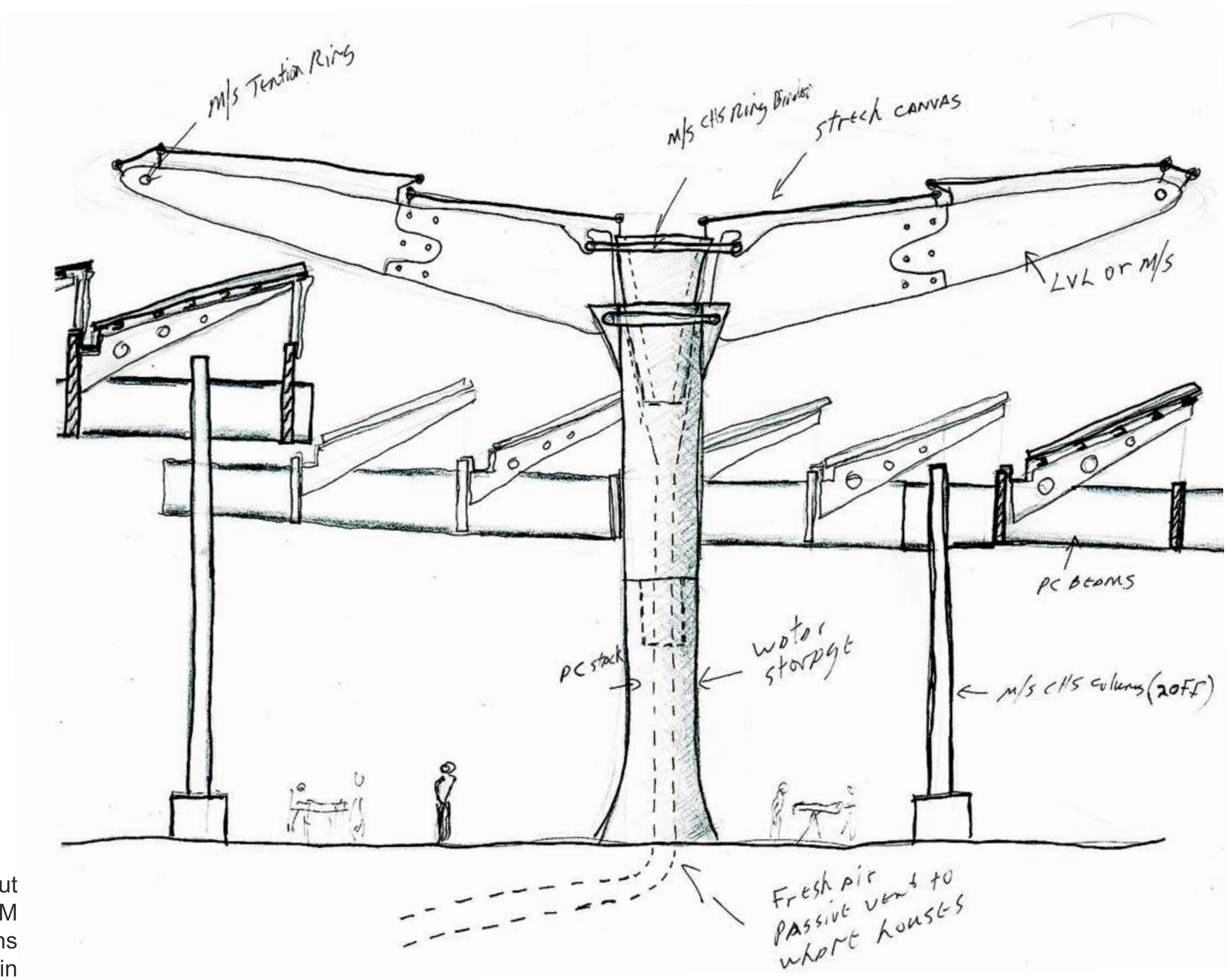


Material flow



Knowledge flow



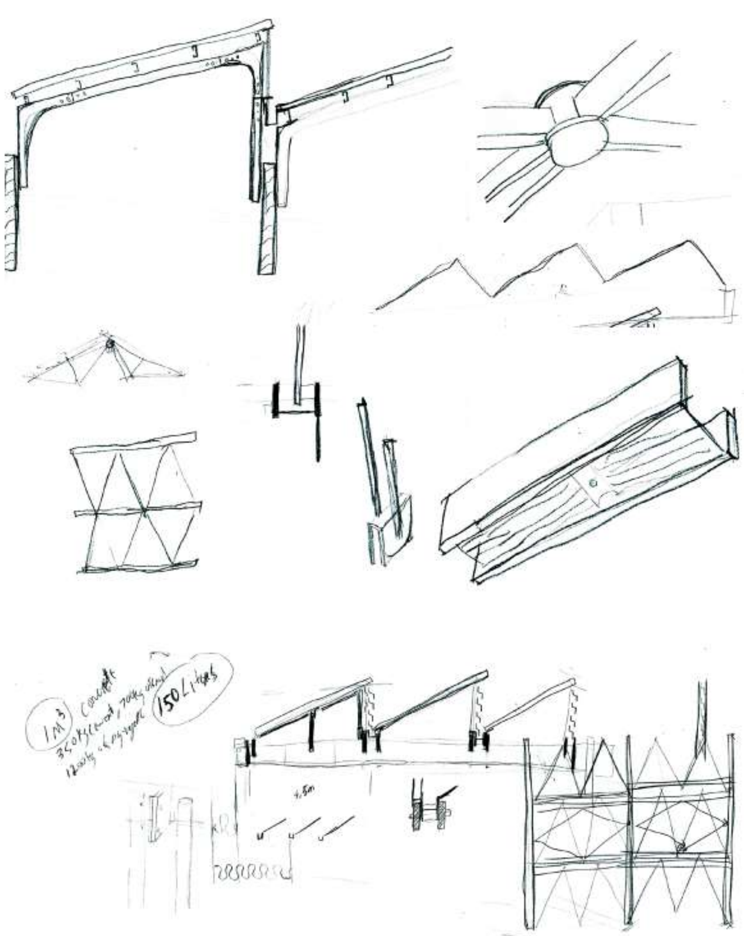


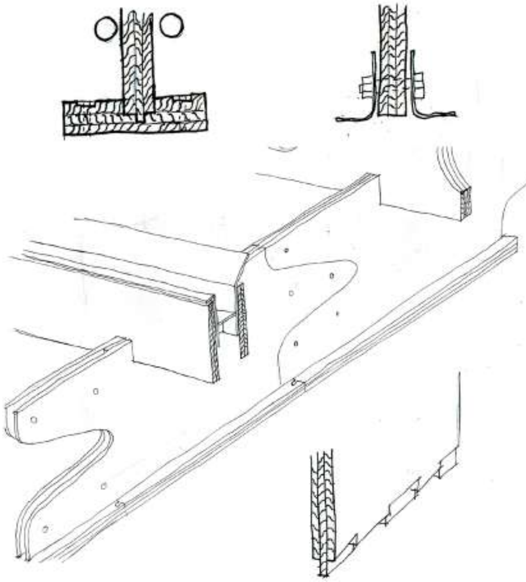
A Place Of Gathering

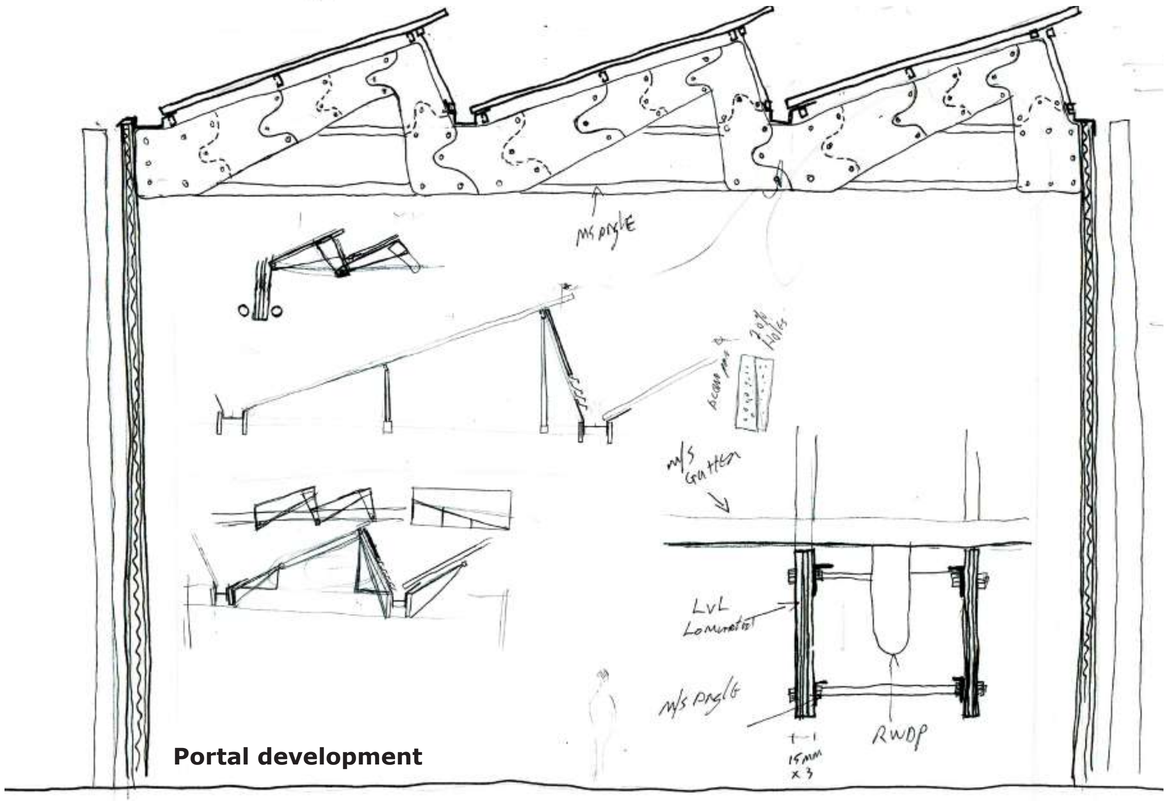
The principle of creating gathering places throughout the complex, to resemble the ethos of the OSM facility, of being a place where professionals, artisans and the public come together was resembled in nodes of shading. This circular shapes or roofs, was derived from the traditional notion of the Kgotla. Steyn (2018) refers to the circular spaces, whether internal or external, as a general traditional notion across many historical African settlements. It was concluded that a more indirect notion of developing 'trees' that could house other practical functions such as water harvesting and a possible cooling mechanism should be developed.

The Composition Of Structure

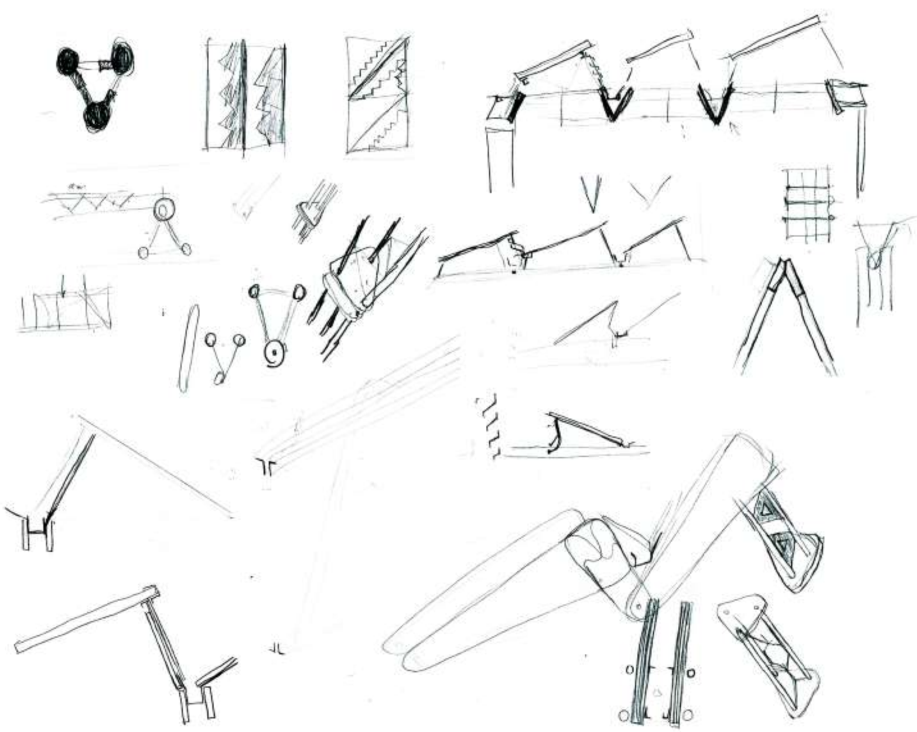
Upon further investigation and iteration the original intention of putting pre-cast beams high up in the air became flawed. Alternative compositions using less material were explored. This had to be done within the idiom of CAD/CAM and the three materials as stipulated.

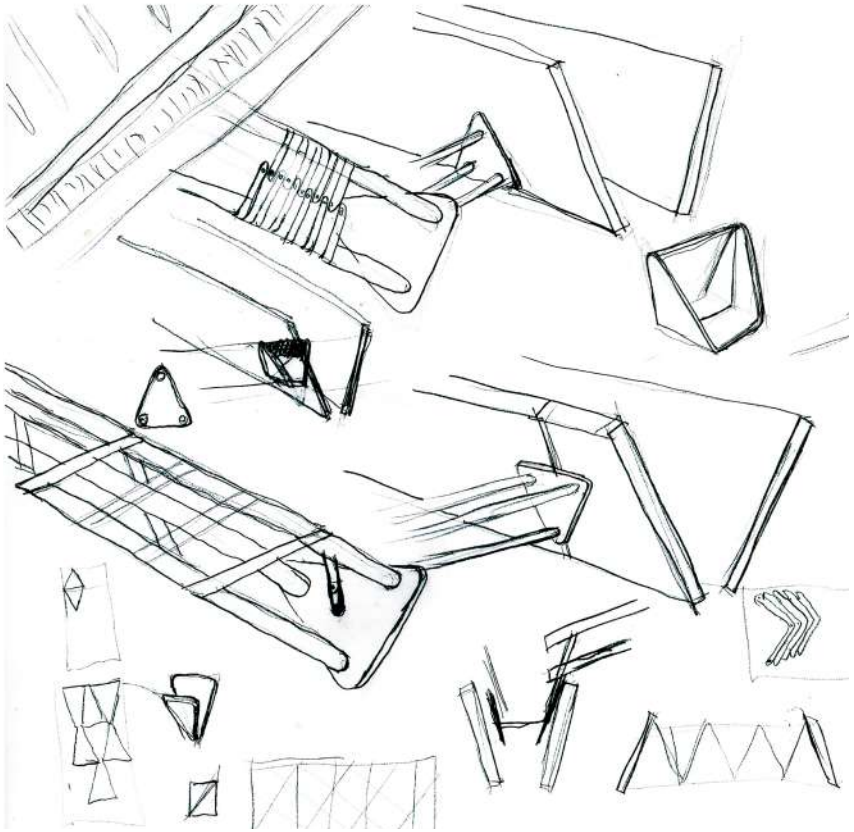




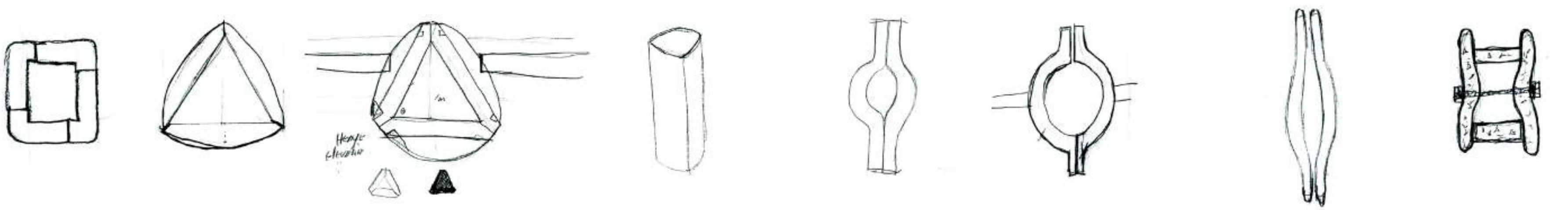


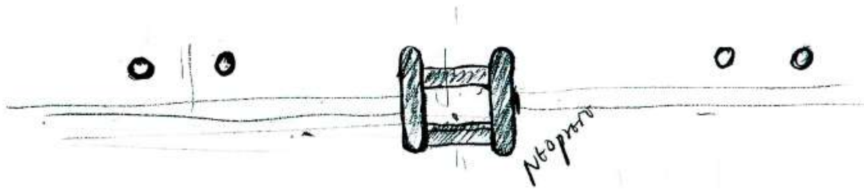
Portal development



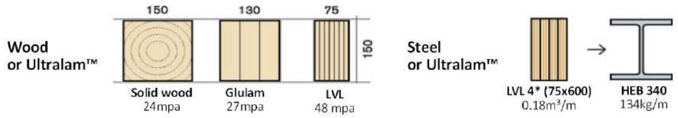


Beam Development



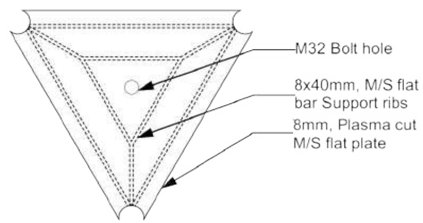


Column Development



Advantages of Laminated vinyl lumber. (Diagrams from, Universal Plywoods. 2019)

800s Telescopic boom lift
(Sky Operating Services, 2019)

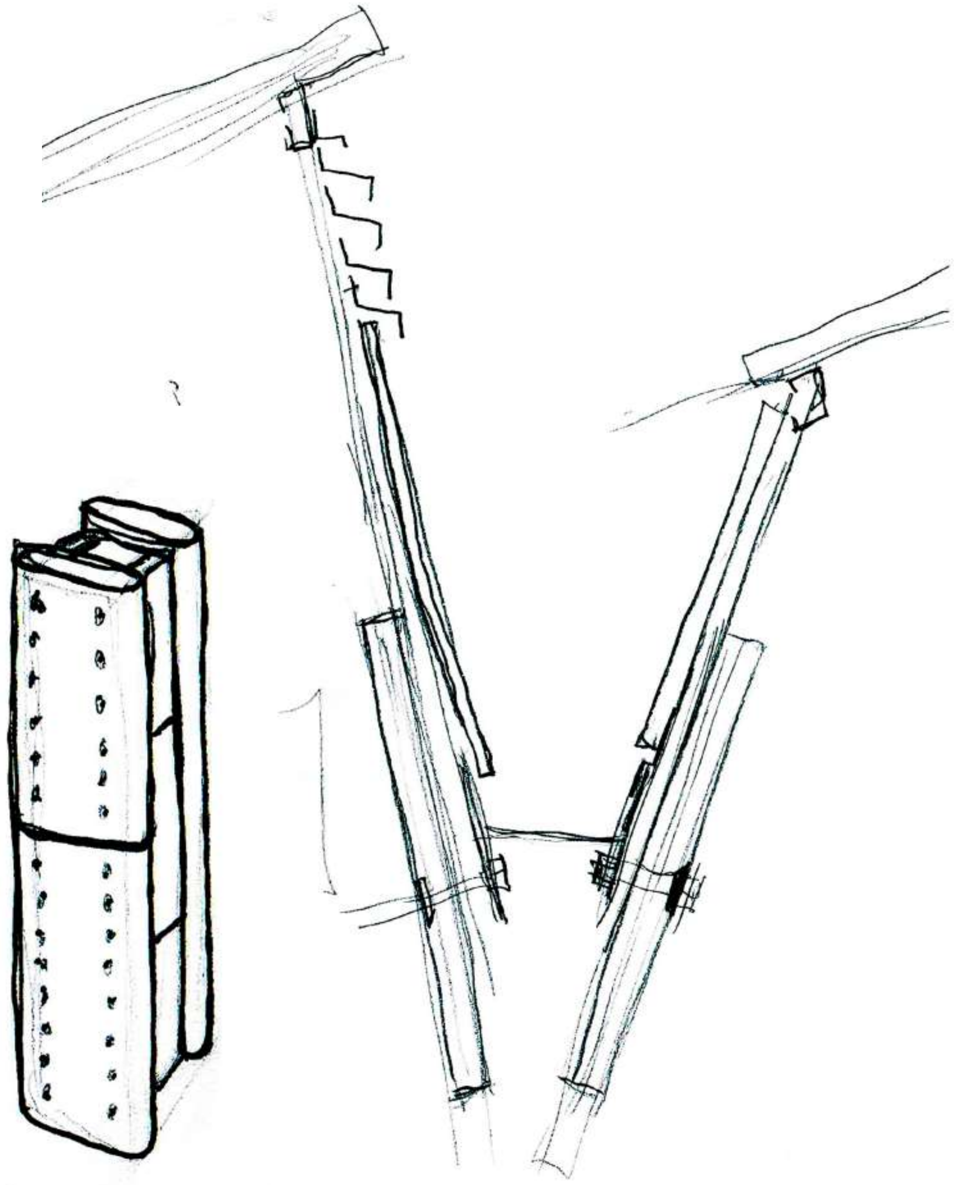


7.
8mm, Plasma cut M/S flat plate
Lattice Girder coupling end plates

1:10

Structure Conclusion

Upon multiple investigations that will be developed further in this dissertation, it was discovered that using OSM and CAD/CAM to create structures were ideal only if one looks at it as a means of bridging between lighter high-end technologies and heavy traditional technologies. To name a few examples, when using UHPC (Ultra High Performance Concrete), one now has the ability to have thinner lighter shells to create particulated structures. This enables a durable material to be assembled on site with minimal help from big cranes. LVL (Laminated Vinyl Lumber) enables us to have greater spans of timber beams with a material that can be shaped to have aesthetic value as well as structural value. CNC techniques can be used to design plates and brackets with aesthetic value for specific connections.



Structure Outcome

Passive and other Urban System Strategies

The approach toward passive energy within the complex was that of systems thinking. Broad strokes/principals were taken and then duplicated in all buildings. As a starting point the SBAT rating system was used to see where this type of complex would need design interventions. The shortfalls (Energy, Water, Local Economy and Management) were used as entry points in designing for the smaller parts of the bigger picture.

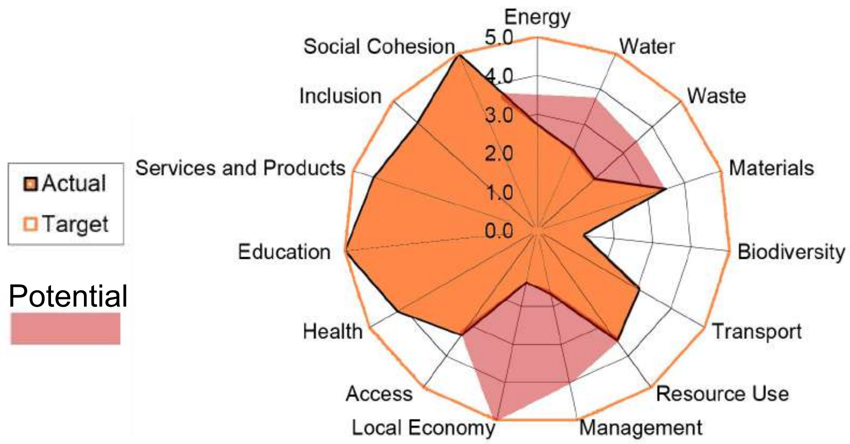
The construction strategies of this thesis were also seen as epistemic and ecologically important. Techniques and strategies that can contribute to the architectural continuum were developed. The efficiencies of construction on site, as well as after construction maintenance or disassembly, needed to be optimized. Smaller pieces that can be picked up by cherry pickers or even assembled by hand, to eliminate expensive time consuming crane rentals needed to be considered. To this end the optimal use of materials in regards to its weight and length was calculated. The position and intentions of materials were also programmed to become lighter the higher up you construct it, to make it saver and more cost effective to be built by hand.

Fig.50: Existing context and proposed building supper imposed in context(original image by Google maps 2019)

Passive systems

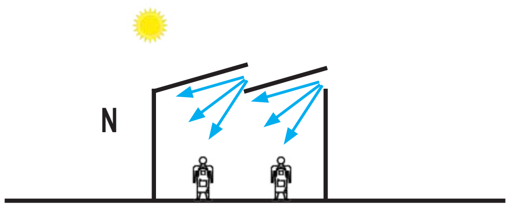
Passive ventilation and lighting systems were considered to save on electrical energy. In the factories the natural wind flow from the north to south was used by designing permanently open aluminium shutters to the south. This draws out the air from the building without using energy. Underneath the Aluminium shutters the light-weight polycarbonate multi-wall windows ensure that the factories are flooded with natural daylighting at al times during the day. In the office spaces, as well as in the restuarant, American shutters with rubber gasket seals can be used that will enable individual controle in these spaces.

A supplementary solar system was sized that could aid and alleviate the energy strain that a factories of this kind needs.



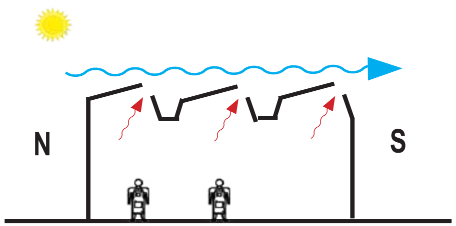
SB4 Environmental, Social and Economic Performance	Score
Environmental	2.3
Economic	2.0
Social	4.6
SBAT Rating	3.0

Fig.51: SBAT outcomes diagram. (SBAT rating spread sheet. 2019)



Lighting

Light from the south will be optimized within working spaces to save energy



Ventilation

Aluminium permanently open shutter will release heated air with the help of the Northern wind

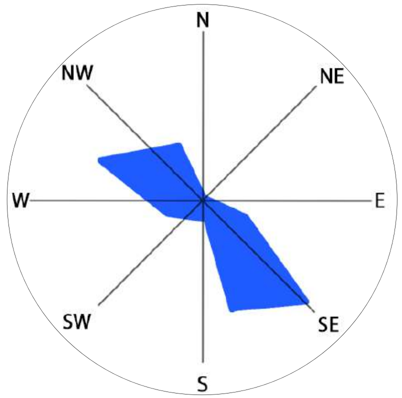


Fig.52: Summer average wind graft for Pretoria (Climate consult 2019)

Supplementary Solar System Intentions

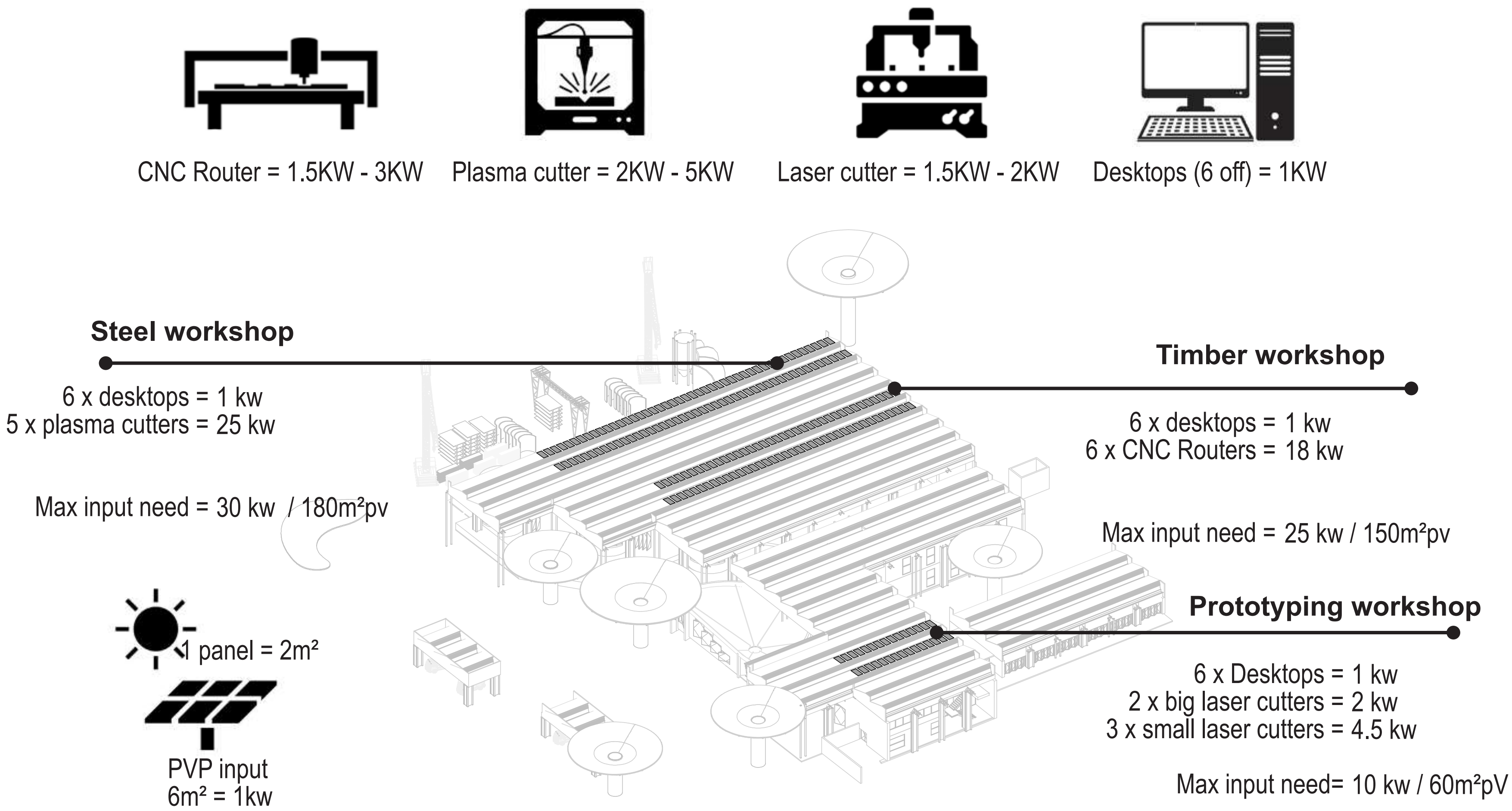


Fig.53: Diagrammatic layout of supplementary solar system.(by Author, 2019. Data was gathered from multiple online sources as well as solar contractors.)

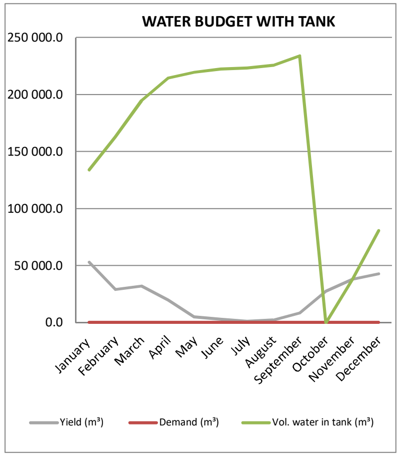
Derived from a model By FOURIE PIETERSE

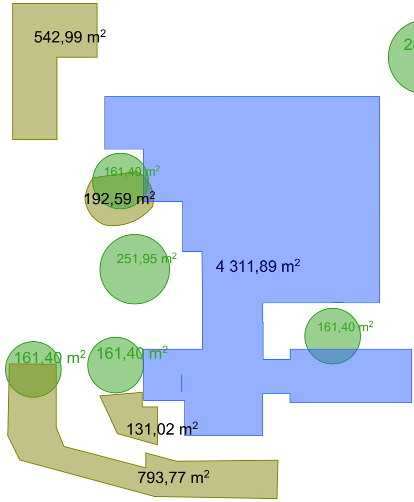
AREA CALCULATIONS			
Catchment	Area, A (m²)	Runoff Coefficient, C	C (weighted)
Roof	431186	0.9	0.89
Trees	1150	0.8	0.00
Planted area	1470	0.85	0.00
TOTAL	433806		0.90

Trees	Roofs	Planted areas	
280	5390	330	
280		170	
280		790	
360		540	
160			
160			
1520	5390	1830	m²

RAINWATER YIELD CALCULATION		
Month	Ave. rainfall, P (m)	Yield (m³) (Yield = PxAxC)
January	0.136	53072.2184
February	0.075	29267.7675
March	0.082	31999.4258
April	0.051	19902.0819
May	0.013	5073.0797
June	0.007	2731.6583
July	0.003	1170.7107
August	0.006	2341.4214
Sept	0.022	8585.2118
October	0.071	27706.8199
November	0.098	38243.2162
December	0.11	42926.059
ANNUAL AVE.	0.674	263019.67

TOTAL YIELD	
Month	Total Yield (m³/month)
January	53072.2184
February	29267.7675
March	31999.4258
April	19902.0819
May	5073.0797
June	2731.6583
July	1170.7107
August	2341.4214
September	8585.2118
October	27706.8199
November	38243.2162
December	42926.059
ANNUAL TOTAL	263019.671





Concrete mixtures

200-300 L/m³

Depending on mixtures 1m³ of conrete takes 0.2-0.3m³ of water to cast

WATER BUDGET (ACCUMALATIVE)				
Month	Yield (m³)	Demand (m³)	Monthly balance	Vol. water in tank (m³)
January	53 072.2	101.3	52 970.9	133 839.5
February	29 267.8	101.3	29 166.4	163 005.9
March	31 999.4	101.3	31 898.1	194 904.0
April	19 902.1	98.1	19 804.0	214 708.0
May	5 073.1	98.1	4 975.0	219 683.0
June	2 731.7	101.3	2 630.3	222 313.3
July	1 170.7	101.3	1 069.4	223 382.7
August	2 341.4	98.1	2 243.4	225 626.1
September	8 585.2	98.1	8 487.1	234 113.2
October	27 706.8	101.3	27 605.5	0.0
November	38 243.2	98.1	38 145.2	38 145.2
December	42 926.1	202.6	42 723.4	80 868.6
ANNUAL AVE.	263019.67	1300.9721	261718.7	

IRRIGATION DEMAND 50% of plants to be watered by harvested rain water				
Month	Planting area (m²)	Irr. depth / week (m)	Irr. depth / month (m)	Irrigation demand (m³/month)
January	915	0.025	0.110714286	101.3035714
February	915	0.025	0.110714286	101.3035714
March	915	0.025	0.110714286	101.3035714
April	915	0.025	0.107142857	98.03571429
May	915	0.025	0.107142857	98.03571429
June	915	0.025	0.110714286	101.3035714
July	915	0.025	0.110714286	101.3035714
August	915	0.025	0.107142857	98.03571429
September	915	0.025	0.107142857	98.03571429
October	915	0.025	0.110714286	101.3035714
November	915	0.025	0.107142857	98.03571429
December	915	0.05	0.221428571	202.6071429
			ave monthly	108.3839286
			ANNUAL TOTAL	1300.60714

WATER BUDGET			
Month	Yield (m³)	Demand (m³)	Monthly balance
January	53 072.2	101.3	52 970.9
February	29 267.8	101.3	29 166.4
March	31 999.4	101.3	31 898.1
April	19 902.1	98.1	19 804.0
May	5 073.1	98.1	4 975.0
June	2 731.7	101.3	2 630.3
July	1 170.7	101.3	1 069.4
August	2 341.4	98.1	2 243.4
September	8 585.2	98.1	8 487.1
October	27 706.8	101.3	27 605.5
November	38 243.2	98.1	38 145.2
December	42 926.1	202.6	42 723.4
ANNUAL AVE.	263019.7	1300.972143	261 718.7

Water Harvesting

It was found that not all the water from the roof needed to be harvested and stored as it would be wasteful due to the cost of running treatment plants for the massive amount of water that the site can harvest. In stead, a budget to store clean water in the canopies/trees was opted for. This can be directly used in casting concrete which is very water intensive. The rest of the water can then be treated and used in the building to flush toilets or be treated for irrigation purposes.

Storage tanks capacity of 120.4m³ allow for casting capacity of 24m³ of concrete p/ month.

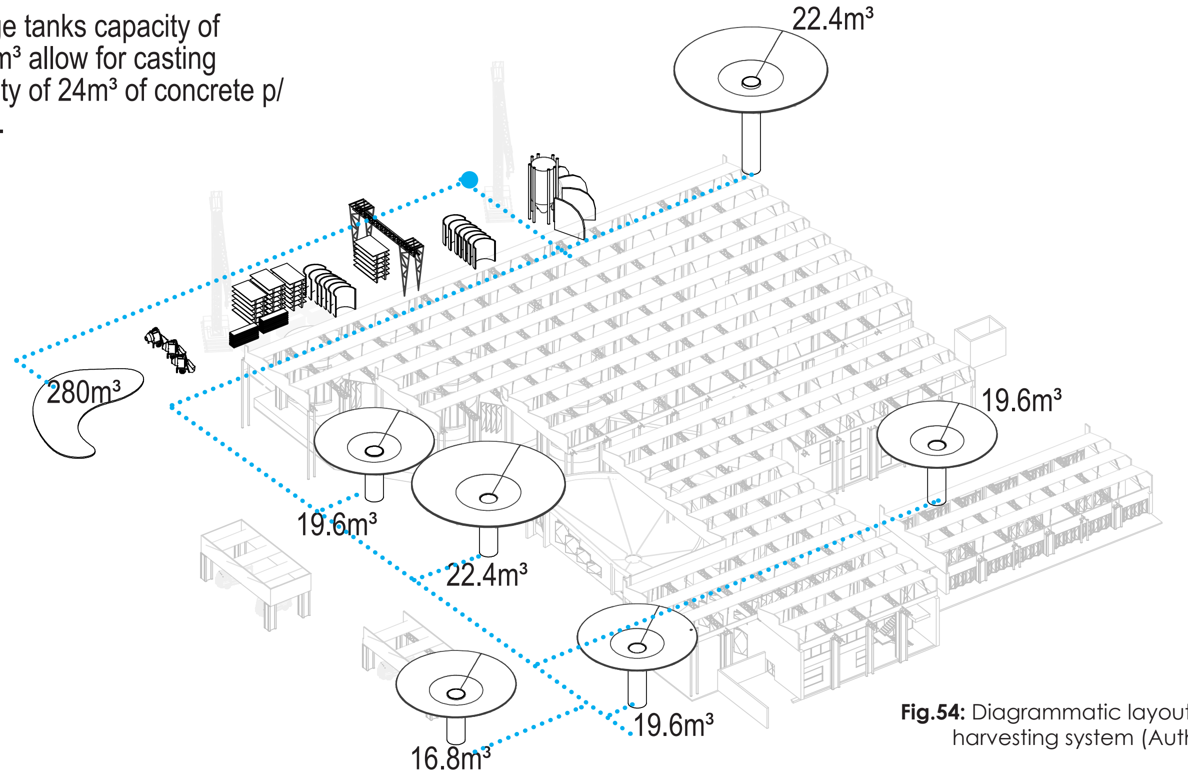


Fig.54: Diagrammatic layout of water harvesting system (Author, 2019)

Storage dam size

Area	140	m²
Ave depht	2	m
Total dam	**280**	**m³**

Tree sorage tank sizes

Height		8	8	**7**	**7**	7	**6**	**Total tanks**
area	**2.8**	22.4	22.4	**19.6**	**19.6**	19.6	**16.8**	**120.4** m³

Total storage capacity

Total dam size + tree storage

400.4 m³

Casting capacity integrated with landscape

(Total Storage - Irrigation demand) x 0.2m³

59.819 m³ Total montly cap for concrete casting if using dam storage

Casting capacity tanks storage only

(Total Storage - Irrigation demand) x 0.2m³

24 m³ Total montly cap for concrete casting if using only canopy storage

Weight and econimical calculations

Primary Structure (2 portals/130m²)

Pre-cast concrete columns	weight/measure	unit	QTY	total weight/Tons	rate	unit	
Precast Reinforced column panels Open	4.75	t	4	19.00	R3 125.00	t	R59 375.00
Precast Reinforced column panels Closed	4.87	t	2	9.74	R3 125.00	t	R30 437.50
M16 PC Column Clamp rods	1.60	kg/m	80	0.13	R30 000.00	t	R3 840.00

Secondary Structure (2 portals/130m²)

Steel girders	weight/measure	unit	QTY	total weight/Tons	rate	unit	
200øx6(2off), M/S CHS Columns	27.770	m	40	1.11	R30 000.00	t	R33 324.00
8mm, Plasma cut M/S flat plate Capital Brackets (2 per bay)	62.800	kg/m²	2.34	0.15	R30 000.00	t	R4 408.56
8mm, Plasma cut M/S flat plate Capital Brackets (2 per bay)	62.800	kg/m²	2.34	0.15	R30 000.00	t	R4 408.56
8mm, Plasma cut M/S flat plate Capital Brackets (2 per bay)	62.800	kg/m²	2.34	0.15	R30 000.00	t	R4 408.56
60x4, M/S CHS (three per bay)	5.500	kg/m	40.5	0.22	R30 000.00	t	R6 682.50
60x4, M/S CHS (three per bay)	5.500	kg/m	40.5	0.22	R30 000.00	t	R6 682.50
60x4, M/S CHS (three per bay)	5.500	kg/m	40.5	0.22	R30 000.00	t	R6 682.50
8mm, Plasma cut M/S flat plate Girder coupling end plates	62.800	kg/m²	4.68	0.29	R30 000.00	t	R8 817.12
8mm, Plasma cut M/S flat plate Girder coupling end plates	62.800	kg/m²	4.68	0.29	R30 000.00	t	R8 817.12
8mm, Plasma cut M/S flat plate Girder coupling end plates	62.800	kg/m²	4.68	0.29	R30 000.00	t	R8 817.12
4mm, Plasma cut M/S Flat plate Lattice girder stiffeners	35.320	kg/m²	3.8	0.13	R30 000.00	t	R4 026.48
25mm thick(3off), CNC Ultralam™ LVL Composite Rafters(6 off)	1.107	m³	6	6.64	R30 000.00	m³	R199 260.00
M12x100 Bolts and nuts per bay	0.120	kg	200	0.02	R30 000.00	t	R720.00

Weight of 3 Girders **2.15** tons
Weight of 1 Girder **0.72** tons
Weight per m² **16.53** kg/m²

Envelope (2 portals/130m²)

Structure elements	weight/measure	unit	QTY	total weight/Tons	rate	unit	
60øx4, M/S CHS Façade and Purlin Substructure or cross Bracing	5.500	kg/m	96	0.53	R30 000.00	t	R15 840.00
75x50x20, CFLC Purlin or Façade hanger	2.400	kg/m	120	0.29	R30 000.00	t	R8 640.00
4mm, M/S Flat plate Gutter paint with bitumen based paint.	35.320	kg/m²	24	0.85	R30 000.00	t	R25 430.40
Infill/envelope materials							
Multi wall and Aluminium louvers	3.000	kg/m²	57	0.17	R1 800.00	m²	R102 600.00
Roof sheeting	4.600	kg/m²	60	0.28	R250.00	m²	R15 000.00

Weight of Roof Envelope of two bays **2.11** tons
Weight of Envelope per m² **17.59** kg/m²

Total of all to be held up per M² 34.12 kg/m²

Cost of 3 bays ###########
Cost per m² ###########

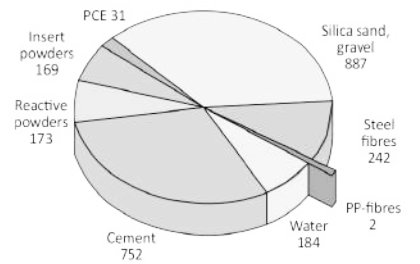
Landscape canopies

Pre-cast concrete	weight/measure	unit	QTY	total weight/Tons	rate	unit	
Precast Reinforced concrete base	1.10	t	1	1.10	R3 125.00	t	R3 437.50
Precast Reinforced concrete clamp shell	0.20	t	10	2.00	R3 125.00	t	R6 250.00
M16 PC Column Clamp rods	1.60	kg/m	10	0.02	R30 000.00	t	R480.00
30mm thick(3off), CNC Ultralam™ LVL Composite Rafters(10 off)	0.100	m³	10	1.00	R30 000.00	m³	R30 000.00

Weight of total structure **4.12** tons

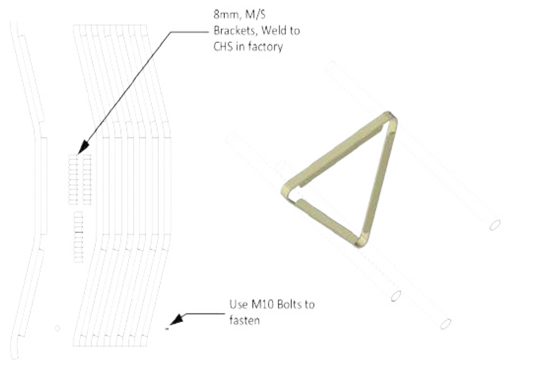
Cost of structure ###########

SPC	UHPC
Standard pre cast concrete	Ultra high performance concrete
24-50Mpa	146+Mpa
2.4 t/m³	1.2 t/m³
Wall thickness min 80	Wall thickness min 60



Mean composition of UHPC (kg/m³)

Strenght and weights(Nematollahi. B et al, 2019)
Composition graph (Sciencedirect.com, 2019)

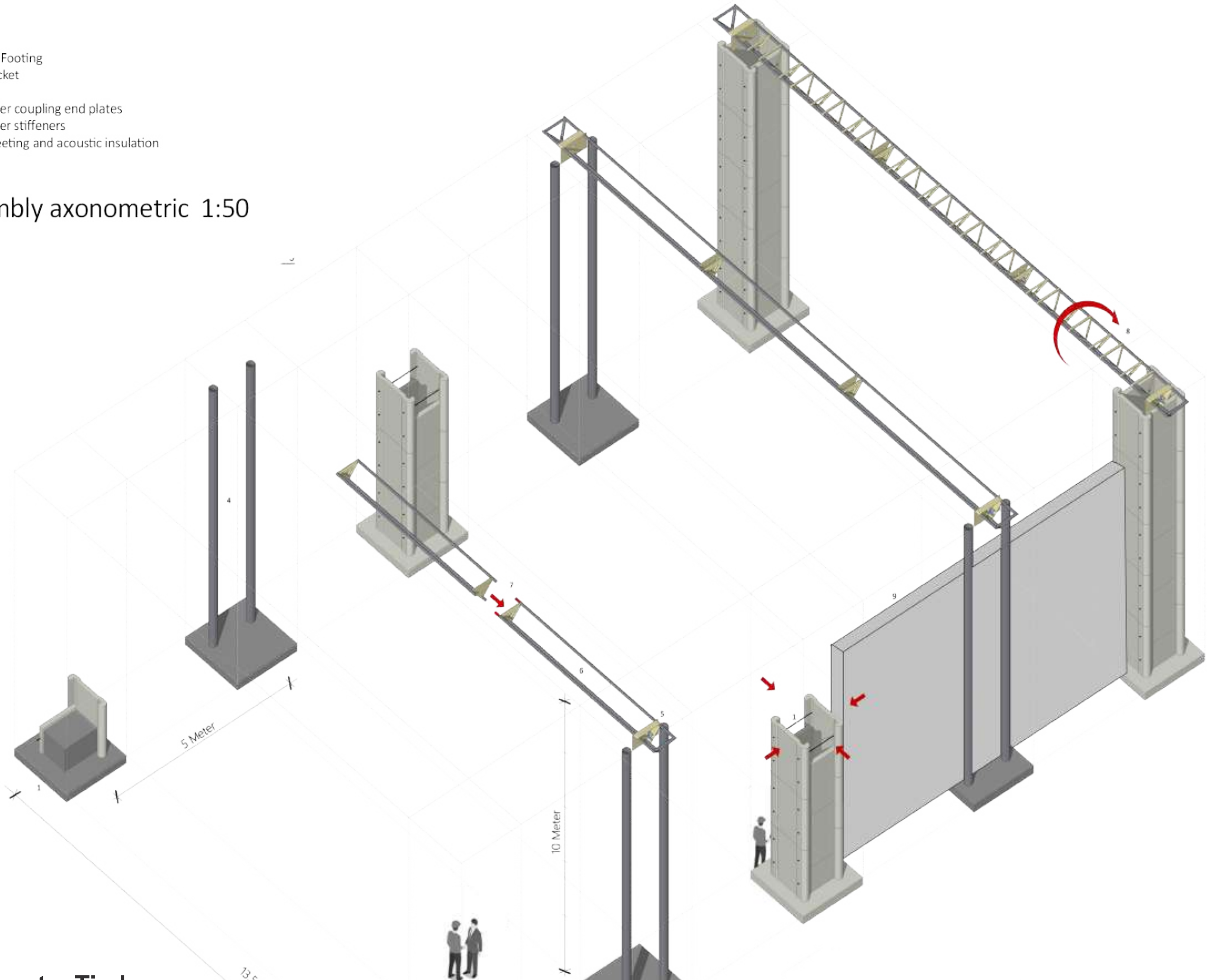


8.
4mm, Plasma cut M/S Flat plate Lattice girder stiffeners 1:50

Tech Development

1. Concrete footing with Clamp block
2. Precast Reinforced column panels
3. M16 PC Column Clamp rods
4. 200⌀x6(2off), M/S CHS Columns, Cast in RC Footing
5. 8mm, Plasma cut M/S flat plate Capital Bracket
6. 60⌀x4(3off), M/S CHS Lattice girder
7. 8mm, Plasma cut M/S flat plate Lattice Girder coupling end plates
8. 4mm, Plasma cut M/S Flat plate Lattice girder stiffeners
9. Light frame steel , cladded with Profiled sheeting and acoustic insulation

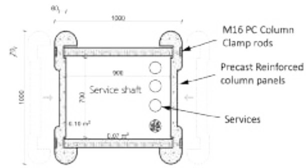
Primary structure assembly axonometric 1:50



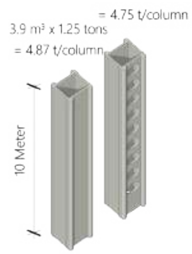
Material strategies(Concrete, Timber Steel)

Investigations into the 3 materials as delimited were made. The following three pages address the characteristics of each of the materials, that benefits the ideals of this thesis. Weight to strength ratios, position of material in structure, as well as aesthetic value were iterated multiple times.

800s Telescopic boom lift
(Sky Operating Services, 2019)



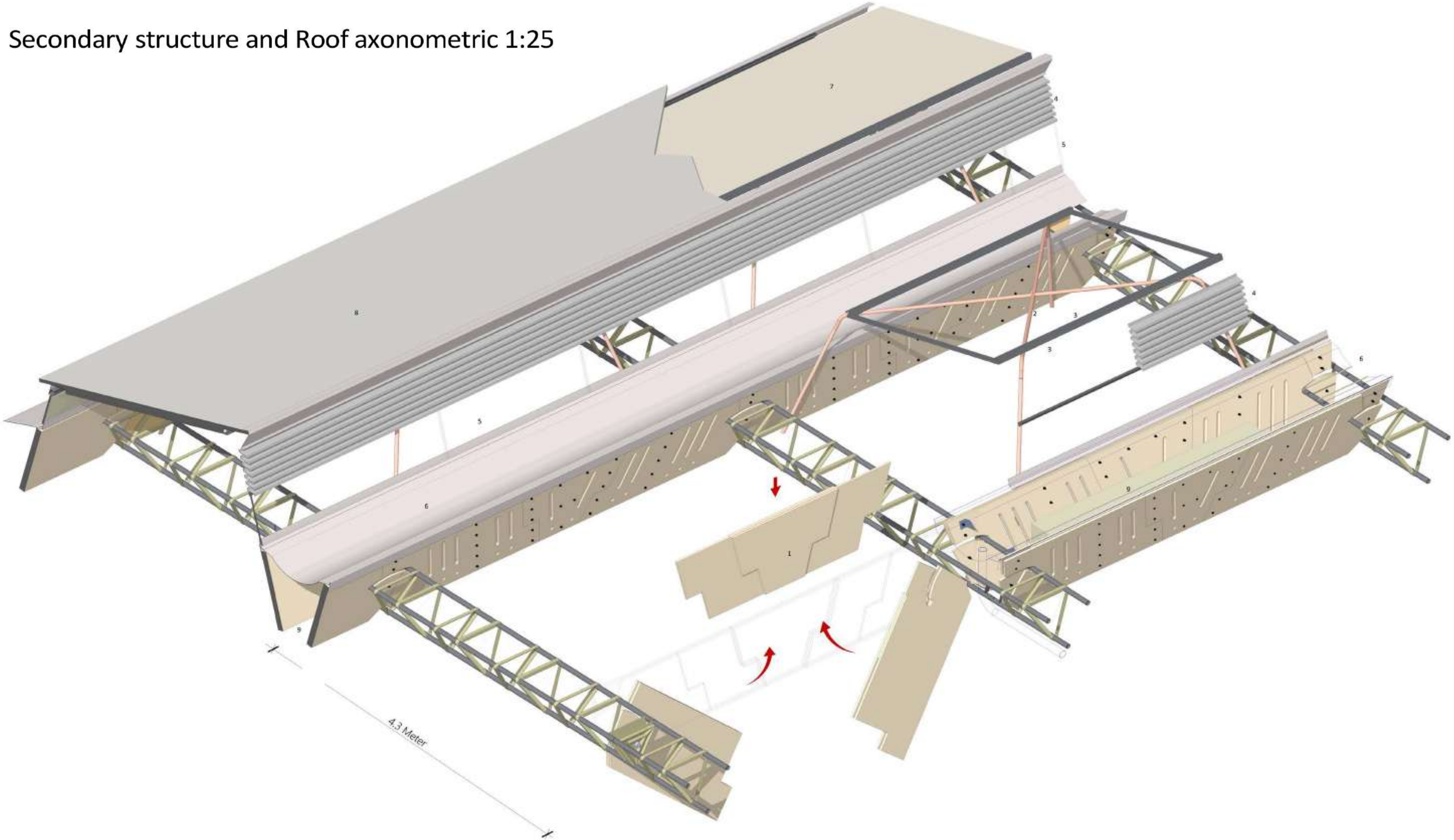
2.
Precast Reinforced column panels
1:20



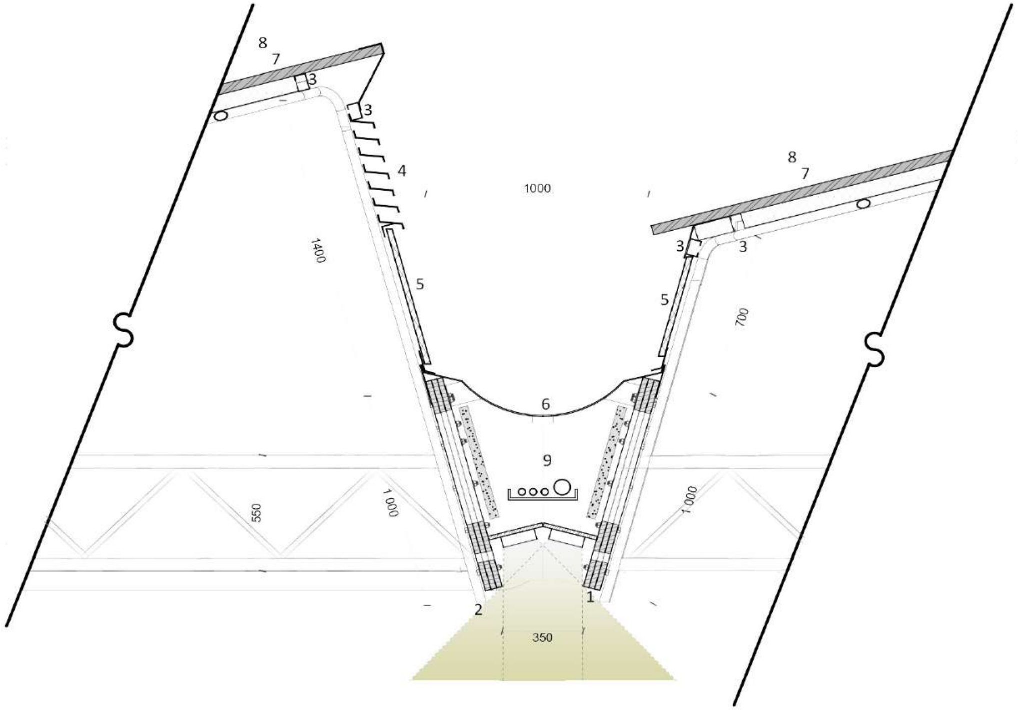
1:100

1. 25mm thick(3off), CNC Ultralam™ LVL Composite Rafters
2. 60⌀x4, M/S CHS Façade and Purlin Substructure or cross Bracing
3. 75x50x20, CFLC Purlin or Façade hanger
4. Aluminium Static Louver system
5. 25mm thick, Multiwall polycarbonate solar control widows in Galv frames
6. 4mm, M/S Flat plate Gutter paint with bitumen based paint.
7. Over the purlin Insulation and acoustic treatment between Purlins
8. Novotexi 440 Roof sheeting system
9. Service duct. Acoustic battens, cable tray, LED Highbay lights

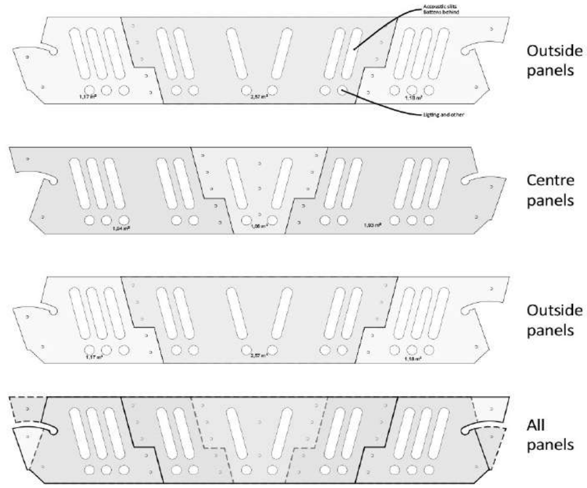
Secondary structure and Roof axonometric 1:25



Iteration 1



RDS_01 Roof Detail Section_01 1:20



1.
25mm thick(3off), CNC Ultralam™
LVL Composite Rafters 1:50

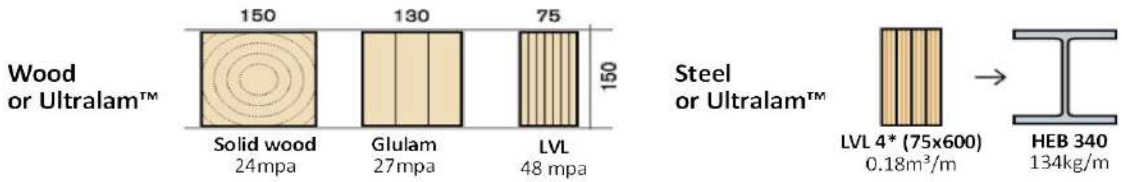
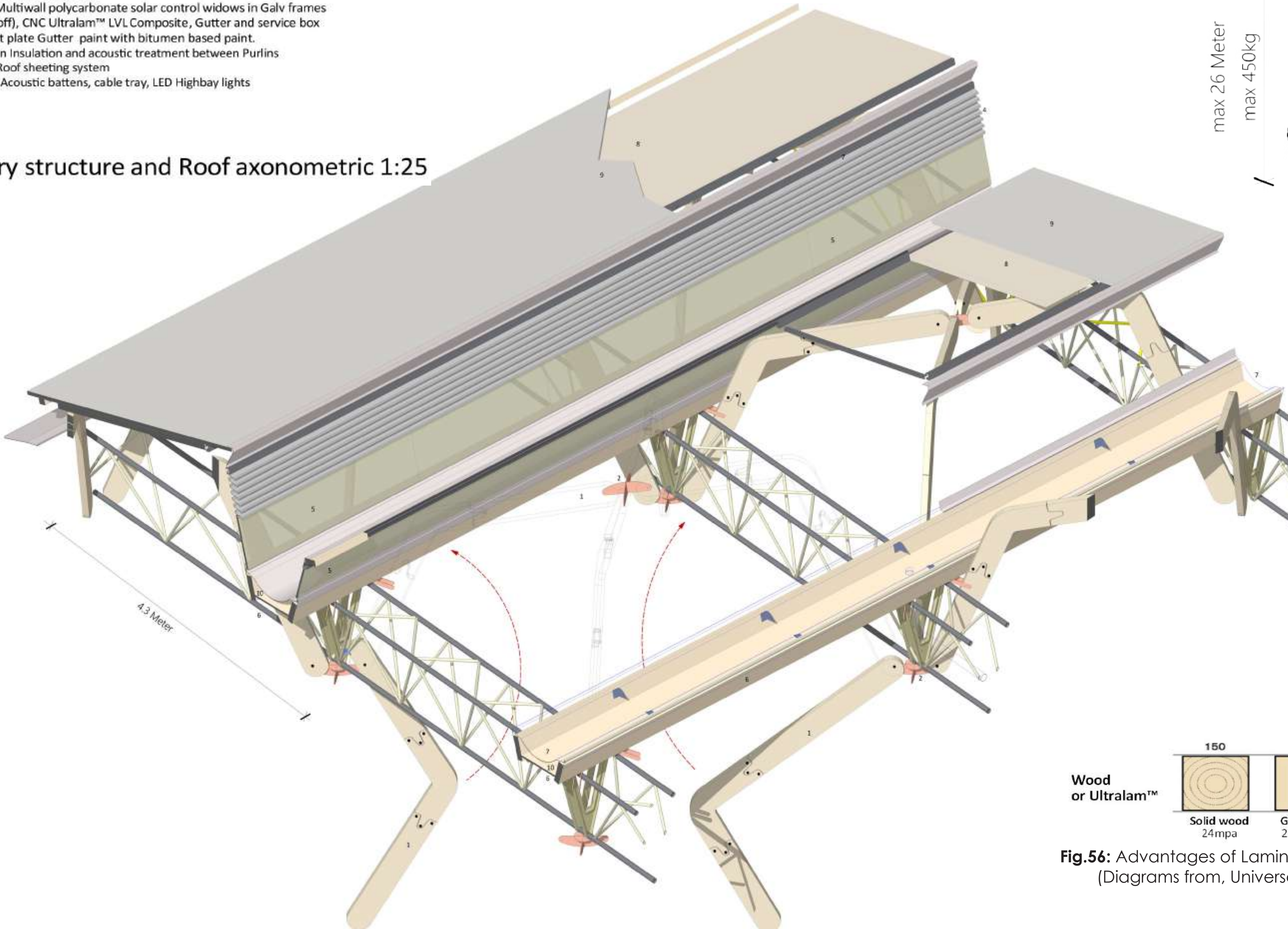


Fig.55: Advantages of Laminated vinyl lumber. (Diagrams from, Universal Plywoods. 2019)

1. 20mm thick(3off), CNC Ultralam™ LVL Composite, Purlin/Facade sub-structure
2. 8mm, Plasma cut M/S Flat plate brackets
3. 75x50x20, CFLC Purlin or Façade hanger
4. Aluminium Static Louver system
5. 25mm thick, Multiwall polycarbonate solar control widows in Galv frames
6. 20mm thick(3off), CNC Ultralam™ LVL Composite, Gutter and service box
7. 4mm, M/S Flat plate Gutter paint with bitumen based paint.
8. Over the purlin Insulation and acoustic treatment between Purlins
9. Novotexi 440 Roof sheeting system
10. Service duct. Acoustic battens, cable tray, LED Highbay lights

Secondary structure and Roof axonometric 1:25



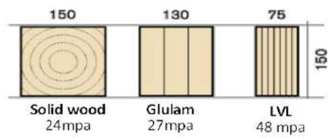
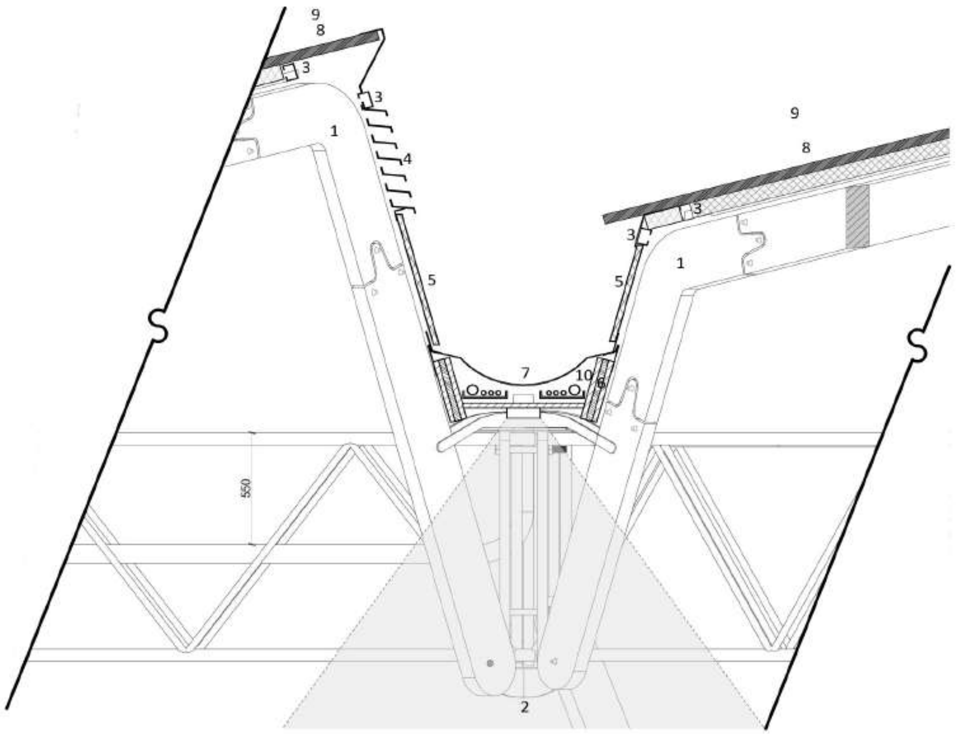
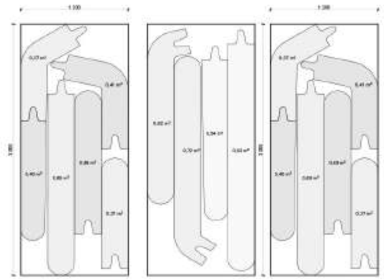
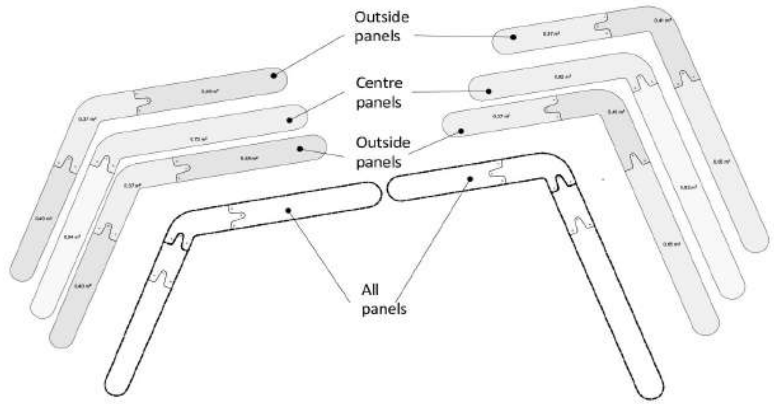


Fig.56: Advantages of Laminated vinyl lumber. (Diagrams from, Universal Plywoods. 2019)



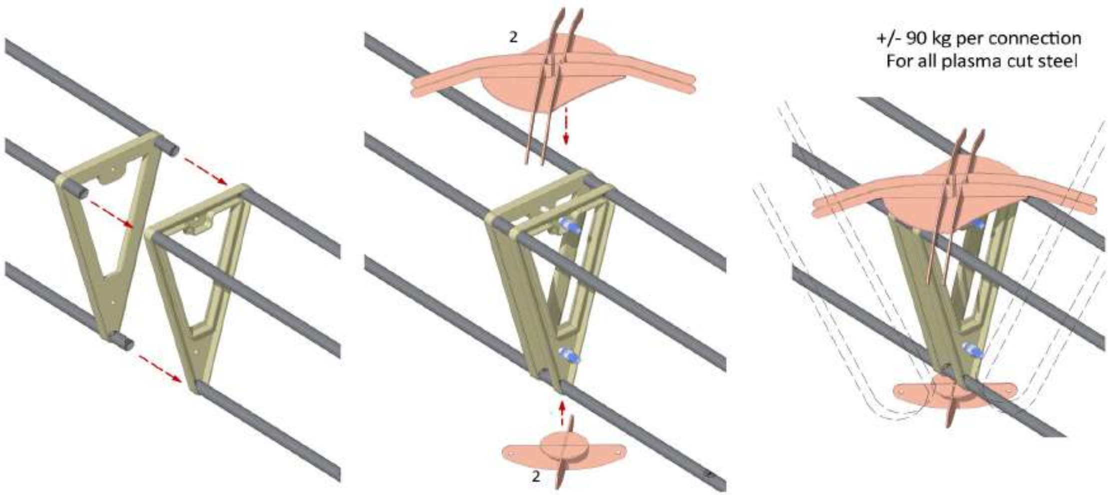
RDS_01 Roof Detail Section_01 1:20





1. 20mm thick(3off), CNC Ultralam™
LVL Composite Rafters

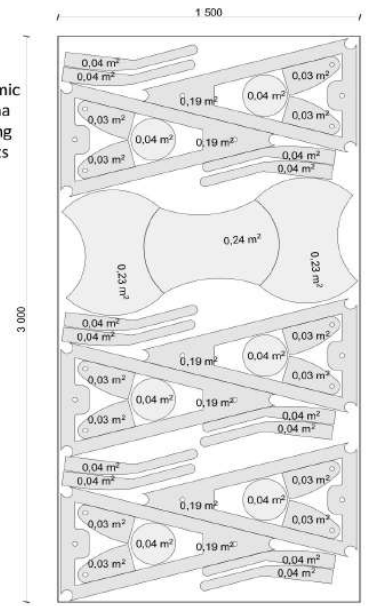
1:50



2. 8mm, Plasma cut M/S
Flat plate brackets

1:20

Economic
Plasma
Nesting
Sheets



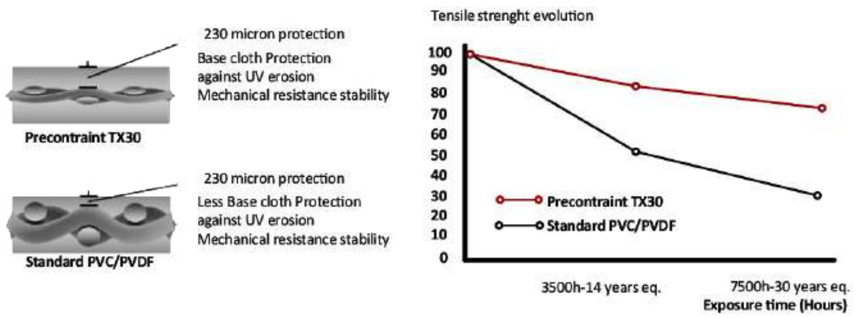
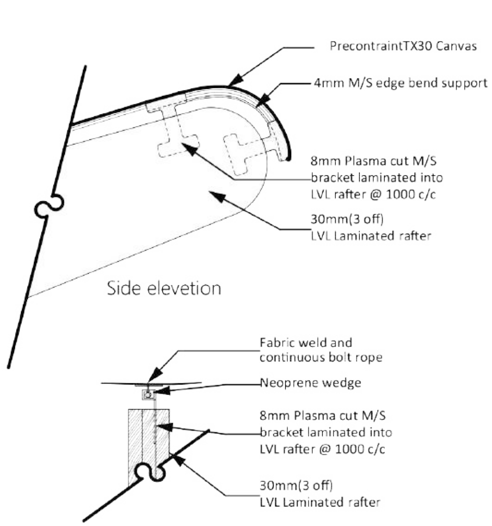
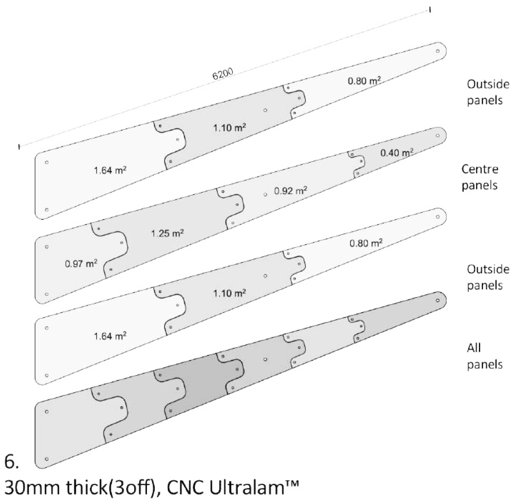


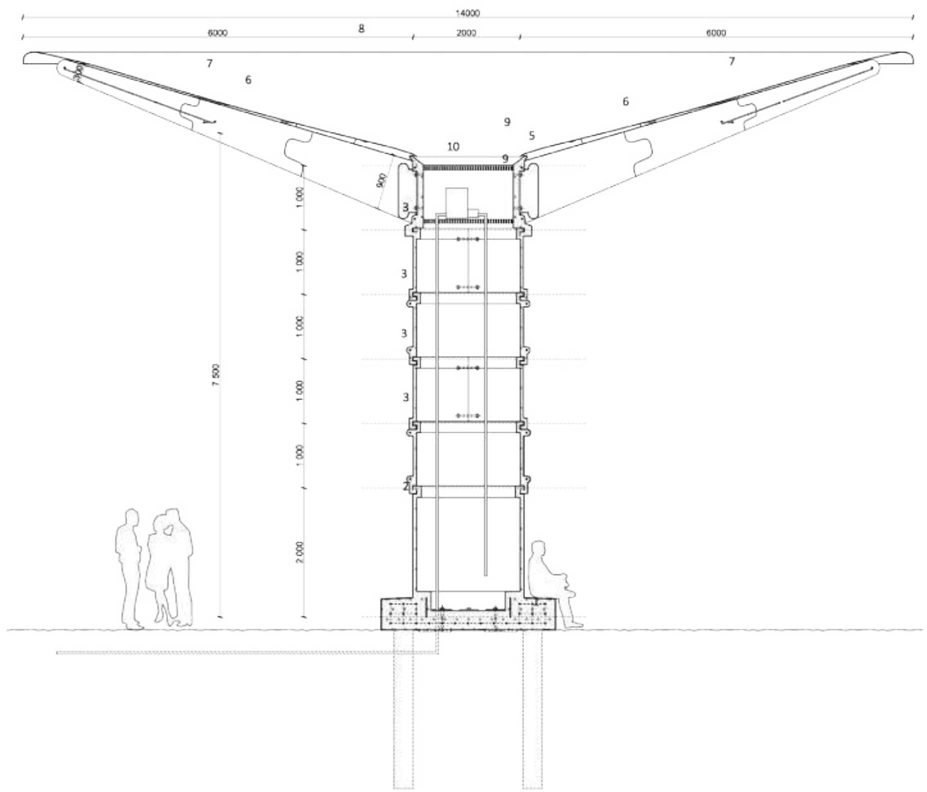
Fig.57: Advantages of Precontriant TX30 Canvas (Diagrams from, Sergeferrari.com, 2019)



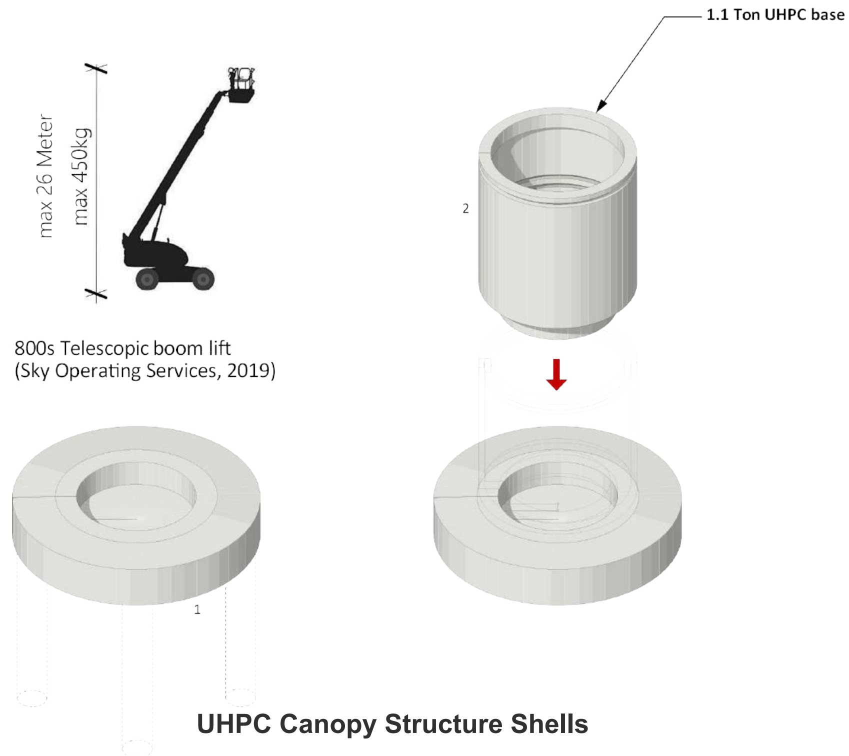
Canvas mount detail



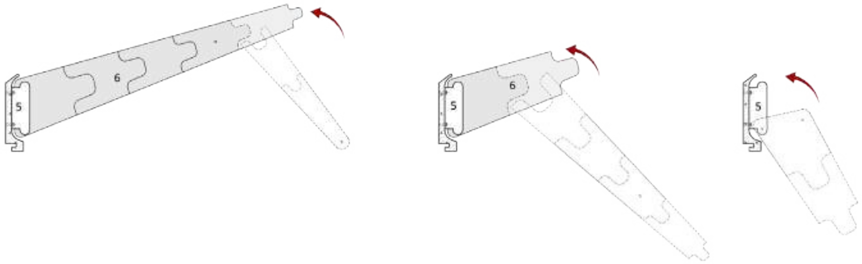
LVL Composite Rafter nesting/layouts



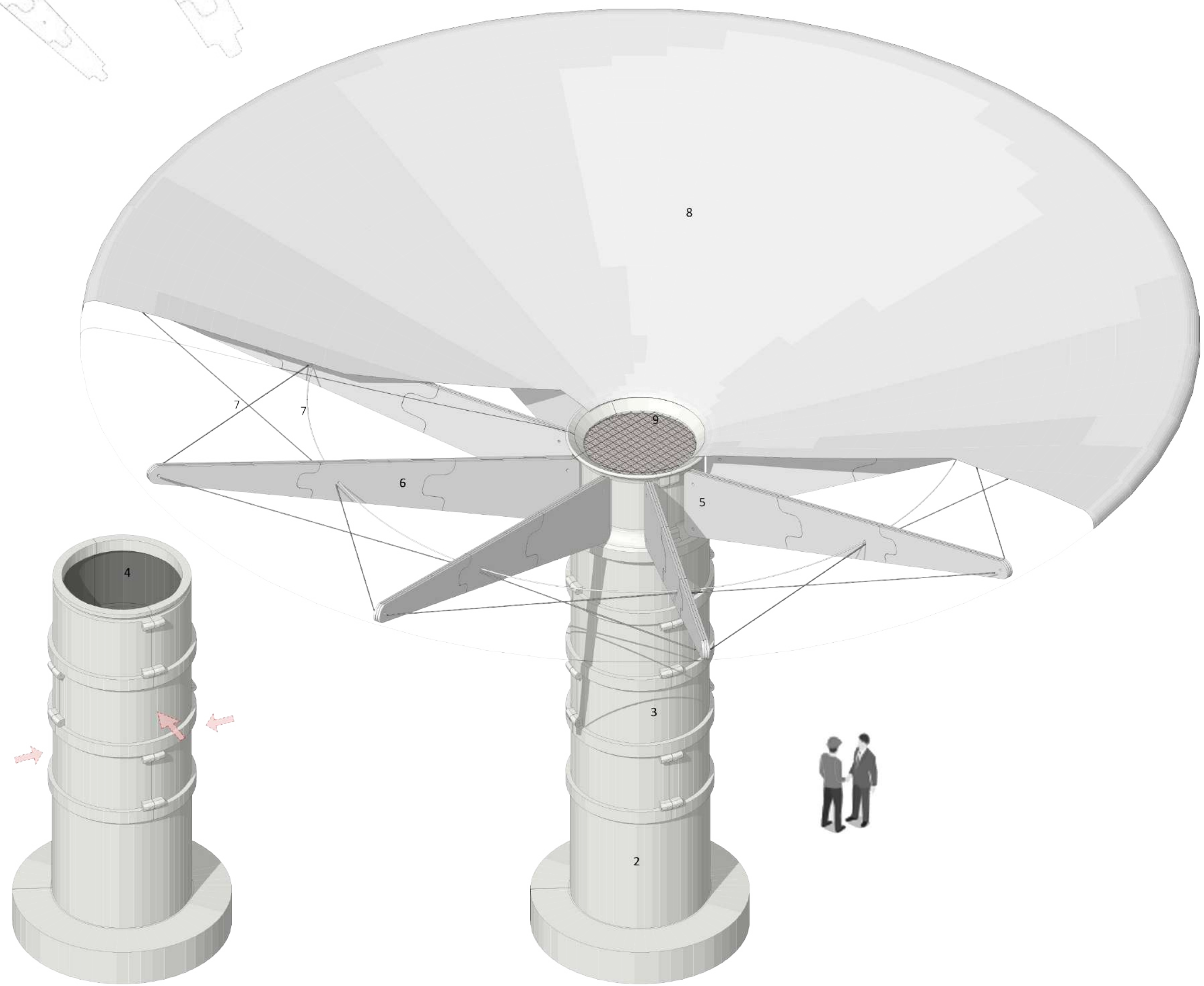
Landscape Canopy Section

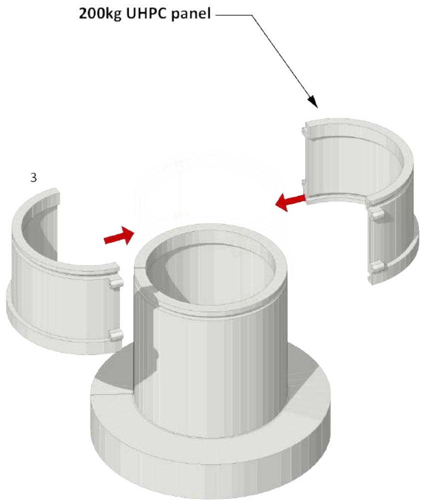


UHPC Canopy Structure Shells

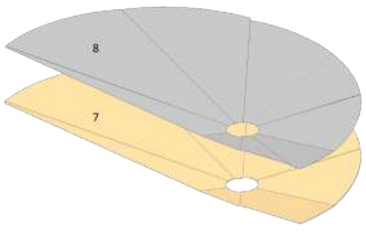


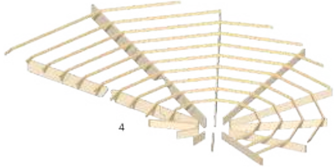
1. RC Ring beam and base floor cast insitu on RC pile foundations.
2. UHPC Base tank, bolted to Ring Beam and base floor with M30 bolts.
3. UHPC tank Shells, clamped with M20 bolts.
4. Bitumen based waterproof compound to inside of tank
5. 8mm, M/S Rafter gusset bolted to Top shell.
6. 30mm thick(3off), CNC Ultralam™ LVL Composite Rafters
7. 12mm, Marine-grade Ringbind/Crossbrace cables with tensioners
8. Canvas canopy, PrecontraintTX30 from Serge Ferrari.
9. RS-40 Menis grating top cover and platform.
10. Submersible pump linked to water harvesting system

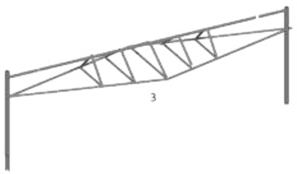


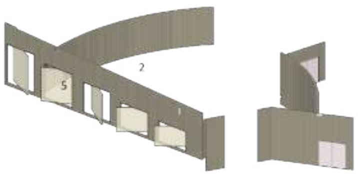


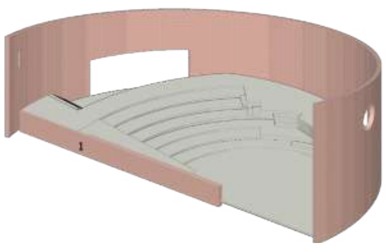
Landscape Canopy Axonometric

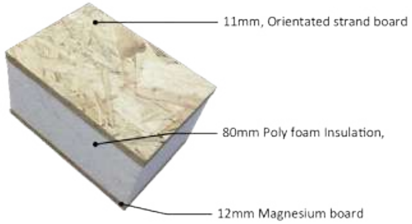












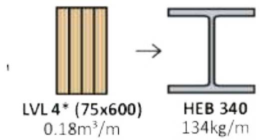


Fig.58: Advantages of Laminated vinyl lumber. (Diagrams from, Universal Plywoods. 2019)

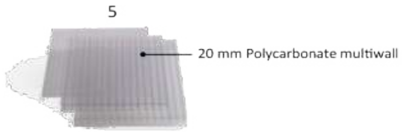
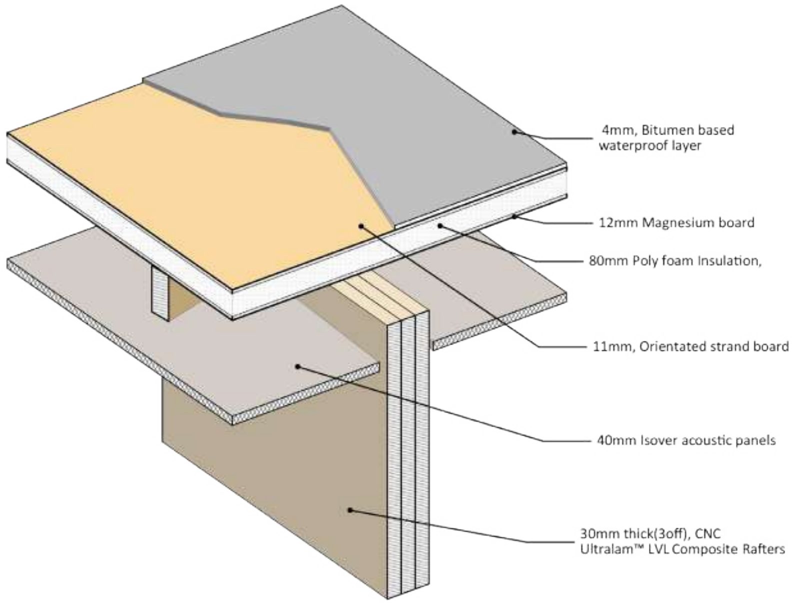
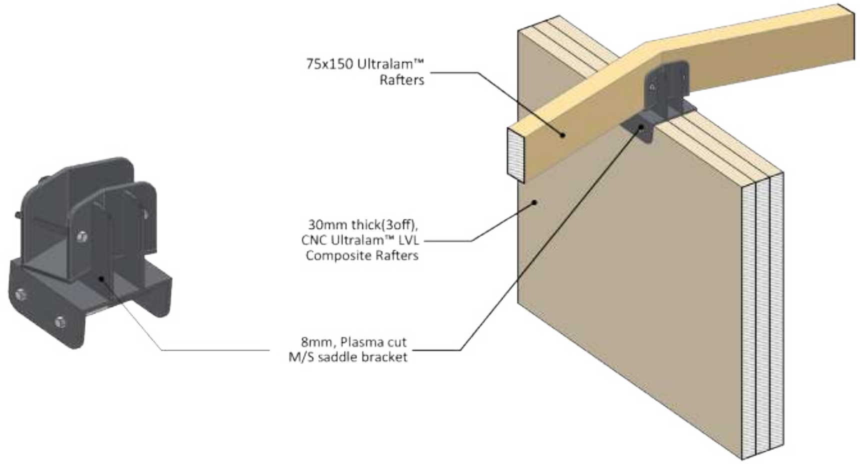
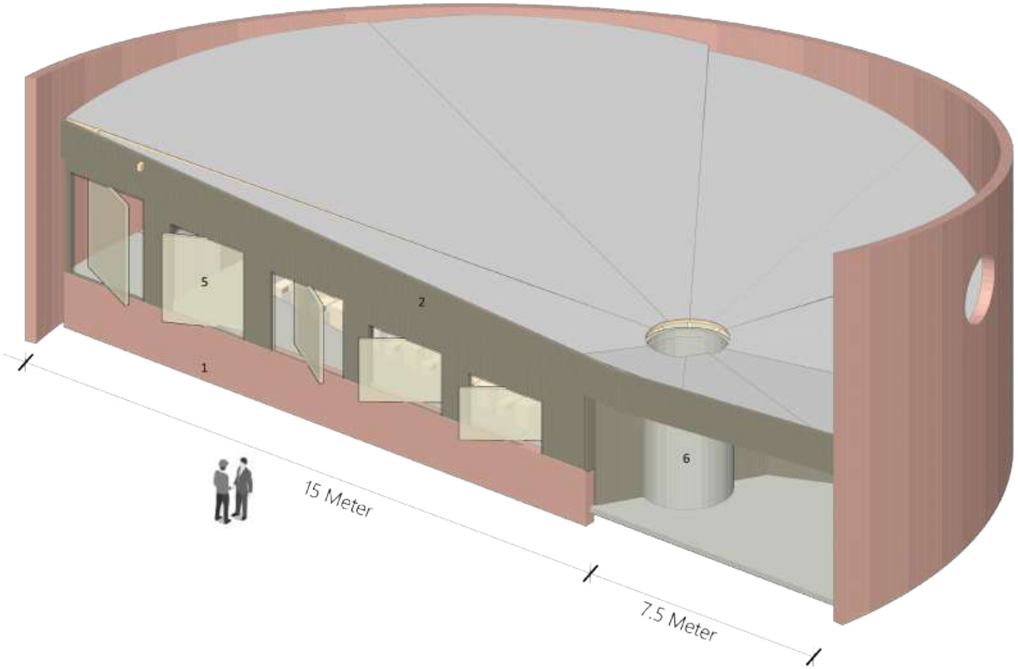


Fig.59: Sheet metal and LSF wall construction (Origional image. Archello, 2019)

OSB Roof	R Value = 1.97
20mm Multiwall	R Value = 0.57
LSF	R Value = 2.5
230 Brick	R Value = 0.25

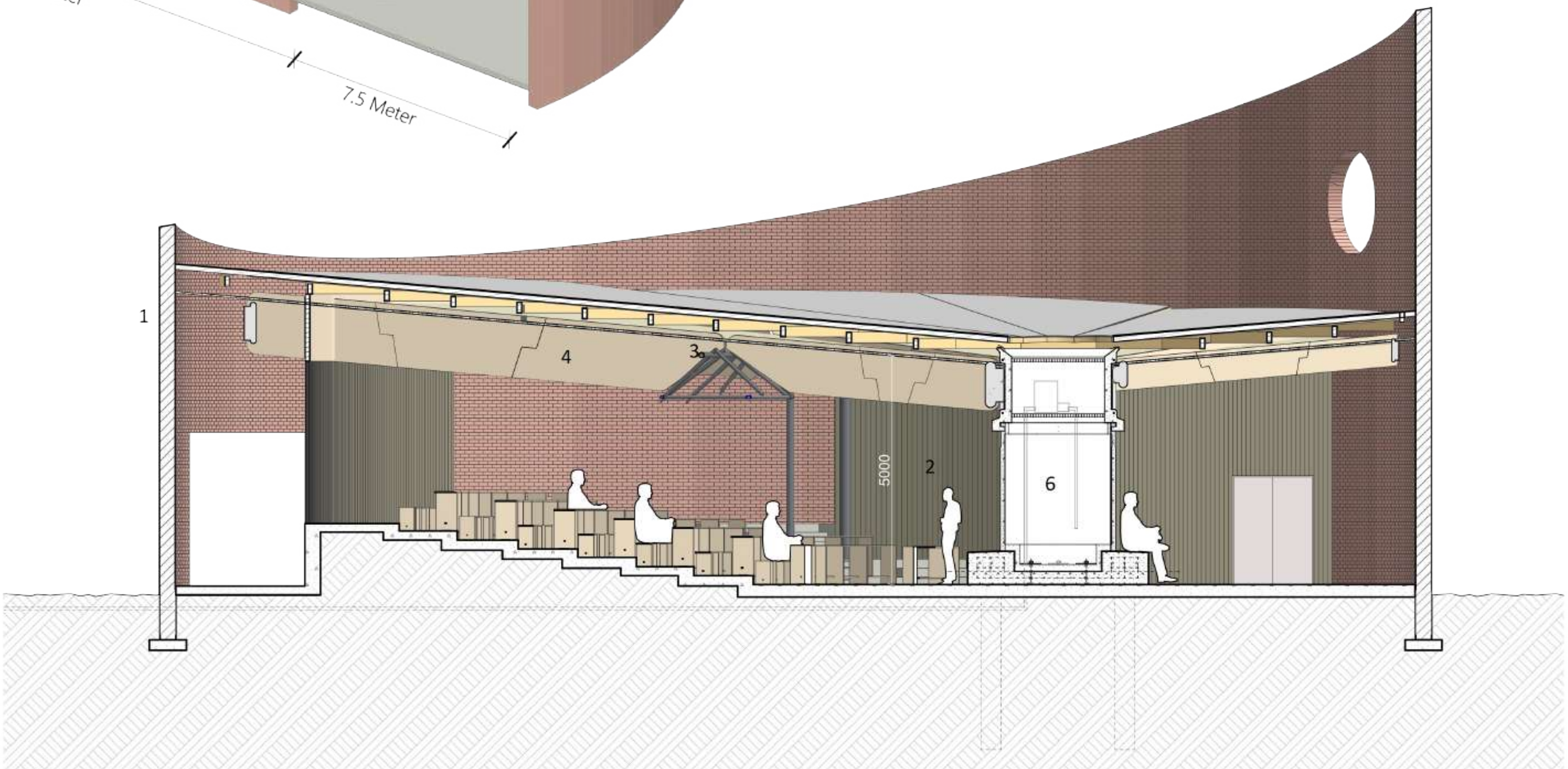






1. Facebrick masonry, Corobrick Firelight travertine, Midrand factory, in Flemish bond.
2. Light steel frame wall paneling, with Macsteel Novotexi 440 sheeting.
3. M/S CHS columns and space frame truss.
4. 30mm thick(3off), CNC Ultralam™ LVL Composite Rafters
5. 20mm, Multi poly carbonate sheeting in standard aluminium frame
6. UHPC Shell paneling tank and pump system.
7. Timber composite roof, 11mm, OSB, 80mm Poly foam Insulation, 12mm Magnesium,
8. 4mm, Bitumen based waterproof layer

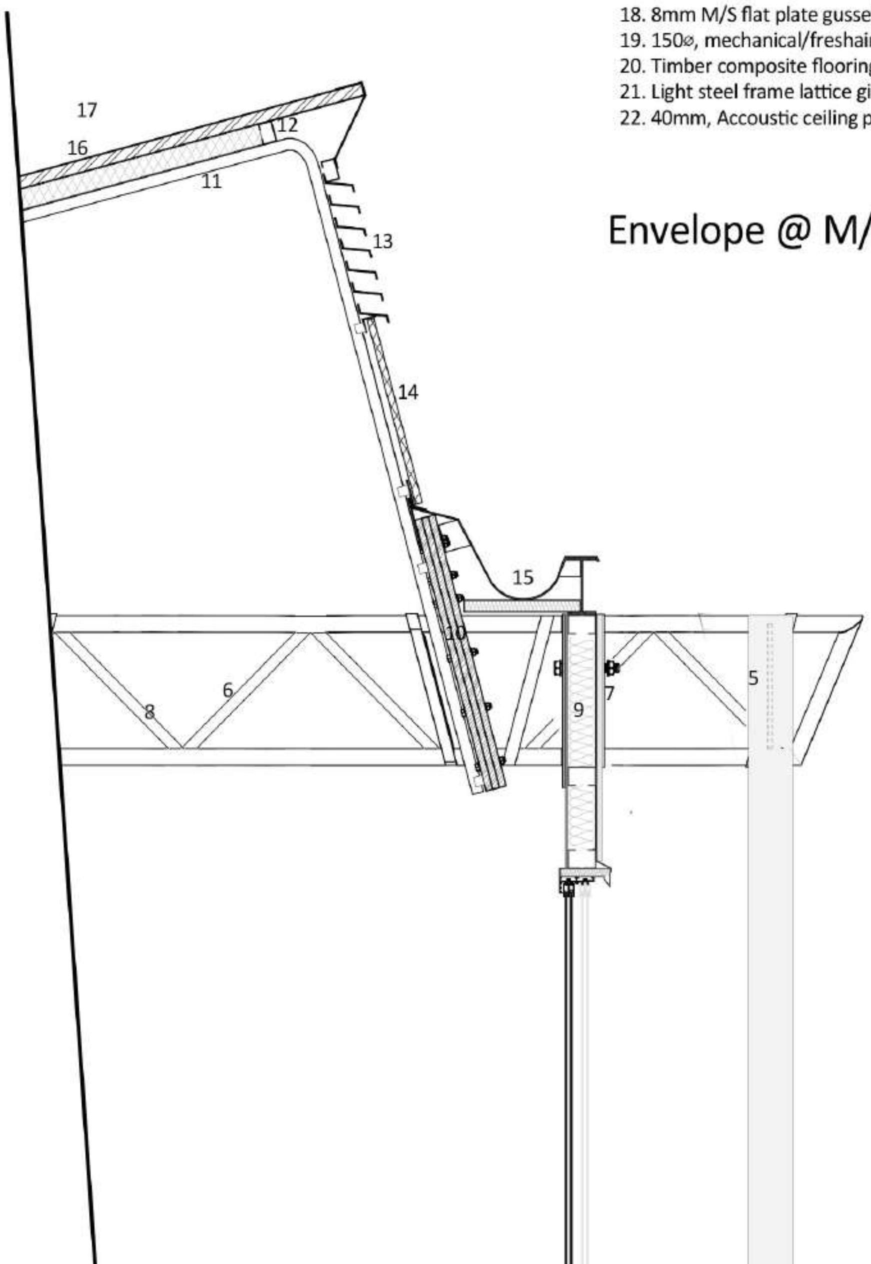
Conference Hall Axonometric

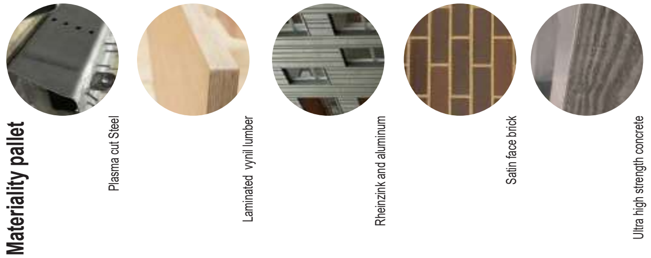


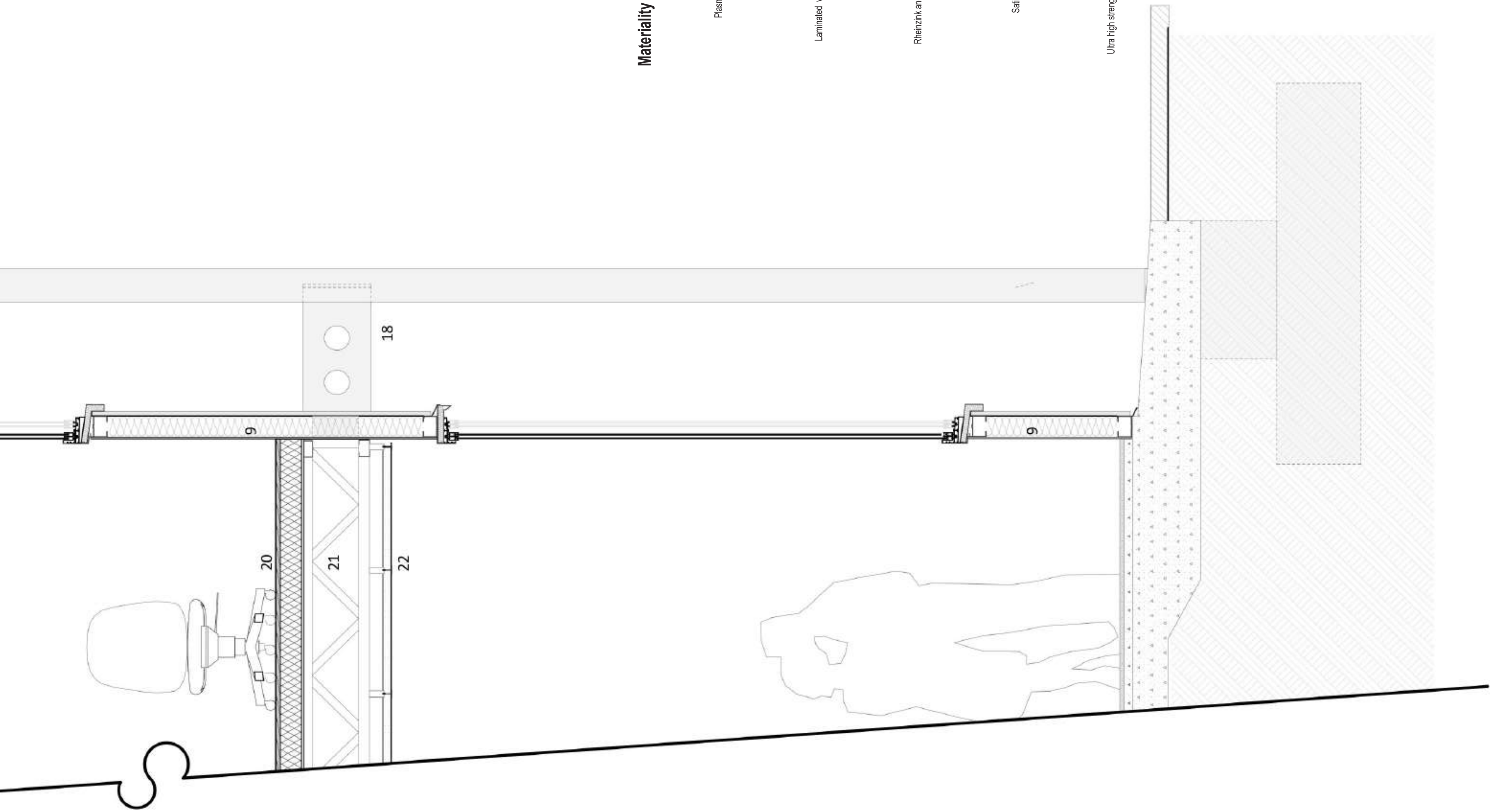
Conference Hall Section

1. Concrete footing with Clamp block
2. Precast Reinforced column panels
3. M16 PC Column Clamp rods
4. 200⌀x6(2off), M/S CHS Columns, Cast in RC Footing
5. 8mm, Plasma cut M/S flat plate Capital Bracket
6. 60⌀x4(3off), M/S CHS Lattice girder
7. 8mm, Plasma cut M/S flat plate Lattice Girder coupling end plates
8. 4mm, Plasma cut M/S Flat plate Lattice girder stiffeners
9. Light frame steel , cladded with Profiled sheeting and acoustic insulation
10. 25mm thick(3off), CNC Ultralam™ LVL Composite Rafters
11. 60⌀x4, M/S CHS Façade and Purlin Substructure or cross Bracing
12. 75x50x20, CFLC Purlin or Façade hanger
13. Aluminium Static Louver system
14. 25mm thick, Multiwall polycarbonate solar control widows in Galv frames
15. 4mm, M/S Flat plate Gutter paint with bitumen based paint.
16. Over the purlin Insulation and acoustic treatment between Purlins
17. Novotexi 440 Roof sheeting system
18. 8mm M/S flat plate gusset bracket
19. 150⌀, mechanical/freshair ventilation ducts from service shafts
20. Timber composite flooring, with engineered oak flooring finish
21. Light steel frame lattice girder floor beams @ 600 c/c
22. 40mm, Accoustic ceiling paneling

Envelope @ M/S CHS column 1:20




Materiality pallet
Plasma cut Steel
Laminated vynil lumber
Rheinzink and aluminum
Satin face brick
Ultra high strength concrete



1. Concrete footing with Clamp block
2. Precast Reinforced column panels
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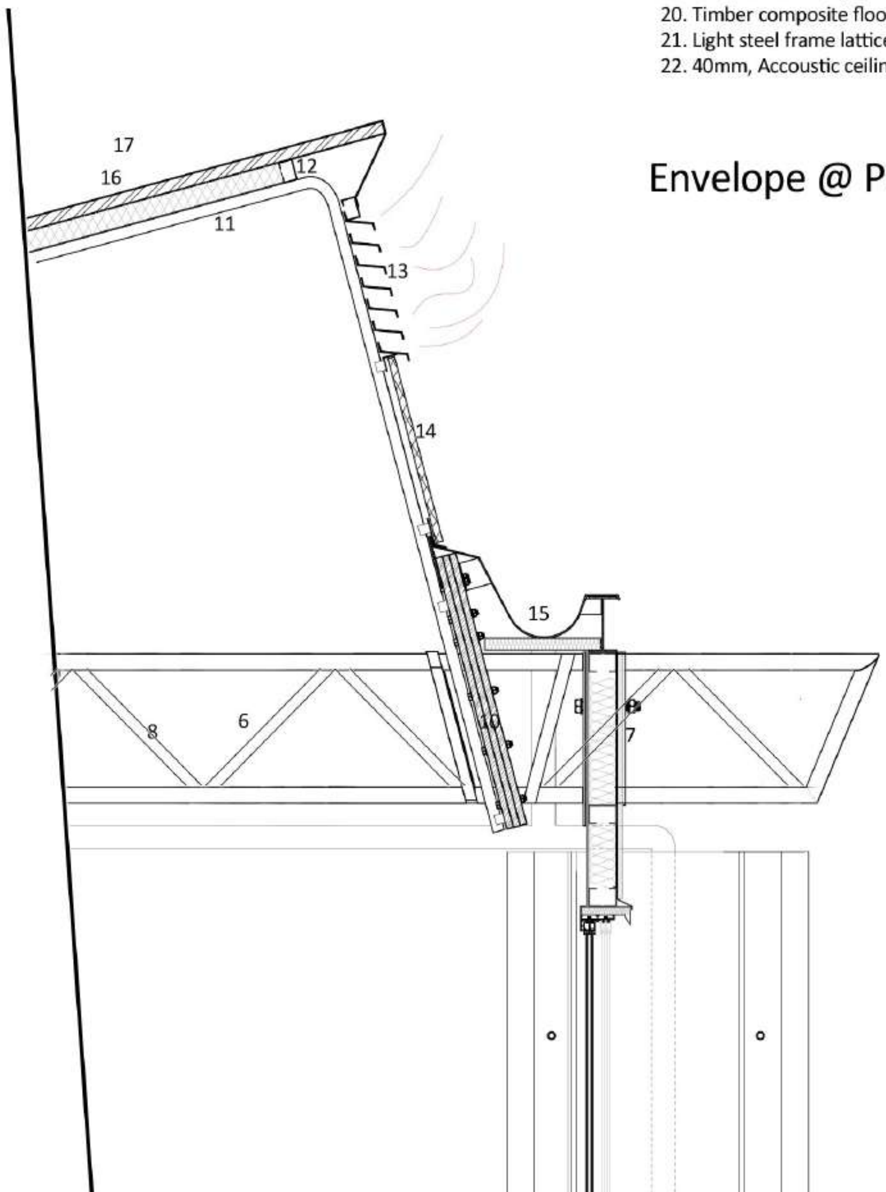
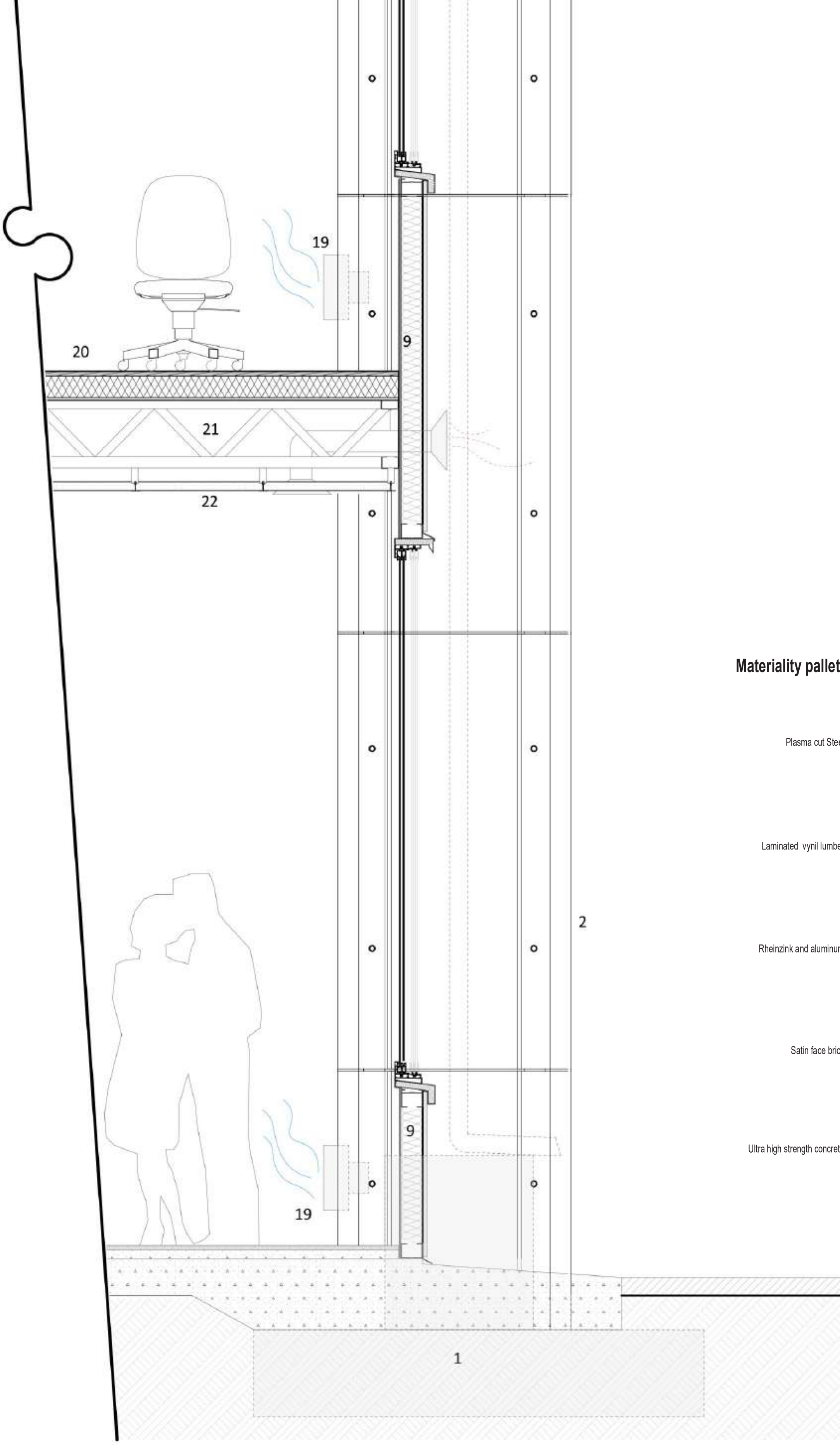
12. 75x50x20, CFLC Purlin or Façade hanger
13. Aluminium Static Louver system
14. 25mm thick, Multiwall polycarbonate solar control widows in Galv frames
15. 4mm, M/S Flat plate Gutter paint with bitumen based paint.
16. Over the purlin Insulation and acoustic treatment between Purlins
17. Novotexi 440 Roof sheeting system
18. 8mm M/S flat plate gusset bracket
19. 150⌀, mechanical/freshair ventilation ducts from service shafts
20. Timber composite flooring, with engineered oak flooring finish
21. Light steel frame lattice girder floor beams @ 600 c/c
22. 40mm, Accoustic ceiling paneling

Envelope @ PC column 1:20





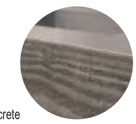
Materiality pallet

Plasma cut Steel

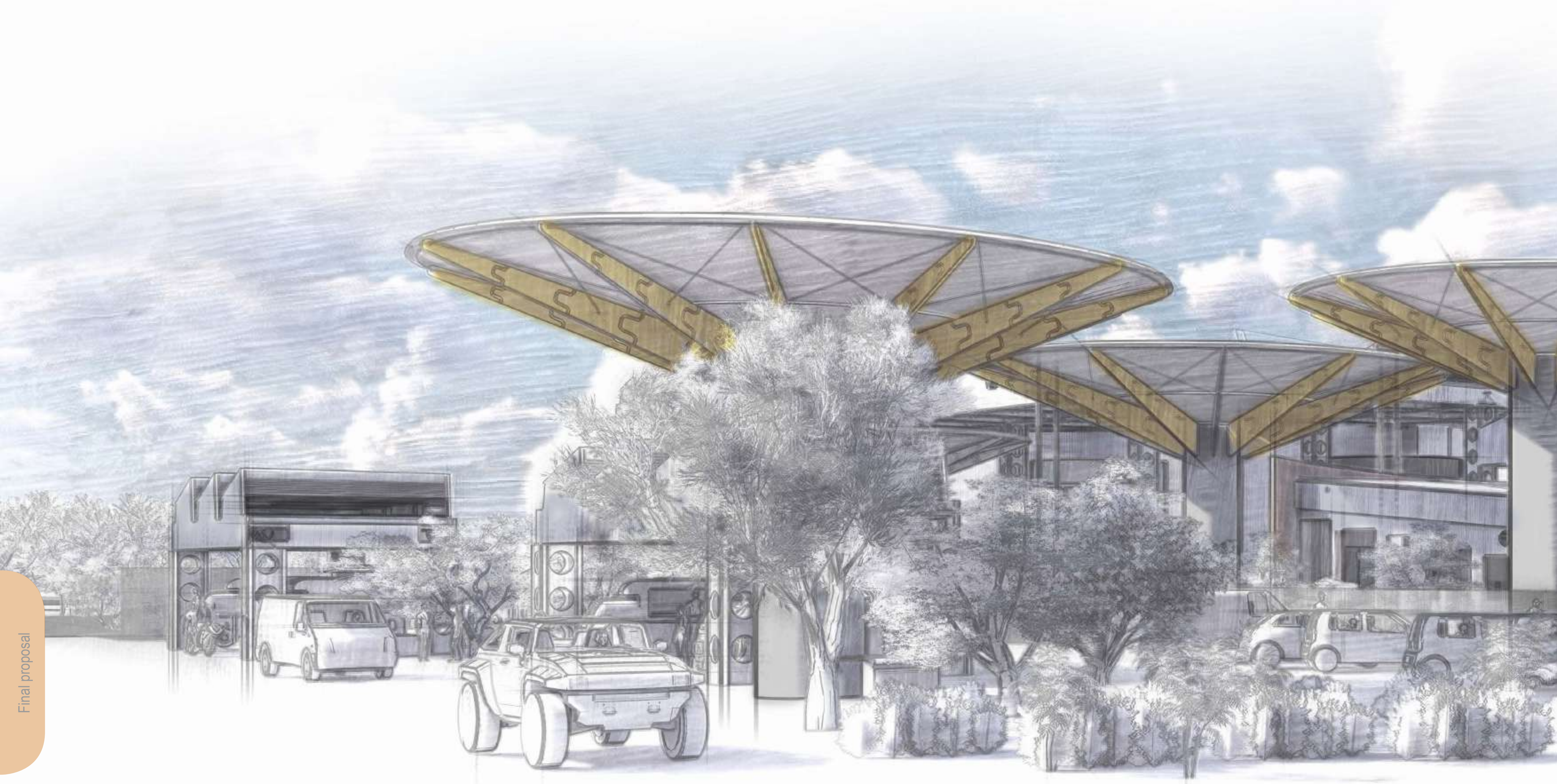
Laminated vynil lumber

Rheinzink and aluminum

Satin face brick



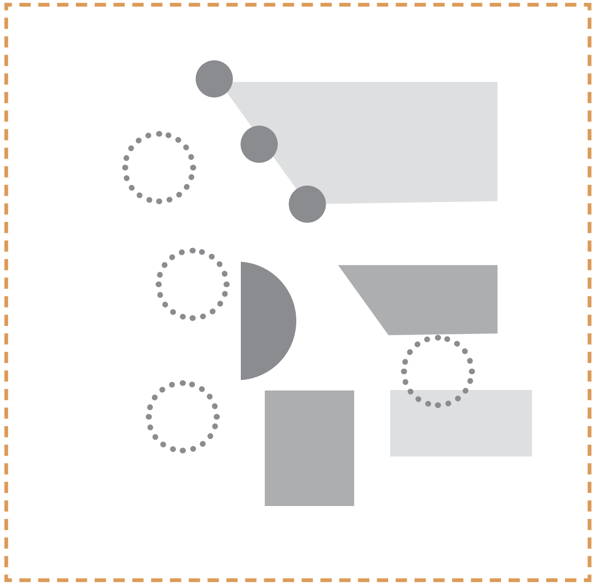
Ultra high strength concrete

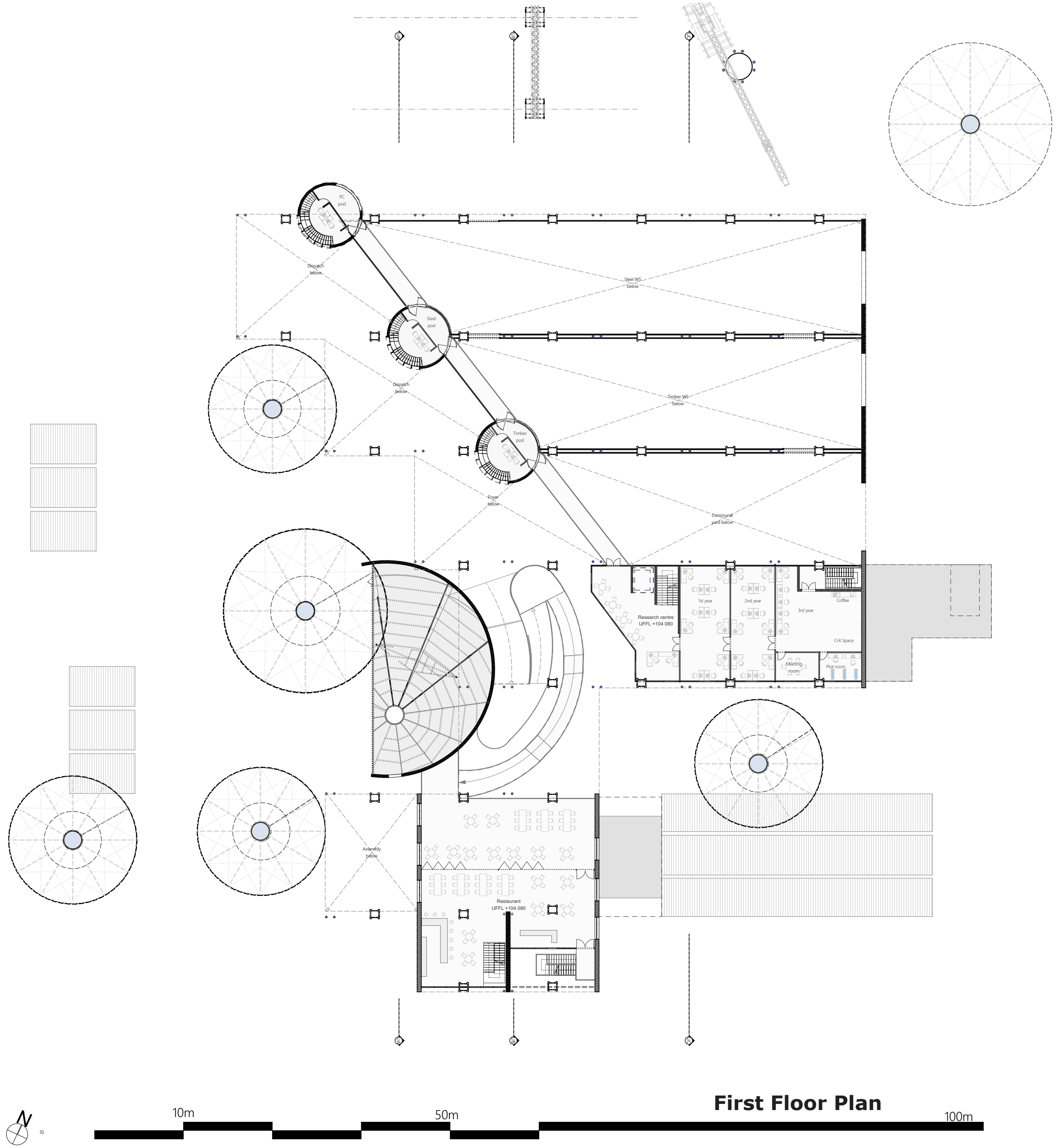


Final Proposal (SW Corner of Complex)

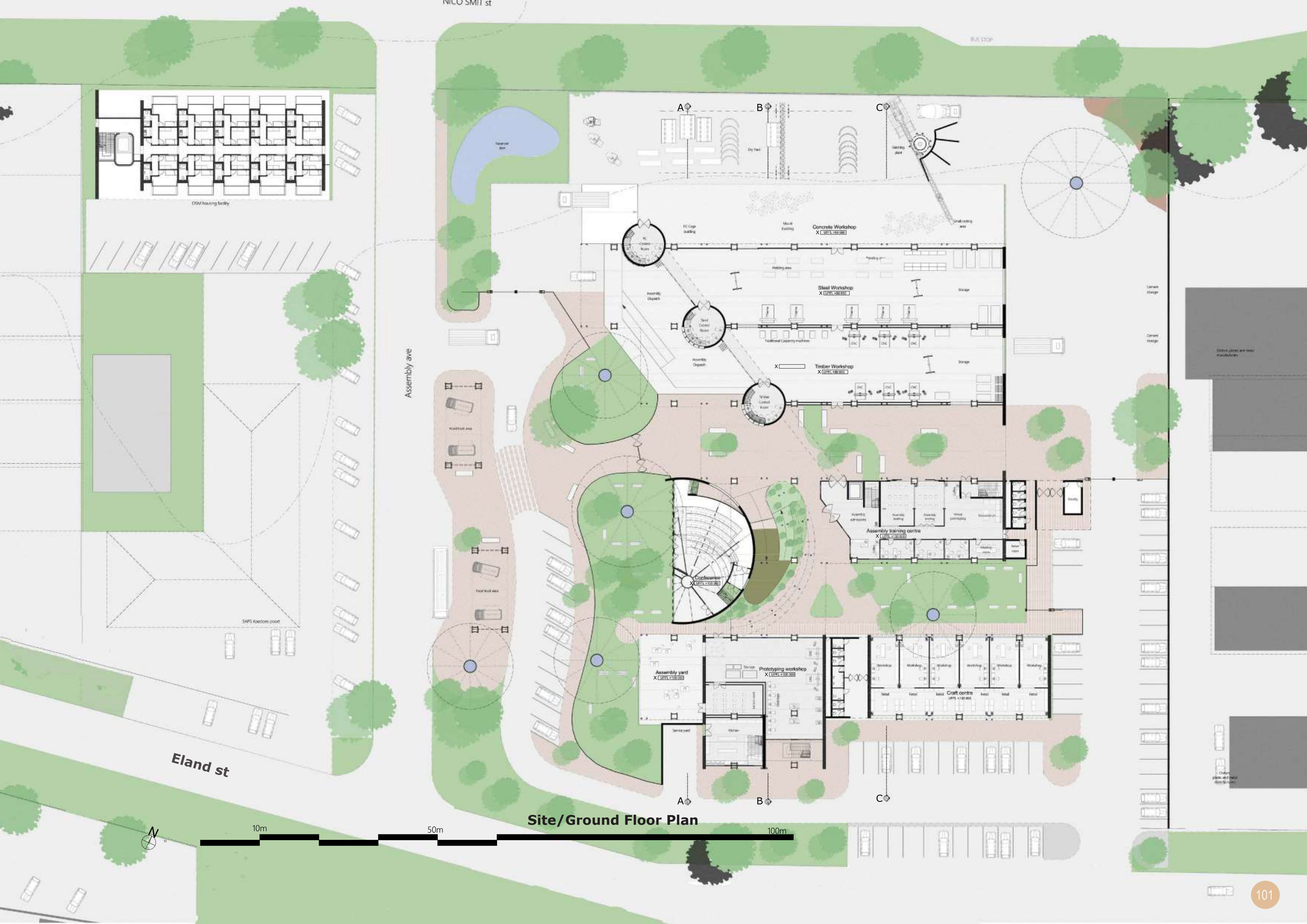
Community Engagement

In order for the complex to form part of the broader community a few interventions were established on the most public edges of the site. These interventions act as catalyst to draw attention to the centre raising awareness about the facilities, in order to draw the public in with different levels of contact.





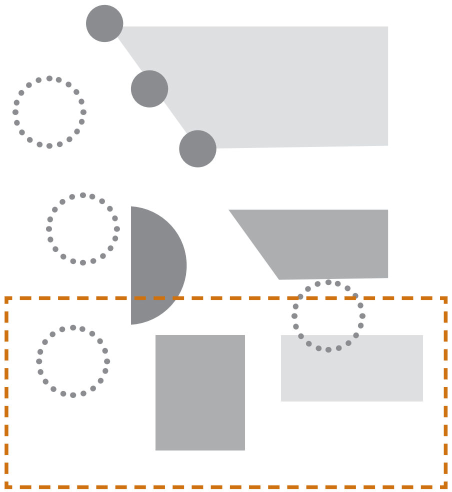
First Floor Plan

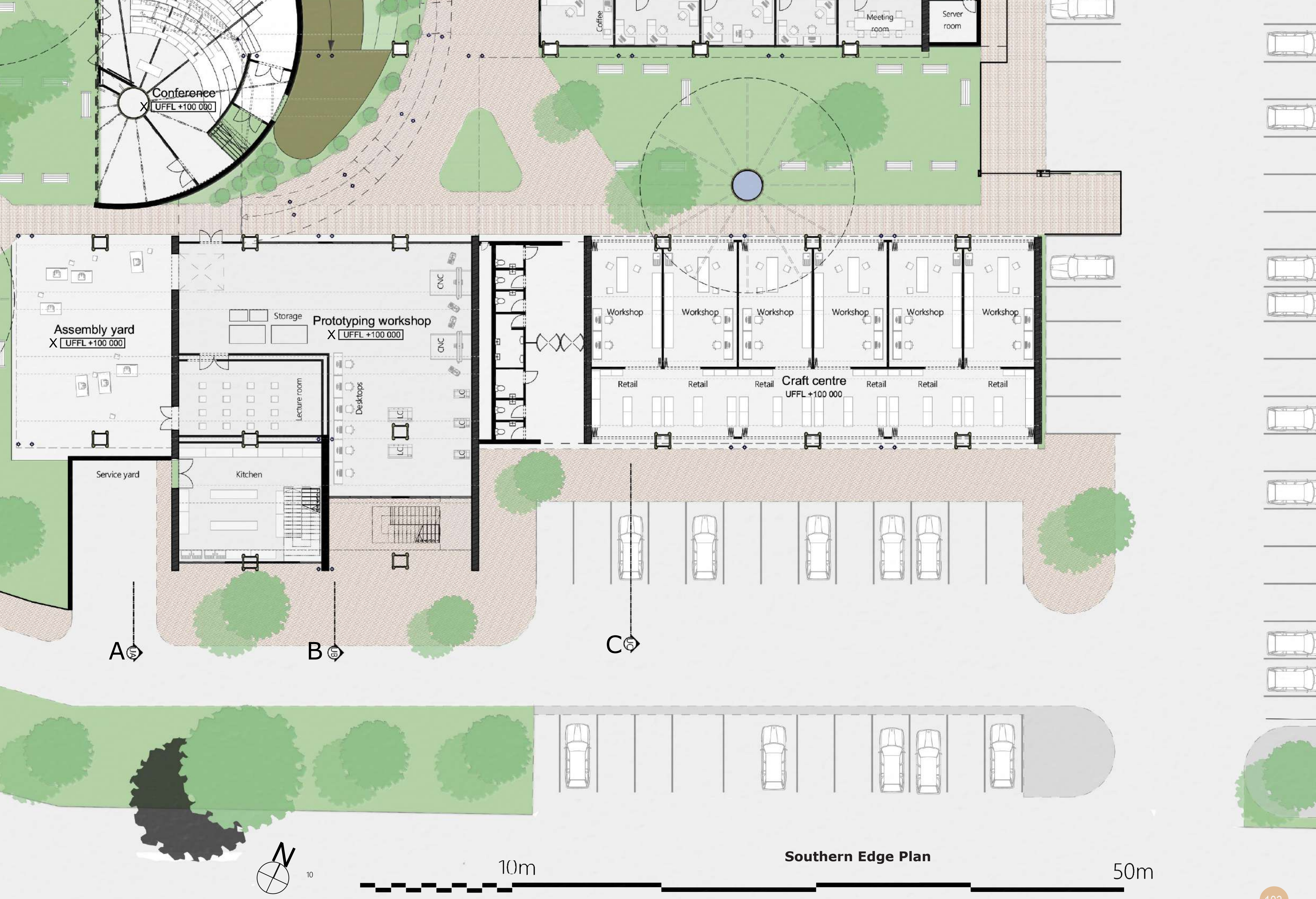


Site/Ground Floor Plan

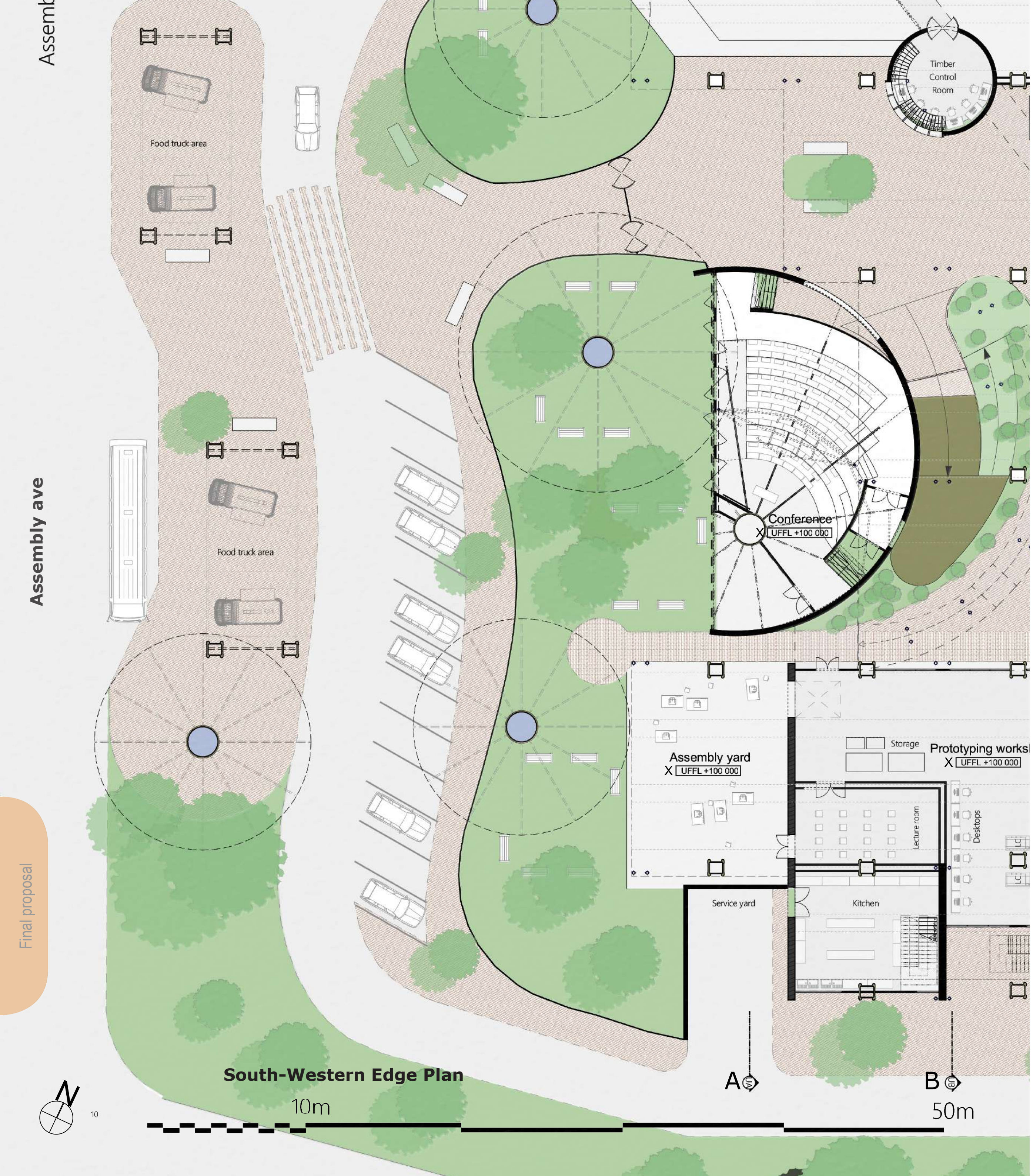
Southern Edge Plan

At the southern edge a Craft retail and Craft workshop centre is situated. This brings the public into the main corridor of the Koedoespoort industrial precinct. A restaurant that services the broader public as well as the complex, is raised above the ground to enable a view into the complex. This enables the public to feel as if they are submerged into the daily activities of the complex whilst having lunch, whilst ensuring their safety and solitude. Passers by have directional views, leading the eye deep into the complex, through both these facilities.





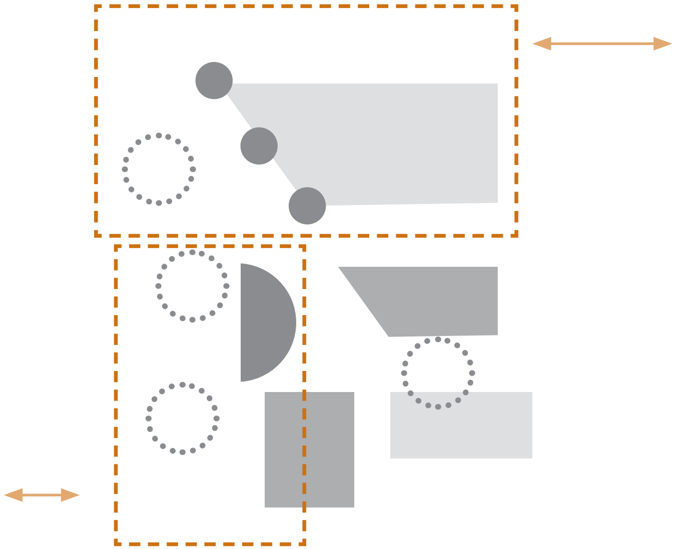
Southern Edge Plan

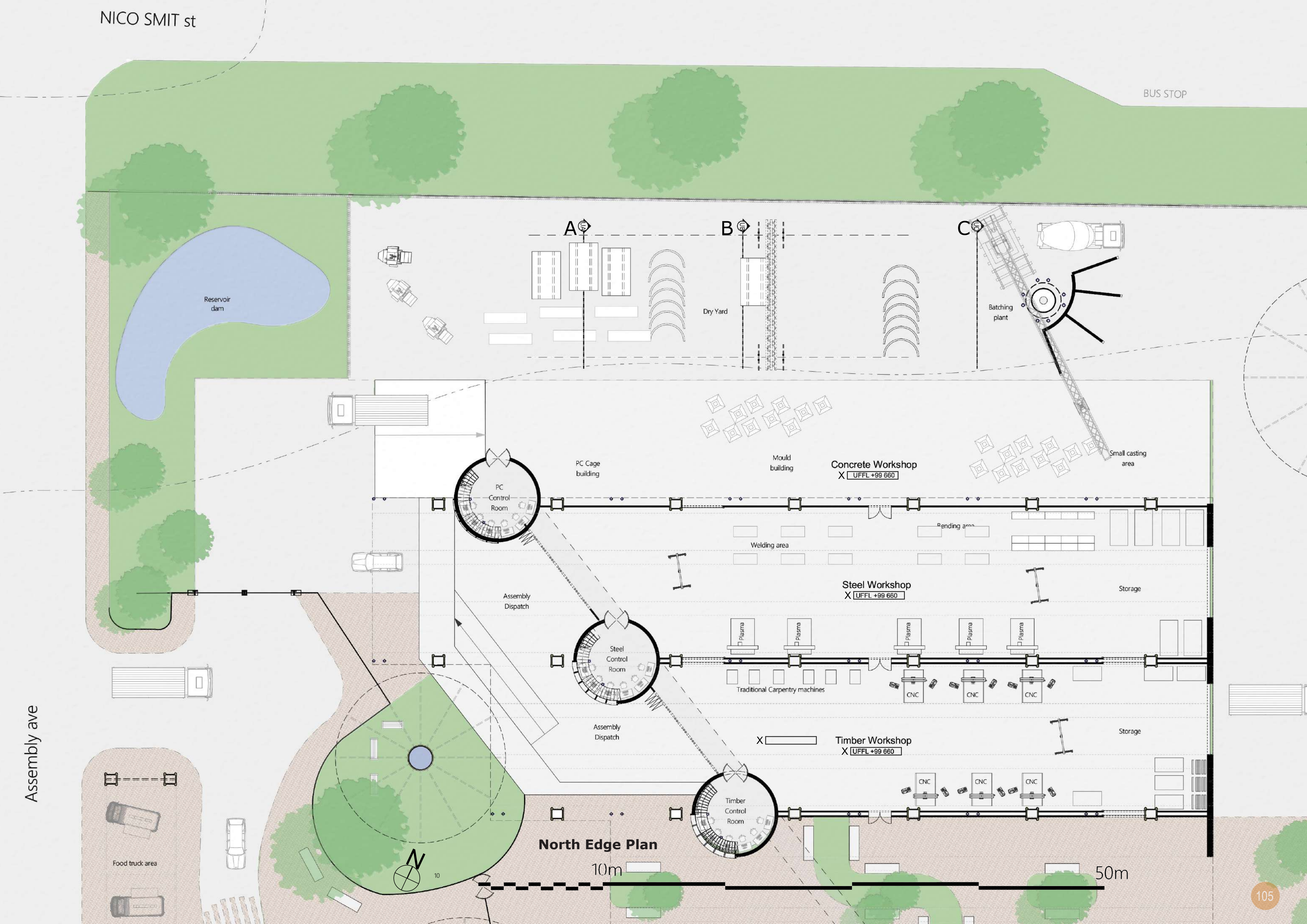


South-Western and Northern Edge Plans

On the western edge of the site, which is the main entrance way into the site, three main activities happen: Firstly, vendors are placed across the police station to stimulate public interaction. Secondly, a visual representation, that also acts as a social actuator in the form of canopies/trees, is placed. This carries forward the ethos of the complex in built form and also harvest water. Lastly, the ethos of the complex is represented in action by the open air assembly yard.

To the north-west of the site a water purifying wetland is placed on the lowest part of the site. This softens the harsh traffic intersection by leaving the factories as a backdrop to the landscape. The northern front is used as a drying yard for the concrete workshop. The movement of cranes along the busy intersection will draw attention to the rest of the facility when traffic passes. This is also the most dangerous spaces in the facility, therefore it is situated on the furthest physical point from pedestrian movement/access.

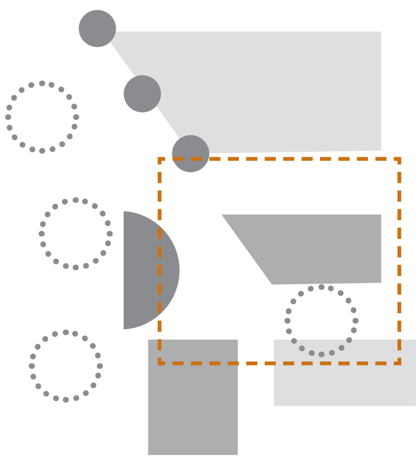


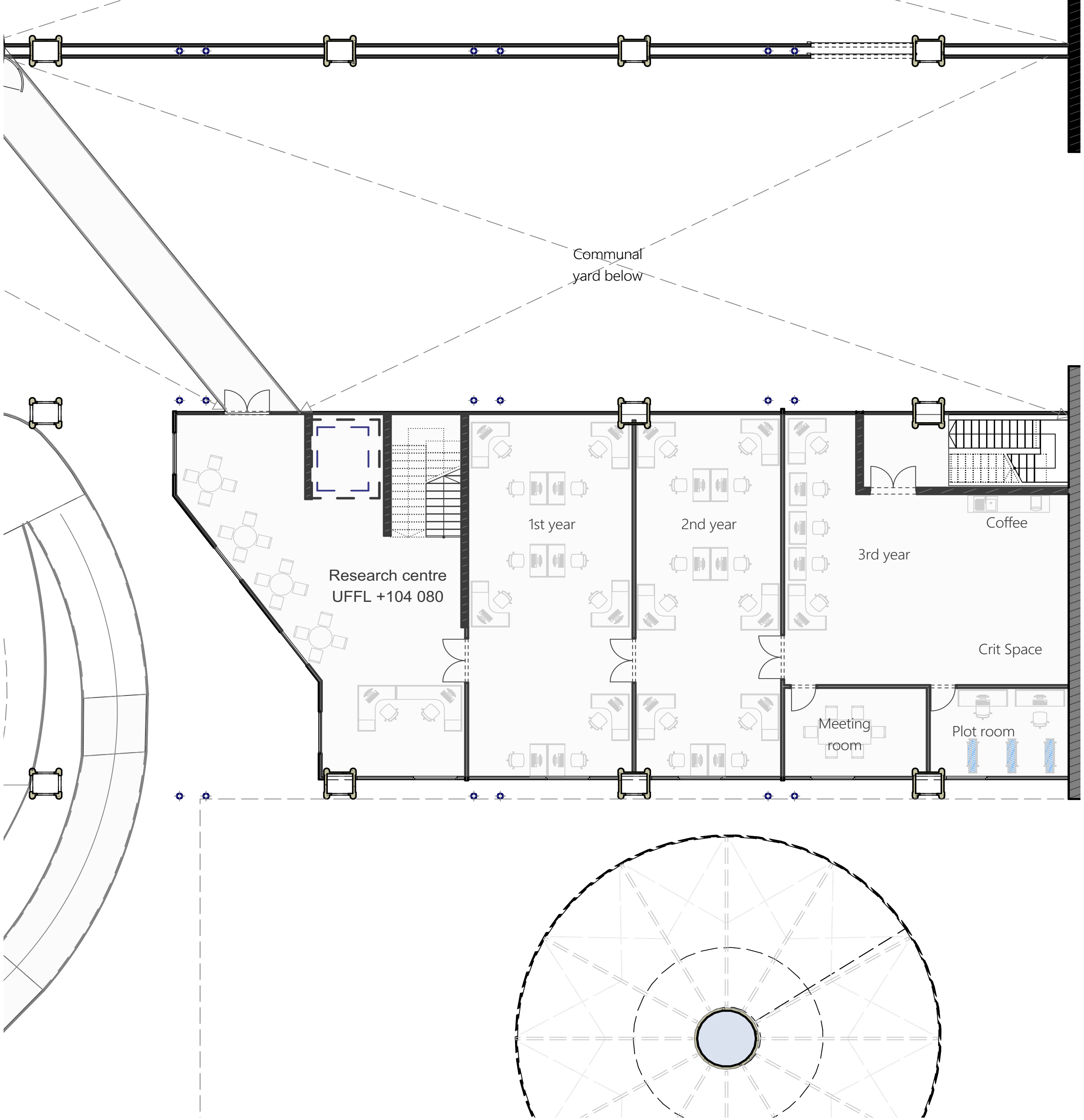

NICO SMIT st
BUS STOP
Reservoir dam
A
B
C
Dry Yard
Batching plant
PC Cage building
Mould building
Concrete Workshop
X UFFL +99 660
Small casting area
PC Control Room
Welding area
Steel Workshop
X UFFL +99 660
Storage
Assembly Dispatch
Steel Control Room
Plasma
Traditional Carpentry machines
CNC
Assembly Dispatch
Timber Workshop
X UFFL +99 660
Storage
Timber Control Room
Assembly ave
Food truck area
N
North Edge Plan
10m
50m

Research and Assembly training Centre Plan

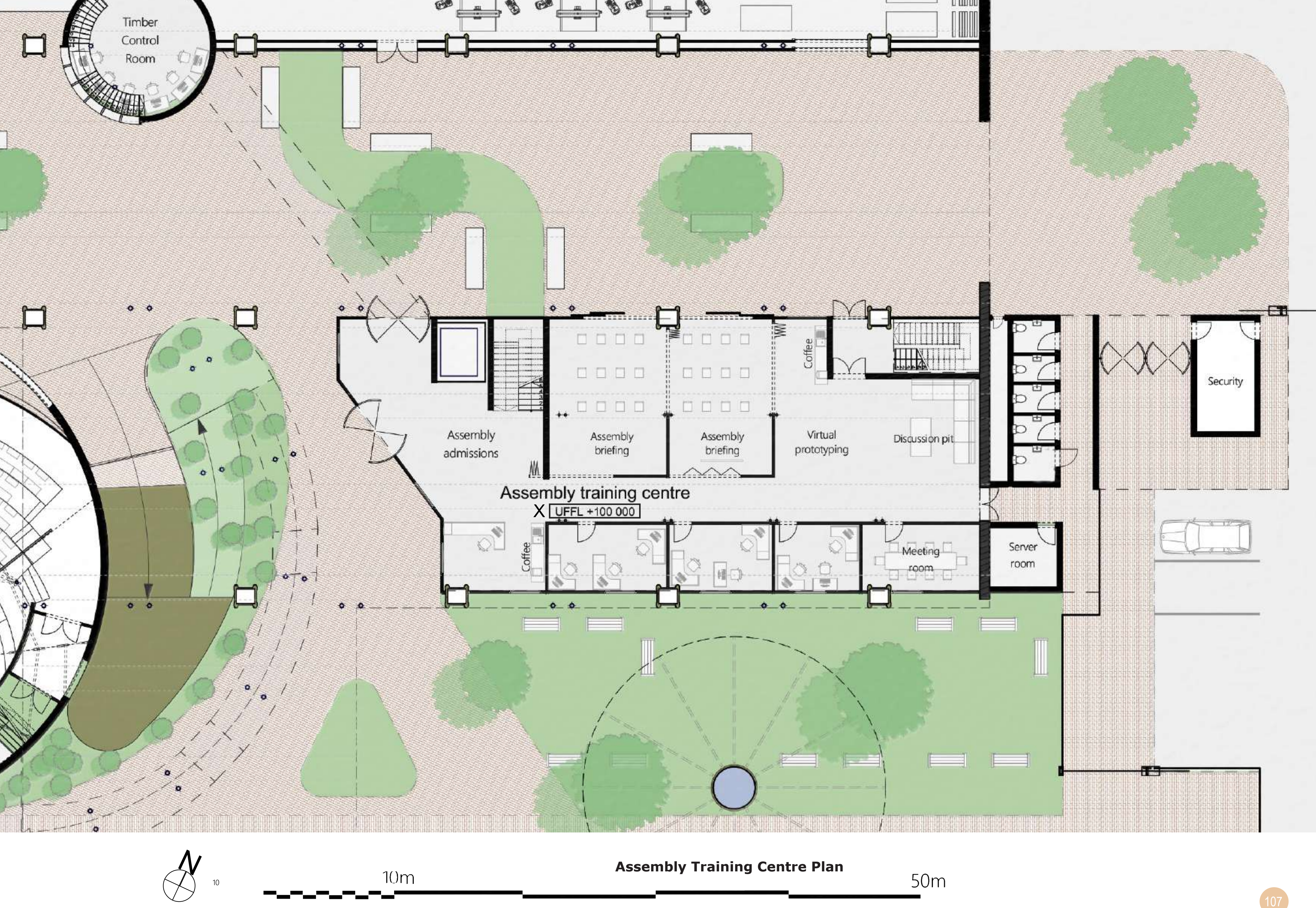
The route leading people past the Convention hall acts as critical axis that connects the inner functions of the complex. This links the manufacturing, research and education as well as craft and prototyping flank. A ramp that enables vistas from multiple view decks takes the user on a journey that will leave them feeling part of the ethos of the facility. Views toward the Pods, the prototyping centre, craft centre, and research centre when moving long the internal ramp, are critical aspect to mention in this conversation.

In the main layering functions on multiple scales were programmed with specific intent. Taking in consideration technical aspects, such as safety, noise factors and proximities needed for such a multidimensional facility to function as a public catalyst, is key to the practical success of such a facility.





Research Centre Plan (1st Floor)



Assembly Training Centre Plan

Public Loading-bay

Functions

- Loading bay 1 ton trucks only
- OSM and CAD/CAM reflection
- Lecture Pods

Practical/Technical

- Noise levels....................................Med
- Dust levels......................................Med
- Mechanical lifting............................Med
- Dangerous machinery.....................Med

Functions in close proximity:

- Main traffic routes
- Entrance
- Main factories
- Food vendors

Water Reservoir

Functions

- Water retention
- Eco filtration system
- Rain water harvesting

Practical/Technical

- Buffer system
- Concrete water saving
- Lowest point of site

Functions in close proximity:

- Concrete workshop
- Loading bay
- Green corner

Food Vendors

Functions

- Loading bay
- Public transport
- Semi permanent
- OSM and CAD/CAM reflection

Practical/Technical

- Noise levels....................................Low
- Dust levels......................................Low
- Mechanical lifting............................None
- Dangerous machinery....................None

Functions in close proximity:

- Main traffic routes and bus stops
- Entrance
- Main pedestrian routes through precinct
- Assembly

Assembly Yard

Functions

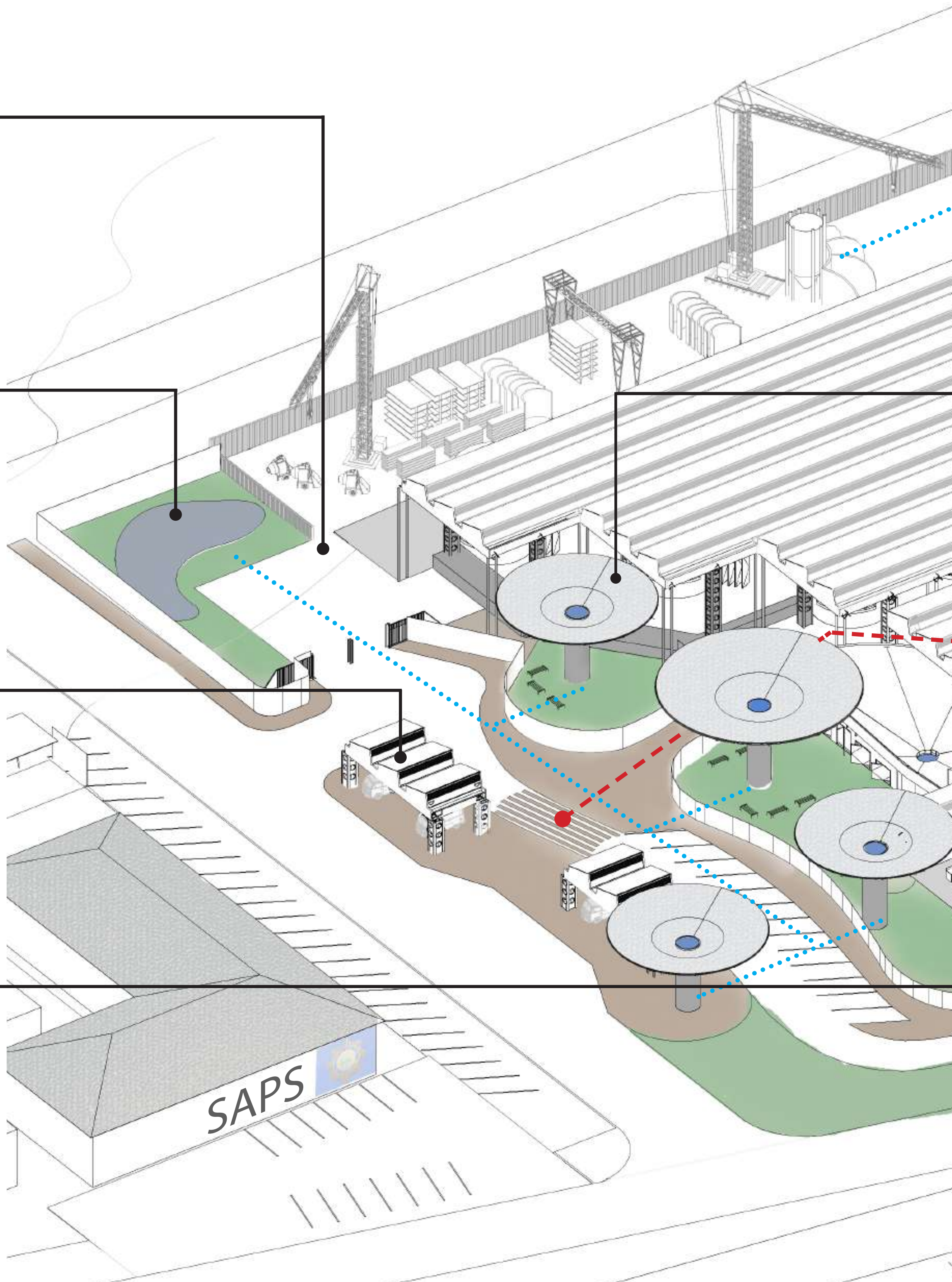
- Public assembly yard
- Demonstration area

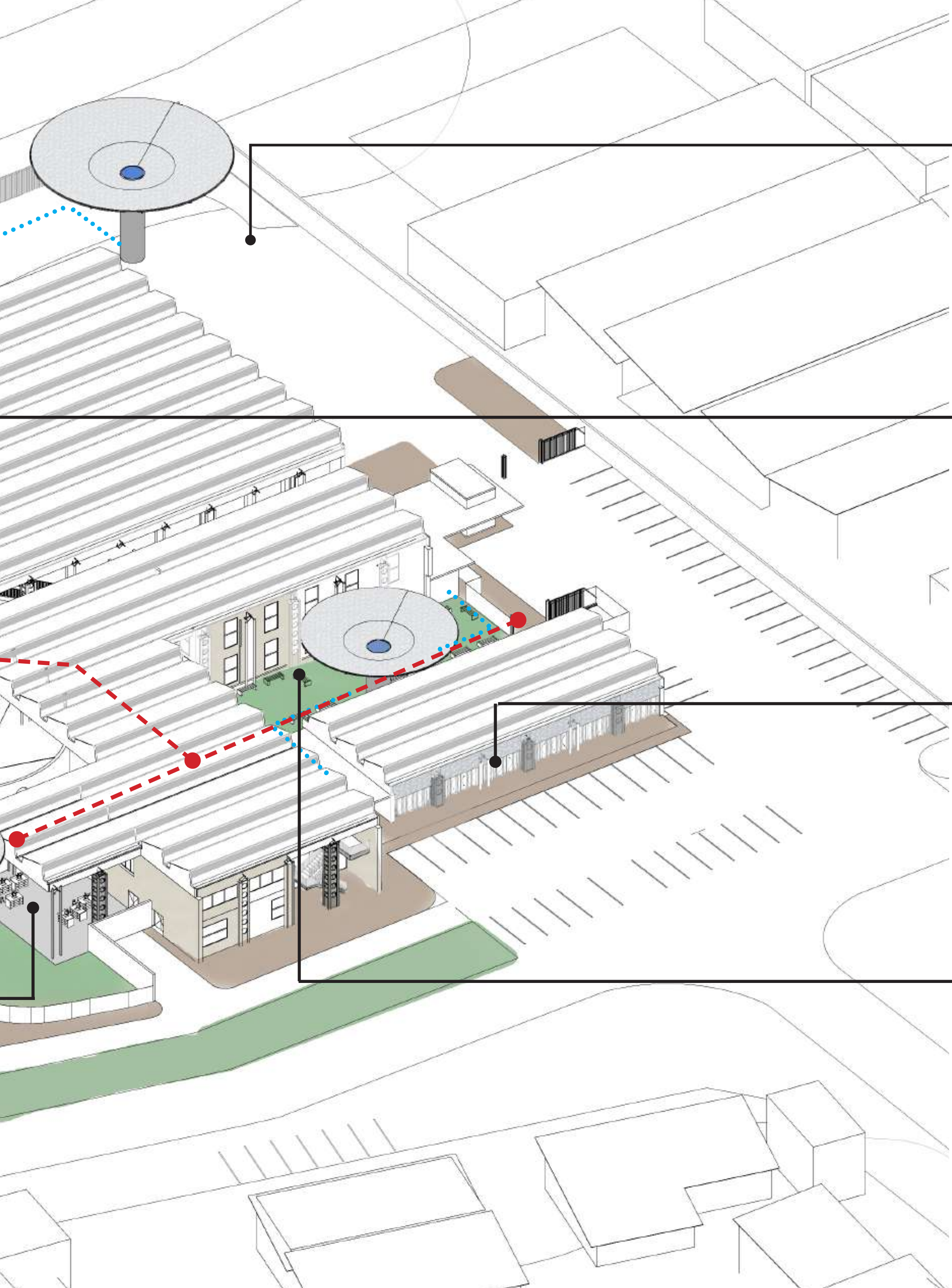
Practical/technical

- Noise levels....................................Moderate
- Dust levels..Low
- Mechanical lifting...................................Low
- Dangerous machinery............................Low

Functions in close proximity:

- Restaurant
- Prototyping workshop
- Food vendors
- Conference hall





Heavy Loadingbay/Storage

Functions

- Workshops
- Assembly training centre
- OSM and CAD/CAM reflection

Practical/Technical

- Away from public front
- Stock store

Functions in close proximity:

- Conference
- Entrance
- Main pedestrian routes through precinct
- Assembly
- Lecture pods

Social Actuators

Functions

- Shading
- Water harvesting
- OSM and CAD/CAM reflection

Practical/Technical

- Buffer system between factory and public

Functions in close proximity:

- Conference
- Entrance
- Main pedestrian routes through precinct
- Assembly
- Lecture pods

Craft Centre Retail

Functions

- Retail
- Rest rooms
- OSM reflection

Practical/Technical

- Noise levels....................................None
- Dust levels......................................None
- Mechanical lifting............................None
- Dangerous machinery......................None

Functions in close proximity:

- Restaurant
- Craft workshops
- Main pedestrian routes through precinct

Craft Centre Yard

Functions

- Relax
- Intercact
- OSM reflection

Practical/Technical

- Noise levels....................................Mid
- Dust levels......................................Mid
- Mechanical lifting...........................None
- Dangerous machinery....................None

Functions in close proximity:

- Assembly training Centre
- Conference hall
- Restaurant
- Craft workshops
- Main pedestrian routes through precinct

1st Phase public interaction

Workshops

Functions

- Timber, Concrete & Steel Manufacturing
- Storage
- View points

Practical/technical

- Noise levels.....................High to Low
- Dust levels..................................High

Functions in close proximity:

- Lecture pods
- Assembly training Centre
- Conference hall
- Loading bay

Lecture Pods

Functions

- CAD/CAM training
- CAM Control room
- View points

Practical/technical

- Noise levels...................................Low
- Dust levels.....................................Low

Functions in close proximity:

- Workshops
- Conference hall
- Loading bay

Conference Hall

Functions

- Conferences
- Seminars
- Water harvesting

Practical/technical

- Noise levels.................................None
- Dust levels...................................None

Functions in close proximity:

- Restaurant
- Assembly training centre
- Craft Centre

Prototyping Workshop

Functions

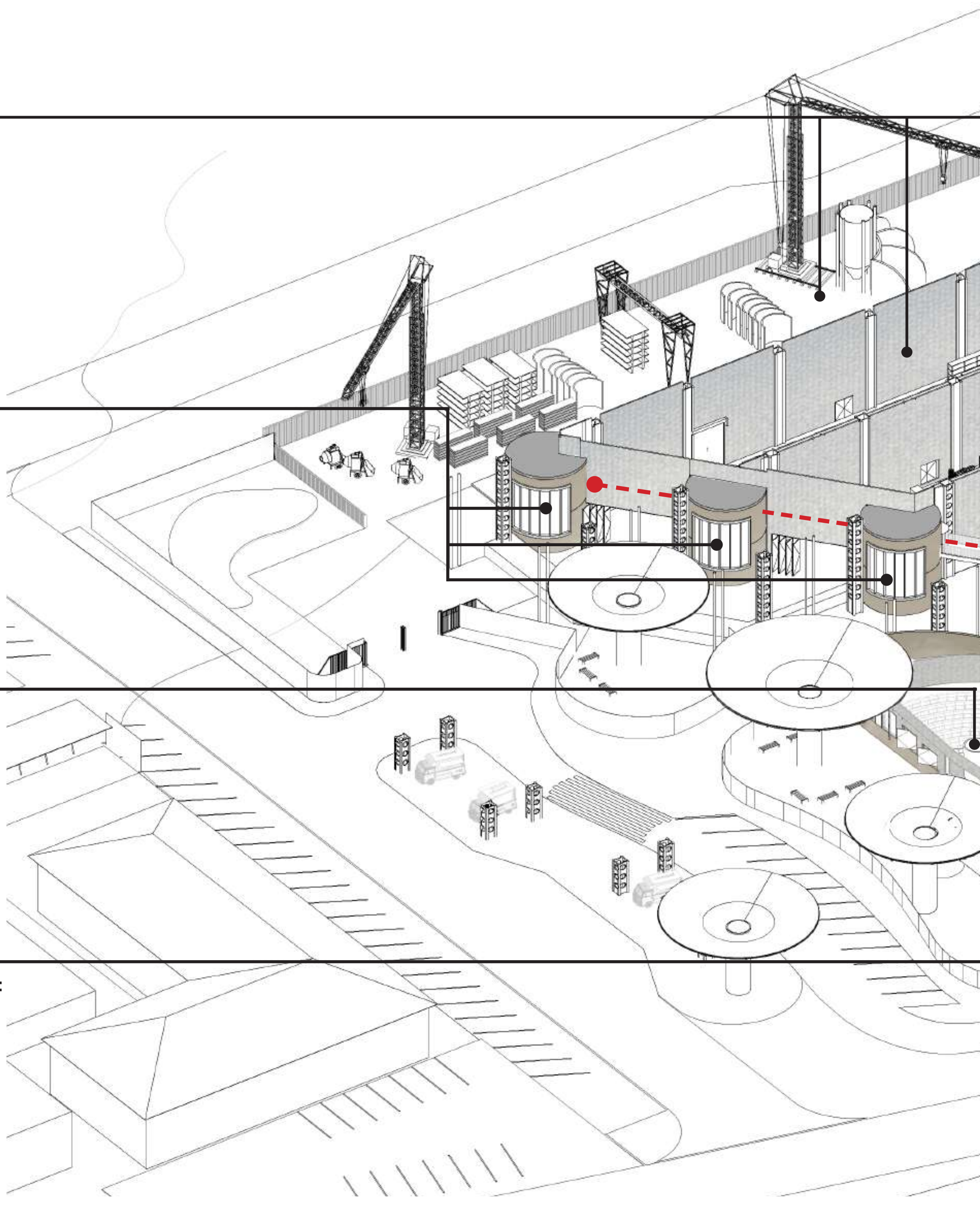
- Semi Public workshop
- Demonstration area

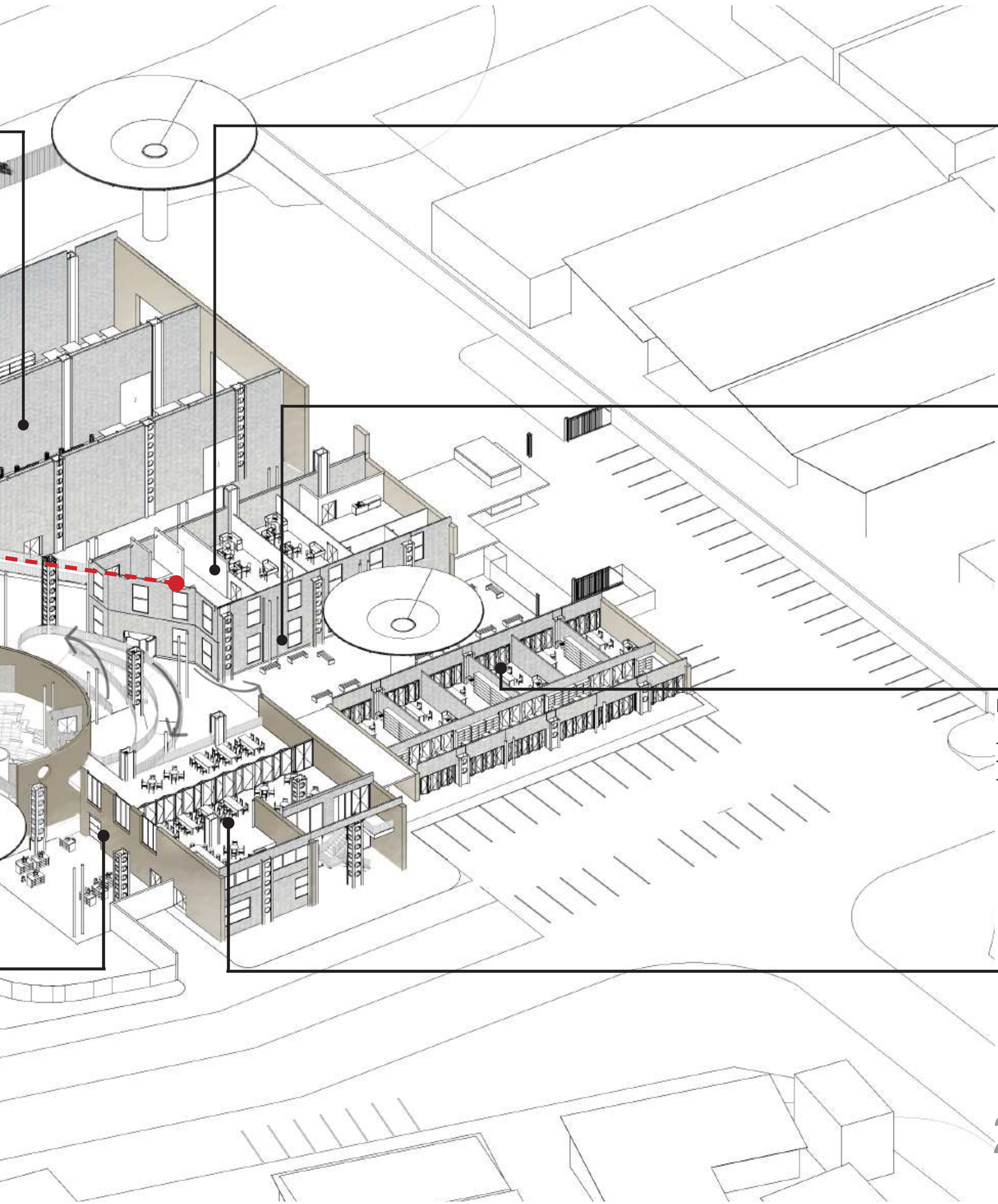
Practical/technical

- Noise levels...............................Moderate
- Dust levels...Low
- Mechanical lifting...............................Low
- Dangerous machinery.........................Low

Functions in close proximity:

- Restaurant
- Assembly yard
- Craft Centre
- Conference hall





Research Centre

Functions	Practical/Technical	Functions in close proximity:
- Student studios - Conversation rooms - OSM reflection	- Noise levels....Low - Dust levels....Low - Mechanical lifting....None - Dangerous machinery....None	- Assembly training Centre - Workshops

Assembly Training Center

Functions	Practical/Technical	Functions in close proximity:
- Training rooms - Lecturer offices - Conversation rooms	- Noise levels....Low - Dust levels....Low - Mechanical lifting....None - Dangerous machinery....None	- Research Centre - Conference hall - Restaurant - Craft workshops - Main pedestrian routes through precinct

Craft Centre Workshops

Functions	Practical/Technical	Functions in close proximity:
- Artisanal public interaction - Rest rooms - OSM reflection	- Noise levels....Mid - Dust levels....Mid - Mechanical lifting....None - Dangerous machinery....None	- Assembly training Centre - Conference hall - Restaurant - Craft workshops - Main pedestrian routes through precinct

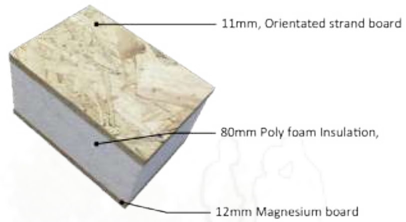
Restuarant

Functions	Practical/Technical	Functions in close proximity:
- Dinning - Public interaction - Bridge route - OSM reflection	- Noise levels....none - Dust levels....none - Mechanical lifting....None - Dangerous machinery....None	- Assembly training Centre - Conference hall - Craft workshops - Main pedestrian routes through precinct

2nd Phase public interaction

CH _ Conference Hall
PW _ Prototyping Workshop
CC _ Craft Centre
AY _ Assembly Yard
R _ Restaurant

ATC _ Assembly Training Centre
RC _ Research Centre
T-Pod _ Timber Pod
S-Pod _ Steel Pod
PC-Pod _ Precast Concrete Pod
TW _ Timber Workshop
SW _ Steel Workshop
PW - Precast Concrete Workshop



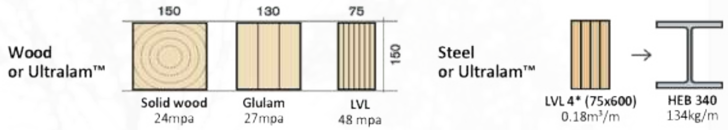
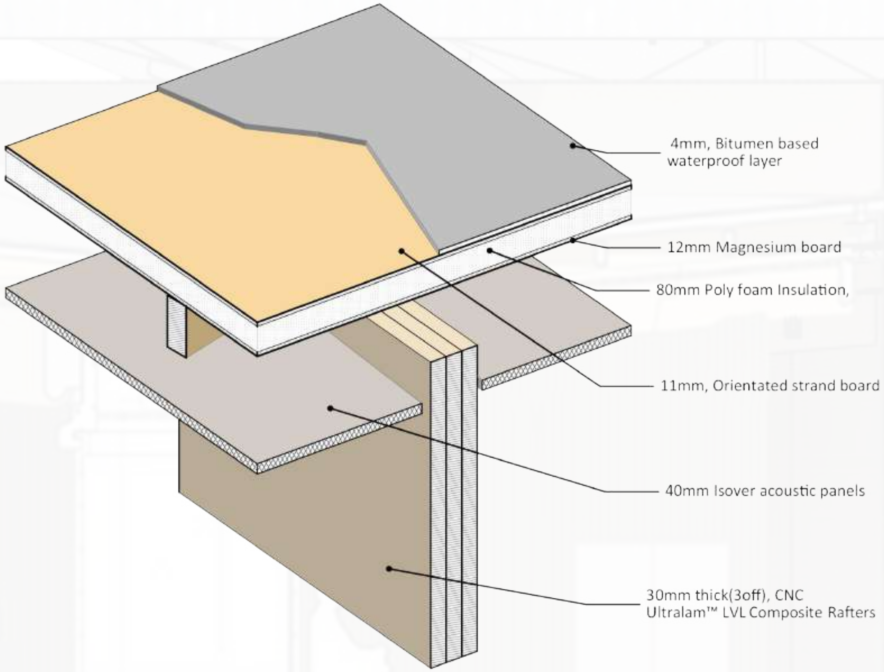


Fig.60: Advantages of Laminated vinyl lumber.
(Diagrams from, Universal Plywoods. 2019)

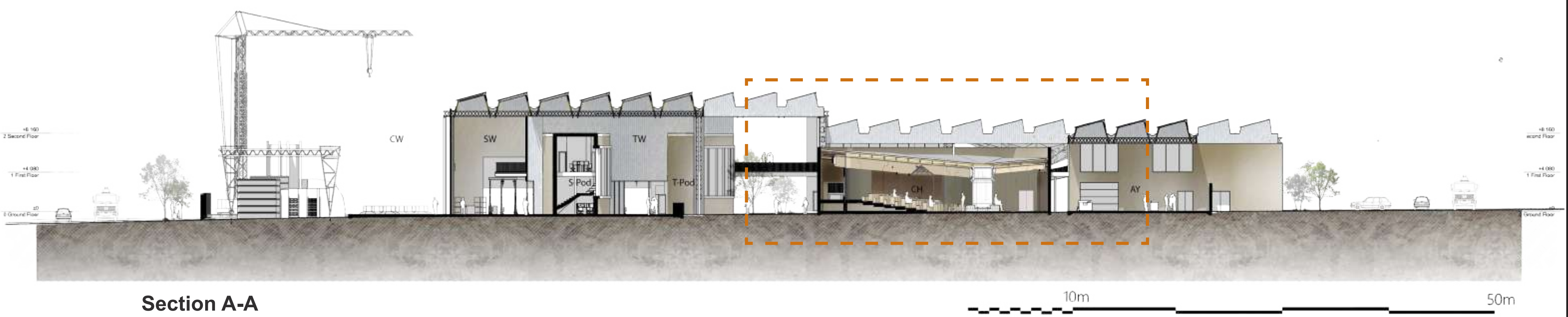
Section A-A

Final proposal

Fig.61: Sheet metal and LSF wall construction
(Origional image. Archello, 2019)



LVL Rafter, Ceiling and Roofing connection

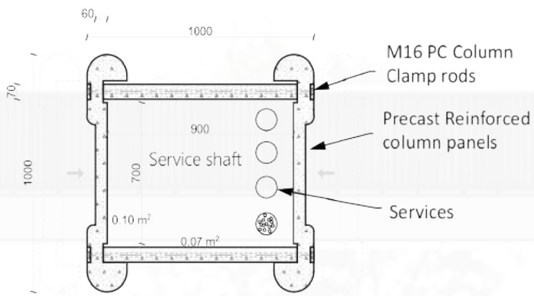


Section A-A

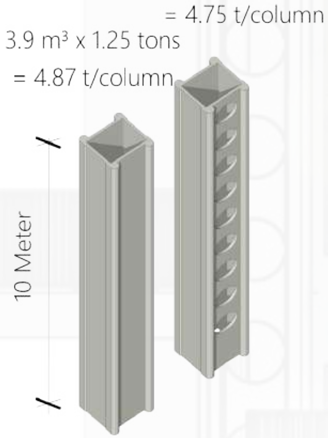
CH _ Conference Hall
PW _ Prototyping Workshop
CC _ Craft Centre
AY _ Assembly Yard
R _ Restaurant

ATC _ Assembly Training Centre
RC _ Research Centre
T-Pod _ Timber Pod
S-Pod _ Steel Pod
PC-Pod _ Precast Concrete Pod
TW _ Timber Workshop
SW _ Steel Workshop
PW - Precast Concrete Workshop

800s Telescopic boom lift
(Sky Operating Services, 2019)

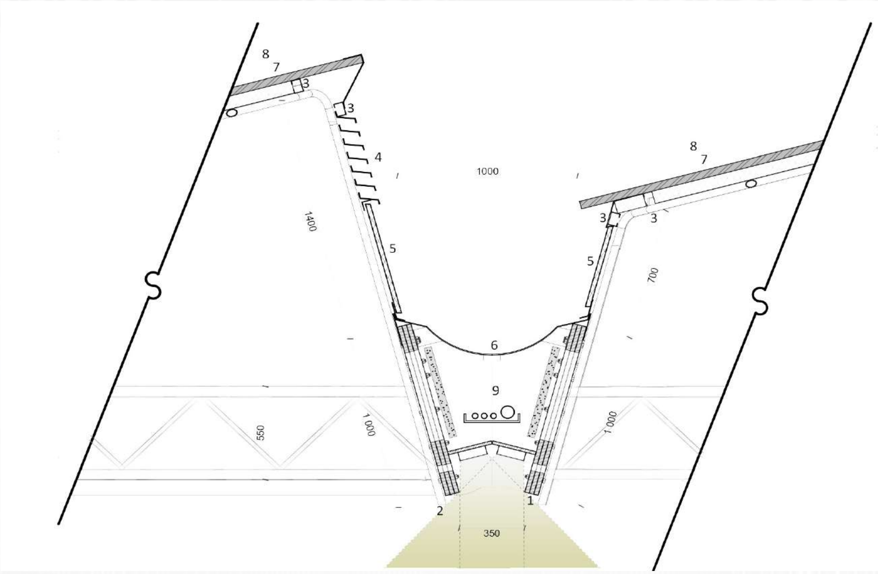


2.
Precast Reinforced
column panels
1:20



1:100

Section B-B



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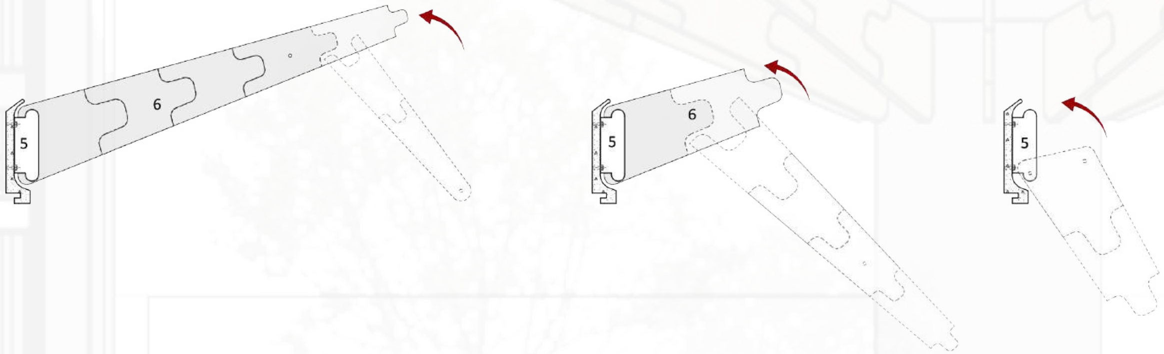
2. 60⌀x4, M/S CHS Façade and Purlin Substructure or cross Bracing
3. 75x50x20, CFLC Purlin or Façade hanger
4. Aluminium Static Louver system
5. 25mm thick, Multiwall polycarbonate solar control widows in Galv frames
6. 4mm, M/S Flat plate Gutter paint with bitumen based paint.
7. Over the purlin Insulation and acoustic treatment between Purlins
8. Novotexi 440 Roof sheeting system
9. Service duct. Acoustic battens, cable tray, LED Highbay lights

Section B-B

CH _ Conference Hall
PW _ Prototyping Workshop
CC _ Craft Centre
AY _ Assembly Yard
R _ Restaurant

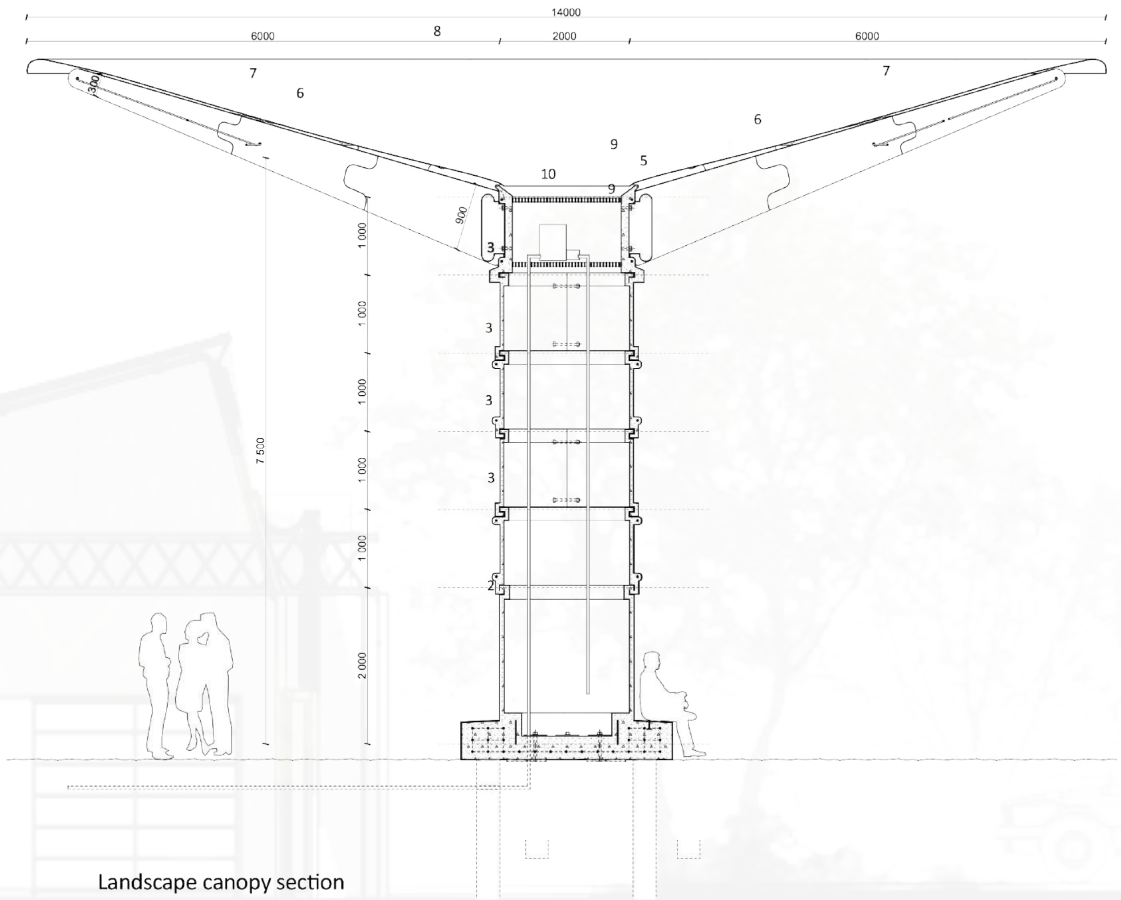
ATC _ Assembly Training Centre
RC _ Research Centre
T-Pod _ Timber Pod
S-Pod _ Steel Pod
PC-Pod _ Precast Concrete Pod
TW _ Timber Workshop
SW _ Steel Workshop
PW - Precast Concrete Workshop



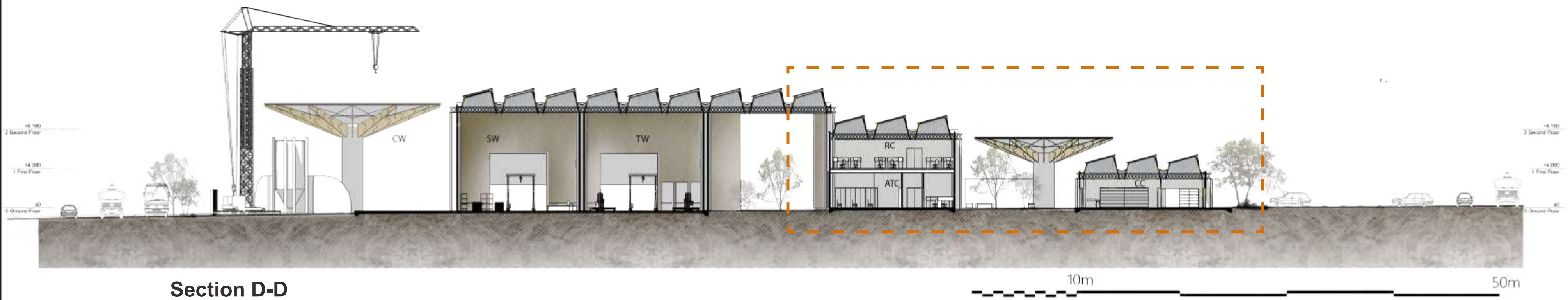
Section D-D

Final proposal

1. RC Ring beam and base floor cast insitu on RC pile foundations.
2. UHPC Base tank, bolted to Ring Beam and base floor with M30 bolts.
3. UHPC tank Shells, clamped with M20 bolts.
4. Bitumen based waterproof compound to inside of tank
5. 8mm, M/S Rafter gusset bolted to Top shell.
6. 30mm thick(3off), CNC Ultralam™ LVL Composite Rafters
7. 12mm, Marine-grade Ringbind/Crossbrace cables with tensioners
8. Canvas canopy, PrecontraintTX30 from Serge Ferrari.
9. RS-40 Menis grating top cover and platform.
10. Submersible pump linked to water harvesting system

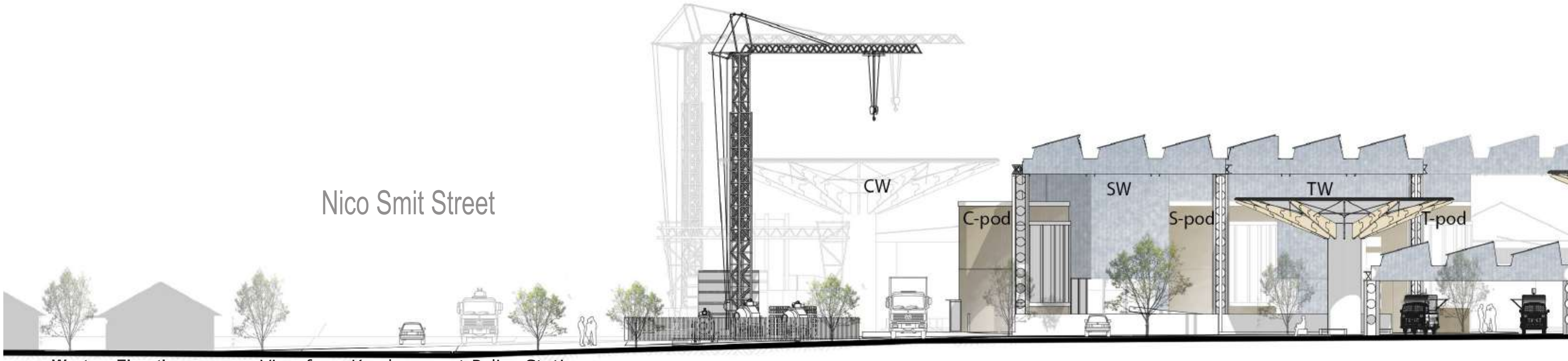


Landscape canopy section



Section D-D

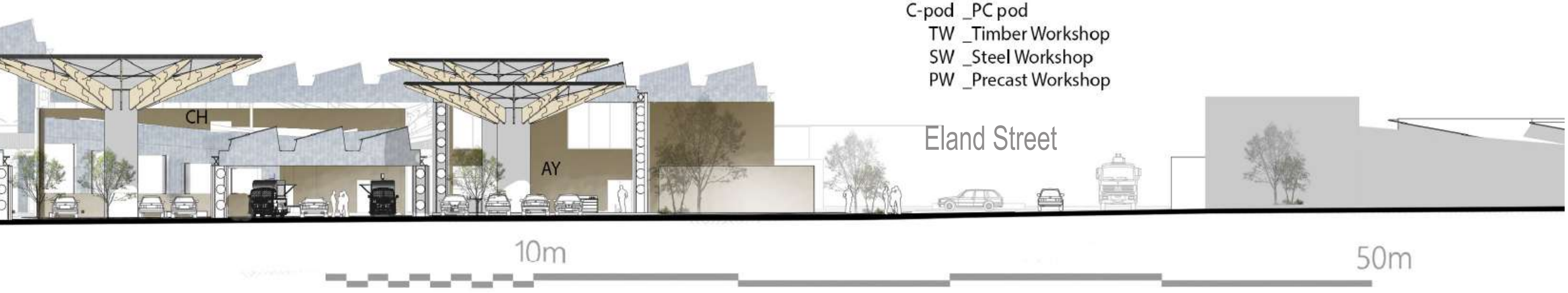
Southern Elevation View from interior street of Koedoesport Industrial

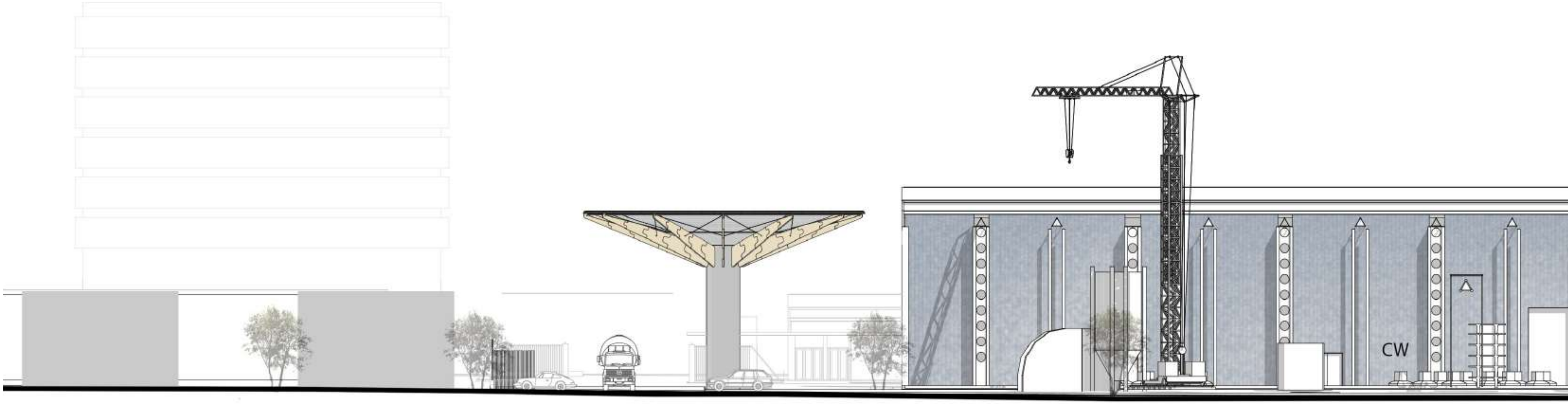


Western Elevation View from Koedoespoort Police Station

CH _Conference Hall
PW _Prototyping workshop
CC _Craft centre
AY _Assembly yard
R _Restaurant

ATC _Assembly training centre
RC _Research centre
T-pod _Timber pod
S-pod _Steel pod
C-pod _PC pod
TW _Timber Workshop
SW _Steel Workshop
PW _Precast Workshop





CH _ Conference Hall
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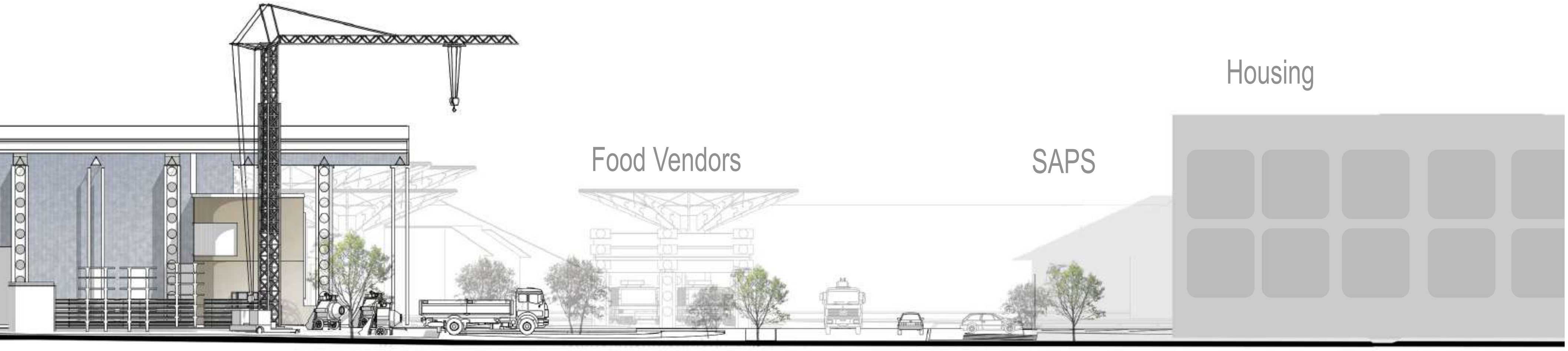


View from Nico Smit Street

Northern Elevation

View from Service Street

Eastern Elevation

Conclusion

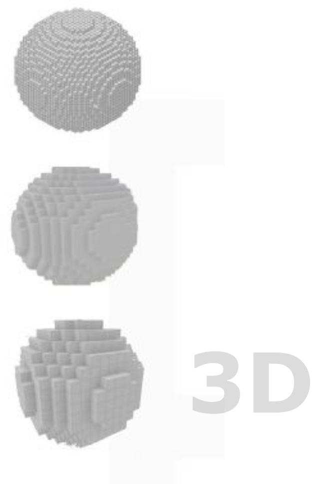
Mainstream manufactures and developers have been developing OSM and CAD/CAM techniques with mostly capital gain and mono-functional value in mind. This directly contributes to a sense of lost meaning in Architecture and cities in general, with bland copies of building being plotted out of context. In order to regain a sense of meaning in architecture and cities in general, the efficiencies of OSM and CAD/CAM must be reprogrammed and focused toward a civic artisanal dialect.

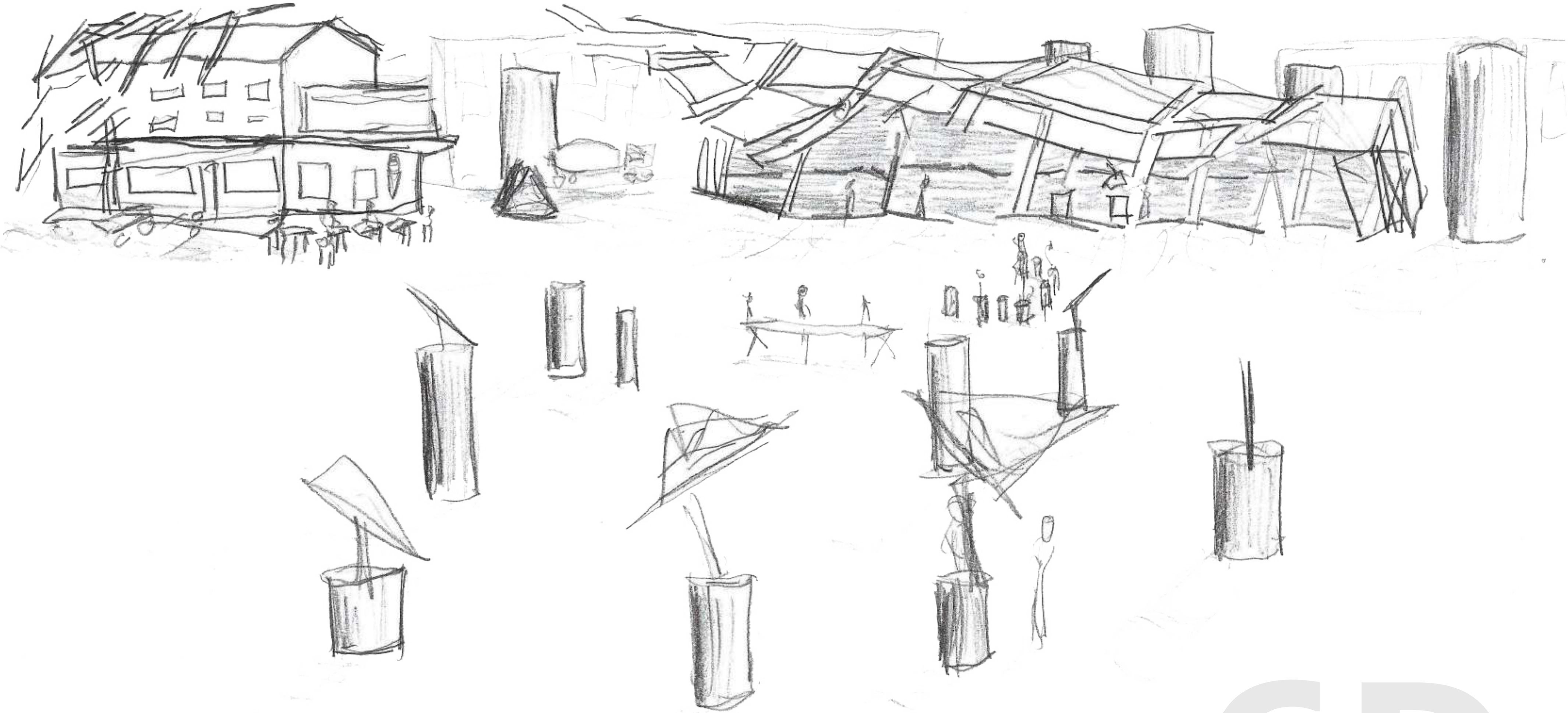
To aid in the school of thinking needed for this dialect to start, a Hypothesis can be set out as follows,
if a parallel is drawn between the Evolution of CAD/CAM, an the evolution of computer. A few findings become apparent. At the onset of the computer evolution 2D,particles/pixels were bundled up to create an image. This image represents ideas, that can be instantly emailed around the world, furthering its development. Lately, games like Mine Craft creates virtual worlds via means of 3D Boxilations or Lego blocks(Ingels,2019). This starts creating a virtual semi consequential world that is loaded with meaning for the user. The next dimension where OSM and CAD/CAM should position itself, is an exponential 6th dimension. Individuals with the aid of professionals will manipulate Particles on screen and fabricate and build these structures. This means of construction will start creating a world that is very real and loaded with meaning.

For this artisanal means of construction to be feasible, buildings should be compiled with smaller/lighter parts of 1-3m. This enables the assembly and disassembly by cherry pickers(small cranes) that alleviate the time/cost burdens that mainstream developers capitalise on. The intention is not to replace traditional/new technologies with this means of construction, but rather to use these techniques to blend the traditional materials/construction with lighter newer technologies. The prime material used in CAD/CAM, namely timber, concrete and steel, must be used in its raw state as a link between technologies . UHPC(Ultra High Performance Concrete), enables thinner walls of elements from between 80-60mm, without reinforcement. With the right additives it can be as much as half the weight of traditional pre-cast concrete. The efficiencies of plasma cut mild steel must be used to create aesthetically pleasing brackets and frames with specific meaning in its context. LVL(Laminated vinyl lumber) enables stronger, harder and more durable beams. We are also now able to manipulate structure to be more than just functional, by creating complex forms with meaning.

Lighter technologies could then be used as infill material. Light steel frame with metal cladding and insulation battens, are existing technologies installed by multiple companies locally and should be used more for its benefits of insulation and cost effectiveness in walls and roofs. For Timber composite floors, with recycled orientated strand board, polystyrene/silica based(for higher fire ratings) foam insulation and magnesium ceiling boards can be used with light steel frames structural beams holding it up to create bigger voids that make services easy and can be closed off by normal gypsum/acoustic ceiling panels. For windows, especially where no vistas is necessary, polycarbonate multi-wall systems should be used. It weighs 3-4kg/m2 and has higher R values compared to double glazing that weighs 15-20kg/m2.

To conclude, OSM and CAD/CAM with primary materials is not a new means of construction. What is proposed is, that due to its nature of being both structural and aesthetic, it has the ability to serve as an interstitial construction, between traditional means and the new lighter technologies. This enables a professional team to use computers and machines to fabricate particles, directing the efficiencies proposed by the impending autonomy of the Fourth Industrial Revolution toward developing a craft of manipulating materials with specific meaning and intent, as well as enabling a visceral perception toward the assembly and disassembly of the building particles. Taylor made particles that can be put together by a team of semi-skilled labourers or by a community themselves, and in so doing a sense if craft, meaning and pride will hopefully be tacitly perceived.





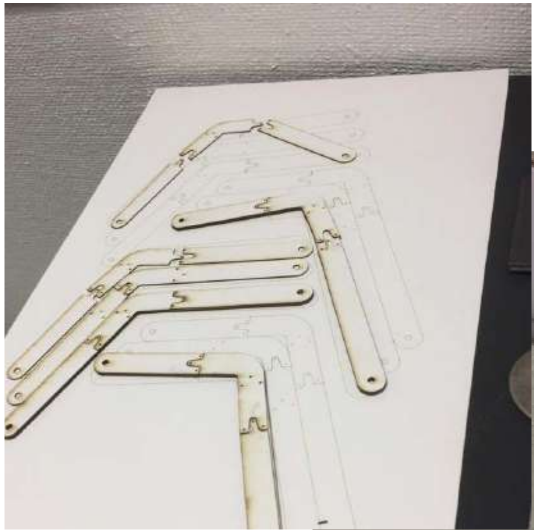
6D

Nov Exam: Final model

Nov Exam: Final model

Nov Exam: Crit layout

Nov Exam: Crit layout



Nov Exam: materail samples and Detail models

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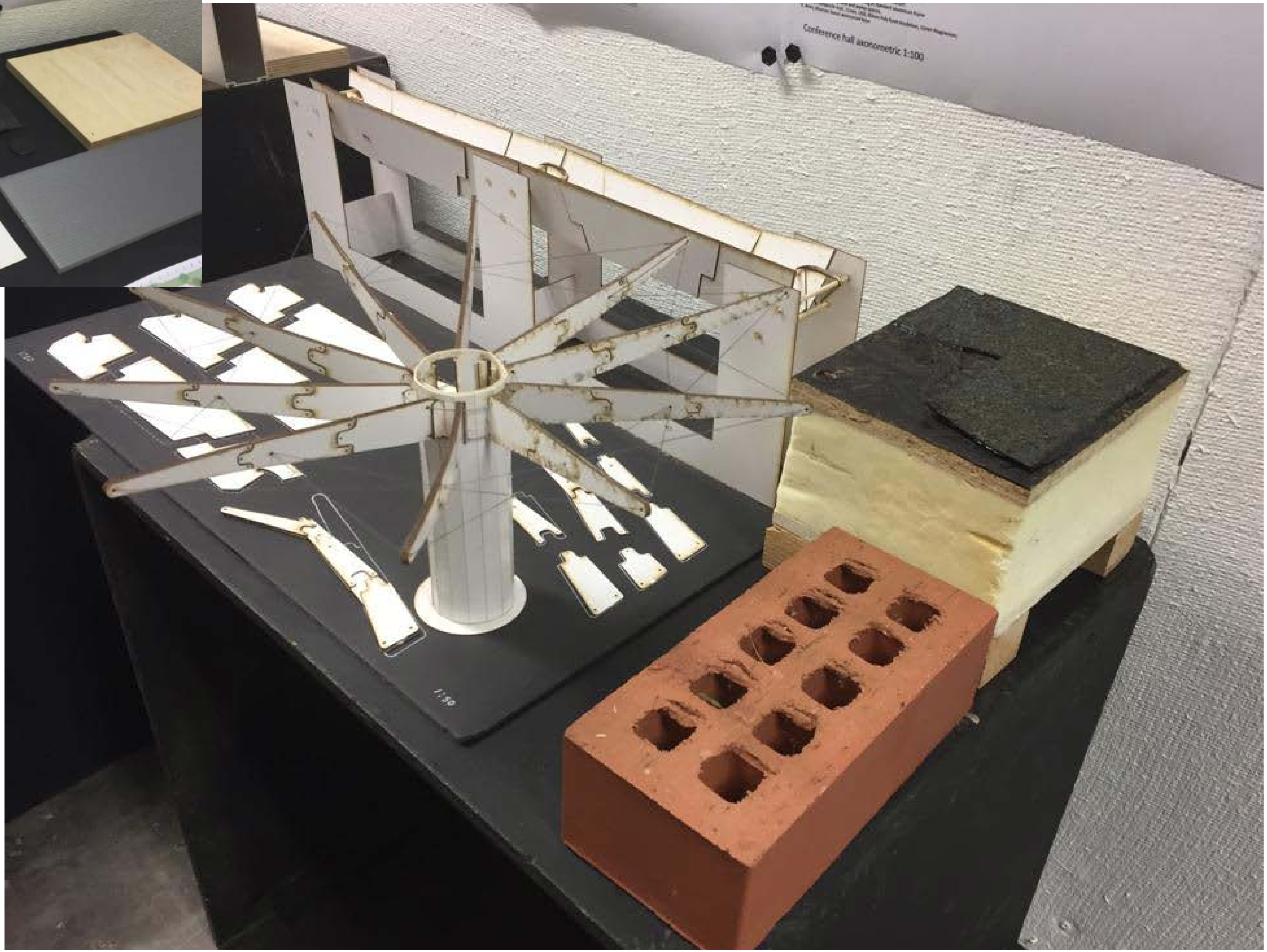

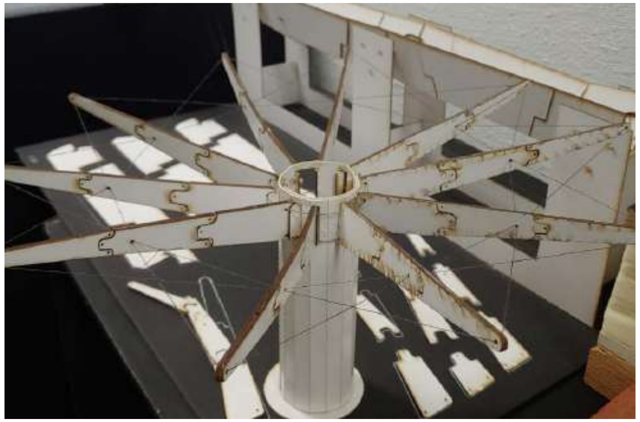

Final exam speech.

Off-site manufacturing (OSM) is an ideal rooted in paradigm of Industrial Rev. For the past two hundred years mainstream manufactures have been developing off-site manufacturing techniques with great advances. At the onset of 21cent with Invent of Comp Aided Drafting and Comp Aided Manufacturing (CAD/CAM) the efficiencies of OSM have come full circle. Yet, it is only being tailored toward unilateral capital gain for the main stream manufacture, with generic mono functional buildings being plotted all over. Kammeyer, claims this disconnects public from civic act of creating architecture and directly contributes a sense of 'lost' of meaning in arch. Eksteen, alludes to the unsustainable value chain, where materials and technologies are being moved across continents and each party in the chain takes its financial cut, without contributing to micro economical climates.

Before I continue remind me to expose a simple truth that I discovered during my masters year at boukunde. But, that's for later. This Dissertation aims Remodel the efficiencies proposed by the Fourth Industrial Revolution and reinstall sense of craft and artisans ship in architecture. An Ideal that can create meaning, rekindle the value of architecture to communities as well as enable micro economies to become self-efficient. By, re-evaluating the value chain of architecture, and investigating possible Architectural contribution directly related to the civic responsibility of space making. The intention is to design an OSM, research, fabrication and education facility within the CAD/CAM idiom. A de-limitation was made towards the three, primary materials that can be manipulated by OSM & CAD/CAM currently in South Africa. Namely, pre-cast concrete, CNC-timber and Plasma-cut Steel. Koedoespoort six kilometres north of Tuks was identified as site, due to its opportunities for convergence of multiple role players. It is located in a confined existing industry, that is conducive to reciprocal trade and conversation. There are many tertiary and secondary education facilities within the neighbourhood and the site is also situated on main transport routes with ease of access for Design professionals and the Semi-skilled labour force.

To develop a hypothesis of what will be possible in the future of OSM and CAD/CAM, a step backwards into looking at what computers have enabled us to achieved in the past 50 years was made. The phenomenology of space and place relative to this evolution is what is important. At the start of the information age thousands of pixels were bunched together to create two dimensional images. These images represent ideas, and with the invent of electronic mail, these ideas was sent around and furthered instantaneously. Lately games like 'Mine Craft' uses three dimensional boxes to create virtual worlds that user can emerge themselves in. Ingles, refers to it as boxilation. In essence it is Virtual world where the user creates representational spaces by himself, and in so doing these spaces gets loaded with meaning… The next dimension where I believe OSM & CAD/CAM will position itself is a sixht dimentional paradigm, I would like to term 'Particulate'. In this paradigm individuals with the aid of professionals will be able to manipulate particles on screen, fabricate and assemble these custom structures. These structures will be very real and consequential. It will translate into spaces flooded with meaning for user and in so doing a sense of belonging to a socio-economic and ecological micro community will be manifested. Habraken, discovered that true ownership and responsibility that goes beyond the building is possible when user engages in customizing spaces in this way.

During the design development of the scheme -and this is not the simple truth that was discovered- so bear with me. But, There were few key aspects that would enable this dissertation to contribute to the architectural as well as urban continuum, and this needed to be developed. Early on a clear split between the Logical/practical functions of such a facility and the Romantic/ideological functions became very clear. These functions had to be laid out in the precinct in a reciprocal manner in order to guide the public. From the communal spaces where prototyping and conversation will takes place, to the dangerous spaces where manufacturing and materials handling will happen, to the quite space where drafting and research can be done. To this end a few architectural elements were strategically developed. From the West, the most public façade of the precinct, processional layering of social spaces breaks down the notion of boundaries and allows the public to informally engage with the facility without being inside the facility. This notion of 'borderless ness' is enhanced by visual anchors that is not only aesthetic but exemplar of the possibilities of OSM and CAD/CAM. The canopies also Harvest and store water to be use in the process of casting concrete. The traditional notion of the circle as gathering and conversation space is expressed by the processional route culminating with a private entrance to the main auditorium space. Within the factory this same circular conversational spaces is expressed by pods overlooking factory floors. This enables the public to engage with factories away from danger. On the Southern boundary craft workshops, retail a restaurant spaces is designed to stimulate public engagement in the core of Koedoespoort industrial precinct.

Now to the technical stuff, before I expose that simple truth. Eksteen's Future Africa dining hall is predicated on the principal of building with smaller parts of 1-3m, that weigh 100-400kg. This enabled a team of semi-skilled labourers to use only cherry pickers to construct the 12x40x9meter high, plywood structure. The aspects of renting expensive time constricting cranes, was here transformed into a sense of pride and artisanal accomplishment. During the technical development of 'Particulate' it was discovered that this idiom of construction is not only dependent building with smaller parts, but on a blend between, the raditional construction means, the three primary OSM CAD/CAM materials & three newer light technologies. Being specific on the intentions and capabilities of these materials and technologies is critical. The three primary OSM, CAD/CAM materials can essentially be used as structure or link between structures. Ultra high performance concrete (UHPC) enables thinner walls of 80-60mm without reinforcement. Compared to traditional pre-cast that can reach strengths of 50mpa, UHPC can reach 150mpa in South Africa. With the right aggregates it can weigh half of traditional elements. Durable puzzle pieces can now be cast that slot in specific places by lifting it with minimal effort. Efficiency of plasma cut steel must be employed to create aesthetically pleasing brackets and frames. The principals of structure standard, but the shapes can become specific. Laminated vinyl lumber, (LVL) can be used to create stronger, harder and more durable beams. The capabilities of CNC should be exploited to manipulate this material to be more than just structural. It could be aesthetic, functional and practical to assemble. Without the limitation of using the traditional long rectangular shapes, that eventually just gets covered up by gypsum board. The three new Light technologies investigated could then be strategically used as infill. The following is not a new discovery or a simple truth. But, for walls galvanized light steel frame substructure with insulation battens and metal cladding are exiting technology installed by multiple companies locally. It should be used more. For floors, a timber composite floor, consisting of Orientated strand board(OSB) substrate. Polistyrine/ cilica spacer foam and magnesium bottom board, instead of gypsum for higher fire ratings. Ensure a light but durable first floor surface bed. This all can once again be kept up by galvanised light frames structural beams, that creates a cavity for services. A Ceiling underneath the space frame structure can then be treated acoustically to isolate the two floors sonically. For glazing, especially where you don't need vistas and natural light only. Polycarbonate Multi wall is a good substitute for double glazing. It can weigh as little as one tenth of double glazing systems with higher R and U values. This relieves the load on structure and once again eliminates the need for cranes.

How the later materials and technologies is curated and used in the design of specific projects with specific intent will open new possibilities in Architecture.

To conclude, and this is the simple truth that needs to be exposed. OSM and CAD/CAM with prime materials is not new means of construction. What was discovered and proposed in this dissertation is that due to its nature of it being both structural and aesthetic, it has the ability to serve as an interstitial construction. Between traditional means and the newer lighter technologies. This enables a Professional team to use computers and machine to fabricate Particles. Directing the efficiency proposed by the impending autonomy of the forth industrial revolution toward developing a craft of manipulating materials with specific meaning and intent. As well as enabling a visceral perception toward the assembly and disassembly of the building particles. Taylor made particles that can be put together by a team of semi-skilled labourers or by a community themselves. And in so doing micro economies can be stimulated and a sense of craft, meaning and Pride will hopefully be tacitly perceived.

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Prof A Barker, Mr JN Prinsloo & Ms C Karusseit
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Your recent application to the EBIT Research Ethics Committee refers.

Approval is granted for the application with reference number that appears above.

1. This means that the research project entitled "*Masters professional dissertation in architecture, landscape architecture and interior architecture*" has been approved as submitted. It is important to note what approval implies. This is expanded on in the points that follow.

2. This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Research Ethics Committee.

3. If action is taken beyond the approved application, approval is withdrawn automatically.

4. According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

5. The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

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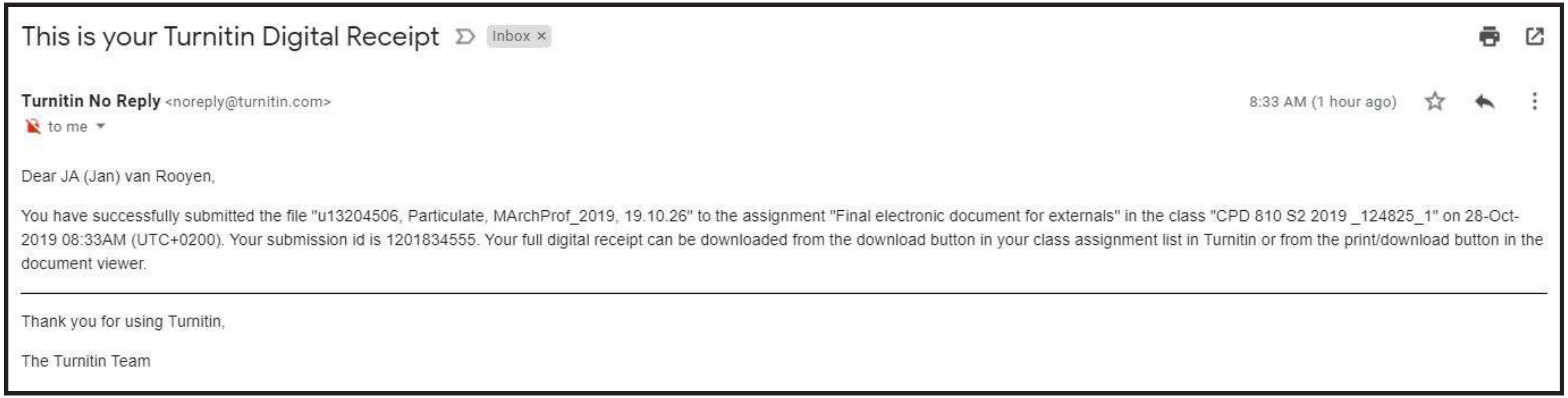

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