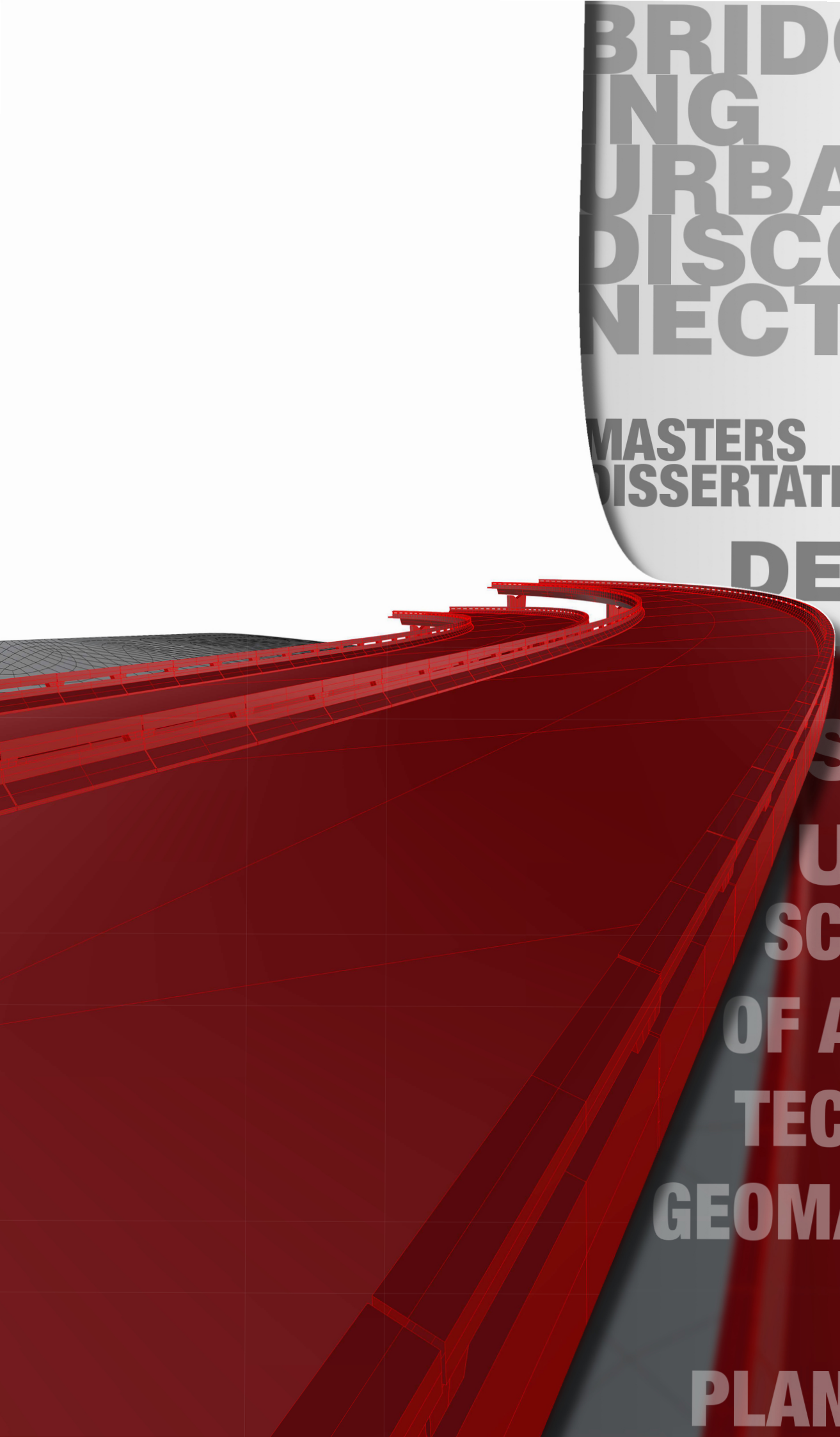
BRIDGING URBAN DISCONNECT

MASTERS DISSERTATION

DEVIN DU PLESSIS

UCT SCHOOL OF ARCHITECTURE GEOMATICS AND PLANNING



Bridging Urban Disconnect

Devin du Plessis

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This dissertation is presented as part fulfillment of the degree of Master of Architecture (Professional) in the School of Architecture, Planning and Geomatics, University of Cape Town

Date: 17 October 2015

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Acknowledgements

I would like to thank my supervisors for their advice, help and encouragement in the process of creating this dissertation; Associate Professor Nic Coetzer for running a well organised, stimulating studio. I would like the express a special thanks to Dr Matteo Fraschini for his tireless guidance through this process. I would like to thank the supervisors of the other studios, Kevin Fellingham and Melinda Silverman, who gave careful and inspiring advice at points where they were called upon for further support in the design process.

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Finally I would like to thank my family for their endless support and encouragement which has been instrumental in keeping me aspiring to do my best.

ABSTRACT

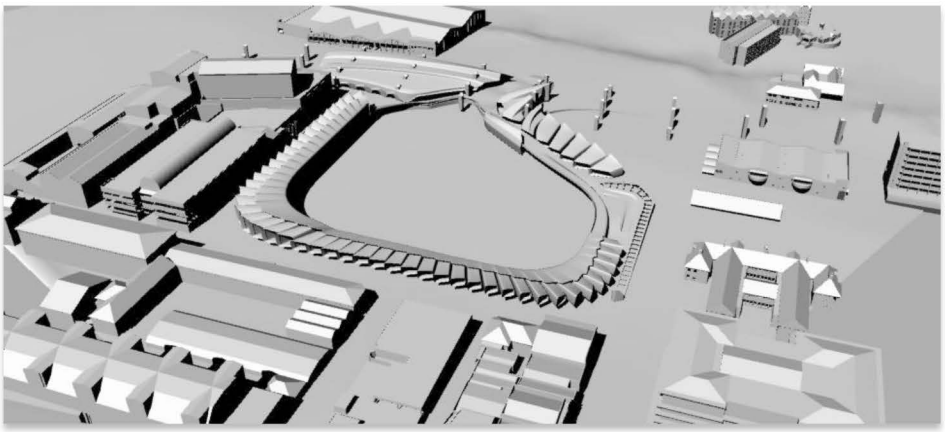

FIGURE 33. Key Image: 82. D. du Plessis. Personal Model. 2015

Bridging Urban Disconnect
Devin du Plessis

There exists an incoherence in many contemporary cities between built architectural, urban fabric and the main transport arteries that feed the city. This incoherence leads to dangerous and disused space in the city which leads to disconnected parts owing to the untraversable nature of these left-over spaces. While there are large engineering solutions to such problems, this project seeks architectural solutions. Contemporary tools can be used to analyse and handle the problem; leading to a healthier city with happier people. The current tools at an architect's disposal allow him/ her to respond to a variety of contextual geometries of varying complexity. These tools present themselves in the form of algorithm based software. The concepts of the project seek to create flows through the city by making spaces that show movement and interrelation and encourage constant activation. To do this a specific city has been used as a case study and a particular site selected for a hypothetical architectural project to be designed. This design grapples with the aforementioned issues and solves the challenges firstly by trying to understand why the dead spaces exist and accepting that the transport elements which led to the disconnect cannot necessarily change. This is a positive project seeking to uplift the city.

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INTRODUCTION

There exists a global issue of the car and the city. Many cities have been built before the advent of the fast-moving motor car. These cities have been retrofitted with transport arteries that feed the city's economy and bring its people in and out. The impact of the infrastructural systems on the city is often negative, even in cities where these are not a retrofit. The negatives can be listed in a number of points (first) their particular geometry cuts urban fabric in a way that leaves negative unusable space between freeway and built context; (second) flyovers tend to be unsafe underneath because of human disuse leading to crime and ground freeways are unsafe because of rapidly moving vehicular traffic; (third) there is a difference in continuity between vehicular roads and pedestrian streets. In a pedestrian street the movement can be broken at any time and any user can stop or change direction or route at any time with no problem. On a vehicular road there is serious danger presented when the continuity of flow is changed in any way and (4) there is often a clash in expression of freeway (being a purely engineering exercise of flowing curves in concrete and tar) versus architectural context (often being finer grain, perhaps historical buildings expressed in a variety of materials). All of these clashes lead to another problem; the freeway becomes an untraversable terrain for pedestrians, cutting parts of the city off from one another.

This paper seeks to find an architectural solution to a problem in the city at urban scale. How can architecture bridge the gap between transport systems and architectural context in contemporary cities? This is done by analyzing a particular example of this condition in the city of Cape Town, South Africa.

There is a pronounced separation in the city of Cape Town between areas of high energy. This project seeks to understand one of these separations, the separation between De Waterkant and the Victoria and Albert Waterfront. The site is placed underneath the evocative foreshore freeway, an elevated freeway that has been the topic of several myths locally because of its ending mid-project. It is a disused freeway in part and cantilevers over the entrance of the Victoria and Albert Waterfront (V & A Waterfront).

The site that I am focused on is a quiet piece of land between the rapidly expanding V & A Waterfront and De Waterkant situated on the side of Signal Hill. The issue of the site is that even though it exists between a high intensity business district (with many bars, restaurants, plenty of retail; leading off from the central business district) being De Waterkant and one of Cape Town's main tourist hubs (which is part industrial, part public space with rapidly expanding retail, social and cultural and historical businesses) being the V & A Waterfront it is completely quiet and underused. At the base of this problem is the Foreshore Freeway which dams the urban fabric of De Waterkant- allowing it to thrive independently of the larger context. It allows such a small trickle through, perpendicular to the highway, that the fabric on the V & A side of the freeway is disjointed; highly defensive and completely unused outside of its particular function (it then has fast moving independent systems which feed the V & A Waterfront). This project seeks to understand the Foreshore Freeway and its impact on the Junction between De Waterkant and the V & A Waterfront.

It is crucial to understand that the Foreshore Freeway is a flyover. This flyover allows vehicular and pedestrian movement to occur beneath it, perpendicular to the freeway. However owing to site conditions this movement is stinted almost completely for pedestrians.

FIGURE 1. Illustrating various aspects of the site including urban fabric and freeway disparity: 50. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015


S ARM ROAD
W QUAY ROAD
DOCK ROAD
WALTER SISULU
SPARSE URBAN FABRIC
ALFRED STREET
PORT STREET
HELEN SUZMAN BOULEVARD
EBENEZER ROAD
BENNETT
PRESTWICH STREET
HOSPITAL STREET
NAPIER STREET
ALFRED STREET
SOMERSET ROAD
CURVED UNFRASTRUCTURAL SYSTEM
CONTINUOUS CUTTING URBAN FABRIC
ORTHOGONAL URBAN FABRIC
NON-CONTINUOUS BUTTING UP AGAINST FREEWAY
FINER URBAN FABRIC

DESIGN EXPERIMENTS

Before the site was known a number of experiments were carried out. These were a list of random, high energy assignments loosely related to architecture. From this it became clear that my project would be about one system's influence on another. The investigations were a series of experiments used to try articulate what it is that interests us subjectively. This is important, that we might gain a better understanding of our architectural interest and its influence on our projects; also that it might inspire us for our choice of architectural installation and site.

The investigative designs started as two separate systems that are able to interact in an expressive way. The first piece; a membrane is stretched over a rigid frame such that the final form is a box. The second system is a smoothed rectangle (smooth is a computer based operation that will take rigid forms and curve them) on a base. The second system is then inserted into the bottom of the box warping the membrane. So the second system is able to interact with the first in an expressive way and it is able to make a hybrid form which is a combination of both systems which also has its own, new characteristics. The membrane reacts to form a dialogue between two systems, between inside and outside

The second experiment sought to articulate this dialogue more carefully. Wire networks are set up under the material membrane such that the objects inserted acts on a network which becomes visible only after their insertion. That is to say when the correct object is inserted into a network in a particular way it can unlock large possibilities. Once again the inserted items create a hybrid form; the objects transform a rectilinear form into a form that is both box and curved form which opens. From this project it became clear that my interest lies in, not only a broader scale; where an inserted architectural element can warp the context notionally and unlock latent pedestrian and vehicular flows causing the context to be more like the inserted element; but also in 'making' in the smaller scale. This was discovered simply by tipping the final object on its side and noticing that peering inside is just as relevant as viewing from the top.

The final object is a mobile expression of the effects two systems can have on each other. It works on two layers. The top layer is a sculpted timber block that has been sliced so as to let the second system interact with it. The second system is a cam shaft. The first system is static and the second system is simply a machine part but together a richer object is formed. The rotating cam shaft transforms the timber slices into a sort of hybrid object once again, this time the hybrid is both transformed in form and movement. And movement or rather movement flows became central to the project at base of the Foreshore Freeway.

FIGURE 2. Illustrating Various Design Experiments: 51. D. du Plessis. Edited Personal Photography. 2015

01

02

03

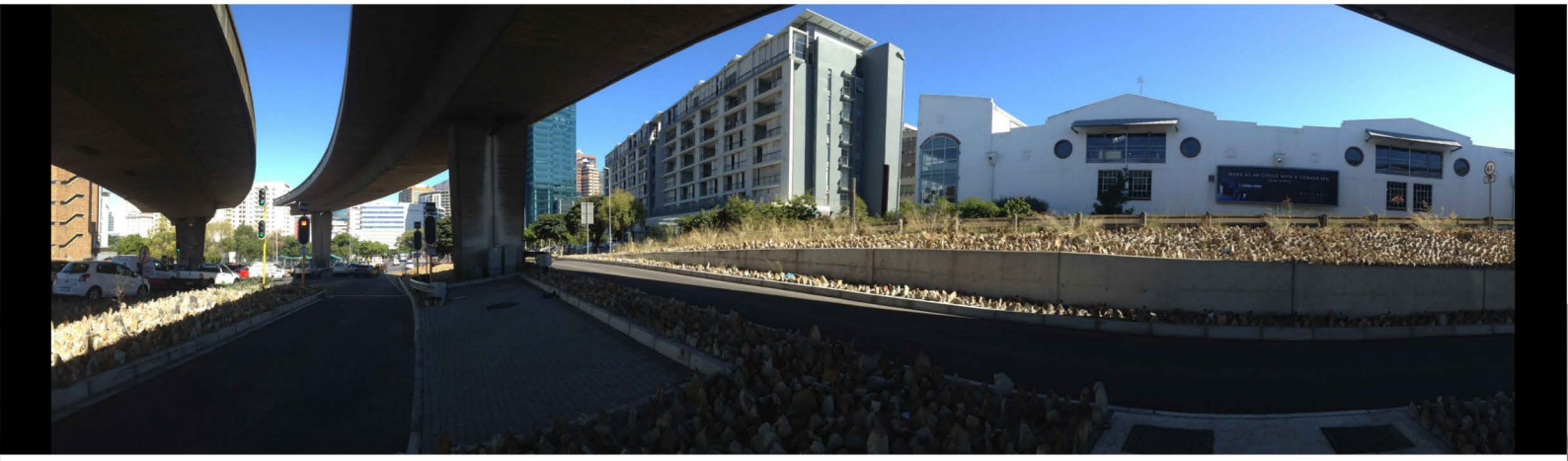
SITE

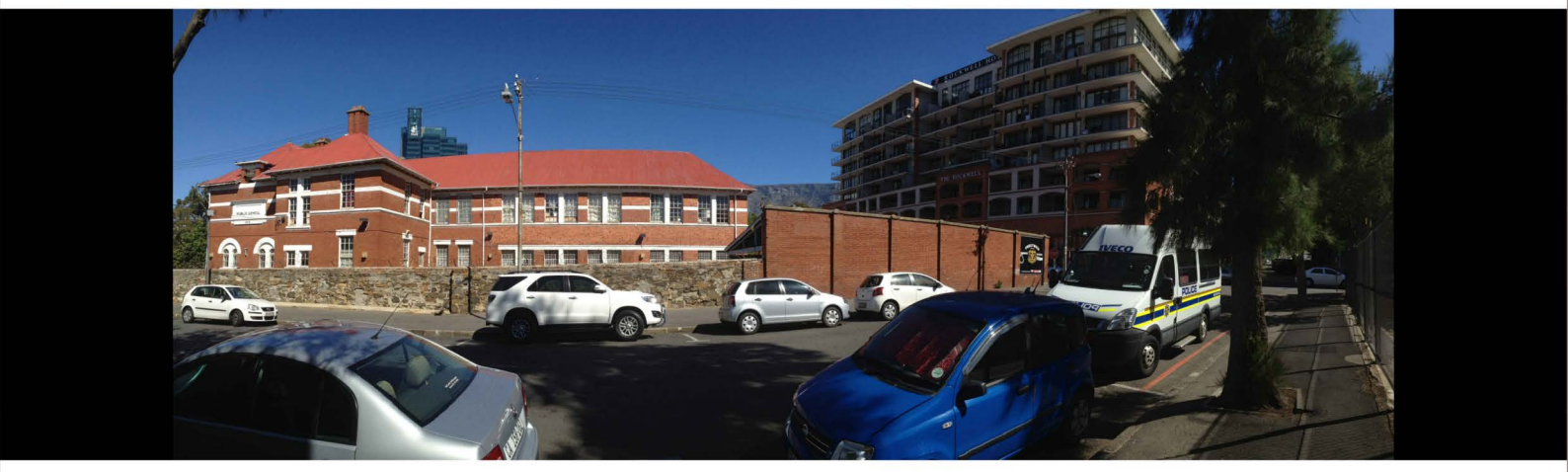
After the insight gained from the experiments, finding the correct site was the next focus. Because my focus was one system's ability to improve another system I began to look for a site that could benefit from positive reinforcement. I looked at the Grand Parade off Darling Street in Cape Town as a site for potential upgrade that could be modified so as to reinforce the flow through and link two parts of the city in a stronger way. The large scale of the castle throttling the link between the parade and Woodstock combined with the vastness of the parade itself and the surrounding amenities hinted at finding another site.

From here I progressed to the site of this study. I began to critique the link of Cape Town city across Helen Suzman Boulevard, the Foreshore Freeway. From here a particular site came into focus, this the stretch of land that the My Citi bus company has used as their premises between Prestwich Street and Port Road and how that site might unlock a flow that could move through the land occupied by the Amsterdam Battery leading to the Walter Sisulu Avenue and Dock Road circle. This link would thus flow from De Waterkant directly to the Victoria and Albert Waterfront. In so doing it would reinforce a link between the city CBD and the separated Victoria and Albert Waterfront.

The reason for the split in the city stems from the morphology of the city. In the development of the city the V & A Waterfront was a purely industrial area separate in use from the rest of the city. As the city grew and the need for larger roads became apparent the split became more and more pronounced. The fact that the highway is cutting through such a crucial part of the city, causing such a divide, cannot be avoided and as such should be viewed as an architectural challenge to be solved. This solution is needed as the city has developed in such a way as to render the V & A Waterfront an asset to the rest of the city in terms of pedestrian flows. Thus the severed pedestrian link between the V & A Waterfront and De Waterkant must be established because the morphology of the city has led to two points of energy stinted by their disconnect. For further information on the city's morphology please see Appendix A. Transcending Urban Borders. page 70-83 .

FIGURE 3. Illustrating the Site. 52. D. du Plessis. Edited Personal Photography. 2015




IVECO
POLICE

Freeway Analysis

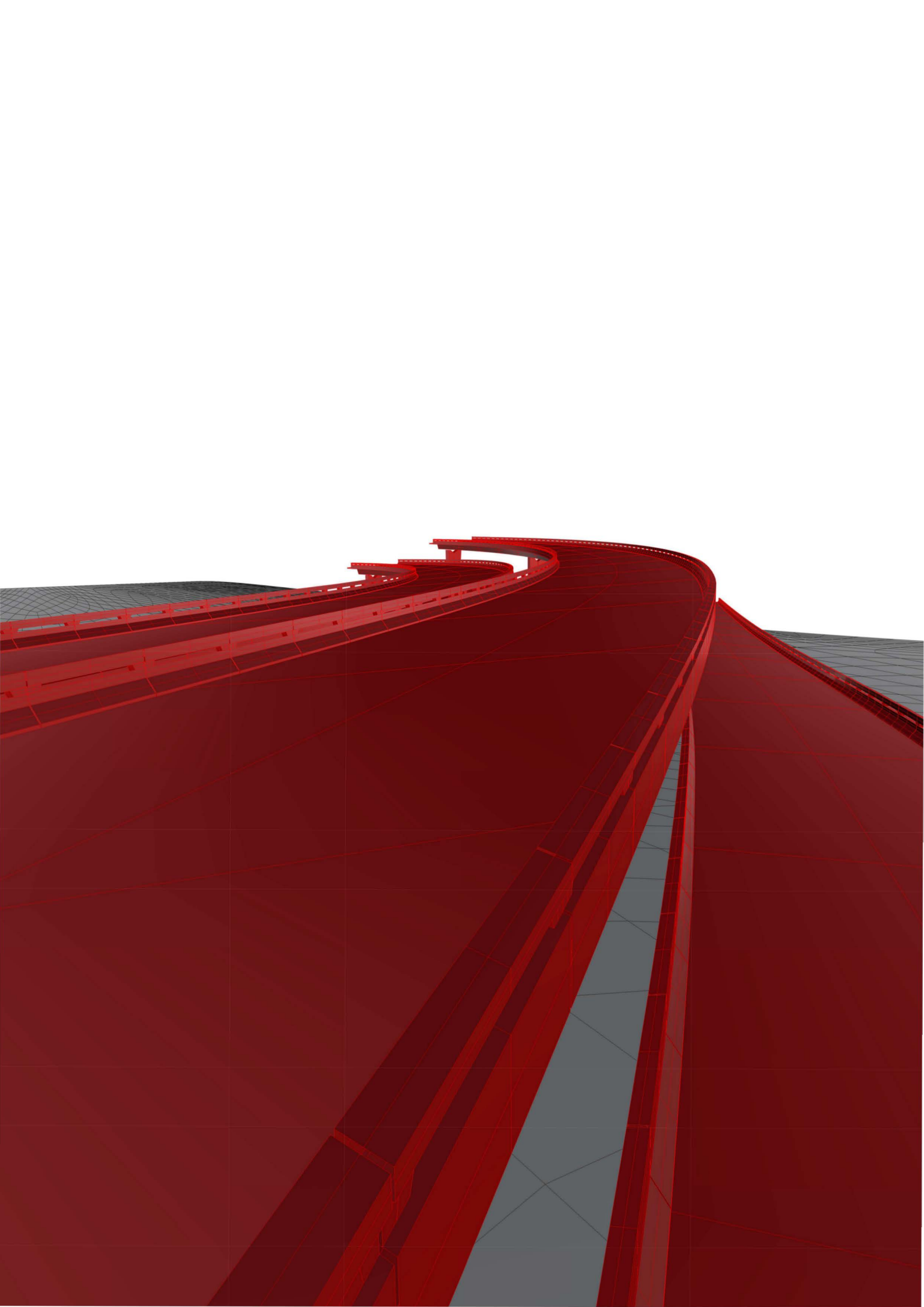
As well as understanding the effects of the freeway on the site from an urban perspective it is also important to understand the bridge geometrically. If the geometry of the freeway can be understood as well as the geometry of the urban fabric on either side of the freeway, it will be possible to understand how an architectural installation can unite the geometries of the site from orthogonal finer grain urban fabric to curved uni-structure freeway to dispersed fabric (moving from De Waterkant towards the V & A Waterfront). It will also make it possible to understand how a building that exists under the freeway should respond to its context. The reason that such a complex analysis of the structure would be necessary is that the structure itself is very complex. From complex curvature of each of the four armatures to the vertical, changing gradient to the differing camber of each armature the freeway needed an in-depth study.

Now that it has been established that a complex computer modeling of the freeway will be needed in order to understand the complex geometries of it, it becomes necessary to understand which type computer modeling software would be most useful. An investigation into the type of curvature used in the construction of a freeway revealed that a software that could construct custom curvatures would be needed. It also became apparent that a software that uses repeatable modeling principles would be the best option. That is to say a software that can extract geometric principles from the freeway that can be used in the construction of an architecture that responds to the urban fabric and the freeway and mediates between them.

To this end parametric programming became a matter of interest. Although I had no experience with software capable of handling complex double axis curvature before or indeed any experience with algorithm based software, Rhinoceros and Grasshopper, known for its algorithm based modeling, stood out as the best choice. What this software made possible is the creation of mathematically based curvature not available outside of transport engineering software. Once the freeway is constructed it is then possible to extract the code used to construct it and then use it to construct architecture based on the same geometric principles.

For a further discussion of the modeling of the highway using Grasshopper and Rhinoceros please see Appendix B. Parametric Technology. Pages 97-131

FIGURE 4. Illustrating The Parametrically Generated Foreshore Freeway: 54. D. du Plessis. Edited Computer Model. 2015



ZONES

Next was a phase of Site analysis both computer based and information collection. A look at zoning and land ownership revealed a pent up energy that could result in a release. The land highlighted in transparent magenta to the North, belongs to the Victoria and Albert Waterfront, revealing a spread towards the city culminating in the black and magenta land section.

The black and magenta land section is specifically set aside for arts and culture thus the Waterfront Film Studios uses most of the land in black and magenta with a small portion belonging to the Waterfront Theatre College. Thus a Cultural gasket can be used to connect the two parts of the city.

The section highlighted in stippled magenta is an area dedicated to mixed use building typology. Thus the program of the building should be both cultural and a continuation of the mixed use typology of the context as a best practice for continuing a pedestrian flow through the site.

The area highlighted in opaque magenta is a zone that will have to be contested with the city as it has been dedicated as a zone of discontinued construction. However highlighting the importance of the link through the city as well as proposing the cultural gasket and showing how pedestrian flows through that piece of land will benefit this flow will make a strong argument. Another factor to be included is showing how the bus terminus can be reconfigured allowing architectural installations to enforce pedestrian flow through the site and better make place. In the reconfiguring of the site the parcel of land marked discontinued use will be freed up for architectural use further motivating its reconfiguration.

This zoning and land ownership study is important as it shows the divide clearly. The freeway acts as a boundary of the V & A Waterfront and De Waterkant that has been tangible to land owners and city zoners. In our contemporary city such a divide is no longer useful, thus a way to push through the highway with a membrane acting as a mediator for this action becomes of critical importance. A language needs to be developed that can be both architecture and freeway.

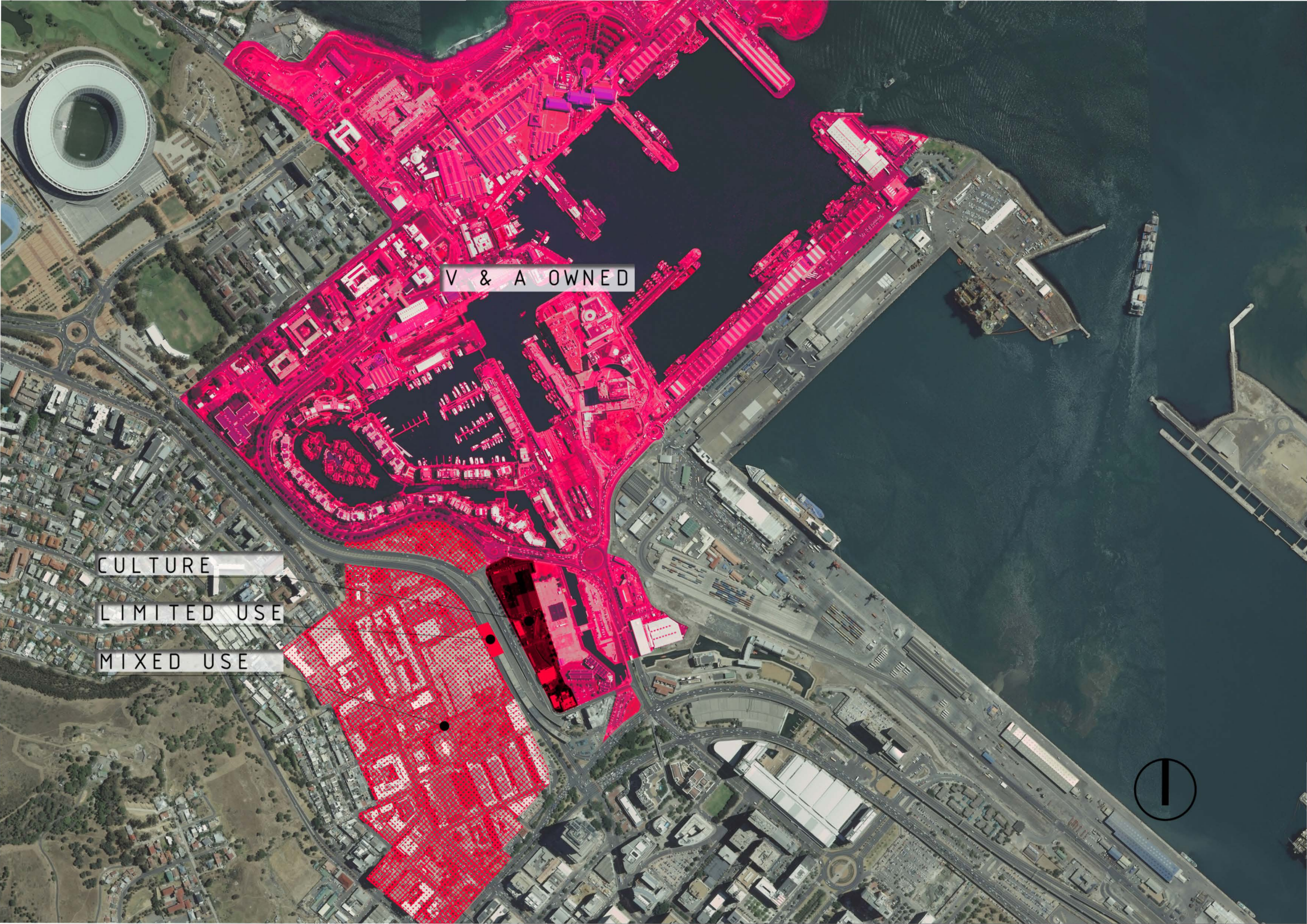
The cultural zone makes it apparent how ‘continuity’ (1) can be accomplished across the site. This continuity is necessary to be able to transgress the border set up by the freeway and allow and promote larger volumes of pedestrian movement.

For further discussion on the topics central to the concept of this project please see Appendix A. Transcending Urban Borders. Pages 84 to 96.

This analysis of the site allows for a space that will be ‘porous’ (2). Not only will the site be the initiator between two activity hubs in the city, with people moving at different speeds, on different time schedules (from tourists to local people relaxing to people on their way to work) but also because of the mixed use of the site, the transport hub and the cultural gasket many different types of activities and users will mix in this high intensity porous linking space.

1. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.
2. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 6. Illustrating Site Zoning and Boundaries: 55. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015


V & A OWNED
CULTURE
LIMITED USE
MIXED USE

FUTURE DEVELOPMENT BY OTHERS

At this point it becomes helpful to analyse how these zones might be connected through the imagination of others working on the site already. GAPP Architects have proposed a future development for the V & A Waterfront which shows a desire to cross Walter Sisulu Avenue. This desire is in agreement with the project that I have suggested. My critique of this is very subtle and has to do with the placement of the crossing point rather than with the move itself. Putting the cross point under the Walter Sisulu Avenue and Dock Road circle the pedestrian is able to choose for himself how to flow through the city. The result of this subtle change is that new links will not be favoured over existing ones; this would help to prevent the slow shift of activity from one zone to another allowing for all zones to be occupied equally.

In this analysis it is shown that a broader urban scheme will be needed for a project aiming to link the V & A Waterfront to De Waterkant. If the circle were to be modified to allow for continuous pedestrian movement it would transform the circle into a 'porous' (3) space as the first or last space where different people would be together going off to their respective destinations.

The move of sinking the pedestrian flow beneath the circle would allow for continuity between the V & A Waterfront and De Waterkant of people from all over whether working, local visitor or international visitor. This alleviation of pressure will allow a scheme situated below the freeway to be 'continuous' (4) in the most efficient way.

3. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

4. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 7. Illustrating Future Development Plan by GAPP Architects: 56. GAPP Architects. Image from http://citythinkspace.com/v-a-waterfront-precinct/. 2015


V&A WATERFRONT
MARINA
PORT AUTHORITY
BUILDING
POSSIBLE NEW YACHT CLUB
CLOCK TOWER
PRECINCT
A
B
C
D
E
F
G
CRUISELINER
TERMINAL
DUNGAN DOCK

CONTINUOUS MUSEUM

Directly opposite the site is the Amsterdam Battery. This analysis borrows from the analysis of GAPP Architects. However it highlights the historical points of the immediate context within walkable distance; these three being the Prestwich Memorial (a memorial to human remains found in the area of slaves, black people, washer women and members of the Dutch Reformed Church) (5), Amsterdam Battery and Chavonnes Battery. The GAPP Architect's analysis focuses on the line of the shore before the land was reclaimed as well as the relationship between the Noon-Gun, the Amsterdam Battery and the Chavonnes Battery as well as the Good Hope Castle being another historical, defensive building on the previous shoreline. This lends a historical layer to their research and resulting architecture. This analysis focuses historical structures' contribution to the site in terms of potential pedestrian flow. Hence a project taking advantage of this will not only benefit from another layer of site use adding intensity, activity, continuity and porosity to the site, but also will allow for a multilayered reading of history of Cape Town (looking at the accomplishments of the colonizers as well as paying respect to those who suffered under their hands).

This shows that a wide variety of factors can influence the use of a sub-freeway installation. This means that because there will be a variety of visitors interested in differing activities the space will be 'porous' (6.) leading to it being constantly active space. Thus even though the architecture does not deal directly with history or the subject matter of the museums it indirectly becomes part of the narrative, being part of the journey.

5. X. Kashe-Katiya.The Archival platform, Prestwich Place Memorial: Human Remains Development and Truth. [Online] Available from: http://www.archivalplatform.org/blog/entry/prestwich_place/ [Accessed October 2015]

6. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 8. Illustrating Museums of Context: 57. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015


CHAVONNES BATTERY MUSEUM
AMSTERDAM BATTERY
PRESTWICH MEMORIAL

CONTINUOUS THEATRE

At this point it becomes important to explain the existing cultural gasket in more detail. It is comprised of Take 2 Films (a warehouse) and series of buildings used to shoot films (they also often use the incomplete freeway as a film location) and the Waterfront Theater School. Being that the cultural gasket is comprised of theatre and acting-related activities on the existing side, a map showing potential flows between theatres and their relation to the site of this project becomes important. This map shows that a likely pedestrian flow is through the site of this project, this flow referring to between theatres in the city.

Another reason to motivate a theatre on site is that the theatre school has only a very small theatre. Putting a theatre in that gasket will help the school with productions but it will do something more valuable it will expose the students to outsiders. These outsiders may be interested for a number of reasons: they may be potential fans who will support the actors through their future careers; they might be recruiters looking for talent to be employed in their shows but the most interesting link that could potentially occur comes from the studio right next to the site. If the school puts on a display it can expose students to international attention as large American shows are periodically shot in these studios. Directors, recruiters and other film related interests might be tempted to view local talent being displayed directly opposite their studios.

Thus theatre as program will make sense across scales. The site also lends important information regarding the scale of such a theatre. If it is to be below a freeway very precise limitations on size are imposed but also if it is to be used by a school it cannot be a high cost large interest, it will have to be moderate in scale and somewhat cross programmable.

This scale makes sense in another way at a larger scale study of the city. Looking at one of the city's gateways it becomes clear the city already has high order, large theatre in the CBD. A theatre on this site should not act to replace it but rather to compliment it. In this way there will not be a shift in focus and use in the city, but rather a spread of it, with each part fulfilling a related but different need.

Such an encouraged cross-pollination allows for 'porosity' (7) of theatre space, spilling into the rest of the site, but it also encourages a 'continuity' (8) in the city as a whole.

7. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
8. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 9. Illustrating Theatres of Context: 58. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015


WATERFRONT
THEATRE SCHOOL
ARTSCAPE THEATRE

CONTINUOUS GALLERY

The next point of analysis will be to look at another similarly related typology, that of the gallery. It is clear to see how an unlocked flow will allow people to move between galleries in Cape Town. This comes into particular focus with the new Zeitz MOCAA art gallery to be completed at the Victoria and Albert Waterfront. A flow from this building to other galleries in Cape Town ending at the Iziko National Gallery will be strongly reinforced. While this distance lays far outside of a walkable neighbourhood, a link through the site that my project proposes will enable a walkable experience for avid explorers (in my mapping I have discovered that large numbers of people walk from the train station to the waterfront everyday). This project seeks to bolster this gallery walk qualitatively- encouraging inhabitants and visitors to experience the route whether they choose to walk the whole way or supplement the route by means of vehicular transport.

This then lends a clue as to what the program of the architectural installation might be. Because of the flexibility of space that can be used as art gallery and studio it can prove to fit into the project seamlessly where needed.

Another reason that gallery and studio space can be best suited to the site is 'porosity' (9). Not only will gallery and studio space draw many different types of people but it will also benefit from the large variety of shoppers, tourists, museum and theatre visitors and people on way to work who will potentially pass by such a space.

Gallery space will also do well in integration with the multiuse zoning as well as the cultural gasket linking either side of the freeway. Owing to the Zeitz MOCAA Gallery (for completion at the V & A Waterfront), gallery space will be helpful for local artists seeking to sell art to visitors who have been able to witness art in the large gallery and who are inspired to buy local African art. Once again this link will not only benefit the artists but the scheme in general. Such a direct link in program will encourage a movement through the city by the pedestrian allowing a cross-pollination of visitor. Hence the space will also be 'continuous' (10) through the city and cohesive in the large scale.

9. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

10. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 10. Illustrating Galleries of Context: 59. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015


ZEITZ MOCAA
ART GALLERY
IZIKO NATIONAL
ART GALLERY

ALGORITHMIC FREEWAY GENERATION

Now that we understand some of the flows in the city a closer look at the lack of flows on site becomes important. To do this we can start with an algorithm that was used to trace out Helen Suzman Boulevard. This will explain how it negotiates its terrain and how it creates a membrane in the city.

After a previous analysis of the interaction between the urban fabric and the road an algorithm was constructed that would generate the Helen Suzman Boulevard as a single guide-line. The principles involved were firstly the outline of the flora was traced. This outline is governed by gradient as well as nature conservation. The next step is to put points on the line that can be adjusted according to city grid size. Each point receives a line radiating out toward the sea. Each radiating line receives a point called a radial point. The radial points are then linked sequentially with straight lines; the collection of straight lines will be called a polyline. The edge of the land, where the sea meets the land, is then traced out and offset inland. An algorithm then traces a single line where the sea-edge-offset line and the polyline intersect; this line will be called the resultant line. An algorithm is used to turn this resultant line into a line comprised solely of straight segments. Another algorithm then curves the corners using the complex geometrical curves of a road known by their transition –curve to circular-curve to transition-curve sequence. Thus tracing out the natural features and selecting things such as city grid size the line of the Foreshore Freeway can be generated. The application of this algorithm is to be placed on site such that the building's circulation can be generated in the same way that a highway can be. Instead of blind building generation however, enough control can be afforded the designer such that the designer generates the plan, instead of the algorithm doing it.

Similar coding to this can be used to allow buildings to work according to a logic separate from the sub-freeway structure, but still respond to the large concrete columns in such a way so as not to be stinted by them being a sort of shifting grid.

There are two opposing ways to respond to a context (firstly) use the main elements directly on the site and form an architectural logic that the new elements will follow- becoming part of the system and (secondly) setting up an architectural logic according to other principles such as larger contextual responses, flows and theoretical principles; then deform to respond to elements directly on the site. This response is like a flow of water, it has a logic but will deform and twist dramatically when an object outside of that logic is placed in its path, such as a large rock.

This type of response is both 'continuous' (11) and 'transparent' (12). It is continuous in that it allows a logic of flow to continue, not having to change it because it does not fit in with the specifics of the site. The two systems interacting is reminiscent of natural, pedestrian and vehicular flows viewed from above, further reinforcing the concept of flow and continuity.

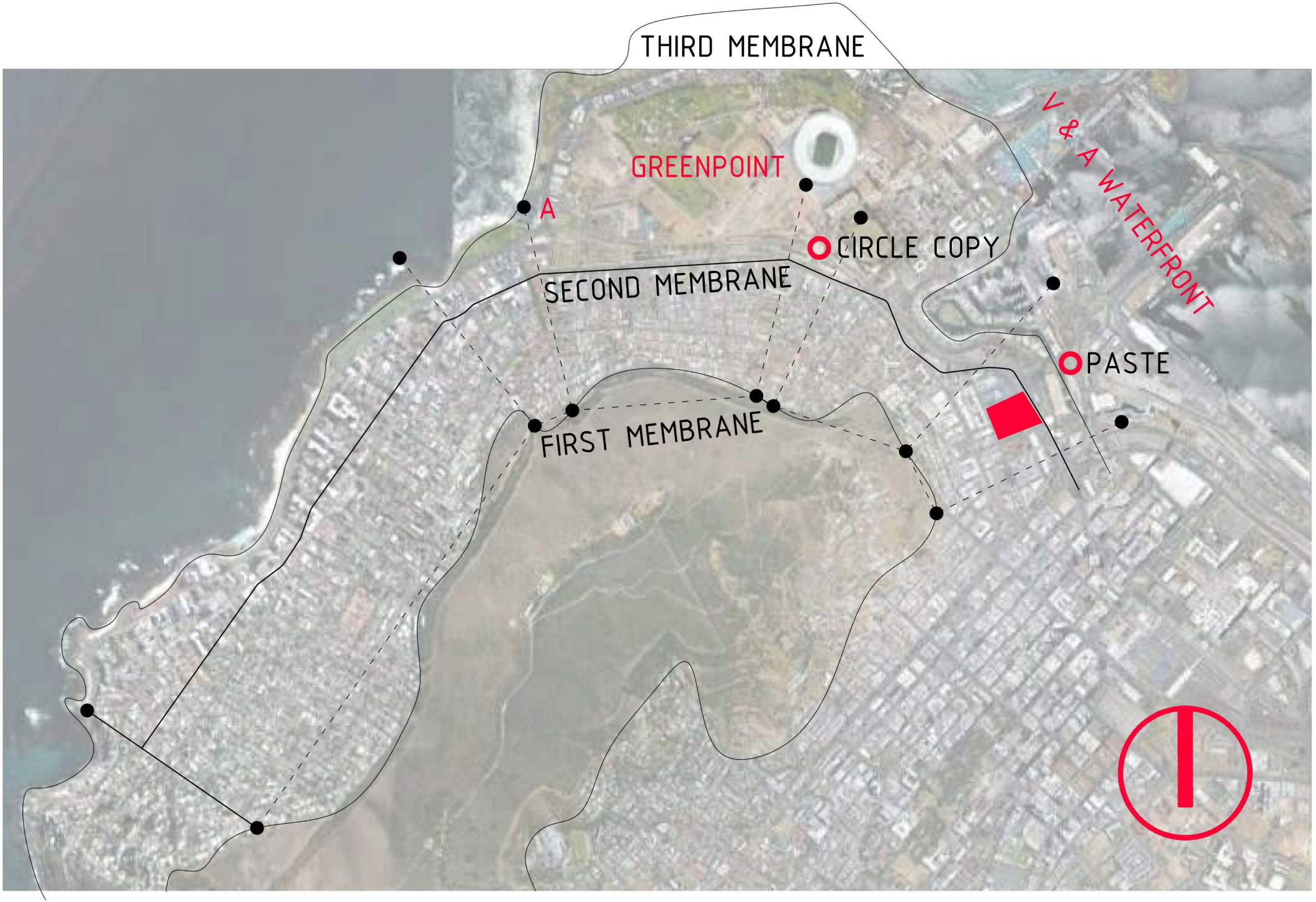
'Transparency' (13) is the ability to view two logics simultaneously and have the ability to see how they interact and also understand them separately. With the logic of deformable response it is possible for the site to be transparent allowing the user to understand two large systems simultaneously.

11. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

12. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

13. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

FIGURE 11. Illustrating Algorithmic Freeway Generation: 60. D. du Plessis. Edited Image Google Earth; Grasshopper. 2015


THIRD MEMBRANE
GREENPOINT
A
CIRCLE COPY
SECOND MEMBRANE
V & A WATERFRONT
PASTE
FIRST MEMBRANE

The resultant diagram helps to highlight an important concept in the city, being membranes. The first membrane is caused by the gradient of the mountain and it articulated by the meeting of flora and architecture. It is a semi-porous membrane mainly transgressed by hikers and nature conservationists at specific points.

The third is a semi-porous membrane even less 'porous' (14) than the first; being the water's edge it can only be transgressed by watercraft and mainly at the V & A Waterfront which acts as a sort of hole in the membrane.

The second membrane is the one of focus in this paper, being the Helen Suzman Boulevard, becoming the Foreshore Freeway. This is the most porous membrane of all. The porosity that is caused is partially owing to need; there is a need to navigate different parts of the city freely. This membrane can become even more 'porous' (15), as it is an artificial construct, which is the task of this project. The porosity of this membrane is partially owing to the streets, which align with the dashed radial lines, as these articulate urban blocks. The effects of the membrane can clearly be seen between Greenpoint and the V & A Waterfront where the membrane becomes watertight. Point A represents a hole in the membrane where a small amount of urban fabric leaks out and claims seafront location.

While the condition of the membrane is something seen over a wider context of Cape Town the focus of this project will be to transgress the membrane at a particular point where the city will benefit from this.

14. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
15. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 12. Illustrating The Bus Depot in context of the Freeway: 61. D. du Plessis. Edited Personal Photography. 2015

CONTEXUAL TYPOLOGY

An analysis of building typology can help us understand the impact of the Foreshore Freeway and also give clues as to how to bridge the gap between the two sides.

This mapping resulted from the need to understand the function of the buildings surrounding the site so that the building to be proposed could speak to those functions. While this information would need to be processed to be directly useful to this project it highlighted the mixed use nature of the immediate area and the flexibility of the context to handle a variety of functions. It also highlighted the fact that the building typologies around the site buttress the divide in the city. Functions that had limited or no public access butt up against the freeway- these being the bus depot, school and provincial head office SAPS Western Cape, parking garage and limited access retail. Functionally these do little to encourage pedestrian flow. This gives a clue as to what type of destruction would be needed to avert the destruction of the site (16). One of the programs butting up against the freeway will need to be modified in order to strengthen the flow through the city.

From this point it becomes clear that the bus depot would be the most likely site of transgression of borders. There are multiple reasons for this. Firstly it is directly opposite the Amsterdam Battery. The Amsterdam Battery is the only break in built context, this makes it the most likely option for a pedestrian flow to occur from De Waterkant to the V & A Waterfront. There is a demolished section of the battery wall that is currently used as a ramp for cars to drive up and park on top of the battery. In plan this path aligns with a bridge that crosses the canal on the V & A Waterfront owned site. Hence the ramp accessing the battery, would be the best starting point for a pedestrian flow.

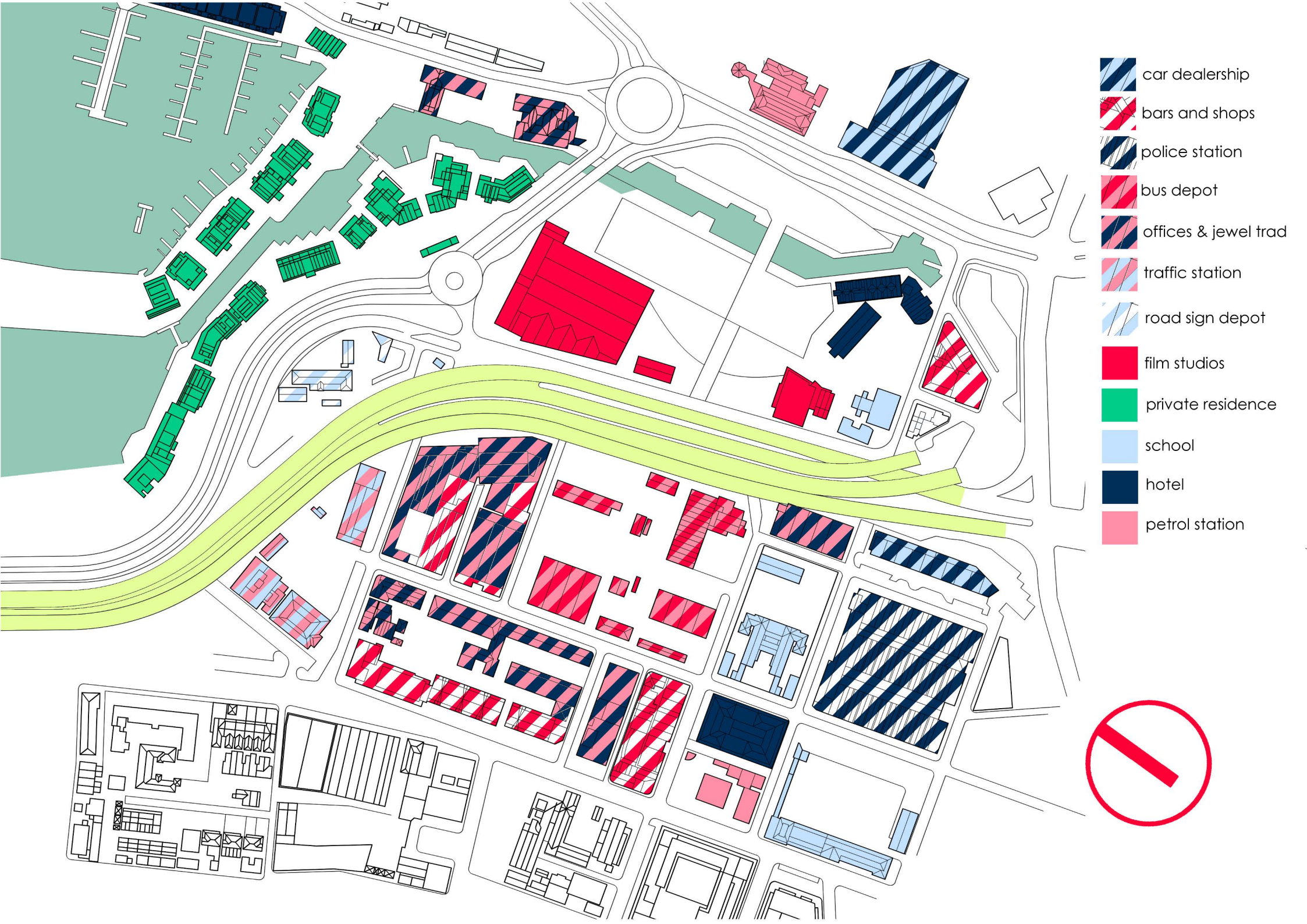
The building function map allows one to understand how the space can be 'porous' (17) as well as informing one of what possible functions would thrive on the site because of a continuity of program through the city.

This analysis also helps to illustrate the lack of relationship between building typologies across the Foreshore freeway. There are corresponding building typologies across the freeway but they have no urban relationship to one another.

This mapping was the starting point for another mapping exercise for the site with one question leading the exercise- how can the context link programmatically through the sub-freeway space through the understanding of flows?

16. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
17. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 13. Illustrating Site Topologies: 62. D. du Plessis. Edited CAD Drawing. 2015


car dealership
bars and shops
police station
bus depot
offices & jewel trad
traffic station
road sign depot
film studios
private residence
school
hotel
petrol station

PARAMETRIC LINK GENERATION

In an attempt to investigate potential energy flows across the site of this project an algorithm was written to link building typologies as they passed over the site. A clear system to articulate the flows was laid out which borrowed the concept from Frei Otto's wet wool experiment. In this experiment Frei Otto made a sort of spoked wheel where the rim acted as a frame and the spokes were loose hanging wet wool. When he shook the system the wool strands stuck together forming networks. (18) This algorithm sought to trace out the typological links of the buildings around the site as they relate to the freeway; that is to say that just as strands of wet wool stick together so these links should converge underneath the freeway. The technique worked as follows. First two buildings would be selected that relate in function. A line would be drawn from building 1, called the initiator line. This line would be parallel to the urban fabric and would stop where it intersects the freeway's centre line. The same process would be followed with building 2. The two intersection points would be used to determine a centre point on the freeway centre line. A border would then enclose urban fabrics such that they would exclude all the terrain to be regarded as a potential site. Where the initiator line intersects with this border a point would be formed. This point will be referred to as the initiator point. The lengths of both initiator lines are then added and divided by two. This length is used to select a section of the freeway centre line, called centre line section. This centre line section will have the same midpoint as the initial calculated midpoint. Straight lines then connect the ends of the centre line section with the initiator points.

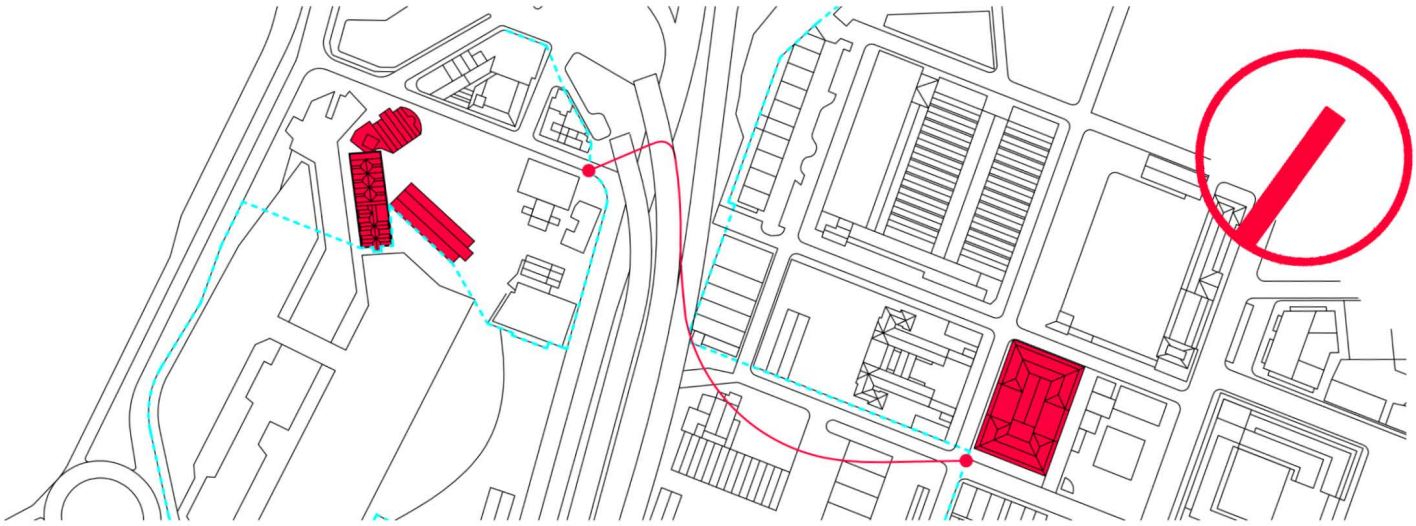
The resultant is that you have a line linking two buildings of related typology through the freeway. The section of line under the freeway is exactly half the length of the total distance between buildings. The two corners are then rounded off using the geometry of the freeway being the transition/ circular curve composite.

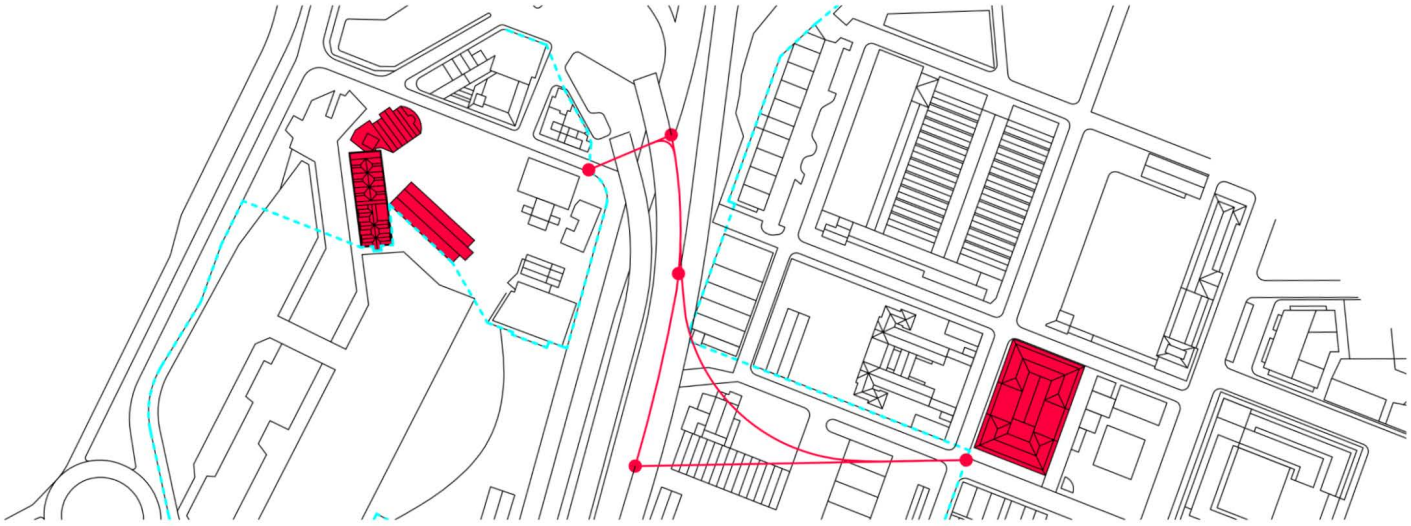
This analysis grapples with the central question of this project- how can two disconnected urban fabrics be reconnected using their geometry as well as the geometry of the severing freeway? This lends itself to being repeated in such a way that all programs can link through the site. The idea with this is that the project can be continuous through the surrounding context as each building chosen can relate to the site.

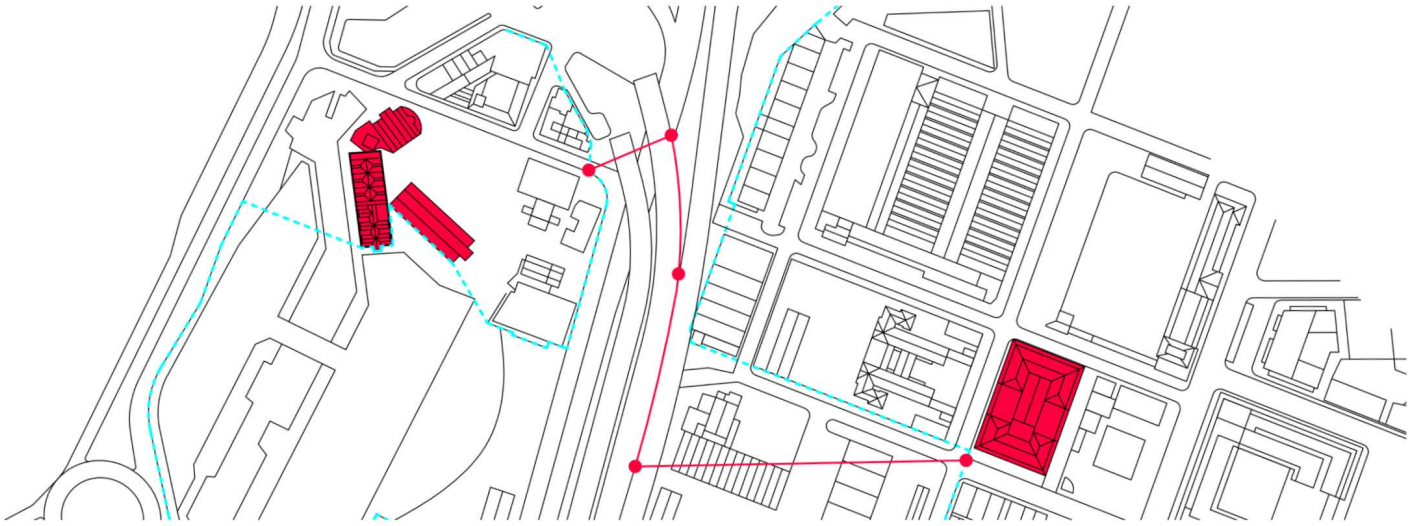
The next step is to see if this system can be used to make a 'grid'. This 'grid' can then be used to form a building that is literally composed of the flows in the city.

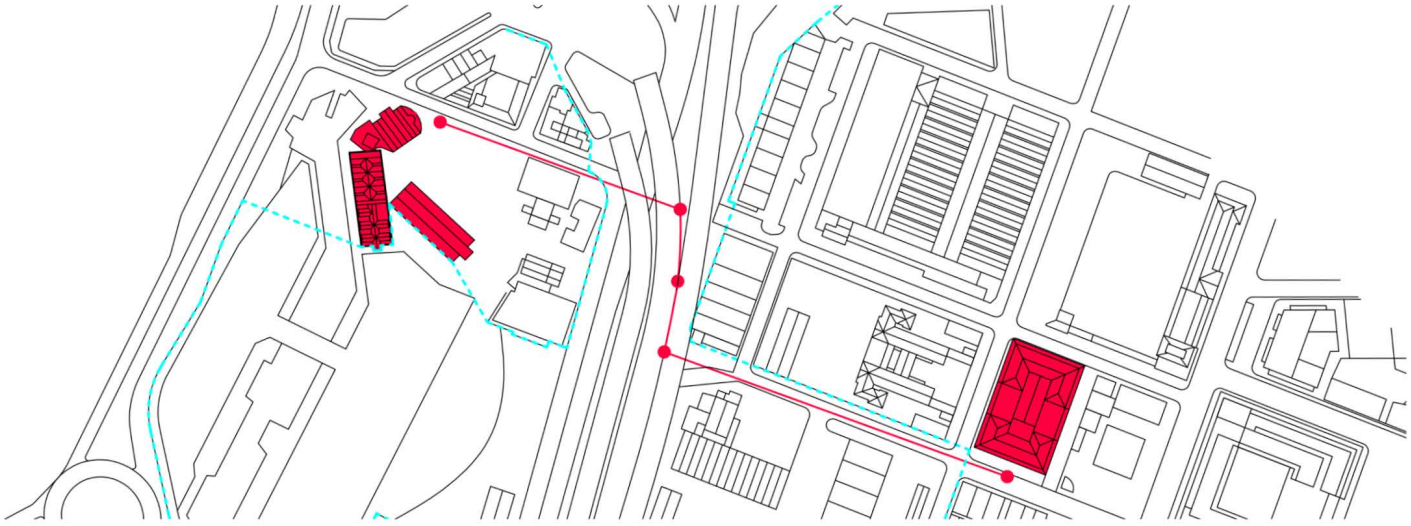
(18) K. Watkins. Frei Otto and the Importance of Experimentation in Architecture. [Online] Available from http://www.archdaily.com/610531/frei-otto-and-the-importance-of-experimentation-in-architecture/ [Accessed April 2015

FIGURE 14. Illustrating Typological Site Links: 63. D. du Plessis. Edited CAD Drawing with Grasshopper. 2015









PARAMETRIC GRID GENERATION

This freeform 'grid' would be a composite of the curves generated in 'Parametric Grid Generation' and would be a fabric used to link two existing, disconnected fabrics by constructing a new one comprised of their programmatic 'continuities' (19). The new grid would be constructed in the language of the freeway with transition and circular curves leading off straight lines. Hence the geometries of the site would be embedded in grid itself. This grid would in a sense be 'transparent' (20) as two unrelated geometries converge to create a new infill. Each building of similar typology is linked but not only is the process repeated with different buildings but different centre lines are used as the flows might best fit different parts of the sub-freeway terrain. The success of this process will be interrogated in corresponding design application.

The aim of the resultant freeform 'gird' was to establish an urban 'continuity' (21) through the membrane in the urban fabric. Being that the immediate context would result in a flow through the project it also aimed to be porous with all types of needs and people passing through the site potentially as they sought to communicate with the context around them. The aim of this grid was to highlight hidden urban flows in the existing fabric to form a fabric that would transgress the membrane of the freeway and bring the membrane into a dialogue with the existing urban fabric.

19. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

20. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

21. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 15. Illustrating Parametric Grid: 64. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015

CITY FLOW STUDY

After the various parametric analyses and the analyses of typological flows in the city, a study of perceivable pedestrian and vehicular flows is of interest. While this notion can be seen in the mapping the narrative became clearer and clearer as the project advanced. In understanding this narrative a study became the topic of focus. A closer look at pedestrian and vehicular flows in and around the site served as a study into how flows through the site might be encouraged on a broader scale.

Following the morning pedestrian movement, a pattern became clear. The mass pedestrian movement to the Victoria and Albert Waterfront originates at the train station in Adderly Street and then flows over the pedestrian bridge, which crosses Buitengracht Street incoming, (and formed part of the Soccer World Cup 'fan-walk' in 2010) then across Buitengracht Street outgoing, across Alfred Street along Walter Sisulu Avenue until the V and A Waterfront parking lot, opposite the Caltex Petrol Station, is reached after which pedestrians infiltrate the parking lot and filter off in two directions.

The first direction crosses the circle, a busy and somewhat hazardous terrain especially in rush-hour traffic. Thereafter pedestrians flow along one of two directions either along W Quay Road, towards V and A Waterfront retail, various offices, yacht basin, Waterfront housing or limited industrial access, or along S Arm Road towards V and A Waterfront retail, offices, a building site or extensive industrial section.

The second direction takes approximately 200% of the first direction. This direction takes the pedestrian, either to a private housing complex at the canal's edge or ,and this route is of particular interest in terms of the type of terrain pedestrians favour, it takes the pedestrians on a tighter, quieter route to the same destination as mentioned in the first circle crossing. The benefit of this route is that pedestrians are able to transgress the border created by the busy circle by going down and under s bridge. This DATA came as a surprise because the route is somewhat obscure and not transparent at first glance (hence posing the risk of becoming dangerous). This DATA then quite clearly highlighted the benefits of sub-circle crossing.

The critique of the path is that it is not marked, is somewhat obscure, it is not transparent and is claustrophobic in terms of width and height it is also somewhat dark. It is a charming path with character that will, no doubt, be a welcome experience to anyone familiar with the area. However in terms of creating international and local tourist flows it cannot be understood as a successful route. In conjunction with the untraversable de Waterkant-to-Waterfront site; the favouring of internal parking garage over the Walter Sisulu Avenue parking lot and the inefficient CBD-to-waterfront route; the obscure path means that non-work-related pedestrian travel between the V and A Waterfront and the rest of the city is seriously limited.

The next point of pedestrian flow study is on the Buitengracht pedestrian bridge. The aim of the study was to ascertain the rate of in and out flow of the pedestrians to and from the V and A Waterfront. This would help to understand the role of the pedestrian bridge in supporting pedestrian flow of the V and A Waterfront as a way to understand the wider context of flow.

FIGURE 16. Illustrating Pedestrian Flows into The Waterfront: 65. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015

FIGURE 17. Illustrating Pedestrian Flows out of The Waterfront: 66. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015

FIGURE 18. Illustrating Vehicular Flows: 67. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015

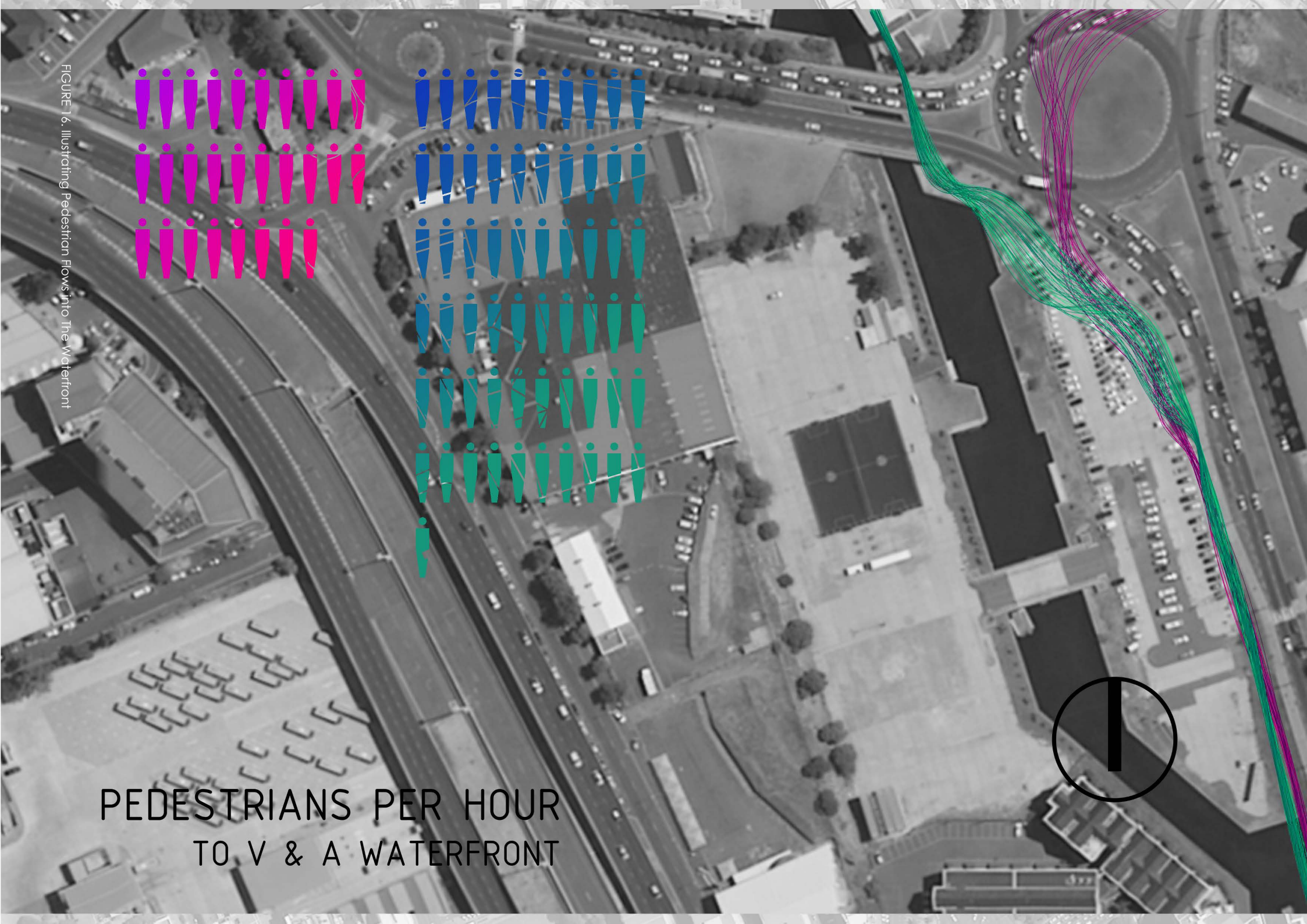


FIGURE 16. Illustrating Pedestrian Flows into The Waterfront

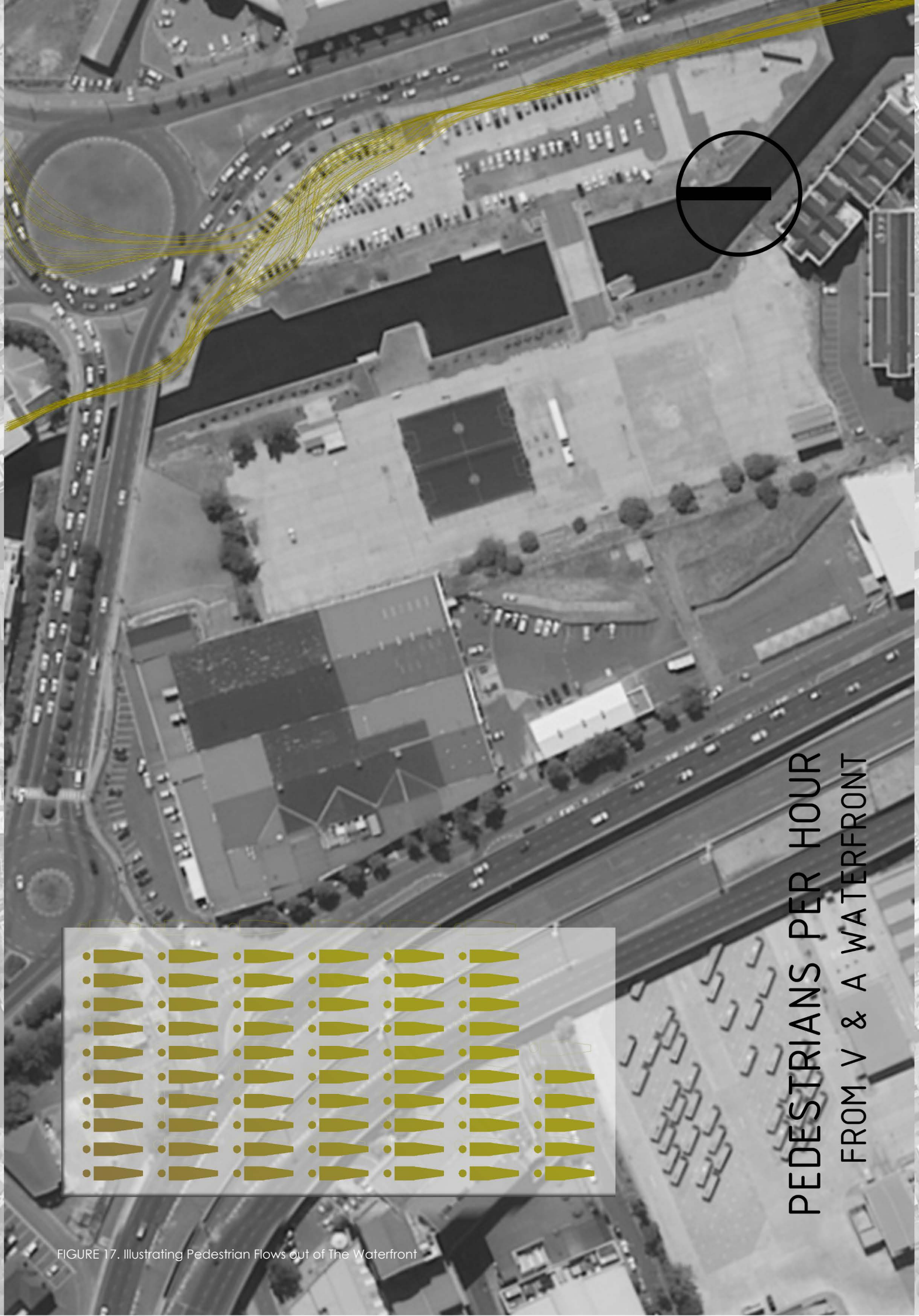


FIGURE 17. Illustrating Pedestrian Flows out of The Waterfront

FIGURE 18. Illustrating Vehicular Flows

The findings show that there is a steady flow of traffic on it at various times of day and it is the main feeder of pedestrian traffic past the area of interest to this project.

Another point of flow that formed part of this study is the vehicular flow from the aforementioned parking lot on Walter Sisulu Avenue. The interest in that is that it is quite an extensive parking lot however it is on a site that could be utilized in a more imaginative way that would benefit the city in terms of improving the pedestrian experience of it. This will be because of two reasons firstly canal-side property is valuable in terms of ambience and this particular site is en-route of the De Waterkant- Waterfront link and could be put to use as meaningful public space or retail space instead of parking space.

Another reason for studying the vehicular flow is to try and understand the potential benefits of transplanting the parking space. If the parking space were to be transplanted and the link to the V and A Waterfront were to be pronounced then the flow from the parking could be boosted by the subsequent vehicle to Waterfront pedestrian flow.

From the study it was ascertained that there is a strong pedestrian flow from the parking space to the V & A Waterfront with only two people parking there and walking towards the CBD. The parking lot peaks at 09:00 in the morning where it is full, thereafter the movement in and out of the site is minimal. Thus transplanting such a parking lot will mean a small rise in vehicular traffic in the morning and afternoon but will not mean excessive traffic from resultant vehicular displacement throughout the day. It will however cause pedestrian flows through the new site from early in the morning.

The second area of vehicular flow investigation is at Ebenezer, Bennett and Port Streets. This study allows one to observe the flow between De Waterkant and the V and A waterfront. Thus it shows the potential link that could exist for pedestrians across the site. It also allows one to understand how busy the site is in terms of traffic.

The study revealed that there are low levels of traffic in Bennett Street and Port Road but much higher levels in Ebenezer Road. From this DATA is the understanding that the flow past the site of this project is very healthy but that there is very low activity in the area. So opening the link across the site of this project will bring much activity to the area.

The study of the flows in the city then highlighted a way that flows can be used to bring the urban fabric into dialogue with the freeway. The desired path starts in Somerset Road and flows down Napier Street. Napier Street is the only street that a vehicle can take that will directly link to the site, it is also the most pedestrian active street flanked by restaurants and a hotel. This flow then continues under the freeway and through the demolished section of the Amsterdam Battery and over the pedestrian bridge leading over the canal. This route is then warped by the strong pedestrian flow and continues to the circle where the pedestrian flow is reinforced by the circle having a sunken, continuous pedestrian component. This analysis forms the base for the final design. Because these flows will bring in people from all over it will help to make a 'porous' (22) site. It is an embodiment of a continuity through the city (23). As this flow interacts with the smaller scale specifics of the site it helps to create a transparent site understood as something localized and deriving from a larger context (24)

22. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

23. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

24. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

FIGURE 19. Illustrating Desired Pedestrian Flows: 68. D. du Plessis. Edited Image from National Geo-Spatial Planning-Cape Town. 3318CD_2014. 2015

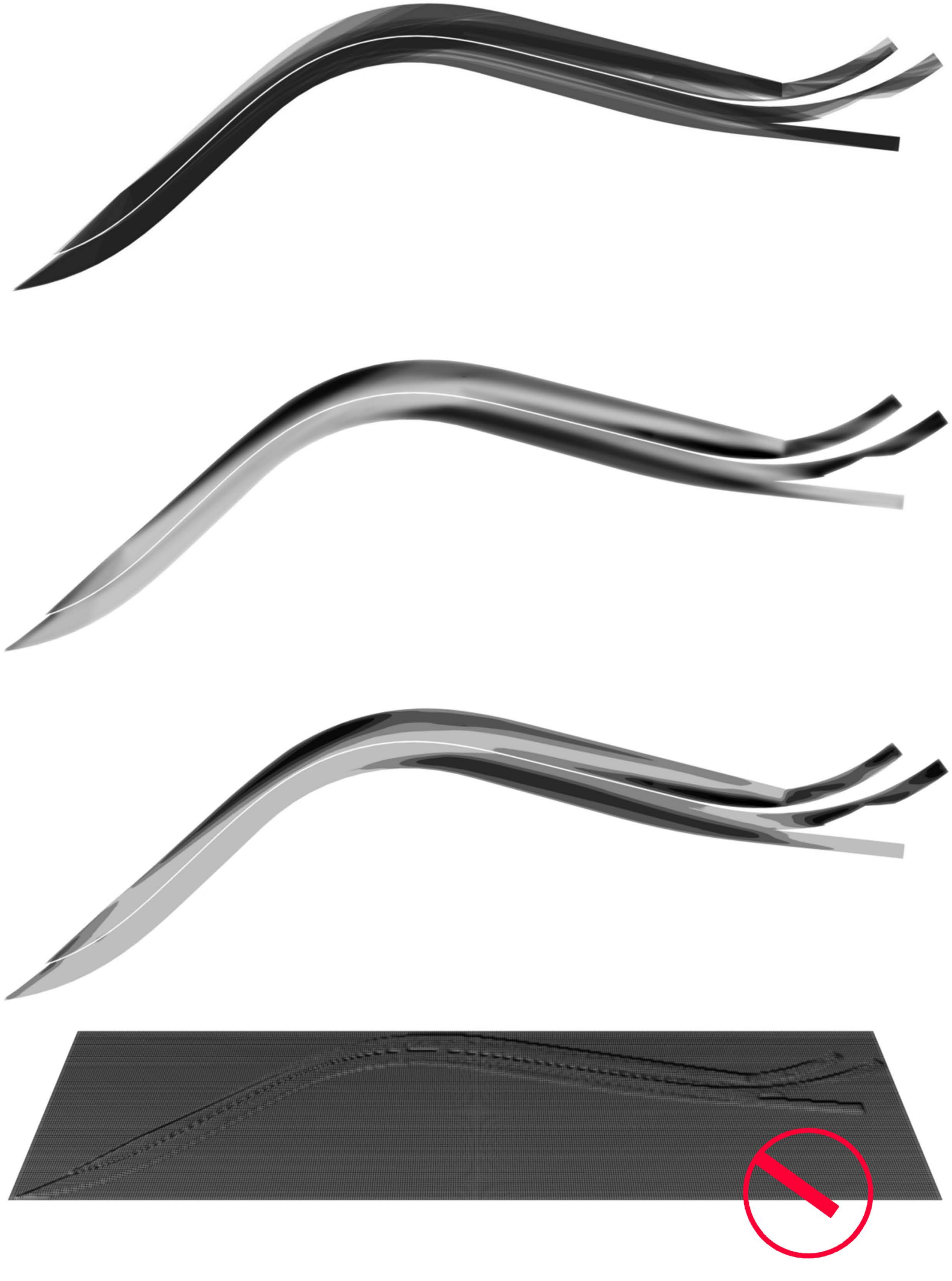

GREENPOINT SUB-FREEWAY CIRCLE
NEW SUB-ROAD CIRCLE
SITE FOR FURTHER DEVELOPMENT
SITE OF FOCUS
NEW PEDESTRIAN FLOW
TO AND FROM V & A WATERFRONT

LIGHT STUDY

A zoom in to the specifics of the site is needed to understand the smaller scale. A process of studying the light under the bridge can be a helpful tool to understand functional dispersion across the site as would apply to the architecture to be proposed to this project. To form this graphic 36 shadows were overlaid and then cropped off by the outline of the freeway above. The shadows were taken at three times in the day for each month. These images were then overlaid with opacity of each layer adjusted so that light and dark zones would be formed. These layers were then blurred to form light and dark zones and colours inverted such that the light zones would be the positive colouring. This was then put through a process called posterisation. This process enabled the formation of distinct light and dark zones.

In the mapping of the light and dark zones the edges of the posterised light and dark zones were then contoured and a surface applied to it. The idea with this is that the sub freeway terrain might be constructed according to the luminosity levels. After the exercise was completed this decision was abandoned owing to the fact nothing was gained for the site except an awareness of light levels across the site, which is not useful. The mapping of light levels is useful in a project like this however, and that is retained to understand how differing part of a building should be placed. A theatre, for example, favours a site of low light as it needs to be dark for the artificial lighting to be effective (that is to say a theatre need not be situated in a dark place but if doing so would allow the light to reach other places, this would be best practice).

FIGURE 20. Illustrating Light Beneath the Flyover: 69. D. du Plessis. Personal Modeling and Graphics. 2015



HEIGHT ANALYSIS

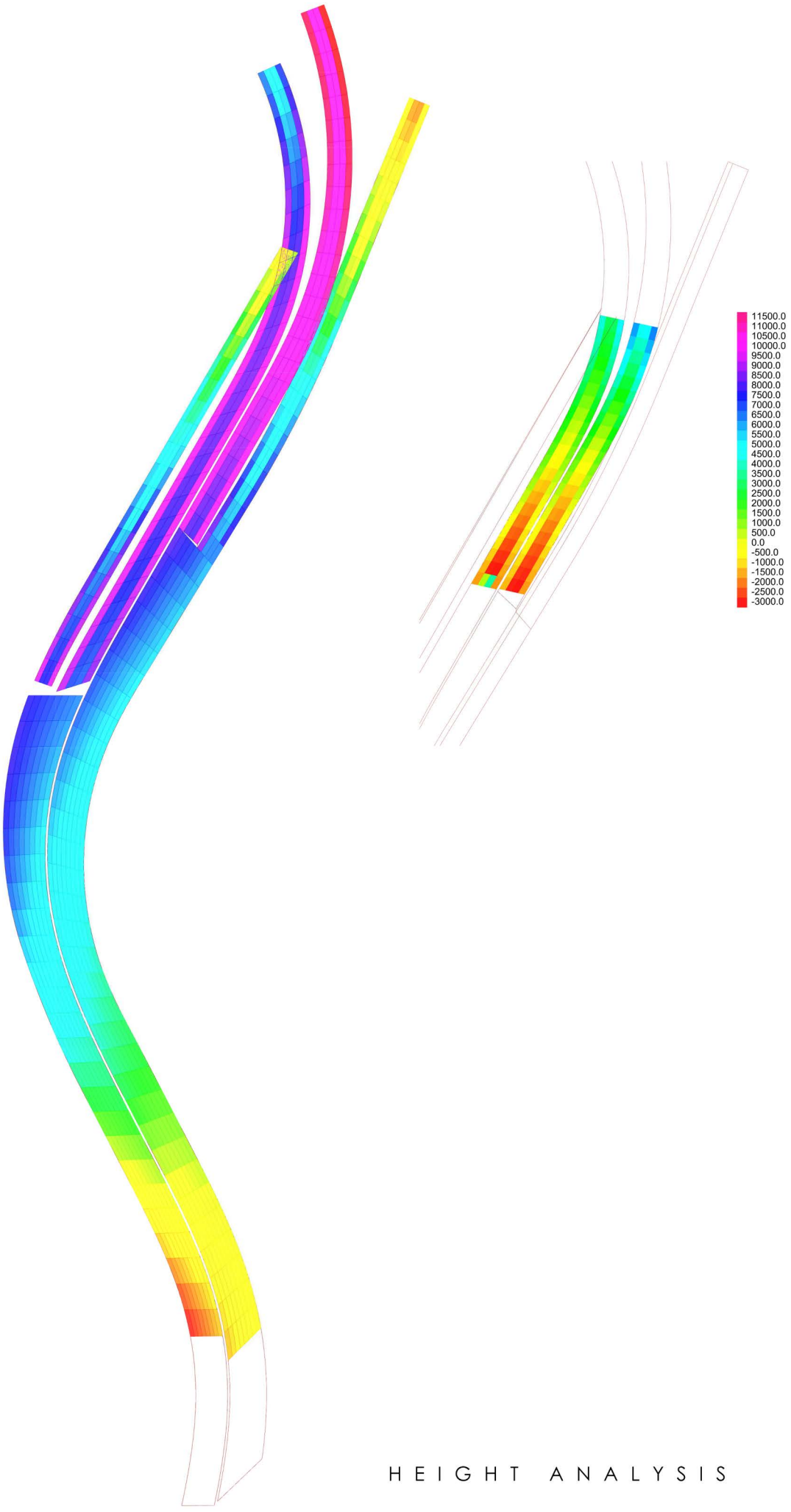
A height analysis also became important because of the complex way that the highway changes height owing to its complex geometry. A colour gradient map became useful to be able to understand the limitations of the site. The technique used was to divide the surface under the bridge up into portions. A line would drop vertically from the midpoint of each portion. The line would then intersect the ground surface allowing the height of each point above ground surface to be attained. These heights would then be matched to a colour and each portion would get a colour corresponding to the height of its midpoint above ground surface. The second important analysis became between the freeway sections going up and those going down. If this height became significant enough it presented a possibility for an installation with a view across to the V and A Waterfront and to signal hill.

Another reason that this analysis became especially important is that the theatre would be beneath the freeway and should be able to express the freeway in the design. This project is about flows, the freeway embodies the notion of flow. The rise-gradient, curvature and camber of the road are specifically calculated according to how a vehicle will flow the safest and most efficiently through space according to network requirements. This project embodies pedestrian flow but it also uses flow symbolically in the expression of the various parts. A dramatic space such as a theatre will benefit greatly from the expression of such a dynamic design and make the visitor aware of immense forces and drama around him or her.

A further logic that this would be the best option is that one of the contemporary concerns about architecture that is parametrically conceived tends to become an a-contextual study of form rather than something grown from the context that reinforces its surroundings and inserts itself as a positive piece of design that helps people and respects its context. Responding so directly to a piece of the context is a way to express belonging and to question how an architecture of flow conceived parametrically might establish itself as contextually appropriate. The next question to be dealt with is how this building might respond to the architectural context.

Also with a limited height it becomes crucial to have a good understanding of the heights of the limiting structure so that the design can reach its full potential.

FIGURE 21. Illustrating The Height of the Flyover: 70. D. du Plessis. Personal Modeling and Graphics. 2015



HEIGHT ANALYSIS

Design Strategies

It is crucial to understand that the designs put forward are located either partially or completely under the freeway.

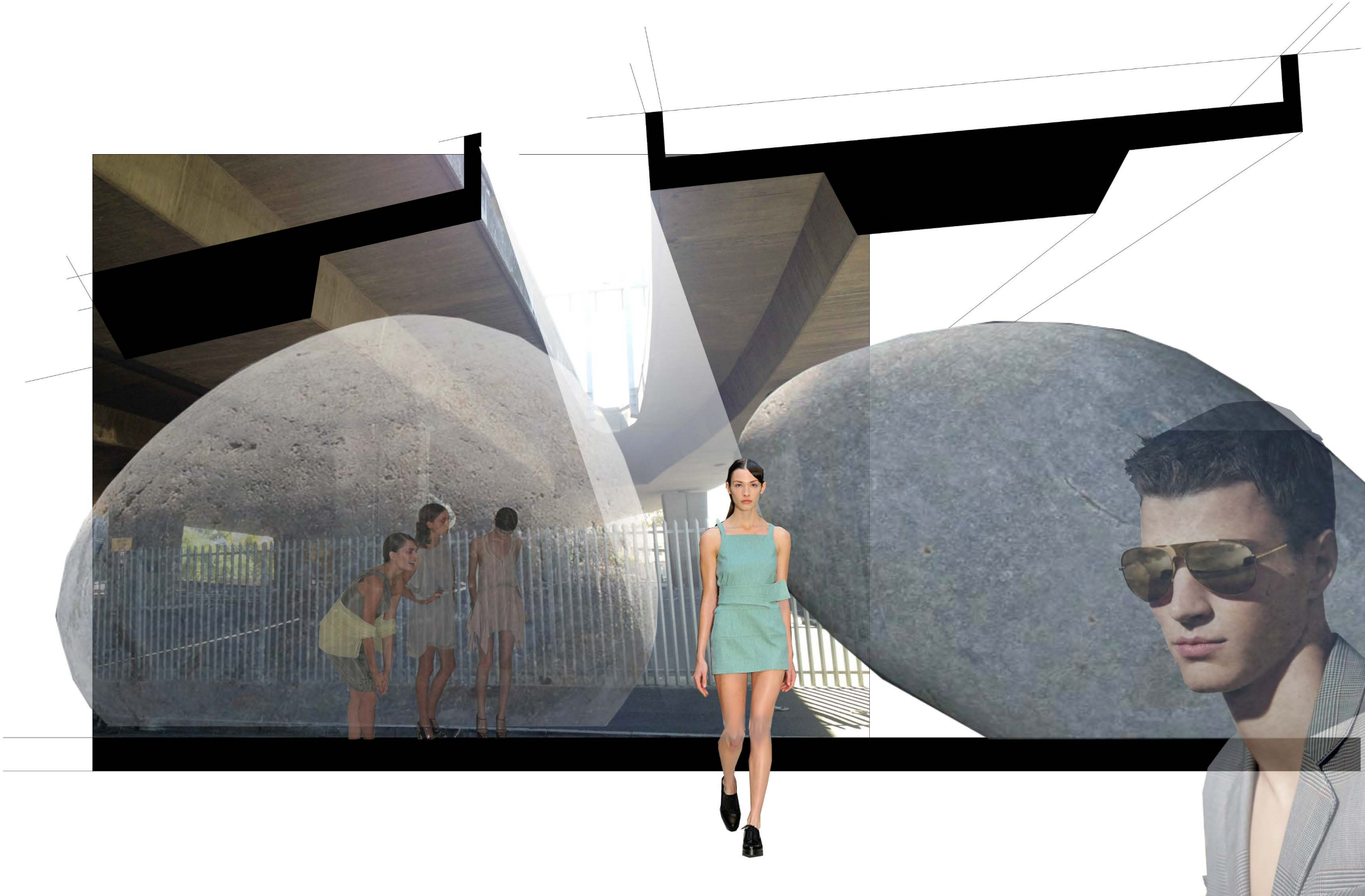
Now that the site exploration has been covered the various design moves can be explained although it should be stated that the design process ran concurrently to the mapping process and as such certain parts of the mapping process will be noticeable in the corresponding designs. To understand what the overall character of the building would be, this image illustrates out-of-scale beach pebbles under the fly-over. In what ways should the building be like beach pebbles under the freeway? Beach pebbles are created by flows and dynamic forces. This would be the concept that should shape this building.

Another way that the building installations should be like pebbles is that they are discrete masses that could have a bearing on the form of each other. The buildings inserted under the flyover should be pods that allow the flyover to sail past while another subsystem can exist on the lower ground level.

The last way that the buildings should be like pebbles is that they are refined forms with a rough texture. This is in keeping with the building technology of the context being medium to high quality red brickwork with some very considered facades.

This approach will allow for buildings that visually interact with the existing structure but disturb it as little as possible and thus will allow the flyover to interact with the buildings instead of being blocked by them. This will allow the user to appreciate the utilitarian design of the highway from a new perspective while understanding its use in relation to the site's use as well as to be able to associate the formal decisions of the project with the architectural and engineered contexts.

FIGURE 22. Illustrating The Character of the Site: 71. D. du Plessis. Personal Collage. 2015

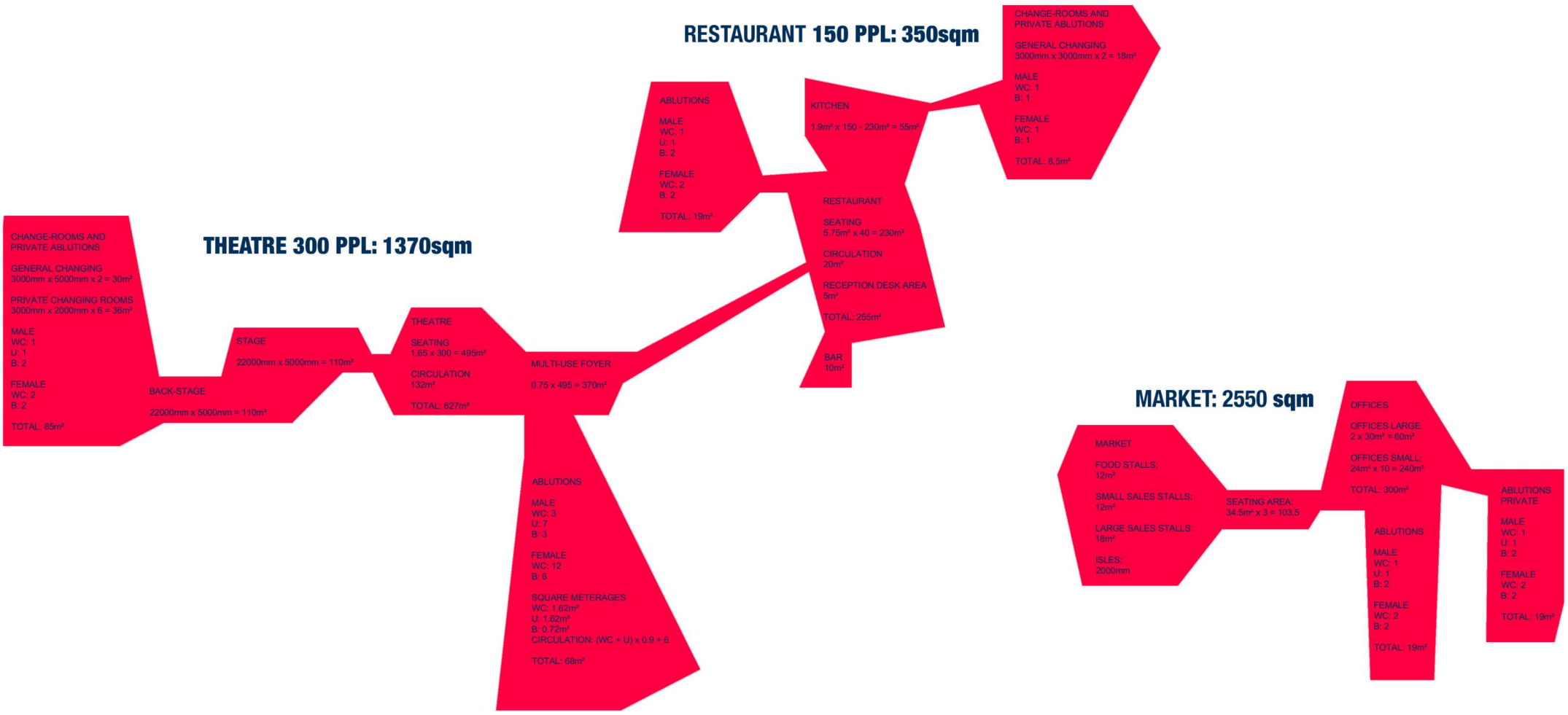


The next investigation was to understand program, relationships in program and overall sizing of various elements of the built component of the project. This is a simple bubble diagram which helps to start the planning with a reasonable idea of the design. The result is a small theatre to serve the theatre school and other small productions that may happen in Cape Town. A market in the project can be a successful addition to the scheme as markets have great success in Cape Town and can be used as a tool to bring pedestrian traffic and interest to a site. Lastly a restaurant; this would be an interesting addition as all the excitement of the site- the theatre, the market, the flow from one node of the city to another, the dramatic under-flyover site and the potential views makes a sort of theatre in itself and could be viewed from a restaurant.

This space speaks conceptually to the idea of 'porous' (25) space; into which varying functions flow and people on differing schedules and rates of flow interact. This then places the route, as the main circulation that would also connect two parts of the city, as the central part of the project, being of central importance.

25. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 23. Illustrating The Areas of the Project: 72. D. du Plessis. Personal Graphic. 2015


RESTAURANT 150 PPL: 350sqm
CHANGE-ROOMS AND PRIVATE ABLUTIONS
GENERAL CHANGING
3000mm x 3000mm x 2 = 18m²
MALE
WC: 1
B: 1
FEMALE
WC: 1
B: 1
TOTAL: 8,5m²
KITCHEN
1.9m² x 150 - 230m² = 55m²
ABLUTIONS
MALE
WC: 1
U: 1
B: 2
FEMALE
WC: 2
B: 2
TOTAL: 19m²
RESTAURANT
SEATING
5.75m² x 40 = 230m²
CIRCULATION
20m²
RECEPTION DESK AREA
5m²
TOTAL: 255m²
BAR
10m²
THEATRE 300 PPL: 1370sqm
CHANGE-ROOMS AND PRIVATE ABLUTIONS
GENERAL CHANGING
3000mm x 5000mm x 2 = 30m²
PRIVATE CHANGING ROOMS
3000mm x 2000mm x 6 = 36m²
MALE
WC: 1
U: 1
B: 2
FEMALE
WC: 2
B: 2
TOTAL: 85m²
BACK-STAGE
22000mm x 5000mm = 110m²
STAGE
22000mm x 5000mm = 110m²
THEATRE
SEATING
1.65 x 300 = 495m²
CIRCULATION
132m²
TOTAL: 627m²
MULTI-USE FOYER
0.75 x 495 = 370m²
ABLUTIONS
MALE
WC: 3
U: 7
B: 3
FEMALE
WC: 12
B: 6
SQUARE METERAGES
WC: 1.62m²
U: 1.62m²
B: 0.72m²
CIRCULATION: (WC + U) x 0.9 + 6
TOTAL: 68m²
MARKET: 2550 sqm
MARKET
FOOD STALLS:
12m²
SMALL SALES STALLS:
12m²
LARGE SALES STALLS:
18m²
ISLES:
2000mm
SEATING AREA:
34.5m² x 3 = 103.5
OFFICES
OFFICES LARGE:
2 x 30m² = 60m²
OFFICES SMALL:
24m² x 10 = 240m²
TOTAL: 300m²
ABLUTIONS
MALE
WC: 1
U: 1
B: 2
FEMALE
WC: 2
B: 2
TOTAL: 19m²
ABLUTIONS PRIVATE
MALE
WC: 1
U: 1
B: 2
FEMALE
WC: 2
B: 2
TOTAL: 19m²

Iteration 1

The first iteration of the project started with an orthogonal plan used to understand relationships between elements rather than really grapple with ideas of geometries and flows. The plan is to be understood as positioned underneath the flyover. To start, the project seeks to mix permanent retail space with market space. This can be done so that at times when the market is not busy the shops will keep the space alive and functioning. This combination is used as the backbone of the project with circulation flowing past it. The armature starts by leading a desire flow, which currently passes from Beluga Restaurant complex into a cut off parking space, into the main circulation route of the proposed project. In doing this the project opens up a latent flow, cut off by the hostile terrain of the current sub-flyover site and releases it to the rest of the city. In doing this the project uses its context to create a 'porous' (26) space of interaction. Not only does it use the context to strengthen it but also strengthens the context by means of its circulation.

The main circulation route leads off to two theatres; one being a small production theatre and the other a movie theatre. Both theatres use the circulation route as the foyer. This encourages a 'porous' (27) space activated by people. It also encourages people to explore new activities of the site. These theatres help to create a 'continuity' (28) across the context. Because it speaks to the theatre school across the road and in some way to the screen production company as well as being part of the general arts category of city activities thus communicating with the new Zeitz MOCAA Gallery to open soon as well as the various art galleries on a followable route through the city.

The restaurant flows off the space of the production theatre and goes up a level, in this way capitalizing on views across the city. It enables other functions to be connected to the main ground level space. It also takes advantage of an opening between highways that allows for views making for a unique experience of the city as one would be able to freeze in a space that would otherwise be out of reach.

Another function is attached to the scheme to enable expansion of the Waterfront film studios and thus create stronger links and flows through the city. This function is a studio for green screen filming space with attached post-production room and sound room. This allows for continuity of function even across a road, helping to break down boundaries as much as possible.

26. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

27. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

28. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 24. Illustrating The First Plan: 73. D. du Plessis. Personal Plan. 2015

FIGURE 25. Illustrating The First Plan Mezzanine Level: 74. D. du Plessis. Personal Plan. 2015

PLAN GROUND

SCALE 1:4000

1. SMALL RESTAURANT
2. CINEMA
3. SHOP
4. MARKET SPACE
5. MARKET CIRCULATION ARMATURE
6. THEATRE
7. RECEPTION
8. GREEN ROOM

FIGURE 24. Illustrating The First Plan

FIGURE 25. Illustrating The First Plan Mezzanine Level

PLAN FIRST FLOOR

SCALE 1:4000

1. KITCHEN
2. RESTAURANT
3. GALLERY

Iteration 2

This iteration grapples with the ideas of flows of the context and begins to express itself that way. The over-sailing flyover is about constant flows, a motorist cannot stop in the middle for danger of causing a collision and he or she cannot change direction and move perpendicular to the direction of flow. It is a system solely about efficiency of flow and anything that threatens it poses a real risk to itself and to the system. When it comes to pedestrian flow another set of rules must be followed because we as humans cannot be organized as machines would be. Hence in the urban fabric below one is allowed to move as one pleases (within limits of course, dictated by edges, paths and public and private space and such-like parameters). This project seeks to find a combination of the two flows- pedestrian and vehicular notionally. Therefore the main circulation route is a direct link between parts of the city but also offers 'eddies' (29), portions of the built environment that allows for pause and direction change in the midst of the flow. To this end the main reception area is central to the space, organising traffic flow and creating places of slower movement and pause.

The second iteration of the plan started to make use of flows and parametric networks to create the form (see Parametric Grid Generation). The informant of this plan is the diagram used to link functions around the site which connect under the highway as discussed earlier. This grid was used to create circulation paths off which the functions would feed.

This resulted in a dissolving of the main circulation route into other smaller routes that would lead through the building. Firstly the armature used to direct flow from the Beluga Restaurant Shopping Complex became a series of shops to communicate with the shopping complex with a release into a parking space behind.

Continuing inward to the centre of the project a link emerges between the current site of the bus depot to the film studio. The bus depot is transformed into urban green space with routes flowing through to the built component of the project. This space is edged by shops with a ramp leading underground for bus parking.

One of the routes of the green space leads through the market component of the project. This route curves out to be joined by Napier Street. Along the way it is possible to change direction to join another flow path and explore another route or a different part of the market. Within the market space attention is paid to create a communal 'eddy' (30), a sub-space wherein people can gather and market stalls can front onto. This space is in the zone where the freeway starts to open up vertically. This means that this space will be volumous and light (as understood from the light study).

29. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
30. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

The main axis now passes the market space in a lighter zone and the main theatre falls into the dark zone. The theatre is backed by the green screen room and both back-of-house functions are sandwiched in the middle. When the Take 2 Studio staff use the green screen room they will pass by the theatre. This causes the space to be 'porous' (31). This porosity will lead to possible exposure of local theatre actors getting international attention because of the clash of spaces used by Take 2 Studio tenants and theatre actors. This iteration of the theatre catches onto the flow emanating from the Waterfront Film Studios. This is a much quieter flow and allows the theatre space to be quieter. The foyer and reception area latch onto the flow into the main space; offering a 'continuity' (32) and a measure of 'porosity' (33).

Towards the South East Corner the market becomes a private space for offices. This then puts the building in communication with many of the buildings in the context but also provides a functional space for the management of the various facilities. This is the best place for the private facilities as the context has the back of house facing this part of the site (opposite the street).

On the Southern side of the project is the theatre counterpoint the movie theatre which is beside the art gallery. What these insertions do is to enable the creation of a central space between the various components of the project. This space is porous and takes the activity of all spaces simultaneously. It also forms an 'eddy' (34) space, a meeting point, a space of collective activity before going on to another part of the city.

A new program is introduced to communicate with the Zietz MOCAA Gallery as a counterpoint that might draw interest through the city. It is not fully developed but fronts the main green space with provision made for light to enter (although it will need to be processed by means of screens and diffusers). It is on the lighter half of the freeway and will allow pedestrians to peer inside.

The critique of this iteration is that the continuities are unclear, the paths created area trace of abstract flows rather than actual human flows. Another critique is that the project is so geometry-focused it makes for awkward planning with spaces that do not fully work. The rezoning to create green space supplants industry of the context to add the same type of functions seen in the context and at the V and A waterfront and the project would benefit from incorporating the industry.
.
Another problem is that the project reaches over and blocks Port Road. This was an attempt to create public space that bridges the gap between the installation and the opposite site, leading people freely up to the museum piece. However cutting off one of the more prominent feeders of the site in a project about flows makes little to no sense. Also so much green space is not appropriate in this location, green space would be much better suited around the canal. This space needs to be denser with for industrial and entertainment related programs.

At this point it becomes clear that the project will have to be broader than simply under the bridge and that as it does this it will have to find a way in incorporate both the addition of art and retail oriented program but also industrial, utilitarian program. Also greater attention needs to be paid to not creating blank frontage rather intriguing frontage that draws people in.

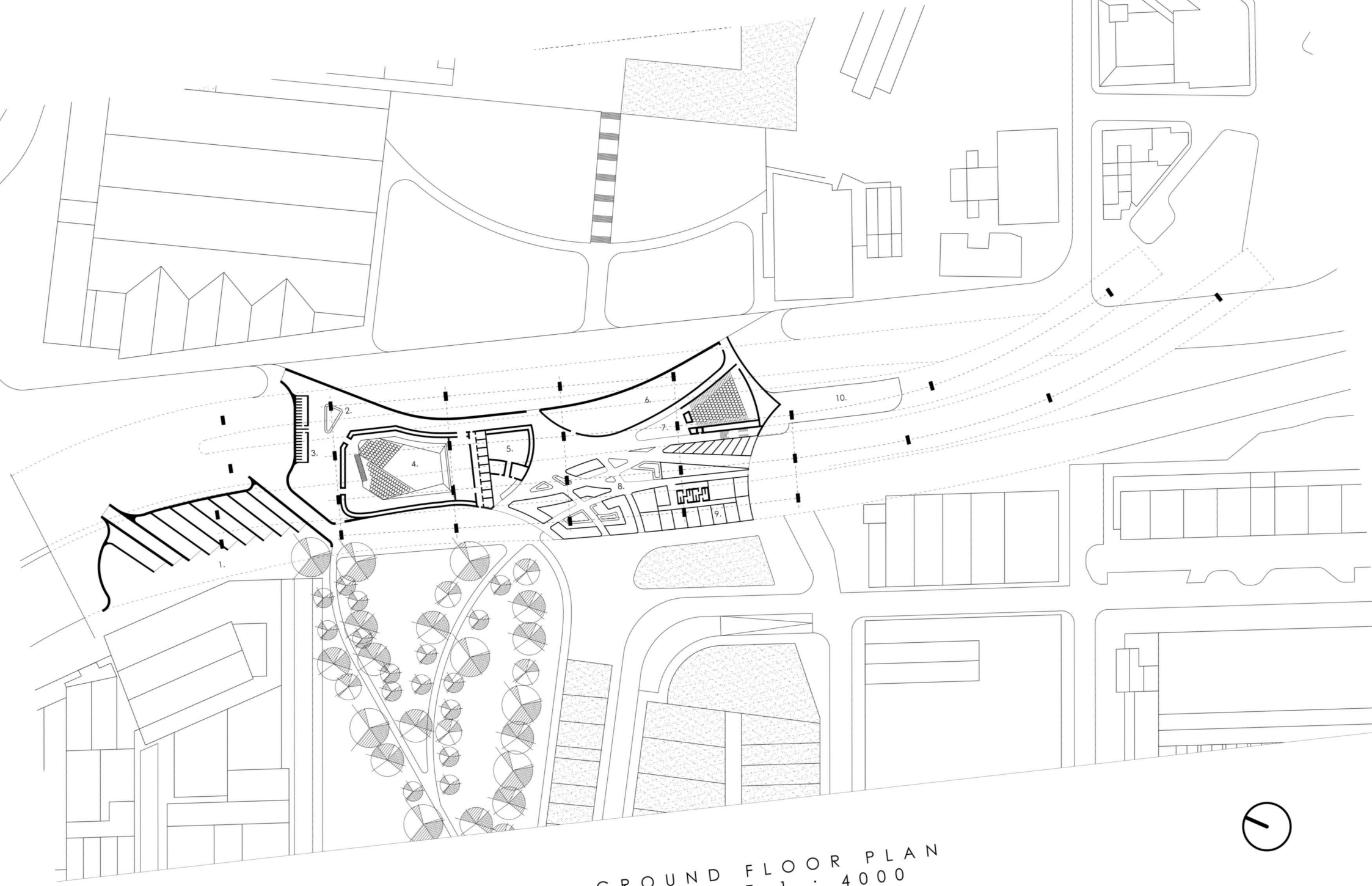
31. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

32. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

33. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

34. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 26. Illustrating The Second Plan: 75. D. du Plessis. Personal Plan. 2015



GROUND FLOOR PLAN
SCALE 1 : 4000

1. Bars and Cafes
2. Theatre Reception
3. Theatre Bathrooms
4. Theatre
5. Green Screen Room with Makeup and Sound Room
6. Gallery Space

Iteration 3

The third iteration is an initial look at a new scheme. This scheme imagines the project as a flow from Napier Street to the Walter Sisulu Circle. It is joined by flows from Hospital Street and from the Beluga Restaurant Shopping Complex. It flows through the demolished path central to the Amsterdam Battery, over the canal and under the circle, along the way being joined by various functions.

Incorporated in this scheme is the bus depot which edges a path that is a flow from Napier Street to the centre of the project. Opposite the bus depot, still on the route, is the market, hence the entire market becomes the 'eddy' (35). Thus the flow-space becomes the 'porous' (36) component, a cauldron of mixed activity.

The shopping space corners the market space and the theatre space. It is shaped in such a way so as to create pools along the flow where people can meet, a relief from the intensity of the flow, places of potential pause for functions such as restaurants.

Towards the Waterfront Film Studio's are two theatre spaces these spaces are separated by two film studios. The foyer spaces are separate.

This iteration is a brief grappling with a final scheme, hence it is not very successful but starts the process on the last iteration. The various critiques of the project are that the geometries do not speak to the nature of the flyover and that the spaces do not flow properly yet, they are still too rigid. Another concern is the lack of edge on the site perimeter. Also the separateness of the gallery spaces is a cause for concern.

35. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
36. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

FIGURE 27. Illustrating The Second Plan: 76. D. du Plessis. Personal Plan. 2015

SITE PLAN

SCALE 1:8000

1. COMMERCIAL SPACE WITH ROUTE THROUGH
2. OFFICE SPACE
3. OFFICE SPACE
4. RETAIL SPACE WITH ART GALLERY
5. MARKET SPACE
6. BUSSES DEPOT RESTRUCTURED
7. THEATRES AND FILM PRODUCTION SPACE

Iteration 4

In this final iteration the flow and play between geometries is designed parametrically. The route from Napier street is gradually warped, using the geometries of highway construction, to lock onto the path through the centre of the Amsterdam battery. So the flows from the existing urban fabric are linked from De Waterkant to the desire lines of the Amsterdam Battery which will continue on into the V & A Waterfront using the language of the Freeway Flyover.

The geometries start as a fine grain 'continuous' (37), iterational geometry; gradually these geometries transform into the flow of the freeway. They start with pods smaller than the size of the existing restaurant-based fabric sizing and end in a building of size that speaks to the larger buildings in the context such as the film studios. These are built on a ramp that starts on the street corner leading people from Napier Street into the complex. Where the ramp crosses under the freeway it widens to make for porous (38) space, easy to see through and easy for people to gather in at the entrances of buildings. The buildings connecting to that sub-freeway space, sweep down to a human scale in height. This is to assure the human experience continues beneath the freeway ensuring flow and transforming a harsh environment into a livable one.

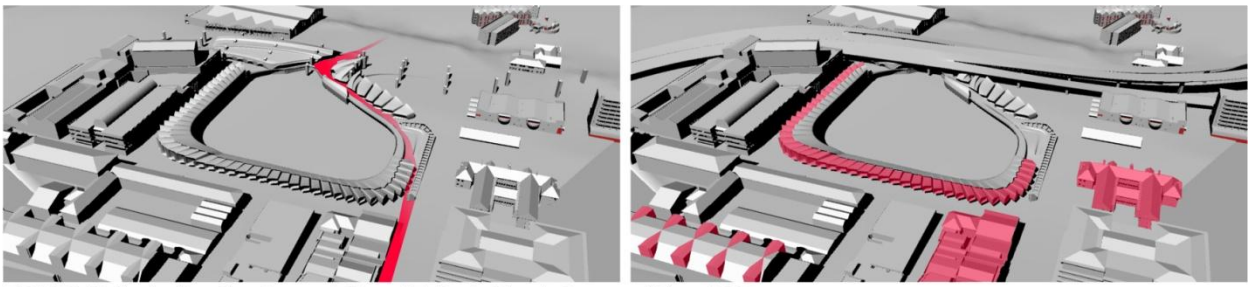


FIGURE 28.Illustrating The Second Plan: 77. D. du Plessis. Personal Plan. 2015

37. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

38. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

39. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

At the beginning of the path, starting at Prestwich Street, is the market. It thus starts leading off a vibrant street space and continues to a gathering space on the corner of Prestwich and Napier this gathering space then begins to flow towards the V and A Waterfront. An 'eddy' (39) in the form of gathering space for the market is created along the way. The market also acts as a filter for anyone wanting the join the flow through from Further down Napier Street. The length of the market flow is calculated such that the ramp gradient is 2% meaning that visitors can flow along the ramp and still stop to buy from market stalls.

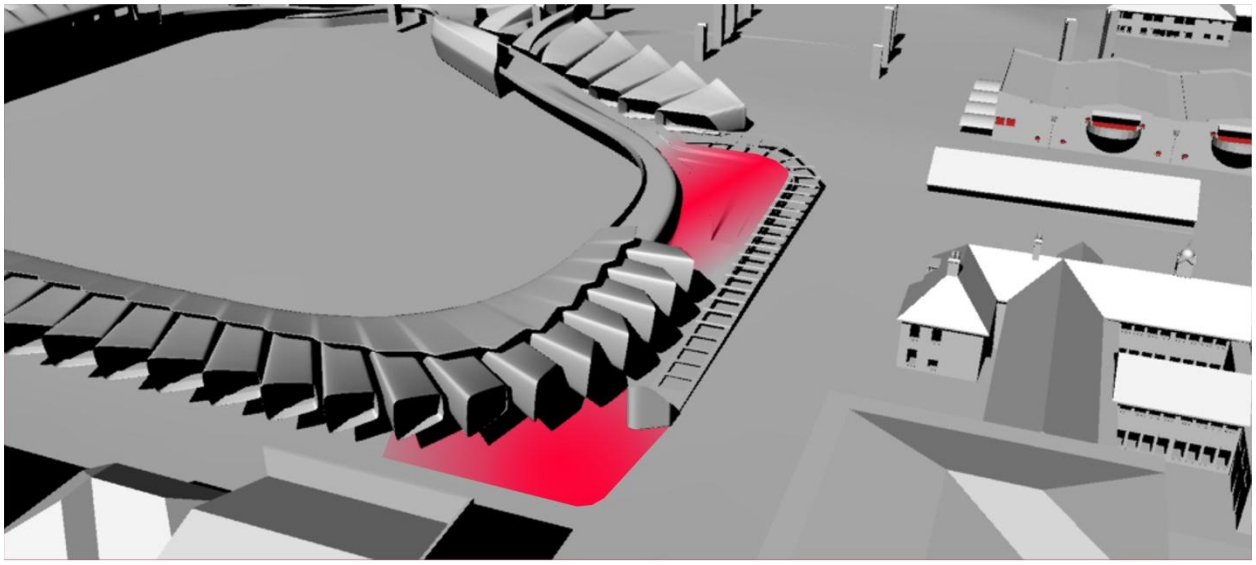


FIGURE 29. Illustrating The Eddies: 78. D. du Plessis. Personal Model. 2015

The shops seamlessly flow from the market space to continue to the edge of the site. All the shops seem to be in motion as if part of the flow of the site. Hence they communicate with the geometries of the flyover. They are iterations of each other which further ads to the flow of the scheme and the concept that they are part of the flyover geometry.

On the Prestwich, Napier and Bennett Street edges are office/ gallery spaces with exhibition/ reception/meeting spaces beneath. While they speak to the concepts of flow and iteration of the flyover they also speak to the formal character of the architectural context. This can be seen by the slanting, repeated roof geometry that is seen in the saw-tooth industrial buildings of the context. The difference is created in that these pods are iterations of each other rather than exact copies. As this is a scheme about flows it is noteworthy to mention that, because the pods are iterations of each other, cars passing by will see a moulding effect as they drive past each iteration which is slightly different to the last. Thus the project not only brings road and architecture into dialogue geometrically but also experientially to some extent.

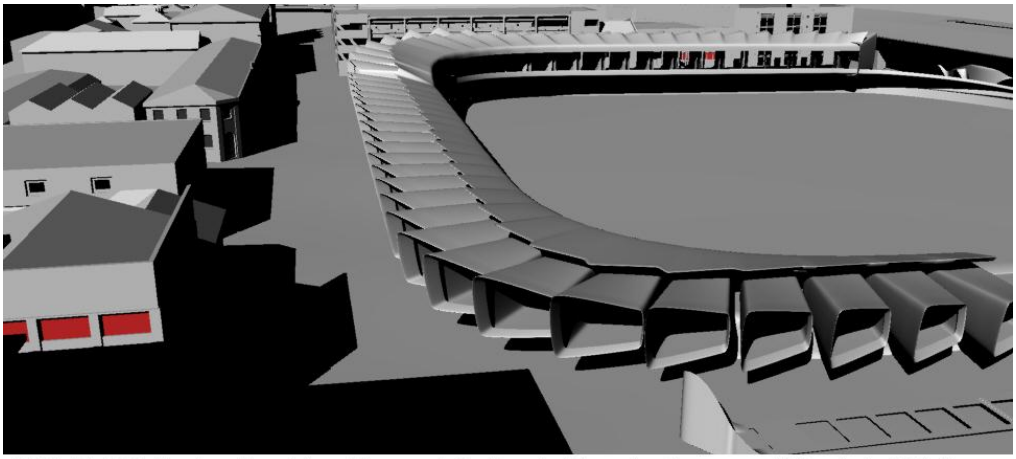


FIGURE 30.Illustrating The Shops: 79. D. du Plessis. Personal Model. 2015

The flow increases in a sense to the entrance of the project as the forms of the pods become more and more pronounced announcing the entrance. The plan geometry of the entrance means that a meeting space is created, a sort of inviting landing, transitional space before the scheme is entered by pedestrians. Thereafter the pods stretch over the flow and allow pedestrians to explore them from another angle.

For the scheme to further communicate with the context Bennett Street, having a much denser massing receives double storey pods with single storey space beneath; while Prestwich Street has single storey pods with single storey space beneath and Napier Street gets single storey pods with clear space beneath.

FIGURE 31. Illustrating Bennet Street: 80. D. du Plessis. Personal Model. 2015

The bus depot is incorporated into the scheme by building a path which leads under the shops and flows into a space 1500mm below ground level. This means that pedestrians can observe the buses while not being directly affected by them. Their flow is subverted by leading them under the shopping complex. They are then sheltered by part of the pods and their walkway. This shelter forms the new warehouses where buses are serviced and washed. The beauty of the flow of the scheme means that buses do not have to perform complex maneuvers to progress from one service point to the next. They can either travel sequentially as the various processes are carried out or by simply turning in and out. The bus can skip the desired number of processes to continue to the centre or underground parking. In this way the bus depot is continuous (40) but so is the pedestrian component of the project.

It is important to keep the buses on the site as one does not want to uproot industry to make space for retail and entertainment on a site so near the waterfront, which is a combination of industry and retail. Also the site has a short history of being a bus depot serving as depot for two bus companies prior to My Citi. Furthermore the depot is en-route of the MyCiti buses (rather than being an isolated depot it is in the journey that the buses take each day). This efficiency no doubt shortens travel time from last stop to depot, rendering the placement of the depot environmentally friendly.

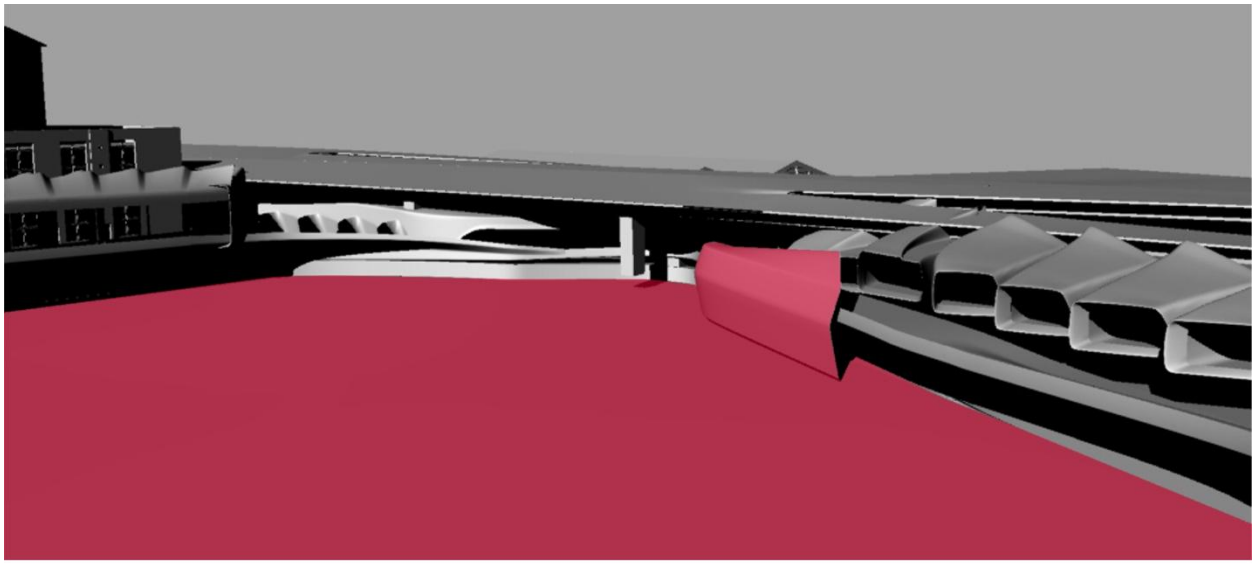


FIGURE 32.Illustrating The Bus Depot: 81. D. du Plessis. Personal Model. 2015

This design puts a bus terminus in the main pedestrian route meaning that the MyCiti bus depot can act as a sort of anchor tenant for the complex keeping a constant pedestrian flow. Finally in a project about pedestrian and vehicular flow it makes sense to have these vehicles in the middle of the scheme. The buses are treated as aeroplanes at an airport and boats at the V & A Waterfront, as being part of things although they are separate. You can look over them and see the bus drivers having tea in the morning sun in much the same you see mariners prepare their boats for a time out at sea.

40. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

The theatre will be opposite the Waterfront Film Studio where it can latch onto a widened path space used as a pause or release space. The form of the theatre means it scoops the flow from the Beluga Restaurant Shopping Complex, leading pedestrians into the heart of the scheme. The auditorium is in the centre of the theatre meaning that the theatre roof can sweep downwards, towards the entrance on the ramp, scaling down for a pedestrian entrance.

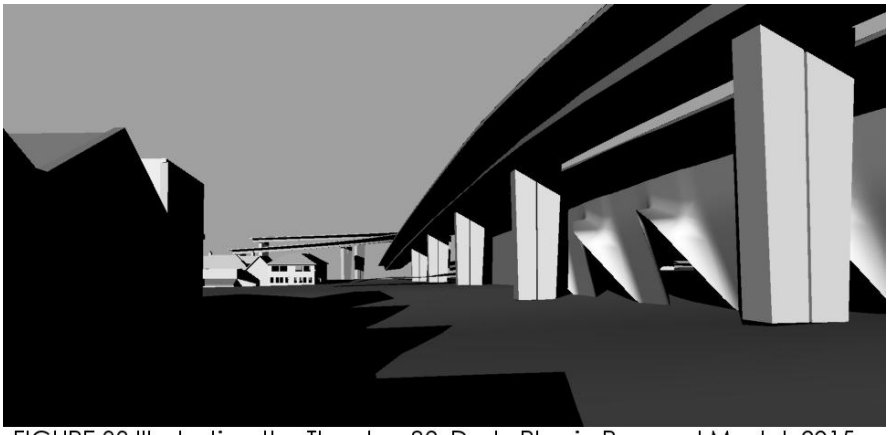


FIGURE 33.Illustrating the Theatre: 82. D. du Plessis. Personal Model. 2015

At the entrance of the theatre a set of ramps direct visitors to the different parts of the auditorium space; the flow of the ground is used to manage the flow of people. This allows people to enter from Port Road and from the central 'street' of the project. The entrance ramp space is used as a restaurant space to keep the theatre active while there are no productions featured. In this way it will also expose various people to the theatre with the hope that they will return to view a production. The restaurant can also serve visitors watching a production, once the it is complete. This space becomes porous (41) because of the multiple functions.

The back-of-house functions are expressed with an orthogonal geometry as they are serving spaces and will not be on display.

Within the theatre building are a number of offices. These look out over the bus depot and act as a replacement for the existing offices on site.

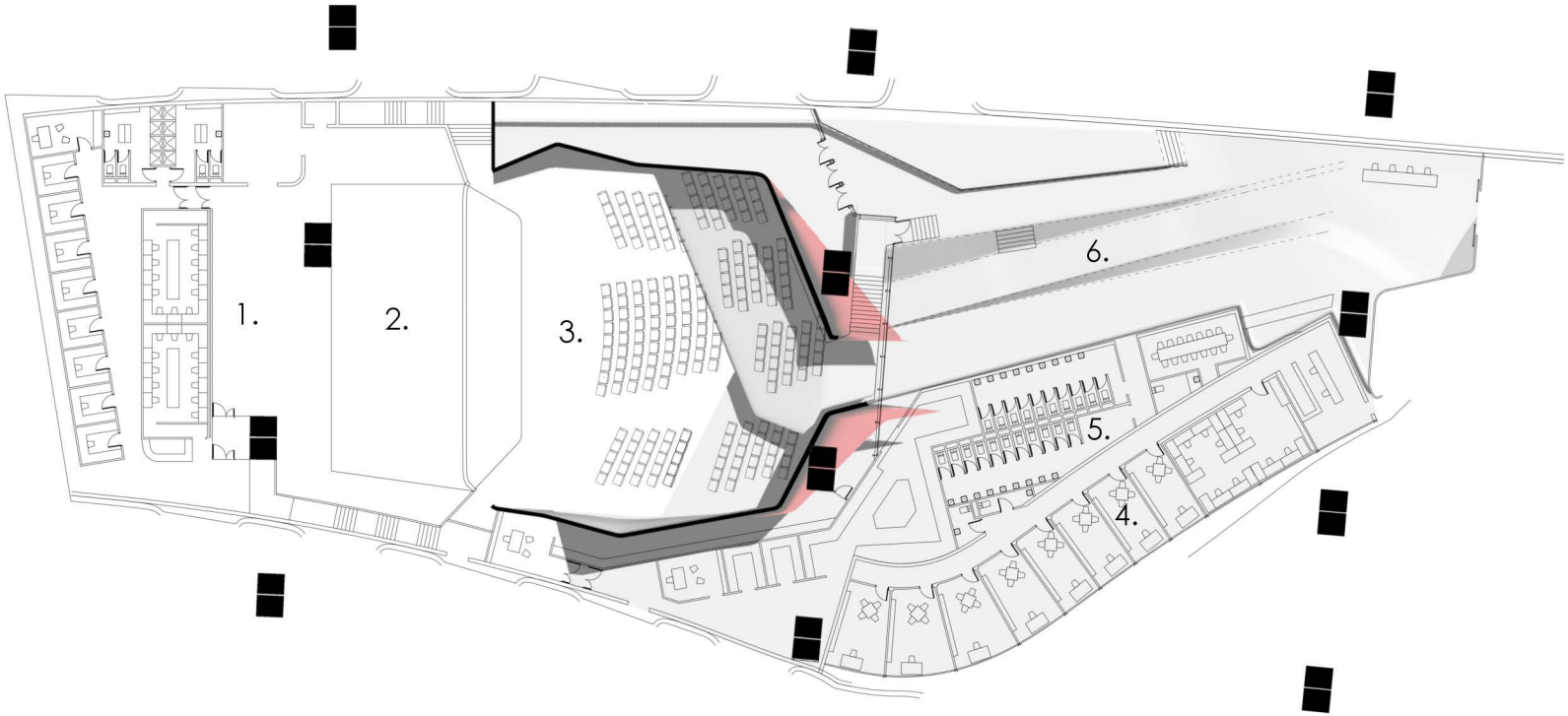
Careful attention is paid to the way the ceiling expresses the freeway above and does not stop flowing in the auditorium, where it swoops down causing a dramatic space flow to the stage. The ceiling allows the space-flow to be continuous (42).

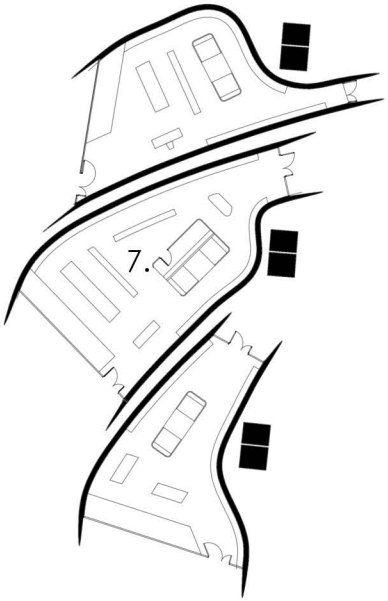
Attention is paid to the openings making them refer to the language of arches in the context.

The placement of the theatre is in the dark zone of the site while to scheme's 'street' is closer to light and the shops are in the light zone.

An important aspect of the project is the continuity of flow. All spaces flow into each other and they flow into the pedestrian 'street'. The aim of this is to create a porous space that will lead pedestrians through an otherwise untraversable space.

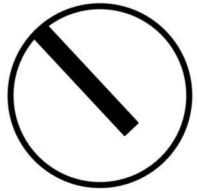
41. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.





1. BACKSTAGE
2. STAGE
3. AUDITORIUM
4. OFFICES
5. WC
6. ENTRANCE RAMP/ RESTAURANT
7. SHOPS

THEATRE PLAN
SCALE 1:500



The important aspects of this project are the linking of spaces; that have become awkward after the separate nature of the morphology of the city. This link exists as an approach to negative spaces in the city such as under large flyovers. The link happens in a way that is continuous (43) – so as to form new flows through the city that are needed. They are transparent (44), giving the user the power to understand his surroundings and porous allowing many different spaces to connect and create a steady flow of pedestrians. The condition exists as a combination of geometries being large infrastructural systems and urban fabric and combining these in a way that is 'continuous' (45) and 'transparent' (46).

CONCLUSION

This project, while being quite radical, seeks to grow from the context on both an urban and localized scale. It seeks to make a better connected city and set president for architecture's ability to traverse hostile, forgotten city spaces. It is a project of 'continuity' (47), 'transparency' (48) and 'porosity' (49) seeking high energy to encourage pedestrian flows through the city by everyone, familiar or not, alike. It seeks to work around large flow systems that seem to strangle the city by accepting these systems as necessary and then working to activate pedestrian flow that transgress those borders. This project seeks to be an example of how cities can be more connected internally this will make them safer as it will help to eliminate dead space. This connectivity will make for a more holistic experience for visitors and locals enjoying the city and will allow them to feely explore the city. It will make the journey for pedestrians to work more pleasant and will encourage more to use this mode of transport to work. It will allow for better business relation across two high energy zones in the city. Finally it will make for a more cohesive city that deals with the junctions of each part of the city ultimately leading to a healthier city.

42. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

43. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

44. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

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FIGURE 32. Illustrating The Bus Depot: 81. D. du Plessis. Personal Model. 2015

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B35. D. du Plessis. Edited image from Grasshopper 3D software. 2015.

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Figure B25. (Top) Points with constant gradient, (middle) manually traced points for DATA matching, (Bottom)Generated Point.
Figure B26. 1. Divide Surface: grids the surface.
2. Sub-surface: turns each 'square' on the grid into a surface.
3. De Brep: break subsurfaces into the three components of modelling (vertices [points], Edges [lines] and faces [surfaces]).
4. Cull: Chose edges to work with.
5. Area: Find midpoint of each sub-surface.
6. Join: Join edges to form complete curves.
7. DivideLength: form points along the complete curves.
8. Surface CP: Generate UV's from the original surface.
9. Evaluate Surface: create normals.
10. Amplify: Give the normal a quantity (that is to say instead of saying north it will say north 230mm).
11. Move: Move the points in a way that they will now be offset in the correct direction.
12. Loft: Make a surface between the original line and the new line.
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Figure B34. Branches: DATA structures associated with grouping.
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Figure B37. Construct Point: Combines x,y,z values.

DEVIN DU PLESSIS

SCHOOL OF ARCHITECTURE, PLANNING AND GEOMATICS UCT

MArch(Prof)

THEORETICAL PAPER

TRANSCENDING URBAN BORDERS

APPENDIX A

Abstract

This paper is set in de Waterkant **between** Cape Town's Central Business district and the Victoria and Albert Waterfront. The reason for this site being the area of focus is that there is no significant pedestrian route from de Waterkant and Cape Town's central business district to the Victoria and Albert Waterfront. This paper will discuss the site, its history and some problem areas to be worked on. From those points architectural concepts will be discussed that can address those problem areas. There are three concepts which will be explained and critically applied to site. Thereafter they will be compared to each other to set up a framework within which to navigate moving forward with the design project.

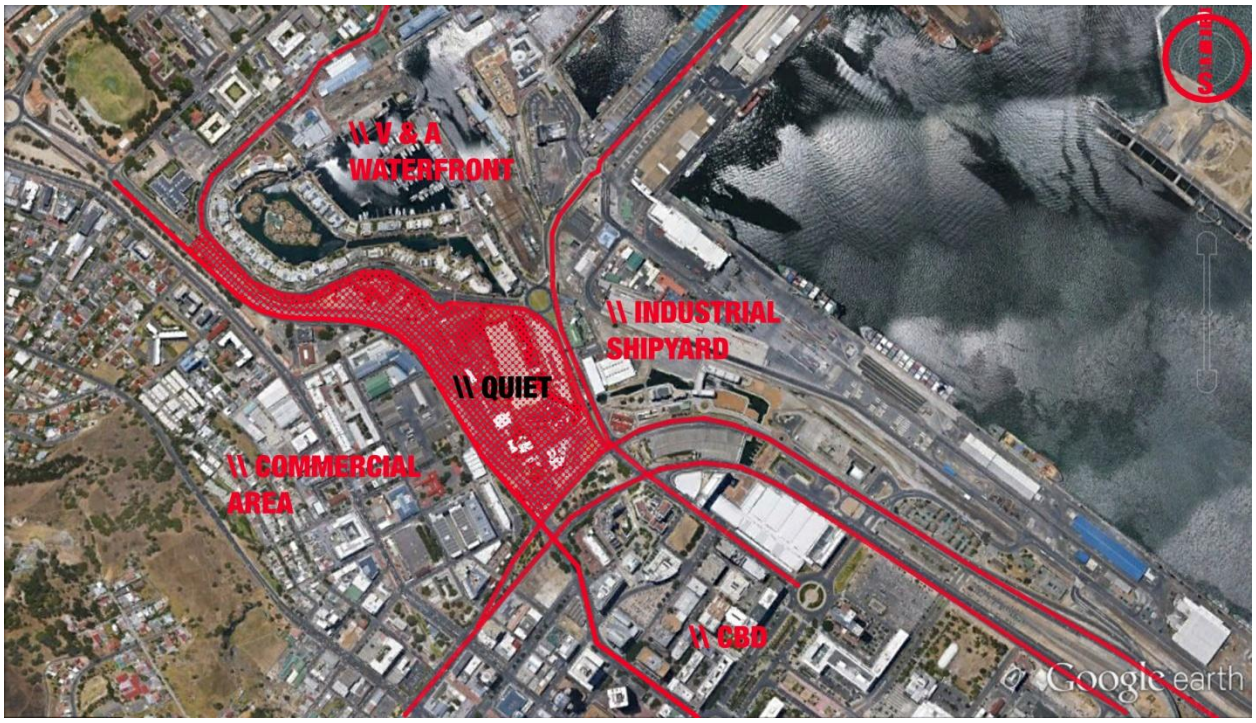


FIGURE 1 Image of site, a quiet zone dividing the city: 52. D. du Plessis. Edited Image from Google Earth. 2015

Preface

I once paid to a restaurant in Franschoek. The floor plan differs with less and more active sections for seating. The intriguing part is in the active zone where visitors sit around a bar. In the centre of the bar is a kitchen which is divided; a section in full view in the centre of the space and a more private section where chefs could find some relief from being on constant display. Thus served and serviced come into direct contact, one could even speak to the chefs who were also able to avoid contact where necessary and permissible. Hence the space is continuous flowing from private to public; porous (1) with the different functions crossing through each other and transparent in that one could get a good understanding of the workings of the space. The only critique may have been that the geometries had no influence on each other as a single geometry was used throughout. Having different types of spatial geometries will help to make the crossing an event, a highlight in the scheme. This space is porous (2). The value of this space to my chosen site and similar concepts will be the focus of this paper.

Introduction

There are various borders between urban spaces that exist in the city of Cape Town. This paper will analyse one of those borders as a type and as a specific located condition in the city. It will then take a look at various strategies for transgression of the border.

1. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
2. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

The Foreshore Flyover

Over the years there have been many myths about the unfinished Foreshore Flyover one of the reasons for its incomplete state was explained to me by Johan Meyer from the roads division at Cape Town City Council. Cape Town's geology makes it very difficult to create efficient road networks that do not cut the city off. The best way to understand this is by comparative analysis. An efficient road network system can be identified in the city of Johannesburg (3); the way that its network system is with a ring road being the main artery with feeder roads which lead to the centre of the city in a diagram reminiscent of Sir Ebenezer Howard's Garden City's transport network system. What this means for the city is that borders created by roads are created as a type of city wall, surrounding it rather than segregating it. Of course as a city such as this grows, the growth will either be stopped by the border or simply cut off by it however planners were able to set the terms of the network system.

FIGURE 2 Illustrating Johannesburg's ring road network system: 53. D. du Plessis. Edited Image from Google Maps. 2015

3. J. Meyer. Personal communication. 1 April 2015.

An analysis of Cape Town as a plan shows how the geological features would limit a city. On the South is Table Mountain it is wide enough to delimit the entire central business district. What this means is that no traffic can enter from the South. To the North of the city is the sea meaning that no traffic could come from the North. What this means is that all vehicles will have to travel between East and West (4). Measuring from the boundary between the mountain and the city and the beginning of the sea you have a range of 0,9 kilometers and 1,1 kilometers. Thus large traffic arteries will inherently create borders within the city instead of around it.

What this means, for the city of Cape Town, is that there would be a complex series of arteries that would need to feed off and fly over one another. Because of this system it became a very expensive operation in relation to other road networks in South Africa thus the project was halted, not because the networks were badly planned or unnecessary but simply because the budget became too extensive (5).

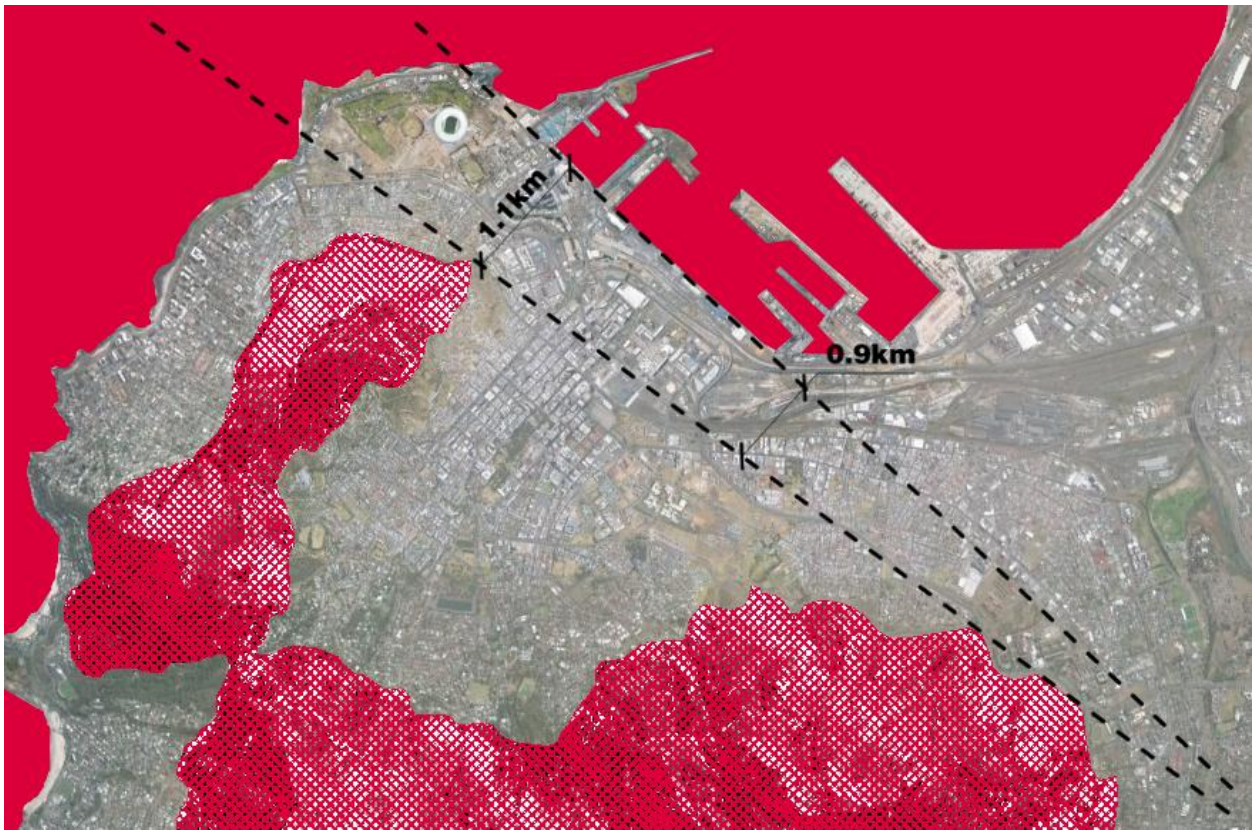


FIGURE 3 Illustrating the narrow piece of land between Cape Town's geological features: 54. D. du Plessis. Edited Image from Google Earth. 2015

4. J. Meyer. Personal communication. 1 April 2015.
5. J. Meyer. Personal communication. 1 April 2015.

The Divided Space

The point that is of interest to me is that this road network system creates a border between two highly relatable parts of the city being the Victoria and Albert Waterfront and Harbour (which I will refer to as the V and A Waterfront) and the central business district of Cape Town. The V and A Waterfront is a large tourist attractor for Cape Town with many of the stores catering mainly for wealthy international visitors; it also functions as a recreational space for local inhabitants. The central business district (CBD) also features many tourist and local attracting recreational spaces. The city would benefit from links between businesses and recreational activities across the two zones. Walkable links between the CBD and the Waterfront exist only faintly. Thus the question must be raised why would the road-border occur where it does? The answer can be found looking into the history of the site.

FIGURE 4 Illustrating the walking distance across the existing waterfront and from the site to the waterfront being equal: 55. D. du Plessis. Edited Image from Google Earth. 2015

History of the Site

At the outset it becomes apparent that the V and A Waterfront was a utilitarian harbour at its inception rather than a recreational waterfront. This insight can be gained by looking at various maps of the area through the morphology of the city. In the earliest example used in this paper the site was home to the Amsterdam Battery (Figure 5), it was a military post created for the protection of the various interests in the Cape against attack by sea created in 1787 (7). Thereafter the battery was demolished and a quarry was put in its place with oil tanks. Close to that a 'Native Location' (Figure 6) highlights the peripheral nature of the site. I must highlight that I mention the 'Native Location' (Figure 6) merely as a way to highlight that people who were marginalized historically were to be housed there emphasizing the view of the site to the people in power at the time. This was in 1921.

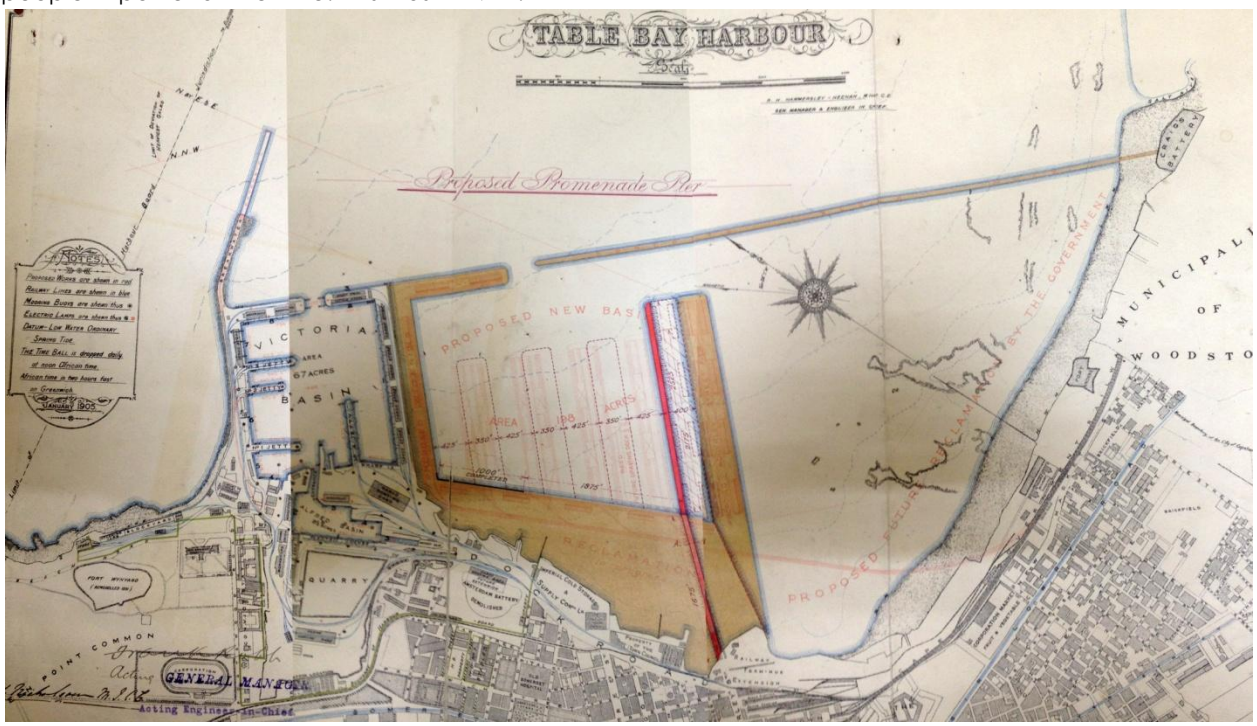


FIGURE 5 Illustrating the utilitarian nature of the site historically: 56. Western Cape Archives and Record Service. Map from CO/818. 1905.

7. Cape Town Heritage. Amsterdam Battery. [Online] Available from: http://www.cape-town-heritage.co.za/landmark/amsterdam-battery.html [Accessed 25 April 2015].

A map of Cape Town dated 1938 shows that there was a 'graanloods' (Figure 7) or grain shed on the site. An analysis of some aerial photographs shows that the Foreshore flyover that stuck close to the coast, with the reclaimed land in contrast to the rest of the city, (Figure 8) in part in the past and divided the industrial area from residential, now cut the reclaimed land off from the CBD. This meant that there was a piece of coast not directly affected by the high traffic freeway which had an industrial area butting up against the freeway. This was changed and an analysis of an aerial photograph from 1983 shows this disjunction as fixed however by a large freeway (Figure 9), the new divisions caused are strengthened by means of a hard line laid down with the large infrastructural gesture of the freeway.

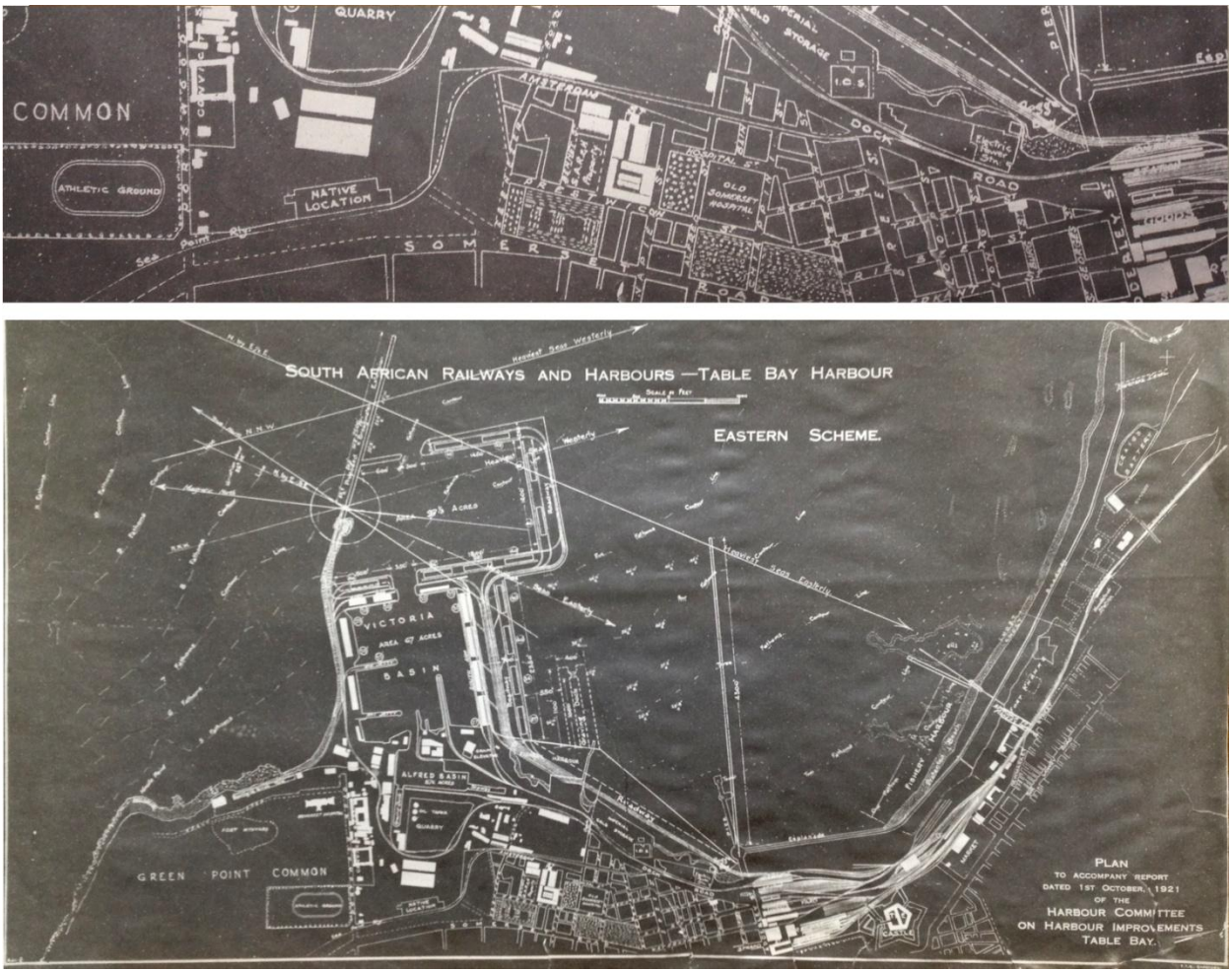
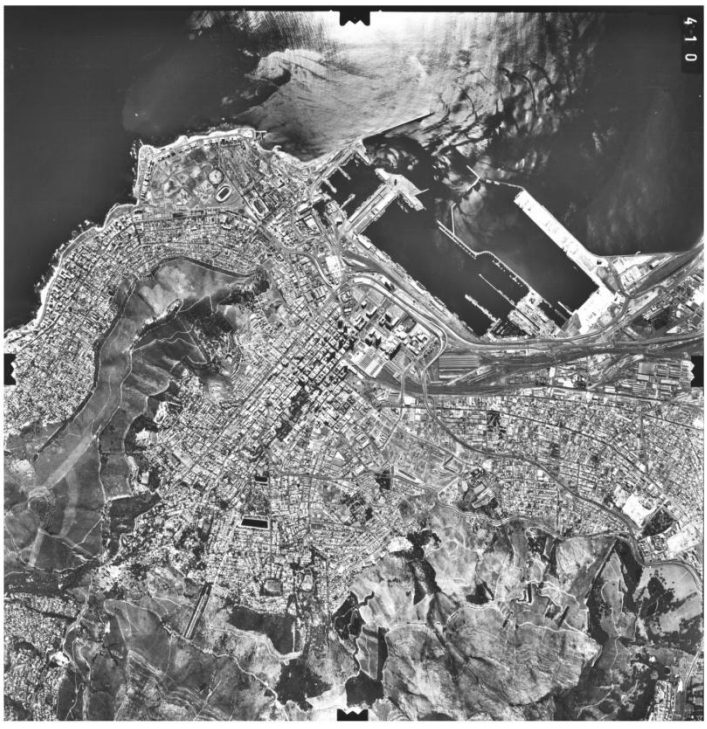


FIGURE 7 Illustrating the industrial function of the site historically: 57. Western Cape Archives and Records Service. Map M1/ 1560. 1921

AERIAL PHOTOGRAPH: 1958



AERIAL PHOTOGRAPH: 1983

FIGURE 8 Illustrating the road following the pre-land-reclamation coastline: 59. National Geo-Spatial Planning-Cape Town. 335. 1958

FIGURE 9 Illustrating the crystallised boundary: 60. National Geo-Spatial Planning-Cape Town. 498_188. 1983

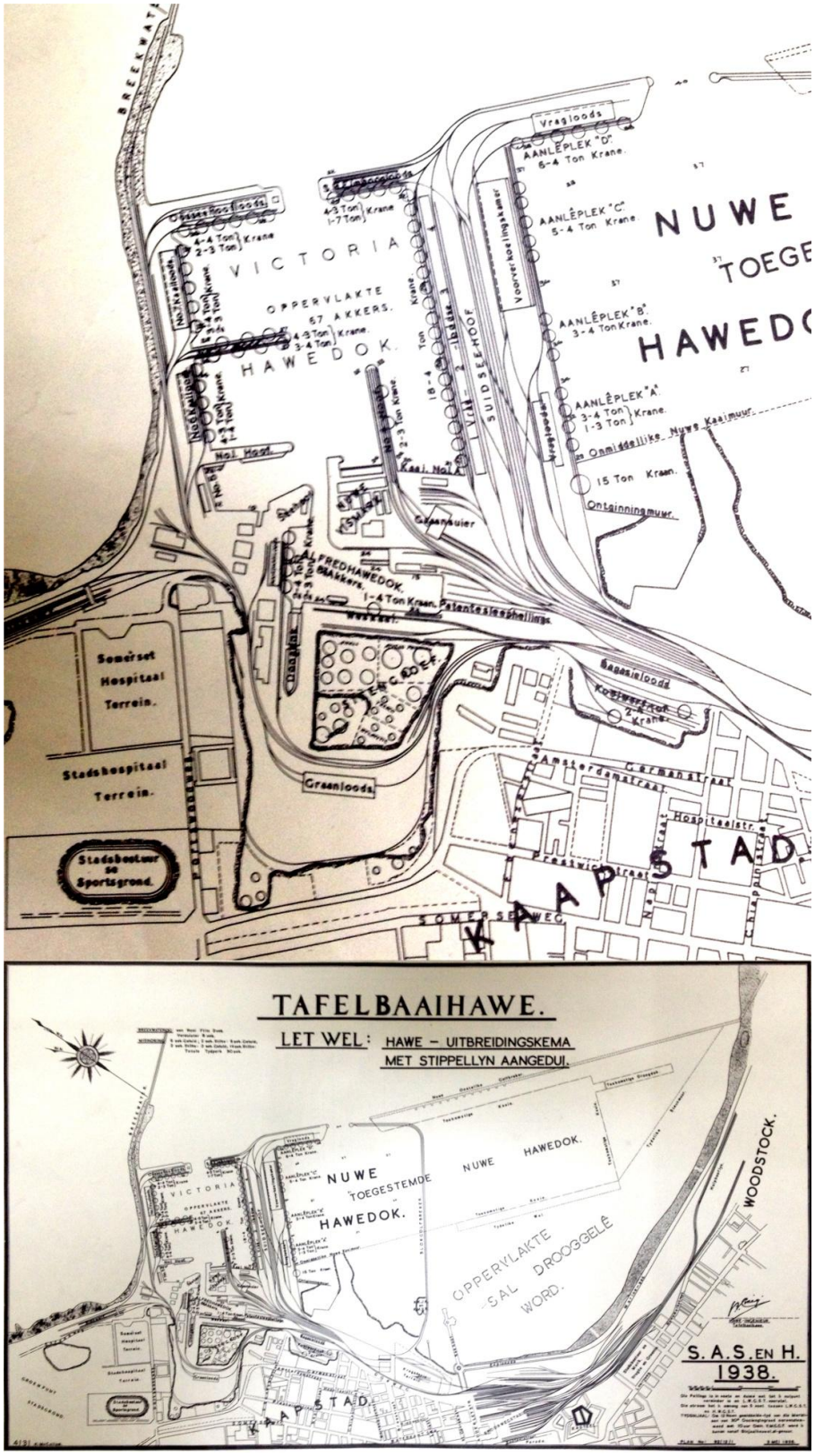


FIGURE 6 Illustrating the peripheral nature of the site historically: 61. Western Cape Archives and Records Service. Map M1/ 2994. 1938

Over this analysis it becomes clear that the strategy to have a main artery straddling an industrial area which could easily feed into it making resource distribution easy makes sense and cutting it off from the rest of the city by this move would not have been a major problem as drawing people to the area was not of interest at the time.

Now that we know why there is a border in the middle of the city and we know the reasoning behind its position we need to investigate methods of transgression of this border. What would be the strategies used to get people use the city in its new form despite having and infrastructural system designed for its old form.

The Site

At this point it becomes important to mention that this project is to be understood as a catalyst for further development. For a meaningful link to develop between the city and the V and A Waterfront focus has to shift to a particular point of interest for this link. A site that would enable a pedestrianising across the Foreshore Freeway without severing it would be most meaningful. Hence De Waterkant enters the narrative this site is linked to an under highway terrain. This terrain under the highway is the most problematic, as a sort of no-man's-land it is a terrain without any occupation in terms of architecture, it is a bus testing and parking lot. This means that people have no specific reason to be there other than to cross the highway or the occasional bus driver to drive. This eliminates it as a route for many which in turn makes it dangerous owing to a lack of surveillance. On the North side of the freeway, the piece of land between Walter Sisulu and Port Roads, there is also very little activity and no direct link to the V and A Waterfront which makes it an even less travelled route. The site functions as a film studio, film school and a hotel with large uninhabited and restricted spaces between them which do not allow pedestrian access. Three main architectural concepts come into focus for the transformation of the sub-freeway terrain into a vibrant and successful space that is a useful insertion into the city transparency, porosity and continuity.

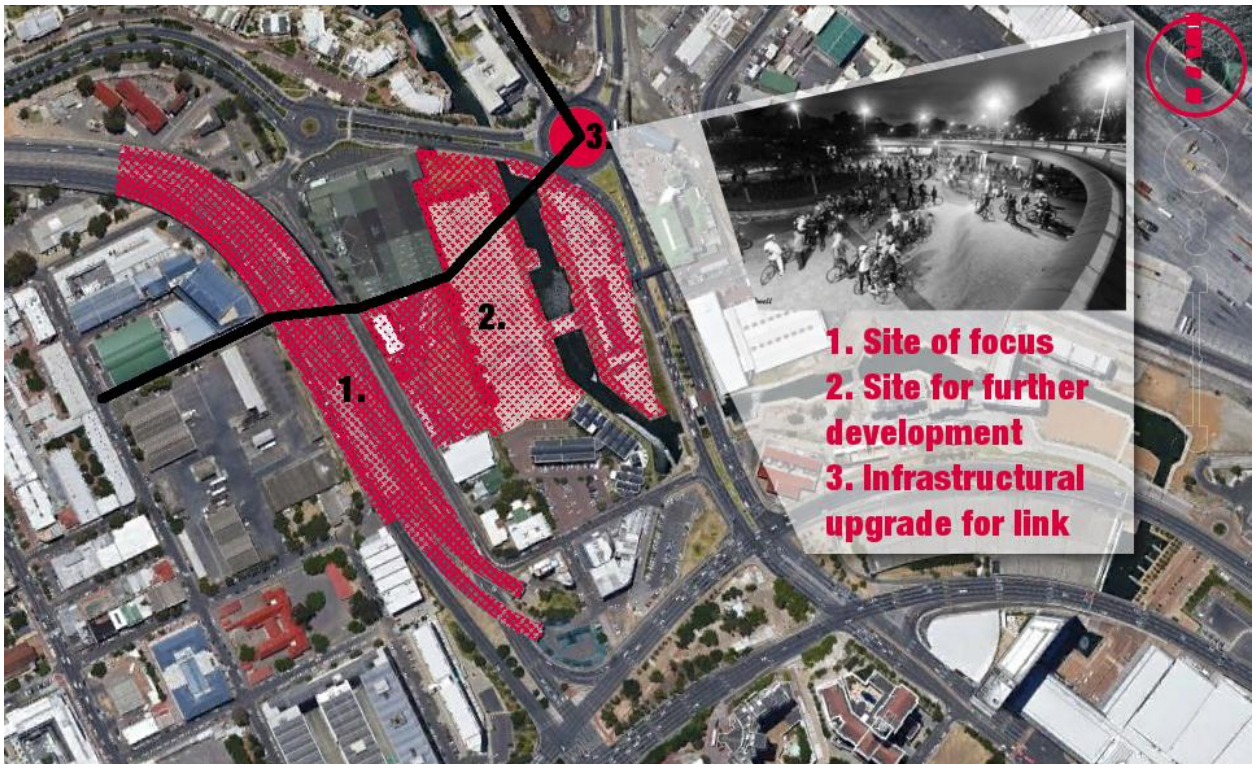


FIGURE 10 illustrating the link through the site as well as future development: 62. D. du Plessis. Edited Image from Google Earth. 2015

Inset Image of the Greenpoint pedestrian accessible traffic circle: Just Kicking It. #bluemoonmass. [Online] Available from: http://www.justkickingitblog.com/2012/08/bluemoonmass.html. [Accessed 28 April 2015].

Scale

On considering the concepts outlined it is important to understand the scale of the project. This project must not be understood as an urban design project while it will seek to make projections for future development. The motivator for this development will be that the site between Walter Sisulu and Port Roads (to be referred to as the Film Block) will be at a crucial point in the city, an important link. This will take a site which is already valuable in terms of investment because of views and centrality and make an accessible area of high pedestrian activity. The project I seek to research and develop will be the sub-freeway terrain which will be a crucial support space for that development.

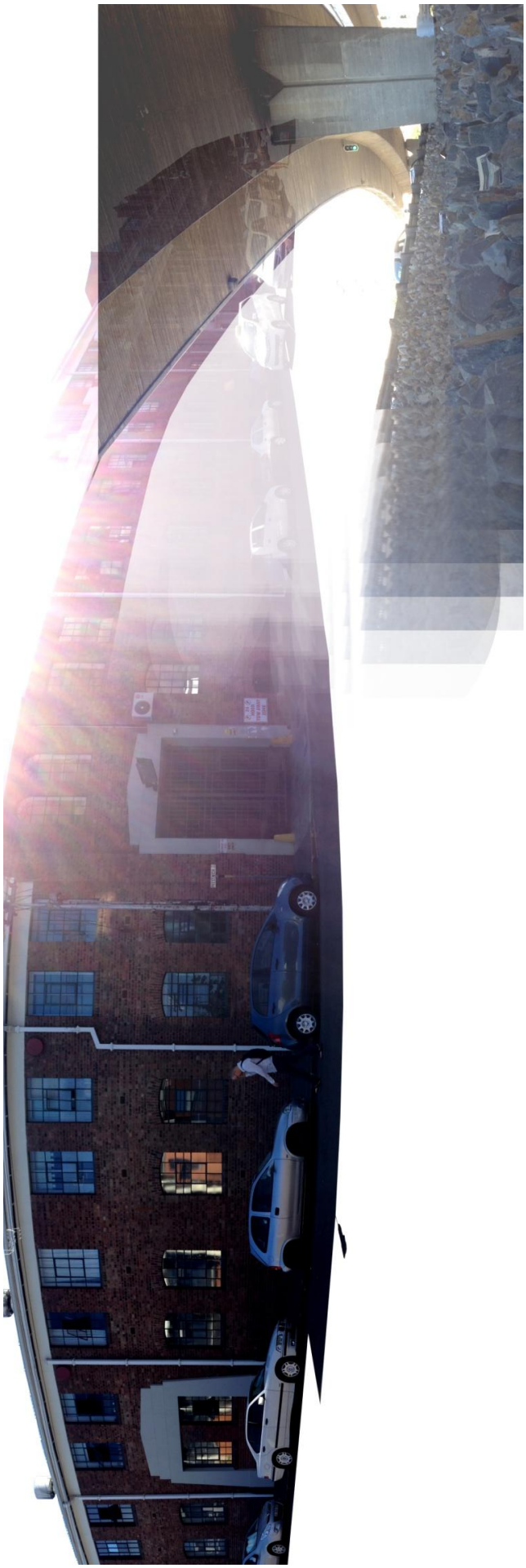
Continuity

Patrik Schumacher speaks on continuity in architecture. In this concept he speaks of grading function as one moves through the architecture (13). Instead of compartmentalization spaces need to flow into each other. Some of this concept is possibly borrowed from Rem Koolhaas with his use of cross-programmed space; Patrik Schumacher speaks of a mixing of function (14) into one space because of the way that functions grade and gradually change where Rem Koolhaas speaks of a space that can be used in multiple ways and interpreted by the user.

If the architecture can flow programmatically it will be able to guide people in and let them flow through the installation as is necessary for a project that seeks to connect parts of the city. Programmatic systems will not be the only things that would grade between each other, inside and outside can grade as well this can be used as a method of creating a flow, a continuity from one side of a system to another.
The formal guidelines of Parametricism will help the project to encourage flow perhaps on a sub-conscious level, it will also be contextually appropriate to a flyover that itself suggests dynamism and flow. The characteristics are variation, deformation and varied iteration rather than simple repetition and rigidity (15). This all relates to the concept of continuity as one element leads to another. Systems must relate and flow rather than be juxtaposed against each other (16). There exists a juxtaposition between the historical, orthogonal, face-brick buildings and the new, curved, concrete flyover. The interest of this project will be to see how it can mediate between the somewhat alien and alienating flyover and the historic context to form a continuity in context. An idea of building as mediator arises where the building will create a continuity in an existing context thus validating itself in relation to its context and its context in relation to itself.

13. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.
14. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.
15. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659
16. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

FIGURE 11 A collage illustrating continuity in a juxtaposed site. 63. D. du Plessis. Edited personal Photographs. 2015



Allain de Botton speaks of form in his book Architecture of Happiness. In it he suggests that form can have intrinsic, contextual and associated meaning (17). For example a concave space is a comforting nurturing safe space like a mother's womb- intrinsic meaning. A concave space into facing the wind and midday sun might be perceived as hostile- contextual meaning. This space may be of certain value to the couple who became engaged to be married in the space- associated meaning. Hence the designer imagines form with an intrinsic meaning but has to consider it in terms of context, despite the best design no one can account for unrelated associated meaning. This is coherent with the way Patrik Schumacher suggests that form be continuous it also reaffirms the need for this form to be contextual and validates building as mediator. De Botton mentions that in time associated meaning can change (18) which is the aim of this project to change people's understanding of the sub-freeway space and the connections within the city (which would be appropriate to the changes in meaning which the V and A Waterfront underwent).

To this end I have constructed the site parametrically. The value of this is that in so doing I hope to show how a system that was not parametrically constructed could be. And thus I hope to show that the architect using a parametric tool will have as much control over the system as he or she chooses. That is to say that the form will not be under considered or a product of random mathematical coding. The benefit of using parametric programming as a tool is that one is able to form a very clear idea of what the context is and how it works. That is to say that if I would like to have a curved element on the site I could use the exact coding used to construct a replication of the Foreshore Flyover to decide the form of my curve. As a small insight into this transition curves are used in the design of roads. This is a spiral that leads into a circular curve. Using a computer program like AutoCAD would render this an impossibility for use in the design of something new. However through parametric coding the possibility of the sequence of straight line- transition curve- circular curve- transition curve- straight line becomes a possibility for architectural design. This would also be possible using industry standard software for roads but the lack of flexibility would mean that my project would then be limited to a particular constraint. With parametric coding various other realities of site will be abstractable into a mathematical calculation which can be used where applicable to inform the next installation into the city. To better understand this work I have written about it in my a paper that analyses the site from a technological perspective.

17. A. de Botton. The Architecture of happiness. London: Hamish Hamilton, 2006, p. 78-100.
18. A. de Botton. The Architecture of happiness. London: Hamish Hamilton, 2006, p. 78-100

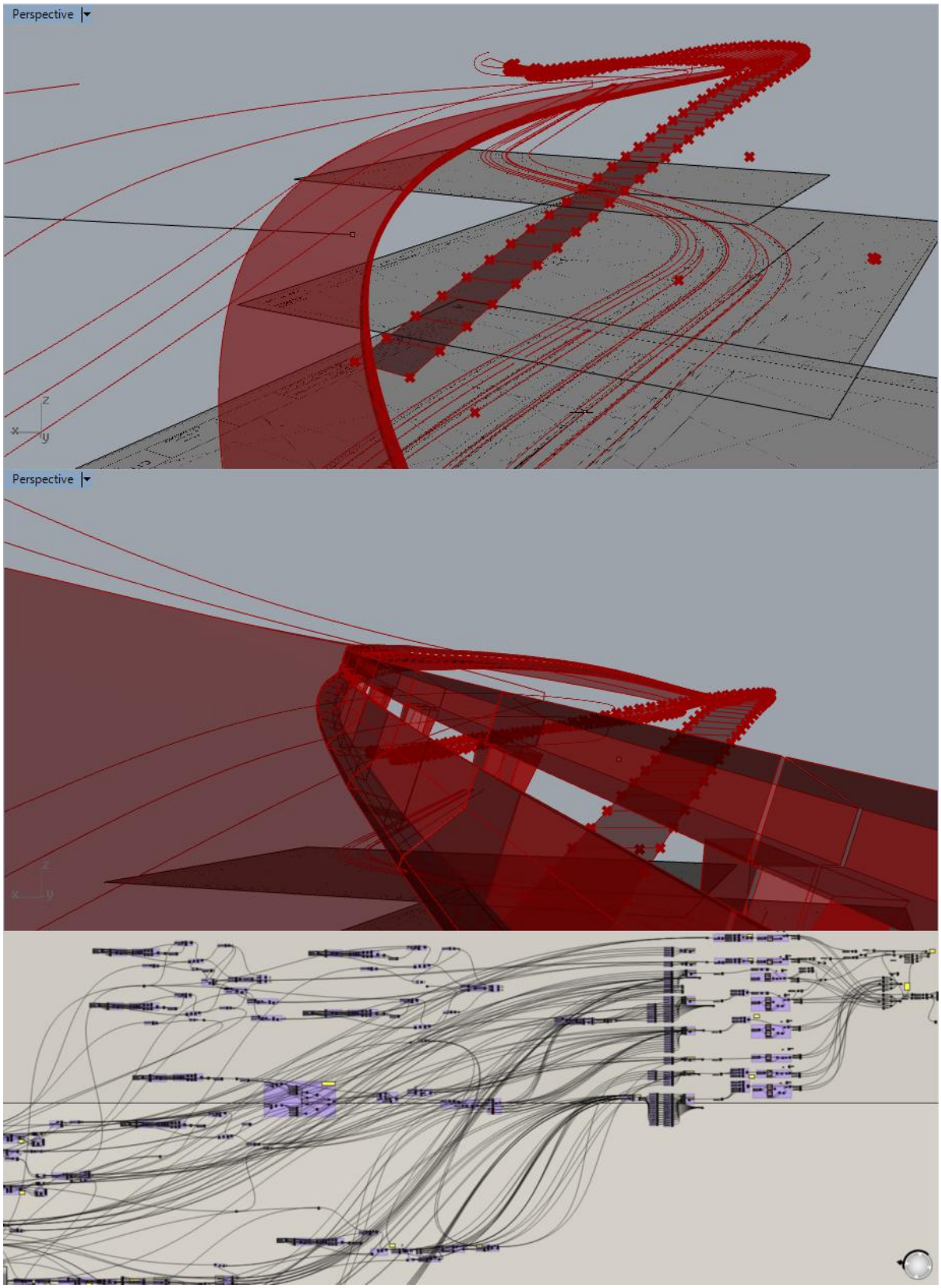


Figure 12 Illustrating Processing context into DATA for design: 64. D. du Plessis. Personal Three Dimensional Modeling. 2015

The point of departure at this point is to investigate the relationship between the highway and the context. The highway has intrinsic, typological rules and so does the city blocks that exist around the freeway. A block has a set of typological rules set up by scale of people and scale of the industries that were housed therein. The two exist next to each other and interact with a set of morphological rules that is to say the typological rules of the architecture affects the typological rules of the freeway and they interact with a set of morphological rules. I believe quantifying these rules parametrically is possible for this site.

Patrik Schumacher speaks of three advantages of parametric architecture being complexity, rigour and elegance.(19) Elegance is very often understood as the simplest solution to a complex problem Patrik Schumacher criticizes this view and states that elegance should be understood through the lense of Baroque space. Baroque architecture is not simple but is unified by the expression. Instead of looking disjointed and awkwardly pieced together the whole scheme flows continuously. According to Schumacher Louis XIV used the Baroque style to unify territories thus entire territories are continuous. Renaissance architecture was additive but Baroque was integrative where one part has an impact on the whole. This was achieved by the use of 'complex concave space' , 'enhanced depth and plasticity as well as details like split double columns and split gables' (20). Continuity in terms of symmetry is a focus of Baroque architecture. And carefully articulated geometry was used to achieve continuity such as the rectangular plan with filleted corners could be continuous into the ceiling by means of corner vaults (21) and how a local asymmetry can rely on the global scheme to achieve unity (22).

In the same way as Baroque, parametric architecture looks to continuity and unity in complexity to achieve elegance. Similarly to Baroque there is a strong focus on geometry (23) in parametric architecture. This geometry can be both seen and unseen (as setting up geometry) but it also transcends into a world of far greater complexity than available ever before being complex mathematical functions. Thus one is able to manipulate geometries which are not possible to construct using standard drawing techniques.

19. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 628-629.

20. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 630-632.

21. R. Venturi. Complexity and Contradiction in Architecture. New York: The Museum of Modern Art, 2007. p. 26-27.

22. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 630-632.

23. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 630-632.

FIGURE 13 Illustrating continuity in a Baroque ceiling. 65. FIGURE 11: The Courtauld Institute of Art. Collegio di Propoganda Fide. [Online] Available from: http://www.courtauldprints.com/image/160110/borromini-francesco-collegio-di-propaganda-fide [Accessed 28 April 2015].

Allain de Botton speaks of elegance as a balance between masculine and feminine, old and new, rough and refined this is very applicable to my site in terms of bringing in architecture that will transform a space rather than replace it (24). Schumacher speaks of elegance as complexity with coherence (25). Balance and coherent complexity have a relationship.

Lars Spuysbroek speaks about architects planning human movement and continuity between movement and image (26). This project is well suited to this type of thinking as there are two types of very strong opposing movements at play. The East/ West movement of the vehicles on the freeway and the imagined North/ South movement of people.

According to Spuysbroek 'typological schema' (27) constructed of relations not components. This further speaks to the idea of continuity through parametrics. Parametric design allows the designer to construct relationships in a structure which can be adapted and changed thus relations means that a change in one part of the structure has continuity as it affects the whole.

While continuity will focus on geometry to achieve unity, space flow and form, transparency may provide a basic strategy of a more complex spatial flow as well as a concept of dealing with the exterior in a way the speaks to the interior.

24. A. Botton. The Architecture of happiness. London: Hamish Hamilton, 2006, p. 203-213

25. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 628-629.

26. L. Spuybroek. NOX. London: Thames and Hudson, 2004, p. 2-13.

27. L. Spuybroek. NOX. London: Thames and Hudson, 2004, p. 2-13.

Transparency

In this discourse transparency is phenomenal transparency rather than physical transparency. Phenomenal transparency is a concept spoken to by Colin Rowe. According to Rowe transparent planning is about merging various different spaces of differing directionalities, spatial interpenetration or overlapping space. It is a concept borrowed from the Avant-Garde art style. It can easily be understood as two overlapping objects with each claiming equal ownership of the spatial overlap. That space becomes ambiguous and lends itself to either object (28). It is important to note that there are two categories of phenomenal transparency being spatial to be understood in plan and external to be understood in elevation.

To create overlapping space two spaces need to be set up that will radiate into a common space. This space is a combination of the two but it makes the user aware of both. The overlapping space will be programmed loosely so that the user can interpret it and use it within the bounds of the program (29).

Where main spaces are planned in terms of spatial transparency they become complex and offer a transparent understanding of the complexities of a site rather than concealing them. Transparent space merges the complexities of a site- 'old and new, public and private, collective and individual' spaces hence everything is transparent and intelligible at once. The geometry of the site can also be an informer of transparent space (30). For example on the de Waterkant site there are conflicting geometries being the city grid as well as the fly-over a transparent space would include both of these geometries layered in one space.

Rowe notes that certain architectural features lend themselves to varying degrees of transparency in terms of our understanding of what they are representing. A strip of ribbon windows indicates a line of movement parallel to the windows with a floor level eye level height below the strip with one single space. As an example Rowe speaks of Le Corbusier's Villa Stein from the front the glazing expresses a line of movement parallel to the glazing with a floor an eye's height below it. The rear of the building is more confusing as the glazing indicates the same thing however the floor is divided into rooms which do not allow such movement (31).

28. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

29. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 111-119.

30. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 101-109.

31. C. Rowe, R. Slutzky. Transparency: Literal and Phenomenal. [Online] Available from: http://links.jstor.org/sici?sici=0079-0958%281963%298%3C45%3ATLAP%3E2.0.CO%3B2-U [Accessed 26 March 2015].

However at the rear of the building another type of transparent space is apparent. Rowe explains that space can be used as transparency vertically as well. This is by space unification, not necessarily by means of a visual connection. For example at Villa Stein two floors are united by a single double volume space, hence both spaces bring each other into focus. Visual connection can be used where there is a layering of spatial directionality: where one space is perpendicular to another the diagonal view becomes the transparent space and brings the spaces in relation to each other (32).

FIGURE 14: Illustrating elements of the site in a transparent way where one is aware of both elements separately but together 66. D. du Plessis. Edited personal photographs. 2015

32. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 57-83.

Porosity

Getting onto porosity Walter Benjamin suggested that the city is made of movement and that time should be considered an important element of porosity in a system. Porosity as a concept stems from biology where membranes act to let particles through; they process them, carbon dioxide to oxygen for example (33). In a building porosity can mean attracting and then leading through. In the case of the Foreshore Flyover site this leading would be a crucial part of the project.

Porosity suggests that 'containment and release' (34) are not as simple as establishing or eliminating borders. Porosity encourages interpenetration- spaces used for different activities supported by differing programs.

'Porosity, if only as a beginning, provides a way of making space and time work together to define both the urban condition and the body's space within it. Time is integral to the understanding of the urban effect.' (35) Benjamin speaks of the link between space and time- the form of a space will limit what is possible in time- a busy coffee shop versus a university library for example (36). Thus the time one would spend in a place will contribute to how porous it is and what type of filtration it would do. Interest might arise when people from both spaces spill into the same space as all three concepts being continuity, transparency and porosity suggest.

This concept of space and time is closely linked to the foreshore Flyover site. With the small time to space ratio of the high speed freeway, the large time to space ratio of the immediate quiet context and the intermediate time to space ratio of Somerset Road. Each of these zones also has their unique sound influence on the space.

FIGURE 15 Illustrating the difference in time on and below the freeway. 67. D. du Plessis Edited personal Photograph. 2015

33. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
34. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
35. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
36. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

A space can be porous in a number of ways it can be a space such as mentioned in the preface that is visually porous or it might be a space that allows a literal connection through it.

Porosity asks the user to question destruction: is piercing the border destruction of the border or is the border destruction of the space? (37) Thus architecture can be used to activate dead space by encouraging defiance of borders. In this quest linearity is opposed as linearity resists edges rather than puncturing and infiltrating. The filtration process will be to decide what type of continuity will be allowed, will it be visual, light, sound or access and to whom will it provide and to what degree? In the site the concept of transgression of borders is very appropriate. A transgression of the border of the industrial harbour would have been a destruction. When the meaning of the context was changed the border became, and still is, a destruction however the destruction was made retrogressively like a tree who's trunk is deformed by a fence the destruction occurred not owing to the placement of the road but because of the change to the V and A Waterfront, rendering it relatable to the CBD and rendering the road a border to that relationship. Only now is a transgression of the freeway border a positive construction rather than a destruction.

Of course this narrative would be somewhat different in this case as the installation for transgression of the highway would be placed under it hence not physically destroying it. A destruction would occur if transgression of a border took on the wrong form at the wrong time. Originally the elevated highway was used to allow industry access to the oil and quarry which would be a very different link typology from what would be needed on the site today.

37. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

Steven Holl's work suggests that porosity can happen on various levels of the building at various angles adding porosity to spaces in the form of circulation shafts- horizontal, vertical and visual as well as using porosity to let light penetrate space. These various levels of circulation real and imaginary light penetrating at different places with different qualities all interact but do not form a mixture, rather layers of complexity (38).

Holl makes porous space in the sense that suggests a surface for interaction and then lets differing functions encircle it. Another concept Holl is intrigued buy is the relationship of inside and outside of a porous space (39). Because porosity is about attracting flow through how it relates to its context is an important consideration- the surface of a sponge that touches the water. On the inside it may be different.

FIGURE 16 Illustrating Steven Holl's porous space: 68. Phillip Stevens. Steven Holl Completes Reid Building at Glasgow School of Art. [Online] Available from: http://www.designboom.com:8080/architecture/steven-holl-seona-reid-building-the-glasgow-school-of-art-03-05-2014/ [Accessed 28 April 2015].

Walter Benjamin spoke to, 'Urban porosity – porous architecture in which buildings and actions interpenetrate in courtyards forming unexpected events.' (40) Thus porous space needs to be supported by functions that activate this porosity. Hence porosity and function have a link. The link that porosity has with continuous and transparent space suggests fluid form. Thus the link between form and function happens through the filter of porous space. He makes another link to transparent and porous space through his interest in the way we travel vertically through buildings by means of elevators and escalators. This changes our understanding of the space and the links between spaces- layers flow into each other.

38. S. Holl. Reid Building at the Glasgow School of Art, A Conversation with Steven Holl and Chris McVoy. [Online] Available from: https://vimeo.com/101409875 [Accessed 24 April 2015].

39. F. M. Cecilia, R. Levene (ed.). Horizontal Skyscraper Vanke Center. El Croquis, 2014, 172, p. 88-113

40. W. Benjamin. One Way Street and Other Writings. London: Verso, 1985, p. 169

Conceptual Comparative Analysis

Finally it becomes important to understand these notions in relation to each other. There lies a common theme between continuity and transparency being complexity. Both do not seek a single simple answer but seem to address the in-between space as a product of multiple other spaces. Steven Holl's porous space is similar in that it is a space constructed by the surrounding spaces thus a porous space can also be successful as an in between space. The de Waterkant site is a space in between two urban points of interest, two geometries and two urban coves.

The difference between the three arises in their dealing with this complex space. Continuity is a gradation of space, mixing varying space types together (41). On the other hand porous and transparent space is a 'the sum of its parts or at least attention to individual parts enjoys supremacy over attention to the whole' (42) approach; on the one hand unity on the other juxtaposition.

The critique of these related spaces may be when two very different functions are placed next to each other the in between space may be problematic issues of noise levels might be a limiting factor for example.

Porosity and continuity comes into focus through a speed analysis. Continuity is about making form from movement of people and other forces (43). When speaking about porous space Walter Benjamin speaks about creating 'eddies' (44) for differing forms of occupation which 'pulse' (45) through the system. This notion relates to Dagmar Richter's Free House wherein the house loses its traditional meaning because people leave the house to experience a 'home away from home' (46). That notion is of interest in terms of making a space hospitable, making a space porous because people feel comfortable in it, an 'eddie' (47) in a public space.

This concept is of importance to the site as there are two layers of movement currently. On the freeway above there is complete continuity. The only way to stop or justification to slow down is if there is an emergency with your car while below it, in the street which passes perpendicular to the freeway, one may chose how to be affected by the continuity of the street.

In trying to understand the difference between porosity and phenomenal transparency it is noteworthy that transparency is about understanding space- the relationship of inside and outside. The user will understand when he is inside and when he is outside but still be able to understand the territory that he is outside of. Porosity encourages a breach of these borders (48). When one is able to understand how space works one should be able to filter through it at will. Porous space is about movement and transience, transparent space is about understanding movement, understanding how the viewer fits into the context.

41. P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.
42. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 119.
43. L. Spuybroek. NOX. London: Thames and Hudson, 2004, p. 2-13.
44. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
45. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
46. A. Benjamin. Armed Surfaces Dagmar Richter, Architecture and Urbanism. 2004, 5, p. 20-27
47. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.
48. G. Hartoonian (ed.). Walter Benjamin and Architecture. Oxon: Routledge, 2010, p. 39-50.

De Botton's contextual meaning of form has a relation to continuity of the site into the elements of the proposed new insertion (49). But the site intrinsically speaks to transparency as a 'both and' (50). This can be said as the site is surrounded by buildings of the industrial history of the site repurposed as restaurants and offices of the new context. And the same will be true of the freeway as it will always be a marker of an industrial area cut off from the CBD. So it can be said that the elements of the site are transparent but an insertion would have value as continuous.

De Botton also spoke of balance (51) and this has a relation to continuity. Of course juxtaposition also has a strong relation to balance in many cases. When juxtaposition is planned it is often to bring balance to a system. The value of continuity in this project could be to bring the juxtaposed site into balance.

Continuity is applied relationships between elements one element influences the next and so on. Transparency implies relationships through layering two differing systems, it relies on interpretation.

Time has a bearing on each of these concepts. Time influences how porous a space is; how many people will enter, how fast they will pass through, how freely they can enter and leave. Continuity can change the user's perception of time through encouraging movement through spaces via gradation and emphasis on movement routes. Transparency takes it's relation to time from the cubist concept of time being an implied entity. A cubist painting displays multiple sides and angles of a single object. We would ordinarily be able to experience this only by adding an element of time and rotating the object. Hence one view implies an element of time. Transparent space gives a view of multiple spatial overlays in a single moment thus the time of a transparent space does not rely on navigating it.

After analyzing the site, concepts of transgression of borders and relatedness to context will be able to inform a project that can act as a catalyst for further development in the city. In so doing creating a continuity through the city where points no longer act in isolation, where one point develops, the supporting space morphs to partake in the same discourse.

49. A. de Botton. The Architecture of happiness. London: Hamish Hamilton, 2006, p. 78-100.
50. W. Oechslin, C. Rowe, R. Slutzky, B. Hoesli. Transparency. Basel: Birkhauser, 1997, p. 119.
51. A. de Botton. The Architecture of happiness. London: Hamish Hamilton, 2006, p. 78-100.

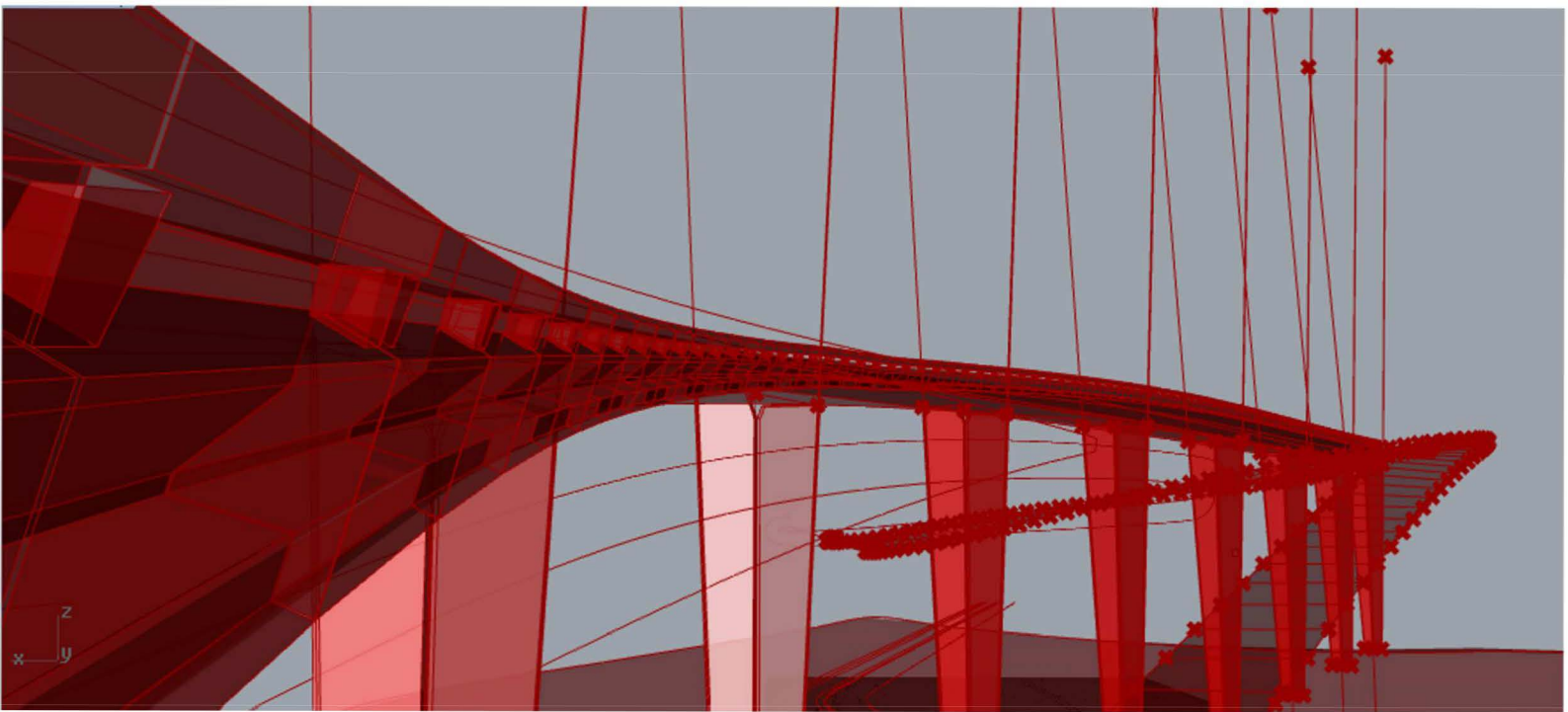
DEVIN DU PLESSIS

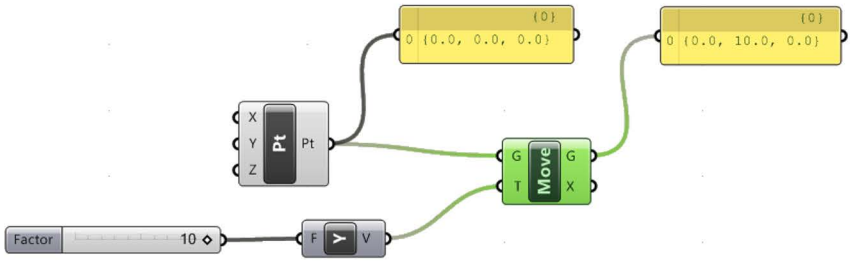
UCT MArch(Prof) Student

TECHNOLOGY PAPER
PARAMETRIC TECHNOLOGY

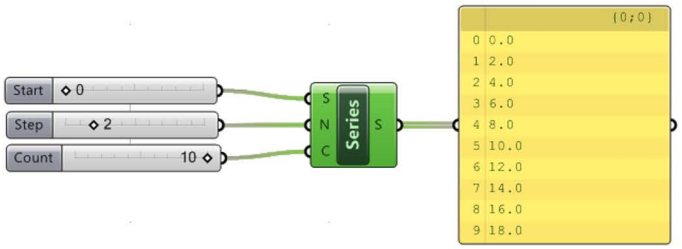
APRIL 2015

APPENDIX B



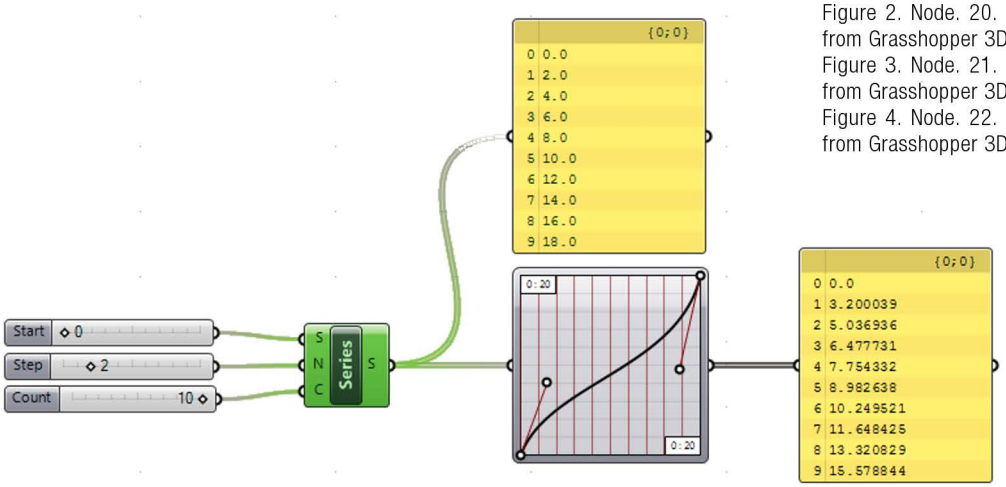


Move function: move and copy notice the change in y value in yellow panel (x, y, z)

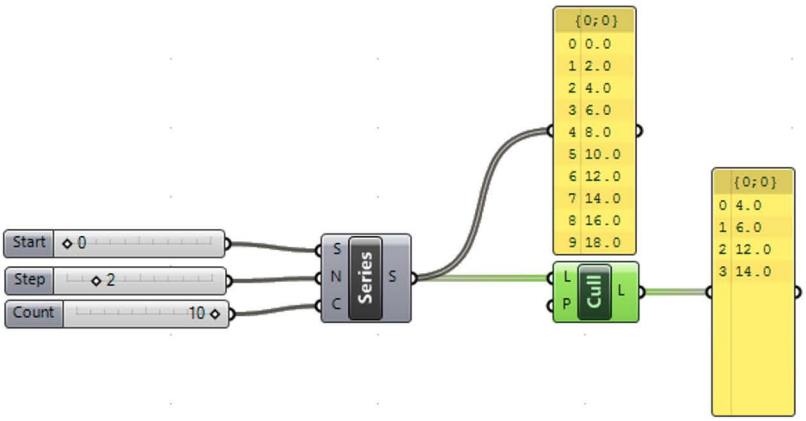


Series Node: generates multiple numbers notice the list always starts with 0 in yellow panel

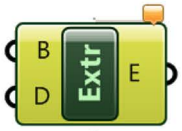
Figure 1. Node. 19. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 2. Node. 20. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 3. Node. 21. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 4. Node. 22. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015



Graph Mapper Node: skews numbers from series notice the number change in yellow panel



Cull Node: Chooses numbers from a list. The standard setting is 'False, False, True, True' therefore it will skip two numbers then select two notice the results in yellow panel



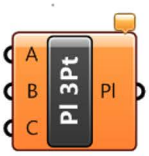
Extrude Node: Will give a flat surface depth

figure 5

Loft Node: Will link two lines with a surface

figure 6

Figure 5. Node. 23. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 6. Node. 24. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 7. Node. 25. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 8. Node. 26. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015

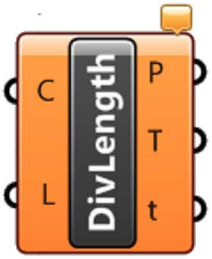


Plane 3 Point Node: Forms a plane from three points

figure 7

Orient Node: Will orient one plane to match another

figure 8



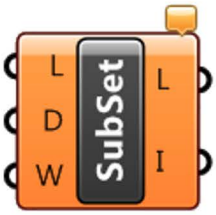
Divide Length: Divides any line into parts of specified distance and marks them off with points

figure 30

Z Vector: Changes a value into a directional value ont he z axis

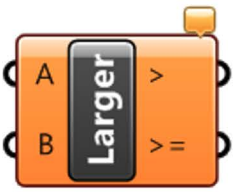
figure 31

Figure 30. Node. 27. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 31. Node. 28. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 32. Node. 29. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 33. Node. 30. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015



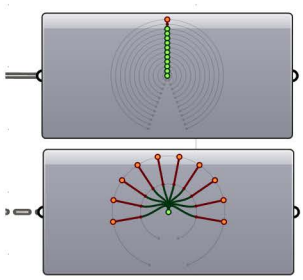
Sub List: Selects a group of values from a list

figure 32



Larger Than: Evaluates if a value is larger than another. Out put is 'True' or 'False'

figure 33



Branches: DATA structures associated with grouping

figure 34

Length: Measures lines

figure 35

Figure 34. Node. 31. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 35. Node. 32. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 36. Node. 33. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015
Figure 37. Node. 34. D. du Plessis. Edited Image from Grasshopper 3D Software. 2015

Point Deconstruct: Breaks a point into its x,y,z values

figure 36

Construct Point: Combines x,y,z values

figure 37

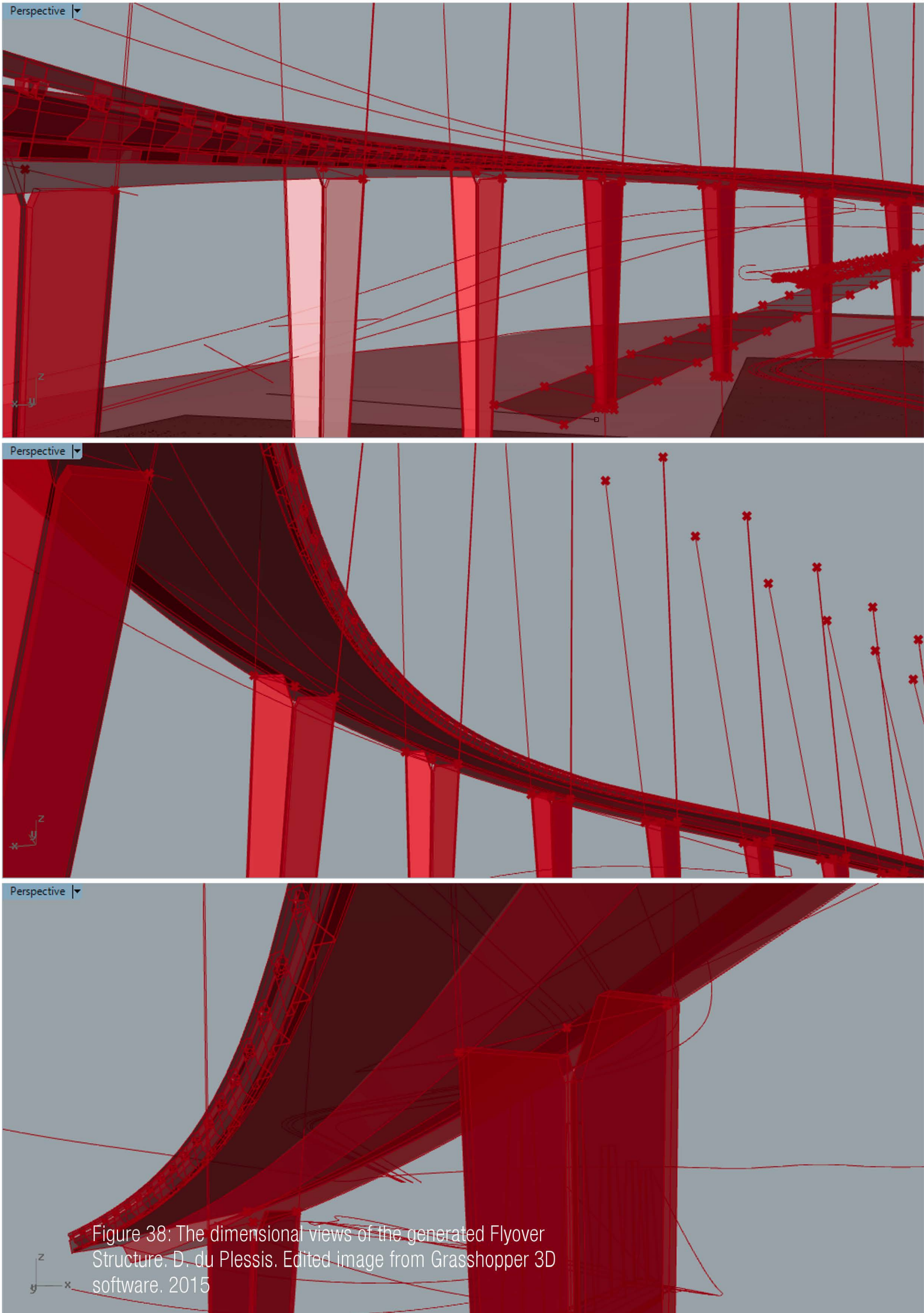


Figure 38: The dimensional views of the generated Flyover Structure. D. du Plessis. Edited image from Grasshopper 3D software. 2015

Preface

In research it is always best to acquire knowledge that will prove to be reusable. As a base of this paper I have parametrically constructed an element on site in so doing I gained much insight into the possibilities of parametric modeling. This has proven to be immensely challenging but as with any challenge also immensely rewarding and exciting. This modeling will later become a design tool but the modeling of a pre-existing structures is in itself a design task as one has to design the DATA flows which will be elaborated on later in this paper. While I have invested time in researching the subject in books much of my research has been hands on experience using the technique in relation to the physical site of my inquirey this year. Additionally the site, that I have discussed in a paper written about theoretical aspects of the project that this paper is based on, is the Foreshore Freeway also referred to as the Foreshore Flyover situated in de Waterkant around Cape Town's foreshore. It is distinct by its incompletion which is why this flyover ends abruptly.

Introduction

This paper will technically analyse parametric design. Firstly this will be done by looking at the aims of parametric design and the benefits. Thereafter an analysis of a parametrically designed structure will be of focus. The process will be analysed in terms of differing techniques for parametric modeling and will be skewed by my increasing experience as the project progressed which I will make the reader cognizant of. Through this paper I will try to dispel the myth that the designer using a parametric design tool breathes life into a machine which then generates the design for the designer. I will also try to express the freedom of parametric modeling- the designer will chose what the 'unknowns' are. I use the word unknown tentatively because in reality the design must have a very clear picture of the design before he or she begins or he or she will simply not be able to set up a coherent parametric system. When a system is not coherent it fails meaning that the designer is presented with a blank screen where a design was expected to be.

What is Parametric Modeling?

Parametric modeling is any type of model making wherein parameters are applied to a system to give it form that is particular to those parameters. Frei Otto modeled parametrically with his soap bubble form finding and his wet wool form finding. Herein he set up a system of points and curves then applied a rule- any form generated must comply with the constraints of a skin such as a bubble or wet wool. (1) Antonio Gaudi applied the same though process when designing the Church of the Sagrada Familia. Here he set up a network of stings and then hung weights at strategic points so as to give the form catenary based parameters. (2)

This type of modeling can also be done by means of the computer. Because of the computer's ability to process much information quickly if one can find the rules of the parameters one wishes to impose and abstract them mathematically the computer will be able to generate models following parameters in a similar way to Gaudi and Otto. In this paper parametric design will refer to computer aided parametric design.

Figure 9. Catenary form modeling by Antonio Gaudi. 36. ITA Project. Antonio Gaudi, Sagrada Familia, Barcelona – Spain 1883- (unfinished). [Online] Available from http://www.itaproject.eu/TTU/6/sagrada.html [Accessed April 2015]

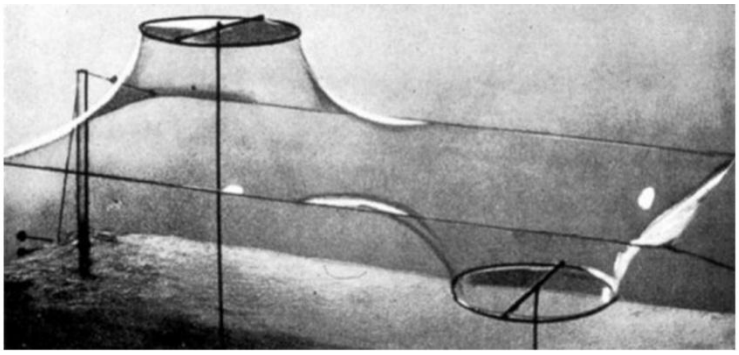


Figure 10. Soap bubble form finding by Frei Otto. 37. K. Watkins. Frei Otto and the Importance of Experimentation in Architecture. 2015. [Online] Available from http://www.archdaily.com/610531/frei-otto-and-the-importance-of-experimentation-in-architecture/ [Accessed April 2015]

(1) K. Watkins. Frei Otto and the Importance of Experimentation in Architecture. [Online] Available from http://www.archdaily.com/610531/frei-otto-and-the-importance-of-experimentation-in-architecture/ [Accessed April 2015]

(2) ITA Project. Antonio Gaudi, Sagrada Familia, Barcelona – Spain 1883- (unfinished). [Online] Available from http://www.itaproject.eu/TTU/6/sagrada.html [Accessed April 2015]

There are three main types of computerized parametric modeling software- graph, algebraic and propagation. (3) The system to be analysed in this paper is the propagation based software type. The way that this type of system works is that the designer will set up a rule system and certain known information, the computer will then fill in the remainder of the unknown information. (4) The way that this type of system works is that a set of 'nodes' (5) are placed together and arranged into 'graphs' (6). The nodes are connected with 'paths' or 'chains' and lead to 'schema' (6). Schema is a word used to describe points on an x,y,z coordinate system.

What this all means is that the designer may start by making a point. He will feed x,y,z coordinates into a node. The node will then understand exactly where in space the designer wants the point to be. From there the node may be moved to another location. It is important to note that 'move' in Grasshopper means 'copy and move'. Thus the designer will now have two points. He may then add another node which will link the points with a line. The points and line are representations of the 'nodes' (7) and the system is called a 'graph' (8).

The next point to understand is that parametric modeling is all about DATA management. To explain; when the designer wants a grid of points he will make a graph of nodes that will simply generate a list of numbers which he will be able to manipulate. He will then link this list of numbers into x,y,z coordinates of a point node. The list of numbers will then be transformed into a list or coordinates which will be represented by a group of points. It is then possible to manipulate the points on the z axis for example. The designer will then use DATA management to manipulate the correct group of numbers so that the points will only be manipulated on their x component and the design may opt to manipulate them varyingly.

Of course doing this manually will take an indescribable amount of time and will result in many inaccuracies. The beauty of parametrics is that once the designer has set up the relationships of the system he can manipulate it by changing one number input, for example.

Hence it can be said that parametric design is accurate form creation by means of mathematical relationships.

(3) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20
(4) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20
(5) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20
(6) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20
(7) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20
(8) Robert Woodbury. Elements of Parametric Design. Routledge, Taylor and Francis Group, 2010, p. 5-20

What is the value?

There are three main reasons that parametric architecture is valuable. The first is articulated freedom, the second 'elegance' (9) and the third surprisingly is contextual relatedness.

The reason that parametrics can be called articulated freedom is that the designer needs to be very clear about the relationships of the parts. While very interesting things are possible with paramtric design the designer has to be very explicit with what he wants achieved. For example in modeling the Foreshore freeway it was necessary for me to have a column that would be asymmetrical with on half taller than the other meeting in the center with a 'v'. Because the column was to be placed in such a way that it would have varying heights and varying degrees of asymmetry I had to have a very clear understanding of how the two halves related to each other, to the road structure and how the 'v' would relate to the column. In this case it is a trivial matter however this type of understanding of how geometries relate means that the architects has a clear understanding of his design and is able to explain it clearly. These relationships may be as to how the building applies to the site, how the internal relationships are configured or even the organization of the façade.

While the relationships are very rigid because they are so explicit, the form need not be as determined. The amazing thing with parametric design is that the relationships can be applied to a variety of parameters. For example one way of working is the draw a simple surface in Rhinoceros (this is the three dimensional software that acts as a platform for Grasshopper, the parametric plug in). This surface will then be imported to Grasshopper where a number of processes will be applied to it, for example applying a triangular grid of 50mm diameter tube to the surface. When that relationship has been set up the designer can change the surface or even replace the surface and the triangulated structure will take on the form of the new surface. Thus the relationships are highly articulated but the overall form is made free for the designer to relate to another set of parameters which may be adjusted later in the project as larger space is needed or a higher roof for example.

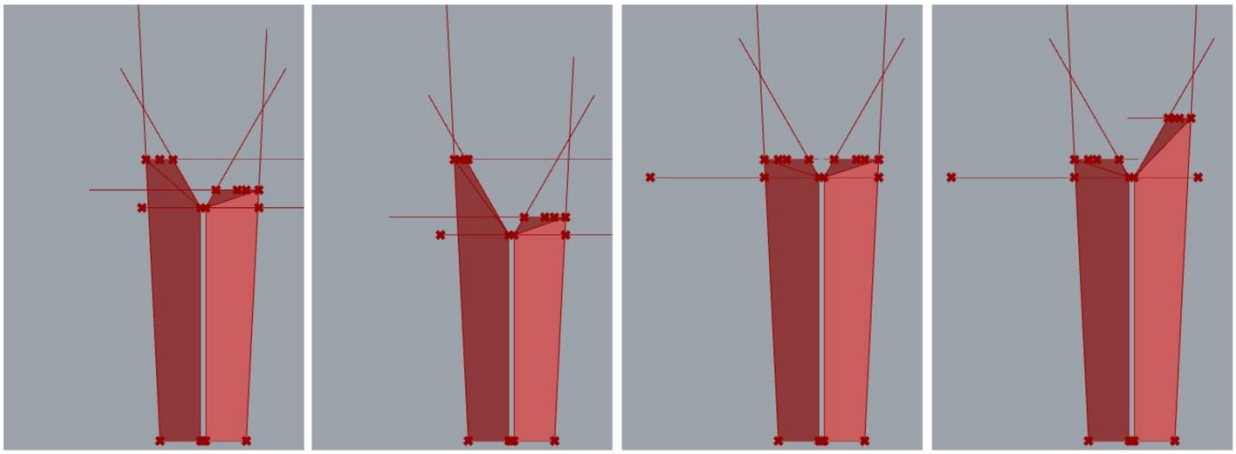


Figure 10. Column construction of the Foreshore Freeway illustrating internal relationships. 38. D. du Plessis. Edited Image from Grasshopper 3D software. 2015

(9) P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 628-629.

There is yet another way that freedom can be achieved is by relating structural elements to variable inputs, thereafter relating the system to those structural elements. Once the design is complete the designer will be able to change those inputs and change the form.

Hence while the designer is very clear on the relationships of the project and how things relate to each other, the project has as much flexibility as at sketch design phase throughout the project. This can be said although the designer would have to test changes to the design on an initial simpler version of the model first as once many components are added to the design the adjustments happen very slowly as the computer has to calculate the change through thousands of elements.

When elegance is mentioned it is by the definition of Patrik Schumacher. This means that there is coherence in a complex system such that it leads to a harmonious whole. With Baroque, elements were inserted that needed opposing elements to achieve symmetry and harmony, such as the split gable. The whole system related globally. There is a link between parametric architecture and Baroque architecture in that there is a global relatedness and dependency in the system (10). Parametric architecture relates surface elements to one another through a deformation using various formulae thus parametric architecture takes a relatedness of a system and a continuity from Baroque and applies 'Continuous differentiation, iteration and mass variation' (11). Parametric architecture speaks to the concept of continuity. This continuity can bring coherence and elegance to a complex system.

(10) P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

(11) P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.

Baroque also had a keen interest in geometry. Looking at Borromini's San Carlo Alle Quatro Fontane it is clear to see that very particular attention was paid to the ceiling geometry generation in much the same way that I used in the generation of the Foreshore Freeway parametrically (Figure 11). Of course geometry and proportion is not particular to Borromini or even Baroque architecture and was the focus of architecture from ancient Greece right up to the modern master himself, Le Corbusier (Figure 12). Thus parametric architecture is somewhat of a return to an architecture concerned with a measurable success of formal arrangement.

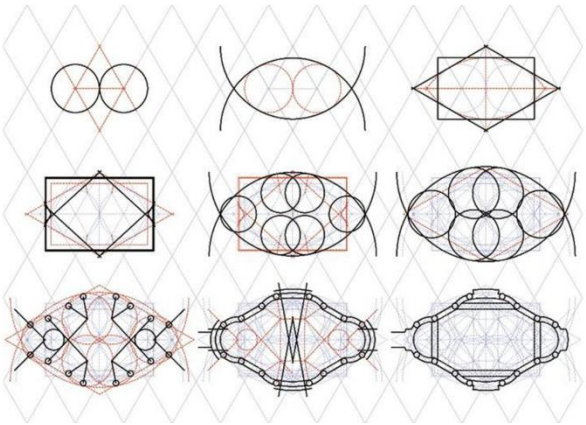


Figure 11. Geometric construction lines of Boromini's San Carlo Alle Quattro Fonatane. 39. Pixshark.com. San Carlo Alle Quattro Fontane Section. [Online] Available from http://pixshark.com/san-carlo-alle-quattro-fontane-section.htm [Accessed April 2015]

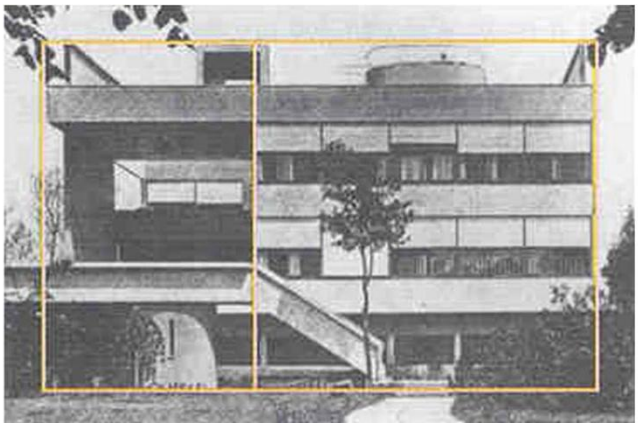


Figure 12. Geometric construction lines of le Corbusier's Villa Garches. 40. Z Karian. Villa by Le Corbusier, 1887 – 1965. 2007. [Online] Available from http://personal.denison.edu/~karian/goldensection/page5.html [Accessed April 2015]

The question now arises, what is the relevance of fitting into a Baroque discourse of continuity and inter-relativity? It places parametric design into an architectural discourse rather than letting it slip into a category of engineering or another type of logistics management. While parametric design can be used by engineers to understand a structure it is important to a designer that his tool falls within his respective field. As will be discussed below it becomes easy for parametric architecture to become an exercise in whatever discipline shaped its environment, thus it is crucial to articulate the architectural discourse that parametric architecture falls under.

Lastly parametric architecture can be related to contextual integration. This is the process that I have engaged through construction the Foreshore Freeway. Through this process I have been able to engage the site by understanding the design processes that lead to the flyover. By this process I am able to copy the code that generated the form for the most prominent feature of the context. Because of generative coding being adaptable it means that the parameters which led to the creation of a particular context can be changed to fit a new installation.

What this enables is for the researcher to extract layers of key DATA from the site. These can then be combined for the generation of a new element to be installed on site. It will then be shaped by the site in a more rigorous, definable way. By extracting processes rather than top and bottom of concrete slab lines, for the generation of a façade for example, the new insertion can be contextually appropriate in less obvious way; as if grown from the site rather than made to match.

Point and Curve Generation

Starting with an analysis of the plan of the Foreshore Freeway a number of elements became clear in the generation of a road. The clue came from markings on the drawing BTC, BCC, ECC and ETC. These stand for Beginning of Transition Curve, Beginning of Circular Curve, End of Transition Curve and End of Transition Curve (12). What this means is that at each elbow on a highway specialized curve systems are utilized. A circular curve is responsible for the main and central bend but there is a need for curves that transition from the straight to the circular curve. The reason for these curves is that there is centripetal force acting on a vehicle moving around a circular curve which is a significant outward force; transition curves allow the vehicle to gradually accelerate into the curve, meaning that the outward force is gradually applied making travel more comfortable and safer (13).

To begin a setup geometry was needed. This process started in AutoCAD. A three point curve was used to trace along the circular curves. These made finding the centre of the circular curve possible which was needed in the first process of transition curve generation.

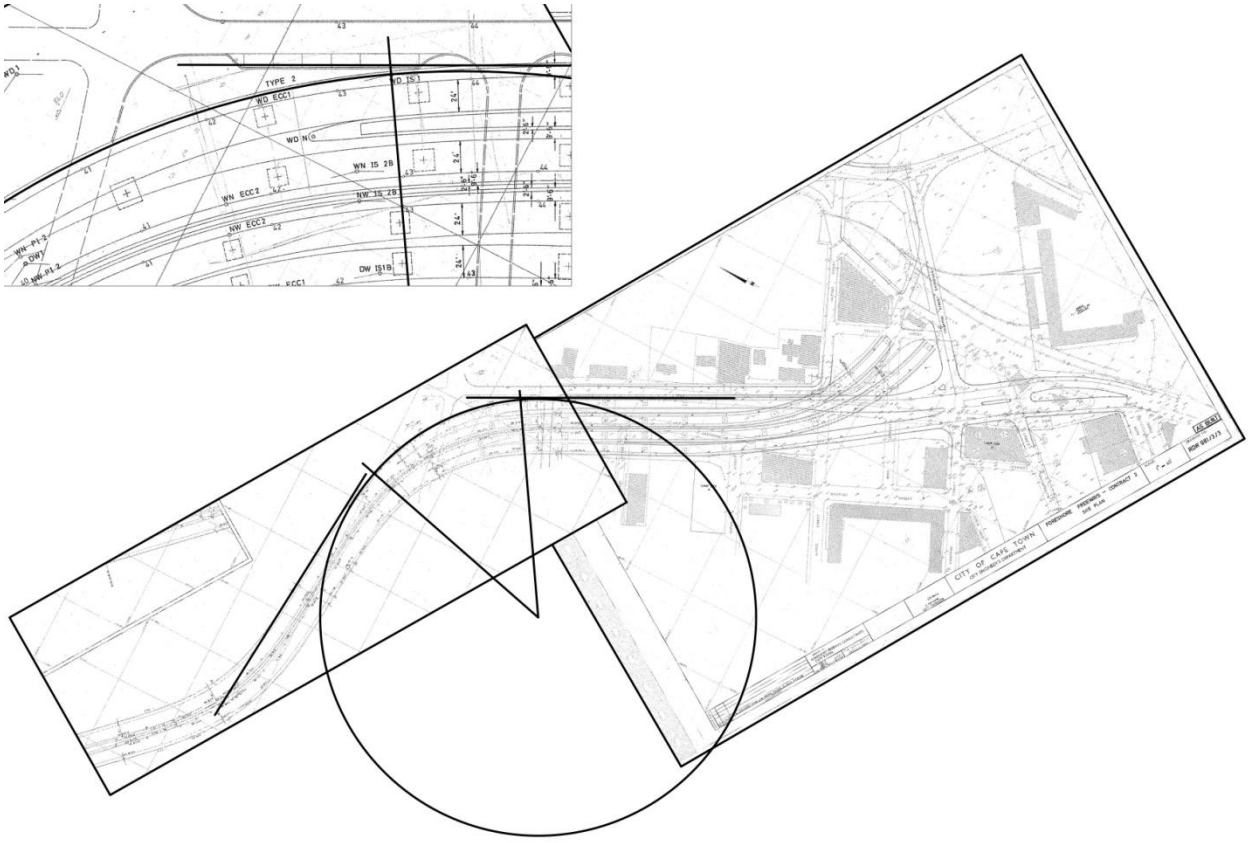


Figure 13. Centre point finding. 41.D. du Plessis. Edited image produced in AutoCAD. 2015

(12) yougo. Curve- detailed description [Online] Available from http://yougo.rtri.or.jp/dic/en/figureList.jsp?Figure_id=17 [Accessed March 2015]

(13) Swinburn Commons. Transition curves (MathsCasts). 2012. [Online] Available from https://www.youtube.com/watch?v=dbC-zk5N46k [Accessed March 2015]

One of the most convenient things about parametric design is that when other designers are dealing with similar design challenges as you code sharing becomes a valuable resource. However it is not always the case that other designers will be dealing with exactly the same design discipline as you and so adaption of their code is necessary.

To this end I downloaded some open source code (14) for transition curve generation in Grasshopper. This code is very accurate and enables the designer to generate a very long curve without losing any accuracy. The package works by the designer programming the type of transition curve he wants by adjusting two numbers. These are mathematical parameters for this code which meant that the curves would have to be generated to match by eye as the usual DATA such as transition curve length was not an input parameter of the transition curve generating code as noted by the tags labeled 'number of rotations' and 'Rotation in Radians' (figure 14).

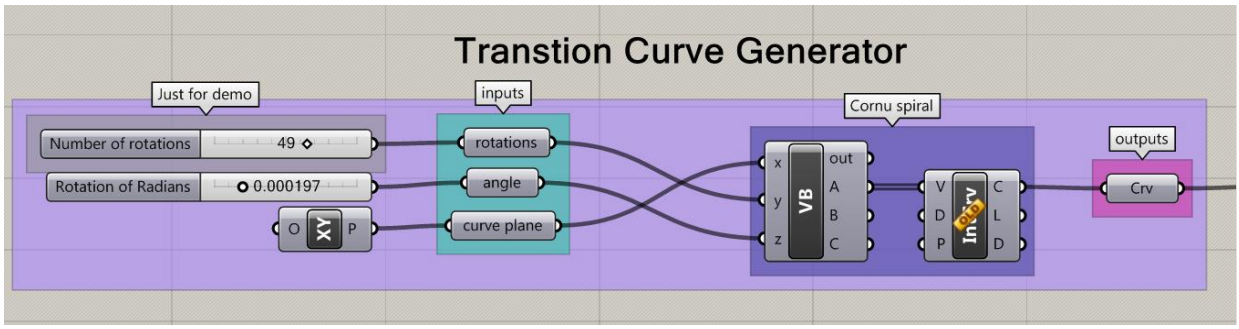


Figure 14. Illustrating the code that produces a transition curve. 42. D. du Plessis. Edited image from Grasshopper 3D software. 2015

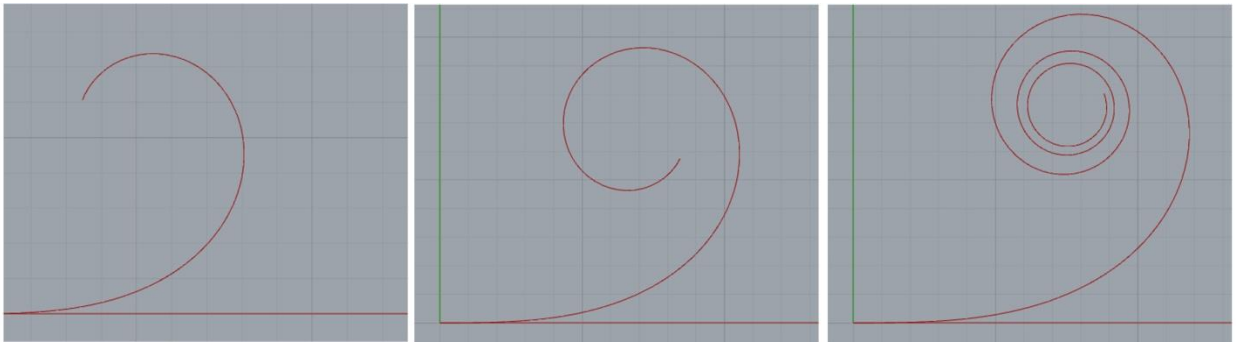


Figure 15. Illustrating Transition curve generated by the copied code. 43. D. du Plessis. Edited image from Grasshopper 3D software. 2015

(14) M. Netterbladt. The Geometry of Bending http://thegeometryofbending.blogspot.com/ Marten Netterbladt. [Online] Available from http://thegeometryofbending.blogspot.com/2008/11/cornu-spiral-in-grasshopper.html [Accessed March 2015]

This DATA meant that two numbers were processed mathematically to produce and number of points, these points were then linked with a curve. Next the curve had t be scaled, mirrored to point in the desired direction and then moved and rotated into place. Scaling is done by eye once the curve is in place. To get it there a line is chosen for the curve to feed off. The line's angle off the x axis is the angle that the curve would have to be rotated by. A point is placed on the line with the function evaluate curve and this point's x and y information is used to move the curve from its origin at point (0;0).

At this point there is a short line with a transition curve leading to a circle so the next thing to do would be to generate the exit curve and extend the straight line. Now another problem with this code becomes apparent in that it is impossible to generate a longer curve with the same diameter circular curve. What this means is that the entrance and exit transition curves have to be of equal length, in this case that was fine as the transition curves have the same length according to the curve DATA on the engineer's drawings. So the next thing to do was to mirror the initial curve and circle and then to rotate the new circle until the transition curve matched up to a straight line at the appropriate angle. Once that was done points were placed on the end of each transition curve and on the circle such that a three point circular curve could be placed between the transition curves and the generated circles hidden.

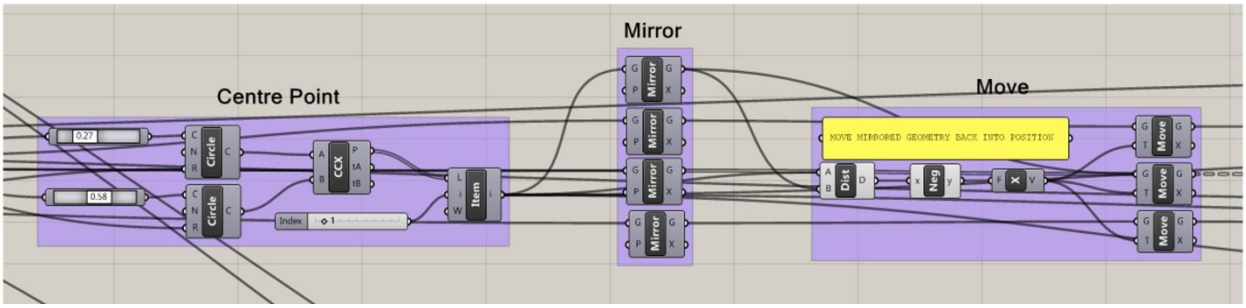


Figure 16. Code used to mirror transition curves, retrospectively the move function can be removed simply by using the point function of the mirror nodes. 44. D. du Plessis. Edited image from Grasshopper 3D software. 2015

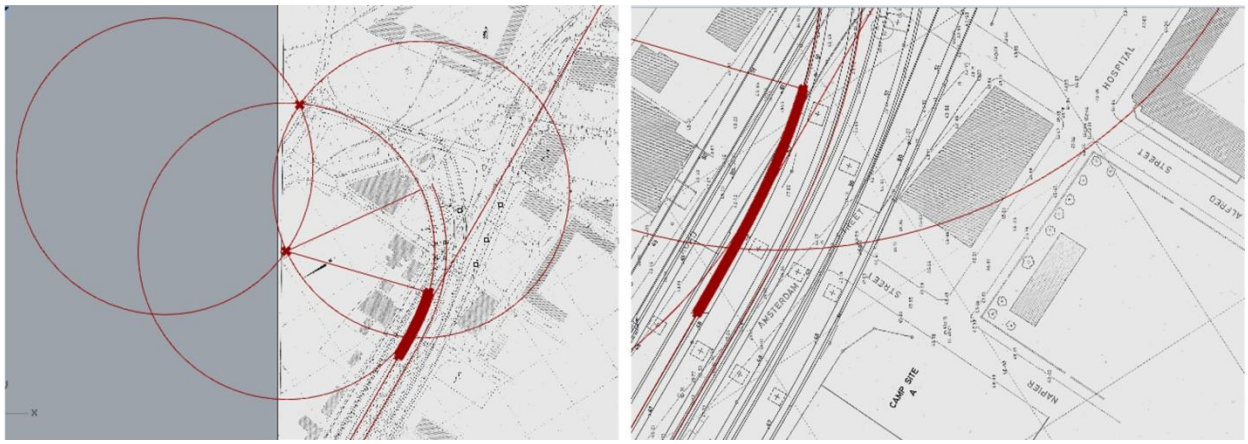


Figure 16. Transition curve generation and circle centre geometry. 45. D. du Plessis. Edited image from Grasshopper 3D software. 2015

Thus a line- transition curve- circular curve- transition curve- line geometry was formed with accurate mathematical curves according what the road engineers would use. The problems with the process was that the code did not have the necessary parameters as inputs and thus had to be improvised which would lead to an ever so slight deviation from the initial plans, although the internal parametric relationships were still intact. The other problem area was that there was no way to generate one size circle with different transition curve lengths meaning that symmetrical transition curves were only possible.

The next process was the offset process. Let us call the above step the Initial Curve. In modeling the freeway the initial curves are next to each other at times and form the basis for the offsets. Thus a line is drawn perpendicular from the initial curve into the other. The intersection point is taken and the distance learned. This is then plugged into the offset algorithm and each line segment is offset.

At this point there were transition curves but they were not completely accurate and had to be symmetrical, however that part of the freeway was complete and offset.

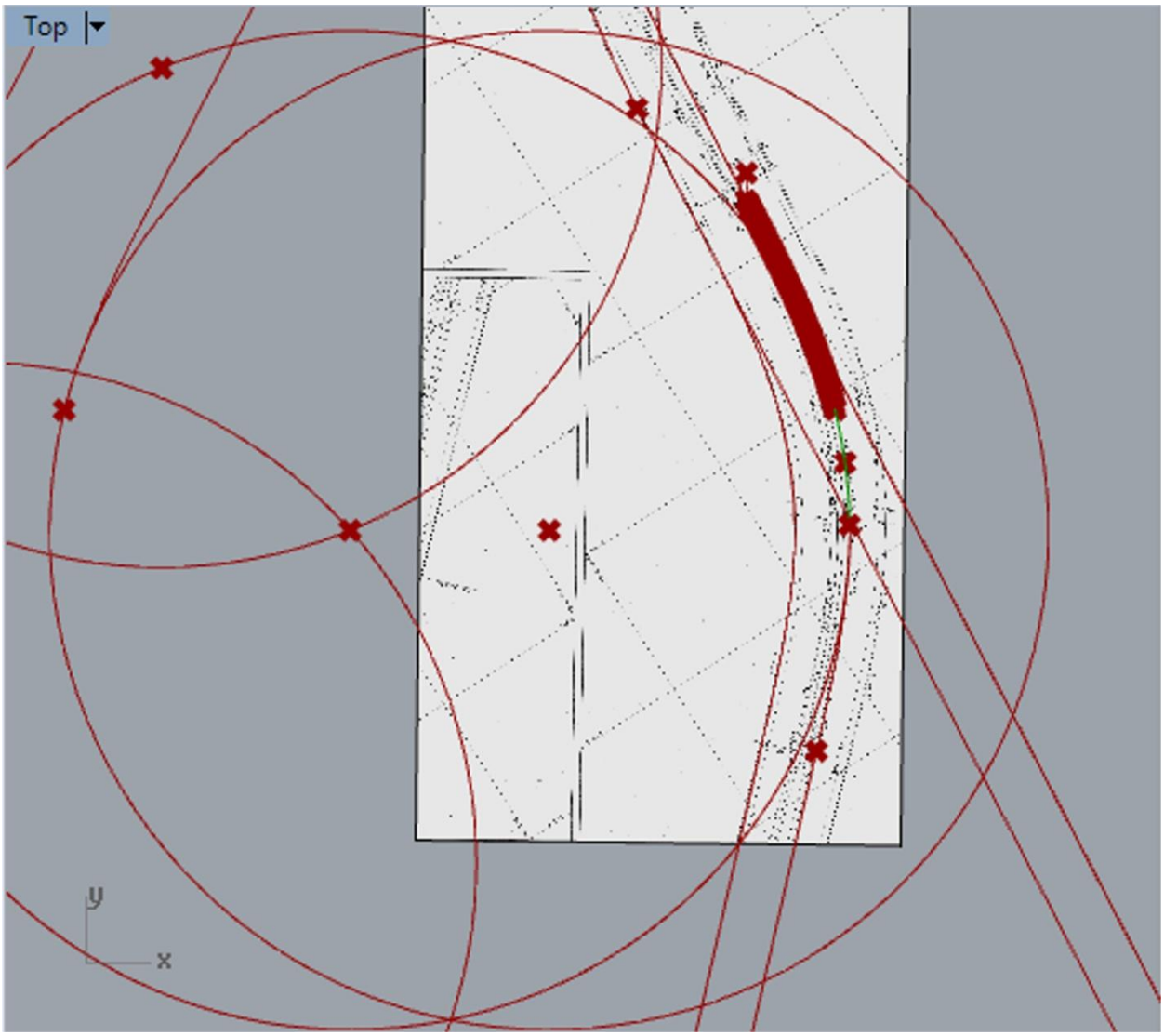


Figure 17. Symmetrical transition curves with three-point curve connector. 46. D. du Plessis. Edited image from Grasshopper 3D software. 2015

The next process is another way of generating transition curves which would be applied to different parts of the highway. The first thing to do was to set up the formulae that lets one find the circle centre point and any point on curve. When a series of numbers is fed through the formulae that gives you points on curves you end with multiple points along where the transition curve is. These points are then related and a curve joins them. Also a circle is then placed where necessary. The input information is now exactly what I had- transition curve length and circle radius. These points are described by the formulae:

$\theta = (s^2)/(2rL)$

$x = s-((s^5)/40r^2L^2))$
$y= ((s^3)/(6rL))-((s^7)/(336r^3L^3))$

$h = x-r\sin\theta$
$k = y+\cos\theta$ where (h; k) this is the centre point of the circle (15)

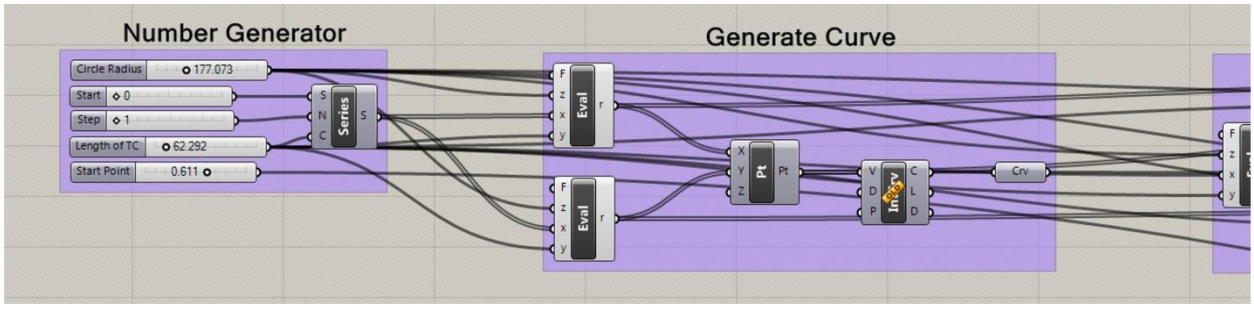


Figure 18. Curve generation- the formulae shown above as x and y are programmed into the 'Evaluate' nodes then lead into the 'Point' node. 47. D. du Plessis. Edited image from Grasshopper 3D software. 2015

This transition curve and circle are generated, scaled by 1000, moved and rotated into place.

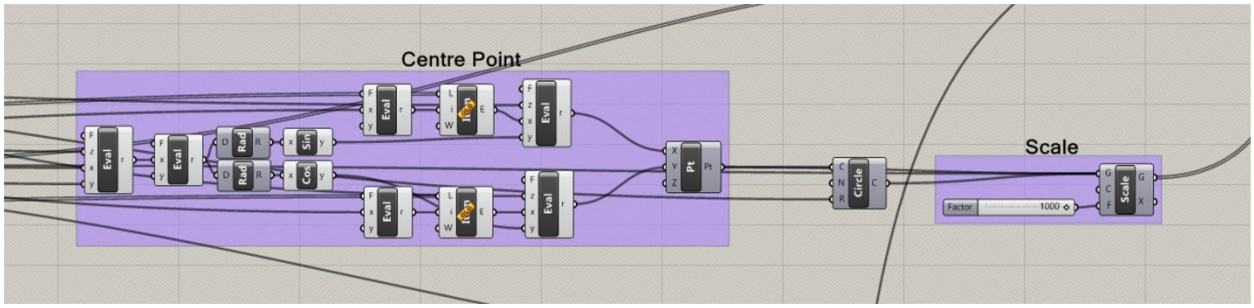


Figure 19. Centre point generation, the remaining formulae are programmed into the 'Evaluate' nodes; the circle is then generated from the centre point with the radius control shown in figure 18, the radius relates to the formula as a whole. 48. D. du Plessis. Edited image from Grasshopper 3D software. 2015

(15) Swinburn Commons. Transition curves (MathsCasts). 2012. [Online] Available from https://www.youtube.com/watch?v=dbC-zk$N46k [Accessed March 2015]

The next process is slightly more difficult. Being that the circle's diameter can be fixed it would now be possible to generate differing transition curves for the same corner. There is however a problem; as the transition curve length is changed the circle changes position. Thus if a copy of the original transition curve were to be mirrored, such that there were to be a second transition curve leaving the circle, the second transition curve would move out of alignment of the circle as soon as the length of it were to be changed.

Thus what was needed was that the original geometry be mirrored. Next the distance between the initial circle and transition curve and the second circle with transition curve of different length be evaluated. The technique used was to measure between constants that were to remain in the same place- being the circle centre. As the second transition curve is generated and the circle moves off the original point the movement is tracked. This tracked movement is fed into a copy of the second geometry moving it back into place. The result is a transition curve that grows while the circle stays in place. The resultant geometry is rotated such that the straight line is at the right angle. This geometry is then offset by the same distance as with the rest of the roads.

This process being the first real challenge of parametric design meant that many mistakes were made. In DATA management one should be sure that all DATA matches and comes in order in a steady flow. What I mean by that is that if a line with many curves were to be constructed it should be done using one technique with an understanding of line directionality. My lines are very messy from a DATA perspective multiple curve drawing techniques were used and at the time I was unaware of the import of the start and end of a line. The curves and lines described that led to each road edge had curves with differing directionalities.

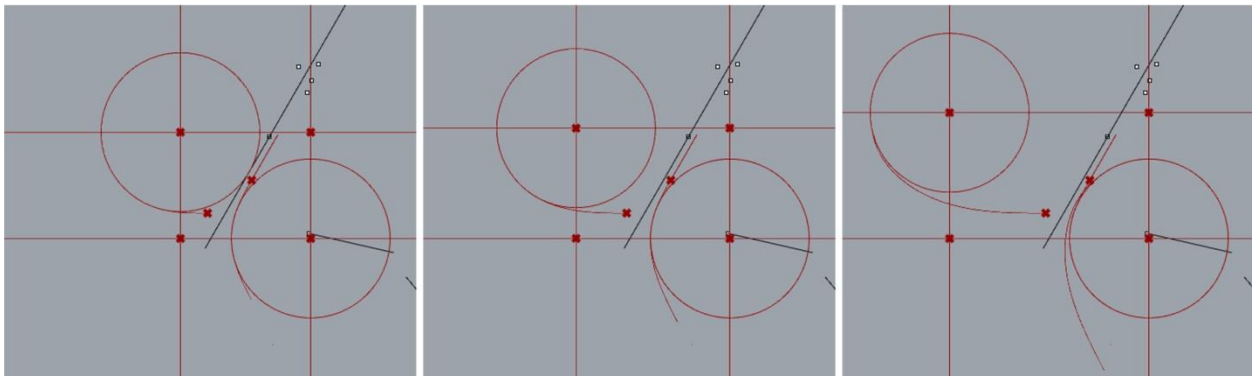


Figure 20. Top circle is the base geometry notice how the circle moves as the transition curve is generated while the bottom circle stays still and the transition curve propagates out, Mirrored geometry not shown. The transition curve now propogates from the circle. 49. D. du Plessis. Edited image from Grasshopper 3D software. 2015.

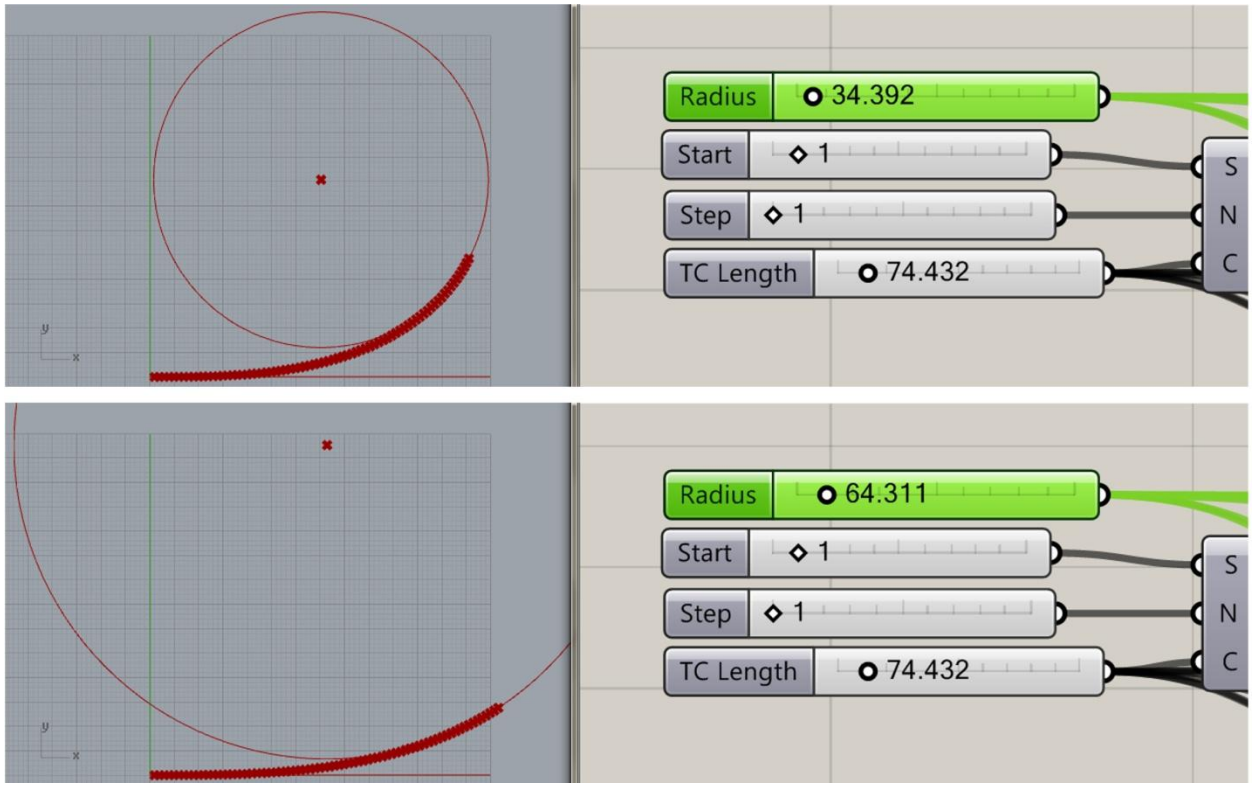


Figure 21. Transition curve generated by formulae shown before. Circle radius adjusted. 50. D. du Plessis. Edited image from Grasshopper 3D software. 2015

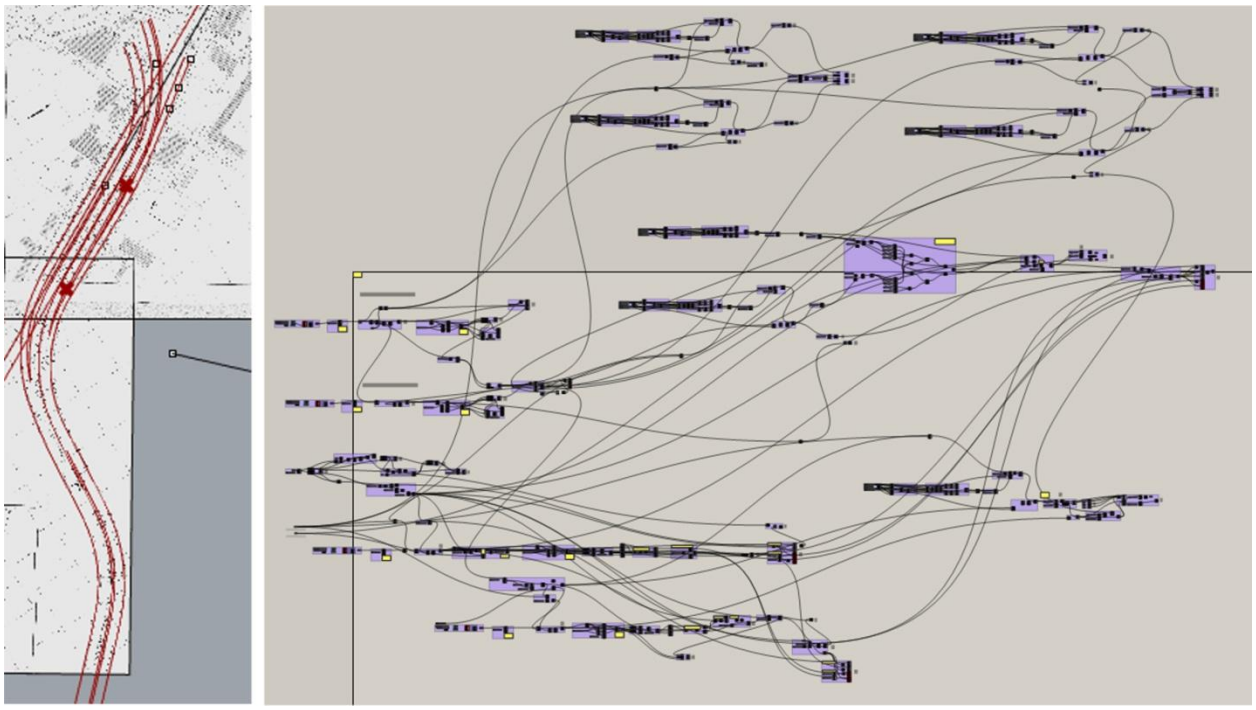


Figure 22. Freeway's base geometry with the generating algorithms. 51. D. du Plessis. Edited image from Grasshopper 3D software. 2015

Setting up for the vertical properties was the next step. Thus the next step in the process is to unify the curves and create fresh DATA owing to the complex initial process. To do this all the curves were re-divided into points along the generated curves. What this resulted in was a non-continuous division. This is owing to the fact that the division tool divides curves of varying lengths into equal segments so through the whole line, as a collective, the divisions change. Hence the irregular point were interpolated and joined with a curve, this was in order to make a line composing of many curves and straights as one element. This collective line was then re-divided using the 'divide by length' **(figure)** node. This resulted in lines with equally spaced points along the collective.

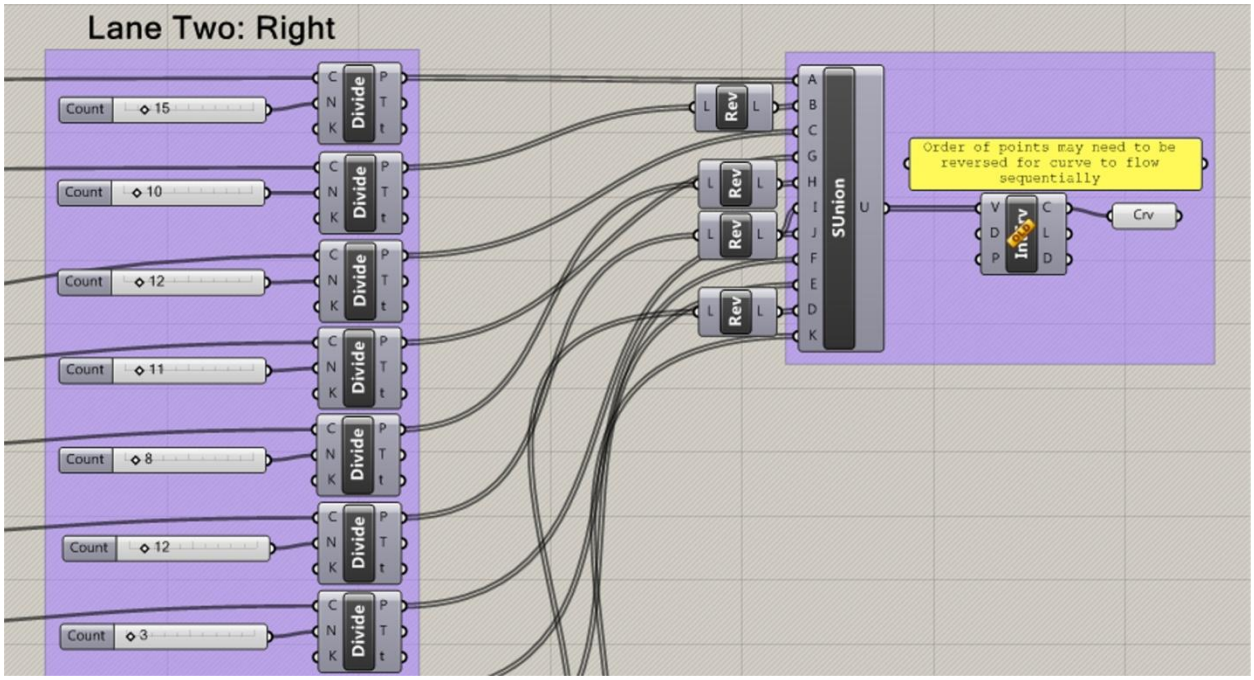


Figure 23. The curves are divided individually, direction corrected, united and then interpolated for a continuous curve to connect them. 52. D. du Plessis. Edited image from Grasshopper 3D software. 2015

That spacing was crucial for the next process which was to introduce a new set of values to control the heights of the points. The way that this is done is by creating a series of numbers. These numbers would then be fed into a 'move' (figure 1) node with a 'z' **(figure)** line of movement parameter. Thus point one would move up by 344mm and point two 2 x 344mm and point three 3 x 344mm and so on. This of course resulted in a line with a constant gradient which is to say that the curve that would be generated from these points would be equivalent to a large ramp. Which explains the need for the points to be equally spaced; if they weren't there would be varying gradients along the line which would be impossible to manage in the next step.

Because the output was a line curved in plan with a constant upward gradient the values fed into the y component needed to be manipulated. The manipulation is done in a very interesting way with a node called 'Graph Mapper' (figure 3). This node manipulates each value to a varying degree and the designer has control over it by means of a graph. I used a Bezier graph which is a graph which allows the designer to manipulate it by hand. To manipulate the points I used two graphs connected to each other which allowed me to get the correct form by means of the two graphs' interference.

To understand how the points needed to be positioned I positioned points on the land surveyor's point-height drawing which I manually manipulated to be at the correct height above sea level. I then used the 'Graph Mappers' (figure 3) to match the parametric DATA with the drawing.

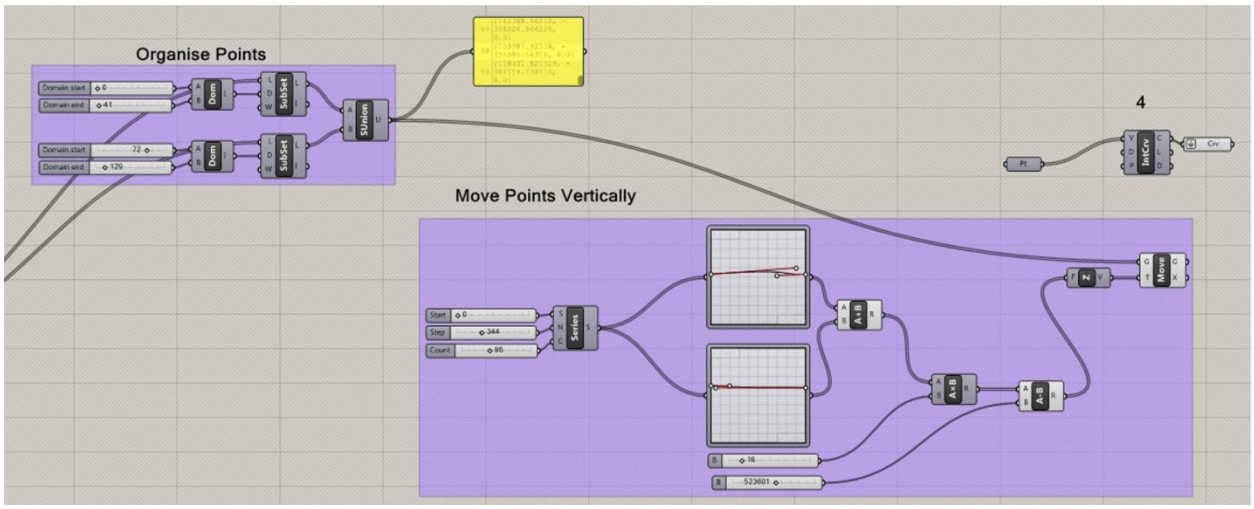


Figure 24. values generated by the series node and manipulated with graphs that interfere with each other, values amplified by means of multiplication. Points from curves then organized and moved, by the values from the graph mapper, on the z axis. Thus giving points height above sea level. 53. D. du Plessis. Edited image from Grasshopper 3D software. 2015

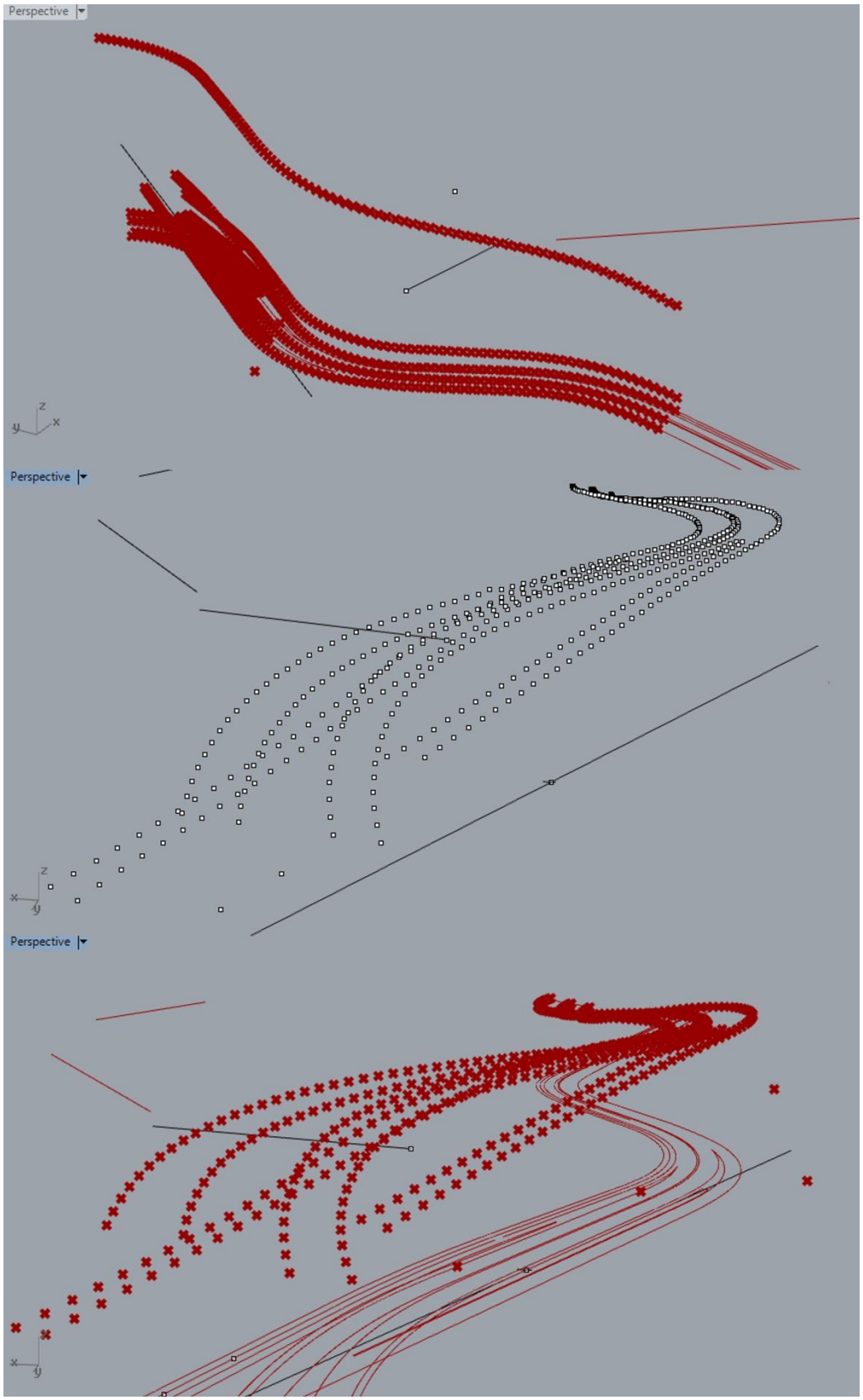


Figure 25. (Top) Points with constant gradient, (middle) manually traced points for DATA matching, (Bottom)Generated Point. 54. D. du Plessis. Edited image from Grasshopper 3D software. 2015

While working with DATA it becomes easy for the program to 'misunderstand' your programming. This will become less and less frequent as the designer becomes more familiar with the software. What I had noticed is that the points, that I was trying to manipulate, had placed a number of points in one spot at various positions. Thus once the y unit of each point was manipulated some unwanted result occurred. To get around this problem I used the 'Sub List' **(figure)** node. This allowed me to exclude repeated points that skewed the overall result by selecting only the points that I wanted to use and combining them. This had to be done retrospectively. As a step it appears before the 'Graph Mappers' (figure 3) but I only became aware of the need for the step after testing the points with the Mappers.

Process to Concept Relation

The benefits of doing this became clear immediately. Where small imperfections made an irregular point network from my manual manipulations the parametrically generated points flowed smoothly with no imperfections. The reason for this takes us back to the concepts spoken of earlier in this paper being continuity and relativity. When working with this software it works on terms relativity. The value generator or 'Series' node works as a number pattern thus any DATA captured from there is a continuous DATA stream thus any form generated by means of it will also be continuous. In the generation of the plan view curve the elements also appear as a type of sequence with a continuity- the beginning transition curve depends on the line before it and results in a circular curve; the exiting transition curve depends on the circular curve for its position and results in a straight line. Thus by the process of curve generation the entire structure relates and if any element changes the rest will too.

Then too the principle of geometry comes through strongly in the process. The process of road curve generation is simply an exercise in geometry which is obvious by the explanation. What is also interesting is some of the unmentioned uses. For example at one curve circular curves were used as transition curves the geometric process used was to generate a line from each circle's center to intersect its curve. Another circle can then be placed with its centre on that line and the intersection points on top of each other thus creating a smooth transition from one circular curve to the next.

Geometry is taken a step further with parametric modeling as non-visual mathematical programming can be transformed into visual geometries. Hence if there is a formula for a given curve's behavior that type of complex geometry can be easily produced and manipulated which would be impossible with any other type of drawing technique if any real level of accuracy is needed.

Surface Generation

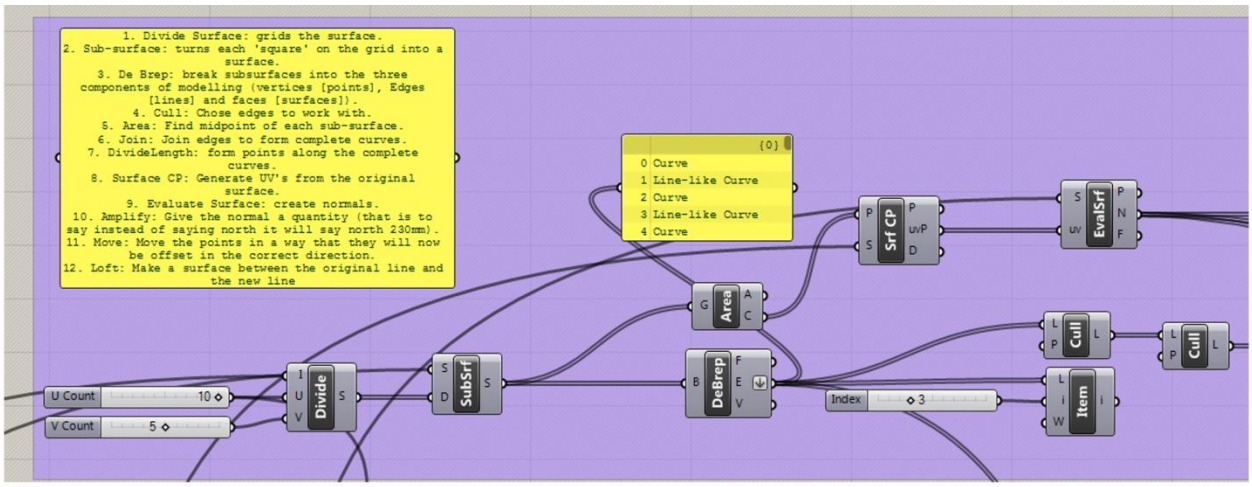
An important operation for surface generation is the 'Loft' node. What this node does it to join two lines with a surface. This surface should be understood as plastic rather than concrete, which is a good thing because it allows a design to be manipulated at any point in the design process.

To do this, points on either side of the freeway were linked with a 'Line' node these lines project perpendicular to the road's direction of travel. This node is then connected to the 'Loft' node and a road surface is created.

The next process is a rather complex one. With a surface that curves and cambers such as is the case with a road, giving thickness is a real challenge. This is owing to the fact that the designer needs to determine where the offset must project to. What this means is that to give a surface thickness it will be offset with a certain number. The offset concept is a combination of moving a surface and scaling it in a complex manner; if a semi-circle if offset the offset line will be scaled bigger if it is offset in one direction and scaled smaller if offset in the opposite direction. On a line where positive and negative lines appear this function becomes quite complex.

The precise process is outlined in (figure 26) and is an adaption of coding learned from Nathan Melenbrink (16). In general terms a way to offset a curve is to move points along the normal of the line where the point appears. The normal of a curve is the line which is perpendicular to its tangent. Heatherwick Studio's UK Pavilion illustrates what normal lines are perfectly (figure 27). The idea used for this function is to quantify a normal that is to say give normal lines a length. The points placed at the end of these lines can be interpolated and joined with a curve. This curve will be the offset required with an irregular line. Once the offset line is generated the designer can loft between the original and the offset line giving the edge-of-slab surface and loft between one offset line and another to generate the bottom-of-slab surface.

(16) N Melenbrink. Build Components on a Surface with Grasshopper. 2013 [Online] Available from https://www.youtube.com/watch?v=RLQuKrW9-YI [Accessed March 2015]



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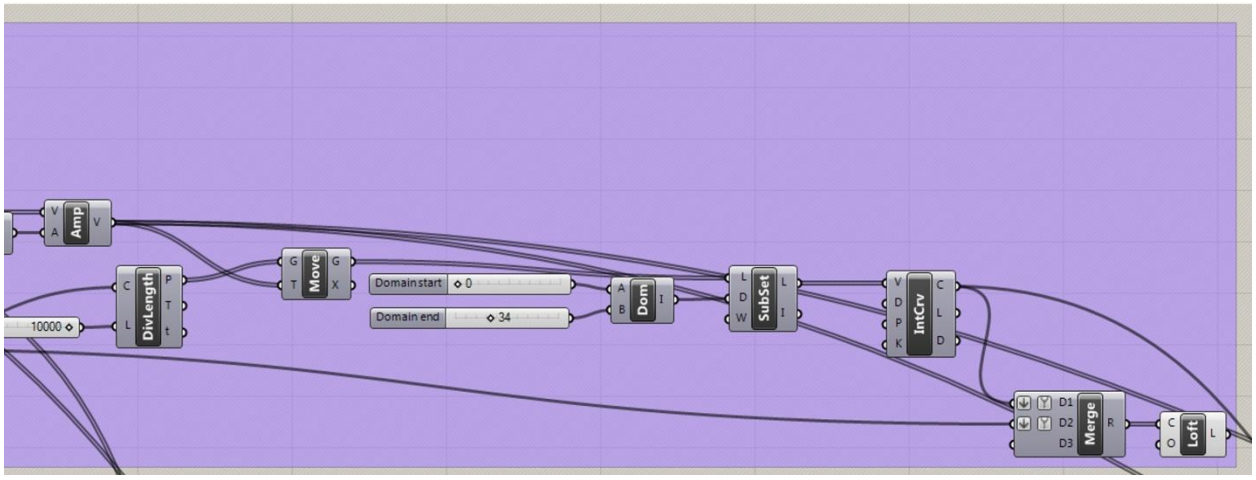

Figure 26. 1. Divide Surface: grids the surface.

2. Sub-surface: turns each 'square' on the grid into a surface.

3. De Brep: break subsurfaces into the three components of modelling (vertices [points], Edges [lines] and faces [surfaces]).

4. Cull: Chose edges to work with.

5. Area: Find midpoint of each sub-surface.

6. Join: Join edges to form complete curves.

7. DivideLength: form points along the complete curves.

8. Surface CP: Generate UV's from the original surface.

9. Evaluate Surface: create normals.

10. Amplify: Give the normal a quantity (that is to say instead of saying north it will say north 230mm).

11. Move: Move the points in a way that they will now be offset in the correct direction.

12. Loft: Make a surface between the original line and the new line. 55. D. du Plessis. Edited image from Grasshopper 3D software. 2015

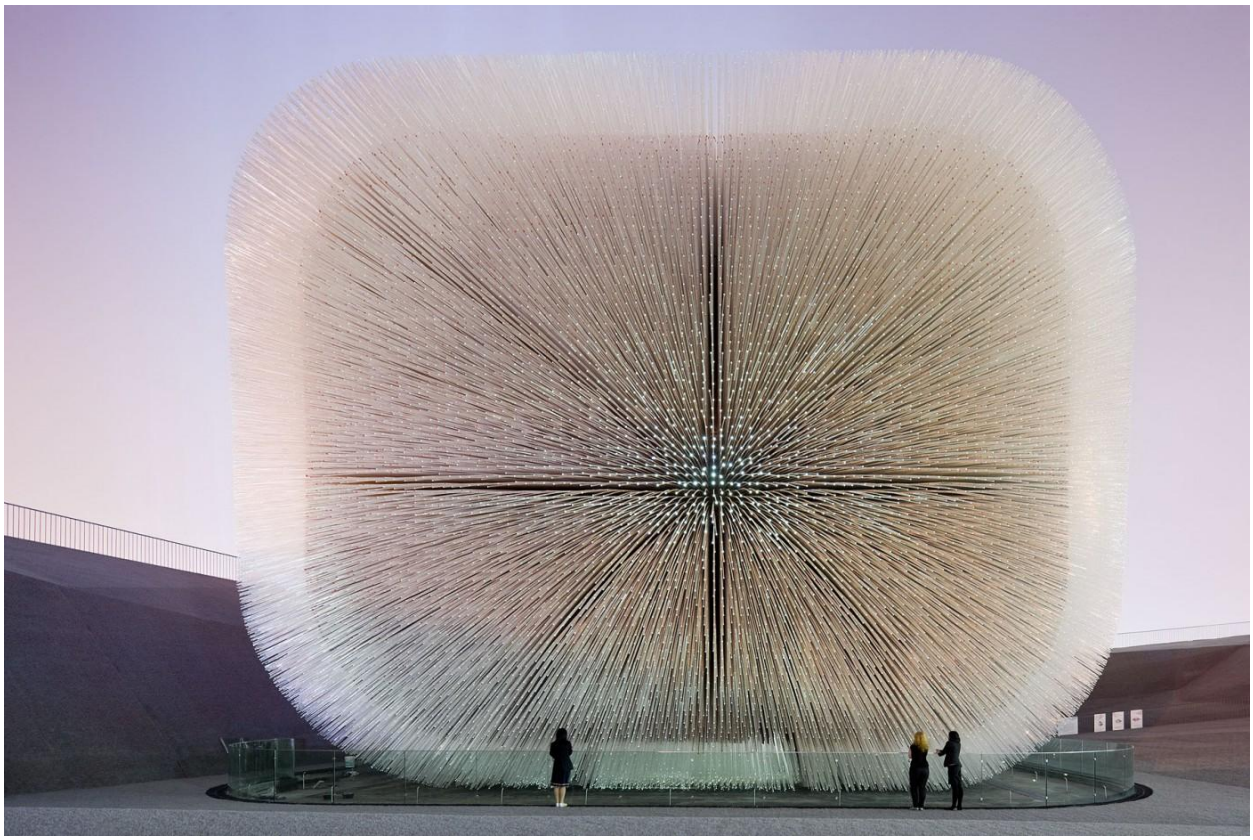

Figure 27. Heatherwick Studio. 56. UK Pavilion Shanghai Expo 2010. 2010 [Online] Available from Figure: http://www.heatherwick.com/uk-pavilion/ [Accessed April 2015]

Guard Rail Positioning

Generating a guard rail in Grasshopper is an unnecessarily tedious process. As a test I drew one up in Sketchup three-dimensional software and timed myself, it took me three minutes to draw it up completely. This process took considerably longer in Grasshopper but there is a very good reason to do this in grasshopper instead of Sketchup and the reason is iterational positioning. What this means is that each guard rail will have a unique orientation as it gets placed on the Freeway, parametric tools can be used to generate element with unique positioning.

The technique used to create this alignment is by setting up a base plane on the Flyover and a base plane on the Guardrail and then using the 'orient'(figure 8) node which moves and orients the planes to be identical. Firstly the base plane on the flyover needed to be created this was done with the 'Plane 3 Point' (figure 7) node. Based on the fact that a triangle will always be two dimensional a plane can be created using three points. Thus the bridge curves were re-divided according to the length of guard rail elements. Then the three points were selected by the following process- select every odd numbered point of the left side of the road, select every even numbered point of the left hand side of the road, select every odd numbered point on the right hand side of the road. The plane function would then create planes with three points at a time which resulted in making planes along the road.

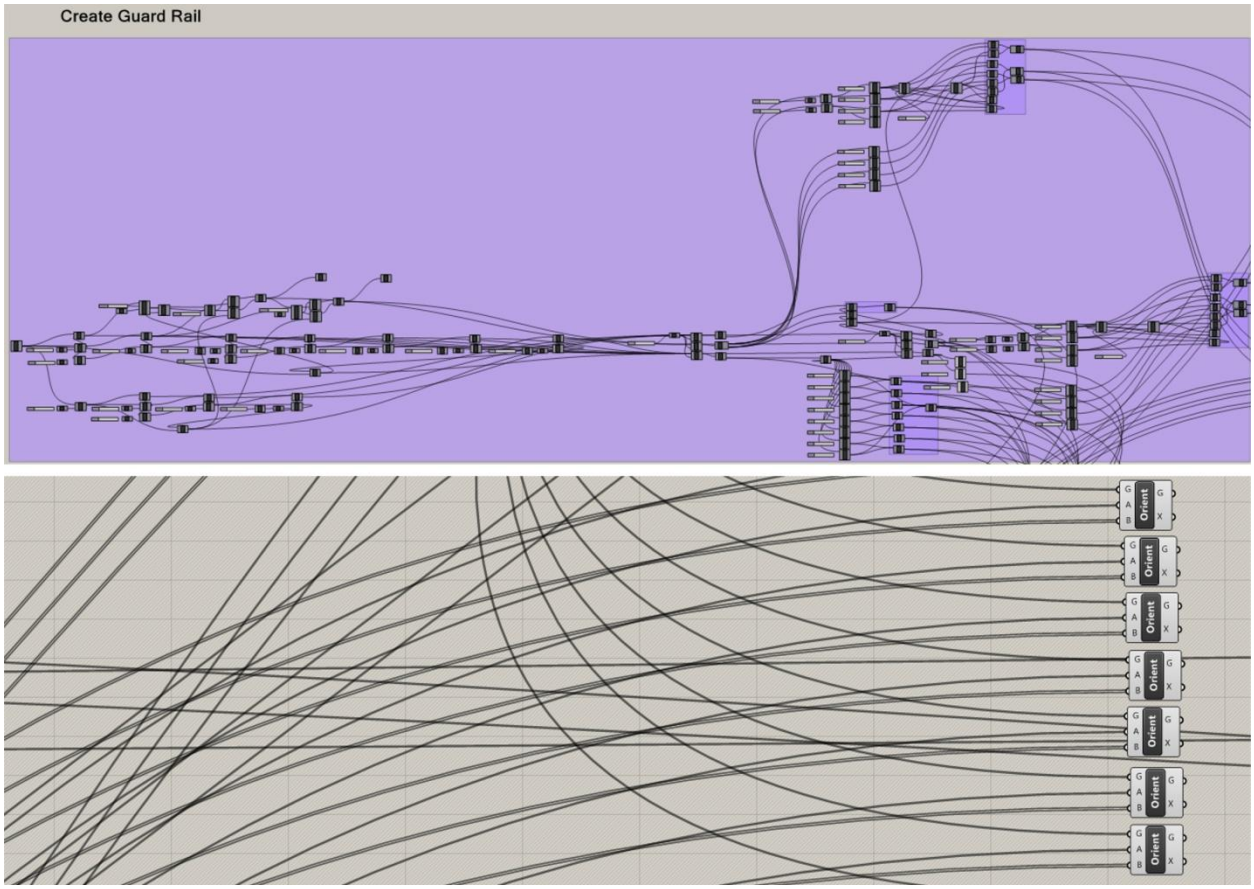

Figure 28. (Top) simple code written to construct a guard rail to be repositioned later. (Bottom) Multiple lofts being repositioned. 57. D. du Plessis. Edited image from Grasshopper 3D software. 2015

The same operation was applied to the surface of the guard rail that was to be placed on the freeway. Thereafter these plane nodes were connected using the 'Orient' (figure 8) node. The 'Orient' (figure 8) node uses two plane inputs and a geometry input. Thus each lofted surface of the guard rail would need to be connected to the geometry input.

Continuity becomes an important parameter for this too. This can be said as a continuous environment is needed so that the elements can match up to one rule.

Column Positioning and Artificial Intelligence

This was perhaps one of the most interesting parts of the project and perhaps the most complicated. Parametric design becomes most tricky and confusing when DATA matching is required, however it is here when elements in the model are able to differentiate according to rules which the designer sets up for the elements. The main generative function being 'Larger Than' **(figure)** linked to 'Cull Pattern' (figure 4) was learned from a tutor named Jose Sanchez (17).

The principle involved is DATA 'branches' **(figure)**. Grasshopper sorts DATA into packages. For instance if the designer were to make a solid cylinder shape he would have a 'Loft'(figure 6) node connected to an 'Extrude'(figure 5) node, other words he would have a number of geometries to make one form. If he were to have twenty of those solid cylinders he would be able to have branches of geometries which would mean that if a list were to be formed instead of listing all the lofts and then all the extrusions Grasshopper could put each geometry collection on its own branch or group. The benefit of this is that if the designer desired to move each group a different distance for instance he could do this from one node. This would mean that there would be a relativity and continuity of parts and it would make a large complex system manageable. The difficulty arises when forming branches the secondary process also has to be a branched output or the DATA will not match and the results will be unpredictable.

This important part of parametric modeling would have made positioning the guardrails a much simpler process but as I have mentioned before some of the modeling would be skewed by my inexperience. In the case of the guardrail I did not combine my geometry and work with branches I used a separate node for each piece of geometry comprising the guardrail.

In this case the columns can be understood as an asymmetrical structure with a small valley in the centre. The structure is asymmetrical as one side needs to be higher as the camber of the road changes. Thus the rule that I set up was that the base of the valley be 500mm below the lower side of the column; to this end the 'Greater Than' **(figure)** command was used in conjunction with the 'Cull Pattern'(figure 4) command. A 'Length' **(figure)** node from either side was connected to the 'Greater Than' **(figure)** command in both directions thus one node has an output of true and the other false. These were then placed into the 'Cull Pattern' (figure 4) node and linked to points on the column. This means that the lower point will always show up as true no matter which side is lower hence geometry could be linked to the 'Cull Pattern' (figure 4) node and would always be generated in relation to the lowest side.

Once the column geometry was created a number of modifications needing 'branch' knowledge was needed; move, rotate and match height. This would mean that each separate column package could be moved to its own point and rotated independently, the heights of either side could be calculated and applied the valley would be in the correct position as a result of the transformations.

The key to achieving this was having lines projected along the movement of the column (which was not simply vertically but diagonally) once these lines had been moved into place the intersection of them with the bridge would be able to give the separate heights which would inform the heights of the columns.

(17) J. Sanchez. Grasshopper inside rhino3d. 2012 [Online] Available from http://www.plethora-project.com/education/ [Accessed March 2015]

An interesting function of the operation is the move calculator. This was achieved by selecting a point for the column to be positioned on. Firstly the 'Deconstruct'**(figure)** node was used to break down each position point into it's x,y,z values. The same was done to a strategically placed point on the column. The x values were then subtracted from each other and the same applied to the y and z values. This gave the difference in positioning of each point in relation to each other. The 'Construct Point'**(figure)** node was then used to transform the separate x,y and z values into one DATA set. This was then connected to the 'Move'(figure 1) function of the column. In effect the function processed what the difference between the respective points is on a Cartesian space and then moved a copy of the column into place.

Retrospectively, the 'Orient'(figure 8) node would have done the function of the move and rotate functions and would have decongested my algorithm.

This presents another dimension to continuity in architecture as with programming like this, the designer is able to program elements such that they will respond to their unique contexts in the same way. While each element is unique it is also continuous as it responds with the same logic to its environment. Globally the elements will help to create a harmonious elegant design.

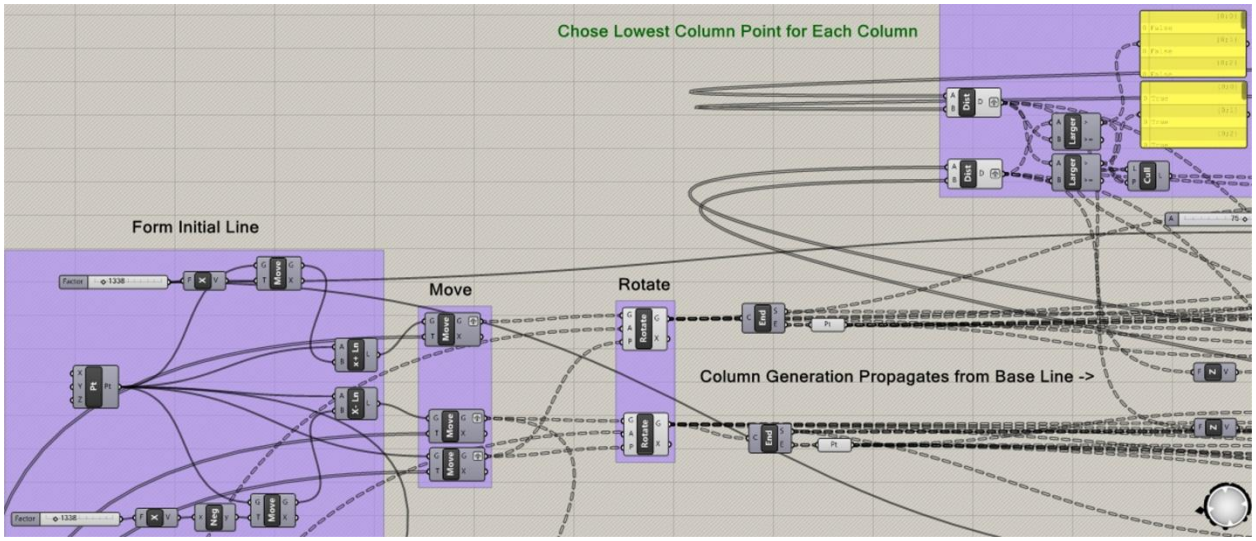

Figure 29. Calculating component of the code. 58. D. du Plessis. Edited image from Grasshopper 3D software. 2015

Conclusion

Coming back to the initial points to benefit architecture as a result of parametric modeling it is clear that the first point of articulated freedom is possible because the designer sets up the rules in a very explicit way and is then able to manipulate the end result within the bounds of the rules while all other additional elements recalculate their parameters. 'Elegance' (18) is achievable as a base systemic rule is applied that all the elements react to thus the whole system can be continuous and related. Finally through this process I was able to extract various algorithms that can be applied to a design later in the process this will lead to a design that is able to respond to its context and systemically problem solve in the same way as the context rather than simple mimicry.

By explaining the very precise nature of coding I have attempted to explain that parametrics does not produce random form but rather that it requires the architect to very specifically articulate what the building is. Thus it can be said that it is the task of the architect to make informed architectural decisions about building form, geometry and contextual approach.

Of course as always the designer must be responsible for the design. It is not appropriate to produce site informed algorithms and indiscriminately allow them to problem solve. This has always been the task of the architect- to critically respond to a context, thus the parametric code does not replace the architect it simply allows him to articulate his ideas accurately.

(18) P. Schumacher. The Autopoiesis of Architecture, A New Agenda for Architecture, Volume II. West Sussex: John Wiley and Sons Ltd, 2012, p. 658-659.