BOUNDARIES TO MEMBRANES
THE URBAN PROJECT REVISITED
- An Urban Strategy for Rio de Janeiro, Zona Norte -

Phebe Dudek
MIT SMArchS Architecture and Urbanism

ADVISOR
Lorena Bello Gomez, MAUD
Lecturer in Architecture (ARCH)

READERS
Alan Berger, MLA
Professor of Urban Design and Landscape Architecture (DUSP)
Director, Center for Advanced Urbanism

Alexander D’Hooghe, MAUD, PhD
Associate Professor of Architecture and Urbanism (ARCH)
Director, Center for Advanced Urbanism
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by

Phebe Dudek

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ABSTRACT

This thesis investigates urban boundaries in the North Zone of Rio de Janeiro. The Zona Norte transitioned in the last hundred years from a rural outskirts area of Rio, into its industrial hinterland, into a fully urbanized dense fabric today. Currently the area is challenged by extreme socio-economic and environmental problems. Zona Norte also has potential for vast redevelopment soon due to the investments for World Cup and Olympics as well as the development of the outer ring road, Arco Metropolitano, which is currently under construction.

The research question underlying my design proposal is: How can new infrastructure investments be used as triggers to pair new development with spatial design solutions for the existing social and environmental issues in the Zona Norte?

The research develops the hypothesis that build-up boundaries in the Zona Norte, between strictly defined land uses can be broken down and made more permeable through urban design. A detailed analysis of industry-favela clusters unravels this problematic based on a twofold reasoning: Industrial areas and favelas are the sites of most profound social and environmental issues and these clusters contain the sharpest boundaries between land use planning areas and infrastructures. Through a systemic analysis of one of these clusters, Fazenda Botafogo, I define a strategy for breaking these boundaries that can be replicated in similar sites across the metro area.

The design activates boundaries with new program, circulation, and development to reconfigure different neighborhoods and stimulate a more robust, diverse fabric without thick boundaries of exclusion and separation. The specific porosity-strategies therefore are the recalibration of infrastructures, the reconfiguration of landscape and the introduction of program-mix and public space. The result is a cohesive urban fabric and mixed-use development that frames river remediation sites and new landscape capacities for environmental improvement.

Thesis Supervisor: Lorena Bello Gomez
Title: Lecturer in Architecture
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Alan Berger
Alexander D’Hooghe
ABOUT THE AUTHOR

Phebe Dudek is an Urban Designer and Civil Engineer-Architect. She is a graduate from the MIT Master of Science in Architecture Studies, Architecture and Urbanism program and holds a Master in Architectural Engineering Degree from KULeuven, Belgium. Prior to graduate school she worked as a Freelance Architect and Urban Designer in Belgium. She received multiple Honors and Awards to undertake her Masters degree at MIT: MIT Department of Architecture Graduate Fellowship, Fulbright, BAEF, Vocatio, Rotary and Fondation Lazard.
Contact: phdudek@alum.mit.edu

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INTRODUCTION

This thesis investigates urban boundaries in the North Zone of Rio de Janeiro and proposes urban design projects that convert boundaries into porous membranes for the area of Fazenda Botafogo. The design proposal functions as a pilot project for a larger scale strategy that can be implemented throughout the whole Zona Norte.

My fascination for the Zona Norte started in the summer of 2013, during my independent research on riverine floods and landslides in Rio de Janeiro. While I was residing in Rio's Zona Sul, my research on the city led me to multiple other sites in the city, one of them being the new cable car system in the Favela complex of Alemão. This visit on top of Alemão's hills gave me a first clear overview of the Zona Norte.

This thesis is developed based on two intense field trips in Rio de Janeiro, the first in June-August of 2013 in which I collected data and got a general understanding of the city through fieldtrips and interviews with city authorities and local professors. During my second field trip in January 2014 I tried to do more detailed site visits in Fazenda Botafogo and interviews with professionals who had expertise on the area. Due to the extreme violence in the favelas adjacent to Fazenda Botadogo, these site visits had to be concise and careful, which restricted the amount of detailed analysis on the site.

This thesis is built up of two major parts: A Multiscalar Urban Analysis and an Urban Design proposal and is structured as follows: The first chapter provides the Urban Analysis on the Metropolitan and the District level, investigating The Zona Norte in relation to Rio Metropolitan area and Industry-Favela Clusters in the District Zona Norte.

The second Chapter focuses on the Urban Analysis at Neighborhood scale, investigating the Pilot Projeto site Fazenda Botafogo getting a better understanding of its context and specific boundary conditions. The third chapter develops the design proposal, which formulates the core focus of this thesis: converting boundaries into porous membranes. Three strategies for porosity are presented: recalibration of infrastructures, reconversion of landscape and the introduction of program-mix and public space. To finally conclude this thesis with a reflection on Richard Sennett and Manuel de Solà-Morales' work, which inspired this thesis.
Fig 1.1 Rio de Janeiro Municipal area showing the Zona Norte located in the Guanabara Bay watershed, with the newly planned infrastructure corridors crossing it.
CHAPTER 1
RIO DE JANEIRO - ZONA NORTE
Fig 1.2 Rio de Janeiro Municipal Area with the Administrative districts marked in white. Zone Norte will be the focus of this thesis.
ZONA NORTE
CENTRO
ZONA SUL
1 RIO DE JANEIRO - URBAN PROBLEMS

Rio de Janeiro has grown with approximately 5 million inhabitants in the last hundred years in its municipal area. As figure 1.3 clearly shows, the major urban expansion has taken place in the North Zone of the city. This thesis investigates the Zona Norte in closer detail, an area of the city that has always been regarded as a backstage and still is regarded as such. The following investigations will reveal that the area is challenged by severe social and environmental problems.

SHORT HISTORY

As Illustrated by the maps on the following pages, the Zona Norte transitioned in the last hundred years from a rural outskirt of Rio, into its industrial hinterland, into a fully urbanized dense fabric today.

Up until the 19th Century the area housed multiple Engenhos or Plantations, growing sugar cane or coffee on the fertile banks of the meandering rivers (fig 1.4). (Abreu, Geografia histórica do Rio de Janeiro (1502-1700) 99) These plantations were the first cause for major deforestation in the area. In 1854 the first train line 'Estrada de Ferro Mauá' was put in place connecting the port of Rio de Janeiro with its hinterland. Many more railways were developed later on, which all crossed the Zona Norte gradually converting it into the industrial hinterland of the city. (Abreu, Evolução urbana do Rio de Janeiro 52) In 1940 the Avenida Brasil was inaugurated and extended in the 1960's with the Avenida Bandeiras as an express-road between Rio and Sao Paolo. (Lopes 32) Along the corridor multiple road-based industries settled in the 1970's in the north and west part of the municipality.

Fig 1.3 In 2013 Rio de Janeiro had 6.5 million inhabitants in its Municipal area and 12 million inhabitants in its Metropolitan area (IBGE). Its population accumulated mainly over the past 100 years growing from a little less than 1 million in 1900 to 6.5 million in 2013, which on average means an influx of 50000 inhabitants every year.
This map from 1928 shows the Zona Norte when it was still a rural exclave of Rio de Janeiro, with the center of the city still mainly located on the area now called 'Centro'. The abbreviations 'Eng' marked on the map show where all the Engenhos or plantations were located.
Fig. 1.5 This updated map from the 19th century shows the first railway line in Rio de Janeiro, called Estrada de Ferro Mauá, was built in 1854. It connected Rio de Janeiro's port (today Praça Mauá) with the hinterland.
Fig 1.6 This map from 1920 shows how the further development of the railway network starts defining the landscape of the Zona Norte.
Fig 1.7 Finally this map of 1960 shows how the Avenida Brasil (then Avenida Bandeiras) is introduced in the complex transportation network of the Zona Norte.
30-40% OF POPULATION ON 13% OF SURFACE

270 OUT OF 600 FAVELAS IN THE CITY
Figure 1.8 shows the high population density of the Zona Norte. My calculations reveal that the Zona Norte's houses between 30 to 40% of Rio's population (IBGE 2013) on only 13% of the total Municipal area. Additionally, the income distribution map (fig. 1.9) illustrates the stark difference in wealth between the Zona Norte and the Zona Sul, confirming that in comparison with its population density, the Zona Norte is extremely impoverished. Finally, the Zona Norte houses 270 out of the 600 favelas in the city (fig. 1.10). These three aspects show that the Zona Norte faces major social problems.
ENVIRONMENTAL PROBLEMS

While a metropolises like Rio de Janeiro always face multiple environmental problems, the most severe environmental pollution happens in the core of its beautiful geographical location: the Guanabara Bay. More than 50% of Rio Municipal area is located within the Guanabara Bay watershed and this map shows the water quality of the different rivers flowing into the Bay.

The urbanized stretch of Rio de Janeiro at the west side of the Guanabara Watershed has clearly a devastating impact on the pollution of the bay, with Zona Norte as one of the most severe zones of pollution. There are many causes for this pollution, the most evident one being the lack of proper sewers network in large tracts of the city, not only in the favelas, but also in large tracks of the formal urban fabric. The lack of purification from industrial effluents is another major cause for pollution.

To make it even worse, most of the rivers in the urbanized areas of Rio have been channelized, which destroyed the natural purification capacity of wetlands and riparian vegetation, as well as their natural capacity to buffer floods from summer storms.
2 RIO DE JANEIRO - URBAN POTENTIALS

Despite Zona Norte’s many problems, I discovered through my research and interviews that the area holds potential for vast redevelopment soon due to the investments for the World Cup and the Olympics as well as the development of the outer ring road, Arco Metropolitano, which is currently under construction.

Fig 1.12 Rio de Janeiro Metropolitan area with a summary of the potentials coming to Zona Norte.
2014 WORLD CUP AND 2016 OLYMPICS

Rio has been the venue for multiple Global Events in the past decades: The 1992 Earth Summit, the 2007 Pan American Games, the 2012 Rio+20 Earth Summit, the 2013 FIFA, etc. The next Global Events that will take place in the city are the 2014 World Cup and the 2016 Olympics. The total cost of the Olympic Games is estimated to be circa US$13 billion for 40 venues in the city. (Rio bid documents + media). Out of this total, circa US$4 billion will be spent on 16 different infrastructure projects. One of these infrastructure projects is the Bus Rapid Transit system that will connect the International Airport with the Olympic venues in the city and therefore cross through the Zona Norte of the city.

The research question underlying my design proposal is: How can new infrastructure investments be used as triggers to pair new development with spatial design solutions for the existing social and environmental issues in the Zona Norte?
ARCO METROPOLITANO

The Arco Metropolitano is the new outer Metropolitan ring road, currently under construction, to connect the industrial complexes of Regual and Itaborai located to the West and East of the City. Despite the fact that there is currently no general master plan to guide new development along this infrastructure line, it is highly probable that the industrial sites currently located in the Zona Norte will eventually migrate to these new areas. Therefore, the industrial sites in the Zona Norte will vacate and provide space for new development which can be triggered by the new infrastructure investments fueled by the Global Events.
3. ZONA NORTE - INDUSTRY-FAVELA CLUSTERS

Unfortunately, the city is not being strategic about the major investments and international attention that is coming to the city, which could guide urban redevelopment and tackle the pressing issues in the area. This is exactly the strategy this thesis wants to propose for the city to be opportunistic about this. This section will investigate how these investments can be redirected to tackle the problems in the Zona Norte and defines specific and strategic sites for further investigation: 10 Industry-Favela clusters.
SITE SELECTION

Both industries and favelas are the types of land uses that lie at the base of the major social and environmental problems of the area. Industries and favelas have a major share in the water pollution through the lack of sewage and treatment of effluents of both land uses. Additionally, favelas are the sites with the most extreme situations in terms of social problems.

Simultaneously, due to the projected migration of the industries, these are the sites where new development can be projected.

This map shows how multiple infrastructure lines cross these industry-favela clusters, which creates strict boundaries on these sites. Additionally, land use planning policies subdivide the Zona Norte in large mono-functional land use areas, which creates boundaries between different types of urban fabric.
ANALYSIS OF BOUNDARY CONDITIONS

These images show examples of how these specific boundaries look like in the Zona Norte of Rio de Janeiro. Nine boundary types have been investigated in total. Six of them are related to infrastructures, each time looking at the relation of industries or favelas to the specific infrastructure: Rail, River or Highway. Three additional boundaries related to land-use differences have been investigated: Industry-Housing, Industry-Favela and Favela-Un-urbanized land.
Each of these boundaries are represented in terms of their porosity, i.e. strict boundaries related to infrastructures are a full black line, while semi-porous boundaries are dotted lines.

What follows is a detailed analysis of the 5 biggest clusters to exemplify the methodology that can be expanded to all 10 clusters in a future elaboration of the research. For each cluster the total length of boundaries is calculated.
1 FAZENDA BOTAFOGO

Fazenda Botafogo is the largest of all clusters and contains all boundary types. This cluster has the largest amount of boundaries between rail & favela and highway & favela compared to the other clusters. It also has the largest amount of boundaries between industry and housing, which means new development on the industrial sites will have the largest impact on the connection to existing neighborhoods.
2 COMPLEXO DE ALEMAÑ

These numbers show us that Complexo de Alemañ is not a very strategic site in terms of its relation between infrastructures, industrial sites and favelas. There are no railways or highways crossing the area. Additionally the length of rivers crossing the site is the lowest in comparison to all other clusters. This cluster has the shortest length of boundaries between favelas and rivers. Nevertheless, this cluster has the largest amount of boundaries between favelas and un-urbanized land, which makes it a potentially strategic site to develop strategies to stop encroachment of favelas on virgin land.

Fig 1.31 Complexo de Alemão Statistics

Fig 1.32 Complexo de Alemão Boundary Map
3 PAVUNA

Pavuna, is clearly strategic in terms of its boundaries with water. It has the largest amount of boundaries between favelas and rivers, but the shortest amount between industry and rivers. Additionally, the site has the lowest amount of boundaries between industry and favela. Therefore investments on this site will have a very specific favela-river interaction.
4 JACARÉ-CACHAMBI

Jacaré-Cachambi is most strategic to tackle the boundary between industries and railway lines, as well as the boundary between favelas and industry. This site has the shortest amount of boundaries between favelas and un-urbanized land.
Manguinhos is a very strategic site in terms of connection to railway lines. It has the largest amounts of railway lines crossing through it in general, but can’t top Fazenda Botafogo’s relation of favelas to rails and Jacaré-Cachambi’s relation between industry and rail. On the other hand it has the smallest amount of boundaries between industry and housing as well as favela and un-urbanized lands.
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**Surface Distribution**

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**TOTAL Boundaries & Infrastructure**

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CONCLUSION

From the summary of this analysis we can conclude that Fazenda Botafogo is the site with the largest amount of boundaries and infrastructures, as well as a site on which all boundary conditions take place. Therefore Fazenda Botafogo is chosen as the site to develop a pilot project for in the reconfiguration of boundaries. Additionally, it is a site that is located along one of the planned Bus Rapid Transit lines the 'Trans Brasil'. As Fazenda Botafogo is the site with the largest amount of boundaries between industry and highways it will be a successful test-site for a project building on the infrastructure investments that will come with the Global Events.

In a later iteration of research on Rio de Janeiro’s Zona Norte this summary document can be used to define other strategic sites of intervention depending on the types of investments that can be related to the site and/or guided by the type of boundaries that need to be reconfigured.
Fig 1.40 Fazenda Botafogo

BOUNDARIES TO MEMBRANES - THE URBAN PROJECT REVISITED
BOUNDARY SECTION ANALYSIS

To get a better spatial understanding of the different boundary conditions, typological sections are developed for each type of boundary in each one of the 5 investigated clusters. The following five maps show the sites where sections were drawn. This is followed by a taxonomy of the different typological sections organized by site and by boundary type.
Fig 1.41 Complexo de Alemão
Fig 1.43 Jacaré-Cachambi
Fig 1.44 Manguinhos
Fig 1.46 Highway and Industry-Housing Boundary Sections
Fig 1.47 Favela-Industry and Favela-Un-urbanized land Boundary Sections
ANALYSIS DISTRICT SCALE
SYSTEMIC AND SPATIAL UNDERSTANDING OF BOUNDARIES IN ZONA NORTE

1. Fazenda Botafogo
   - 3.98 sqkm

2. Complexo do Alemão
   - 2.67 sqkm

3. Pavuna
   - 2.3 sqkm

4. Jacare - Cachant
   - 1.55 sqkm

5. Margaridas
   - 1.42 sqkm

BOUNDARIES TO MEMBRANES - THE URBAN PROJECT REVISITED
SUMMARY

The taxonomy of sections and boundary analysis reveal two things: Similar boundary conditions can have different reasons for lack of porosity: physical or administrative, defined or unclear, infrastructural or landscape. Additionally, the taxonomy reveals that industry-favela clusters are sites of extremes, not only in terms of social and environmental problems, but also in topography and urban risk. Industrial sites are mostly located in valleys, close to railways and rivers, at risk of floods. Favelas are located on sites that were undesirable for others to build on. Therefore favelas are mostly located on landslide prone hills, in flood-prone valleys or on landlocked sites between infrastructures. Fig. 1.48 shows the flood and landslide events for the Zona Norte since 1990.

With this systematic analysis of Industry-Favela clusters as a base, Fazenda Botafogo is further developed as a site for a Pilot Project to exemplify how urban boundaries can be reconfigured into porous urban membranes.
CHAPTER 2
FAZENDA BOTAFOGO

RIÓ PAVUNA WATERSHED
Fig 2.1 Fazenda Botafogo as a strategic site for a Pilot Project
1 FAZENDA BOTAFOGO - CONTEXT

Fazenda Botafogo is chosen as the site for the development of a Pilot Project, to exemplify how the investments for the global events can be used opportunistically in order to tackle the existing social and environmental problems in the Zona Norte and to provide the city with a long-term vision for urban (re)development.

Fazenda Botafogo is currently (2013) a vibrant industrial area (according to the Secretaria Municipal de Urbanismo of the City, interview). Only 2 of its industrial buildings are currently vacant. On the other hand, the area is very unsafe and violent. The two neighboring favelas 'Favela de Acari' and 'Complexo de Chapadao' are communities with extremely violent drug traffickers and/or militia ruling them. The strict boundaries on the site are therefore not only problematic in terms of general urban porosity and interchange, but especially because they make it very easy for these drug cartels to control the local inhabitants. By setting up their guards on strategic entrances to the site cartels maintain the overview of the area. This is an example of severe social issues that are reinforced by physical boundaries and confirms the goal of this thesis: the need to convert boundaries into porous membranes.

HISTORY OF THE SITE

Fazenda Botafogo is the name of the Industrial area that developed on the site in the 1970's. The map from 1976 shows the site had only 3 industrial buildings. The residential neighborhood next to the site, also called Fazenda Botafogo was established much earlier. The map of 1999 shows that the development of the industrial complex of Fazenda Botafogo influenced the growth of favelas on the nearby hills, which were still mainly un-built in 1976.
Fig 2.5 Fazenda Botafogo measures.

Fig 2.6 Manhattan, New York, USA pasted into the site of Fazenda Botafogo.
SCALE OF THE SITE

The total surface of the industrial site of Fazenda Botafogo is approximately 1 square kilometer. This scale-exercise introduces dense urban fabrics of New York, Ipanema and Barcelona into the site to get a better understanding what scale of urban development could take place if the site were to be fully built. This of course, is not the goal of the thesis, but exemplifies, how a dense urban fabric at the boundaries of the site could provide in sufficient development in order to keep its core open and natural. This way the social issues can be solved at the edges of the site and the environmental issues at the center of it.
Fig 2.9 Picture of the flood event that happened in December 2013.

Fig 2.10 Past flood events from 1971, 1992 and 2013 in Fazenda Botafogo overlayed in one map.

Fig 2.11 Landslide events in Fazenda Botafogo which have taken place since 1990.

Fig 2.12 The industrial activity on the site of Fazenda Botafogo, which highlights the risk for contamination of the site.
URBAN RISKS

As mentioned in the last chapter, the industry-favela clusters are sites of extremes. These detailed maps show how different urban risks affect the site.

Floods - Fazenda Botafogo is located along the Acari River at the confluence of two of its tributaries. The area has therefore always been prone to flood risk, which is probably one of the reasons why the site was only developed as an industrial area much later. The flood risk in this area is mainly related to flash floods in the rainy summer season. As the valleys between Rio’s steep mountains have too gentle a slope and therefore only low drainage capacity, the tropical rains cause the area to intensely flood. (Interview prof. Ehrlich) Additionally most rivers have been canalized over time, destroying the natural capacity of meanders and lagoons to absorb the excess water. The most recent flood happened last December 10th and 11th in 2013.

Landslides – The hills surrounding the site are prone to landslides. The reason for landslides in this geographic setting is mainly rainfall. Both short and long showers can cause different types of landslides to happen. (Interview prof. Avelar) As most of the surrounding hills are fully populated with favelas, multiple families are at risk. In the South Zone of the city, the systematic resettlement of people in landslide prone areas is taking place. This happens simultaneously with the installation of pluviometers and a landslide alert-system (‘Alerta Rio’) managed by the Civil Defense Department, which forces people to evacuate from the hills when exceeding amounts of rainfall are measured. (Interview Marcio Motta) Unfortunately this public infrastructure hasn’t reached this part of the Zona Norte yet. In any case a (partial) de-population of the favelas seems to be an essential step to develop a safe living environment for all inhabitants in the area and provide in essential public infrastructure.

Soil and Water contamination - The industry has been active on the site since the 1970’s and is still active today. The types of industries on the site range from light to heavy industries, related to oil, machine production and other activities. The past 50 years therefore undoubtedly have had their impact on the soil through contamination. I have not been able to collect detailed information about the type and amount of contamination but from an interview with INEA it is clear that the site is contaminated and studies exist which elaborate on the amount of contamination. A detailed investigation of the river edge shows that the sewage outfall from industries flows directly into the river. As the adjacent favelas don’t have a sewer system, their crude effluents also flow into the river. This is one of the many causes for the high environmental pollution rate of the waters flowing through the Zona Norte.
ANALYSIS NEIGHBORHOOD SCALE - FAZENDA BOTAFOGO
INFRASTRUCTURES IN ZONA NORTE ARE OUTDATED

BOUNDARIES TO MEMBRANES - THE URBAN PROJECT REVISITED
2 FAZENDA BOTAFOGO - DETAILED BOUNDARY ANALYSIS

This section investigates infrastructures crossing Fazenda Botafogo in more detail, as they are the most un-porous boundaries running through the site. This section of the multi-scalar urban analysis will provide detailed findings on the neighborhood scale.

Each infrastructure is mapped using the same methodology: Over and underpasses on the infrastructure line are mapped. These inform how porous the infrastructure is and where problematic areas along the infrastructure arise in terms of porosity. The different stations (proposed BRT for the highway or metro/train-stops for the railway lines) are mapped as well as the adjacent land uses to them. Based on the intervals between these stations, walking distances are determined and the longitudinal section completes the analysis of the infrastructure.

Based on this analysis multilayered analysis of the infrastructure, a strategic proposal is made for the stations on the infrastructure lines in order to intensify public use and increase porosity.
The Avenida Brasil was built in the 1960's. The highway has a quite regular pattern of overpasses connecting neighborhoods at both sides of its profile. This gives the false impression of porosity of this infrastructure, as it is actually not possible to cross it on ground level at any point. The BRT stops that have been projected for the Avenida Brasil are currently located on sites that are quite mono-functional in terms of land use.
Therefore the proposal for this infrastructure is to maintaining the same sequence of BRT stops, but shift their location with half a walking distance length. This way the BRT stops will be located on much more strategic sites, i.e. along the industrial sites where new development will come and on the crossing with the existing metro-line, creating an inter-modal station.
Fig 2.15 Zoom on the crossing of Highway and Supervia

Fig 2.16 Zoom on the crossing of Highway and the Acari River
These zooms show how the highway crosses with the other infrastructures on the site: supervia, river and metro. It is clear that there is no porosity whatsoever between the different infrastructures when they cross.
The Metro is an old train line that was converted into a Metro line in the 1980's. It is a very un-porous infrastructure when crossing the site of Fazenda Botafogo but becomes much more porous towards the south of Zona Norte, where it is an elevated rail and underpasses become larger. It seems that the lack of porosity also has an impact.
on the amount of passengers using the Metro-service near Fazenda Botafogo. The Metro-stops are strategically located and cover a wide variety of land uses. The strategic investment proposal therefore is to connect the Metro network with an intermodal hub to the new BRT station on the Avenida Brasil.
Fig 2.21 Zoom on the Metro to the North of its crossing with the Highway

Fig 2.22 Zoom on the Metro to the South of its crossing with the Highway
These zooms show how the Metro still functions as an old train line in terms of porosity to the adjacent fabric. It is located between walls and had tremendous amounts of under-utilized space along its profile.
The Supervia is part of the train network that was put in place in the 19th Century. The railway lines have known a major disinvestment in the last decades. This shows in the fact that the Supervia has much less daily passengers than the Metro line. The popular impression of the Supervia is that it’s mainly used by the poorer section of society.

Fig 2.26 Detailed boundary analysis Supervia
The infrastructure is a hard boundary and has an irregular pattern of stops. The proposal shows how the line could be reconfigured with more stops, serving more neighborhoods, but becoming slower in service. On the other hand, the line could be envisioned as an express-train line, diminishing the amount of stops. This would maintain the line as a quite strong boundary to ensure express transit. Therefore the design of this infrastructure will not be further developed in this thesis.
Fig 2.27 Zoom on the Supervia to the North of its crossing with the Highway

Fig 2.28 Zoom on the Supervia to the South of its crossing with the Highway
These zooms show how the Supervia and the Metro have a similar profile. The Supervia also has large tracks of under-utilized land along its profile and it runs on ground level between walls, blocking all connections and acting as a hard boundary.
INFRASTRUCTURES IN ZONA NORTE ARE OUTDATED

Fig 2.31 Summary drawing of the detailed boundary analysis.
Towards Design Proposals for Fazenda Botafogo

While this detailed infrastructure research developed multiple strategic proposals along the length of 10km of each one of the infrastructure lines, this thesis will only focus on the nodal interventions located most closely to Fazenda Botafogo. The focus of the design proposal will spur off the Avenida Brasil Highway, as this will be the infrastructure where the BRT will be implemented. Figure 2.32 shows the summary of the strategic interventions, which are concentrated on two BRT stops, one as an intermodal hub connecting the Highway and the Metro-line. The other related to the industrial site and therefore triggering new development. The design proposal will investigate how the hard boundaries can be converted into porous membranes using different urban design strategies.
CHAPTER 3
BOUNDARIES TO MEMBRANES
THE URBAN PROJECT REVISITED
1 BOUNDARIES TO MEMBRANES

The design strategy is developed on two levels: the scale of the industrial site and the scale of boundaries.

The industrial site is re-envisioned as a nucleus with porous membranes. This could be called a 'civic park', even though this term doesn't stimulate sufficient openness in design approach. Zooming out to the scale of Zona Norte one could envision all industry-favela clusters to be reconfigured as nuclei with porous membranes. This sequence of nuclei would refuel the Zona Norte with essential new development and re-establish a much stronger environmental capacity for the area.

The nucleus of Fazenda Botafogo connects multiple types of boundaries as shown in fig. 3.2. To convert these boundaries into porous membranes, the design activates boundaries with new program, circulation, and development to reconfigure different neighborhoods and stimulate a more robust, diverse fabric without thick boundaries of exclusion and separation. The specific porosity-strategies therefore are recalibration of infrastructures, reconfiguration of landscape and the introduction of program-mix and public space as a counterweight to the isotropic existing surroundings.

2 POROSITY-STRATEGY 1: RECALIBRATING INFRASTRUCTURE

The first porosity-strategy, the recalibration of infrastructure, builds on the infrastructure analysis of the previous chapter. This strategy focuses on two infrastructures that are directly related to the newly projected BRT stops: The Avenida Brasil and the Metro.
Fig 3.4 Image of the existing crossing of Highway and Metro

Fig 3.5 Image of the existing profile of Avenida Brasil
AVENIDA BRASIL

The Avenida Brasil has clearly not been updated since the 1960's, its profile is neither a clear highway nor an avenue. As fig. 3.7 shows the avenue has multiple ramps and exits directly leading off its express route. Therefore it is an extremely inefficient transportation corridor that should be recalibrated to become an actual urbane Avenue with porous connections to the adjacent urban fabric.

Fig. 3.6 shows the plan of the recalibrated avenue. The BRT is envisioned at the center of the Avenue, with at both its sides an express lane and ground-level cross-sections with main perpendicular axes. To make ground-level crossings possible, the Avenue is brought down to the topography of the surrounding landscape, breaking down the current flyovers over other infrastructures. This will be illustrated with the recalibration of the Metro-line. Local roads that provide direct access to the development along the avenue parallel the continuous central express-lane. The sections on the next page show how the Avenue has a different profile crossing the porous nucleus in order to stimulate the porosity of the nucleus' boundary and provide a clear rhythm and character in the profile of the avenue.
The current sections of the highway show its ill-defined profile with favelas growing up till its borders and illustrate how the highway becomes a hard boundary at the crossing with the Metro line.

Fig 3.8 Existing sections of the Avenida Brasil
The new profile of the Avenue is envisioned to have maximum porosity in different aspects: the pavement is brought to maximum porosity and planted with a vast tree-canopy to provide shade, ameliorate air-quality and help define the urbane character of the street. The central soft core of the BRT acts as a swale where infrastructural runoff can be collected and transported to the nearby nucleus for treatment. Finally the sectional design of the avenue stimulates traffic flow efficiency as well as ground level crossings for pedestrians. This pedestrian-friendly profile is achieved through the alternation of vegetation with different lanes of BRT, express, local and soft traffic.
BOUNDARIES TO MEMBRANES - THE URBAN PROJECT REVISITED
These images show how the profile of the Metro still follows the logics of a 19th century train line. It is a hard boundary between walls. To bring the Metro and Highway to a ground level crossing, the Highway will be brought down to the surrounding topography as shown in figure 3.11.

Fig 3.11 Existing and new longitudinal section of Avenida Brasil crossing the Metro line (left)

Fig 3.12 Image of the existing crossing of Metro and Highway

Fig 3.13 Image of the existing profile of the Metro line.
Additionally, the Metro needs to be reconfigured into a light rail. This means that the walls along the line will be taken down and the rail-bed will be redesigned to make pedestrian and car crossing possible. The recalibration into a light rail will possibly slow down the speed of service a little, but more frequent trains can easily compensate this. The main assets of the recalibration of the Metro-line is the fact that it will trigger development all along its profile and stimulate the existing ill-defined spaces to function as essential public space and (re)connect the neighborhoods along the line.
Fig 3.16 Existing topography of the site

Fig 3.17 Reconfigured topography of the site
3 POROSITY-STRATEGY 2: RECONFIGURING LANDSCAPE

The second strategy for porosity brings us back to the industry-favela clusters as sites of extremes. As presented earlier, the site is prone to landslides, floods and at risk of contamination soil and water. Therefore the reconfiguration of the landscape will act as a strategy in order to break down hard edges and make boundaries between river and adjacent fabric more porous.

The reconfiguration of the landscape combines topographic changes, buffer capacity, runoff purification and flood accommodation for the river.

TOPOGRAPHY

The fifty years of industrial contamination of the site require the layer of contaminated soil to be scraped off the site and replaced by a new layer of clean soil. This allows for a reconfiguration of the topography of the site, which can guide the development. Fig. 3.17 shows the reconfigured topography of the site, where the west part of the site follows a stepped pattern from the favela down to the river, while the east part has a topography perpendicular to this. The existing terraced structure of the site is maintained for the areas of future development, while alternating with porous park-chambers, which lead down to a buffer volume for the river.
Fig 3.20 Image of the existing profile of the Acari River. Because of its function as a sedimentation basin, a large part of the river has vast amounts of plants growing on the sediment.

Fig 3.21 Runoff purification diagram

RUNOFF PURIFICATION

The re-naturalization of the Rio Acari from the canal and sediment-basin it is today, into a meandering river allows for increased environmental capacity. A purifying wetland at the confluence of the rivers will treat the runoff collected from the newly configured Avenida Brasil.

BUFFER VOLUMES

Through the reconfiguration of topography, buffer volumes at the core...
of park-fingers can collect the first storm amounts during the summer rains and buffer them before discharging them into the river.

**FLOOD ACCOMODATION**

The adapted topography also ensures that in case of a flood event, the riverbed can widen up to double its size and flow in a guided floodplain defined by the new topography, ensuring urban fabric to be safe from flood, while allowing the lowest parts of the park to absorb it.
A continuous canopy of local trees will both guide the recalibration of infrastructure and define the porosity and privacy between landscape and urban development. A tree-nursery in the north-west corner of the development will provide all trees for planting on site and on the long term for planting in the Zona Norte. During the phased development tree-nurseries will be provided in the core of development to ensure the porosity of the central park. These nurseries will be relocated each time a new phase of the development is created to finally come to the final site in the north-west corner of the nucleus. The canopy will consist of a variety of local trees in order to stimulate the redevelopment of ecological corridors and keep planting efforts and maintenance to a minimum.
Fig 3.25 Image of the existing profile of the avenue

Fig 3.26 The Avenida-membrane in relation to the Fazenda Botafogo nucleus.
4 POROSITY-STRATEGY 3: INTRODUCTION OF PROGRAM MIX AND PUBLIC SPACE

The final porosity-strategy is the introduction of program-mix and public space. This strategy builds off the initial infrastructure recalibration. The three main boundaries that are converted into membranes on the site are Avenida, Neighborhood and Favela and they all have different logics for urban porosity and development.

AVENIDA MEMBRANE

The recalibration of the Avenida will allow and stimulate dense urban fabric to develop along its being a crucial part of the new character of the Avenida.

Fig 3.27 The recalibrated sections of Avenida Brasil
The Avenida-Membrane will take the form shown in fig. 3.28. It will essentially be built up by a slim and medium-dense street-front building to provide continuity along the avenue. Whereas the perpendicular developments to this building will provide essential density and porosity towards the park.
The development of this fabric will happen in parcels, which all have a front at the Avenida and combine a part of the street-front building and a perpendicular building as to ensure the success of full porosity from avenue to park. This logic also stimulates a combination of program mix, by providing offices and commercial functions at the Avenida front, with possibly residential space on the highest floors, while the perpendicular blocks contain a balance between residential space and offices.
Fig 3.32 Image of the existing street-character of the neighborhood-membrane.

Fig 3.33 The neighborhood-membrane in relation to the Fazenda Botafogo nucleus.
The boundary with the existing neighborhood is currently a broad industrial-scale road, which needs to be scaled down to fit the character of a central neighborhood street. The street is converted into a membrane with a simple street section, providing double lane traffic and longitudinal parking. A row of trees buffers between the traffic and broad sidewalks and provides essential shade.
The development of the neighborhood-membrane happens through a system of plugs and connecting elements between the plugs. These main plugs can be put in place each time an industry vacates the site and the reconfiguration of the landscape has taken place for that strip. The plugs therefore follow the logic of the terraced topography of the site and create longitudinal developments that range from high density along the membrane to low-dense deeper in the park. The plugs provide a wide variety of programs: offices and commercial functions at the membrane edge, with small manufacturing, industries and ateliers to the back of it, apartment buildings paired up with small offices, central public facilities and finally down to the scale of single family residences.
The connectors provide continuity in development at the membranes edge and through underpasses the pedestrian connection and secondary mobility routes are ensured. The towers at the end of the plugs provide concentrated density in residences and a local café or restaurant at the park edge. The porosity of the site is mainly steered by the central public functions, which provide a secondary passage from the street to the park and make the transition from the more mixed towards more residential part of the neighborhood. The ground floor fronts of the membrane are essential to the porosity and provide activity to the neighborhood through commercial program. Finally the introduction of soccer fields and a samba school form the basic constituents of communities in Rio, therefore they are an essential element in creating porosity and connection between both neighborhoods.
Fig 3.39 Image of the existing Favela-Industry boundary

Fig 3.40 The Favela-membrane in relation to the Fazenda Botafogo nucleus
FAVELA MEMBRANE

The development of this membrane happens in one clear move along the complete boundary of the favela. The recalibration of the street takes the form of a double street with central public plazas and public pavilions. Perpendicular streets connect to existing streets in the favela to maximize porosity and interaction.

Fig 3.11 Recalibrated street section of the Favela-membrane.
The urban fabric follows a clear and well-defined rectangular blocks structure to ensure favelas would not encroach on the site. This block structure also provides a clear definition of the public spaces in the fabric, as well as a clear park edge, which will provide a readable and well-defined base for porosity and interaction between the favela and the new neighborhood.

The public facilities along the favela edge are the core elements for the porosity of this membrane. They provide all facilities currently lacking in the favela and act as a mediator between the...
new neighborhood and the favela. The public-spaces in the urban fabric provide space for gathering and interaction between both neighborhoods.

The guiding principle of this membrane and the nucleus as a whole is that the favela can be (partially) de-densified through resettlement of the favelados in the development on the site of Fazenda Botafogo. This ensures that existing community relations are maintained and the general urban quality of the area is upgraded.
The development of these different membranes is not envisioned as one masterplan, but as a set of intermediate scale urban projects. The membranes are designed as such that the migration of the industry can be used in the advantage of the project to ensure favelas wouldn’t encroach on the vacated industrial sites.

Fig 3.46 Phasing logic pairing the migration of industries (black) with new development (red).
PHASING

The following sequence shows how the phasing of membranes can take place. The development will start at the Avenida and work its way back into the different neighborhoods, each time coupling the migration of the industries (demolition shown in black) to a new development of part of the boundaries (shown in red).
BOUNDARIES TO MEMBRANES - THE URBAN PROJECT REVISITED
SUM OF URBAN PROJECTS

The result of this phased membrane development a cohesive urban fabric and mixed-use development that frames river remediation sites and new landscape capacities for environmental improvement. Each phase of the development is conceived as an Urban Project and can therefore function in its full capacity with no necessity for the full nucleous development to be completed.
This aerial view shows how the different membranes will come together on the site of Fazenda Botafogo, bringing the existing and new neighborhoods together through porosity of infrastructure, landscape and urban fabric.
6 REFLECTION

This thesis was mainly focused on fieldwork, research through interviews & mapping and the development of a design proposal based on my acquired knowledge. Therefore the theoretical framework guiding my research and design decisions has functioned more as a practical input of ideas, rather than being an in-depth theoretical investigation. Nevertheless it is essential to shortly touch upon the work of Richard Sennett and Manuel de Solà-Morales that have inspired the research, design and development of this thesis.

BOUNDARIES AND MEMBRANES

In his essay and lecture entitled ‘The Open City’ Richard Sennett argues that cities should be developed as open systems instead of the closed systems we are making them today. He suggests three ways in which open cities can be designed (Sennett 8): ambiguous edges, incomplete form and unresolved narrative. The ‘ambiguous edges’ is the most explicit suggestion used as the theoretical base for this thesis: how to convert boundaries into porous membranes, changing the city from a closed to an open system. By developing the public facilities in the design on the border of the existing and the new development, areas of interaction are created in which different communities start to mingle. This is the type of porous membranes Sennett is alluding to in the examples he mentions.(Sennett 10)

The question of incomplete form and unresolved narrative are nevertheless also embedded in this work. The variety of urban fabrics in the design proposal tries to provide in a wide range of spatial options, in which program is loosely defined in relation to the form, as the mix of different programs is more important. As an answer to Sennett’s suggestion of ‘unresolved narrative’, the phasing strategy shows the openness of the development, where at each stage the project can be considered final and will be successful as such.

THE URBAN PROJECT

The work of Manuel de Solà-Morales has been influenced by Richard Sennett’s thinking and his design strategy of the intermediate scale urban project therefore lies in the same line of Sennett’s Open City argument. His five-point definition of the urban project has certainly been a guideline for this work, as well as his other writings in ‘A Matter of Things’, the compilation of his essays and life work. (Solà-Morales
i Rubió, Frampton, and Ibelings). His use of the urban section as a method to bring urban flows together from the territorial scale to the local scale has had a major influence on this thesis. Additionally his conception of the project as a process and his choice to design on peripheral sites as drivers of urban change reflects in this work as well.

CONCLUDING REMARKS

As many have said before me, now that I’m able to look back at it, a thesis is much more about the process than about the final result. This thesis and the thorough guidance of my committee, especially Lorena, have taught me essential strategies in urban design, analysis and planning. It has been quite a challenging investigation to find the right urban approach to every scale of the specific and realistic problem I chose to investigate. It is exactly this confidence in multi-scalarity and the understanding of how a specific section -investigated in centimeters- will have its impact on the urban and regional scale, which for me is the most precious and rewarding knowledge I got from this process.

Additionally, the struggle and search to come to this design proposal has confirmed my initial understanding of urban design as a field in which the balance between infrastructural, territorial and architectural interventions is key.

I thank you for your interest in reading this manuscript.
BOUNDARIES TO MEMBRANES
THE URBAN PROJECT REVISITED

- AN URBAN STRATEGY FOR RIO DE JANEIRO - ZONA NORTE -

Piere Dettke - GMcG3G Urbansim
Advisor: Lorena Bello Gomez - Hazards: Alan Berger, Alexander D'Incrocci
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Prof. Ehrlich, Mauricio. Interview UFRJ Prof. Geotechnical Engineering. 19 July 2013.


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