Adaptable Porosity

Presentation P5

Mohammad Jooshesh
OFFICE BUILDING EUROPPOINT

Skidmore, Owings & Merrill, 1971-1975, Galvanistraat 15, Rotterdam

What began as an overblown design for a World Trade Centre in two towers at Leuvehaven in the city centre was eventually realized in a slightly modified form as the Europoint three-tower complex on Marconiplein. The two towers linked by a low entry block house the Urban Planning and Public Housing Agency; the third is let. The elevations of white travertine cladding and tinted glass in bronze-coloured frames look rational and abstract yet have been given every aesthetic consideration. Each successive storey widens by just a few centimetres as a perspective-correcting device.
Site Marconiplein
RELLOCATION OF ORIGINAL FUNCTIONS OF MERWEHAVEN

Harbour becomes obsolete:
- Due to existing and expanding residential areas around Merwehaven, the harbour cannot be expanded and modernised

Reasons for relocations:
- New technologies allow for better preservation of product
- Size of ship increased as a result
- Merwehaven cannot be expanded in order to meet demands
### 2007 - 2040 Development Strategy

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Wonen (aantallen)</td>
<td>100</td>
<td>2.250</td>
<td>3.150</td>
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<td>Bedrijfsruimte (nieuw) (m² bvo)</td>
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**Reducing Industry**
**Business & Schools**
**Creative Startups**
**Diverse City**

HTTP://STADSHAVERNSROTTERDAM.NL/
<table>
<thead>
<tr>
<th>Floor</th>
<th>Area (m²)</th>
<th>Program</th>
<th>Structure</th>
<th>Circulation</th>
<th>Climate</th>
<th>Scale</th>
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</thead>
<tbody>
<tr>
<td>Ground</td>
<td>4620</td>
<td>Reception / Restaurant / Store</td>
<td>Service</td>
<td>Steel / Concrete</td>
<td>Horizontal</td>
<td>Micro</td>
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<td>Floor 1</td>
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<td>Transport and Traffic / Company Physician / Help desk</td>
<td>Office</td>
<td>Steel / Concrete</td>
<td>Vertical</td>
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<td>Floor 2</td>
<td>1608</td>
<td>Transport and Traffic</td>
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<td>Steel / Concrete</td>
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<td>Floor 19</td>
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<td>Property Development / Process Documentary Information / Help desk DIV</td>
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<td>Steel / Concrete</td>
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</tbody>
</table>
Problem Statement

- No inside-out and outside-in connections between the towers
- No connections between the towers except from two towers from the basement

- Mono-functional towers which don’t share any spaces with it’s context
Healing Current Situation

Finding the starting Basis

Vacant Spaces in the Towers

Starting with re-programming

Recovery Process

Illness

Existing Towers

Continuous Variation

Adaptation

Porosity Change in all Scales
Starting Point

The recovery process includes the reprogramming and the subtracting the current structural formations in order to provide the desired climatic conditions for the current functions. Re-programing process starts form the vacant parts of the towers.

Porosity Ranges

79%  85%  70%
Re-Programing

Mapping the Programs in the site and the surrounding area

Existing Functions in Site

- Residential
- Art and Cultural
- Research
- Parking
- Medical
- Offices
- Industrial
- Public Space
- Parks
- Food Commerce
- Educational
- Creative Activities
- Retail
- Energy supply

Existing Porosity of Program in site

[Vacancies in buildings and the possibility of using open area in the plot]
The maximum range value = defined through the municipality regulations regarding site occupation [building foot prints and volume]
# Program Parameters

<table>
<thead>
<tr>
<th>Functions</th>
<th>Type of users</th>
<th>Type of activities</th>
<th>Time of being used</th>
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</thead>
<tbody>
<tr>
<td>Retail</td>
<td>9</td>
<td>SH</td>
<td>T_W, T_WN, Morning_S, Evening_E</td>
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<tr>
<td>Medical</td>
<td>9</td>
<td>HC</td>
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<tr>
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<td>V</td>
<td>T_W, Morning_S, Evening_E</td>
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<td>Industrial</td>
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<td>W</td>
<td>T_W, Morning_S, Evening_E</td>
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<td>Office</td>
<td>4</td>
<td>W</td>
<td>T_W, Morning_S, Evening_E</td>
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<tr>
<td>Public space</td>
<td>1,2,3,4,5,6,7,8,9</td>
<td>R,M,E</td>
<td>T_W, T_WN, Morning_S, Evening_E, Evening_S, Morning_E</td>
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<tr>
<td>Parks/recreation</td>
<td>1,6,9</td>
<td>V,R</td>
<td>T_W, T_WN, Morning_S, Evening_E, Evening_S, Morning_E</td>
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<td>1,2,5</td>
<td>L,RS</td>
<td>T_W, Morning_S, Evening_E</td>
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<td>E</td>
<td>T_W, Morning_S, Evening_E</td>
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<td>Creative activities</td>
<td>1,3,4,8</td>
<td>W,RS,L</td>
<td>T_W, Morning_S, Evening_E</td>
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## Type of users

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</table>

## Type of activities

<table>
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<tr>
<th>W</th>
<th>E</th>
<th>S</th>
<th>R</th>
<th>L</th>
<th>RS</th>
<th>HC</th>
<th>M</th>
<th>V</th>
<th>SH</th>
<th>LI</th>
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</thead>
<tbody>
<tr>
<td>Working</td>
<td>Eating</td>
<td>Sleeping</td>
<td>Relaxing</td>
<td>Learning</td>
<td>Researching</td>
<td>Health caring</td>
<td>Meeting</td>
<td>Visiting</td>
<td>Shopping</td>
<td>Living</td>
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</table>

## Time of being used

<table>
<thead>
<tr>
<th>Day</th>
<th>Start Time</th>
<th>End Time</th>
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<tbody>
<tr>
<td>T_W</td>
<td>Morning_S</td>
<td>Evening_E</td>
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<tr>
<td>Weekdays</td>
<td>08:00:00</td>
<td>20:00:00</td>
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<tr>
<td>Weekends</td>
<td>08:00:00</td>
<td>06:00:00</td>
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</table>
Program Determination Strategies

- Defining the relation network between the functions surrounding the site and the functions in the site

- Mapping the key parameters of each program such as [type of users, time of users, equipment, infrastructural demands, environmental parameters, ... ]

- Distributing the degree of each node through “Preferential Attachment” algorithm. The system works such a way that the “agents” (function parameters) which share more similar values tend to create link among themselves and the other nodes which are looking for other connections are more likely to create link with bigger hubs. The nodes which share more links become more prior hubs in the network. Hence, more likely to be selected for the project programs.
# Program Determination Strategies

<table>
<thead>
<tr>
<th>Functions</th>
<th>Percentage</th>
<th>Net Volume</th>
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<tbody>
<tr>
<td>Public space</td>
<td>20%</td>
<td>10200 m³</td>
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<tr>
<td>Residential</td>
<td>18%</td>
<td>9180 m³</td>
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<tr>
<td>Creative activities</td>
<td>14%</td>
<td>7140 m³</td>
</tr>
<tr>
<td>Biomaterial gardens</td>
<td>14%</td>
<td>7140 m³</td>
</tr>
<tr>
<td>Food services</td>
<td>10%</td>
<td>5100 m³</td>
</tr>
<tr>
<td>Park/recreation</td>
<td>10%</td>
<td>5100 m³</td>
</tr>
<tr>
<td>Hospitality</td>
<td>7%</td>
<td>3570 m³</td>
</tr>
<tr>
<td>Art &amp; culture</td>
<td>7%</td>
<td>3570 m³</td>
</tr>
</tbody>
</table>
Program Analysis

**Integration Analysis (Integration)**
Performs integration analysis as described in The Social Logic of Space. Intuitively, the higher the integration value, the more likely for a space to be communal and the lower the integration value, the more private that space.

**Choice Analysis (Choice)**
Performs Choice (Betweenness Centrality) analysis as described first in L. Freeman A set of measures of centrality based on betweenness and later as a Global Dynamic measure in Hiller. B. Burdett. R. Peponis. J and Penn. A 1987. Creating Life. Indicates how often a node (space) happens to be on a shortest path between other spaces; in other words, it measures the degree of choice each represents (how likely it is to be passed through) on all shortest space routes from all from all spaces to all other spaces in the system.

**Control Analysis (Control)**
Performs Control analysis as described in Hiller. B. Hanson. J and Peponis. J. 1987. The syntactic analysis of settlements. Intuitively, indicates how strongly a vertex in a graph (a space in a configuration) is linked to other points in a superior manner.

**Entropy Analysis (Entropy)**
Performs Entropy analysis as described in Hiller. B. Hanson. J and Peponis. J. 1987. The syntactic analysis of settlements. Intuitively the higher the entropy value, the more difficult it is to reach other spaces from that space and vice-versa.
## Rules to be Applied on Programs as Agents

<table>
<thead>
<tr>
<th>Direct Spatial relation</th>
<th>Demand for Direct Sun Light</th>
<th>Need for Day Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential &gt;&gt; Public Space</td>
<td>Gardens</td>
<td>Office</td>
</tr>
<tr>
<td>University &gt;&gt; Public Space</td>
<td>Residential</td>
<td>Creative Activities</td>
</tr>
<tr>
<td>Office &gt;&gt; Public Space</td>
<td>Public Space</td>
<td>Educational</td>
</tr>
<tr>
<td>Art &amp; Culture &gt;&gt; Public Space &amp; Entrance</td>
<td>Recreational</td>
<td>Hospitality</td>
</tr>
<tr>
<td>Office &gt;&gt; Hospitality</td>
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<td>Food Commerce</td>
</tr>
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<td>Art &amp; Culture</td>
</tr>
<tr>
<td>Food Commerce &gt;&gt; Entrance &amp; Parking</td>
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<tr>
<td>Recreation &gt;&gt; Entrance &gt;&gt; Residential</td>
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<tr>
<td>Gardens &gt;&gt; Parking</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assigning attractors for fixed situations such as Sun path and the current functions
Agent-Based Program Position Finding Simulation

Each agent is representative of the found program and different values and attractors are assigned to them based on their relations between themselves and their environment.
Morphogenesism Strategies

Defining standard Voxel system for "Adding and Subtracting" strategies.

"Boolean" principals

TRUE cells with Positive charge

FALSE cells with Negative charge

Assigning the program to the cluster of cells based on the program ratios (in the porosity range)

Cell cluster generation based on the cubic meters needed in each program

FALSE cells are generated based on the need for open space in each program

Daniel Widrig, Projects "Fractal Forms" and Grid
FALSE Voxel Growing System

- The voxels are growing alongside the curves representing the connection between the spots which receive the longest hours of sun-light and the darkest spots.

- The voxels are growing in line with the programs which require open spaces.
Reference

LT COLLINS ST BATHS
VOID Creation
Path Optimization Simulation
TRUE Voxel Growing System

The voxels are growing alongside the curves representing the direct spatial relations between the programs.
Spatial Formation

- Housing
- Farming
- Office
- Workshop
- Public Space
Topology Optimization Simulation
Structural Formation Based on Stress Conditions

- Load and Support Conditions
- Optimized Topology
- Stress Lines, X-Axis
- Stress Lines, Y-Axis
- Stress Lines, Z-Axis
- Functional Zone of Structure
The added geometry also functions as a new structure in such principal that where the surface intersects with the existing Core of the tower, it morphs to the core geometry. The aim is to reinforce the existing core structure for the new building.
Existing & New Structure

The cross overs of the existing beams in the towers will be trimmed and they connect with the new free form structure in the intersection spots.
Existing & New Structure
Stress Analysis

Compression

Tension
Stress Analysis

Through the stress pattern of the structure, the robotic motion paths and the deposition pattern of materials for reinforcement are gained.
Existing & New Structure

Surface Points
Angle of each spot
Critical Bending Spots
Average of Stress Points

Supporting Beams
Supporting Beams
Supporting Beams
Supporting Beams & Additional Public Spaces
Bridge Structure
Bridge Structure
Structure
Structure
Schematic Sections
Envelope
South Elevation
Plans
12th Floor Plan
7th Floor Plan
Fabrication Technique
Fragment of structure
Picking representational element of the structure: a cantilevering slab

Setting conditions
Defining the loads, supports and boundary geometries

Topological optimization
Optimizing material layout within the given design space
Fabrication Technique
Fabrication
Composite Swarm
Interior Impressions
Thank You