P5 presentation

Rotterdam Blaak Railway Station
Erosion based design for the Binnenrotte

Student: Rutger van Doren
Student number: 4019970
MSc 4: Hyperbody Graduation Studio
Tutors: H. Bier, N. Biloria & K. Vollers
Date: 26-01-2015
Location

Rotterdam, Zuid-Holland, the Netherlands

Rotterdam Blaak/Binnenrotte:
51° 52' 01.38", 4° 49' 09.03"

Source:
Bing Maps

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Location

Binnenrotte, district Laurenskwartier West, Rotterdam

Station Rotterdam Blaak is located on the Binnenrotte, between the famous cube houses and the market hall.

Source: Bing Maps

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Problem statement

The past...

The Binnenrotte is used for the central market of Rotterdam on Tuesdays, Saturdays and during the summer also on Sundays...

Source:
http://static.panoramio.com/photos/large/40297375.jpg
Problem statement

The past...

... but it is just an empty square on the other days of the week.

Source: http://static.panoramio.com/photos/original/37131079.jpg

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A masterplan created by Kees Christiaanse Architects & Planners (2007), was commissioned by dS+V Rotterdam. This has led to a renewal of most of the buildings.
Problem statement

.. the present..

MVRDV’s Markethall is part of this masterplan by KCAP. A part of the central market will move inside this building.

Problem statement

.. and the future

This diagram shows where new buildings are wanted. This includes:
- (Yellow) Research done and ready to be designed/built;
- (red) research going on;
- (brown) no research done yet.

Building nr. 5, 10, 13 (brown) are on or adjacent to the site and therefore suitable to perform a study on. Since the station (nr. 5) is the only building that is on the Binnenrotte I chose for a redesign this building.

Source:
KCAP (2007), Masterplan Laurenskwartier West
Problem statement

.. and the future

The municipality of Rotterdam made to sketches for a new square on the Binnenrotte.

Since the market shrinks, and will not be the most important function anymore, the municipality promotes the following:

- Green spaces;
- space for terraces for restaurants/cafés;
- space for events (e.g. market/festivals).

Source:

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Valencia, Spain

The river that used to flow through the city of Valencia is turned into a huge park landscape, because it flooded up to seven times in the past. This landscape is now an attraction for both locals and tourists.

Source: Bing Maps
Valencia, Spain

The 'Jardines del Turia' are not only popular because of the huge green space, it is also the architecture from Santiago Calatrava that makes Valencia an attractive city for tourists.

Source:
http://farm3.staticflickr.com/2735/4244989043_d8f76fd673_o.jpg
References

Bondi ‘Hex’ train station, Sydney

This building is part of an erosion landscape, which includes a train station and a small market.

Source: http://arch2o.com/wp-content/uploads/2013/02/Arch2O-Bondi-Train-Station-4.jpg
Proposal

Market square vs. landscape

Market square
- 148 single market stalls
- 101 double market stalls

Landscape
- green spaces
- 2/3 restaurants with terraces
- landscape elements above and below ground

The proposal for the new Binnenrotte will be a combination of a market square and a landscape route.

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The market on the Binnenrotte should count 148 single and 101 double market stands. The total functional floor area is ca. 10,250 m². Adding 25% for the gross floor area will take 13,000 m² of space on the Binnenrotte.
Area sizes

Binnenrotte, market & landscape

The total area of the Binnenrotte is 29,600 m². For the market a functional floor area of minimal 10,500 m² is needed. Adding about 25% results in a gross floor area of ca. 13,000 m².

The station's gross floor area will be about 9,000 m² which means there is space for ca. 7,500 m² of landscape elements.

Total area Binnenrotte: 29,600 m²
- Functional floor area market: min. 10,500 m²
- Gross floor area market: + 25% = 13,000 m²
- Gross floor area station: Ca. 9,000 m²
- Landscape area: 29,600 - 13,000 - 9,000 = 7,600 m²
Current catering facilities

District Laurenskwartier West

This map shows the current catering facilities in the district Laurenskwartier West. The top number shows the maximum allowed catering functions per building; the bottom number shows the maximum area of each of these functions.

Source:
Stadsontwikkeling Rotterdam (2011) Ontwerpbestemmingsplan Laurenskwartier

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The site concept is to have an entwined market and landscape route. The market route will be flat, while the landscape route will vary in height and will have pop-up restaurants in it embedded.
Station hall concept

In the current situation (above) each type of public transport has its own entrance. By lowering the station hall to subway level (proposal), the station hall will give access to all the public transport types.

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Design strategy

Top down & bottom up

Traditional top down method

Bottom up simulations
- Collecting & processing data

Bottom up simulation:

Self organising distribution system of functions

Parameters:

People flow  Solar radiation  Proximity

The traditional architect uses a top down strategy in his design process. In this graduation studio we learn to use a bottom up strategy next to the traditional top down method.

This bottom up strategy consist of various kinds of simulations by collecting and processing data; in this case a self organising distribution system is chosen.
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*Bottom up simulation:*

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The functions are divided in five groups:
- Station hall functions (yellow)
- public transport (blue);
- catering (red);
- public functions (green);
- offices (orange).
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Parameter: people flow

Possible directions

The first step for the self-organising distribution system is to collect data. The first parameter which is going to be used is the 'people' parameter; a simulation is going to be made to map the use of the square. The dashed lines represent possible directions.
Parameter: people flow

Collecting data

NS Station Rotterdam Blaak

De ideale ligging en een bezoekersaantal van ruim 10,000 reizigers per dag maakt station NS Rotterdam Blaak een goede locatie voor promotiecampagnes. Door dit NS station te gebruiken als decor voor bijvoorbeeld een flyeractie doormidden van een ervaren flyersteam kan iedere mogelijke doelgroep goed worden bereikt. Mocht u interesse hebben in een promotieactie op NS station Rotterdam Blaak, neem dan contact op met VeldMark voor een advies op maat.

<table>
<thead>
<tr>
<th>Locatie</th>
<th>Stationsbezoekers per dag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotterdam Blaak</td>
<td>10,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flyerlocaties</th>
<th>Eventplek</th>
<th>Pop-up store</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ja</td>
<td>Nee</td>
<td>Nee</td>
</tr>
</tbody>
</table>

The figures shown here are just a few of the many collected articles/webpages etc. They show information about the public transport in this case.

Source:

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Parameter: people flow

Storing data

<table>
<thead>
<tr>
<th>Day</th>
<th>Amount of people - Excel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>7534</td>
</tr>
<tr>
<td>Tuesday</td>
<td>9060</td>
</tr>
<tr>
<td>Wednesday</td>
<td>8496</td>
</tr>
<tr>
<td>Thursday</td>
<td>6932</td>
</tr>
<tr>
<td>Friday</td>
<td>7875</td>
</tr>
<tr>
<td>Saturday</td>
<td>6376</td>
</tr>
<tr>
<td>Sunday</td>
<td>7678</td>
</tr>
</tbody>
</table>

Amount of people estimated in Excel for each day.

All the collected data is stored in an Excel sheet for later use.

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Parameter: people flow

Possible directions

The first step for the self-organising distribution system is to collect data. The first parameter which is going to be used is the ‘people’ parameter; a simulation is going to be made to map the use of the square. The dashed lines represent possible directions.
Self-organising distribution system

People parameter: simulation
Self-organising distribution system

People parameter: simulation

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Design strategy

Top down & bottom up

Traditional top down method

Bottom up simulations
- Collecting & processing data

Bottom up simulation:
- Self organising distribution system of functions

Parameters:
- People flow
- Solar radiation
- Proximity

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Parameter: solar radiation

Collecting data

The sun path for this specific location is created. The time zone is set to +2 to match the daylight savings time.
Parameter: solar radiation

Collecting data

The next step is to create a sky dome based on the sun path. The sky dome is divided in patches, each patch surface has the solar radiation measured on it.
Parameter: solar radiation

Collecting data

The result would be a bit incomplete if the shadows are not calculated within this process. However, it seems that the shadows of the buildings doesn't affect the solar radiation on this area during the summer.
Design strategy

Top down & bottom up

Traditional top down method

Bottom up simulations
- Collecting & processing data

Bottom up simulation:

Self organising distribution system of functions

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Parameter: proximity

Attraction and repulsion forces

High cluster value: attraction

Low cluster value: repulsion

When a function has a high value for the cluster parameter, it will attract towards other nearby functions. When the value is lower than 50%, a repulsion force is active.
Design strategy

Top down & bottom up

Traditional top down method

Bottom up simulations
- Collecting & processing data

Bottom up simulation:
- Self organising distribution system of functions
- Parameters:
  - People flow
  - Solar radiation
  - Proximity

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Self-organising distribution system

Simulation
Self-organising distribution system

Chosen configuration (perspective view)

This is the chosen configuration from the self-organising distribution system.

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Self-organising distribution system

This is the chosen configuration from the self-organising distribution system.

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The most busiest route from the station to the end of the Binnenrotte is selected as the ‘market route’. This route remains on ground floor without a slope so market stall owners have their space to place their equipment.
Market route

Busiest route from simulation
Looking at the top view of the chosen configuration, you can see a curvature in the way the functions are located. This curvature is used to connect to the landscape route.
Landscape route

Entwined route along the Binnenrotte
Space-filling geometry

Different types of polyhedra

Cube
Stackable: Yes
Stagger: No

Octahedron
Stackable: Yes
Stagger: Yes

Dodecahedron
Stackable: No
Stagger: -

Icosahedron
Stackable: No
Stagger: -

Truncated octahedron
Stackable: Yes
Stagger: Yes

Rhombicuboctahedron
Stackable: Yes*
Stagger: Yes

6 types of polyhedra are shown on the left. The ideal type of geometry would be a 'rock-shaped' element which can be perfectly stacked with stagger to imitate a landscape.

There are many elements like the Rhombicuboctahedron which can be stacked well, even though the inbetween space is of a different shape.


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Chosen elements

Stacking truncated octahedrons

The elements will have a height of 5 meters, which is the difference between ground floor level and the station hall level. When stacked, floors can be attached at 1/3 or 2/3 or at the top or the bottom of the truncated octahedrons.
Usage of elements

Different purposes

- **Sitting**
  - The top of the elements are cut off.
  - **Location:** 5-15 m from commercial/restaurant functions
  - **Height:** 40-80 cm

- **Walking**
  - Some elements are cut off at 1/3 or 2/3 of its height.
  - **Location:** different places along the landscape route
  - **Height:** height differences are max. 1.67 m

- **Building function**
  - Most elements stay intact; no cut off
  - **Location:** where functions are placed, mostly near destination hall
  - **Height:** floor heights are 3.33 m or 5 m, building height is max. 30 m

The truncated octahedrons are used in 3 different ways, based on their purpose.

- If their purpose is to sit on, they have a max. height of 80 cm. They can be filled with plants and trees.
- If they are meant to walk on, the height differences are maximum 1.67 m because the steps are relatively steep.
- If there is a function inside, the height from floor to ceiling is in most cases 3.33 or 5 m.

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Erosion elements

Hexagon deformation
Erosion elements

Hexagon deformation

- Current terraces
- Hoogstraat
- Church
- Station hall

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Erosion elements

Hexagon deformation
Every function has a certain height. The result - the cylinders - are going to be tested on intersections with the truncated octahedrons.
Geometry intersections

Intersections between truncated octahedrons and functions

After the calculation every element has a value assigned: 0, 1 or 2.

If the value is 0, the truncated octahedron is inside the cylinder. If the value is 1, there is an intersection; if its equal to 2 it means it is outside the function.

Only the truncated octahedrons with value 0 or 1 are used.

Values:
0 = inside
1 = intersection
2 = outside
Erosion strategy

Erosion based on functions

This would be the result if only the functions are a factor in the erosion process.

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Erosion strategy

Erosion based on functions - Top view

This would be the result if only the functions are a factor in the erosion process.
Erosion strategy

Making (structural) connections - Top view

The red elements are added to connect the functions with each other. These connections could also be structural connections.
Erosion strategy

Making (structural) connections - Perspective view

The red elements are added to connect the functions with each other. These connections could also be structural connections.

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Station hall design

Hexagonal grid

A section is taken at ground floor level. The hexagonal pattern is the result of the section of the ground floor plane with all the elements on the Binnenrotte.
The station hall will be positioned between the elements which were left over after the intersection test.
Station hall design

Moving station hall to subway level

The station hall floor is then moved 5 meters under the ground. This is on the same level as the subway platforms.
Station hall design

Stair position

The red area shows the position where the stairs are going to be placed to have access to the Binnenrotte.
Station hall design

Stair design

- Base hexagons
- Top view
- Offset inwards
- Connect curves
- Perspective view

The design for the staircase is based on the hexagons as well. These hexagons are offset inwards and then the curves are connected with each other.
Station hall design

Stair placement

The positioning of the stairs is showed with red color.
Station hall design

Bicycle storage

The underground bicycle storage should be big enough to host 650 bikes. The municipality of Rotterdam really wanted an underground solution due to the overpopulation of bikes near the station.
Station hall design

Commercial functions

The other side of the station hall is filled with commercial functions.

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Station hall design

Underground result

All the functions on level -01 (5 meters below ground floor).

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Station hall design

Ground floor overview

An overview of ground floor level. The section is taken at 10 meters height.

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Station hall design

Glass walls

To protect the station hall from wind, rain etc., glass walls are placed between the erosion elements.

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The whole building derived from the erosion process.
Station hall design

Glass roof

Just like the glass walls, a glass roof is placed on top of the station hall to protect the travelers from rain and wind.
Landscape curves

Combining the landscape with the building

Both curves are connected to the building. People should be able to walk on the building via the landscape.

On the location of the numbers show where landscape elements are placed with a function in it.

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Landscape design

Pattern - top view

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Landscape design

Small elements - top view

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Landscape design

All elements - top view

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Landscape design

Pattern - perspective view
Landscape design

Big elements - perspective view
Landscape design

Small elements - perspective view
Landscape design

All elements - perspective view
Landscape design

Top & side view

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Landscape design

Landscape with function inside

One of the three bigger pieces of landscape which can hold a function inside.

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The second largest piece of landscape which can hold a function inside.
Landscape design

Landscape route on building

People can walk on the landscape and arrive in the restaurant at 20 meters height.
Building functions

Main station hall

People can walk right in the station hall via the subway. On the other side, people can use the stairs to access the Binnenrotte.
Building functions

Bicycle storage

The bicycle storage is big enough for 650 bikes. It gives direct access to the Binnenrotte and to the station hall.
Building functions

Commercial functions

Commercial functions are placed on both sides of the station hall. In total, there will be 4 shops.

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Building functions

Public staircases and elevators

The staircases and elevators are free to use for everyone who wants to get to the top of the building or to ground floor level.
Building functions

Public staircases and elevators

The staircases and elevators are free to use for everyone who wants to get to the top of the building or to ground floor level.
Building functions

Subway access

The old subway entrances remain, but get a new skin which is about the same size as it has now.
Building functions

Exhibition route start

The start of the exhibition route is on ground floor and has public access.
This is part of the landscape route where people have access to the restaurants in the top of the building.
Building functions

Level 01

The staircases, elevators and the exhibition route makes its way to the top of the building.
The staircases, elevators and the exhibition route make its way to the top of the building.
Building functions

Office 1

The first office is accessible via the 2nd floor.
Building functions

Level 03

The exhibition route is connected to the tourist information in the center of the building.

The first office has a larger space on level 03.

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The second office is placed in the north of the building. Just like the 1st office it has its own entrance to make it a private space.
The tourist information is located in the center of the building. It is accessible via the exhibition route and the staircases.
Building functions

Level 04

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Building functions

Restaurant terrace

Via the landscape route, the first restaurant is accessible.
Both restaurants are placed in the top of the building.
Facade panels

Different facade layers

- Prefabricated concrete panel, $d = 170$ mm
- Rockwool thermal insulation ($R_c = 3.5$), $d = 120$ mm
- Cavity, $d = 30$ mm
- PVC, $d = 12$ mm

This image shows the structure of the facade of the building. The panels are made of prefabricated concrete panels on the inside, covered with insulation, a cavity and a layer of PVC.
Facade structure

Attaching the panels

The concrete panels could also be replaced with glass panels. This image shows how.
Structure stability

When only the skin is used as structural elements, the displacement of the top of the building will be huge. Also, the bending moments are so huge that structure will collapse.

Therefore horizontal stability is added using the floors as stiff connections. The floors will be made of reinforced concrete.

Vertical stability is added by making triangles.
3D trusses

Stability method

3D representation of the truss system.
Building cores

Cores & truss positioning

The upper image shows the cores of the building, the lower image shows the positioning of the trusses.
Situation

Landscape route on building

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Elevations

North elevation

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Elevations

East elevation
Elevations

South elevation
Elevations

West elevation
Sections

Section AA'
Floor plans

Ground floor
Floor plans

Level 01
Floor plans

Level 02

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Floor plans

Level 04
Building details

Wall on foundation

Vertical building detail taken at level -01: wall on foundation.
Building details

Wall on foundation

Vertical building detail taken at level -01: wall on foundation.
Building details

Floor with wall

Vertical building detail of pre-fabricated walls with a cast in place reinforced concrete floor.

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