T.E.S.T - Technical, Economical and Sustainable Transformation

P5 PRESENTATION

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3rd Tutor:  Marcel Bilow
Gecommitteerde: Ana Maria Fernandez Maldonado
PROBLEM STATEMENT

&

RESEARCH SUMMARY
PROBLEM STATEMENT

existing situation:
- different neighborhoods
- different structures, functions
- architecture value

URBAN SPRAWL

transport?
zoning?
social division?
greenery?
abandon?

NO AVAILABLE SPACE?

SOURCE: denijl.nl
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

65 meter empty building
**OVERALL DESIGN QUESTION**

How to redesign existing buildings, to make them functionally flexible and adaptable, and apply Cradle to Cradle idea of re-use keep the future transformations sustainable?
FACADE INTEGRATION

PROBLEM STATEMENT

TECHNICAL RESEARCH QUESTION

How to design façade that fulfill the different program requirements, in terms of light, ventilation, sunshading, noise, heating/cooling and maintenance?

SUBQUESTIONS

How to adjust façade elements for the redesign program?

How to implement heating, cooling, sunshading and ventilation solutions in the façade panels and reduce number of indoor installations?

How to make façade elements adaptable to different types of structures and sizes, as the structure grid, storey height etc.?

How to make façade elements easy to install and dismantle?

How to implement Cradle to Cradle idea in the design, according to the material aspect and building life cycle, to meet new energetic requirement?

How to improve existing process of the recycle method and make it more sustainable and efficient?

How to redesign existing buildings to meet new energetic requirements?
SCOPE OF THE RESEARCH QUESTION

PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

VENTILATION

SUNSHADING

LIGHT

NOISE

HEATING COOLING

MAINTENANCE

OPEN/CLOSE

C

FACADE REQUIREMENTS TO THE FUNCTION
(VENTILATION/SUNSHADING/LIGHT/NOISE)

B

SPATIAL DIVISION
FUNCTIONAL TRANSFORMATION
INSTALATIONS

A

MATERIAL PROPERTIES
CLOSED CYCLE

TRANSFORMATION OF EXISTING BUILDING
(CRADLE TO CRADLE)
Part A

Bio-composites as Cradle to Cradle material
> fully biodegradable
> 250mm of the panel = 0,19 W/m2K
> flax oil based resins
> 3D modeling
> H max around 14m
  width max around 3,5m

SOURCE: http://anaheviainteriorismo.files.wordpress.com/2013/10/worlds-first-biobased-composite-panels-npsp.compositesen.com/Nabasco®

WOOD
FLAX
HEMP
SOIA

SOURCE: en.wikipedia.org
SOURCE: www.flaxandhemp.bangor.ac.uk
SOURCE: www.mixerplanet.com

CRADLE TO CRADLE - NABASCO BIO-COMPOSITES

TRADITIONAL APPROACH

*Le Corbusier: build machines for living
now: build machine for coexistence*

Cradle to Cradle concept
CRADLE TO CRADLE - NABASCO BIO-COMPOSITES

NABASCO APPROACH

RAW MATERIAL → PRODUCTION → CONSTRUCTION → MAINTENANCE → DEMOLISH DISMANTLING → RE-USE BIOMASS → WASTE → RAW MATERIAL

ENERGY → RAW MATERIAL → BURNING → BIOMASS → FERTILIZER

ENERGY → PRODUCTION → CONSTRUCTION

BIOMASS → BURNING → ENERGY

RAW MATERIAL → RE-USE
two types of metabolism: biological and technical, should cooperate in life cycle - one cycle will give “food” for the other one

Cradle to Cradle concept
Part B
Space, function, services

Part C
Facade
HOW TO COMPARE FUNCTIONS / REQUIREMENTS TO GIVE RELIABLE RESULTS?

TEST MODEL
## Tools for the Design

<table>
<thead>
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<th>Annual Sun Track</th>
<th>PV</th>
<th>Solar</th>
<th>Annual Wind Rose</th>
<th>June</th>
<th>July</th>
<th>Nat. Ventilation</th>
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</table>

**Design Concept**

**Reflections**

**Problem Statement**

**Climate**

**Design**

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**Note:** The symbols represent the feasibility of certain design elements such as PV panels, solar energy, wind roses, and natural ventilation based on the orientation and seasonal wind patterns.
**PROBLEM STATEMENT**

- **WEST EAST**
- **SOUTH**

36% 64% 80%

Heat demand: 61 W/m²
Determine total building envelope: 22,08 m² (80%)
Area transparent parts: 5,28 m² (20%)
Area closed parts: 16,8 m²

Heat demand: 59 W/m²
Determine total building envelope: 17,44 m² (64%)
Area transparent parts: 9,9 m² (36%)
Area closed parts: 7,5 m²

Heat demand: 56 W/m²
Determine total building envelope: 14,94 m² (55%)
Area transparent parts: 9,9 m² (36%)
Area closed parts: 5,0 m²

Heat demand: 55 W/m²
Determine total building envelope: 14,94 m² (55%)
Area transparent parts: 9,9 m² (36%)
Area closed parts: 5,0 m²

**CLIMATE**

- **Volumic mass air r**: 1,3 kg/m³
- **Infiltration rate**: n=0,2
- **Heat recovery percentage (sensible heat)**: hrp: 0%
- **Air change rate**: n=1,3

**BASIC DATA:**

- **Volume**: 145 m³
- **Area**: 41 m²
- **Size**: 6,9 (L) x 6 (W) x 3,5 (H) [m]

**OFFICE**

- **Heat recovery percentage (sensible heat)**: hrp: 0%

**DESIGN CONCEPT**

- **Reduction only to 24 W/m²**

**DWELLING**

- **Heat recovery percentage (sensible heat)**: hrp: 90%

**DETERMINATION OF TOTAL HEAT DEMAND**

- **Capacity lighting**: 10 W/m²
- **Number of persons**: 15
- **Solar heat load**: 600 W/m²
- **Average g-value**: 0,15
- **Building envelope**: 7,92 m² (36%)
- **Area transparent parts**: 0,2 W/m²K
- **Average U-value closed parts**: 1,50 W/m²K
- **Outdoor**: 28 °C
- **Indoor temp**: 24 °C
- **Cooling capacity**: 40 W/m²
- **Cooling capacity option 1**: 1,48 m²
- **Cooling capacity option 2**: 2,47 m²
- **Cooling capacity 1P**: 1,50 m²

**AVAILABLE SPACE**

- **Area closed parts building envelope**: 12,42 m² (49%)
- **Area transparent parts building envelope**: 14,94 m² (55%)
- **Determine total heat demand**: 56 W/m²

**ENERGY EFFICIENCY**

- **Heating capacity**: 61 W/m²
- **Cooling capacity**: 10 W/m²
- **Number of persons**: 4

**ERGONOMICS**

- **Volume**: 145 m³
- **Area**: 41 m²
- **Size**: 6,9 (L) x 6 (W) x 3,5 (H) [m]
location

Amsterdam
Brettenzone
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

example:

Change Architects
Plaats: Amsterdam
Oppervlak: 90.000m2
Opdrachtgever: Ontwikkelingsbedrijf
Gemeente Amsterdam
Jaar: 2008

source: www.changearchitects.nl
PROBLEM STATEMENT

max. m² available

energy label
idea
idea
idea
idea
functions
commerce
functions

office
functions
greenery / sport
functions

housing (in general)
functions

car park
CONSTRUCTION GRID

7,20m x 7,20m
transformation principle
transformation principle  hardware  software
functions public (fitness, exhibition, culture, restaurant etc.)
functions  offices
functions  housing
<table>
<thead>
<tr>
<th>functions</th>
<th>exhibition - offices - for Cradle to Cradle idea</th>
</tr>
</thead>
</table>

**PROBLEM STATEMENT**

**DESIGN CONCEPT**

**CLIMATE**

**DESIGN**

**REFLECTIONS**
communication
communication
communication
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS
TYPOLOGY

- Reinforced concrete: 30.00
- Insulation: 12.00
- Screed: 3.00
- Floor: 2.00
- Plaster: 2.00
- PE foil
- Thermal active ceiling
- Air duct
- HVAC

DETAILS

- Dwelling Type A & B Floorplan 1:50
- Dwelling Type C Floorplan 1:50

- Sizes: 48 m², 35 m², 80 m²

PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

ARCHITECTURAL ENGINEERING

MATEUSZ RYBAK

DRAWING TYPE

DATE: 23.05.2014

VERSION

SCALE

PAPER SIZE

ARCHITECTURE

DRAWING NAME

DWELLING TYPE C FLOORPLAN 1:50

DWELLING TYPE A & B FLOORPLAN 1:50

SECTION

SIZES

80 m²

48 m²

35 m²
EMERGENCY STAIRCASE

BIG EXHIBITION

TOILETS

SMALLER OFFICES

EMERGENCY STAIRCASE

EXHIBITION

LATER LOFTS

EXHIBITION
CLIMATE / SUSTAINABILITY
RESEARCH IMPLEMENTATION

PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

ANNUAL SUN TRACK

S

PV

SOLAR

ANNUAL WIND ROSE

JUNE

JULY

NAT. VENTILATION

WEST EAST

SOUTH

NORTH

JANUARY-DECEMBER

SUN TRACK
LOCATION FACTORS

- **SUN** (Energy - PV/Heat)
- **WIND** (Natural Ventilation)
- **SUNSHADING** (Prevent Overheat)
- **NOISE** (Extra Factor)
LOCATION FACTORS

Sunshading
SOURCE: facadesconfidential.blogspot.com

Schroeder noise diffusor
SOURCE: www.primacoustic.com

Fan
SOURCE: uk.hardware.info

PV panel
SOURCE: www.redren.in
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

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REFLECTIONS
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS
ventilation summer
GENERAL

ventilation winter
GENERAL
INTEGRATED PANELS / MECHANICAL VENTILATION

INTEGRATED PANELS / MECHANICAL VENTILATION
LOCATION FACTORS

SUN (ENERGY - PV/HEAT)

WIND (NATURAL VENTILATION)

SUNSHADING (PREVENT OVERHEAT)

NOISE (EXTRA FACTOR)
NOISE DIFFUSION

SCHOEDER BOX DIFFUSOR
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

SUNSHADING PRINCIPLES
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

SUNSHADING
INTEGRATED FACADE PANEL

HVAC DEVICE

INTEGRATED FACADE PANEL

PV PANEL COLOR POSSIBILITIES

6” MULTI SERIES

- LAVENDER
- VELVET RED
- AMETHYST
- CELADON
- GOLDEN BROWN
- ANGEL WING
- DIAGONAL CIT
- MIDDLE CIT

PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS
entrance
PROBLEM STATEMENT

DESIGN CONCEPT

CLIMATE

DESIGN

REFLECTIONS

office
housing
exhibition that can change into...
...lofts!
**PV AND SOLAR PANELS LOCATION**

**DWELLING**

**BASIC DATA:**
- size: 6,9(L) x 6(W)x3,5(H) [m]
- area: 41m²
- volume: 145m³
- wall: 250mm cork (0.2 W/m²K)
- air change rate: n=1.3
- Heat recovery percentage (sensible heat) hrp: 0%
- Infiltration rate: n=0.2
- Volumic mass air r: 1.3 kg/m³

**HEATING**
- indoor temp = 20° C
- outdoor = -5° C

Determine total heat demand: 18 W/m²
Determine total cooling demand: 46 W/m²

with no sunshading!

**OFFICE**

**BASIC DATA:**
- size: 6,9(L) x 6(W)x3,5(H) [m]
- area: 41m²
- volume: 145m³
- wall: 250mm cork (0.2 W/m²K)
- air change rate: n=1.3
- Heat recovery percentage (sensible heat) hrp: 0%
- Infiltration rate: n=0.2
- Volumic mass air r: 1.3 kg/m³

**HEATING**
- indoor temp = 20° C
- outdoor = -5° C

Determine total heat demand: 16 W/m²
Determine total cooling demand: 57 W/m²

with no sunshading!

**ENERGY CONSUMPTION**
### DWELLING

**PV AND SOLAR PANELS LOCATION**

- PV per person = 650 kWh (medium)
- Modules = 200W
- Efficiency 18%
- 1 panel = 1.1 m²

**TYPE 1**

1 person living

- 7 m² (panels)
- +1.4 m² (roof) - 8.4 m² (+2 m² extra)
- 70% time use

Energy for: 1.78 persons

(-0.78 extra persons)

**TYPE 2**

2 person living

- 7 m² (panels)
- +0.7 m² (roof) - 7.7 m² (+2 m² extra)
- 60% time use

Energy for: 1.63 persons

(-0.37 extra persons)

### OFFICE

**PV AND SOLAR PANELS LOCATION**

- PV per person = 990 kWh (very high)
- Modules = 200W
- Efficiency 18%
- 1 panel = 1.1 m²

**TYPE 1**

8 person working

- 10.5 m² (panels)
- +2 m² (roof) - 12.5 m² (+2 m² extra)
- 70% time use

Energy for: 1.75 persons

(-6.25 extra persons)

**TYPE 2**

5 person = 5 * 990 = 4950 kWh = 25,6 m²

10 person = 10 * 990 = 9900 kWh = 52,2 m²

Available panels 1680 m²

Energy for: 407 persons
**PROBLEM STATEMENT**

**DESIGN CONCEPT**

**CLIMATE**

**ENERGY PRODUCTION**

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**DWELLING PV AND SOLAR PANELS LOCATION**

**SOLAR PANELS**
use of water/day = 50 L/day (medium)
hot water = 45°C
sun irradiation - 762.4 kWh/m²/year

**PV AND SOLAR PANELS LOCATION**

**Dwelling office**
7m² (panels)
+1,4m² (roof) - 8,4 m² (+2m² extra)
70% time use

water for: 4,52 persons
(3,52 extra persons)

**TYPE 1**
1 person living
7m² (panels)
+1,4m² (roof) - 8,4 m² (+2m² extra)
70% time use

**TYPE 2**
2 person living
7m² (panels)
+0,7m² (roof) - 7,7 m² (+2m² extra)
60% time use

energy for: 3,37 persons
(-4,63 extra persons)

---

**OFFICE PV AND SOLAR PANELS LOCATION**

**SOLAR PANELS**
use of water/day = 100 L/day (high)
hot water = 45°C
sun irradiation - 762.4 kWh/m²/year

**PV AND SOLAR PANELS LOCATION**

**Office**
10,5m² (panels)
+2m² (roof) - 12,5 m² (+2m² extra)
70% time use - 8,75m²

energy for: 3,37 persons
(-4,63 extra persons)

---

**TYPE 1**
8 person working
10,5m² (panels)
+2m² (roof) - 12,5 m² (+2m² extra)
70% time use - 8,75m²

---

**TYPE 1**
1 person working
7m² (panels)
+0,7m² (roof) - 7,7 m² (+2m² extra)
60% time use

---

Available panels 1680 m²

---

**ENERGY PRODUCTION**

hot water for: 1034 persons

---

**CLIMATE**

---

**DESIGN**

---

**REFLECTIONS**
### FOR UNITS THAT PRODUCE AND NOT PRODUCE ENERGY

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<tr>
<th></th>
<th>DWELLING I</th>
<th>DWELLING II</th>
<th>DWELLING III</th>
<th>OFFICE</th>
<th>WHOLE BUILDING</th>
<th>COMMON</th>
<th>TOTAL</th>
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<td>-0,11</td>
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<td>-1,18</td>
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- **70% time use**
  - for: 4.52 persons (3.52 extra persons)

- **60% time use**
  - for: 4.15 persons (2.15 extra persons)

**PV AND SOLAR PANELS LOCATION**

- DWELLING OFFICE: 7m² (panels) + 0.7m² (roof) = 7.7m² (+2m² extra)
- TYPE 1: 1 person living
- TYPE 2: 8 persons working

**Climate**

- Use of water/day = 50 L/day (medium) for hot water = 45° C
- Sun irradiation = 762.4 kWh/m²/year

**Criterion**

- Only 50% units produce energy
- NOT ENOUGH ENERGY FOR USERS
- Orientation problems

**Design Concept**

- SOLAR PANELS
- Water use: 100 L/day (high) for hot water = 45° C
- Sun irradiation = 762.4 kWh/m²/year

**Problem Statement**

- 178316 kWh
- TOTAL: 2460 m²
- PER UNIT: 100% facade
- PER UNIT: 100% facade

**Reflections**

- Orientation problems
### FOR UNITS THAT PRODUCE AND NOT PRODUCE ENERGY

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<tr>
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<th>30% facade</th>
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### DWELLINGS I, II, III

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<td>+1034</td>
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<tr>
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<td>-152</td>
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### 70% Facade vs. 30% Facade

- **70% Facade**: More efficient use of energy, reducing environmental impact.
- **30% Facade**: Less efficient use of energy, with higher environmental impact.

### Problem Statement

- Design Concept
- Climate
- Reflections

### Climate

- 178316 kWh
- Total: 2460 m²
- Cradle to Cradle ideology – biodegradable panels – no environmentally harmful elements

- energy consumption reduction

- reduction of the indoor services – no need to manufacture new ones

- green roofs (biodiversity)

- step further to the zero energy buildings (low CO2 emission)

- refurbishment of the office building – reducing of abandoned and unprofitable spaces

- higher flexibility by implementation of the integrated panels

- no need (partly) of the indoor installations

- integrated panels – energy production

- rent costs reductions and cheaper refurbishments

- mixed function increase attractiveness of the area in terms of living and recreating

- awareness of the energy consumption increases

- implementation of the Cradle to Cradle idea – increased awareness of the material cycle problem

- because of different sizes of the apartments higher social diversity

- integrated panels increases the interior configuration possibilities

- awareness of the energy consumption increases

- implementation of the Cradle to Cradle idea – increased awareness of the material cycle problem

- because of different sizes of the apartments higher social diversity

- integrated panels increases the interior configuration possibilities
THANK YOU!