GRADUATION PRESENTATION [P5]
TRANSFORMATION ‘OFFICE TO DWELLING’ AND ‘DWELLING TO USER’

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TECHNICAL UNIVERSITY OF DELFT
BUILDING TECHNOLOGY
GRADUATION PRESENTATION [P5]
TRANSFORMATION ‘OFFICE TO DWELLING’ AND ‘DWELLING TO USER’

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INDEX

Background and motive
Objectives
Process and methodology
Concepts
Case study
Applying strategy
Design explanation
Conclusions

presentation duration = aprox 45 minutes
BACKGROUND AND MOTIVE
FACT SHEET VACANCY

- 6.3 million m$^2$ office vacancy, 4 million m$^2$ structural vacant

- Highest vacancy rates by small and medium sized offices

- Highest vacancy rates by offices constructed in the year 1960 till 1980

- We build our own structural vacancy and this will increase
REASONS VACANCY

- esthetical decay
- functional decay
- technical decay
- energetically decay
WHY TRANSFORMATION

- the building is structural vacant
- housing shortage....

- 80,000 dwellings must be build every year, demand will increase after 2015
- expected vacancy rates: possibility of creating 140,000 dwellings of 70 m²
TRANSFORMATION PROBLEMS

- traditional transformation is a customized and monumental solution
- high book value and price of offices
- difference in lettable floor area between office and apartment buildings
- low floor height
- difficulty and impossibility of penetrating (pre strained) concrete floors
- interference is related to more problems and thus higher costs!
how to prevent that the transformed building becomes again part of an existing ‘discard cycle’?
LEVEL OF INDIVIDUALISM
READY FOR THE UNKNOWN FUTURE

- changing energy requirements
- changing building code requirements
- different/changing comfort wishes
- able to keep in pace with new technology
- easy to integrate the latest developments
- energy efficiency on a large scale
‘OFFICE TO DWELLING’

+ 

‘DWELLING TO USER’

= 

TRANSFORMATION AND OPEN BUILDING
OBJECTIVES
“an uniform process and system implemented on existing structures with limited interference”
“conform (individual) requirements and wishes of users and government - now and then“

- by using an upgradable catalog -
“extra floor space needed for feasibility”
RESEARCH QUESTION

“How is it possible to develop a systematized and flexible façade (the support) for transforming small and medium-sized office buildings from the year 1960 till 1980 to residential buildings with respect for the individuality, where the facade is an integral part of the building-climate concept (the infill) and limited interfering with the existing structure of the building?“
RESEARCH APPROACH

facade layers
“How can a typical office building from the year 1960 till 1980 be transformed into flexible housing along with the needed comfort, user requirements and energy efficiency, where all the needed interventions are facilitated in the façade layer?”
RESEARCH APPROACH
3 FUNCTIONS ('FILLING')
- Adaptable to User Requirements
- Adaptable to Legislation
- EN Consumption
- Installations
- Dimensions and Capabilities

4 INFRA STRUCTURE
- Wiring and Connecting
- Ducts, Pipes, Data, etc.
- Adaptability

5 INNER LAYER

6 FUNCTION AREA
- Output Systems
- Sanitary

1 OUTER LAYER

2 FRAME ('CARRIER')
PROCESS AND METHODOLOGY
TEN STEPS OF FUTURE TRANSFORMATION

01. why transformation
02. inspection, mapping and revitalization
03. coordination, parcellation and routing
04. demand = scenario
05. manufacturing, implementation and transport
06. assembly on site
07. supply = hypotheses
08. outcome and ownership
09. outcome$^2$ and future
10. scope and possibilities
01 WHY TRANSFORMATION

TRANSFORMATION

02 INSPECTION, MAPPING AND REVITALIZATION
03 COORDINATION, PARCELLATION AND ROUTING

04 DEMAND = SCENARIO
07 SUPPLY = HYPOTHESIS

08 OUTCOME AND OWNERSHIP
CONCEPTS
CREATE EXTRA SPACE

POSSIBLE EXPANSION DIRECTIONS
PRINCIPLES FOR EXPANSION

- thicken
- up-topping
- dig-in
- tie on
- close building
- sporadic apply
PRINCIPLES FOR EXPANSION

- means that the building becomes thicker
- extra space with limited resources and interference
- equal expansion provides 20-25% extra m$^2$
- additional space can serve as outdoor space
- placing the facade around the existing structure it is conserved - building physically wrapped
CREATING EXTRA SPACE
FAÇADE CONCEPTS

- support and infill
- permanent and non-permanent
- control and decision-makers
- short and long lifetime
- collective and individual
LAYERS, LIFETIME AND DECISION-MAKERS

OFFICE STRUCTURE
GRID AND PATTERNS
- MANUFACTURER
- STRUCTURAL ENGINEER
- FACADE ENGINEER
- ARCHITECT
- BUILDING REGULATIONS
- BUILDING PHYSICIST

FRAME
- 100 YEARS

INNER LAYER
- 1 - 15 YEARS

INFRASTRUCTURE

SPACE PLAN
- MANUFACTURER
- BUILDING SERVICES
- ARCHITECT
- DEMANDS AND WISHES
- BUILDING PHYSICIST
- MECHANICAL ENGINEER

FILLINGS
FUNCTIONS
- FACADE ENGINEER
- MANUFACTURER
- BUILDING PHYSICIST
- BUILDING SERVICES
- DEMANDS AND WISHES
- BUILDING REGULATIONS
- SURROUNDINGS
- ENVIRONMENT

OUTER LAYER
- ARCHITECT
- FACADE ENGINEER
- MANUFACTURER
- BUILDING REGULATIONS
- ENVIRONMENT
- SURROUNDINGS
- "THE URBAN CONTEXT"
- ARCHITECT
- AND MUNICIPALITY

INDIVIDUAL RESIDENTS

MUNICIPALITY POLICY
HORIZONTAL AND VERTICAL FRAME PRINCIPLE

- provides extra square meters
- the extension consists of a horizontal and vertical frame
- the frames are based on a programmable grid
- the frames provides space for the infra-structure and infill
- individualization and collectivity of layers
- two building physical lines (in- and outdoor)
SANDWICH FRAME PRINCIPLE

- combination with previous concept
- support and infill
- programmable
- panels provides the building physics
- provides freedom in placing the openings or the architectural appearance
COMFORT AND SERVICES CONCEPTS

- collective or individual
- how much flexibility is desired?
- efficiency or individual choice
- space reservation shaft and apartment
- influence on building
- heating, hot water, ventilation, electricity, etc.
INSTALLATION CONCEPTS
HEATING CONCEPT

- collective
- efficient systems possible
- save apartment space
- save energy costs

- infrastructure shaft: 2 x Ø 50mm
- infrastructure apartment: 2 x Ø 15mm
PROGRAMMING THE FACADE

- calculating and programming
- transparency
- ventilation
- heating
- infrastructure

<table>
<thead>
<tr>
<th>FLOOR SPACE</th>
<th>LIVING ROOM</th>
<th>59.8 m²</th>
<th>30.9 m²</th>
<th>90.7 m²</th>
<th>21.4 m²</th>
<th>30.9 m²</th>
<th>15.1 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL FACADE SURFACE</td>
<td></td>
<td>36.3 m²</td>
<td>9.9 m²</td>
<td>46.2 m²</td>
<td>13.2 m²</td>
<td>9.9 m²</td>
<td>7.4 m²</td>
</tr>
<tr>
<td>CALCULATED FACADE SURFACE</td>
<td></td>
<td>28.4 m²</td>
<td>7.7 m²</td>
<td>36.1 m²</td>
<td>10.3 m²</td>
<td>7.7 m²</td>
<td>5.8 m²</td>
</tr>
<tr>
<td>TOTAL Ae_i</td>
<td></td>
<td>22.27 m²</td>
<td>6.16 m²</td>
<td>28.88 m²</td>
<td>8.24 m²</td>
<td>6.16 m²</td>
<td>4.64 m²</td>
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<tr>
<td>BUILDING LAW 0,5 m²²</td>
<td></td>
<td>0.5 m²</td>
<td>6%</td>
<td>0.5 m²</td>
<td>1%</td>
<td>0.5 m²</td>
<td>6%</td>
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<tr>
<td>BUILDING LAW 10%</td>
<td></td>
<td>5.98 m²</td>
<td>40%</td>
<td>3.09 m²</td>
<td>25%</td>
<td>9.07 m²</td>
<td>21%</td>
</tr>
<tr>
<td>NEN COMFORT AMBITION B</td>
<td></td>
<td>14.95 m²</td>
<td>99%</td>
<td>7.73 m²</td>
<td>63%</td>
<td>22.68 m²</td>
<td>52%</td>
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<tr>
<td>REQUIRED TRANSPARANT SURFACE ABOVE 600mm</td>
<td>combined</td>
<td></td>
<td></td>
<td>63%</td>
<td>52%</td>
<td>40%</td>
<td>65%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLOOR SPACE</th>
<th>LIVING ROOM</th>
<th>59.8 m²</th>
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<th>90.7 m²</th>
<th>21.4 m²</th>
<th>30.9 m²</th>
<th>15.1 m²</th>
<th>10.1 m²</th>
<th>20.7 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILDING LAW DEMAND</td>
<td></td>
<td>0.9 dm³/s m²</td>
<td>0.9 dm³/s m²</td>
<td>0.9 dm³/s m²</td>
<td>0.9 dm³/s m²</td>
<td>0.9 dm³/s m²</td>
<td>14 dm³/s</td>
<td>0.7 dm³/s m²</td>
<td>50.1 m³/h</td>
</tr>
<tr>
<td>NEEDED CAPACITY</td>
<td></td>
<td>193.8 m³/h</td>
<td>100.1 m³/h</td>
<td>293.9 m³/h</td>
<td>69.3 m³/h</td>
<td>100.1 m³/h</td>
<td>48.9 m³/h</td>
<td>14 dm³/s</td>
<td>exhaust</td>
</tr>
<tr>
<td>DECENTRALIZED DEMAND</td>
<td></td>
<td>0.7 dm³/s m²</td>
<td>0.7 dm³/s m²</td>
<td>0.7 dm³/s m²</td>
<td>0.7 dm³/s m²</td>
<td>0.7 dm³/s m²</td>
<td>0.7 dm³/s</td>
<td>exhaust</td>
<td></td>
</tr>
<tr>
<td>NEEDED CAPACITY</td>
<td></td>
<td>150.7 m³/h</td>
<td>77.9 m³/h</td>
<td>228.6 m³/h</td>
<td>53.9 m³/h</td>
<td>77.9 m³/h</td>
<td>38.1 m³/h</td>
<td>exhaust</td>
<td></td>
</tr>
<tr>
<td>REQUIRED DECENTRAL UNITS (125 m³/h)</td>
<td>combined</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STANDARD FACADE, REQUIRED FILLINGS

<table>
<thead>
<tr>
<th>COLOR</th>
<th>LIVING ROOM / KITCHEN / DINING</th>
<th>BED / BATH ROOM</th>
<th>BED ROOM</th>
<th>INSULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL POSSIBLE FILLINGS</td>
<td>504</td>
<td>108</td>
<td>144</td>
<td>U = 1.2 W/m²K</td>
</tr>
<tr>
<td>NEEDED FOR DAYLIGHT</td>
<td>232</td>
<td>33</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>NEEDED FOR DECENTRAL VENTILATION/HEATING UNIT</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>NEEDED EXTRA HEATING</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NEEDED FOR DISTRIBUTION / INFRASTRUCTURE</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>FREE CELLS</td>
<td>211</td>
<td>64</td>
<td>67</td>
<td>R = 3.5 m² K/W Thickness Ins.: 140 mm</td>
</tr>
</tbody>
</table>
### Green Living Facade, Programmed Fillings

<table>
<thead>
<tr>
<th>Color</th>
<th>Living Room / Dining</th>
<th>Bed / Bath Room</th>
<th>Bed Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Possible Fillings</td>
<td>504</td>
<td>108</td>
<td>144</td>
</tr>
<tr>
<td>Used for Daylight</td>
<td>346.5</td>
<td>49.5</td>
<td>99</td>
</tr>
<tr>
<td>Used for Discontinuous Ventilation / Heating Line</td>
<td>16</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Used Extra Heating</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Used for Distribution / Infrastructure</td>
<td>9</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Free Cells</td>
<td>132.5</td>
<td>49.5</td>
<td>28</td>
</tr>
</tbody>
</table>

- **Insulation**: $U = 0.3 \text{ W/m}^2\text{K}$
- **Thermal Insulation**: $R = 4.0 \text{ m}^2\text{K}/\text{W}$, Thickness inc., 240 mm

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### Outside Sun Shades
- | 38.5 | 5.5 | 11 |
- PCM Panels | 99 | 0 | 0 |
- Solar Collector / PV Cell | 67.5 | 49.5 | 0 |
- Vegetation | 99 | 0 | 0 |
- Domotica Panel | 1 | 0 | 0 |
CASE STUDY
LOCATION

- near Amsterdam
- good infrastructure
- green spaces
- demand for housing
- municipality wants to invest and cooperate
- structural vacancy of offices
APPLYING STRATEGY
EXISTING
COORDINATION AND PARCELLATION
ROUTING
PARCELLATION CHOICE

- square meters
- clustering (horizontal or vertical)
- orientation
- in- and outdoor spaces
- infill-level
- budget
SPACE PLAN USER

catalog
choice user
program
outcome
<table>
<thead>
<tr>
<th>Package</th>
<th>Description</th>
<th>Orientation</th>
<th>Number of Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD PACKAGE</td>
<td>Everything you need for standard comfortable living without high costs</td>
<td>SOUTH</td>
<td>8+</td>
</tr>
<tr>
<td>GREEN PACKAGE</td>
<td>For environmental conscious residents, save on energy use and costs, with a green appearance</td>
<td>SOUTH</td>
<td>8+</td>
</tr>
<tr>
<td>DELUXE PACKAGE</td>
<td>High quality materials and finishing, usable for larger apartments and higher incomes</td>
<td>SOUTH</td>
<td>8+</td>
</tr>
<tr>
<td>BLANK PACKAGE</td>
<td>Customize your own package, all wishes, budgets and appearances are possible</td>
<td>SOUTH</td>
<td>8+</td>
</tr>
</tbody>
</table>

### Frame Changeability

<table>
<thead>
<tr>
<th>Inner Layer</th>
<th>Grid Module</th>
<th>Components</th>
<th>Outer Layer</th>
</tr>
</thead>
</table>

### Energy Efficiency

- **R-value Opaque**: 3.5 m² K/W
- **U-value Transparent**: 1.2 W m²/K
- **Glass Percentage**: NEN GA-B
- **Energy**: €
- **Costs**: €

- **R-value Opaque**: 5.5 m² K/W
- **U-value Transparent**: < 1.2 W m²/K
- **Glass Percentage**: > NEN GA-B
- **Energy**: €
- **Costs**: €

- **R-value Opaque**: 3.5 m² K/W
- **U-value Transparent**: 1.2 W m²/K
- **Glass Percentage**: NEN GA-B
- **Energy**: €
- **Costs**: €

- **R-value Opaque**: 3.5 m² K/W
- **U-value Transparent**: 1.2 W m²/K
- **Glass Percentage**: NEN GA-B
- **Energy**: €
- **Costs**: €
outdoor space

Indoor space

glass balustrade

wood finish
outcome = choice individual user
DESIGN EXPLANATION
SHORT AND LONG LIFETIME

- Uniform building grid
- Vertical infrastructure
- Main frame
- Console and horizontal frame
- Outer layer
- Inner layer
- Grid-system and infrastructure
- Infill
- Existing structure

Color codes:
- ± 1-15 years
- ± 15-40 years
- ± 1-100 years
- ± 40-100 years
- ± 100-200 years
CONTROL AND DECISION-MAKERS_01

USER(S)

PROFESSIONALS / GOVERNMENT

GRID-SYSTEM AND INFRASTRUCTURE

INNER LAYER

MAIN FRAME

VIRTUAL INFRASTRUCTURE

UNIFORM BUILDING GRID

OUTER LAYER

CONSOLE AND HORIZONTAL FRAME

EXISTING STRUCTURE

INFILL

COMPONENT

PROFESSIONAL AND GOVERNMENT

USER(S)

PROFESSIONAL

USER(S) AND GOVERNMENT

USER(S) AND PROPERTY MANAGEMENT
CONTROL AND DECISION-MAKERS_02

- USER(S)
- PROFESSIONALS / GOVERNMENT
- PROFESSIONALS AND GOVERNMENT
- USER(S)
- PROFESSIONAL
- USER(S) AND GOVERNMENT
- USER(S) AND PROPERTY MANAGEMENT
SCENARIO
CONSTRUCTION SEQUENCE

01. remove existing facade
02. retain and revitalize existing structure
03. mounting (clamping) consoles
04. placing horizontal frame
05. placing vertical infrastructure, vertical frame and support systems
06. placing components, infill and grid-systems
07. outcome
existing situation
remove existing facade
retain and revitalize existing structure
mounting (clamping) consoles
placing horizontal frame “the support”
STRUCTURAL ANALYSIS

EXISTING SITUATION

LOAD

M = 0

MIN = 23.01 KNm
(17.32, 1.435)

MAX = 108.77 KNm
(75.80, 1.435)

ADDING EXTRA SPACE

M = 0

MIN = 49.50 KNm
(37.21, 1.435)

MAX = 108.77 KNm
(75.80, 1.435)

ELIMINATE MOMENT

M = 0

MIN = 49.50 KNm
(37.21, 1.435)

MAX = 108.77 KNm
(75.80, 1.435)
DEAD WEIGHT FACADE : 0,5 KN x 1,2 = 0,6 KN PER FACADE ELEMENT

VARIABLE LOAD : 2,51 KN/m x 1,5 = 3,77 KN/m

DEAD WEIGHT BEAM : 0,69 KN/m x 1,2 = 0,83 KN/m
$$M_{\text{MAX}} = 35.54 \text{ KN/m}$$
$$\delta_{\text{MAX}} = 10.88 \text{ mm}$$
$$\theta_{\text{ANGLE}} = 0.46^\circ$$
a few possibilities
placing vertical infrastructure, vertical frame and support systems
SHAFT DESIGN
placing components, infill and grid-systems
outcome = choice individual user
CONCLUSIONS
“extra square meters are created”

“existing structure remains intact with minimum interference“

“separation of layers makes the system universal, upgradable and future proof“

“the upgradable catalog makes it possible to conform to different requirements and wishes“

“flexible parcellation and clustering of apartments“

“transformation to other functions is possible“
“transformation is feasible when stakeholders and investors want to cooperate”

“methodology and façade provides an uniform approach for transformation“

“total areas can be transformed or just one building, the users comes first“

“lifetime is determined by constant and dynamic change in aesthetics, functionality and technology“

“freedom has a framework, there is no total freedom“