Façade intervention
of post-war high-rise office buildings

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Mentor team
01 Analysis phase
02 Conceptual phase
03 Embodiment phase
04 Elaboration phase
The Red Apple, Rotterdam NL, KCAP Architects, 2009
“How can Dutch ‘post-war’ (1950-1972) office buildings be refurbished externally using a unitized second skin façade system in a future-directed building physical and energy efficient way, that is aesthetically innovative and applicable to a wider range of similar office buildings?”

“How can the original architectural character of the building be merged with new façade features in a refurbishment project that has the intention to improve the building physics and to upgrade the aesthetic appeal of the building.”

Research questions

- 6.7M m² vacant offices (14%, 5% normal)
- 25-40% is functionally out-of-date (2010)
- 7M m² new, 1M m² used (2000-2010)
- Property value -50% and rent -36% (over 20 years)

Office market
Problems areas:

- Cold bridges
- Outdated services
- Outdated materials
- Poor insulation
- Outdated infrastructure
- Nondescript look
- Uncomfortable indoor climate
- Façade damage
- Vacancy
- Maintain architectural character
- Unique and innovative appearance
- Integrate existing façade
- Less energy consumption
- Cost effective

Original building + New fabrication technology + New material technology + System engineering and fresh ideas = Cyborg building

Design principle

Star Trek: The Next Generation, Captain Jean-Luc Picard
Case study 1

- Vertical orientation
- 15 stories, 53 m
- 1956
- H.D. Bakker
- De Leuve office tower
Case study 1

De Leuve, Rotterdam NL, H.D. Bakker, 1956

Legend

1. In situ reinforced concrete column
2. In situ reinforced concrete floor slab
3. In situ reinforced concrete parapet addition
4. Prefabricated reinforced concrete post
5. Prefabricated concrete window sill
6. Corrugated aluminium panel
7. Double glazing with aluminium frames
8. Wood and plaster ceiling

Legend

- **Red**: Generated heat
- **Orange**: Heat loss
- **Blue**: Ventilation
Case study 2

- Horizontal orientation
- 18 stories, 78.3 m
- 1970, C. Elffers Partners
- Erasmus University building H
Case study 2

Erasmus University, Rotterdam NL, Elffers Partners, 1970

Legend

1. Reinforced concrete column  
2. Reinforced concrete floor beam  
3. Prefabricated concrete floor elements  
4. Fixation gutter filled with concrete  
5. Prefabricated reinforced concrete parapet  
6. Aluminium frame with single glass pane  
7. Convector unit  
8. Suspended ceiling with louvers
Concept phase 02 Conceptual sketches
<table>
<thead>
<tr>
<th>Parameters (A-J)</th>
<th>Components (1-8)</th>
<th>Morphological Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural properties</td>
<td>Building physical properties</td>
<td>Materialistic properties</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Material</td>
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03 Embodiment phase

Render of façade section
Main properties

- 2nd layer unitized façade system
- Applicable to wide range of buildings
- Improved insulation value
- Fresh unique look through customization
- Existing façade reused
- Architectural character respected (cyborg)
- Building does not need to be vacated
Moment in column
100% of original

1614 Nm
1980 kg

Mechanics
Moment in column
225% of original

Mechanics

3647 Nm
Mechanics

Moment in column 36% of original
Activities

A. Drill holes in parapet
B. Assemble parts
C. Tighten top and bottom tension rod
D. Align parts
Activities
A. Drill holes in parapet
B. Assemble parts
C. Tighten top and bottom tension rod
D. Align parts
Activities
A. Hoist modules into position
B. Slide modules sideways
C. Adjust stud bolts (vertical)
Activities

A. Hoist module into position
B. Slide module sideways
C. Place fixation plate
Initial $\rightarrow$ $\sigma_{\text{max}} = 369$ MPa  $u = 1.03$ mm

Final $\rightarrow$ $\sigma_{\text{max}} = 162$ MPa  $u = 0.47$ mm
Activities

A. Remove existing windows
B. Remove existing window sill
C. Paint parapet (optional)
Activities

A. Remove existing windows
B. Remove existing window sill
C. Paint parapet (optional)
**Installation**

A. Open walkover grid
B. Insert decentralized ventilation unit
C. Connect air ducts

**Maintenance**

A. Open walkover grid
B. Slide away Trespa panels
C. Replace filters etc.

View from inside (existing building removed)

View from outside (façade modules removed)
Activities
A. Hoist parapets into position
B. Secure with bolts

Assembly
External parapets
Elaboration phase 04

Parapet suspension module detail

Weight (500 kg max)
Energy reduction (± 1%)

<table>
<thead>
<tr>
<th>Season</th>
<th>Original façade</th>
<th>R1: New façade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>100%</td>
<td>73%</td>
</tr>
<tr>
<td>Winter</td>
<td>100%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Relative energy consumption (original façade = 100%)

Energy reduction:
- Summer → 27%
- Winter → 77%
Erasmus building H

Total building costs

± € 6,600,000

Variant A
Erasmus building H

Variant A

Total building costs

± € 6,600,000
Variant B

Total building costs

± € 6,950,000
Erasmus building H

Variant B

Total building costs

± € 6,950,000
Erasmus building H

Variant C

Total building costs

± € 7,300,000
Erasmus building H

Total building costs

± € 7,300,000

Variant C
Energy price scenarios 2011-2051 (€ / GJ)

- **Scenario 1**: 29.5 – 32.5
- **Scenario 2**: 28 – 30
- **Scenario 3**: 26.5 – 28.5
- **Scenario 4**: 22.5 – 24

**Investment return period**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Range</th>
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<tbody>
<tr>
<td>1</td>
<td>29.5 – 32.5</td>
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<tr>
<td>2</td>
<td>28 – 30</td>
</tr>
<tr>
<td>3</td>
<td>26.5 – 28.5</td>
</tr>
<tr>
<td>4</td>
<td>22.5 – 24</td>
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</tbody>
</table>

▲ Parapet variants

**Investment return period**
Conclusions

- Building physics
  - Improved insulation value
  - Reduced heat loss through ventilation
  - More comfortable indoor climate
  - Increased productivity

- Energy consumption
  - 77% less in winter
  - 27% less in summer
  - Profitable in 25 - 30 years
Conclusions

- Aesthetics
  - Unique look
  - Architectural character maintained
  - Strong corporate identity
  - Corporate exposure

- Function
  - More rentable floor space
  - Property value increased
  - Rent value increased
  - No need to vacate building