A Self-Assembling Curtain Wall System

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Outline

- Problem
- Chances
- Existing Solutions
- Design Problem
- Design Method
- Design Results
- Reflection
Problem

Assembling curtain wall system
Problems by the assembling of curtain wall elements

- Assembling conditions are unsafe and not labor friendly
- High buildings need a tower crane
- Climate conditions delete the work
- A lack of skilled labor

- The life cycle of curtain wall system is about 10 years
Chances

Developments robotic technologies

• *Mini actuators (50 mm²)*

• *Sensors*
Existing solutions

Assembling wall elements Rembrandt Toren

1. 
2. 
3. 
4. 
5.
Existing solutions
Conclusions of the earlier study

• Safe construction site for assembly workers.
• Curtain wall is appropriate for high-rise constructions involving a steel load-bearing construction.
• The curtain walls are only made of aluminum and glass.
• The curtain wall is equipped for the assembly and disassembly processes. Its components can also be used for user functions (particularly systems) of the façade element.
• Only one remote operator is necessary for the (dis)assembly process.
• Mini- and micro-robot devices are used.
Design Problem

Design goal

*Develop a concept for a self-assembling curtain wall system that is safe, labour friendly and can be used in all weather conditions, without a construction crane.*
**Design Method**

Design steps:

1. Re-formulating the requirements.
2. Analyzing the problem.
3. Designing the concept by using morphologic schemes and Systematic Inventive Techniques (SIT).
4. Engineering the concept.
5. Creating a 3D Virtual simulation on the assembly process.
6. Reflection by experts.
**Design Method**

Systematic Inventive Technique (SIT)

**Creativity techniques:**
- The object removal tools
- The division tool
- etc

**Filter:**
- Market
- Technology
Design Method

Design meeting
### Design Method

#### Design meeting

**Morfologisch schema na SIT-sessie**

<table>
<thead>
<tr>
<th>Concept</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>Transporteren element naar de juiste positie, positiesbepalen</td>
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<td>Transporteren element naar de juiste positie, aandrijving</td>
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<tr>
<td>Verticaal transporteren naar de constructie</td>
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<tr>
<td>Stabiliteit op het moment dat het verticaal naar de constructie beweegt</td>
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<td>Bevestiging van constructie</td>
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<tr>
<td>Detaillering, wind en waterdicht afsluiten</td>
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</table>
Design result

The concept

The element
**Design result**

**The concept**

- *The frame of the element is standard.*
- *The filling is customized.*

The concept is from the car industry
Design result

The concept

The lower row
Design result

The concept

Assembling element
Design result

The concept

Assembling element
Design result

The concept

Assembling element
Design result

The concept
Design result

The concept

Assembling panels
Design result

The concept

Replacement element
Design result
The concept
Replacement element
Design result

The concept

Replacement panel
Design result

The concept

Replacement panel
Design result

Engineering

Prototype A
Design result

Engineering

Prototype B
Design result

Engineering

Prototype C
Design result

Fixing
Design result

Wind and water sealing
Reflection

Comments by the industry

- No influences of climate by guiding system.
- Doubt if market is interested for such façade facilities.
- Integration of the electric drive and the positioning very interesting.
- Reliability of the guidance system and water and wind sealing is weak.
- Easy for renewal is interesting.
Reflection

Discussion

• Most of the requirements are full filled.
• Not the whole façade is self assembly.
• Same parts have not still been tested, such as wind and water sealing, gear transmission and guide rails.
• The cost of the driving motor is relatively high and has too much power output for the functions as ventilation and sunscreens. A solution would be to use a replicable motor.
Reflection

Conclusions

• The concept (dis)assembly work is safer and more labour-friendly.

• Weather conditions have less influence on the progress of the construction work.

• There is drive for ventilation and sunscreens.
Reflection

Coming research

- Testing the water and wind sealing between the elements.
- Testing the guiding of the elements
- More research to a suitable drive.
QUESTIONS?