“Triggering elderly’s behavior to an energy neutral and healthy use of the facade”
INTRODUCTION • PROCESS
• PROBLEM STATEMENT
• BAM 2ND SKIN PROJECT
• METHOD

LITERATURE • THE WELL-BEING OF ELDERLY
• ENERGY CONSUMPTION IN DWELLINGS

DESIGN • VISION
• DESIGN REQUIREMENTS
• FINAL DESIGNS - PART 1
• FINAL DESIGNS - PART 2
• INTEGRATION DESIGN PART 1 + 2

DISCUSSION • EVALUATION
• CONCLUSION
• RECOMMENDATIONS
PROCESSES

- **ALCOA**

  - **BROADER PERSPECTIVE**

  - **P1 PRESENTATION**
    - “HOW WILL BUILDING USERS INTERACT WITH THEIR FACADE IN FUTURE TO GENERATE COMFORT?”

  - **P2 PRESENTATION**
    - “HOW CAN HUMAN BEHAVIOR BE TRIGGERED TO USE THE FACADE ENERGY EFFICIENT?”

  - **P3/P4 PRESENTATION**
    - “HOW CAN ELDERLY BE TRIGGERED TO AN ENERGY NEUTRAL AND HEALTHY USE OF THE FACADE?”
PROBLEM STATEMENT

1. **ELDERLY HAVE TO AGE IN PLACE INDEPENDENTLY** LONGER, WHILE THEIR MENTAL AND PHYSICAL HEALTH DETERIORATES.

2. **WE HAVE TO ACHIEVE THE GOAL OF ENERGY NEUTRAL BUILDINGS IN 2020.**
1. Elderly have to **age in place independently** longer, while their mental and physical health deteriorates.
PROBLEM STATEMENT

2. WE HAVE TO ACHIEVE THE GOAL OF **ENERGY NEUTRAL BUILDINGS** IN 2020.

RESPONSIBLE FOR 40% OF THE **TOTAL ENERGY CONSUMPTION**
2. WE HAVE TO ACHIEVE THE GOAL OF **ENERGY NEUTRAL BUILDINGS** IN 2020.

**RESPONSIBLE FOR 40% OF THE TOTAL ENERGY CONSUMPTION**

**NL: \( \frac{1}{3} \) OFF ALL DWELLINGS BUILT BETWEEN 1945 AND 1975**
2. We have to achieve the goal of Energy Neutral Buildings in 2020.

Responsible for 40% of the total energy consumption.

NL: $\frac{1}{3}$ off all dwellings built between 1945 and 1975.

Don’t meet the energy restrictions anymore.
2. We have to achieve the goal of Energy Neutral Buildings in 2020.

- Responsible for 40% of the total energy consumption

- NL: \( \frac{1}{3} \) off all dwellings built between 1945 and 1975

- Don’t meet the Energy Restrictions anymore

- BAM 2nd Skin Project
1. Elderly have to **age in place independently** longer, while their mental and physical health deteriorates.

2. We have to achieve the goal of **energy neutral buildings** in 2020.

**Research Question**

“How can elderly be triggered to an **energy neutral and healthy use** of the facade?”
An energy-neutral dwelling needs a little amount of energy, generates renewable energy and uses the energy energy-efficient.
METHOD

- **ELDERLY**
  - Deterioration Factors
  - Well-being of Elderly
  - Comfort Preferences

- **Energy Consumption**
  - Energy Neutral Behavior
  - Preferences Occupants

**Vision**

- Design Requirements According to Elderly
- Design Requirements According Energy Neutral Use

**Design Concepts**

**Final Design**

**Conclusions and Recommendations for Future Research**
THE WELL-BEING OF ELDERLY
ELDERLY

1970 AGE DISTRIBUTION THE NETHERLANDS
2010 AGE DISTRIBUTION THE NETHERLANDS
2030 AGE DISTRIBUTION THE NETHERLANDS

(CBS, 2014)

MOBILITY DISORDERS
SENSORY DISORDERS
HEARING DISORDER
SIGHT DISORDER
INCONTINENCE
COGNITIVE DISORDERS

Single elderly
Unhealthy elderly
Elderly with little social contacts

have more mobility problems

(ELEONORE AGHINA - 1524755 - 29th OF OCTOBER, 2015)
ELDERLY

- MOBILITY DISORDERS
- SENSORY DISORDERS
- INCONTINENCE
- COGNITIVE DISORDERS
ELDERLY

GERIATRIC GIANTS

- MOBILITY DISORDERS
  - WALKING ISSUES
  - ISSUES CARRYING
  - STAND UP/ BEND DOWN ISSUES

- SENSORY DISORDERS
  - HEARING DISORDER
  - SIGHT DISORDER

- INCONTINENCE

- COGNITIVE DISORDERS

ELEONORE AGHINA - 1524755 - 29th OF OCTOBER, 2015
Elderly

**Geriatric Giants**

- **MOBILITY DISORDERS**
  - Walking issues
  - Issues carrying
  - Stand up/bend down issues

- **SENSORY DISORDERS**
  - Hearing disorder
    - Avoid low frequency noises
    - Filter surrounding noises (with 50dB < noise level)
    - Hearing devices
  - Sight disorder
    - Glasses
    - Enough (day)light
    - Surgery

- **INCONTINENCE**
  - Cannot directly be prevented, but by preventing the other geriatric giants, the risk decreases

- **COGNITIVE DISORDERS**
  - Enough (day)light (day/night rhythm)
  - Implementing technologies in time

- **Exercising enough/stimulate moving**
  - Connection with the environment is important (to prevent social isolation which contributes to mobility problems)
  - Enough daylight (vitamin D)
Elderly

- Physical Health
  - Mobility Disorders: Going outside less
  - Sensory Disorders
    - Hearing: Need more light
    - Sight
  - Incontinence
  - Cognitive Disorders
  - Social Isolation: Frequency of social contacts, Living alone

The occurrence of certain deterioration symptoms (can) have influence on other deteriorations of mental and physical health.
Of course not all deterioration factors can be resolved or prevented by a facade design, but to achieve the best design all factors should be taken into account.
ELDERLY & ENERGY CONSUMPTION

- Higher temperature preference
- Ventilate too little, consequence; stale air and odours
- Hard to achieve comfortable conditions because of mobility
ELDERLY

INTERVIEWS - PERSONAS

1. “EASY COMFORTABLES”
   - A LOT AT HOME
   - DON’T WANT TO PUT A LOT OF EFFORT IN SAVING ENERGY
   - NO IDEA OF THE HEALTH OF THEIR INDOOR CLIMATE

2. “ALL TIME SAVERS”
   - HALF OF THE TIME AT HOME
   - VERY INTO SAVING ENERGY, WANT TO SAVE MORE ENERGY
   - INTERESTED IN CAUSES OF PEAK ENERGY CONSUMPTION

3. “SPENDERS”
   - A LOT AT HOME
   - COMFORT IS MOST IMPORTANT
   - DON’T WANT TO PUT EFFORT IN SAVING ENERGY
**ELDERLY**

**INTERVIEWS - PERSONAS**

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---

**A. “MOBILITY-SUFFERERS”**

- DIFFICULTIES IN WALKING & REACHING
- STIMULATING MOVEMENT IS VERY IMPORTANT
- SUNLIGHT IMPORTANT TO CREATE VITAMIN D

**B. “SIGHT-SUFFERERS”**

- DIFFICULTIES IN READING (LIGHT INTENSITY)
- AVOID OVEREXPOSURE
- PREFERENCE FOR DAYLIGHT RATHER THAN ARTIFICIAL LIGHT
ELDERLY - conclusions interviews

VENTILATION

VENTILATE TOO LITTLE - STALE AIR AND ODOURS, BAD HEALTH

NATURAL VENTILATION

INSECT PROTECTION

RAIN PROTECTION

ELDERLY - DETERIORATIONS

DETERIORATION - EASY OPERATIONS

REACHABILITY

TRANSPARENCY - ON ALL LEVELS

COMFORT - HIGHER TEMPERATURE PREFERENCE

CLEANABILITY
ELDERLY - conclusions interviews

COMFORT

OUTSIDE AREA/ BALCONY IS PREFERABLE

OUTSIDE AREA SHOULD BE PROTECTABLE AGAINST WIND

DAYLIGHT IMPORTANT FOR SIGHT, RHYTHM, VITAMIN D, BUT SHOULD BE POSSIBLE TO REGULATE IT

CURTAINS TO PROTECT AGAINST HEAT AND COLD, BUT ALSO PRIVACY

WINDOWSILL (INSIDE)

IT SHOULD BE POSSIBLE TO KEEP PLANTS, IN AND OUTSIDE
ENERGY CONSUMPTION IN DWELLINGS
ENERGY CONSUMPTION

Building Characteristics

Occupants' Behavior

Energy Use

Household Characteristics

(Guerra-Santin, 2014)
ENERGY CONSUMPTION

BUILDING CHARACTERISTICS

OCCUPANTS’ BEHAVIOR

ENERGY USE

WHERE DOES THE ENERGY GO TO?

HOUSEHOLD CHARACTERISTICS

(Guerra-Santin, 2014)

‘The energy consumption of a building in the end always depends on the behavior of the users.’

(DeltaWonen, 2014)
ENERGY CONSUMPTION

ENERGY CONSUMPTION HOUSEHOLDS

ELECTRICITY CONSUMPTION HOUSEHOLDS

GAS CONSUMPTION HOUSEHOLDS

(Energieloket, 2013)
ENERGY CONSUMPTION

ENERGY CONSUMPTION OF SPACE HEATING DEPENDS ON

- TYPE OF HEATING
- TYPE OF VENTILATION
- PRESENCE AT HOME
- ROOM TYPE
ENERGY CONSUMPTION

ENERGY CONSUMPTION OF SPACE HEATING DEPENDS ON:

- **TYPE OF HEATING**
  - RADIATOR (MANUAL VALVES)
  - PROGRAMMABLE THERMOSTAT
  - MANUAL THERMOSTAT

- **TYPE OF VENTILATION**
  - WINDOWS
    - Usually open a few hours a day
  - GRILLES
    - Usually closed/open all day
  - MECHANICAL VENTILATION
    - Households with mech. ventilation keep their system either always off or at the lowest setting

- **PRESENCE AT HOME**
  - HOURS SPENDING AT HOME
    - Higher temperature setting than other households
  - PRESENCE OF ELDERLY
    - Fewer hours of open windows in bathroom and living room

- **ROOM TYPE**
  - LIVING ROOM
    - 50% always kept radiators on
  - BEDROOM
    - Larger % always kept windows open
  - BATHROOM
    - 50% always kept windows open

HOUSEHOLDS TEND TO VENTILATE MORE OFTEN WITH GRILLES AND WINDOWS THAN MECH. VENT.
CONCLUSIONS

Elderly VENTILATE their rooms TOO LITTLE. (bad health of indoor climate)

WINDOWS are often SIMULTANEOUSLY open when the HEATING SYSTEM is on in the same room.

Occupants PREFER NATURAL VENTILATION over mechanical ventilation.

AUTOMATED OR PRE-PROGRAMMED SYSTEMS COST IN THE END OFTEN MORE ENERGY than systems which are partly operating manually.
CONCLUSIONS

Elderly **VENTILATE** their rooms **TOO LITTLE.** (bad health of indoor climate)

**WINDOWS** are often **SIMULTANEOUSLY** open when the **HEATING SYSTEM** is on in the same room.

Occupants **PREFER NATURAL VENTILATION** over mechanical ventilation.

**AUTOMATED OR PRE-PROGRAMMED SYSTEMS COST IN THE END OFTEN MORE ENERGY** than systems which are partly operating manually.

WHAT TO DO?

Stimulate them to **VENTILATE MORE.**

Trigger them to **REDUCE ENERGY** and **AVOID HEAT LOSS.**

Make them **AWARE** of their **ENERGY CONSUMPTION.**
ENERGY CONSUMPTION

VENTILATE MORE
ENERGY CONSUMPTION

- VENTILATE MORE
- BE MORE AWARE OF CONSUMPTION
ENERGY CONSUMPTION

VENTILATE MORE  BE MORE AWARE OF CONSUMPTION  REDUCE ENERGY/ AVOID HEAT LOSS
ENERGY CONSUMPTION

VENTILATE MORE

HUMIDITY
  too high or too low

CO₂ - LEVEL
  too high

NO₂ - LEVEL
  too high

FINER PARTICLES
  too high

UNHEALTHY INDOOR CLIMATE
ENERGY CONSUMPTION

VENTILATE MORE

BE MORE AWARE OF CONSUMPTION

HUMIDITY
too high or too low

CO₂ - LEVEL
too high

NO₂ - LEVEL
too high

FINER PARTICLES
too high

UNHEALTHY INDOOR CLIMATE

OPEN ONE OR MORE WINDOWS

TRIGGER TO ACTION

SWITCH ON THE MECHANICAL VENTILATION SYSTEM
ENERGY CONSUMPTION

- VENTILATE MORE
- BE MORE AWARE OF CONSUMPTION
- REDUCE ENERGY/ AVOID HEAT LOSS

- HUMIDITY
  too high or too low

- CO₂ - LEVEL
  too high

- NO₂ - LEVEL
  too high

- FINER PARTICLES
  too high

HEMS

- OPEN ONE OR MORE WINDOWS

- UNHEALTHY INDOOR CLIMATE

- TRIGGER TO ACTION

- SWITCH ON THE MECHANICAL VENTILATION SYSTEM
VISION

USER-RELATED DESIGN

1. [Diagram showing user-related design with icons for cognitive problems, vision disorders, mobility problems, and hearing disorders.]

WELL-BEING OF ELDERLY

ENERGY NEUTRAL USE/BEHAVIOR

RENOVATION-RELATED DESIGN

2. [Diagram showing renovation-related design with a new 2nd skin element.]

ENERGY NEUTRAL FACADE ELEMENT

COMFORT, EASY OPERATIONS
VISION

USER-RELATED DESIGN

1. 

RENOVATION-RELATED DESIGN

2. NEW 2nd SKIN

WELL-BEING OF ELDERLY

ENERGY NEUTRAL USE/ BEHAVIOR

BEHAVIOR DESIGN

ENERGY NEUTRAL FACADE ELEMENT

FACADE ELEMENT DESIGN

COMFORT, EASY OPERATIONS
DESIGN REQUIREMENTS

- Behavior Related
- Facade Element Related
**DESIGN REQUIREMENTS**

**BEHAVIOR RELATED**
- Make occupants ventilate more
- Trigger to improve health of indoor climate
- Reduce energy consumption
- Opening windows linked with heating system
- Opening windows linked with mech. ventilation
- Stimulate movement
- Create habits/ awareness

**FAÇADE ELEMENT RELATED**
- Applicable in the BAM 2nd skin project
- ‘Energy neutral’ facade
- Aluminium window frames
- Natural ventilation - large openings facade
- Insect protection screen
- Transparency facade
  - Transparent balustrade
  - Privacy vs. transparency
- Prevention of overexposure
- Opportunity to keep plants
- Noise protection
DESIGN PART 1 - HEMS
DESIGN PART 1 - HEMS

(Wikipedia, 2015)
DESIGN PART 1 - HEMS

DESIGN PART 1 - HEMS

- Opening windows
- Heating system on
- Mechanical ventilation system on

UNHEALTHY INDOOR CLIMATE

Solar Energy

Electric Vehicle Energy
**Design Part 1 - HEMS**

**“Easy Comfortables”**

**Overall Energy Consumption**

- Neighbours
- You

**You Are Doing Great 😊**

**Gas vs. Electricity Consumption**

- TIP: Switch off heating at night
- TIP: Switch off not used plug sockets at night

**Sensor - Indoor Climate**

- **Summer Night**

**Unhealthy Indoor Climate**

**Ventilate by Opening the Windows**
"ALL TIME SAVERS"

OVERALL ENERGY CONSUMPTION

YOUR CONSUMPTION TODAY  295 kWh

YOUR CONSUMPTION YESTERDAY  211 kWh

GAS VS. ELECTRICITY CONSUMPTION

TIP: switch of heating in living room during the night

TIP: switch off washing machine when done

SENSOR - INDOOR CLIMATE  summer night

UNHEALTHY INDOOR CLIMATE

VENTILATE BY OPENING THE WINDOWS
DESIGN PART 1 - HEMS

“SPENDERS”

OVERALL ENERGY CONSUMPTION

YOU

NEIGHBOURS

YOU ARE DOING GREAT 😊

GAS VS. ELECTRICITY CONSUMPTION

TIP: switch off washing machine when done

TIP: switch of heating in living room during the night

SENSOR - INDOOR CLIMATE ➔ summer night

UNHEALTHY INDOOR CLIMATE ➔

VENTILATE BY OPENING THE WINDOWS
**DESIGN PART 1 - HEMS**

### “EASY COMFORTABLES”

- **OVERALL ENERGY CONSUMPTION**
  - **NEighbours**
  - **You**

- **YOU ARE DOING GREAT**

- **GAS VS. ELECTRICITY CONSUMPTION**
  - **TIP:** switch off heating at night

- **SENSOR - INDOOR CLIMATE**
  - **UNHEALTHY INDOOR CLIMATE**
  - **VENTILATE BY OPENING THE WINDOWS**

### “ALL TIME SAVERS”

- **OVERALL ENERGY CONSUMPTION**
  - **YOUR CONSUMPTION TODAY** 295 kWh
  - **YOUR CONSUMPTION YESTERDAY** 211 kWh

- **GAS VS. ELECTRICITY CONSUMPTION**
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- **SENSOR - INDOOR CLIMATE**
  - **UNHEALTHY INDOOR CLIMATE**
  - **VENTILATE BY OPENING THE WINDOWS**

### “SPENDERS”

- **OVERALL ENERGY CONSUMPTION**
  - **NEighbours**
  - **You**

- **YOU ARE DOING GREAT**

- **GAS VS. ELECTRICITY CONSUMPTION**
  - **TIP:** switch off heating in living room during the night

- **SENSOR - INDOOR CLIMATE**
  - **UNHEALTHY INDOOR CLIMATE**
  - **VENTILATE BY OPENING THE WINDOWS**

### “MOBILITY SUFFERERS”

- **ARCHITECTURE OF THE HEMS**
  - **- FIXED / PORTABLE**

### “SIGHT SUFFERERS”

- **LEVEL OF FEEDBACK/ ARCHITECTURE OF THE HEMS**
  - **- SUITABLE CONTRAST PATTERNS/ LETTER SIZE**
DESIGN PART 2 - FACADE ELEMENT
DESIGN PART 2 - FACADE ELEMENT

FACADE ELEMENT RELATED

APPLICABLE IN THE BAM 2nd SKIN PROJECT

‘ENERGY NEUTRAL’ FACADE

ALUMINIUM WINDOW FRAMES

NATURAL VENTILATION - LARGE OPENINGS FACADE

INSECT PROTECTION SCREEN

TRANSPARENCY FACADE
  - TRANSPARENT BALUSTRADE
  - PRIVACY VS. TRANSPARENCY

PREVENTION OF OVEREXPOSURE

OPPORTUNITY TO KEEP PLANTS

NOISE PROTECTION
DESIGN PART 2 - FACADE ELEMENT

**FACADE ELEMENT RELATED**

- Applicable in the BAM 2nd Skin Project
- ‘Energy Neutral’ Facade
- Aluminium Window Frames
- Natural Ventilation - Large Openings Facade
- Insect Protection Screen
- Transparency Facade
  - Transparency Balustrade
  - Privacy vs. Transparency
- Prevention of Overexposure
- Opportunity to Keep Plants
- Noise Protection

**FACADE ELEMENT**

- Applicable in the BAM 2nd Skin Project
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PREVENTION OF OVEREXPOSURE
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FACADE ELEMENT

APPLICABLE IN THE BAM 2nd SKIN PROJECT
‘ENERGY NEUTRAL’ FACADE
ALUMINIUM WINDOW FRAMES
NATURAL VENTILATION - LARGE OPENINGS FACADE
TRANSPARENCY FACADE
   - TRANSPARENT BALUSTRADE

EXTRA OPTIONS

INSECT PROTECTION SCREEN
TRANSPARENCY FACADE
   - PRIVACY VS. TRANSPARENCY
PREVENTION OF OVEREXPOSURE
OPPORTUNITY TO KEEP PLANTS
NOISE PROTECTION
DESIGN PART 2 - FACADE ELEMENT

BEDROOM 1+2

Facade element (width and height)

Cross section facade (width and height)
DESIGN PART 2 - FACADE ELEMENT

CONCEPT A

TOPVIEW

1 2 3 4
DESIGN PART 2 - FACADE ELEMENT  CONCEPT A
DESIGN PART 2 - FACADE ELEMENT

CONCEPT A
DESIGN PART 2 - FACADE ELEMENT

CONCEPT B
DESIGN PART 2 - FACADE ELEMENT

CONCEPT B

TOPVIEW

1

2

3

4

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DESIGN PART 2 - FACADE ELEMENT

CONCEPT B
DESIGN PART 2 - FACADE ELEMENT  CONCEPT B
DESIGN PART 2 - FACADE ELEMENT

CONCEPT C
DESIGN PART 2 - FACADE ELEMENT  CONCEPT C

TOPVIEW

1

2

3

4

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DESIGN PART 2 - FACADE ELEMENT

CONCEPT C
DESIGN PART 2 - ASSEMBLY
DESIGN PART 2 - ASSEMBLY

1. Remove existing balconies + existing facade windows
2. Attach Isokorf elements + first insulation layer
3. Attach balcony profiles to Isokorf construction
4. Prefab isolated panels (including facade windows)
5. Cladding
6. Attach balcony finishings
7. Roof insulation + roof covering
8. PV panels + solar collectors
DESIGN PART 2 - FACADE ELEMENT

EXTRA OPTIONS

INSECT PROTECTION

ADJUSTABLE SUNSHADING

ABILITY TO KEEP PLANTS
DESIGN PART 2 - FACADE ELEMENT  EXTRA OPTIONS

- **CURTAINS INSIDE**
- **TRANSPARENCY**
- **REACHABILITY - MOTOR DRIVEN**
HOW WILL THESE TWO DESIGN PARTS BE INTEGRATED?
INTEGRATION DESIGN PART 1 & 2

NEXT
ACTIVE FACADES

- type advanced
  - fresh air injection
  - installation box
  - fresh air injection
  - overflow to central drain
  - (partial) recirculation
  - Sunshade silver screen
  - Control via computer (optional)

- ventilation
- heat recovery
- heating
- air supply
- cooling
- air supply and air drain
- sun- and heat regulation

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INTEGRATION DESIGN PART 1 & 2

NEXT
ACTIVE FACADES

ventilation heat recovery
heating air supply
cooling air supply and air drain
sun- and heat regulation

HUMIDITY too high or too low
CO₂ - LEVEL too high
NOₓ - LEVEL too high
FINER PARTICLES too high

SOUND FILTER

COLOUR THERAPY

fresh air injection
installation box
fresh air injection
overflow to central drain
(partial) recirculation
Sunshade silver screen
Control via computer (optional)

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EVALUATION

INTERVIEWS

- BALCONY
- TRANSPARENCY BALUSTRADE
- OPERATION FACADE ELEMENT
- HOME ENERGY MANAGEMENT SYSTEM
## EVALUATION

### INTERVIEWS

- BALCONY
- TRANSPARENCY BALUSTRADE
- OPERATION FACADE ELEMENT
- HOME ENERGY MANAGEMENT SYSTEM

### PERSONAS

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<tr>
<th>HOME ENERGY MANAGEMENT SYSTEM</th>
<th>FACADE ELEMENT</th>
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</thead>
<tbody>
<tr>
<td>- “easy comforts”</td>
<td>- “mobility sufferers”</td>
</tr>
<tr>
<td>- “all time savers”</td>
<td>- “sight sufferers”</td>
</tr>
<tr>
<td>- “spenders”</td>
<td></td>
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# EVALUATION

## INTERVIEWS
- BALCONY
- TRANSPARENCY BALUSTRADE
- OPERATION FACADE ELEMENT
- HOME ENERGY MANAGEMENT SYSTEM

## PERSONAS
- HOME ENERGY MANAGEMENT SYSTEM:
  - “easy comfortables”
  - “all time savers”
  - “spenders”
- FACADE ELEMENT:
  - “mobility sufferers”
  - “sight sufferers”

## REQUIREMENT CHECKLIST

<table>
<thead>
<tr>
<th>VENTILATION</th>
<th>ELDERLY</th>
<th>COMFORT</th>
<th>FUNCTIONALITY</th>
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</thead>
<tbody>
<tr>
<td>STIMULATION TO VENTILATE</td>
<td>MORE</td>
<td>SMOKE ALARM</td>
<td>IN</td>
</tr>
<tr>
<td>SMALL NATURE VENTILATION</td>
<td>(SMALL AND BG OPENING)</td>
<td>INSECT PROTECTION</td>
<td>RAIN PROTECTION</td>
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<tr>
<td>DESIGN 1</td>
<td>+</td>
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<td>DESIGN 2</td>
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RESEARCH QUESTION

“How can elderly be triggered to an energy neutral and healthy use of the facade?”

- How do you trigger elderly to use the facade energy efficiently?
  - Extensive Home Energy Management System
  - Design the Home Energy Management System for different personas

- How do you make sure the facade design contributes to the physical and mental health of elderly?
  - Make people aware of the health of the indoor climate
  - Optimize the connection with the environment

- How do you make sure the facade design will be bought by the occupants?
  - Give the occupants the opportunity to choose for different options
  - Provide comfort, design for an added value
RECOMMENDATIONS

- according to the **Home Energy Management System (HEMS)**
  - Managing the *perceived temperature* (by light colours for example)
  - *New insights* for HEMS  ➔ testing the HEMS on a *long timespan*
    ➔ testing the *additional aspects* (from this research)
  - *Integration* between the HEMS and the (NEXT) facade element

- according to the **Facade element**
  - *Screen to alleviate hearing disorders*
  - *Further development* NEXT *active facade element*
  - *Research into leasing* facade elements
  - *Research into keeping the existing balconies* instead of replacing them
“Triggering elderly’s behavior to an energy neutral and healthy use of the facade”
HEMS

HUMIDITY
 too high or too low

CO₂ - LEVEL
 too high

NO₂ - LEVEL
 too high

UNHEALTHY INDOOR CLIMATE

OPEN ONE OR MORE WINDOWS

TRIGGER TO ACTION

SWITCH ON THE MECHANICAL VENTILATION SYSTEM
UNHEALTHY INDOOR CLIMATE → HEMS → SWITCH ON THE MECHANICAL VENTILATION SYSTEM → OPEN ONE OR MORE WINDOWS → HEMS → SWITCH OFF THE MECHANICAL VENTILATION SYSTEM

UNHEALTHY INDOOR CLIMATE + HEATING SYSTEM ON → MECHANICAL VENTILATION → OPENING WINDOWS

AVOID