Efficiency-Facade PLUS
for an urban Benchmark

Development Facade according to Strauß

1920 Curtain Wall

1980 Polyvalent Wall

2020 Energy Generating Wall

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491

TU Delft
Delft University of Technology

P5

powered by innovation

INSTITUTE
Content

Introduction

- Problem Statement
- Objective
- Technical Research Question
- Overall Design Question
- Methodologies

Research

- Context
- Program
- Technical Research

Design

- Objective
- Example
- Design

End

Reflection

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Problem Statement

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491

Card material: Google Maps
Objective

Redesign Q-Port Building
by S2 Architects and Hooper Architects

Sustainable Refurbishment:
ecological, social and economic importance
Technical Fascination

Energy generating facade

Requirements on facades according to Knaack
Technical Fascination
Energy generating facade

"A wall for all seasons" Mike Davis

How to integrate technical innovations in architecture?

Davies’ idea is not meant as a realistic product example, but as one possible way to go.
Methodologies

Integration of Technical Innovations in Architecture

Analyse
Current Stand of Technique in Energy Generating Facades

Tech. Research Question

Research Paper
Overview Energy Generating Skins

Concept

Design

Architectural Integration

OV Design Question

Analyse
Context/Program Needs

Research

Design

End

Intro

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Technical Research
Energy generating facade

How can an active intelligent building skin generate energy and which potential has this climate construction program for the design?

Integration of technical innovations in architecture!
Overall Design
Sustainable Redevelopment

How can I integrate an energy generating facade into the urban area and how can I transform the existing housing stock of the Q Port building to a Hotel and Congress Center?

Refurbishment of the vacant office space.

Sustainable Transformation:
Ecological, Social and Economic
Introduction

Problem Statement
Objective
Technical Research Question
Overall Design Question
Methodologies

Research

Context
Program
Technical Research

Design

Objective
Example
Design

End

Reflection

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Context

Urban Problems
**Context**

**Urban Green**

Historical concept of green wedges don’t exist:
Greenery with less leisure potential

Head green structure 2012

- **Head green**
- **Green outside the head green**

Natural Value

- low class natural value
- High class natural value

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Context

Urban Connections

Traffic as urban planning principle

1. Network car connection
2. Network public traffic
3. Network transportation
4. Network bicycle
Program

Program Problems
Program Functions

Monofunctional Sector:
Lack of Public Facilities

Intro
Research
Design
End

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491

Card material: www.kaart.edugis.nl
Program
Buildings

1900 - 1944
1960 - 1969
1990 - 1999
2000 - 2010

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Program
Further Development
Faseringsbeeld 2030+

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Conclusion
Context and Program
Objective
Redesign Q-Port Building
by S2 Architects and Hooper Architects

Sustainable Refurbishment:
ecological, social and economic importance

- 70% Vacancy
- Building year 2001
- Energy Level C
- Not included in the Further Development Strategy
Conclusion

Context and Program

Context:
- Green Areas with less Occupancy Quality
- Lack of Public Activities
- Traffic as Urban Design Concept

Program:
- Monofunctional Sector
- High Office Vacancy
- Bad Energy Performance

Increasing Public Activities

Development of Use Strategy:
Redevelopment of the Q-Port building to a Hotel and Congress Center

Increasing Energy Performance
Technical Research
Facade

Facade as boundary between indoor comfort and outdoor climate

Case Studies of Energy Generating Facades

New role of facade according to Tillmann Klein
Task I:
Protection - Outdoor Climate

Netherlands:

C - Warm moderate rain climates
-fb - Maritime temperate climate
Technical Research
Climate - Indoor

Task II:
Secure - healthy Indoor Climate

Individual appraisal
Criteria

Physical measurable Factors

Thermal Factor:
Room - Temperature
Air - Humidity
Air - Speed
Surface - Temperature

Acoustic Factor:
Auditory Cognition of vibration transfer

Visual Factor:
Illumination
Optic Task

Olfactory Factor:
Air - Quality
Task III: Production - Energy

Biomass  Geothermal  Water  Solar  Wind

Able to be NEW again
Technical Research
Constructive Involvement

Decentralization

Integration

Subsystem Energy Generation + Subsystem Building Skin

Conflation

Subsystem Energy Generation = Building Skin
Technical Research

Constructive Involvement

Conflation

Decentralization

Integration

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491

Universität Lichtenstein: Prototyp Fluidglass
Dyson: Integrated Concentrating Solar Facade System
Rietveld, Steven Architects: Wind Wall
Boeri: Bosco Verticale

Herzog, Double Shell Facade
KMD, Steven Architects: Wind Wall
Saleh: Solar Farming
Boeri: Bosco Verticale

P5
Delft University of Technology

powered by innovation
Fluid Glass Facade Prototype

Conflation: Production FLUID

- Fluid Layers arranged in different layers
- Double Layer Approach:
  Outer Fluid Layer acts as a control for the energy transmission by absorption of solar radiation, while the Inner Fluid Layer regulates the inner surface temperature

Provides Thermal Energy
Solar Office, Doxford
Studio E

Conflation: Production SUN

- Solarfacade: building integrated PVs
- holistic Energy Concept

Provides mainly Electric Energy and preheated air for the ventilation system
Integrated Concentration
Dynamic Solar Facade

Decentralization: Production SUN

- transparent Concentrators which are moveable with Fresnel Lens
- stamp-size spectrolab Solar cell
- includes a Fluid which absorbs the heat behind the solar cell
Provides Thermal Energy and Electric Energy

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Headquarter building
Wind wall
KMD Stevens, San Francisco

Decentralization: Production
WIND
- vertically Wind Turbines

Provides Electric Energy

Drawings/ Photos by KMD, Steven Architects: Wind Wall

Ducted Shroud or Windwall.
This Airfoil acts to accelerate the wind making more energy available to the wind-turbines

Prevailing Winds from the NW

Vertical Axis Wind-turbines
Bosco Vertical Mailand
Boeri Studio

Decentralization: Production GREEN

- Green Vegetation Layer as building envelope

Provides Oxygen and Evaporative Cooling

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491P5

Drawings/ Photos by Boeri: Bosco Verticale
Bio-responsive facade
Smart material house - Hamburg

Integration: Production BIO-MASS

- Bioreactor as flat facade element includes Algae Biomass

Provides Thermal Energy for the building and Thermal Energy or Electric Energy by the external use of algae biomass.
High-Rise in Hannover
Herzog+Partner

Integration: Production AIR

- Double Shell facade:
  Corridor facade acts like thermal Buffer

Provides Thermal Energy!
Energy Production Q-Port Facade: Sun, Wind, Air, Fluid, Biomass, Green

Constructive Involvement Q-Port Facade:
Decentralization or Integration of the technical subsystem energy generation after partial changes an.
Methodologies

Integration of Technical Innovations in Architecture

Research Paper
Overview Energy Generating Skins

Analyse
Current Stand of Technique in Energy Generating Facades

Analysis
Context/Program Needs

Tech. Research Question

OV Design Question

Architectural Integration

Concept

Design

Intro

Research

Design

End

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Objective

Redesign Q-Port Building
by S2 Architects and Hooper Architects

Sustainable Refurbishment:
ecological, social and economic importance

- 70% Vacancy
- Building year 2001
- Energy Level C
- Not included in the further development strategy

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Example
Refurbishment - Low Budget

‘Like a Living Room for the whole block, where you can walk in and work on your laptop or grasp a coffee and read the newspaper’
Example
Benchmark - Highlight

Create a Benchmark out of the Q-Port building to form the urban character of the Brettenzone.

Facade as a surface for urban, art or commercial installation and the production of energy.

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Q-Port Building
Benchmark - Highlight

Create a Benchmark out of the Q-Port building to form the urban character of the Brettenzone.
Redesign Q-Port Hotel & Congress Center
Urban Intention Benchmark

OBJECTS
Tower + Podium

MONOLITHIC - Inward Focus

URBAN POROSITY

INTEGRAL URBAN FORM
An open public space spirals upwards from the street to create a vertical way carved out within the existing tower structure.

Benchmark Building for the character of the Brettenzone!

Living Room for the whole block!
Redesign Q-Port
Hotel & Congress Center
Urban Intention
Programm

An open public space spirals upwards from the street to create a verticale way carved out within the existing tower structure.
Redesign Q-Port
Hotel & Congress Center
Urban Intention

Sequence of different scenarios!
Redesign Q-Port
Hotel & Congress Center
Urban Intention
Programm

New Functions

- Congress
- Hotel
- Restaurant
- "Grüne Lunge"
Redesign Q-Port
Hotel & Congress Center
Energy Intention

“Grüne Lunge“
“Green Lung“
Q-Port Building
Benchmark - Highlight

Create a Benchmark out of the Q-Port building to form the urban character of the Brettenzone.
Redesign Q-Port Hotel & Congress Center

Energy Intention

- Natural Ventilation: “GRÜNE LUNGE”
- Night Cooling Out: “GRÜNE LUNGE”
- Interseasonal Storage: Aquifer
- Multiple Recovery Systems
- Green Garden: Evaporative Cooling
- Energy Production: Solar Farming
- Energy Production: Thermal Energy Production “GRÜNE LUNGE”
- Energetic Effective: Building Organisation Insulation Standards

REDUCE - REUSE - PRODUCE
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“

PRODUCE - RELAX
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port Hotel & Congress Center Energy Intention

KEY Feature

“Grüne Lunge“
Redesign Q-Port
Hotel & Congress Center
Energy Intention

KEY Feature

“Grüne Lunge“
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port
Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
"Grüne Lunge"
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port
Hotel & Congress Center

The “Grüne Lunge”, an open public way and an Energy Generating Technology as design element of the façade to unite the Urban Concept and the Energy Concept within the façade design.

Context Analysis + Technical Research = Design

Urban Concept + Energy Concept = Facade - Design
Redesign Q-Port
Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge”
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Redesign Q-Port Hotel & Congress Center
Energy Intention

KEY Feature

“Grüne Lunge“
Redesign Q-Port
Hotel & Congress Center
Organisation

New Functions

- Congress
- Hotel
- Restaurant
- "Grüne Lunge"
Redesign Q-Port
Hotel & Congress Center
Organisation
Redesign Q-Port
Hotel & Congress Center
Organisation
Redesign Q-Port Hotel & Congress Center Organisation

Different values of green: public - private

Shades of spatiality!
Redesign Q-Port Hotel & Congress Center Organisation

Horizontal Green spread also in the Vertical.
Redesign Q-Port
Hotel & Congress Center
Urban Intention

Sequence of different scenarios!
Redesign Q-Port
Hotel & Congress Center
Scenarios & Climate

Oxygen:
Human Need: 0.5-2kg of Oxygen per day
Production Tree: 10-15 kg of Oxygen per day

Cooling:
One Tree: Evaporate up to 400l a day maximum; average is 1460 kg a year.
870 MJ (= 240 KWh = 0.241 MWh) Cooling-potential
Average room temperature reduction 1.6 °C
Redesign Q-Port
Hotel & Congress Center
Energy Intention

KEY Feature
“Grüne Lunge“
Grow Fresh Air

Sansevieria Trifasciata
Oxygen production also during the night

Chrysalidocarpus Lutescens
Most efficiently in converting

Epipremnum Aureum
removes harmful chemicals from the air

Schefflera Actinophylla

Ficus Elastica Robusta

Arancaria Heterophylla

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491
Redesign Q-Port
Hotel & Congress Center
Scenarios & Climate

Oxygen:
Human Need: 0.5-2kg of Oxygen per day
Production Moss m²: 4 kg of Oxygen per day

Cooling:
Mossland m²:
50GJ (=13.8 MWh) Coolingpotential
Lower surface temperature around 6-8°C
Average room temperature reduction 3-4°C
Redesign Q-Port
Hotel & Congress Center Organisation

KEY Feature

“Grüne Lunge“
Air Plants - Moss Planting Panels
Redesign Q-Port Hotel & Congress Center
Scenarios & Climate

“Grüne Lunge“ spirals out:
- Separation for control of the air speed
- Section can be closed to prohibit fire spread
Redesign Q-Port Hotel & Congress Center

Scenarios & Climate

Ventilation:
Possible room temperature reduction 3-5°C

Night Cooling Out:
Will offset 20-30 W/m² of heat gains

Reduces daytime space temperature up to 3°C
Redesign Q-Port Hotel & Congress Center
Scenarios & Climate

Exemplary calculation of 3 office floors
- After the enhancement of the Insulation Standards, Solar Farming and Use of a Heat Pump
- Without “Grüne Lunge” Features
Redesign Q-Port Hotel & Congress Center Facade

Visible Statement to the world outside!
Redesign Q-Port Hotel & Congress Center Facade

“Grüne Lunge“

Inspired by Nature!
Redesign Q-Port
Hotel & Congress Center
Facade

“Grüne Lunge“
Inspired by Nature!
Redesign Q-Port
Hotel & Congress Center
Facade
Redesign Q-Port
Hotel & Congress Center
Facade

“Grüne Lunge“
Inspired by Nature!
Redesign Q-Port
Hotel & Congress Center
Facade

Intro       Research       Design       End

Graduation Studio
Dorothee Hemmelgarn
Nr. 4323491

TU Delft
Delft University of Technology
P5

powered by innovation

INTECTURE
Redesign Q-Port
Hotel & Congress Center
Facade

Media Facade
Summer:

Night Cooling out of the building over the "Grüne Lunge" in the summer.

Enhancement of the building storage mass by activated screed floors.

Media Facade:

Colored glass with BIPV at the south side.

Natural Ventilation Concept:

Natural ventilation over the "Grüne Lunge" is possible without noise and air pollution from the surrounding streets.

In the Winter time preheated air will be transported from the south side of the building over an air guide system in the raised floors to the rooms in the north part of the building.

In the Summer time cold air will be transported from the north side of the building over an air guide system in the raised floors to the rooms in the south part of the building.

In addition, the air will be controlled and the temperature will be adjusted by Heat Exchangers over the Interseasonal Heatstorage of the Aquifer.

Linked to Heat Recovery.

Controlable Louver for an adjustable Ventilation Strategy depending on the weather conditions.
Introduction

Problem Statement
Objective
Technical Research Question
Overall Design Question
Methodologies

Research

Context
Program
Technical Research

Design

Objective
Example
Design

End

Reflection
Questions?
Thanks for your attention!