Graduation Plan
Architecture Engineering Graduation Studio
Intecture 2016-2017

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Faculty of Architecture and built environment
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Why did I choose AE Intecture Studio?

There are mostly two reasons. Firstly, the AE intecture studio provide me chance to approach architecture design in new perspective and in collaboration with other disciplines such like sociology, engineering and biology. I could dive into our personal fascination in structural design and sustainability through research and design. Meanwhile, second one is personal interest in the social issues on reconstruction program of housing in seismic and flooding area. Emergent housing design after disaster is nowadays responsibility of architect to consider.

Title: Transformation in nature

Sub-title: Integrating bio-mimic structure into anti-seismic architecture design in seismic-affected Groningen

Research Title: Light weight and portable housing in bio-mimic and organism structure.
**Graduation Project**

**Problem Statement**

The Groningen is facing a continuous and potential danger of the frequent earthquake these years due to over-exploitation of the oil in the underground soil layer. Most buildings in threatened areas by earthquake are masonry construction. Although very few constructions really collapse, it has been accumulated that quite a few buildings in Groningen are in different extents of the damage. The engineers attempt to stabilize the existing structure with the technical and engineering solutions, which always lacks consideration of the aesthetic value and functionality. Beyond providing decent retrofit to the existing constructions, architects should prepare for the new construction methods and design. The collaboration between the architects and engineers should not only take account for the structure strengthening stability, but also offer more value on the social, economical, sustainable aspects.

In terms of economical and social aspect Groningen has abundant of undiscovered landscape resource value in farmland. People are losing interest of the rural landscape and rural life style. Furthermore, the city is facing the challenge of population shrinkage. Less and less people are willing to live in this area. Thirdly, the start is made by HOLLAND’S STATE FORESTY COMMISSION to regrow the forest canopy in heavily exploited and densely populated areas called "Reforestation Program". How to bring the value back to the rural life stimulating the village vitality, at the same time with responding to the appeal of the reforestation plan?

**Objective**

The object of my graduation studio is to seek for a bio-mimic construction method responding to the seismic Groningen. Simultaneously reinterpreting the relationship between the man-made construction and nature.
CONTEXT
- Menkema Garden
- Seismic Groningen
- Reforestation Program

PROGRAM
- Seismic Museum
- Menkema Extentional Pavilion
- New Landscape

TECHNOLOGY
- Biomimetic Structure
- Earthquake Resistance Technology
- Responsive skin
Site & Context

The site is located in the south of the Menkenma garden in Ulthuizen, surrounding with abundant high trees in three faces, the southern orientation is towards the broad farmland, which is a great horizontal landscape scenery (figure 7).

The Menkenma garden is designed by Allert Meijer in 16th century. "The gardens are marked by a clear cut, orderly and symmetrical layout with principal axis and a transverse axis which intersect at the center of the house. The style proclaims "man, the master of nature."

Whether rationality can really conquer and control the nature? Whether the 16th centuries' notion of relationship between human and nature is one subjected to the other one? This is one question that I try to respond in this design.

Thereby, how to reinterpret the position of the man made design in front of nature?

Program & New landscape

My ambition is to design a biomorphological seismic museum. The form of the Museum will be distinctly different from the existing strictly organized garden, with suggesting the human's creativity will be an imitation of the natural creation rather than conqueror. The design itself will be a new interpretation of the nature just like the artificial landscape (figure 8). The other goal of the design is to attract the development of the tourism industry and revitalize the local community life.
1. Unreinforced masonry structure in seismic area
2. Reforestation Program
3. Population Shrinkage
4. Loss confidence of rural landscape

Problem

Current Solution

My idea

My Solution

Object

Limitation

1. Less aesthetic value
2. Only retrofit the existing masonry buildings

Comparison

Advantage

1. Biomimetic lightweight timber structure.
2. Responsive skin
3. More aesthetic value
4. A new construction way
5. Less energy consumption
6. More sustainable and recycled material
7. Intimate touch with nature environment

Technology

Society

Economy

Environment

1. Engineering Technology to strengthen stability, such as adding braces and ring beam.
2. Learn seismic strategy from nature
3. Integrate natural construction with seismic challenge.

1. A new organic and biomimetic architecture
2. Reinterpret the farmland landscape regarding architecture morphology
**Personal Fascination:**

Through the study on the space formation and structure design, I am aware of structure acting an essential role in the space formation. In the seismic architecture design, the structure can be either passively utilized as an approach to strengthen the structure stability regardless of the aesthetics and functionality, or can be integrated with the space formation and architecture morphology. The role of the architect is to understand the responsive relationship between space and structure provoking the creative inspirations on the new construction method and material use.

The topic of this research paper is set upon the bio-mimetic structure and natural form finding with the purpose of reinterpreting the man made landscape morphology. On the other hand, this biology-inspired approach should also be beneficial to the seismic proof design. The interest of bio-mimetic structure oriented to the application of the spine structure as pretension and compression structure, with light weight timber as material choice.
**Overall design question**
Can I design a bio-inspired museum in Seismic Groningen reinterpreting the local nature landscape?

-1. How to create a new anti-seismic structure with the knowledge on bio-mimetic research and timber construction?
-2. How to integrate the responsive skin technology into the museum design creating a charming space atmosphere?
-3. How to facilitate the social activity and village vitality via constructing a museum?

**Thematic Research Question**
"How to set up a bio-mimetic strategy for the seismic Groningen, taking the landscape, context, responsive technology into account?"

- **Seismic design research**
  -1. what constraints the architecture design should conform to in seismic region?
  -2. what kind of the architecture approaches could contribute to the seismic resistance design?

- **Biomimetic structure research**
  -1. what kind of biology-inspired structure in general architecture applications?
  -2. which structure type could better match with the anti-seismic principle?

- **Bioclimate technology research**
  -1. what kind of interactive skin technology could be integrated into the museum design?
  -2. How to attached into the new structure in an appropriate way?
Matching Process

Technical Complement

Methods: Literature study, case analysis, lecture and courses

Seismic Research

Problem Statement

Research Question

Research Goal

Seismic Design

Biomimetic Solution

Bioclimate: Responsive skin

- Ventilation
- Thermal Insulation
- Light control

Biomimetic structure analysis & Integration

Biomimetic structure

- Self-organization Principle
- Morphology Analogy
- Structure Optimization

Frei Otto’s experiments and Cases

- Lightweight Structure
- Tensile Structure
- Moveable Structure
- Tree Column Evolution

Timber construction

- Tension & Compression
- Cable Node Components
- Construction

Structure Optimization

Architecture Toolbox

- Lightweight Structure
- Tension & Compression
- Cable Node Components
- Construction

Bioclimate: Responsive skin

Integration of New Construction Way

Design Constraints and Principles

Seismic Design

Methods: Literature study, case analysis, lecture and courses

Bioclimate: Responsive skin

- Ventilation
- Thermal Insulation
- Light control

Technical Complement
Methodologies
- Preliminary research – Context and typology:
  1. Context and site research
  2. Literature reading on ‘seismic architecture’
  3. Case analysis on ‘Portable and flexible architecture’
  4. Literature reading and case analysis on ‘Emergent housing types’
  5. Seismic Principles for construction in nature.
- Medium research by design – Form finding and structure Design:
  7. Study on timber construction and detail of joints.
  8. Study on the responsive skin system
- Sustainable Integration – Technology and Production:
  11. Construction procession program
  12. Prototype of 1:5 model to examine the construction and material property.

Project Planning
- Presentation 1- Preliminary design (24.10.2016):
  1. Research and Method Position Paper
  2. Relevant Literature Study on modular architecture
  3. Portable and transformable architecture
  4. Site and Context research
- Presentation 2- Medium research by design (23.01.2017):
  1. Form finding and structure design
  2. Seismic structure design
  4. Research on responsive skin
  5. Material construction and details design
- Presentation 3- Sustainable Integration (27.03.2017):
  1. Computational stimulation & load bearing analysis
  2. Physical model & structural optimization.
  3. Test – Evaluation – Modification- Redesign
- Presentation 4- (15.05.2017)
  1. Summary of the chart and analysis
  2. Representation of the Design project:
     - Video for the production, assembling, and experience;
     - Construction, Technical, Drawing;
     - Perspective. City, human-eye
- Presentation 5- (03.07.2017)
  1. Model making and summary of outcome.
Relevance

-Social Relevance:
The design is to approach a new way to design museum in the seismic area like Groningen. In comparison with rational garden design in the 16th century. Such new architecture illustrates that nature and architecture should be integrated in abroad social and geographical framework. As architectural solution in this particular context, the outcome will be architecture assumption to get social integrity, function, program and sustainability into account.

-Scientific Revelance:
The idea of bio-mimic structural design is a new intervention into the context of anti-seismic construction design. Both Research and design methods will be used to improve the structural design for timber architecture. The research and final design should be a precedent to explore the new construction possibility on how to integrate material properties, bio-mimetic structure, and seismic design principle into the form finding process.

Literature Reference:
1. Informal, Cecil Balmond with Jannuzzi Smith, A+U, Cecil Balmond
2. Michael Heine and Joachim Heine: Lightweight Structures in Architecture- The principle need to reduce the over consumption of building materials
3. The Continuing architect: Light weight structure for sustainable and efficient building solution
4. AA 2015 Emergent technologies and design
5. Robert Kronenburg: Houses in motion-the genesis, history and development of the portable building
6. Sean Topham: Move HOUSE
7. Vitra Design Museum: LIVING IN MOTION-Design and architecture for flexible dwelling
8. Design In Modular Construction
9. Robert Kronenburg: TRANSFORMABLE
10. Architecture,Response to change, Robert Kronenburg
11. The Organic approach to architecture, Wiley-Academy, Deborah Gans, Zehra Kuz
15. design by analogy
16. transfer nature to architecture
17. the evolution of design
18. Timber construction manual
19. Emergent timber technologies
20. Timber construction: details, Products, case studies
## Appendix 1- Time-planning schedule

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