Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences
Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

<table>
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<tr>
<th>Personal information</th>
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<tbody>
<tr>
<td>Name</td>
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<td>Student number</td>
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<td>Telephone number</td>
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<td>Private e-mail address</td>
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<th>Studio</th>
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<td>Name / Theme</td>
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<td>Teachers / tutors</td>
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<td>Argumentation of choice of the studio</td>
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<th>Graduation project</th>
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The posed problem,
The use of natural forms in architecture have been used for over decades for both esthetical as constructional purposes. One of these natural forms is the tree. For decades architects like Antoni Gaudí and Frei Otto have been researching these shapes and built several examples using tree-like structures. The main issue about these structures is finding the most reasonable form to solve the problem of actual project. The branches of tree structures should be arranged properly. Then only tension or compression is present, resulting in a higher structural efficiency and less material use. (Zhao, Z., Liang, B., Liu, H., 2017). Research had been done by several methods of form-finding. In the beginning this form-finding consisted of physical models and the usage of graphic statics (Sassone, 2014). In the past decade the form-finding methods have changed due to the usage of computers. Computer-aided Design (CAD) and Finite Element (FE)
models are programmed to calculate and design ‘optimized’ branching structures. (Knippers, 2016) Problem with computer simulated solutions is that they often are based on an extremely large amount of iterations, searching for the best possible solution or approximation. This method is time-consuming and the designer or engineer loses the ability to truly understand what the effect of different forces on a structure is. With the expansion of knowledge in the field of building and construction, architects and engineers try to reach the limits of what’s possible. This results in bigger span architecture or new challenging shapes. These new shapes leave the engineers with more complicated problems. Branching structures in three dimensions are often used to support these new shapes but the structural behavior of the branches is difficult to predict. Finding statically equilibrium for a two-dimensional branching structure can be done but a third dimension often creates statically indeterminate structures. Right now, there is no method to calculate the optimal branching structure as a support of freeform architectural expressions.

Research questions and

In this research I will answer the following question

“How can we design structurally efficient three-dimensional branching structures as a support for non-uniform roof surfaces”

To get to this question I’m trying to answer a set of sub-questions:

What are branching structures?
What is the structural behavior and advantages of branching structures?
What previous methods used for form-finding of branching structures?
What is graphic statics and how can it be applied to branching structures?
How can we determine the best state of equilibrium?
Can graphical statistics be used in three-dimensional statically indeterminate structures? And to what extension?
| design assignment in which these result. | By combining the knowledge of structural behavior of branching structures and methods used for optimizing other type of structures I want to achieve the following during my graduation:

*Create a form finding tool for 3D branching structures based on minimum complimentary energy.*

With this final tool a design can be made for a specific location and shape. The boundary condition such as the location and shape will be determined between P2 and P3. |
**Process**

**Method description**

- Define graduation topic
- Search for literature
  - Physical model study's
  - Computational study 2D/3D behavior
  - Literature study
    - General description of structural behavior
    - Conclusions/ Possibilities
- Hand calculations
- Write method for 3D branching structures
  - Script method grasshopper
  - Set up design criteria
- Design
  - Check criteria
  - Yes
  - Final Design
  - No
  - Design input
- P5 presentation

**Literature and general practical preference**


Reflection

Relevance

My graduation plan will increase the knowledge on the field of structural design and form-finding. This will make it possible to design in a more efficient way and maybe achieve different or more challenging shapes. Combining this tool with for instance the growing use of grid shell structures will give more possibilities and freedom in design.

Time planning

See next page