ARCHITECTURAL & MEDIA STUDIES REPORT:
Using digitally driven design tools

INTRODUCTION

The studio of Hyperbody is focussed and advanced in using digitally driven design tools to create architecture. The studio provides interesting perspectives to approach architecture on a digitally way and they give the students the opportunity to learn and use the tools. Although I believe that the digitally driven design can only be used as a tool and not otherwise, I will explain in this report how I will use the tools for my project by explaining my approach according to the graduation exercise. Here, student needs to develop a proposal for 6500-7000 sq. m. of student housing on the Green Village in Delft. This design must comply on the following four demands. First, the building needs to be able to control its climate according to environmental conditions. Second, the CO2 of both the construction and the consumption of the building should be sufficiently reduced to its emissions. Third, generators of renewable energy should be integrated in the architecture to provide the building of power. And fourth, the integration of computational tools in both the design and fabrication of the building.

PROJECT

The site of the Green Village offers enough space for the building to use advantage of external weather condition like the wind and sun. These conditions could arrange a part of the climate within the building. This passive design strategy prevents additional energy consumption of an active system. Using computational tools I can optimise the shape of the building towards a desired passive climate solution.

To reduce further CO2 emission, the building needs to be efficient. Meaning two things. First, optimise the fabrication and assembly process to a minimum amount of energy. And second, extend the lifespan of the building components. Because I aim for a longterm preservation of the building, I have to take in account that the program of the building can change in the future from student housing to something else. To adopt to this possible change I need to design the spatial layout flexible. This will include the student housing itself but also the infrastructure of the facilities such as electricity, water and drain inside the building. This possible change, the maintenance of the building and possible obsolescences of building components will require a subtile distinction from the main structure of the building to preserve the building as long as possible.

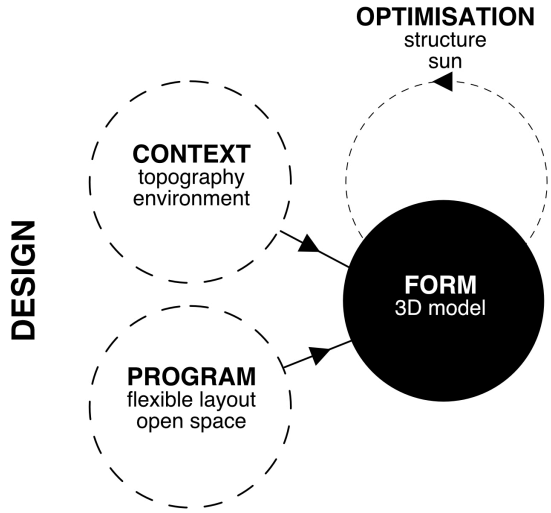
The focus of the design will lay in proofing the main structure of the building. which will exist out of unique building components made of wood. Which as a material can solve these demands. I choose the theme “Robotic Building” to develop these building components that fits the requirements of precision and mass customisation. CNC technology can offer the solution.

COMPUTATIONAL APPROACH

In order to create the architecture i need to abstract the design for two reasons. One is to experiment with the shape of the building, this can be by physical models, 3D models and sketches, and second to realise the design. The most efficient way to do this is digitally. I will use the 3D model to adjust the design further and to use the data of the 3D model to fabricate in order to realise the building. Therefor I would say that there are two processes to create architecture. First the design process and second the realisation process.

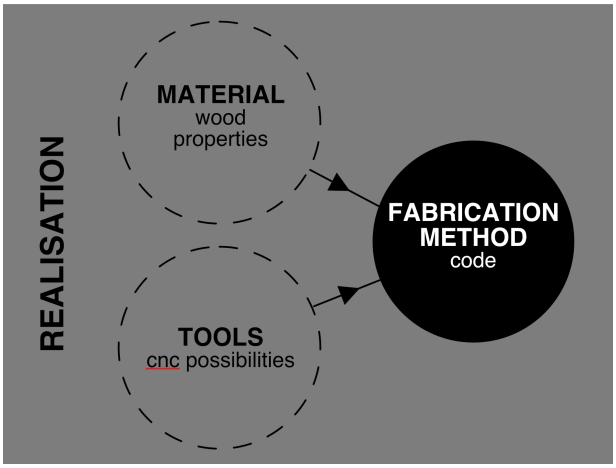
The design will be informed by the context and the program. By understanding the surrounding and the orientation of the site I can position the building roughly. The program of the building will determine the spatial layout of the design. These things will result in a 3D model of the design and will undergo several iterations of optimisations. During a workshop of Hyperbody Msc3 about performance

and environmental data integration (http://rbse.hyperbody.nl/index.php/W4) we learned how to do solar analysis. Because I aim for a passive climate approach I will optimise the main structure to the different positions of the sun according to the seasons. Meaning that structure will reflect the sun during the summer when the sun is high and let the sunlight enter during the winter when the sun is low. Besides solar optimisation I will do a structural optimisation and find a balance of the two to develop a 3D model to work with.



Design process: own illustrations

To realise the design I will develop a fabrication method to modify the wood. Because the shape of the building can result in a free form structure, I need to think of how I can fabricate the wood for mass customisation (Bier, 2015). This Design to Robotic Production (D2RP) can only reach it full potential when I understand the properties and know the best and efficient way fabricate the material.



Realisation process: own illustrations

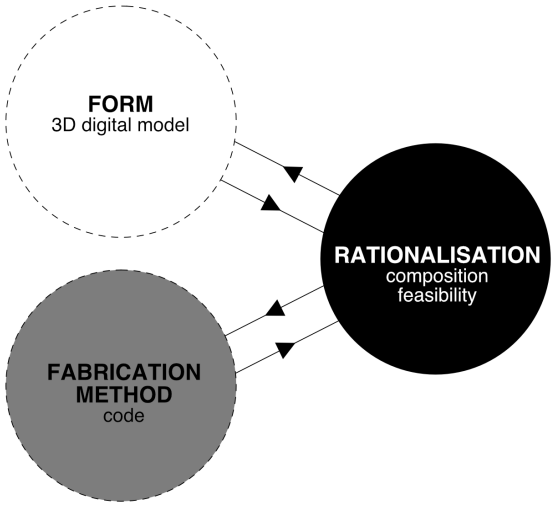
During the GSM3 symposium on Robotic Building, Christina Doumpioti (hyperbodytudelft, 2016) talked about material opportunities, limitations, potentials and speculations. She specifically said that if we look at biology, we can see how the materials are distributed more on areas with high stress concentrations and that the fibres are growing along these stresses. This is especially important for using wood, where fibres are growing along the length of trunk. The grains of a tree will affect the production method, it indicates how the material needs to be modified. The precision of CNC technology can be used to mill joineries systems to connect two pieces of wood together. By using the fibres correctly, the two joints can work as one and act like a solid piece of wood.

On the GMS3 symposium on S.M.A.R.T. Environments, Jelle Feringa (hyperbodytudelf, 2016) inspired me for this by presenting a fabrication method of cutting stone in a double curved shape by sawing the stone with a wire by circulating.

Carrara Robotics: (roboticsinarchitecture, 2014)

A method like this can be the result from, on one hand think of how to realise a design and on the other hand what is possible in terms of production. This is why it is important to find the right machinery to fabricate the wood to benefit the material properties, and at the same time find an efficient production process. The only thing next is the code or instructions for the machine to execute fabrications to the material. Depending on the dimensions of the component, the code will generate the data for fabrication.

When the two processes are brought together, they need to be rationalised in order to work along. This means that the design will be adjusted for composition and feasibility reasons.



Rationalisation process: own illustrations

This can mean that the design will not be optimal for the sun and structure, but more towards efficiency of making the components and finding the right composition of the structure. I believe that this visual quality of the building is of great value and determine the lifespan of the building for a great part.

CONCLUSION

To realise the design we need to abstract the building in a very detailed way. This is where we can use digitally driven design tools and that is where the extra value lies in. Using the tools will exclude future problems of realising the architecture. We can use the data of the design to develop the building components. In this way the architecture can be faster, cheaper in the end and delivered with a higher quality. This can be achieved because of the precision of robotic fabrication. The efficiency of architecture lies therefore in this collaboration of design and manufacturing. That is why understanding these fields is essential for a designer that is using digitally driven design tools. To come up with more productive and better architecture.

BIBLIOGRAPHY

Bier, H. H. (2015). *Parametric Design Strategies: Robotic Building In Academic Architectural Research And Education*. Retrieved from https://www.researchgate.net/publication/305867142_Parametric_Design_Strategies_Robotic_Building_In_Academic_Architectural_Research_and_Education

Hyperbodytudelft. (2016, November 11). GSM3 S.M.A.R.T. Environments Live Stream 2 [Video file]. Retrieved from https://www.youtube.com/watch?v=OTVneir21UA

Hyperbodytudelft. (2016, November 11). GSM3 Robotic Building Live Stream [Video file]. Retrieved from https://www.youtube.com/watch?v=gbuqGrx7Q4A&t=4851s

Robotsinarchitecture. (2014, May 05). Carrara Robotics [Photograph]. Retrieved from https://vimeo.com/94076571