REFLECTION – P4

Andreas Holterman

Introduction

This master's thesis is the outcome of the research done within the chairs of Design Informatics and Climate Design, with focus on acoustics. This topic for my graduation was not the one I had in mind in the first place, where I started out with the combination of Design Informatics with Structural Design. One month before my P2 presentation, I decided to let go of this subject and to continue with a different topic: Pattern Cutting for Responsive Wooden Surfaces.

Objective

The main objective for this research was to combine the technique of pattern cutting with acoustic design in order to create a flexible acoustic panel. The idea of pattern cutting to increase the flexibility of rigid flat panels is relatively new, meaning that actual applications based on this technique began just over a decade ago. The amount of scientific research on this technique is still scarce, which makes it a challenging subject that demands further research. The combination with acoustic design brings new opportunities for acoustic panels to change and adapt to the desired acoustic performance.

Methodology

This research starts with a literature study on the subject of pattern cutting and acoustics. For the little scientific reports that are available on pattern cutting, the more there are to find on acoustics. The study into the literature about the first subject was limited and left more to be explored and defined by myself. Research by design was done by creating physical models and study the bending behavior of different models with each a unique set of pattern parameters. The designed patterns were created within a parametric model, that used the defined pattern parameters as input.

Creating the algorithm for the parametric model was taking up more time than expected. This has probably to do with the fact that I liked working on this model and tried to optimize it continuously, by adding and experimenting on additional features. It resulted however in a model with extra features, that allow for various local adjustments in the pattern and is for example capable of creating sample pieces of a pattern automatically, which were used for acoustic measurements. Several other aspects I wanted to include as well have not made it into the model due to the complexity of these parts and the limited amount of time left. But the effort put into it resulted in a better understanding and new insights of the possibilities of the software and opens up new opportunities for further elaboration in the future.

Acoustic measurements were done to analyze the influence of the pattern parameters on the acoustic performance. The pattern parameters have been translated to four different acoustic parameters, which relate to the pattern design and the surface curvature of the panel. The measurements with the Impedance Tube gave accurate and reliable results, as they were almost identical for repetitive measurements. This type of measurement is quite convenient, as only small samples are required and there are few possibilities for flaws and errors in the results. A minor downside with this measurement is that it only measures with normal incidence and does not give any information on acoustic performance with random incidence. That means that the effect of one of the four acoustic parameters, the surface curvature, could not be measured.

All collected data from the research and the measurements was then combined to create a full scale prototype of the panel. The constructed prototype has been used for Impulse Response measurements, which should give more insight in the fourth acoustic parameter, how the surface curvature affects the acoustic performance. Unfortunately, this measurement ended up in results that were not so accurate and therefore not useful to give detailed information on the acoustic performance of a full scale panel and the effect of a curved surface.

The resulting values were meant to be the input for acoustic simulations, which have not been performed due to the unreliable results and a lack of time.

Based on the available results, it can be concluded that the adaptation of the panel to changing acoustic needs is quite limited. However, the results of the research, the measurements and the built prototype, showed that the principle of responsive acoustic panels is definitely promising and demands further development.

Relevance

Acoustic panels are already widely available, but only few of them are capable to change its acoustic performance in order to meet the changing acoustic needs in a multi-purpose room. The relative simple technique of kerfing a pattern onto a wooden sheet to transform it into a three-dimensional geometry, is a cost efficient approach to create responsive acoustic panels. This technique is relatively young and currently still under development, which makes it a suitable topic for this research.

Sustainability

Besides the fact that wood is a durable and renewable material, it can also be easily processed, either by CNC laser cutters, milling machines or by hand. The possibility of transforming a flat wooden sheet into a three-dimensional geometry, is cost efficient and reduces the amount of waste compared to building a 3D geometry straightaway. The manufactured panel can be placed in its original flat position, which allows for compact storage and transportation. Once placed, it has an aesthetically pleasing appearance that keeps its quality with little care and maintenance.

The main research question has been answered during this research, but there is more to discover in this work field. There is plenty of room to overcome several design challenges, optimize the pattern design and include other design aspects to create an actual product that can be applied in any room and responds to changing acoustic needs.