DESIGN PROCESS AND STRENGTH ANALYSIS OF A BIOPLASTIC MEETING ROOM CHAIR

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Fully recyclable products have become more popular over the last years, since the environment is still being polluted and resources are running out. It is therefore of importance to rethink how we use products and materials, and plastics in particular. The company Arapaha agrees with the importance of this fundamental change. Moreover, their whole company philosophy is based on circular business design, using only products that are fully recyclable and applying bioplastic wherever possible. Arapaha redesigns commonly used products into a fully recyclable version. The knowledge gained from this thesis will be used on the coming products of Arapaha.

The design process of this thesis is for an office meeting room chair. The main research question is: "How to design a fully recyclable meeting room chair made from PLA for the company Arapaha?" To answer this question four sub research questions have been formulated:

- What is PLA, and in what ways can it be used?
- Which specifications and requirements should a design of a chair meet?
- How will the different parts of the chair be connected using PLA?
- Is the design able to hold the weight of daily usage?

To provide an answer to the main question, these sub questions have to be answered. The approach was to carry out knowledge research on all the topics that could be of influence during the design process. The design process will apply the Delft innovation model as a base.

Polylactide or Polylactic Acid (PLA) is a biodegradable and renewable thermoplastic made from lactic acid, commonly found in fermented milk products and many other agricultural products. The characteristics of PLA make it a great replacement for commonly used plastics. However, using PLA as a replacement is relatively new, and therefore quite unknown. This will give some limitations when it comes to designing a product entirely made from it. PLA does however have many advantages as a material. It is therefore of the importance to test the full capabilities of PLA and identify its limitations

When it comes to the design of a chair, there are also limitations on the design. It has to be more than only aesthetically pleasing, it should also be a comfortable chair. In order to provide the user with the ideal level of comfort, existing regulations and guidelines on the ergonomics have been adopted. It is important to adhere to these

guidelines, this will ensure the users will sit in the correct sitting position and it helps with the future market introduction of the chair.

An internal and external analysis has provided the company with a strategic position, resulting in the formulation of the target group and basic requirements for the new design. Using this information, the ideation phase of the meeting room chair was started, with a general idea on the shape of the chair It was of particular importance to establish how to connect the legs to the rest of the chair, using only PLA. Research on the connecting system, further iteration on the chape of the chair, and some last adjustments resulted in a finalized design concept.

To validate the design of the chair, strength calculations have been performed, identifying the weak spots of the design and to make clear where additional support would be needed. Due to the limited knowledge of the material properties of PLA, the strength analysis only showed an estimation of the reality. The initial strength analysis displayed some concerning weak points between the legs of the chair, implying an adjustment to the design had to be made. Adding strengthening bars between the legs resulted in a significant improvement during the second strength analysis.

The final design of the chair fits within the standards of Arapaha and the chair is likely to withstand daily usage in an office environment. It should however be taken into account that the strength analyses only showed a estimation on how the material will respond to the applied force.

Further research has to be performed in order to have a final design and physical finalized product of the chair. Additional may be deeded with regard to the bottom parts of the legs, and the cushioning of the chair. Adding these last components to the design, will provide Arapaha with the final concept of their meeting room chair. With the completed design, the first prototypes could be made. As there is limited knowledge on the material properties of PLA, starting with prototypes, instead of performing more simulations could be the better choice. Once a strength analysis has been performed on the prototypes, it would be useful to test the chair on long term with the use of a fatigue analysis.

With all the necessary test and additional research done on the design of the chair, the production of the chair is of importance. Further research on the production and marketing has to be carried out.