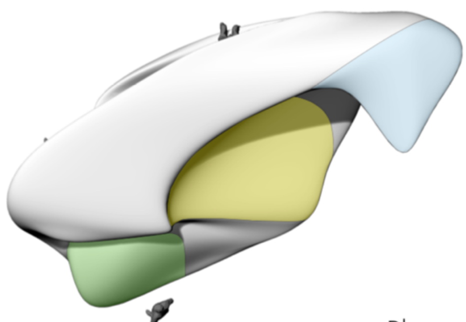
Introduction

In response to our collaboration with Arwin and the study of what is the influence of cell structures towards characteristics of the TPE surface we have set up this report. For our MSc 1 studio Non-standard and Interactive Architecture (by Hyperbody) we are currently designing a furniture for joggers. For this furniture we came up with a set of different fitness-activities which all have their own requirements regarding the material and the softness of this material.
In order to choose an adequate structure for the TPE for our furniture we've done some research.

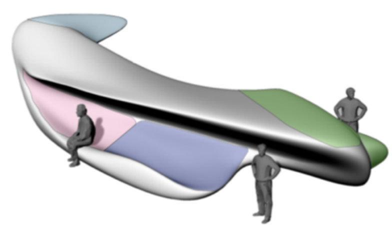
In this report we will firstly discuss the research method we have handled. Secondly we will state all our research results. After that we will end our report with a conclusion, a reflection and a discussion for a potential follow-up study.

The research method

For our research we handled the method of research through design. This means that we designed three different patterns in Grasshopper. Each pattern with a different cell structure with the aim of manipulating the softness of the material. After finishing the designs, we printed the patterns with a 3D printer. This in order to examine the deformation, soft-, and hardness of the patterns after imposing a force on it.

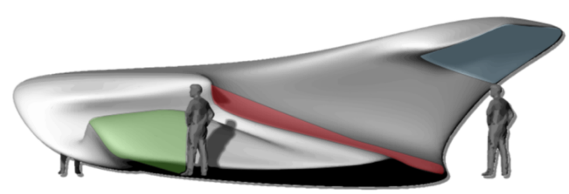


Plan view



Perspective I

Front

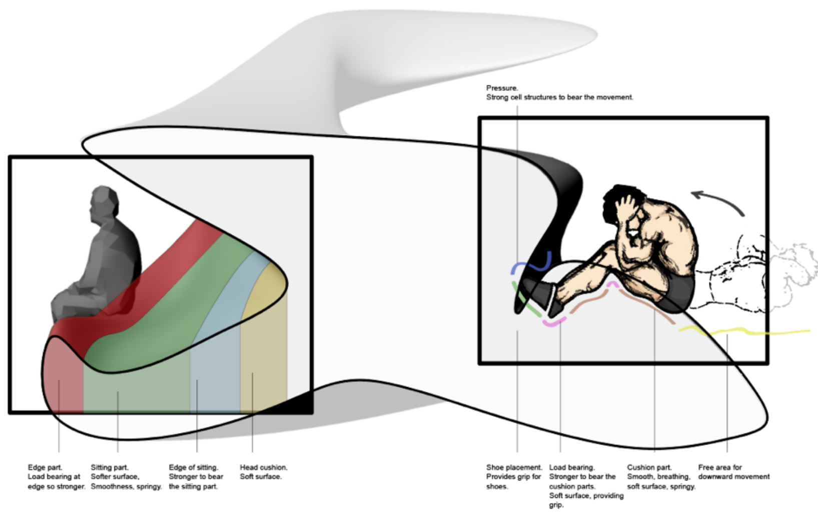


Side

The research

Requirements

As said before the designed furniture has different requirements conform materialization. There are parts that need to be soft, parts that need to be hard, parts that can be hollow etc. We started our research with mapping out the different requirements. The figure on the right shows the different requirements.



Fragment

After it was clear what the requirements are for each part of the furniture, we chose a fragment of the furniture to focus on. Focusing on a small fragment was necessary considering the time and manpower we had.

Patterns

For the chosen fragment we designed 3 different patterns, each with different cell structure. For inspiration we looked at the nature, research that had already been done and haphazardly designing figures in the hope to invent something useful. After some days searching for the right patterns we came up with three totally different structures as shown below.

3D printing

Our next step, after designing the three patterns, was to print out what we had designed. As printing with TPE is something not usual, printing with TPE was a research on itself. Luckily we could get some help from Serdar Asut from the Building tech print lab.

Results

Conclusion

The TPE experiments can be printed after the holidays at the Building Tech print lab so our conclusions follow…

Discussion

LECTURE POETEINI SETAKI
In the presentation of Foteini Setaki given on Tuesday the 31st of October we got inspired by the idea of using recycled plastic for our furniture. For this reason, we did some research into using recycled plastic as a filament for our 3D prints. The conclusion of our research was, in short:

Recycling plastic is an intensive process that takes a lot of time and energy. The process includes collecting, washing, shredding, adding chemicals a reforming the plastic. Beside the insensitivity and the time taking process recycled plastic hasn't the same characteristics as TPE. The most important characteristic is the flexibility of the material. Shortly that is the reason why there is not chosen for recycled plastic as main material.

LECTURE MILICA PAVLOVIC
At the start of this course we've analyzed the activity on the site during different times of the day. Knowing who is around the area helped us define what target group we should design for: a furniture for runners. After this exercise we started to remap the experience of going for a run (as explained in the lecture of Milica Pavlovic). We observed that Kralingen is an amazing area for runners, but giving runners the option to do a run combined with sport-exercises on a parametric furniture would be an interesting addition for runners. User remapping helped us define this concept.
Continuing this approach, we've came up with a set of passive workouts. We zoomed into these activities by looking at the movements happening doing these activities and the relation to the surface and the human body. We translated these activities into sections, which we used to make a complete form using clay models.

H. Bier and S. Mostafavi
Structural Optimization for Materially Informed Design to Robotic Production Processes

The additive production approach
Mapping stress lines using Karamba gave us insights in the structural forces and tensions happening in our macro geometry. This exercise enabled us to generate a point cloud inside our geometry, based on structural loads. By optimizing point cloud densities based on generated stress lines we are dealing with the so-called demand driven architecture. Of course, load bearing aspects is just one of the demands we need to deal with in our sub-divided components, but rain, usability patterns, assembly methods etcetera are also demands that could be added in later stages. We focused on the efficiency of material usage and load bearing demands because we felt like this was a logical bottom-up approach, adding further demands later onwards.

Also, a lot of our research is based on experimenting with the characteristics a semi-flexible 3D-printable TPE material. Designing a variety of 3d-patterns and printing these at the Building Technology print-lab, we are integrating digital production processes with material characteristics. Doing such experiments is of a great value because now we can judge the materials bending behavior and learn from the production process, manipulating the patterns from these conclusions and we even combine these structures with each other in order to generate an even more efficient structure. (Bier & Mostafavi, 2015)

Optimizing structural load bearing The objective of our research Our aim was to find the right porosity in TPE, forming a smooth and soft surface.

Reflection

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T-Splines to Grasshopper
New insights developed in order to code what we want to achieve in Grasshopper
Grasshopper skillset developed
Understanding the process of making models 3D-Print-ready

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Presenting our results more clearly short on time/manpower
Defining our end product but only dealt with structural demands is not the complete end result we wanted to achieve.
Spent a lot of time getting coding to work in Grasshopper, at the cost of presentation

The goal of the second workshop was to create a structure that could make a transition between a load-bearing structure and a soft surface. Because our objective was quite clear, we immediately dived into Grasshopper to get this print-ready.

During the Grasshopper coding process, we've learnt how to make a Geowrapping structure out of a point cloud. This function creates a sphere around a point. Dense point clouds would create many spheres and merge them together. The spheres have a smaller radius at dense areas, which would make them stronger.
By making a scale model of this PLA-printed structure we could conclude that Geowrapping can be a very suitable pattern to use at places that have to deal with force or tension. Geowrapping creates a very strong structure, while not being too dense by its infill.

Although the workshop made us find a new pattern that can solve structural stresses, a lot of optimization of our code is still required. Our next aim should be to combine this structural geowrapping method with a soft porous sponge material. Shortage of time and manpower made us no reach this objective. But it is still a very interesting objective to find a transition between a soft, porous surface that transits into a wireframe if it does not need to carry load, or thick mass as a structural element.
At last, we also need to redefine our point cloud, which right now reacts to attractor/repellent curves. Right now this point cloud is based on a random infill, we also need to find a grid-system for this to gain a more optimized transition.