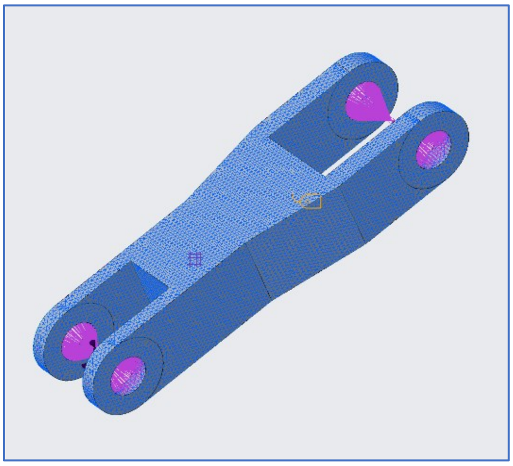
Aalto University
School of Engineering
Department of Mechanical Engineering

PORTFOLIO FROM CAD DESGIN, PROTOTYPES AND TOPOLOGY OPTIMIZATION

Author: Juan Silva

Creo Parameters Topology optimization upper torsion link of a Boeing 777

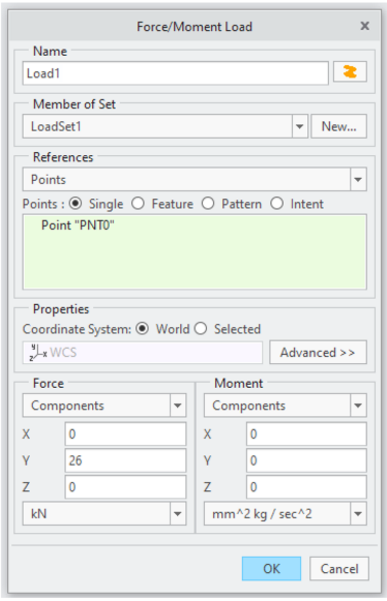


Mesh size in Creo

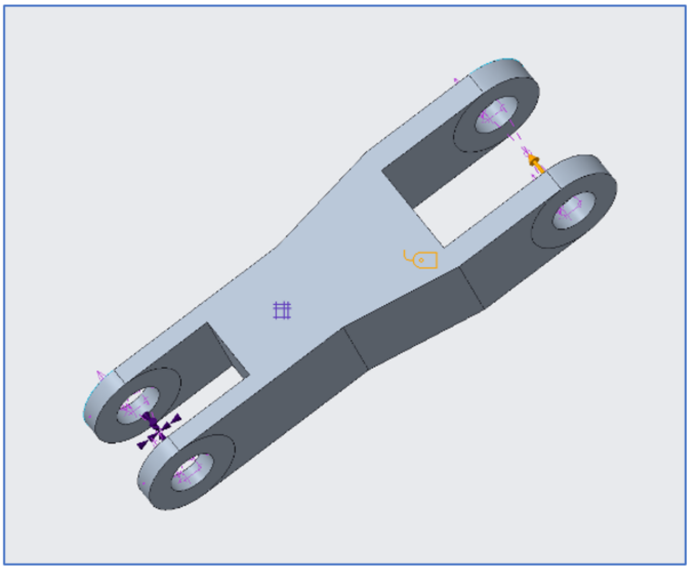
This topology optimization report was done for the Design for Additive Manufacturing course at Aalto University.

Parameters utilized: The mesh size was 5 mm, and the load was 26 kN in the Y-direction Fixed constraint. The points in the intersection between the center line of the holes and the mid-plane. Rigid links between the points and the inner surfaces of the holes. Original mass from the part: 1,84 kg.

Optimized Mass: 1,27 kg, Reduction: 0,57 kg, 31% weight reduction

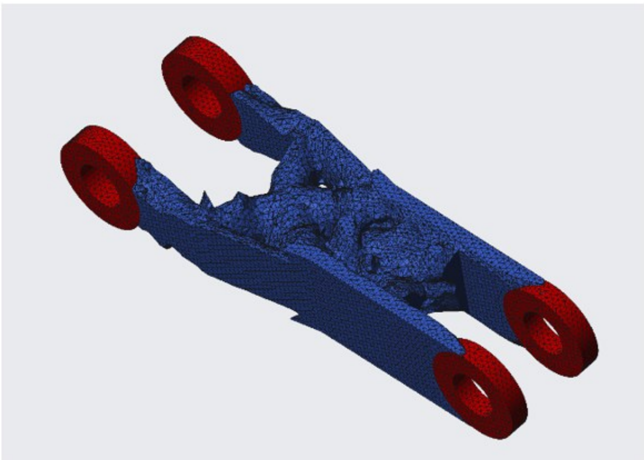


Load Parameters for the Topology optimization

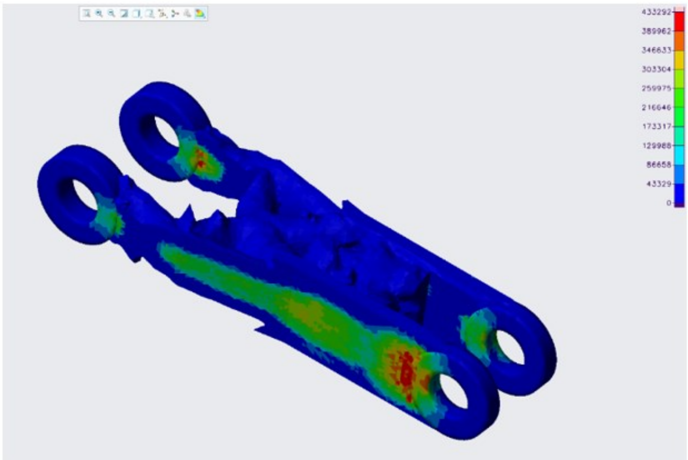


Direction of the forces in CREO

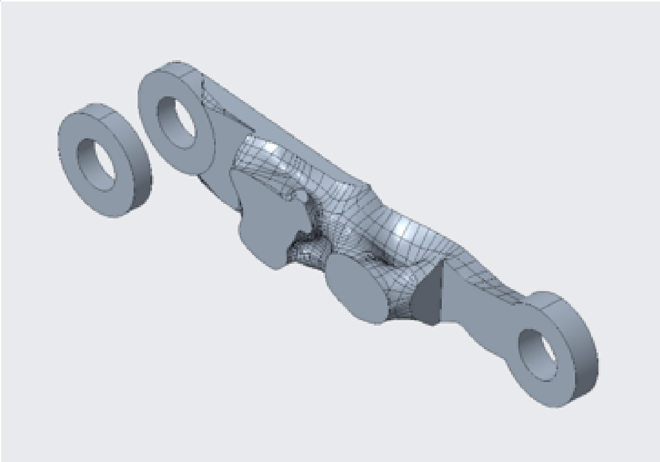
Resutls



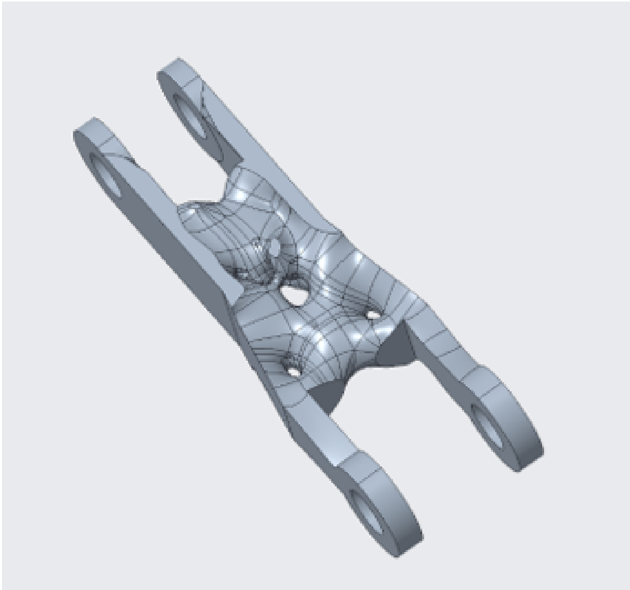
Settings: Density Subsurface 0.15."Smear" function.



Stress levels after the optimization. Maximum 433 MPa.

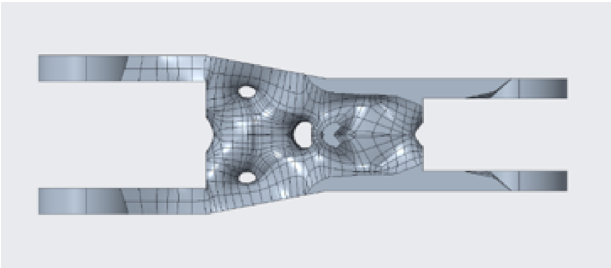


Solid part cut in half

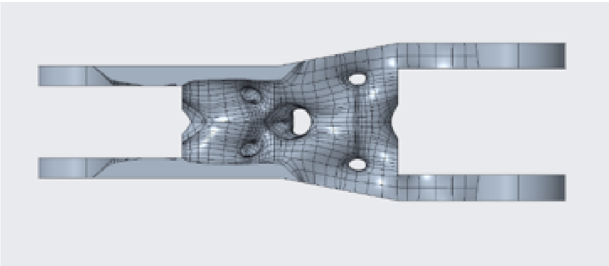


The optimized part turned in to a solid body

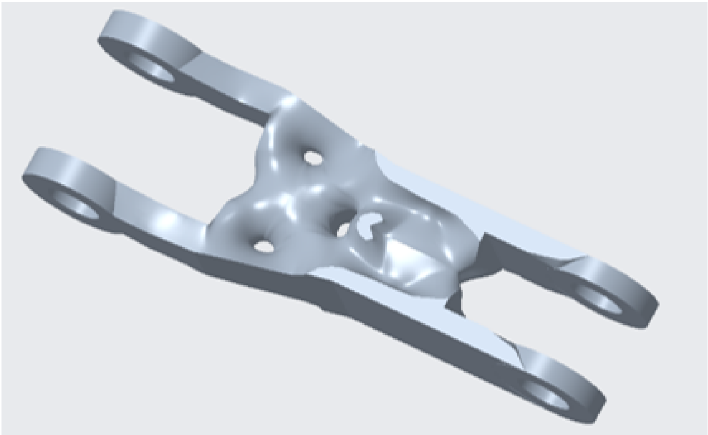
The part is displayed, after the the smoothing has happened.



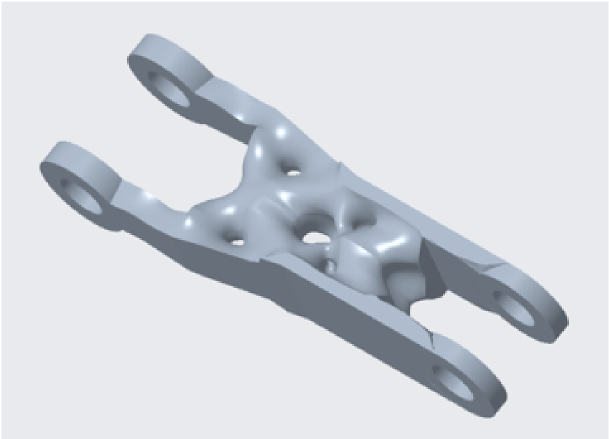
Mirrored body, top side



Mirrored body, bottom side



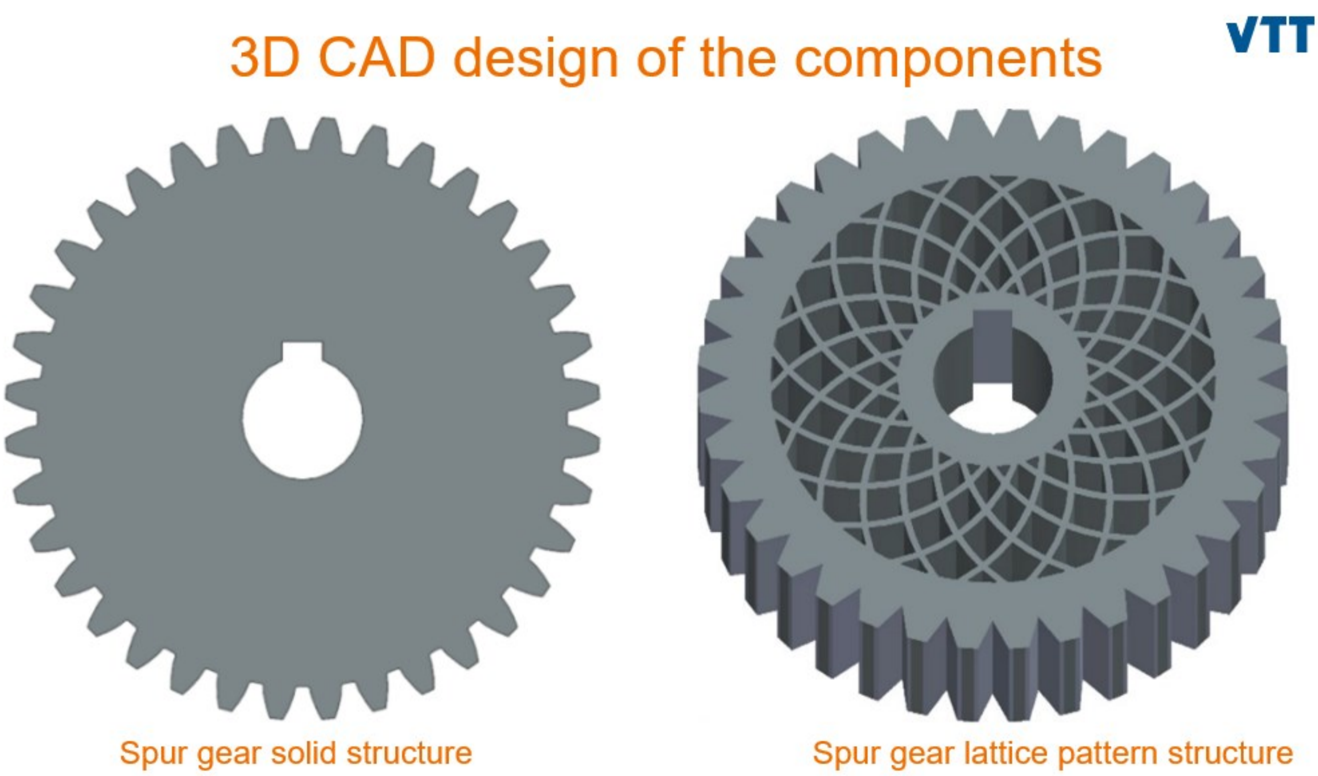
Mirrored top side



Mirrored bottom side

CAD of Lattice pattern spur gear for weight reduction and PBF metal 3D printing

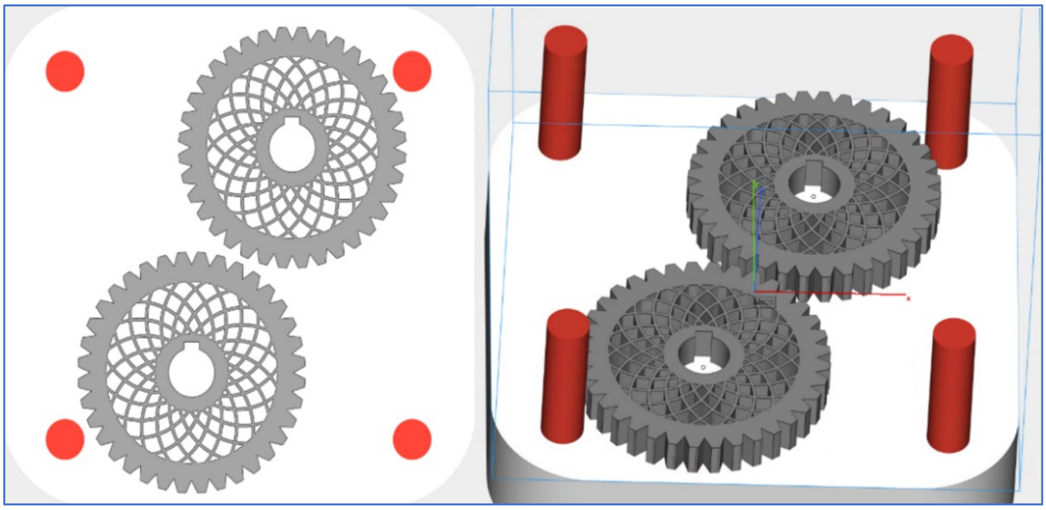
Master thesis work:



This is the gear I manufactured with Oulu University's help to decide the tooth path according to what tools they have available at the machining shop. The lattice gear was designed in Solidworks and aimed to reduce the weight of the component.

Lattice pattern spur gear build preparation

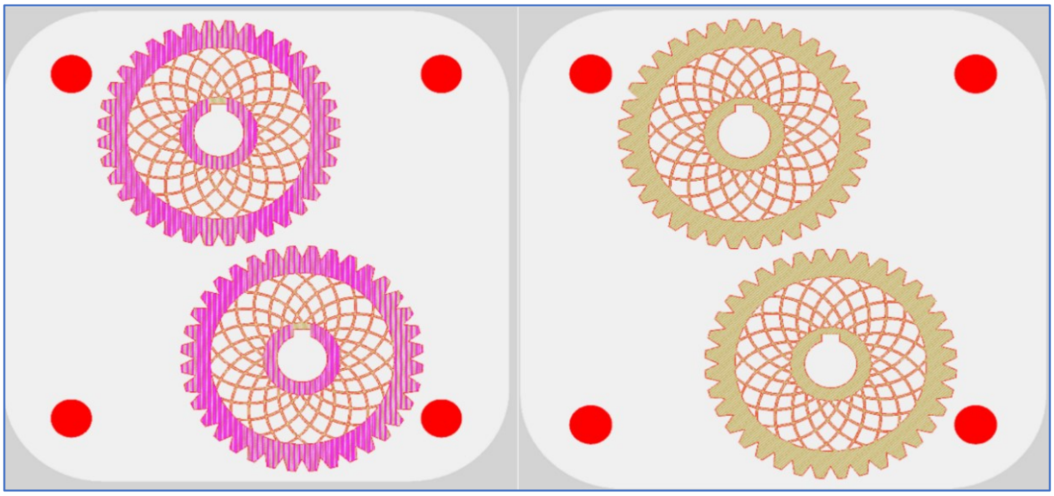
The following image shows lattice pattern gear inside Magics Materialize software. Due to the diameter of the spur gear, only two were fitted in the build plate. As a result, the printing orientation was "flat," so no support was needed.



Lattice pattern gear in Magics Materialize.

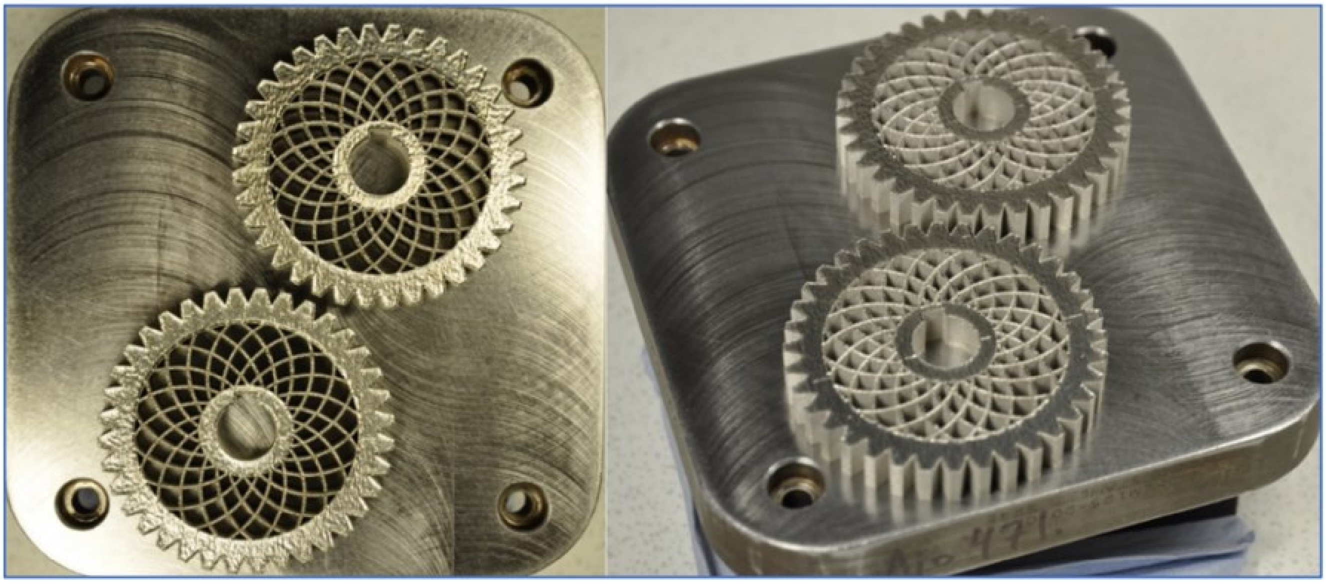
SLM Slicer Viewer software

The following figure shows the lattice pattern gear in SLM slicer viewer software. The image on the right side shows the first layer printed. The image on the left shows the last final layer printed in pink. Some color differences in the previous layer are due to issues in the vector generation in the software.



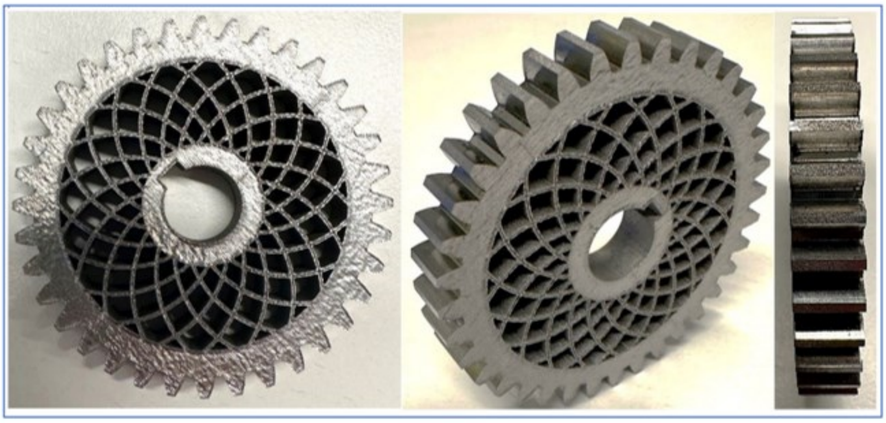
Lattice pattern gear in the SLM Slicer viewer.

3D printed lattice pattern spur gear for weight reduction



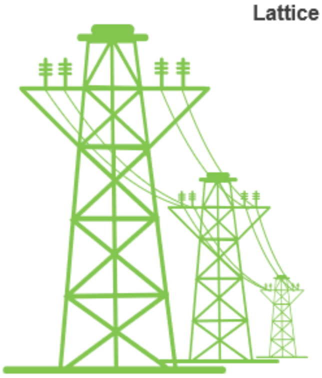
Metal 3D printed gears in Powder Bed Fusion SLM 125 HL system

The gears are printed on top of the build platform after metal 3D printed in Powder Bed Fusion SLM 125 HL system with Stainless Steel 316 L. This print was made at VTT advanced manufacturing laboratory in Otaniemi, Espoo, Finland.



I designed the spur gear and the Lattice gear in Solidworks. The spur gear solid was made at Oulu University for the Greef project.

Results from Master thesis: CNC machining vs PBF metal 3D printing of the spur gear



Lattice gear in PBF had a greater energy consumption than the solid gear in CNC by **3.3 times**

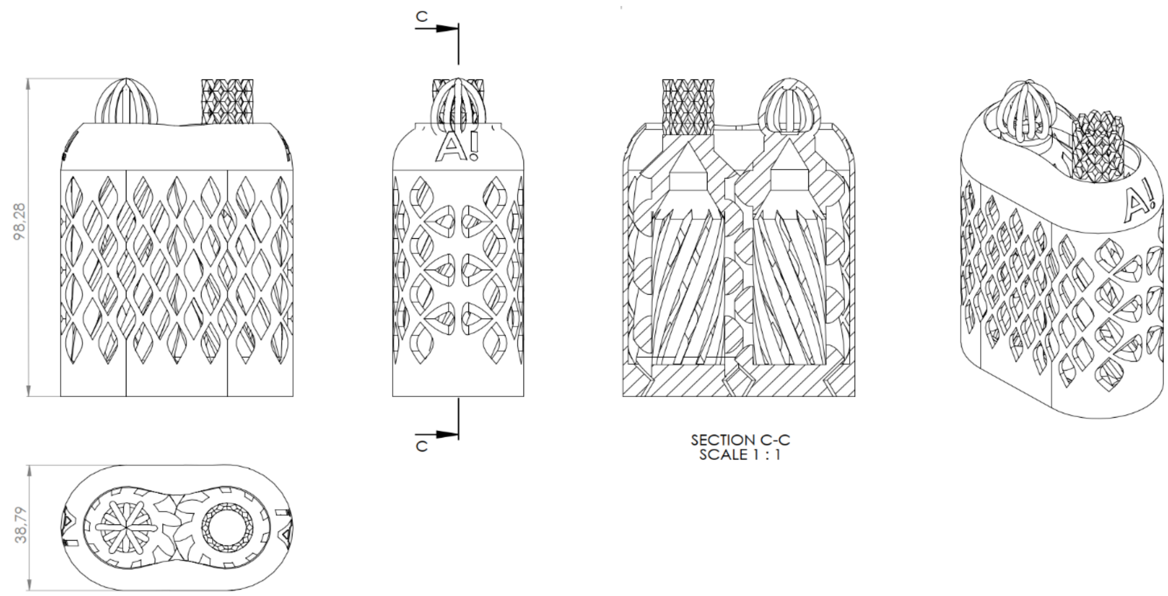
Lattice gear in PBF vs solid gear in CNC had a reduction of weight of **40%**

Lattice gear in PBF vs solid gear in CNC had higher waste of material of **69%**

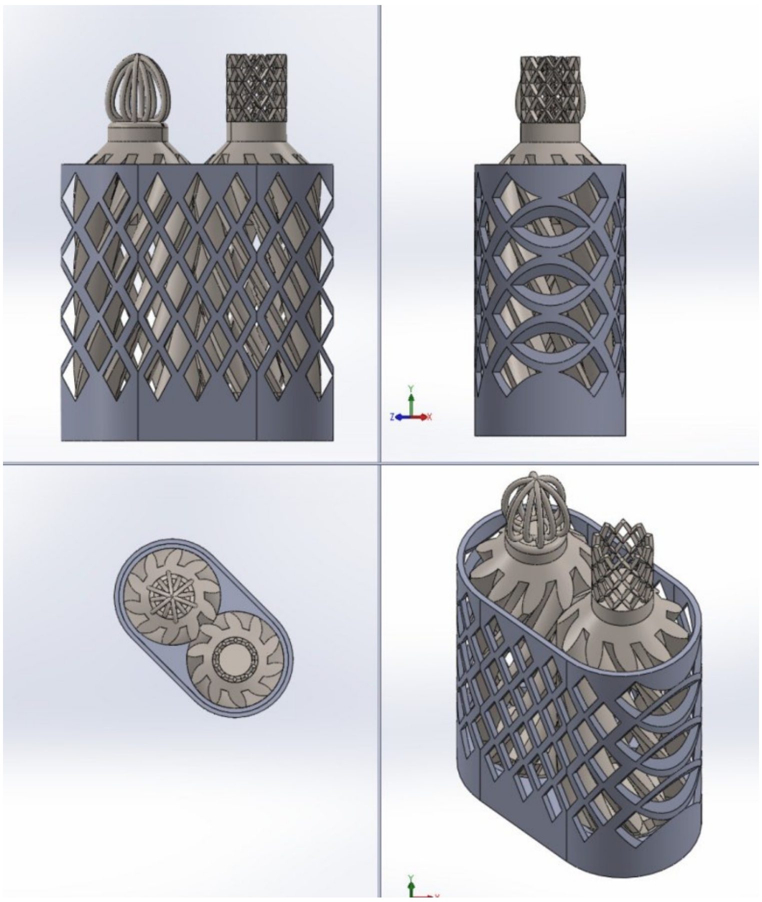
Energy consumption from the PBF machine that came from the laser was **40%**

Advanced Manufacturing course at Aalto University

Design with no support for the printing means that the angles relative to the printing bed are significant and were considered throughout the piece. No post-processing was allowed, and the designs were printed in a single print. The plan contains some of the elements suggested by the teaching team, such as moving parts and lattice structure, including features that would not be easily achieved with conventional manufacturing methods.



Design overview from the 3D CAD design finished.



Design in SolidWorks view

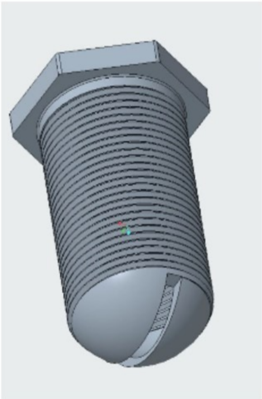
Screw design for Ensto Oy at Product Development Project at Aalto University

These designs were investigated further according to their cost and manufacturability point of aspect, and further discussion about the functionality of the screw tips was performed. After these designs, some of the ideas were dropped, and some were modified for testing.

Teeth screw

The idea behind the teeth screw is that the screw would "bite" itself into the conductor cable, ensuring tight clamping to the connector.

Collapsible screw

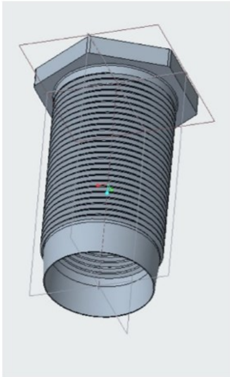


This screw deforms around the conductor, resulting in a higher contact surface to the conductor, which decreases the electrical resistance between screw and conductor and ensures that all the conductor strands are pressed towards the connector body.

Archimedes screw

Archimedes screw has a sharp tip, with Archimedes type thread going around the tip with a large pitch and constant distance from the rotational axis of the screw.

Hollow screw

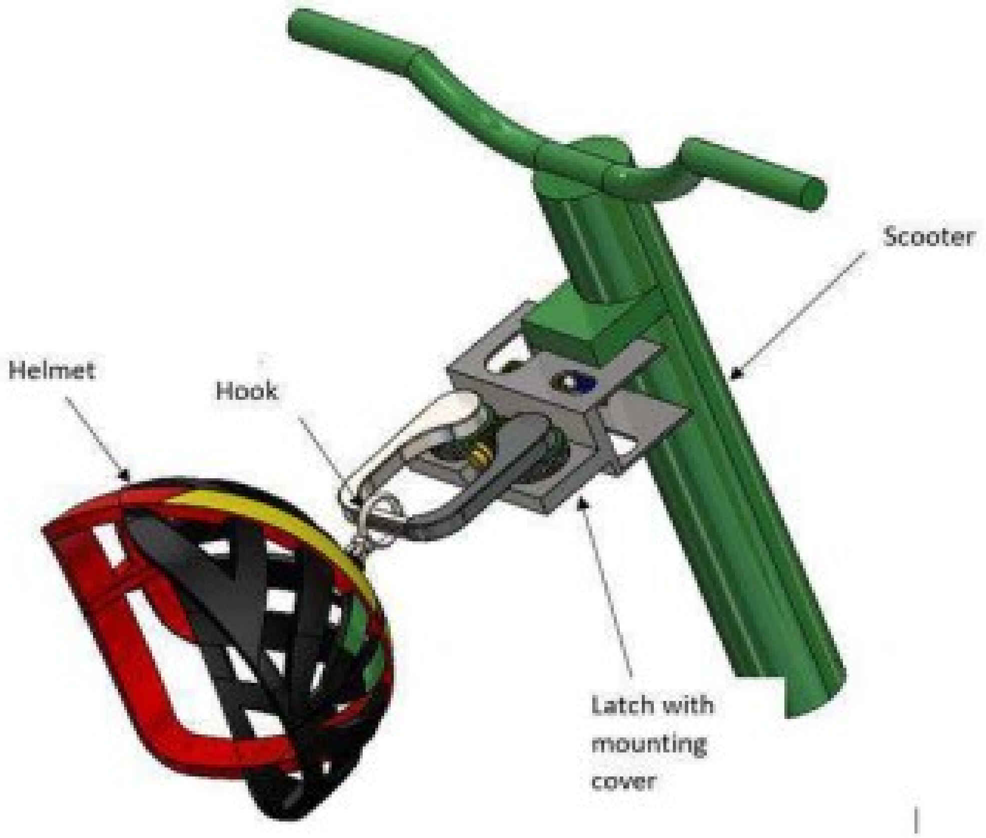


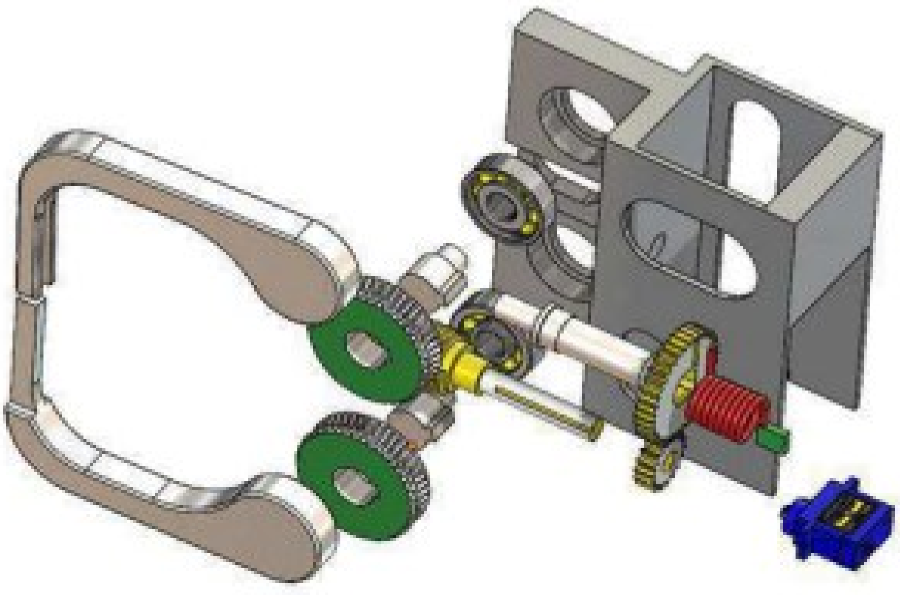
The hollow screw has a hollow cut to the tip. The inside and outside threads are not manufactured to the tip to ensure that the strands would not rise with the thread as the screw is tightened.

First iteration of screws prototypes manufactured with CNC lathe.

During the Product Development Project course, I took part in the material selection analysis and study and the ideation of these mechanical designs with the study of the mechanics of materials. At the end of the project, I became the team's project manager for the PDP final Gala.

Machine design course at Aalto University Latch Mechanism for E-scooters

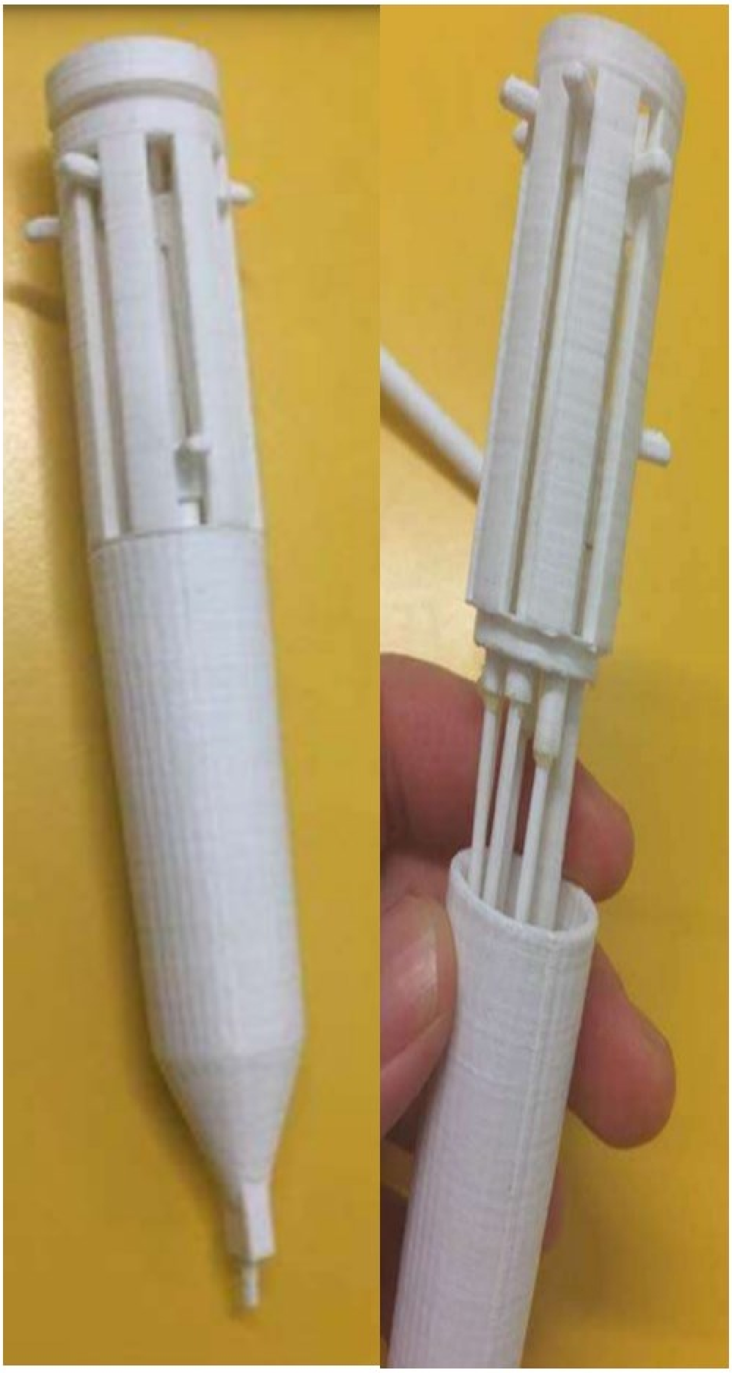


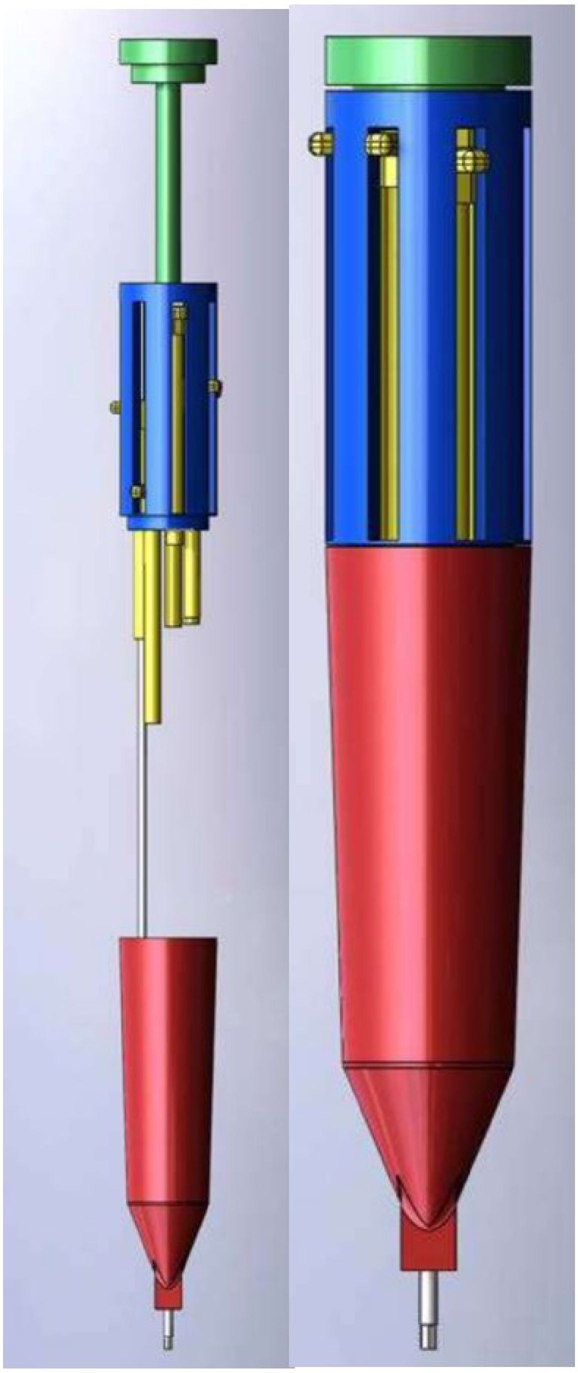


For this course, I was part of designing and assembling this latch mechanism for the E-scooters. I also acted as a project coordinator within the engineering student team at Aalto University. The idea is that the hooks open and close to keep the helmet attached to the scooter.

Multi-screwdriver for Advanced Manufacturing course at Arcada University

In this course, I was part of the design and ideation, 3D printing of all the features, and prototype assembly. As a result, the prototype was functional and worked as a proof of concept, and our team won the competition for an advanced manufacturing course.



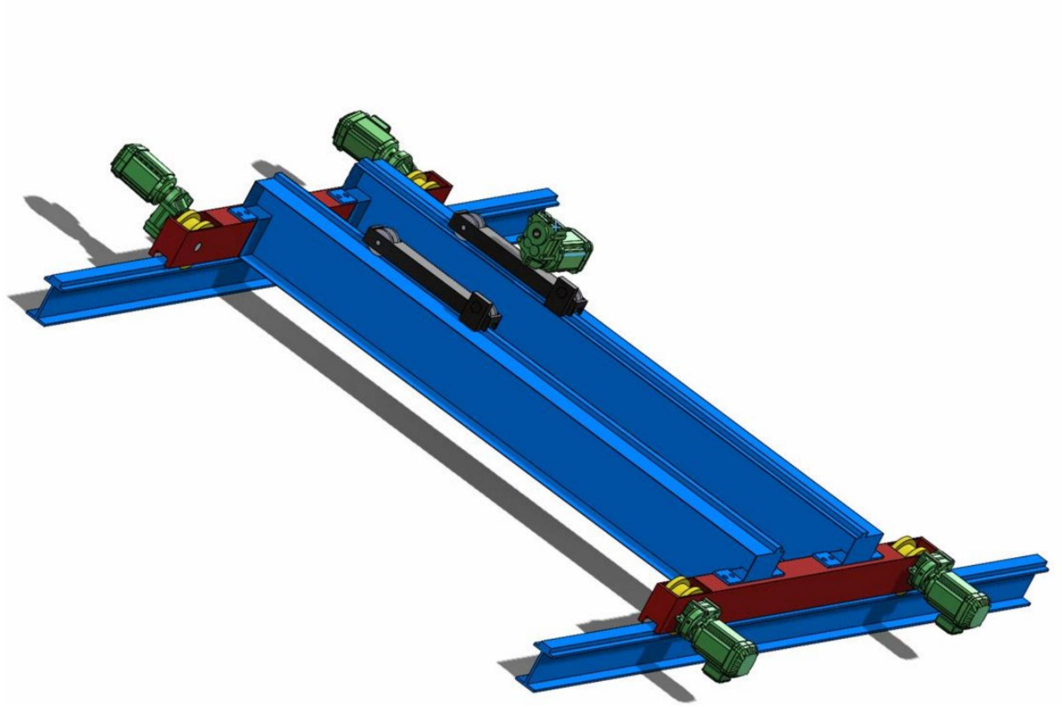


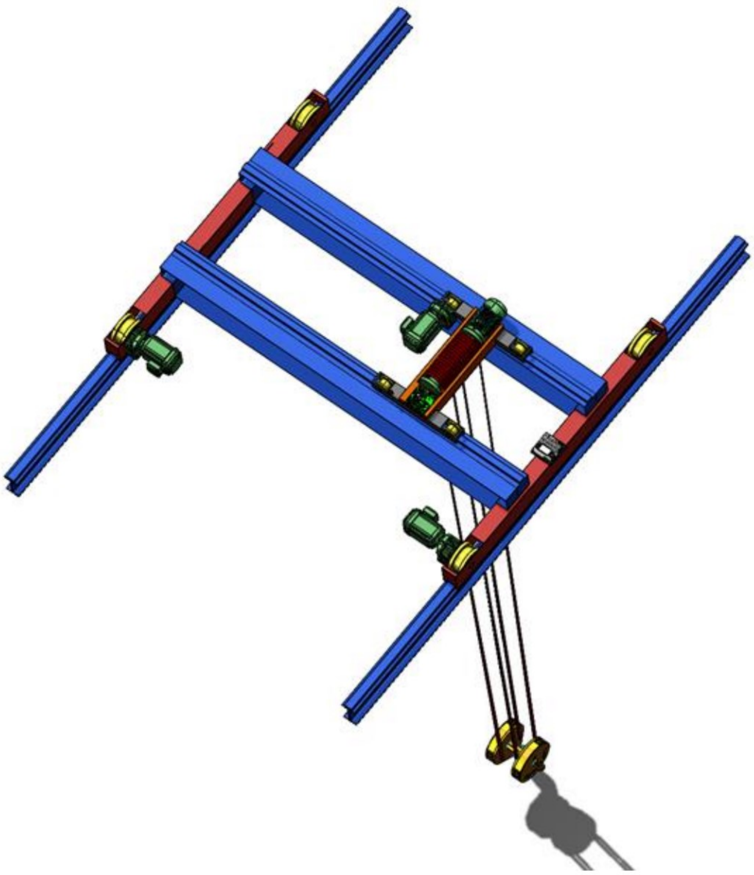
Mountainboard design for Product Modelling course at Arcada University

This design was part of a product modeling course (5 Credits). The CAD was done by following the tutorial in Solidworks pdf for the mountainboard.

Mechatronics Machine Design Project at Aalto University

Crane hook sway simulation and control design.

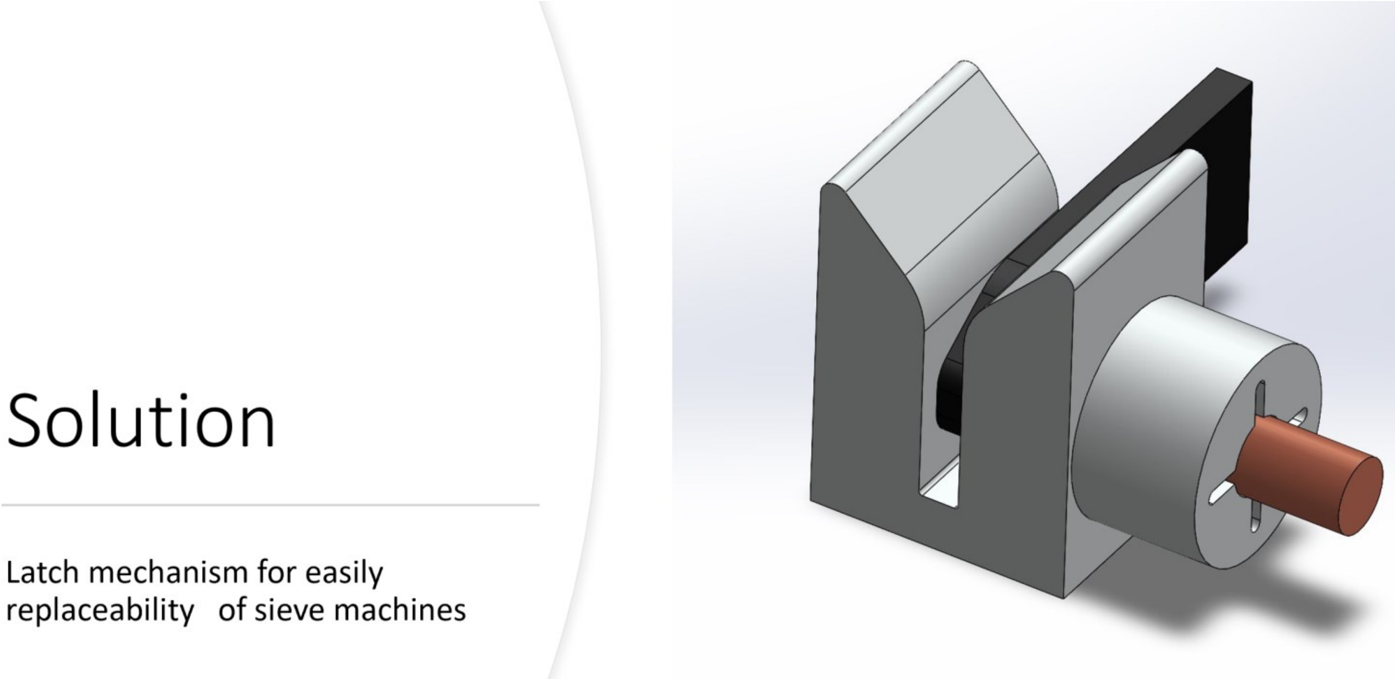


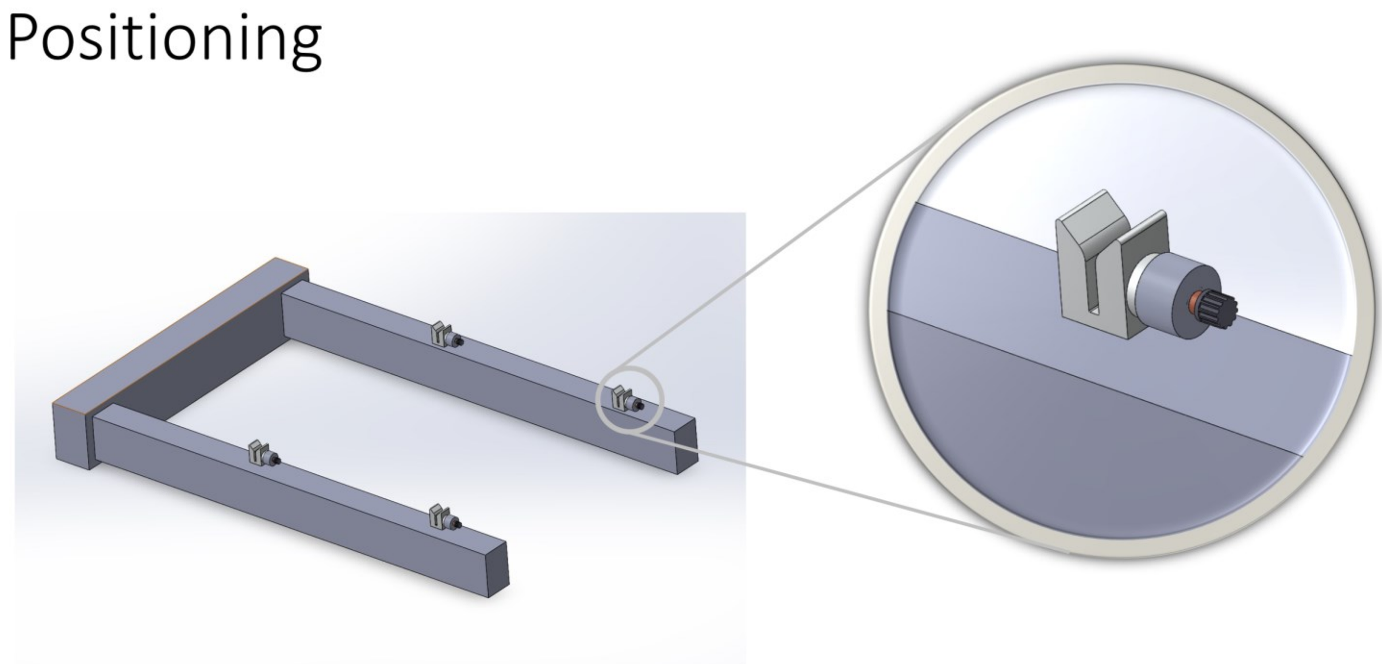


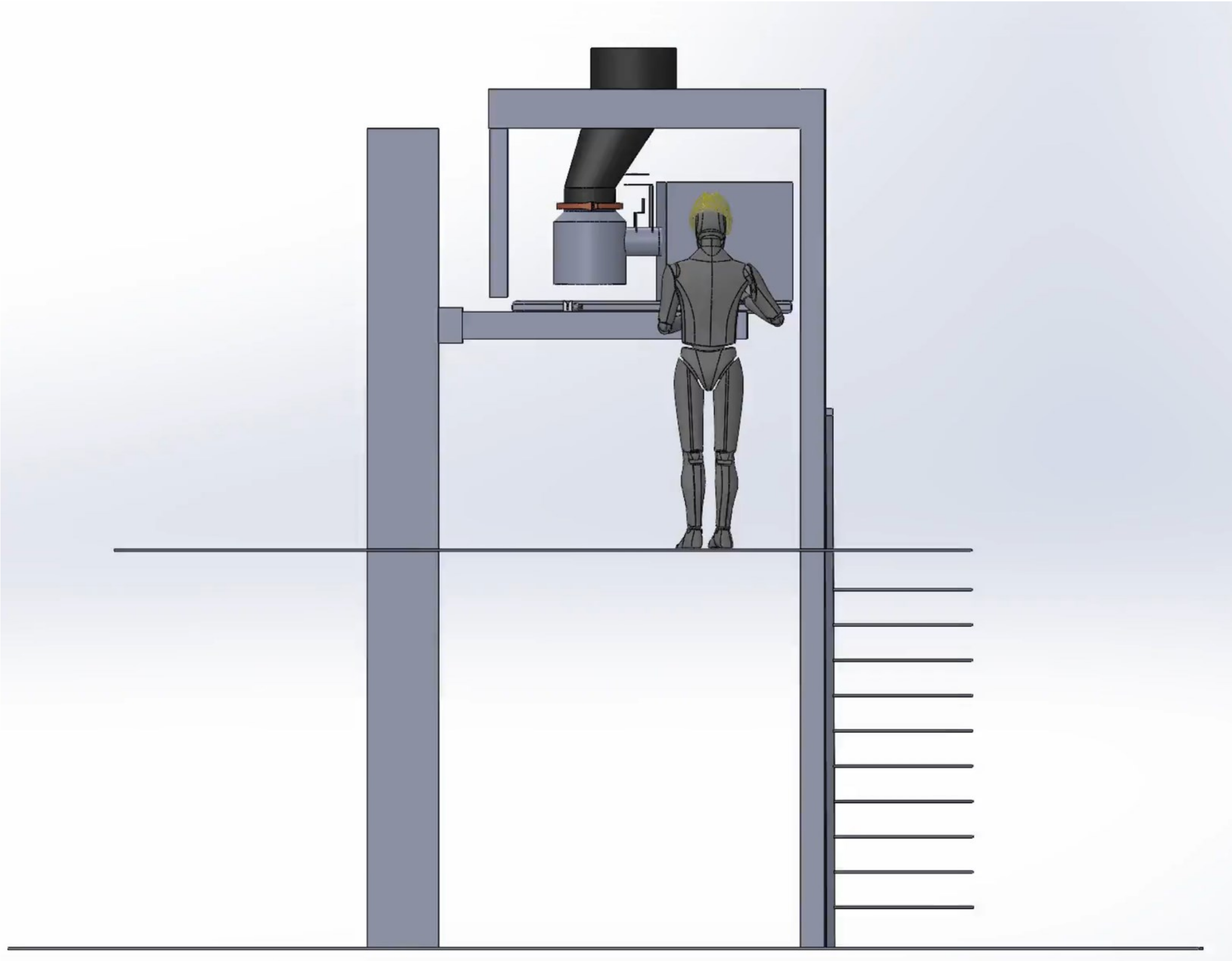
In this course, I designed the crane in SolidWorks and added SEW motors as IMU sensors to simulate the hook sway control.

Mechanical design for Orion Oy, Industrial project course at Aalto University

At the Industrial Project, I was the contact person between my team and Orion company and acted as project manager. We visited the Orion screening room 5 times to take dimensions and designed all the screening rooms in SolidWorks. The final solution was a latch mechanism that saved Orion 1 hour each time they must change the sieve machines.







The screening room at Orion Oy with new cone design and a new latch design for a Quadro sieve machine.

The new cone was also designed in SolidWorks to fit the tight dimensions of their screening room. Finally, Orion liked our latch design, and they were kin to proceed with the idea.