

Dansk
AM Hub

presents

DfAM

Design for Additive Manufacturing

Business cases from a 3D printing
design course with 15 Danish SMEs

DfAM - Design for Additive Manufacturing

DfAM - or Design for Additive Manufacturing - is a design innovation course with 15 Danish SMEs that is facilitated by Danish AM Hub in collaboration with Danish Technological Institute.

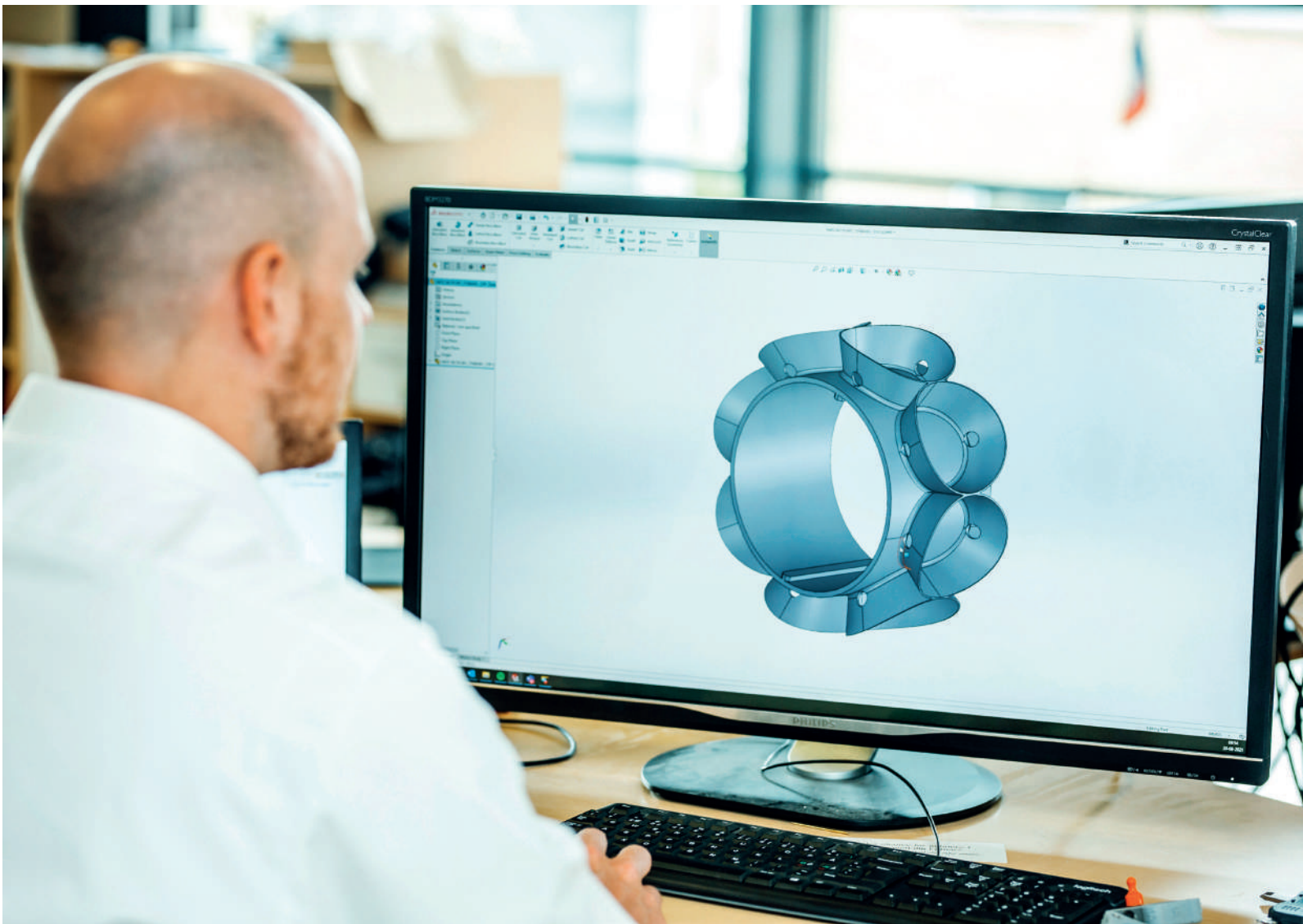
This design course is focused on spreading knowledge about 3D printing and the design principles used for the technology via concrete case examples from 15 Danish SMEs. Furthermore, the goal is to enable Danish companies to exploit the technical and business opportunities that the technology provides.

Traditionally, 3D printing has been used for prototyping. But the technology contains a wide range of other possibilities. 3D printing can also be advantageously used for, e.g., pilot and small series production, and the manufacture of fixtures and auxiliary tools, injection molding tools, and spare parts.

DfAM is initiated by Danish AM Hub and managed by Danish Technological Institute. In addition, the partners PLM Group, Hexagon and WikiFactory have contributed.

The DfAM course has been running from April 2022 until August 2022.





Case 1

Airflight



CHALLENGE

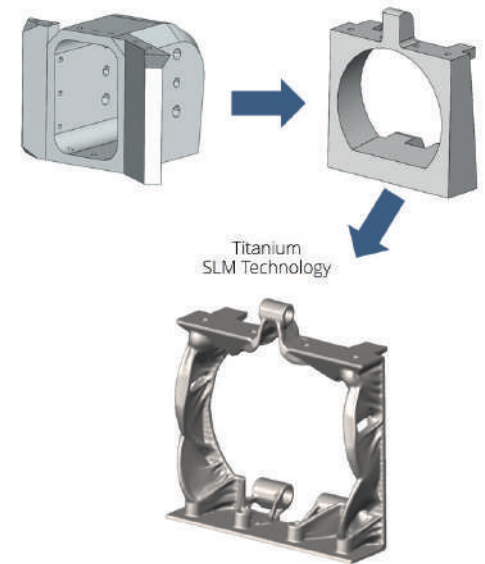
Make a hinge for a drone arm as strong and light as possible.
The Drone has 8 arms should have a 200 kg carry capacity
The part should also be easier to assemble and operate

SOLUTION

Redesigning the part and using topology optimization to make it light and still withstand the opposite loads in flight and on the ground. Even though the material was changed from aluminium to titanium, the part got lighter.

RESULTS

Material & technology: Titanium (SLM 3D print)
Weight reduction: 1,36 kg pr. hinge / 10,9 kg pr. drone / 67 %
Price increase: 68 %



Case 2

BenBen



CHALLENGE

Make it possible to create more complicated and lightweight titanium bike parts, which are not possible to create in a traditional way.
Create a new design of a seat post head which is lightweight, strong, unique and fits to the design of BenBen bikes.

SOLUTION

Additive Manufacturing makes it possible to create complicated titanium designs unique designs which is not possible to manufacture in other ways.
Topology optimized design helps reducing the use of material and therefore lowering the manufacturing cost.

RESULTS

Material & technology: Aluminum & Titanium (SLM)
Leadtime: 10 working days
Design freedom: High
Most parts were only possible with AM



Case 3

BEWI



CHALLENGE

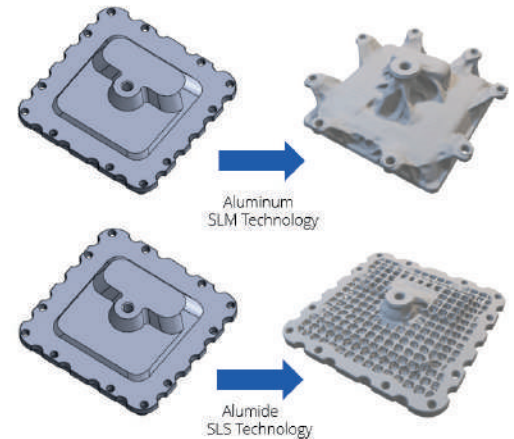
Creating more complicated mold designs in a quality and price level that is competitive with traditional manufacturing technologies.

SOLUTION

Additive Manufacturing makes it possible to create complicated designs and reduce the number of components from 3 to 1. Topology optimization helps reduce the use of materials and therefore lowering the manufacturing costs.

RESULTS

Material & technology:	Aluminum (SLM 3D print)	Alumide (SLS 3D print)
Weight reduction:	74%	68%
Price reduction:	53%	80%
Lead time reduction:	25 %	25%
Design freedom	Very high	Very high



Case 4

CPHi Holding

CHALLENGE

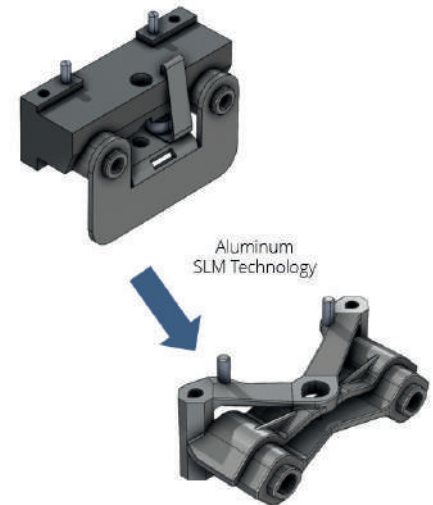
The challenge is to design a new version of a fixture in aluminum with lower manufacturing costs. The original part was machined from all sides to add geometry and holes for mounting components. To reduce assembly time/cost, it is important to combine the fixture and some of the surrounding parts into one.

SOLUTION

8 parts is consolidated into 2 parts, which are optimized to fit as many parts as possible on a platform, have the least amount of material to withstand the loads. With more parts consolidated into 2 the assembly should be easier. With additive manufacturing it was not possible to reduce the cost of the parts and assembly.

RESULTS

Material & technology:	Aluminum (SLM 3D print)
Number of consolidated parts:	from 8 to 2
Weight reduction:	64 %
Price increase:	313 %



Case 5

CeramicSpeed



CHALLENGE

Design a new exclusive and strong cage for pulley wheels in titanium with a special design, that use the design freedom of additive manufacturing.

SOLUTION

Additive Manufacturing makes it possible to create complicated titanium designs. In this case features like lattice structures was used, to make it lightweight compared to solid print, look special and still have high strength. To make the part more exclusive, the material was changed from polymer to titanium. On the 3D printed version, the shaft and cage is the same material resulting in easier reuse.

RESULTS

Material & technology:	Titanium (SLM 3D print)
Weight increase:	188 %
Volume reduction:	43 %
Design freedom:	High



Case 6

Dantech Dynamics



CHALLENGE

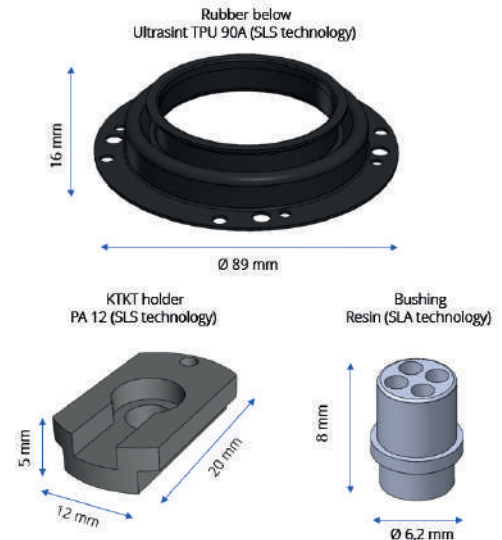
Introducing and testing new materials in SLS and SLA technology.
Reducing costs of existing components with additive manufacturing.

SOLUTION

Using TPU, which is a rubber-like material, as an alternative to injection moulding EPDM shore 50, creates new design possibilities. Compared to CNC machining, using SLS has lowered the unit price significantly.
Printing the bushing in SLA increases the resolution compared to the chosen conventional method.

RESULTS

Material & technology: PA12 & TPU (SLS 3D print) + Resin (SLA 3D print)
Price reduction: 76% on PA12 parts
Tolerance: Approved



Case 7

High Precision Systems



CHALLENGE

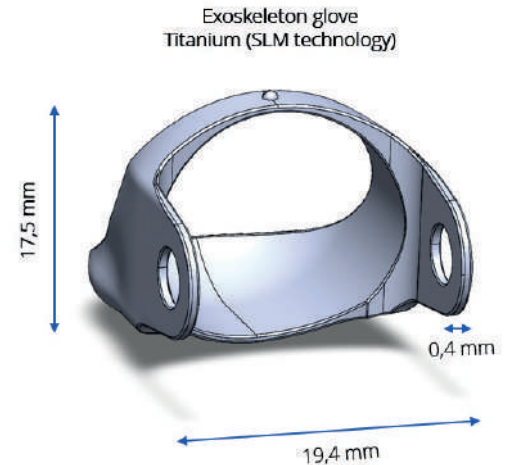
Achieving the most slender design possible without losing stiffness by using metal 3D printing.
Reducing unit price and time spent on preparation of the designs.

SOLUTION

Lowering the wall thickness in increments from 0.8mm to 0.4mm resulted in a slender design with improved functionality and it has lowered the unit price.
Challenging the limits of metal 3D printing regarding thin structures.

RESULTS

Material & technology:	Titanium (SLM 3D print)
Wall thickness:	Reduced from 0.8 mm - after 0.4 mm
Weight reduction:	44% on specific parts
Print price reduction:	6%



Case 8

KK Wind Solutions



CHALLENGE

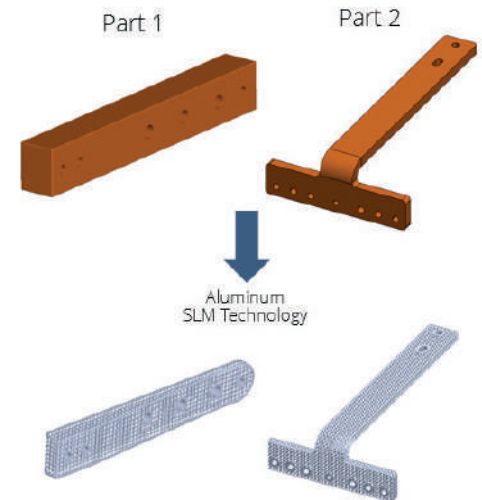
Investigate if it is possible to 3D-print busbars for high voltages application in Aluminium. Busbars are made from copper to have good thermal conductivity, but Copper is expensive to 3D-print. It's hard to get efficient cooling with other materials than copper

SOLUTION

Redesigning two different busbars using gyroid structures to increase the surface area as much as possible. The material is changed from copper to aluminum, but with the increased surface area, it is expected to have a similar conductivity as copper because of the enhanced cooling.

RESULTS

Material & technology:	Aluminium (SLM 3D print)
Weight reduction:	Part 1 = 96% - Part 2 = 91%
Surface area increase:	Part 1 = 129% - Part 2 = 165%
Price increase:	Part 1 = 317% - Part 2 = 497%
Electric conductivity:	To be determined



Case 9

Anonymous

CHALLENGE

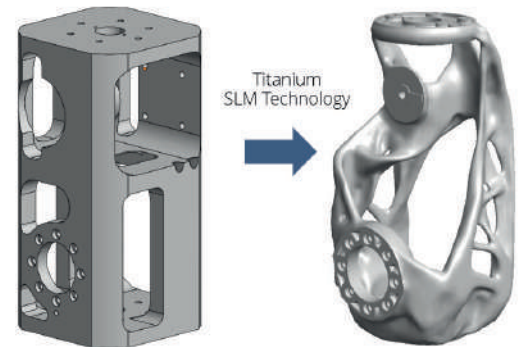
Make it possible to create a stronger and lighter design of the cradle, which can withstand the loads that the part are exposed to. It is not allowed to change any holes and surfaces for mounting and the weight must be as close to the rotational axis as possible.

SOLUTION

Additive manufacturing tools like generative design and topology optimization that designs the part to be able to withstand the added loads and boundaries were used to create the new design. Even though the material was changed from aluminum to titanium, the part got lighter and stronger.

RESULTS

Material & technology:	Titanium (SLM 3D print)
Weight reduction:	43 %
Price increase:	200 %
Strength increase:	130 %



Case 10

Linattech



CHALLENGE

Create a lightweight cover, for a machine that rotates with 300 rpm and with a high stiffness so that it doesn't deform under use. Every machine has four of these parts installed.

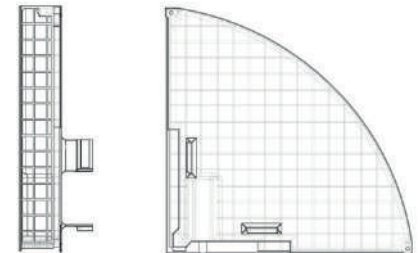
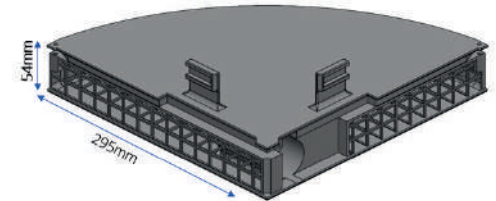
SOLUTION

3D-printed part with SLS technology in PA12 powder. The part is made hollow and filled with a lattice structure. This is a new developed part, so 3D printing is the main production technology from the start of the development.

RESULTS

Printed as one part with built-in snap joints

Weight reduction:	81%
Price reduced:	42,8%
Energy saved each pr. year:	638 Watt
Kinetics Energy needed to rotate the part, reduced:	328 Ws



Case 11

Newtec

NEWTEC

CHALLENGE

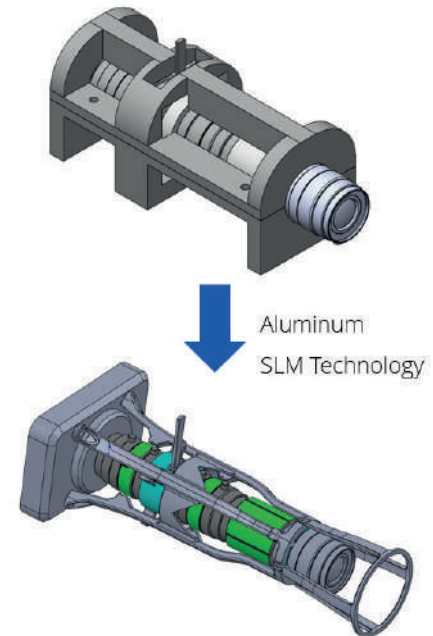
Create a lightweight and rigid cage for a special optical system with multiple components. The optical system will be attached to a camera on a drone which is why it must be lightweight. At the same time, the cage must be rigid to hold the optical system in place and protect it.

SOLUTION

Additive Manufacturing makes it possible to create complicated designs, lightweight and rigid structures with a material like aluminum, which were chosen for this challenge. The idea for the new design came from the Eiffel tower and was made with an open structure of hollow elements to have it lightweight, yet rigid and give the operator the opportunity to adjust settings on the lens.

RESULTS

Material & technology:	Aluminum (SLM 3D print)
Weight:	143 g
Volume reduction:	75,8 %
Strength increase:	794 %
Lead time:	10 working days



Case 12

Podovo



CHALLENGE

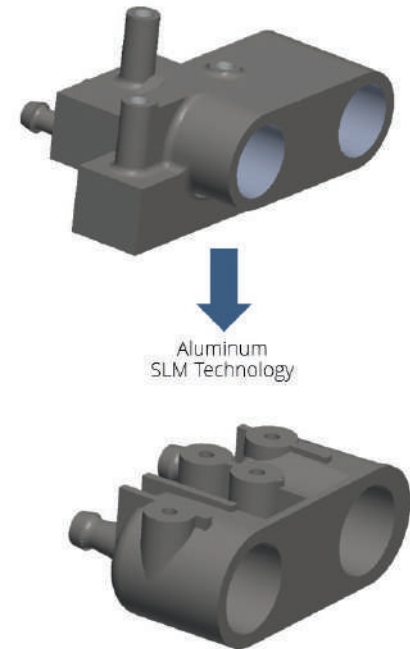
Make a manifold for respirator-related equipment
Price needs to be reduced as much as possible
Short lead time is vital

SOLUTION

Designing of 3D printing a smaller manifold in two weeks while waiting for the tools for injection moulding to be made.

RESULTS

Material & technology:	Aluminium (SLM 3D print)
Volume reduction:	7,5 cm ³
Lead time:	2 weeks
Price reduction:	38%



Case 13

Scan-Speak



CHALLENGE

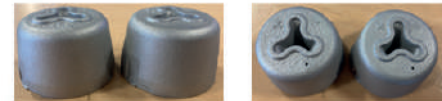
To discover which technologies and post processes that is needed to give the 3D printed parts the quality, that are suitable for Scan-speak products. If AM can provide an approved quality, Scan-speak will have a greater amount of design freedom for some parts, and will be able to make affordable small batches, when customization is needed.

SOLUTION

The original Scan-speak parts was printed 1:1 to test materials and post processes. Additive Manufacturing turned out to provide great results on tolerances and surfaces, with the right post process. For polymers deburring and vapor smoothing was used and for metals it was deburring and glass blasting. The MJ-F technology provides TPU as material, which gave Scan-speak the possibility to design dampening parts, that are easy to mount and fits perfect on their speakers.

RESULTS

Material & technology:	PA12 & TPU (SLS) & Aluminum (SLM)
Tolerances:	Approved
Surface:	Approved
Lead time:	10 working days



Case 14

Serman & Tipsmark



CHALLENGE

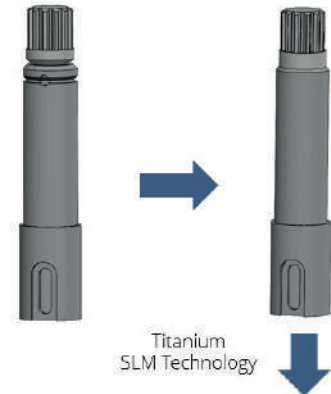
Explore the possibilities of using AM to make parts for hydraulic-testing systems
Long Lead Time
Expensive to produce

SOLUTION

Consolidating 3 part into one and using topology optimization to reduce the material needed as much as possible.
3 different loads were used to showcase the design possibilities

RESULTS

Material & technology:	Titanium (SLM 3D print)
Weight reduction:	Up to 79 % (Titanium)
Price reduction Titanium:	0%
Price reduction Aluminium:	32%



Case 15

Washpower



CHALLENGE

Make a more efficient solution with additive manufacturing to one of the parts on a machine for cleaning.

SOLUTION

Additive manufacturing makes it possible to create more complex shapes, which is used for the internal geometry of the part, to make it more efficient. A couple of different designs was tested, to verify which design was the best. At the same time 2 parts were consolidated into 1 part to reduce assembly and number of parts.

RESULTS

Material & technology:	Titanium (SLM 3D print)
Part reduction:	From 2 parts to 1 Part
Design Freedom:	Possibility to test exotic shapes
A patent application will be made based on the results	





The project is initiated by:



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