Finalists

purmundus challenge 2020

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Nadin Ram

Titanuim Skeleton

Description

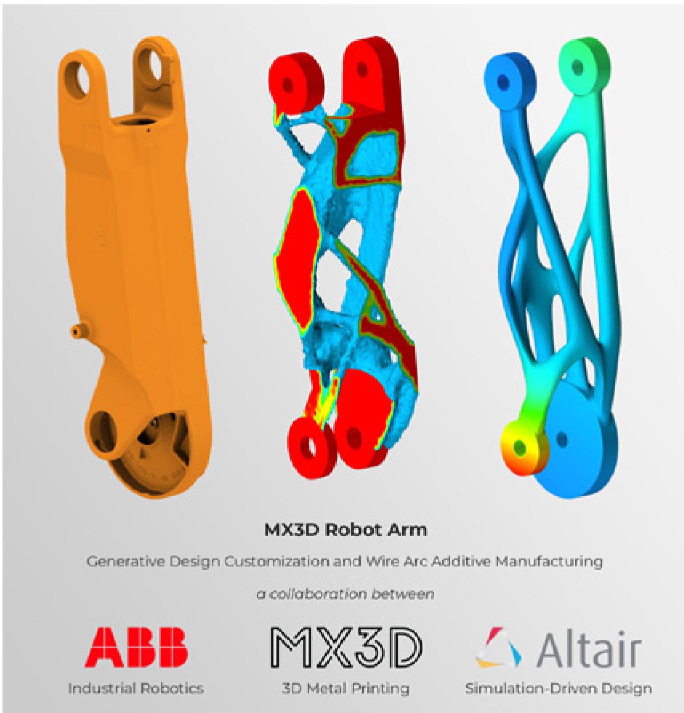
The 'skeleton look' in my heel shoe collection truly accentuates my fantasy of being 'born in heels' as they are the integral part of a woman's body. My collection uses anatomical and minimal structures which is printed in titanium for the purpose of 'lifting' and holding the foot in a high heel position. what connects between the foot and a titanium skeleton is an 'anatomical foothold' of a printed polymer that's transparent to the human foot. The 'tailor made foothold' is mechanically separated into the titanium skeleton which can be replaced and exchanged to different colors, textures,or customizations in the sense of a soft and hard feel.

Materials: Titanium Ti-6Al-4V, polymer PLA
Technology: Electron Beam Melting SYS

The project is a collaboration with the Israeli Institute of Metals, the Technion.

MX3D I Altair I ABB I Thomas Van Glabeke I Mirko Bromberger I Jaideep Bangal I Tony Gray I Michael Wawrzinek I Richard van Dam I Cas Nieuwland I Max Peek I Martin van der Have I Gino Seesing

MX3D Robot Arm



Description

Metal 3D printing company MX3D has printed an optimized industrial robot arm, designed by engineers at Altair for a robot supplied by ABB. This project is an application of large-scale 3D metal printing for Heavy Equipment Parts, with the goal of customizing and optimizing the robot arm for operational requirements and conditions. It shows the potential of using Generative Design Customization and a Digital Twin Design approach to increase productivity for tailored robotic applications. The stainless steel robot arm is fully 3D printed via Wire Arc Additive Manufacturing (WAAM) at >50% reduced weight compared to the original part.

The robot arm is re-designed by Altair engineers using Generative Design Customization to generate the most efficient shape and operational performance of the robot arm. Next to increased productivity, the robot arm was optimized for handling improvements (lower kinetic energy), higher precision and build rates via the Digital Twin Design process. This process included performance requirement identification via kinematic motion simulation of assemblies. Generative design was applied to create new designs with geometric efficiencies derived from the topology concept which were then compared and validated on the grounds of performance and manufacturing feasibility.

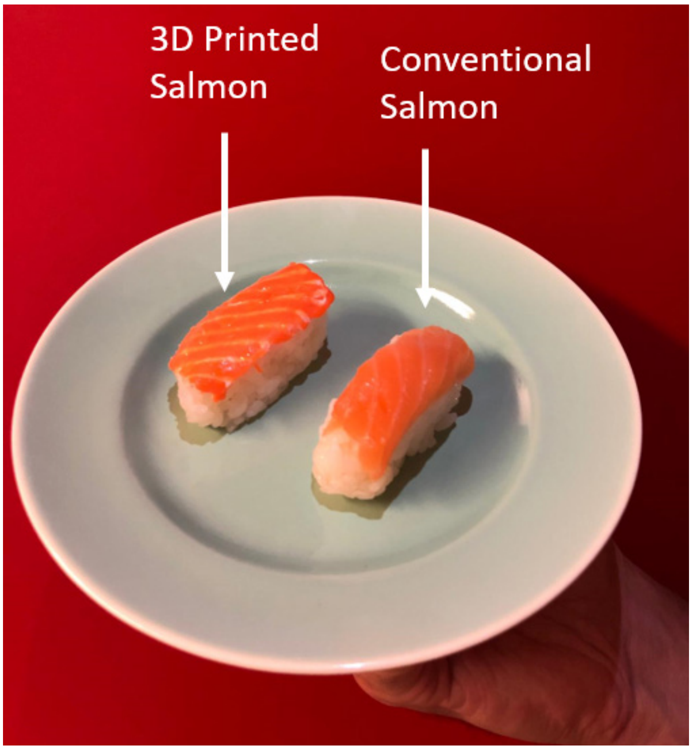
The robot arm is fully 3D printed in stainless steel using an advanced version of MX3D's WAAM technology. This technology features advanced geometry processing which allows complex organic geometries to be printed upright. Intelligent algorithms also determine the optimal printing strategy and toolpath direction for each geometry feature, ensuring the part is built up efficiently. While the original part was 150 kg, the generative robot arm weighs only 73 kg, resulting in >50% material weight reduction. With 24/7 production, the print can be performed in 4 days. The part is finished by a standard 3-axis milling machine to achieve the right tolerances at the connecting points.

The large scale optimised part was first presented to the public back in November 2019, just before installation. After a pause in the project due to the corona crisis, the installation of the optimised part in the original industrial robot has now successfully been completed by the project team.

The Robot Arm project now covers the complete process, starting from disassembly, reverse engineering, optimising, printing, finishing and finally assembling and using the robot. The goal of the joint project was to enable the manufacturing of customized replacement parts. This allows for rapid and automated production of large-scale parts that normally require extensive tooling and overseas production, causing long lead times and limited customization options. Equipment manufacturers and sellers now have the possibility to manufacture spare parts in-house, without the need for an external casting and milling company.

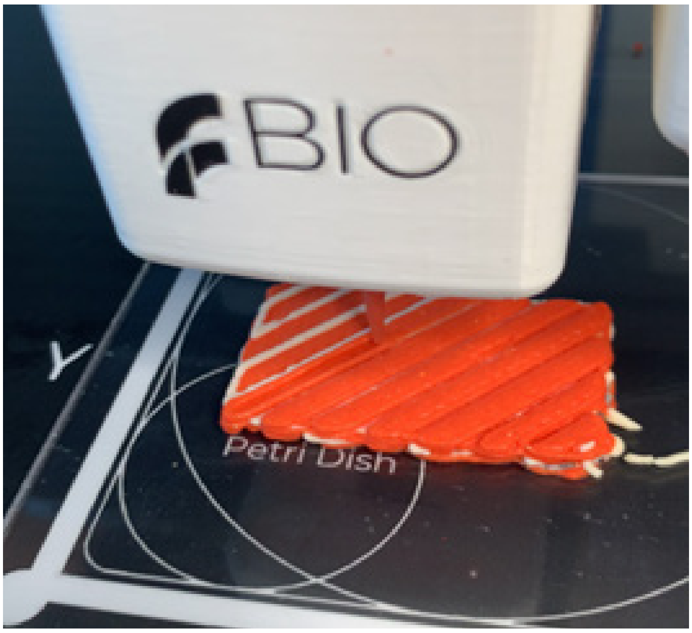
Legendary Salmon

Plant-based Sushi, produced by 3D Food Printing



The way we produce food is about to be disrupted by 3D Food Printing. Legendary Vish develops 3D printed fish and sushi from plant proteins, such as mushroom or algae. We utilize a double print-head setup to recreate the shape and the distinct appearance of salmon fillets. With this design, we want to appeal to environmentally conscious consumers, who like to consume seafood without accepting the detrimental effects of overfishing, destruction of the marine ecosystem and high intensity aquaculture. As part of the Industry 4.0, we promote short supply chains and localized, flexible production. For a highly traded product such as seafood (>50% of all seafood is produced in China and Indonesia), this is an essential criteria to reduce the environmental footprint of food supply chains. The main challenge of our product design is the recreation of the fibrous texture of meat, which is responsible for the characteristic mouthfeel and taste of the final product. While salmon is our first product, we plan to commercialize also tuna, yellowtails and the European bass.

By using plant proteins, our products can be produced with up to 95% less green house gas emission and up to 90% less energy usage compared to conventional seafood. Only with 3D Food Printing, it is possible to recreate the full structure of complex products such as salmon fillet, which cannot be produced with more traditional food processing methods. Therefor, 3D Printing is at the core of our technological development. Living in harmony with our planet and with respect to its resources is what drives our mission.



Francois Hurtaud Design I François Hurtaud

Eva

Meaning life, Eva is a modern aquaponics furniture

The waste of the fish, ammoniac, is pumped up to the garden where the substratum of roots of the plants break down the ammoniac into nitrates and nitrites. The former feed the plants and the latter become food in return for the fish.

The earliest example of this technology is believed to be the Aztecs, who raised plants on rafts on the surface of a lake in 1,000 A.D. Aquaponics is a highly sustainable method of agriculture, increasing crop production per square foot versus traditional farming with low water and low power consumption.

Eva was designed so that the different parts simply dovetail with one another and let gravity do the work, no tools are required. Both the garden and the fishtank share a commun source of light, floating at the very core of the product. The frosted finishing combined with the extruded facets serve at optimizing the light diffusion. Mimicking a natural environment, the light switches on and off softly at dawn and dusk.

Eva finds its place in restaurants, hotels, schools or offices. It is a guarantee of fresh food, a place of gathering, a light source full of life.

Eva was engineered thoughtfully with the strict minimum parts involved, combining composants of the same material and avoiding the use of more than two different materials. The aquarium and the garden are printed in photosensitive resin while the base is produced glass reinforced concrete.

3D printing technology allows for great accuracy of complex forms with zero waste during production compared to injection moulding. The glass reinforced concrete provides great strength and stability to carry the weight it bears with the water and the soil.

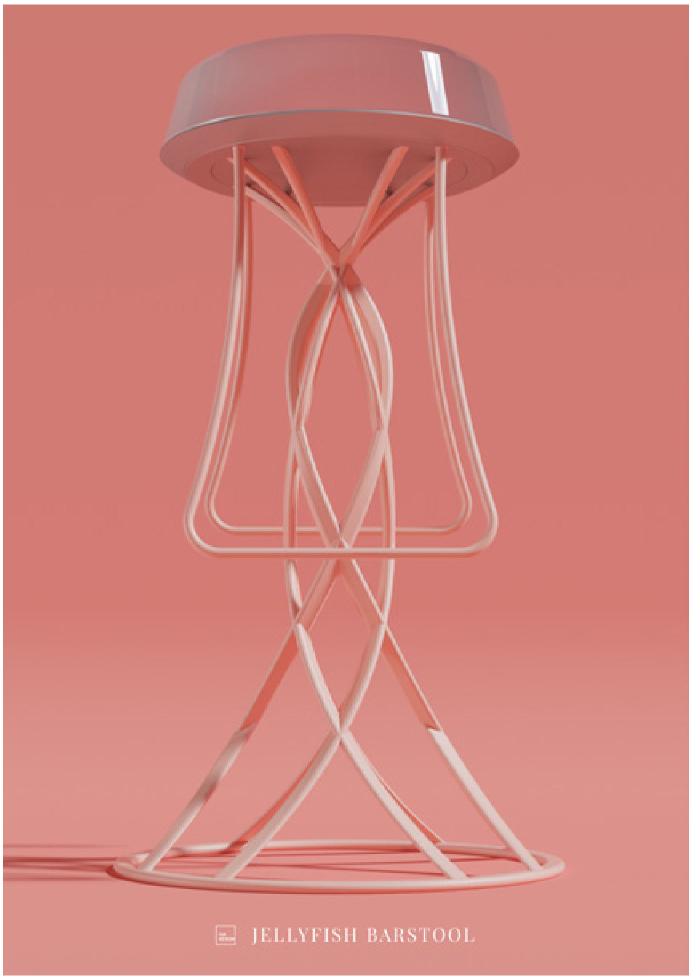
Eva was designed to be assembled quickly and easily. The different parts simply dovetail with one another and let gravity do the work, no tools are required. Deliberately meant to have no front, no back and no sides, Eva is to experience at 360 degrees. Both the garden and the aquarium share a commun source of light, floating at the very core of the product.

Eva comes with an app, which enables the user to control, time and automate the water pump, air pump, and the lighting. By default, in order to mimic a natural environment, the light switches on and off softly at dawn and dusk. Data fetched via sensors such as temperature, humidity, pH and light help the user to monitor its activity.

The choice of a frosted finishing serves two purposes. One is that the fish and plant appreciate is a subtle intimacy. The second is that the delicate texture combined with the extruded facets enhance the light diffusion. The fauna and flora as well as their observers enjoy a homogenous lighting all around.

The choice of white isn't insignificant. Insofar as white avoids color, and thus more strongly awakens physicality, it is materiality. The Chinese character for "white" is said to have developed from the hieroglyph for "skull". In ancient societies, the objects most naturally engraved as "white" in the consciousness of our ancestors were the bones, giving the impression of white as a trace of life.

Jellyfish Barstool

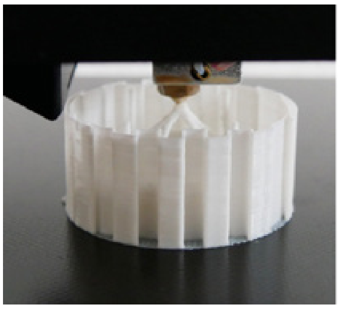


Inspired by nature

The jellyfish appears unreal with its transparent body, its long woven threads, which are in constant motion, as well as its extraordinary colors. These characteristic features result in a symphony of unique shape, color and optics, which are iconically implemented in the Jellyfish Barstool.

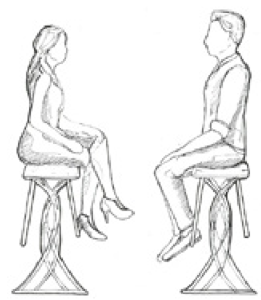
Advantages 3D print

In its organic structure, the Jellyfish Barstool relies on the advantages of 3D printing: the wide base does not allow the chair to tilt and requires seamless connections in the struts of the support structure. In the upper area, the crossing struts build on the stable layer structure in 3D printing, which fuses the individual struts centrally into one another and yet lets them appear individually. For the material, 3D filament made from recycled Ocean Plastic is to be used - a filament made of HDPE can already be obtained, whose dimensional stability and properties would be very well suited for production.



Ergonomics

The opposite footrests are attached to suit the different sizes of women and men. These are fixed on a circular rail, which can be easily rotated all around. The milky-transparent seat conveys another ergonomic aspect. True to nature, the soft silicone gel cushion has a natural suspension that adapts to the posterior and gently supports the lower back muscles with mild compensatory movements.



Sustainability

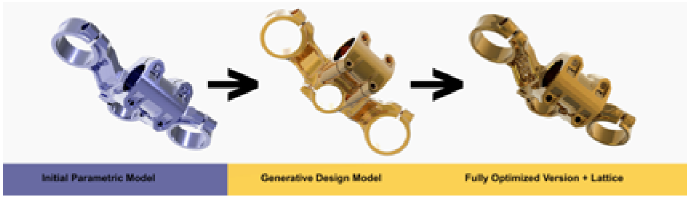
In order to draw attention to the worldwide phenomenon of coral bleaching, a symbolic sign of sustainability is set: the furniture is available in a natural color as well as in a completely white edition. Furthermore, the choice of its material is experimenting with the use of ocean plastic or recycled materials, such as the extraction of 3D printing filament from recycled plastics. Ultimately, however, this collection should show one thing above all: recycling design does not have to come in the typical eco-look, but can be presented in a stylish and modern way.

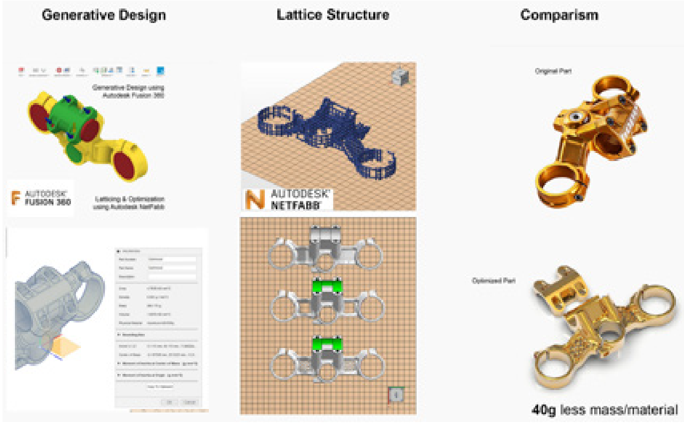
Dunamis Cognitio I Landmark University, Nigeria; Mechanical Engineering I Obasogie Okpamen I
Obasogie Ikponmwosa I Obasogie Osasumwen

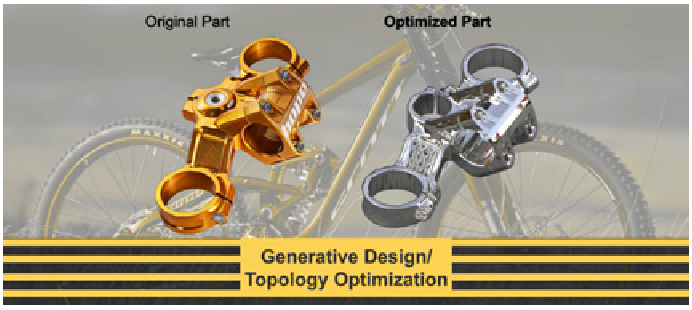
Hope Top Crown Stem Combo 31.8 for Fox 40

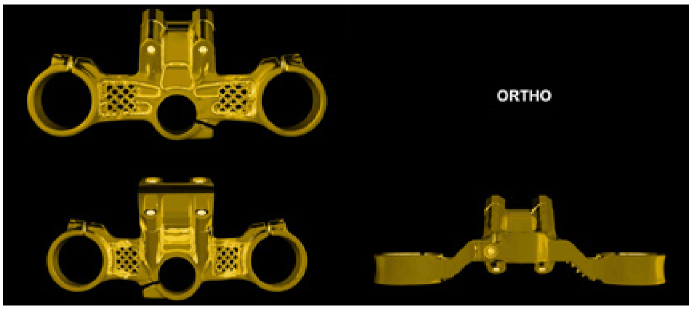
Description

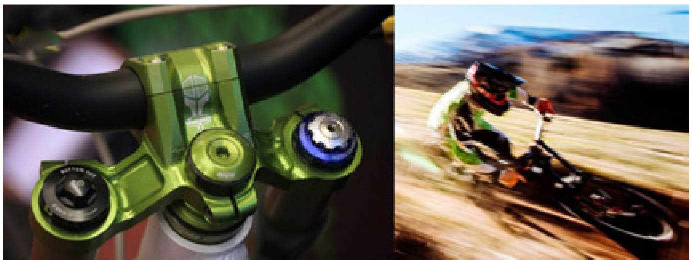
The Hope Top Crown Stern Combo 31.8 for Fox 40 by Hope Technology (IPCO) Ltd is a great piece for performance, strength, stiffness and style in mountain bike design! With Additive Manufacturing inclusive of #Generativedesign, Lattice Structures and all round topology optimization this part could be even better. This makes a case for the future of spare parts production using Additive Manufacturing.









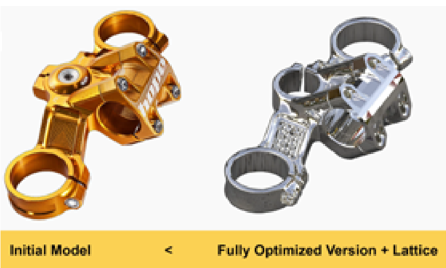


Details of Part:
- Handlebar clamp integrated into crown
- It is compatible with the 009 onwards FOX40 models

Manufacturing

This part was initially produced by CNC machining and crafted from a solid billet of 2014 T6 aluminium. The crown gives a 50mm reach whilst keeping the bars as low as possible.

With the new and Optimized design we achieve equal performance but with lesser material and a more aesthetic form by generative design and lattice structures both in the hollow shell of the part and in its exterior.



Results

Mass/Material Reduction:
14g from (302.57g to 259.43g)

Alexis Walsh I Justin Hattendorf

EXO COLLECTION

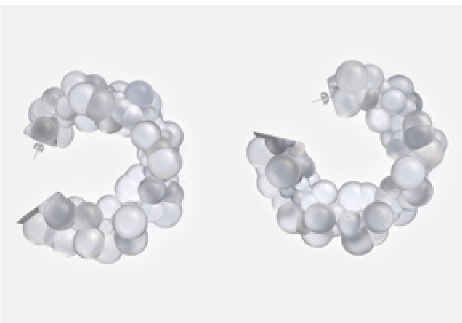
Description

EXO Collection is a fashion collaboration by Alexis Walsh and Justin Hattendorf merging code, handcraft, and fashion. Exploring the duo's signature 3D printed hardware, this collection is entirely hand-sewn and crafted locally in NYC. The 3D printed components are made using both biodegradable plant-based plastics and through zero-waste fabrication methods. The collection consists of three full looks, including five garments, jewelry, and accessories, and an AR filter that allows consumers to virtually try on the 3D printed jewelry.

The designs were developed with the brand's own proprietary custom software, designed to merge complex, precise digital models with the tactile nature of working by hand. The collection incorporates traditional craft with custom physics simulation to generate 3D printed hardware for garments and accessories; this design process marries handcrafted embellishment and generative digital form.

Once 3D printed, the translucent hardware is outfitted with brass threads and manually applied onto the garments. By integrating fashion design with 3D printing and virtual simulation, the designs are able to be quickly modeled, iterated on, produced, and assembled. The brand's custom software efficiently maps out complex hardware assemblies within a flat tailoring pattern to eliminate excess plastic and fabric waste. Through simulating how the hardware will physically interact with the body, the design prototypes can be generated and visualized digitally before manufacturing them.

Produced using sustainable materials and processes, EXO Collection utilizes virtual design to blur the boundary between our physical and digital identities.

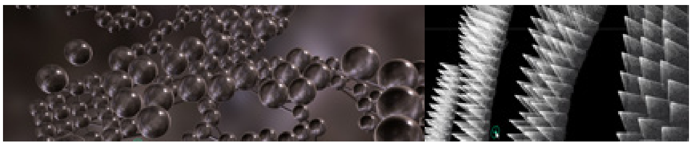


EXO Collection utilizes traditional fashion garments as the foundation for the collection. What makes the collection unique is the process in which the pieces are designed, assembled, and developed, and the blend between physical and digital environments. Though using traditional paper pattern pieces and cutting fabrics, the pattern shape is translated into a 3D model to place the hardware components. By uploading the pattern pieces digitally, the 3D printed hardware can be perfectly placed within the boundaries of the garment patterns, and can be customized to any size or level of visual complexity. This methodology helps to reduce fabric wastage and unnecessary labor by eliminating the need for producing physical iterations.

Unlike traditional fashion design, virtual design is boundless and sustainable. The garment hardware is created using a customized software that enables quick design iterations, through combining flat tailoring pattern pieces with 3D modeled hardware. By simulating concrete material boundaries within a virtual environment, any number of physically informed prototypes can be rendered in real-time without relying on manufacturing physical products. This allows for full design flexibility, so the pieces can be responsive to any range of sizes or design customizations, on-demand, while only producing physical designs when the final product is ready to be crafted.

Sustainable practices are critical to the design and construction of EXO Collection. The garment hardware, jewelry, and accessories are created through 3D printing in biodegradable plant-based plastics, and Selective Laser Sintering, a zero-waste 3D printing method. The garments are sewn and assembled by hand, made locally in NYC. The fabric pattern pieces are specially arranged to minimize fabric waste during pattern cutting and to utilize as much of the fabric as possible. The products are all made-to-order and printed on-demand. This business practice eliminates the need for stock and excess materials.

To augment the collection's 3D printed jewelry line, there is an Instagram AR filter so that consumers can try on the jewelry pieces before they buy. Because the designs are created completely within a virtual environment, the interactive experience of AR invites consumers to participate with physical designs in a virtual space as a seamless continuation of the design experience.



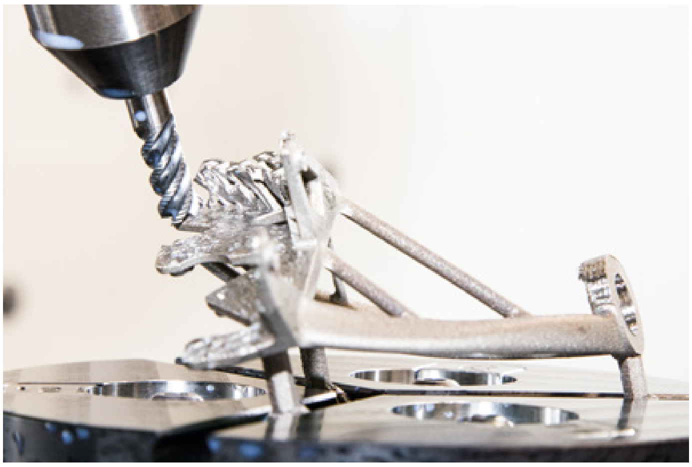
Alexis Walsh is a fashion designer and artist based in New York City. Through the exploration of emerging technologies including 3D printing and digital modeling, integrated with traditional handcraft, Alexis utilizes an interdisciplinary approach to push the boundaries of fashion design. Alexis graduated with honors from Parsons The New School for Design. Her work has been presented in runway shows and exhibitions in New York, Boston, Paris, London, Moscow, Madrid, Manila, Dusseldorf, Frankfurt and Berlin.

Justin Hattendorf is a multidisciplinary designer with work in architecture, product, fashion, and industrial design. His work aims to merge advanced digital techniques with intuitive, tactile processes for the creation of surreal objects and environments. Justin is a graduate of the Pratt Institute School of Architecture.

Alexis and Justin have been collaborating on fashion, jewelry, accessories and hardware design since 2017. They launched their new jewelry design studio JAW STUDIO in 2020.

ETH Zürich I Inspire AG I Gressel I Julian Ferchow I Marcel Schlüssel

Bolt it



Automated Post-Processing for Metal Additive Manufacturing

The BOLT-IT concepts enable an automated physical and digital post-process chain. BOLT-IT are universal interfaces, produced within the #additivemanufacturing (AM) process. They enable automated gripping and handling of the AM part. The position of the AM part is from the CAD known, so there is no need for referencing. In addition, robust machining with accessibility from five sides is made possible. A simple torsion removal of the interfaces completes the process. The project was conducted as part of an R&D collaboration between Inspire AG, ETH Zurich, and Gressel. The two-year project was funded by the innosuisse and headed by Julian Ferchow (Research Associate at Inspire AG, ETH Zurich) and Marcel Schlüssel (Head of Technology at Gressel).

A Video can be found here:
https://www.youtube.com/watch?v=i3TioiUHCOE&t=2s

HUHN cycles I Ralf Holleis

Moorhuhn Fahrradrahmen

Description

The Bicycle industry developed very quickly the last couple years, bikes got lighter and stiffer at the same time. Those great achievements where mainly possible with a composite material called Carbon fiber, unfortunate this material has a very high carbon footprint until the product is produced in addition carbon products have a very short Product lifecycle as there is a certain safety risk in using second hand or crashed Carbon Products.

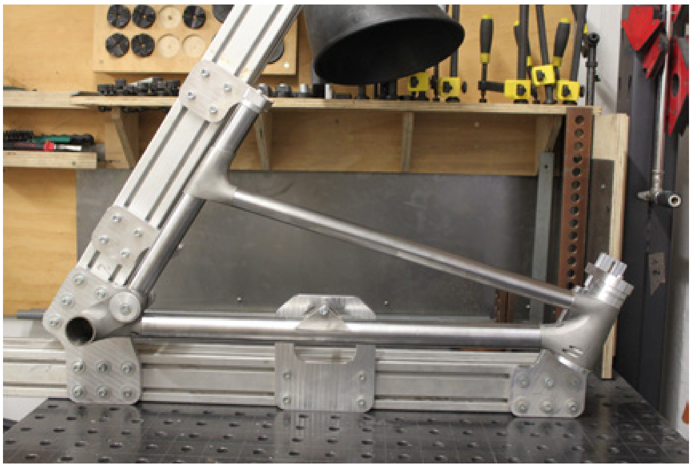
Sadly there are nearly no ways to recycle this composite Material, so most of the time Carbon frames end up in land field or get burned. Metal Recycles forever!

Titanium is a material that could complete with the advantages Carbon has for Bike-frame building, it is just very difficult to process therefore the design is very limited, functionally titanium frames feel a lot softer than Carbon frames due to their tube to tube welding connections.

The Moorhuhn combines the advantages of super light Titanium tubes and connects them with additive manufactured Lugs, this makes the joints extremely stiff as they can be designed according to the forces within a bicycle frame, and distributes them equally. The joints are super light and stiff at the same time as a lattice structure inside supports the super thin walls. Further more additive manufacturing makes it possible to produce each frame according to the needs of each individual as there are no tools required, functions like cable guiding, seat clamps, bearing housings as well as additional material for welding can be integrated in the design and make the life of the Framebuilder a lot easier.

But all that is very detailed and nerdy to summ it up shortly: Additive Manufacturing makes it possible to build modern titanium Mountainbikes which are as light and stiff as Carbon frames but additionally they are locally produced and can be custom fitted to its rider.

Most importantly the production process is a lot more environmentally friendly and Frames can be repaired as well as recycled. A modern Mountainbike should not be thrown on the Lend-field after 2 Years because it is not save to repair it. A Titanium Frame does not need Paint at all as there is no corrosion so even the finishing process involves no Chemicals and does not force the producer into health risky situations.



TU Braunschweig - Institut für Konstruktionstechnik | Dr. Hagen Watschke | Karl Hilbig |
Dr. Peter Hartogh | Prof. Dr. Thomas Vietor

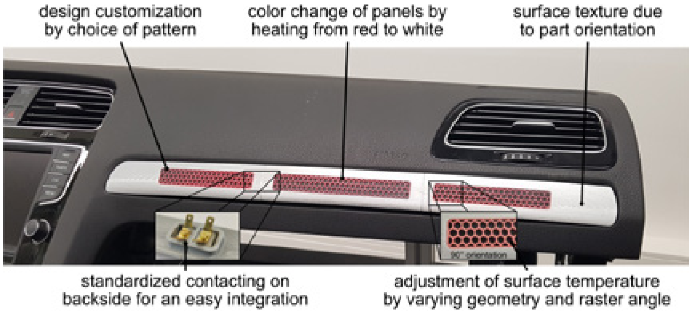
Integrated heating panels for efficient conformal temperature control

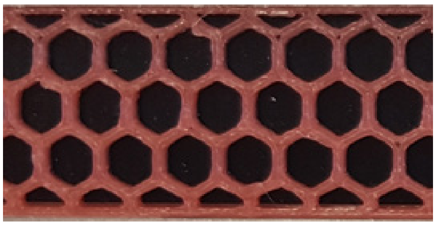
Garnish molding with integrated heating panels for efficient conformal temperature control and increased climate comfort in vehicle interiors

Additive manufacturing provides new design freedom for the integration of functions. Material specific functions e.g. electrical conductivity for heat generation can be integrated locally by using multi-material design and minimizing additional mounting or joining processes. The garnish molding demonstrates the potential for integration of additively manufactured panels for conformal heat generation by using multi-material design. Despite omitting of exhaust heat, efficient temperature control of the interior of battery electric vehicles is thus possible. The surface temperature of heating panels is set by the electrical resistance, which can be individually adjusted by varying geometry or process parameters.

The utilized material – a composite filled with carbon nanotubes – has a linear current-voltage characteristic that allows surface temperature to be controlled via voltage. A specific adjustment of the current-voltage characteristic is achieved by defining the electrical resistance through both geometry of the heating panel and process parameters like raster angle orientation. In this way, a required temperature can be set via geometry and process parameters as a function of a specified input voltage. At 12 V, approximately 45 °C is reached after 60 s and approximately 65 °C after 180 s respectively.

Thus, 3D printing provides an individual adjust-ment of the resulting electrical properties of the heating panels according to requirements by both, material choice and by geometry as well as process parameters. For an easy integration of the heating panels in automotive interiors – for example in dashboard, armrest, head-rest, seat or door –, a standardized electrical contacting on the back of the heating panels has been developed by using silver paste and a screw fixing. Surface textures and a honeycomb pattern as well as a thermochromic material, which undergoes a thermally induced color change from red to white, have been used as customizable design elements for the garnish mold and the heating panels, respectively. Besides the design function, the color change also provides a safety feature by visually indicating the warm surface.



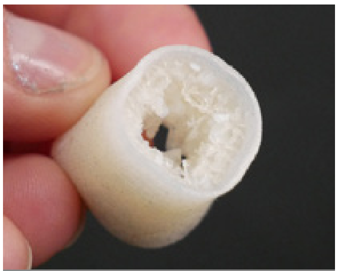


Victoria University of Wellington I Samantha Whitham

Printing People, Heterogeneous Multi-Property Printing of Humanoid Anatomics.

Finger, slightly bend

Recreation one, bent



Sixteen B, angled

Twenty-two, side bent

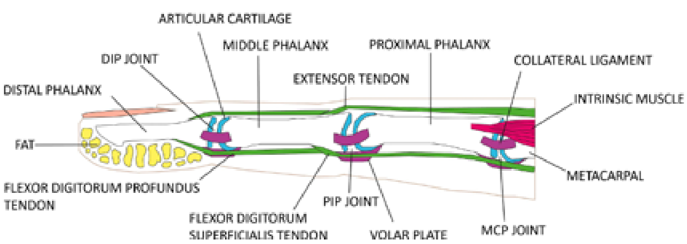
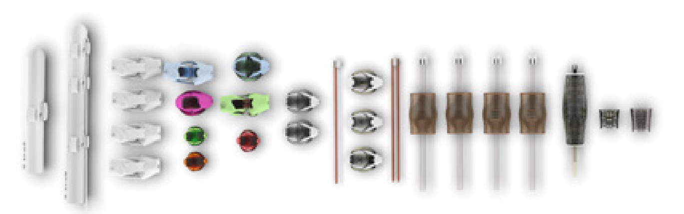


Diagram of finger anatomy



All tests, render

All tests, render

Description

Film and television (TV) have been a way to view unthinkable worlds for many years. Physical props are a fundamental part of many films as they help to portray the story in the real world, which results in a more believable experience for the audience. The technology used in the production of props and creatures has evolved with the changes in the manufacturing process to allow for more computer-controlled machinery. This begs the question; what could multi-property, 3D/4D printing bring to the way the film prop manufacturing industry creates physical props? Printing in the fourth dimension (dynamic) is a relatively new concept and is being researched by leading 3D printing companies. This area of study has yet to apply the four-dimensional (4D) capabilities of multi-property printing to the creation of heterogeneous humanoid anatomic's.

Heterogeneous 3D printing is the combination of multiple elements and material qualities in one print, which is possible by using the Stratasys J750 Polyjet printer. This printer allows for both hard and soft components to be incorporated into one design by blending the full-colour hard Vero material with soft, translucent Agilus material. The final humanoid objects have varying material hardness throughout the design, representing the different densities and materiality that is found in the finger joint. By taking the basic parameters of a section of human anatomy, the ability to create a creature by merely changing the size, colour, or the number of joints is achievable. With this technology, the ability to rapidly produce and easily edited final on-screen props is possible.

Keywords: 3D/4D printing, Heterogeneous printing, Human anatomy, Film and TV, Design.

Video found at this think, https://www.youtube.com/watch?v=r23I46Qr924

School of Design Innovation, Victoria University of Wellington | Yejun Fu

Adaptive splint

Description

Compared to conventional manufacturing processes, 3D printing has proved its capability of building various structures with high accuracy and material economy. 4D printing adds the fourth dimension, time, to 3D printing technology. Changing through time is a key property of products built by 4D printing. This research focused on bio-based responsive materials, as a means of initiating change and transforming 3D printing to 4D printing.

A number of studies have been done to develop the performance of responsive materials or to explore geometric structures for these materials in order to configure products that can benefit from this transformation. Precedents in medical field show great potential for combining bio-based materials with 4D printing in manufacturing highly customised products that adapt to the shape, movement and physiological requirements of a human body.

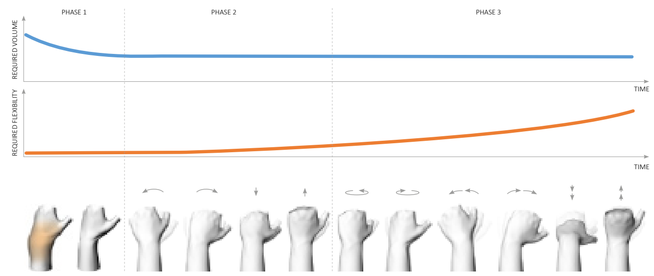
This research project was initiated by the development of printable responsive bio-based polymers, intended to contribute industrial design expertise to a multidisciplined team of material sientists and engineers as part of National Science Challenge (NSC) Portfolio 5 Spearhead Project "Additive manufacturing and 3D or 4D printing of bio-composites" https://www.sftichallenge.govt.nz/ourresearch/projects/spearhead/additive-manufacturing-and-3d-and-or-4d-printing-of-bio-composites/.

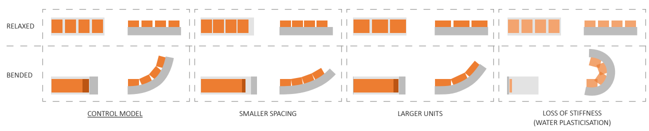
The project explored the possibility of engaging 4D printing in building wearable devices, exemplified by an adaptive wrist splint for progressive rehabilitation. This included researching wound healing processes and related rehabilitation methods to determine the required functionality of the splint and exploring relevant biological structures as inspiration for the design geometry.

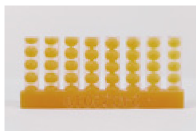
Working alongside materials scientists, the design was developed along two paths. Firstly, using the new experimental polymers and testing their responsiveness to configure a printable shape-shifting layer of the splint that adapts to changes in the wrist during the healing process. Secondly, integrating these experiments into 3D models for an adaptive splint, comprised of three layers, that responds to the requirements of progressive rehabilitation.

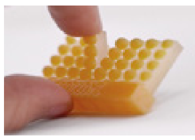
The research challenges the properties of the new materials and the associated printing processes, and more research will need to be done to improve both printability and responsive performance. However, the design of the splint provides a case study for potential applications in the broader field of wearable devices that incorporate multiple layers of responsive materials and different geometries that can adapt to the needs of a human body.

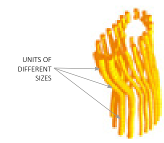
For more details, please see: https://www.behance.net/gallery/84896425/An-adaptive-splint-Masters-project

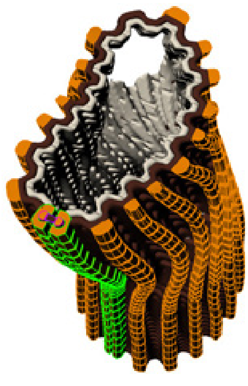


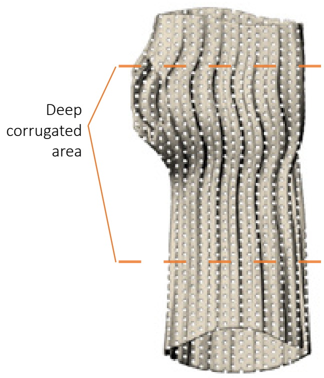


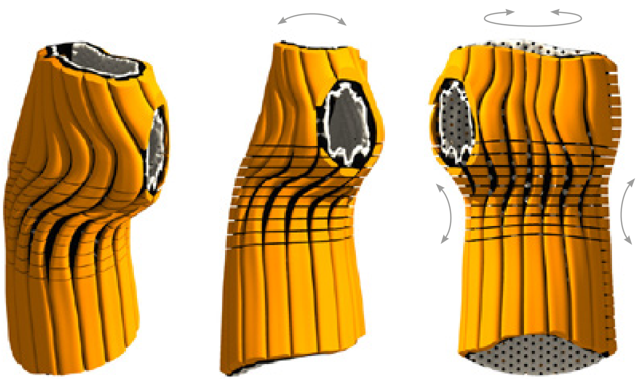












Spazio Z Design Studio I Zihan Zhao

Zero Chair




Zero Chair is produced by a self developed 3D printing pellet extruder

We use PA66 thermoplastic material and resin for compounding, which improves the physical properties of 3D printing material, and the surface treatment effect has reach treatment effect has reached the level of productied the level of productizzationation. It can replace traditional production methods to put in mass productiontraditional production methods to put in mass production.

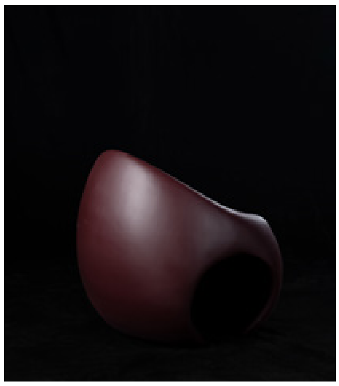
As a two legged chair that is rare on the market, Zero Chair take s into account all force points of human contact. Unlike the dispersive four point force of the four legged chair, two curved arcs are used to disperse the strength of the chair when we are designing the load bearing method of the Zero Chair leg.

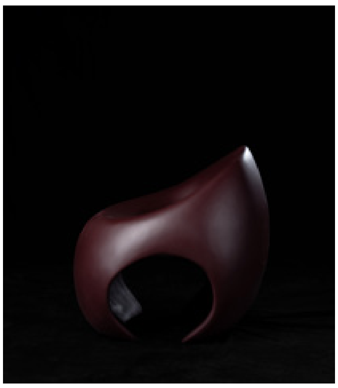
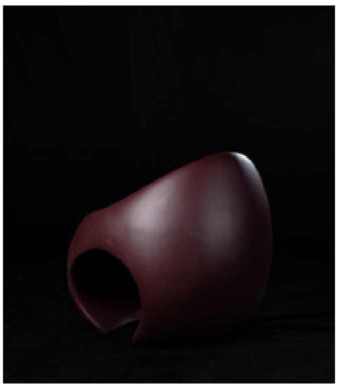
The thickness of the chair is 0.4mm. In order to ensure the stressed structure, the support structure with an average width of 2cm and a thickness of 2mm is reinforced during printing.

The Zero chair comes from the fact that the arc between the two legs of the chair creates a shape similar to the Arabic number „0“, and the curve of the chair surface and the back of the chair also perfectly outlines the shape of the number „0“, which is the mutual integration of geometry, 3D printing and material forming.

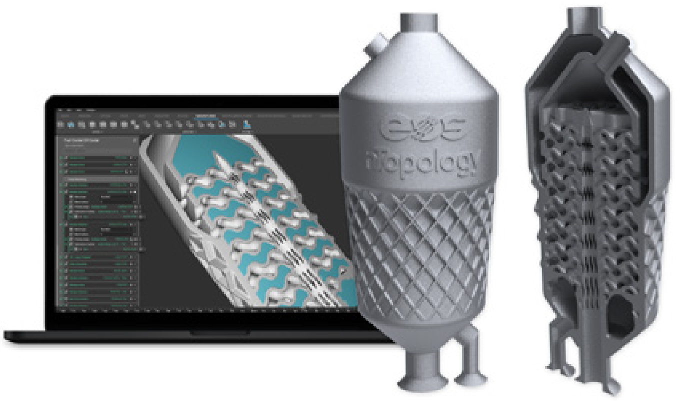


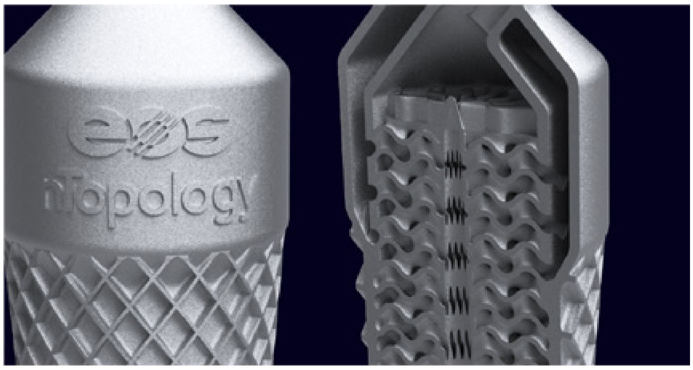





nTop Platform - Heat Exchanger Design and Simulation





Description

Using nTopology's advanced geometry kernel in nTop Platform, it is now possible to produce the next-generation of high-performance heat exchangers for the aerospace industry using advanced materials and manufacturing methods. When coupled with ANSYS CFX, the evaluation of these high-performance designs can be achieved in ways that were not previously possible.

This design was inspired by an America Makes project where it was required to leverage additive manufacturing on a legacy shell and tube HEX for both part replacement and to discover whether advanced design and manufacturing could be used to increase the performance of a legacy component.

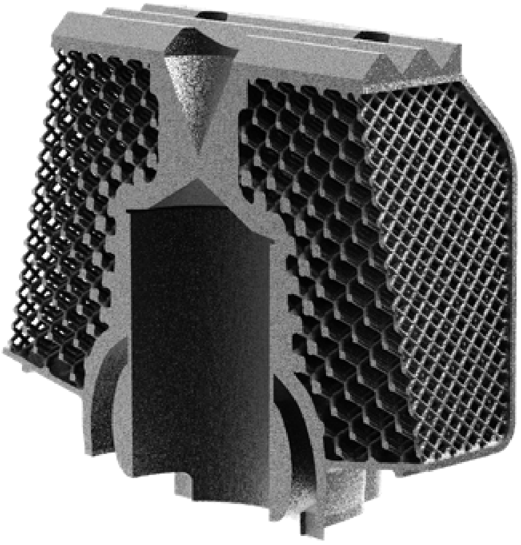
Many aerospace capabilities are built upon hardware platforms that often cannot be changed without serious modifications. As such, it is imperative that design engineers are enabled to do more with less. One way this can be done is by using an advanced geometry representation to mathematically and precisely control the geometry within the interior volume of this design space. In this example, nTop Platform was used to define a volume that could be used to iteratively design a modified FCOC that maximizes surface area while minimizing mass within its interior walls. With these constraints there are only two ways to increase the performance of a HEX: maximizing surface area and minimizing wall thickness.

By using nTop Platform to design the internal core with a gyroid structure, it was possible to increase the surface area by 146% and reduce wall thickness by half, which increased the overall heat transfer of the FCOC by approximately 300% within the same volume as the legacy design.

nTop Platform allows the user to create complex geometries (TPMS structures, fluid volumes, smooth lattice-solid transitions), while maintaining complete control over the geometric model, and then easily allows the user to export the geometry outside of nTop Platform for validation and verification. The ability to do such complex operations in a single tool while integrating with external CAE tools is unprecedented and can allow for rapid design iterations to be achieved on complex geometry.

nTopology I Nicky Soane

Thermally Optimized Engine



Description

Advanced computational-modeling company nTopology supported Cobra Aero and Renishaw in a project to optimize the design, development and additive manufacturing (AM) of Cobra's new A33 drone-engine cylinder. Test results on the 3D-printed, air-cooled component – which has a novel, interior lattice structure designed with nTop Platform software – demonstrated superior performance to Cobra's current exterior-fin design.

Background

Cobra Aero is a one-stop partner for power and propulsion that offers engineering expertise, product-development facilities and manufacturing of engines and related components. The company designs, develops, and manufactures roughly 2,000 engines per year for specialty markets, including unmanned aerial vehicles (drones) and motorcycles. nTop Platform is a unique computational modeling software that allows for simultaneous consideration of design, simulation and manufacturing data. It enables users to rapidly create, iterate and optimize performance-driven geometries that take advantage of everything additive manufacturing offers to innovative companies like Cobra Aero. Any company that makes products for aerospace knows the value of lightweighting designs for flight: decreased fuel consumption, increased payload and range, a reduction in expensive material costs and more. And in the multiphysics world of vehicles that operate above the ground, temperature, pressure, stress, airflow and other environmental variables must also be considered when designing for performance. Leading additive manufacturing machines (in this case provided to Cobra Aero by Renishaw), can now print the production-quality parts that aerospace manufacturers need. But, until recently, design software has lagged behind production capabilities. The only software that can flawlessly create the unbreakable models and complex geometries 3D printing is capable of producing – a complete toolset for Designing for Additive Manufacturing (DfAM) – is nTop Platform.

The Challenge

Cobra Aero already had a finned cooling system – an AM-adapted, commercially successful design that is being flown now. "The finned part that we're currently shipping works wonderfully and prints beautifully," says Cobra Aero president Sean Hilbert. "But it requires a lot of post-processing because it has almost as much support structure on the cooling fins as material in the part itself. And all those support structures have to be manually removed after 3D printing. We knew we could improve on that design."

Looking for alternatives to fins, Hilbert's team became intrigued by the internal lattice structures they saw being used across a variety of industries, from aerospace to medical devices. By hollowing out a solid aircraft bracket, or a human joint implant, and filling the space with a lattice, honeycomb or gyroid structure, weight can be decreased and strength improved. The bonus: lattices are self-supporting so don't require any support structures during the AM build. , "One, a lattice structure would be very print-friendly and two, it might allow us to tailor-fit heat transfer in a better way. The motor we were working with is designed to be used in drones, where extra mass can take a particularly heavy toll on payload, range and performance."

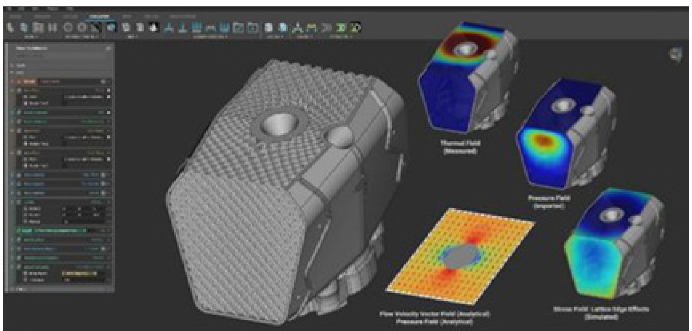
The Solution

"The possibilities that nTopology's nTop Platform software opened up were virtually endless. The fact that the generation of hundreds and thousands of different lattice shapes is mathematical, accomplished without having to create discrete, surface-based models like you'd see in traditional CAD packages, meant we could be a lot more adventurous with our designs for 3D printing." - Kevin Brigden, DfAM expert at Renishaw. Using nTop Platform's automated capabilities, Cobra was able to quickly generate different sizes of lattices and varying wall thicknesses of struts, filling-in the lattice inside their cylinder geometry, and terminating it on a highly undulating surface. Through every configuration, the software handled all data generated by lattice iterations with ease, automatically filling in fillets to broaden and smooth strut intersections and connections to the part skin. This distributes stress more uniformly, reducing concentrations that can lead to delamination, and promoting both manufacturability and durability. Hilbert notes, "The issue we were exploring is that the amount of pressure drop across the cooling duct is directly related to the amount of drag on the airframe. We needed to find that sweet spot where we're getting enough heat pulled away from the cylinder but we're not adding a tremendous amount of drag onto the entire structure so the UAV can fly longer, more efficiently."

"By the time we were done, our models had evolved to the point where they were simply beautiful!" he recalls. "Apart from the lattice, we soon realized there were many other advantages to using nTopology software besides no longer needing support structures. We were able to integrate the cooling duct with the cylinder itself, consolidating parts into a single piece. Overall the design is just cleaner, simpler, a tighter package that prints perfectly and presents itself a lot nicer on the engine." A trio of final cylinder designs was achieved, ready for 3D printing and real-world testing. nTop Platform then produced the engine cylinder part-geometry data in the sliced format required to drive the path of the laser in the layer-by-layer process of metal additive manufacturing. "Testing showed that the new lattice structure design with nTopology was more efficient at cooling than our fin design. In every case, at every different RPM, less cooling air was required to maintain proper engine temperature. What this means to design going forward is that we can now make a smaller inlet to the cooling duct, which in turn makes a smaller frontal area on the aircraft, so we have less drag on the aircraft for the same amount of cooling – exactly what we were hoping for." - Sean Hilbert, Cobra Aero

Moving Design Forward with Multiphysics in nTop Platform

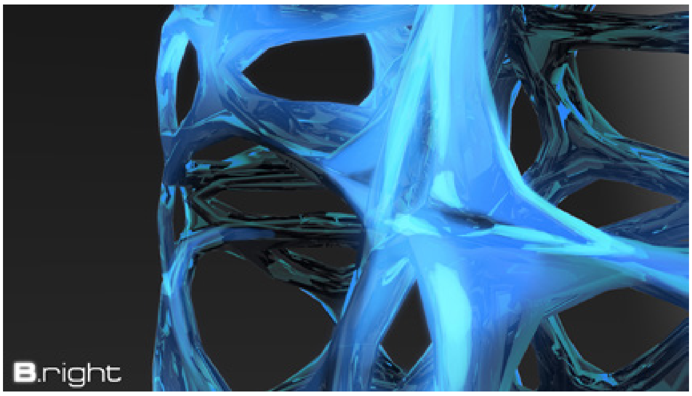
With their cylinder test results in hand, Cobra Aero is now in a position to take further advantage of other advanced capabilities available in nTop Platform as they refine their design towards commercial production. The next round of testing will measure inlet and outlet pressures across the cooling structure to help determine which lattice density is optimal for the final production part. From those results the lattice geometry might be redesigned in nTop Platform to be progressively thicker or thinner depending on where it is in relationship to the cylinder walls. The software's field-driven simulation capabilities can drive how a model is generated based on a wide range of multiphysics inputs – including temperature, flow velocity and stress as well as pressure. Reusable workflows allow designers to regenerate models without having to start from scratch each time and the software's implicit algorithms slash computational run times dramatically. "We've definitely come to the conclusion that our new lattice-cylinder design is a better mousetrap than our fin cylinder – which is a big deal," says Hilbert. "We now know we're in the ballpark in terms of lattice density. From here on out it's a matter of using nTop Platform to fine-tune all the design parameters we need and make the final tweaks of what we want to go to production with."



Screenshot demonstrates the effects on the design of a broad range of multiphysics fields, here being simulated, explored and evaluated through a hypothetical engine cylinder model in nTop Platform.

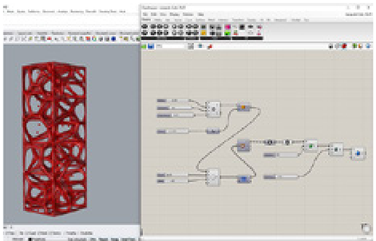
Danny De Carolis I Matteo Mochi I Omar El Houdna

B.right



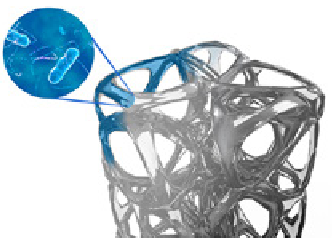
Geometry

Lamp structure was designed throughout a series of manual operation with the help of parametric modeling. This process allowed us to realise a really complex geometry and to make the realization process optimizable based on the users need. Parametric modeling also allowed us to ease the design of organic and more natural forms.



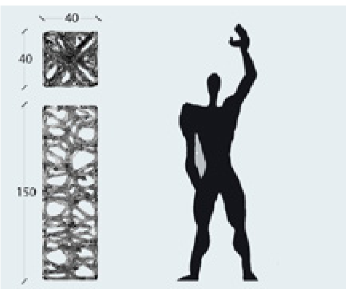
Material

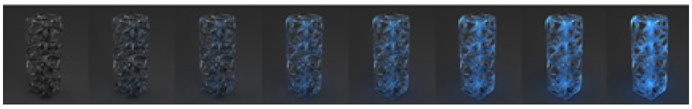
The empty section of the object is filled with a liquid containing modified micro-organisms: Cyanobacteria and Escherichia Coli. The first one is a photosynthetic organism that absorbs carbon dioxide and releases oxygen. The second one, instead, is genetically modified by the bioluminescence enzyme. It will produce energy thanks to the oxigen presence, and so it will lightup.



Harmony

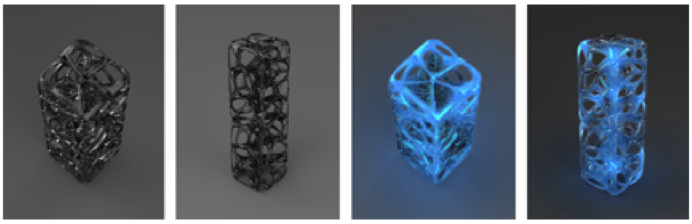
B.right is an autonomous, bioluminescent and o-emission lamp. The lamp structure is algorythm generated and 3D printed by Polylactic Acid (PLA) and a liquid flowing in it that contains Cyanobacteria and Escherichia Coli. It doesn't need electric or sun energy thanks to these Bacterias and it's totally autonomous because the lamp luminescence is regulated by itself, based on the environment lights.





Lighting Process

The name of the lamp come from the lamp luminescence (Bright). And „Be Right" has its meaning too because it's a 3D printable lamp, with o-emission e no need for energy so it means that you are right if you have it.



Node Audio Research I David Evans

HYLIXA

Description

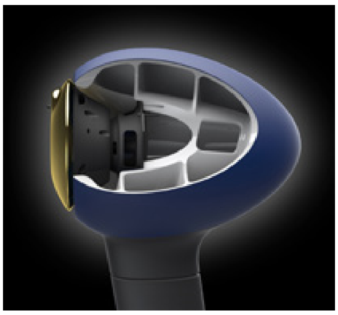
HYLIXA embodies elegant innovations to deliver music without the compromises of traditional box-like speakers. Liberated from conventional manufacturing, HYLIXA's internals are radically different from anything else, delivering music unlike anything else.

HYLIXA's complex cabinet geometry is only possible thanks to 'Selective Laser Sintering'. As a result, the entire cabinet geometry, baffle and crossover are produced as a single, unified part.

A patented helical design is driven by a rearward firing woofer, creating a free-flowing 'transmission line'. The rotational pressure increases the effective line length to an astonishing 1.6 metres, extending bass performance.

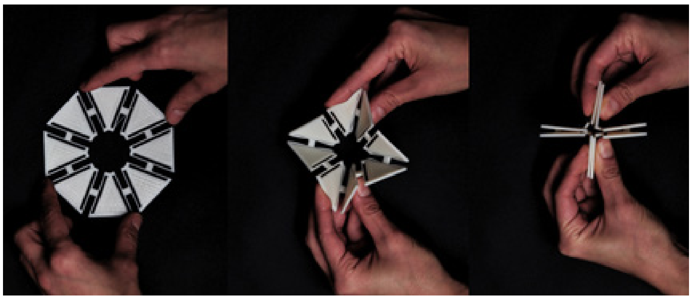
Uniquely, the orbital path of the transmission line allows it to be fed from two optimised points, controlling the first standing wave. The constantly changing line section further suppresses the build-up of smaller standing waves associated with box-like cabinets. The result is bass that is, quite literally, revolutionary.

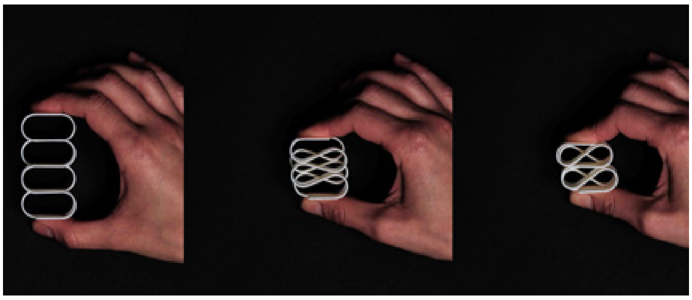
HYLIXA launched in 2019 and has already gained great recognition in the audio industry.



Moriel Blau

compliance





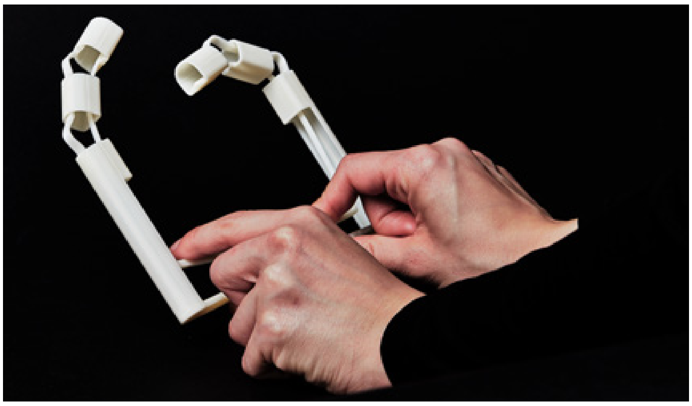
Description

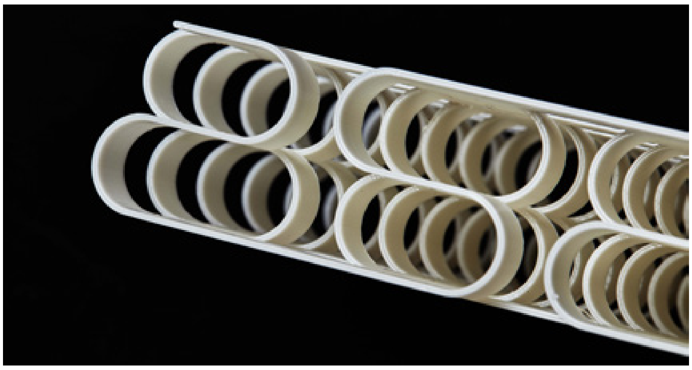
“compliance“ is a research project in the field of flexible mechanisms made out of one piece. Mechanisms that gain some or all of their motion through the deflection of their flexible members are classified as compliant mechanisms. This subcategory of mechanisms dispenses with the traditional joint-concept while relying on control over the material and its reversible deflection. Accordingly, the decisive component of these mechanisms is their geometry. This results in a dependency of form and function. The design of the compliant mechanism’s form alone decides on the type and quality of its function. Crucial to the behavior of these forms is their geometrical configuration. One continuous monolithic geometry emerges by omitting joints and rigid connections. This reduces the number of components to only one, while simultaneously equipping it with a mono-material property.

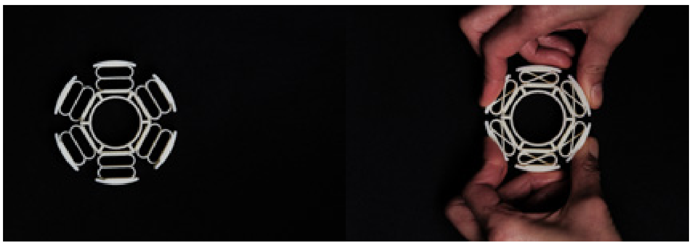
Compliance is the key to lighter, quieter, more precise and efficient mechanisms. Constructions built with several components can be replaced by monolithic constructions capable of performing the same function. Compliant mechanisms present an efficient and economical design. For this purpose, the designed and manufactured objects were constructed from a monolithic and continuous geometry. All of the results are 3D printed.

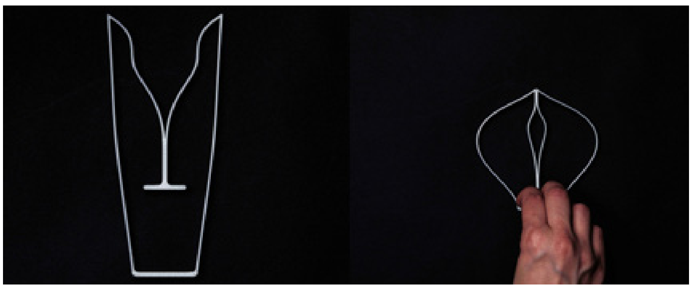
The research project serves as an outlook on the future of durable and elastic products. A vision of shape-changing products emerges. The concept of flexible and resistant structures implies not only a further development of mechanisms which are part of products, but the concept can also bring forth an evolution of entire products.

This research project proves that the task to be performed by the traditionally constructed mechanism can be replaced by a flexible and resistant structure – a compliant mechanism.









Svet Abjo

ZERO - 3D printed sneakers

WHAT

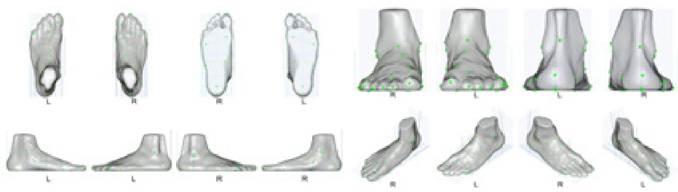
This is a fully functional Custom made 3D printed shoe based on foot scans. The whole shoe was printed at one go eliminating any stiching or gluing processes. Sole, midsole, and upper - all in one print and out of one material.

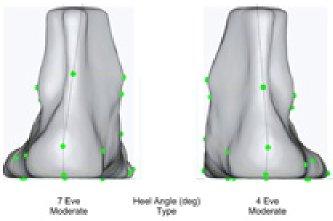
WHY

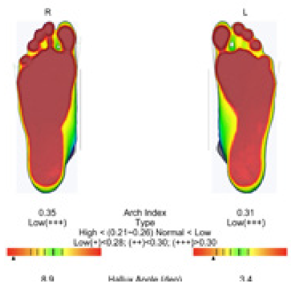
In 2020 climate change and environment is one of the biggest concerns and I truly believe that 3D printing footwear out of recyclable material holds a very potential future. The complete shoe is made out of one material - TPU (shore hardness 60 A). The shoes could be eventually melted down and new shoes could be printed out of it. Moreover no traditional shoe lasts are required as this can be directly implemented in the CAD model.

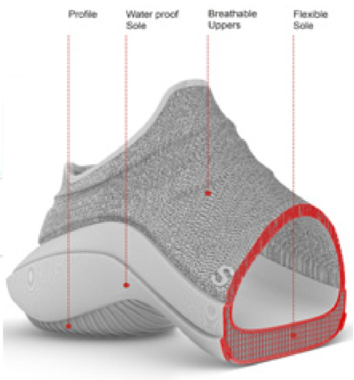
POST COVID IMPACT

Due to the Recently hit pandemic worldwide several footwear brands have suffered a huge revenue loss. Many of these brands have a Supply chains which are primarily based in Asia and other countries with lower economies where the workers are exploited for a lower wage. 3D printing shoes could be done locally which eliminates any need of of big infrastructure or production hall. Moreover there will be no over production as compared to traditional manufacturing ways.









Maximilian Klyk

Arch

3D-printed ice climbing device

Arch is a technical ice-climbing device that is produced using additive manufacturing. The introduction of the new production method makes it possible to revolutionise the product with innovations relating to use, experience and appearance. The project is part of my diploma in Industrial Design at Darmstadt University of Applied Sciences.

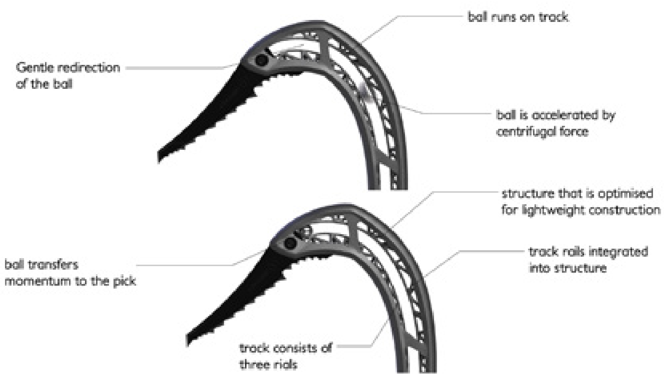
Design

The tool's design plays with the contrast between the organically optimised internal structure and the smooth external surfaces. The fibres used throughout the product are also used to define clear lines, in contrast to the random-seeming structure. The shape of the grip is mainly functional, and was defined with the help of an ergonomic study.

Innovation and use

There is always a contradiction when it comes to ice-climbing tools. They should be as light as possible in order to conserve strength and energy when climbing, because both the striking motion and overcoming the vertical distance are very tiring over time. On the other hand, the tools need to have a certain weight so that they have enough momentum to penetrate the ice and improve their precision.

Additive manufacturing makes it possible to reduce the weight while also integrating an acceleration system, resulting in impact energy that is comparable with heavy equipment produced using conventional methods, thanks to optimised, lightweight structures. This acceleration system consists of a ball that runs along a track that is integrated into the lightweight structure. When the tool is swung, centrifugal force pushes the ball towards the head, where the impact transfers momentum and energy to the pick.



Customisation

Additive manufacturing also offers the possibility of customising the tool. The grip in particular can be made to fit the individual user's hand. The level of ability and the manner of striking are also taken into consideration in a particular tool.

Production and prototype

Arch is made from aluminium ALSi10Mg, using the SLM process. The pick is made from tempered steel using conventional forging methods. A layer of rubber is also applied to the handle to improve heat insulation and grip. The project involved the creation of a prototype, in order to test the tool and serve as a design model.

HKK Bionics GmbH I Dominik Hepp

exomotion® hand one

Description

The exomotion® hand one from HKK Bionics is an innovative bionics hand orthosis for paralyzed hands. Designed as a "motorized glove", it enables patients to carry out everyday gripping tasks. Until now, people with completely paralyzed hands could not been cared for and many of them saw a hand amputation as there only way out. As the first product on the market, the exomotion® hand one enables people with complete hand paralysis to perform various gripping functions again.

The functional principle: An intelligent software with an associated sensor recognizes the wearer's intention to move via a muscle that is still active and controls the powerful micro drives in the arm splint. These direct power into the actuation mechanisms of the glove, which open and close the fingers and thus provide them with the necessary grip force. All components are connected by the supporting arm splint, which is manufactured individually for each patient.

In combination with a control unit for simple, intuitive use and the powerful battery, these elements form the exomotion® hand one - a long-term, everyday solution that closes a gap in the market. The hand orthosis can perform six different types of grip, such as the power grip or the tweezer grip which cover the most important applications. The predefined variants determine which fingers are involved in gripping to create a grip that is as functional as possible. In order to ensure that every orthosis fits perfectly and can be worn in everyday life without bruises, individual production is necessary. HKK Bionics GmbH works with previously trained medical supply stores. This cooperation combines the manual processing of medical silicones with 3D scanning, automated construction and laser sintering. A modular system was developed in order to manufacture a technical product for each patient in an economical way. This contains standardized parts as well as the individually and partially automatically constructed arm splint manufactured by a professional 3D printing service provider. At the same time, additive manufacturing enables integrated sections for components, mechatronic components and undercuts to be realized. A degree of miniaturization can be achieved that is not possible with conventional production methods. Height and weight decrease and the patient's acceptance of the aid increases.

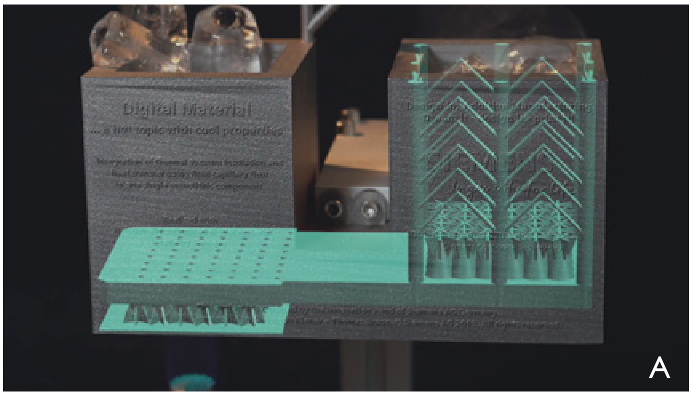
All plastic parts of the orthosis are printed in the laser sintering process from biocompatible PA12 and colored in the color of the patient's choice. Due to the individual construction and coloring, each orthosis is unique. Surface customization is also possible. Only the finishing and dyeing technology for printing, which only has been available for a few years, makes it possible to manufacture products such as the exomotion® hand one with a high-quality and medical device-compliant finish. For the creation of the arm splint, which is based on a 3D scan of a plaster model of the patient's arm, a special, partially automated construction software was implemented, with which the construction time of this complex, always individual geometry was reduced to a few hours and at the same time the reproducibility requirements of medical devices is sufficient.

Siemens AG, Corporate Technology I Dr. Christoph Kiener I Dr. Yves Küsters I Robert Otto I Thomas Braun

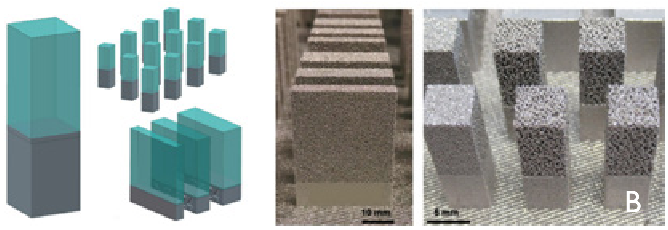
Hot versus cool: highly efficient heat transfer through capillary effects with “Digital Materials”

Description

The perfect interaction of material, geometry, function and manufacturing is demonstrated by a heat pipe, an evaporation-condensation heat transfer system (pressure cooker principle) with a vacuum insulation: While ice does not melt directly above the gas flame, water boils at some distance without any visible heat source.

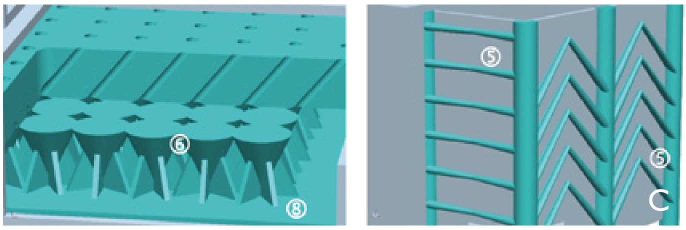


The combination of CAD form flexibility and structural functionality allows additive manufacturing (AM) - in this case, laser-beam metal powder bed melting (PBF-LB) - disruptive applications for complex functional components.

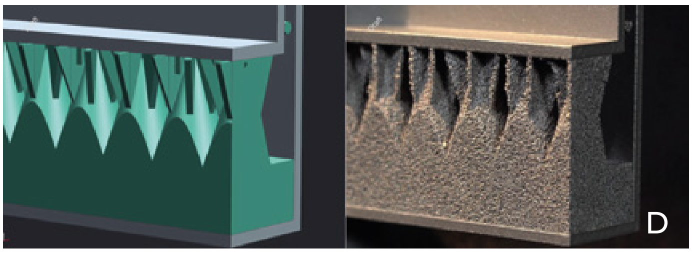


Just as coffee ascends by itself in a sugar cube, the capillary transport of fluids takes place hidden inside the heat pipe in porous metal structures. Heat is transported by evaporation and condensation of this fluid - a very attractive application for transporting large amounts of heat over long distances in confined spaces with small cross-sections. The heat pipe works „passively“ without mechanical or electrical components, purely by the capillary effect. In addition, the hot areas are wrapped by a vacuum jacket for thermal insulation.

The function of the condensate transportation can be compared with the water transportation of a tree: Fluid uptake (roots), capillary transport (vascular system in trunk and branches) and fluid release (evaporation in leaves) are realized as microstructural processes in sections of porous metal.



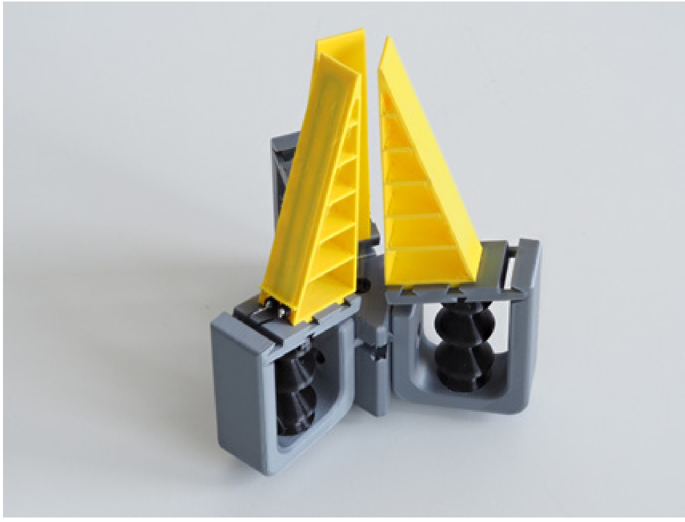
They are planned in CAD together with macroscopic solid forms and manufactured in a 3D printer. Geometries made of high-performance metal alloys interact over four orders of magnitude from “50 μm to 50 cm” to implement the goal of efficient heat transport according to the heat pipe principle.



Tailor-made porous materials offer an immense potential for future innovative technologies and applications, with the widest imaginable range of uses. These include cooling in efficient rocket and aircraft propulsion systems as well as cooling applications in power electronics for electromobility. In future, such systems may also be implemented in even more complex geometries - however, this will only be possible by means of additive manufacturing.

TU Braunschweig - Institut für Konstruktionstechnik I Dr. Hagen Watschke I Julius Heubach I Karl Hilbig I Prof. Dr. Thomas Vietor

Adaptive gripper with integrated resistive sensor

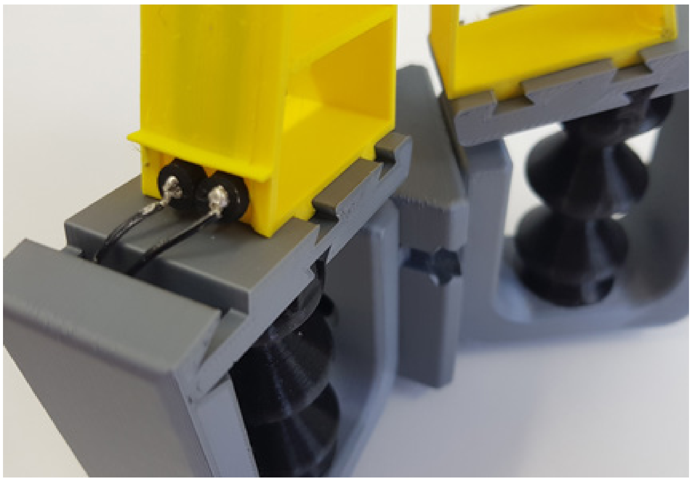


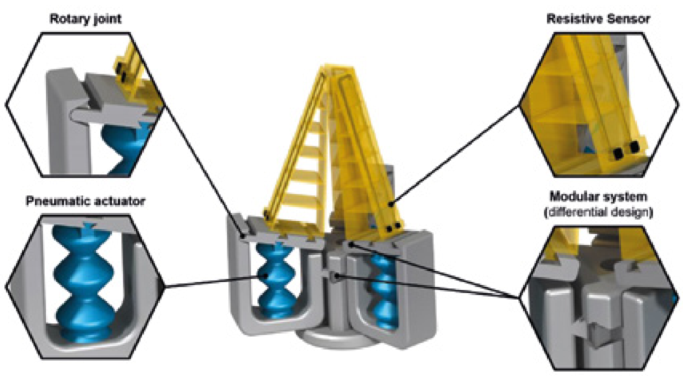
Description

Adaptive gripper system with integrated sensor for flexible handling of components with different geometries with object recognition

Additive manufacturing offers new opportunities for function integration. Multi-material designs allow a local integration of material-specific properties such as electrical conductivity or elasticity. The adaptive gripper – based on the Fin Ray Effect® (Leif Kniese) – demonstrates the potential for the realization of shape-flexible and for the integration of sensor structures using material extrusion. The gripper has a modular design to enable an adaptation to different handling tasks. The gripper fingers as well as the pneumatic actuators can be easily exchanged via a form-fit connection in order to be able to react to different requirements of the handling process by varying geometry or material.

The pneumatic actuator is made of thermoplastic polyurethane (TPU) with a Shore hardness of 70A, the gripper fingers are made of TPU with a Shore hardness of 82A, while the rest of the structure is made of PETG (polyethylene terephthalate modified with glycol). The sensor integrated in the gripper fingers is made of an electrically conductive polylactide (PLA) filled with carbon black. By deforming the gripper fingers, the 3D-printed sensor is also deformed on the backside by the resulting bending load. Because of the resistive material behavior of the carbon black-filled PLA, the degree of deformation can be measured by strength of change in electrical resistance. The contacting is done with a conductive adhesive. In this way, conclusions can be made about the gripping state (object gripped or not) and the size of the object (amount of change in resistance). Due to elasticity of gripper fingers, the adaptive gripper allows flexible handling of objects with different geometries. The deformation of the gripper fingers is used to draw conclusions about the gripping state and the type of object through the integrated sensor. 3D printing makes it easy to integrate the resistive sensor into the gripper finger, since the shape can be chosen almost arbitrarily. This means that sensor integration is possible even if the gripper geometry is varied. The sensitivity of the sensor (gauge factor) can be adjusted to suit the application via the sensor geometry (e.g. height) and the process parameters (e.g. layer height and fill pattern orientation).

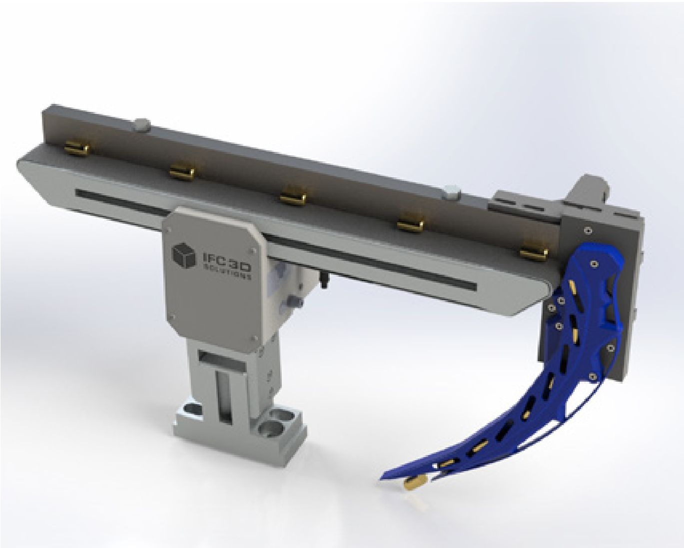


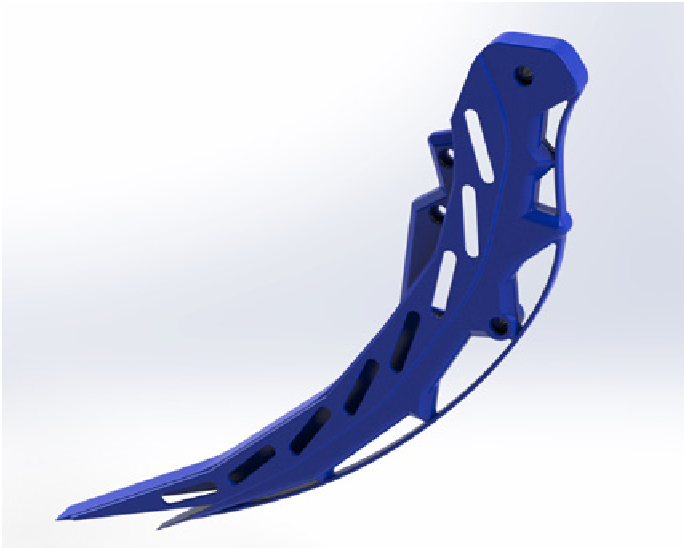


INSTITUT FÜR KONSTRUKTIONSTECHNIK

IFC GmbH I Andreas Schirmer

3D gedruckte Übergabeeinheit für Kleinteile





Brief description of function

Small parts often need to be conveyed to a downstream handling or assembly system. Based on the current state of technology, this is usually achieved using a pipe. This means that a pipe with a diameter that is "somewhat" suitable is bent and then attached directly to the diverter pulley at the end of the line in order to fill the pipe with parts. The parts slide down the bent pipe to the next process.
This involves accepting the following drawbacks:

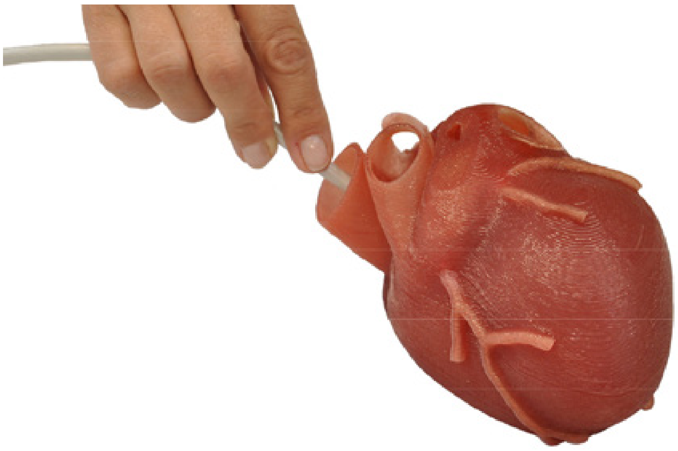
- A large bending radius, particular for parts with a substantial length/diameter. A great deal of space is therefore required
- Delays to the production-dependent welding process, requiring manual adjustment and reworking, thus preventing reproducability. This is particularly critical in the case of replacement parts.
- The pipe is enclosed and offers no opportunity for monitoring, for example in the event of blockages.
- Possibility of damage to the parts

Benefits of the printed solution

- Very low bending radius thanks to undercut
- Reproducibility in the region of 3-4/10
- Changes or retrofitting in the event of type changes or additional types very simple by creating new design and printing a replacement part
- Windows to monitor shaft integrated
- Protects parts, and wear-resistant
- Modern and appealing design

ANAMOS UG (haftungsbeschränkt) I Lehrstuhls FAPS, FAU Erlangen-Nürnberg I Wacker Chemie AG I
Hannah Riedle I Anna Seufert

ANAMOS Herzmodell



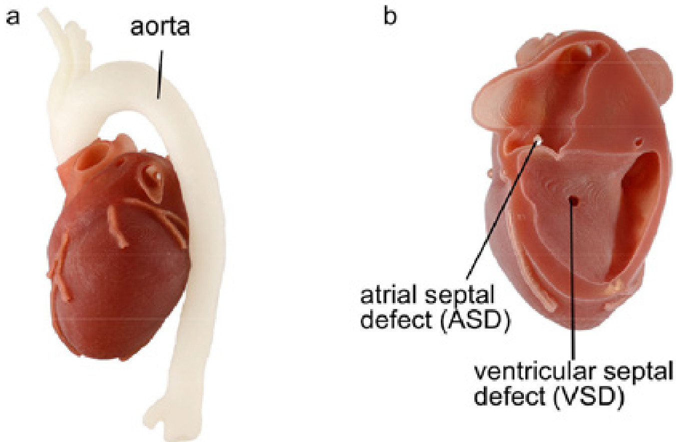


Figure 1: 3D-printed model of the left-hand side of the heart with an atrial ventral defect (ASD) and ventricular septal defect (VSD) in translucent red silicone with a Shore A hardness of 20 (a) Silicone model with a model aorta attached for demonstration purposes, (b) View of the heart model with ASD and VSD

Anatomical heart model for operative simulation

With its realistic function and feel, the anatomical model of a human heart, which is produced using additive methods, opens up new opportunities for the simulation of surgery. As a substitute for direct application involving a human body, new training and evaluation environments are created, improving the efficiency of medical training, the development of medical products, and research. Unlike biological models, such as human or animal corpses, the artificial ANAMOS models are always available, easy to store and manage, and can recreate any anatomies or conditions. The ANAMOS heart model is the product of an innovative generic design method involving medical CT imaging data, which allows the ventricles and atria of the heart, as well as the relevant surrounding vessels and coronary arteries, to be be recreated realistically. The focus of the model is on realistic functionality. That is why it has unique, designed, anatomical valves, and hollow vessel structures. Additive manufacturing using silicone and ACEO® technology (Wacker Chemie AG, Munich) allows the heart tissue's elastic properties to be recreated while maintaining geometric complexity. When not under stress, for example, the valves of the ANAMOS heart model have small gaps. When force is exerted in the direction of the blood flow, the elastic valves open towards the wall of the heart or blood vessel. If force is exerted against the direction of the blood flow, however, the valves are pressed together and close the opening. This functionality is only possible thanks to the unique combination of the generic design approach, additive manufacturing and the use of elastic silicone, which make it completely ground-breaking.

The model's design can be adapted to recreate different conditions. The version shown shows a model with an atrial septal defect (a problematic opening between the two atria) on the left-hand side, and a Ventricular septal defect (a problematic opening between the two ventricles). The potential applications for simulated surgery include intraoperative navigation, the replacement of pathological heart valves, and the closure of a septal defect. A scientific study confirmed the necessary anatomical accuracy, compatibility with ultrasound imaging techniques and echocardiography, and functionality in a surgical simulation.

History

The concept for the model stems from the joint „Silicone Biomodels" research project Conducted by the Faculty of Production Automation and Production Systems at the University of Erlangen-Nuremberg and Wacker Chemie AG. In 2020, this research project gave rise to the „SofTiss Anatomics" project, which is supported by the EXIST founder's scholarship. In August 2020, in support of this project, ANAMOS UG (Limited liability) was founded for the development and distribution of 3D-printed anatomical Models for the medical and medical equipment market.

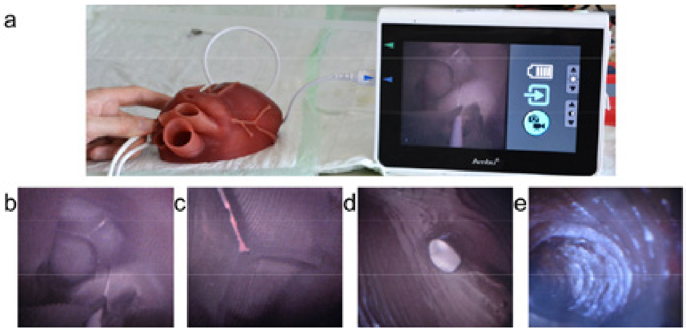


Figure 2: Endoscopy of the heart model (a) Investigation; endoscopic images: (b) View of the aorta and mitral valves with endoscope visible from the left ventricle, (c) View of aortic valve from aorta, (d) View of VSD from left ventricle, (e) View of a coronary artery of the left atrium

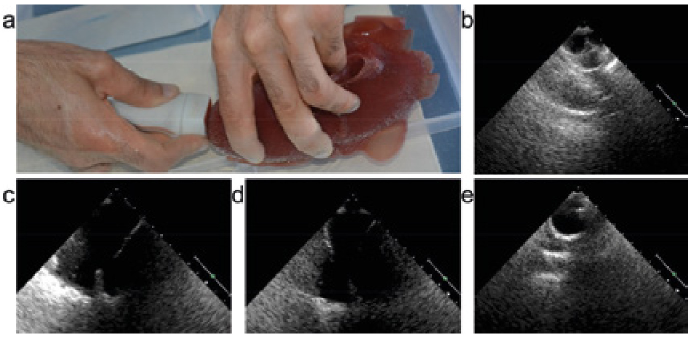


Figure 3: Echocardiography (ultrasound) of the heart model (a) Investigation; echocardiographic images: b) Aortic valve, (c) Mitral valve with papillary musculature, (d) Apical two-chamber view of heart, (e) Aorta

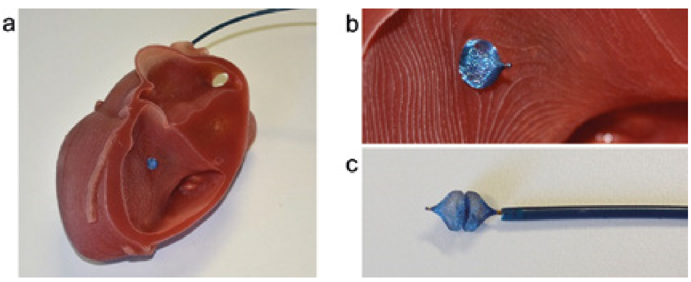
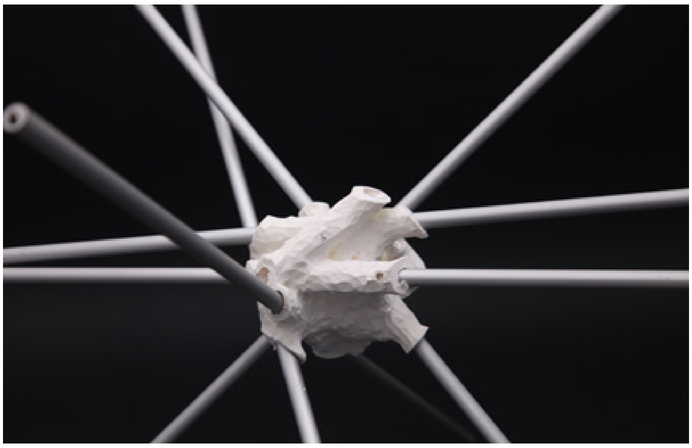


Figure 4: Simulation of the implant to surgically close a VSD (a) Heart model with implant, (b) Enlarged view of positioned implant, (c) Amplatzer® vascular plugs 4 (8 mm)

dMA Leibniz Universität Hannover I Prof. Mirco Becker I Philipp Mecke I Jan Zobel I Marco Schacht I Clemens Barther I Ole Brederlau I Rebecca Faulhaber I Sophia Haid I Jiakun He I Chang-Ting Lin I Ann Loewe I Maximilian Löwen I Isadora Machado I Leon Schittek I Janek Zindler

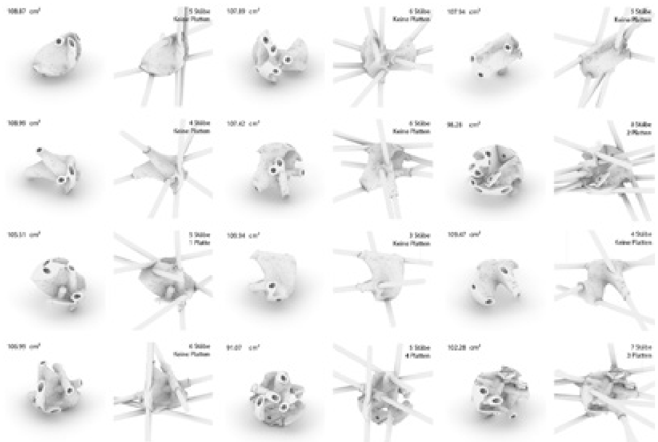
Universal Super Joints

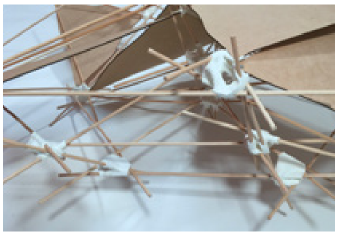


Description

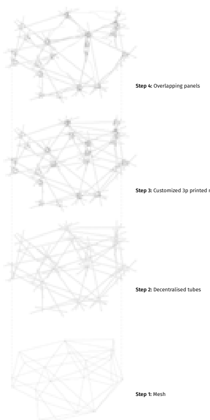
In the 20th Century, the history of the universal joint, a connecting rod for space frameworks, was influenced by architects such as Konrad Wachsmann, Richard Buckminster Fuller and Fritz Haller. In recent years, 3D printing technology has advanced to the stage that it can be used to produce universal super joints.

In the winter of 2019, a group of students created a prototype universal super joint, and implemented it in the summer of 2020 as an architectural demonstration piece.



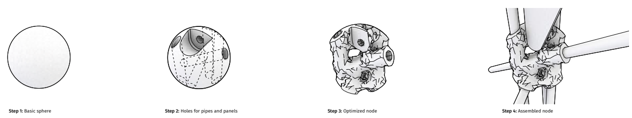


Structural process



Assembly process

Design process



Optimization process

Porsche AG I Mahle International GmbH I Trumpf GmbH & Co. KG I Frank Ickinger I Volker Schall I Dominik Abele I Steffen Rübling

3D printed piston 911 GT2 RS

Component selection

Vehicle: 911 GT2 RS
Engine: 6-cylinder flat engine with displacement of 3.8l
Specifics: 515 kW (700 hp), 750 Nm (+ 50 Nm), up to 7200 1/min
Components: Piston with D = 102mm (series forged)
Piston injection

Overview

Production
- Metallic 3D printing (selective laser melting (SLM) with special aluminium alloying for pistons

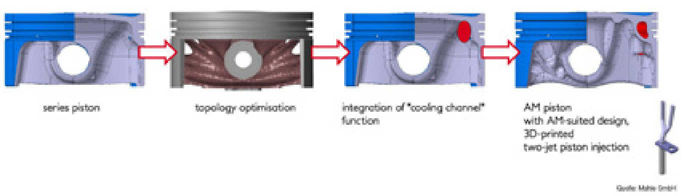
Objectives
- Increased rigidity, reduced weight through topology optimisation
- Integration of cooling channels
- Reduced development time (prototype part = series production part)
- Tooling costs eliminated

Improved performance
- Reduced mass → Increased rpm → Increased output
- Reduced component temperature → Increased stability → Increased stress → Increased output

Improved efficiency
- Reduced component temperature → Increased stability → Increased → Better thermodynamics → Improved consumption

Serial piston 3D-printed piston

Design process

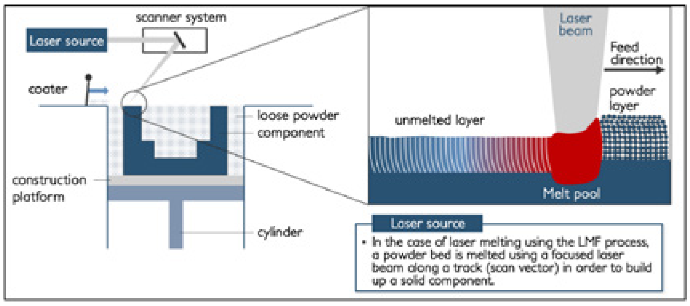


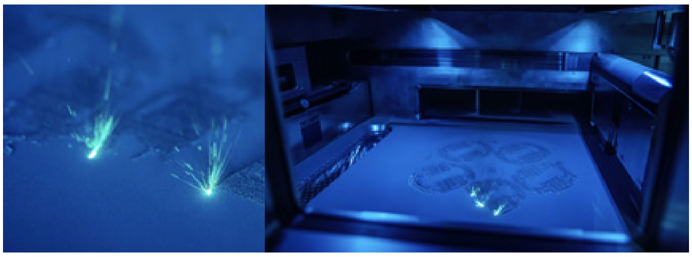
Simulation

- 10% reduction in weight (50g) → Potential 20%
- Temperature in first ring nut reduced by 20K
- Permissible tensions and safeties OK

Process development

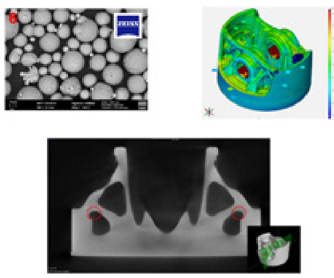
- Powder material qualified (special Mahle Al casting alloy)
- Process parameters defined for special Al alloy
- Material values comparable to cast material





Quality assurance (additional project partner ZEISS)

- Powder analysis, including evaluation of recycled powder (metallographic, fluidity, humidity measurement, microscopy, CT, ...)
- Measurement deviations of part within tolerance (3D scan and CT)
- Component analysis using metallographic sectioning, light microscopy, X-ray spectroscopy and computer tomography



Test bench endurance testing

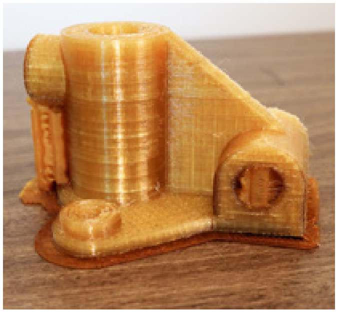
- 200h endurance testing
- 24h high-speed track → ~ 6000 km with average speed of 250 km/h, including stops to refuel
- ~ 135 hours full throttle at various different rpm values
- ~ 25 hours towed load at various different rpm values

Infinite Material Solutions - a Nagase Holdings America Company I Dr. Jeffrey Cernohous

AquaSys® 180 Water-Soluble Support Filament

Description

Stable at chamber temperatures of up to 180°C, AquaSys® 180 is the world's first water-soluble 3D printing support material that effectively functions with Polyetheretherketone (PEEK) and other engineering-grade materials. Now, users of fused filament fabrication (FFF) printers can create detailed parts using high-temperature thermoplastics – then move on to other tasks as the supports rapidly dissolve.



Concept

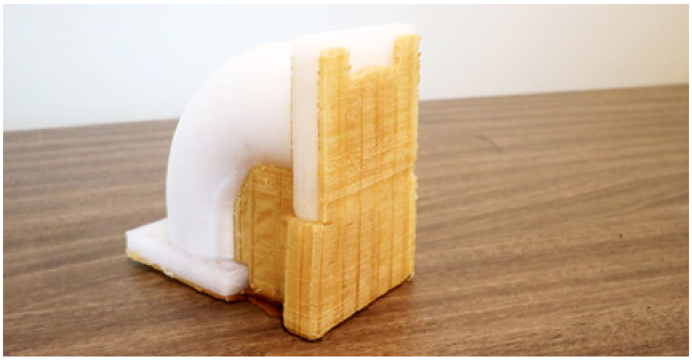
As a novel material that enables new shapes to be printed with high-temperature materials, AquaSys® 180 has a deep, harmonious relationship with geometry. It fosters creativity by supporting complex shapes with internal cavities and sharp angles. It bolsters productivity by reducing post-processing, which gives end users more time to focus on other aspects of their projects. And as a result, materials which previously required laborious breakaway support removal can now be used to their full potential to produce complex, contiguous, functional geometries – all at a lower operational cost than ever before.

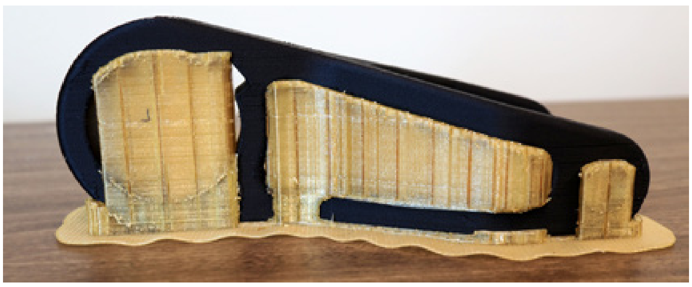
No other material offers the same combination of adhesive, thermal, and soluble properties that AquaSys® 180 does. In addition to its water-soluble performance, here are a few of the advantageous features that help it move the 3D printing industry forward:

- It offers excellent thermal stability and adhesion characteristics, allowing users to print with PEEK, PEKK, PEI, and PPSU.
- It provides excellent stability in higher printing temperatures, allowing for better printing results.
- It dissolves up to six times faster than other soluble support materials such as PVA.
- It dissolves in warm water with minimal post-processing required and no need for hazardous solvents.
- It's made of 100% hydrophilic, non-toxic, and non-carcinogenic components.
- It provides an excellent surface finish on finished parts.

In order to represent the capabilities that AquaSys 180® provides, our team has created a printed part in an S-bend shape, using PEEK. Due to its 90-degree angles and internal cavity, this design could not feasibly be printed in one contiguous part without the use of water-soluble support material. It demonstrates a smart, practical application made possible by AquaSys® 180.

Looking beyond this single printed part, we invite the jury to imagine what this means for the advancement of the industry. AquaSys® 180 represents innovation at its best not only because it's a first-of-its kind material, but also because it answers long-standing market demands. Now, original equipment manufacturers (OEMs) can produce detailed parts for commercial applications at a lower cost per unit. Now, businesses in industries like aerospace or automotive can create prototypes more quicky, leading to greater efficiency. Now, 3D printing is a legitimately viable process for manufacturing end-use parts.





Addition I Saulo Armas I Oriol Massanes

A.I. Bindings

Description

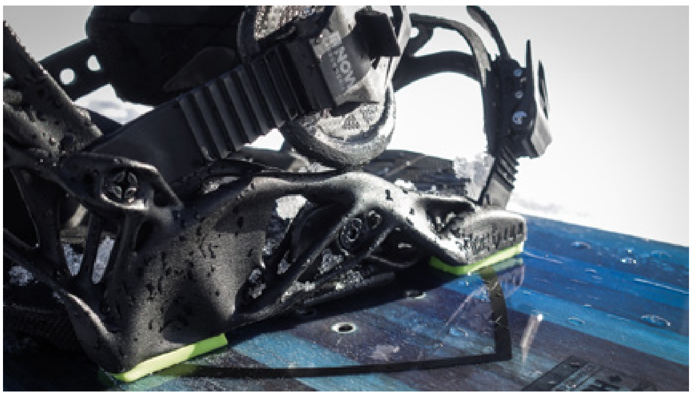
The innovative snowboard brand NOW, Nidecker Group, and ADDIT·ION, the Artificial Intelligence design specialists, have unveiled the first ever 3D-printed AI snowboard binding entirely designed by Artifical Intelligence.

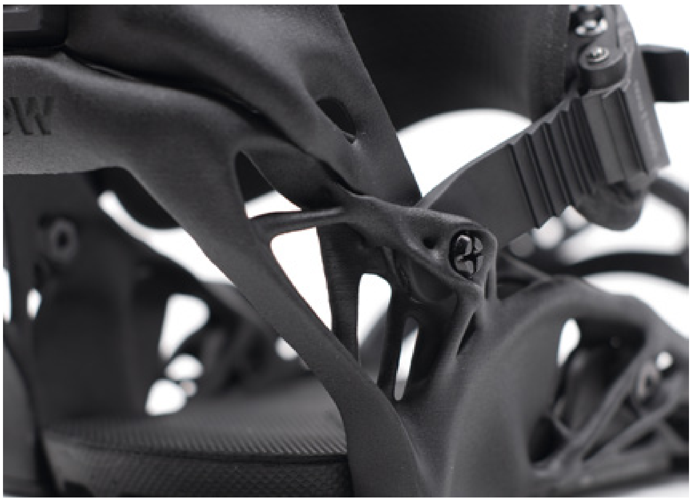
To create a responsive binding, optimised for turning, we had to deliver maximum stiffness with the lowest possible mass. To make that happen, Addit-ion brought their mastery of AI design and 3D printing, Now brought their patented Skate Tech Technology & Nidecker Group brought their extended knowledge of binding Technology.

Together we built a Load Case that would emulate the stress that bindings undergo during aggressive carving and turning, then used a minimal mechanical representation of Skate Tech to generate the ultimate shape around it using Autodesk generative design.

We had dozens of different outcomes to compare, with different materials and technologies, but after hours of simulation and data analysis, we came up with the best option, to be printed in PA12.

Full Board weight - ~5kg
Binding Set weight - 1600gr





Ganit Goldstein

WeAreAble

3D printed Kimonos

For the first time in 3D printed fashion, textiles can be leveraged as the skeleton of the garment. 'WeAreAble' project focuses on the process of creating 3D printed garments based on measurements from a 360 degrees body scanner. The result is a cutting edge concept of personalized garment production. Two outfits 'kimonos' produced using Stratasys R&D new technique of printing onto fabric, using unique combination of colours and materials including the Vero clear new transparent material, presenting crystal-like look. These two outfits present a hybrid working process of embroidery and 3D printing technology. This allows for extra movement within the fabric, but also enables full gain between the capacity and material thickness that is printed on top of the fabric. This enables designers to bring unique designs to market that are not possible in any other way.

The inspiration for the printed Kimonos comes from the IKAT traditional weaving process, where unique patterns are becoming new gradient and harmonic surface in 3D technology. The combination of past and future techniques allowing tailor made production with unique materials and parametric patterns.

Each garment is crafted from 3D to 2D CAD manipulations which create a single, precise piece of fabric for the garment, meaning there is less need for multiple seams and fabrics to create a single garment. The collection focuses on a sustainable approach using 3D printing without any support or waste materials. This is a unique approach for the future of 3D printing in the world of textiles. In fashion, it's important that we continually optimize and evolve to introduce new design forms. During the past year, I experimented with numerous different fabrics and technologies to incorporate 3D printing within textiles. Achieving this milestone takes us away from 2D design and opens up a world of wearable 3D garments.

The 3D printed garments can be seen in a Virtual Reality application, engineered a realistic 360 exhibition space to display collection of digital and printed garments. This allows the audience to view the 3D collection in virtual reality via website.

Ganit's project awarded as one of 10 project part of Horizon 2020 EU grant. Re-FREAM is a collaborative research project where selected artists and designers team up with a community of scientists to rethink the manufacturing process of the fashion industry. Goldstein leveraging Stratasys direct-to-textile printing technology exemplifies Re-FREAM's goal of fully digitizing design workflows – from design through to production. In doing so, it demonstrates the possibility for localized manufacturing and customization – considered by many as the future of fashion.

AdditiveCeramics | Maurice Riegler | Lennard Wilde

Dekagon

Description

Starting with a single continuous path we designed Dekagon. It was less about creating a functional object than about pushing the boundaries of vase mode and demonstrating why 3D printing is a raison d‘être in ceramics manufacturing and fabrication. The design cannot be produced using standard manufacturing processes (casting, turning). The appearance not only gives a sense of the manufacturing process, but also makes it very clear to people who are interested in 3D printing. We also noticed that people without background knowledge of additive manufacturing were able to understand the printing process much better than, for example, with classic FDM plastic printing, due to the low resolutions and scale.

The object was printed from semi-fat Westerwald clay and then glazed and fired at 1240°C. It was printed at a layer height of 2mm with a 4mm nozzle. Printing time 1h 46min.

AdditiveCeramics | Maurice Riegler | Lennard Wilde

Karaffe_hnkl_404

Description

Since the beginning of the year we are working on a small tableware series consisting of cup, bowl and carafe. Since only one object per submission is approved, we decided to submit the carafe as a personal favorite piece of our series. Especially the blend from the smooth surface to the structure and back again is the special attraction of this object. However, the surface structure is not only a decorative ornament, but also a functional element. It ensures a good grip and a visual connection between the individual objects. In addition, the structure also provides improved heat insulation, making handles superfluous.

We have named the series „hnkl_404“ in reference to the function and the computer-based form finding process. The name is composed of the word „henkel“ whose vowels have been removed and the Internet error code „404“, which is nowadays widely associated with the absence of content.

Taktilesdesign GmbH I Sylvia Goldbach I Eric Bahr

Tactile Compass for colours

Description

1st generally valid definition of the tactile 3D surfaces of colours for the blind.

Layout/Design

The Tactile Colour Compass leads into a new world of perception. It guides its users through landscapes, pictures and everyday objects. The surfaces of the compass are created by LFS by approaching nature, associations. Taktilesdesign adds specific elements. The reference to the historical compass & colour wheel serves to open up association to guidance and orientation. As in nature, the tactile surfaces from soft to hard, through warm to cold materials, do justice to the colours in their representation. This high demand on the production of different properties in one process is only possible with the latest generation of 3D printing

Degree of innovation

There is no standard code for colours yet! The new language of haptic experience for blind people creates a new harmonic sensation when touching. Texture will act in function of communication, regardless of language

Potential for additive manufacturing

The individual group of users justifies a less high edition. The small hexagon part can fill construction spaces effectively. Numerous materials are being used. Our Compass cannot be manufactured in other than additive manufacturing due to 1 step combination of models with high level textures and colour with the latest materials of stratasys and Roland UV printing.

Economic potential

The inclusion of a disadvantaged section of the population in the public sphere is in the social interest. 80% of the blind are older than 50 years Tendency: increasing due to abuse of diplays in early childhood.

Shape-changing Edible Paper

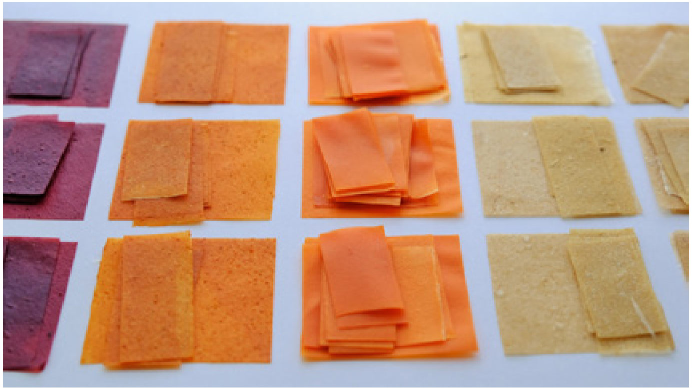
Description

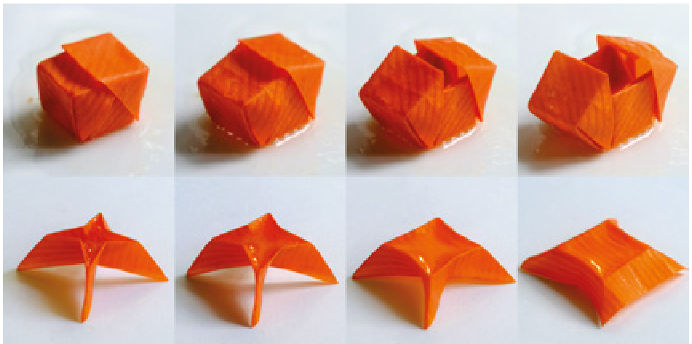
Supporting Chefs in Creating Dining Experiences with Shape-changing Origami Structures, using Vegetable and Fruitbased Paper

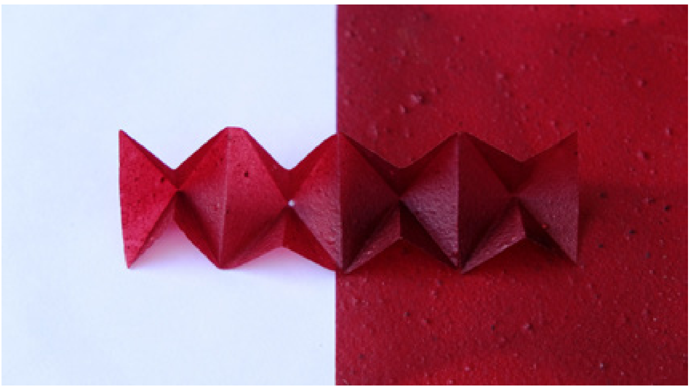
This project started as Elzelinde her Industrial Design Research project at the Eindhoven University of Technology. The intention of the project was to create a shape-changing material, that could be made by chefs in their own kitchen, with the only addition of a 3D food printer.

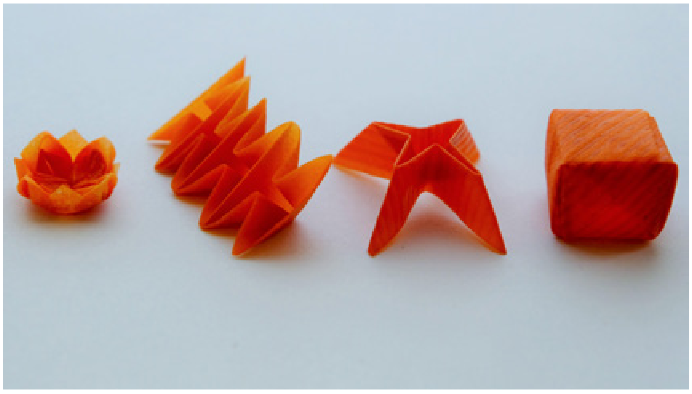
The result is edible, shape-changing origami, which can be used by chefs to create unique dining experiences. Origami structures are folded from vegetable and fruit-based paper, on which a pattern is 3D-printed. Those folded cubes transform when adding a sauce on top, creating this surprising fourth dimension. The paper composition and the material solution were developed while focusing on three requirements; the paper needed to be foldable, reactive and easily made in a restaurant kitchen. The outcomes of this material research were evaluated with chefs who were guided in folding an origami structure, tested the changeability and were asked to taste the paper. Interviews were transcribed and analysed, enthusiastic ideas for implementation in dishes were derived and a direction was set for future developments.

The first phase of the project is finished, now the focus is on creating an even faster reaction and better mouthfeel of the edible paper. Also, because the material both can be produced from fruit and vegetable residuals, using fermentation techniques and the 3D food printing technology, it will be implemented as part of the products and services of Upprinting Food.









Victoria University of Wellington I Courtney Naismith

Digitally crafted flax baskets

Concept

Using design and 3DP technologies within the upcycling process allows for a more efficient production line and they play a crucial role in adding value to designed products, so consumers have longer user to product relationships. 3DP products can also offer customisation, optimisation, localised production, and can repurpose low-value materials into functioning objects. The final products show that even the most problematic plastics which are considered 'non-recyclable' can be repurposed through additive technologies and design. Plastic waste materials such as polystyrene and soft plastics from Air New Zealand were upcycled into 3D printed designed artefacts that reflect NZ identity and culture. Organic waste materials such as flax strands from the New Zealand Māori Arts and Crafts Institute (NZMACI) were added to filament combinations to enhance aesthetic qualities and produced better 3D printability. Experimentation enabled the discovery of unique material properties, tailoring design aesthetics to FDM printing capabilities. By developing novel visual, tactile and structural qualities using 3DP to accentuate or complement material properties, it has resulted in products that tell stories. These narratives are deeply embodied within the products and are communicated through form, structure, material quality and surface texture. These cultural, material and technological references, symbolise their heritage, explaining where the artefacts are from in both a cultural and material sense, thereby giving them entirely new value. Using identity and narratives within products allows users to build a connection with the object, so they tend to hold on to it for longer. Alternatively, 3DP upcycling enables these materials to be recovered and transformed into entirely new products when value or quality deteriorates.

Description

The soft plastic and flax filament combination produced a natural, organic-looking material quality connecting indigenous materials to contemporary production and reuse. The visual and tactile qualities of the designs are reminiscent of traditional Māori weaving aesthetics; however, they are crafted in a completely different and modern way. The designs celebrate imperfection and age with grace as they change colour from an organic green to natural brown overtime. Additionally, due to the uniqueness of each flax strip, every print and layer has differences in pigmentation. 3DP enables designs to be adapted, and surface textures can be changed, producing bespoke products for every print.