

Finalists

purmundus challenge 2018

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 Altair

3D PRINTING
INDUSTRY


materialise
innovators you can count on


3D SYSTEMS

e3s
e-Manufacturing Solutions

 **DSM**
BRIGHT SCIENCE. BRIGHTER LIVING.

 **Fraunhofer**
GENERATIV

PRODWAYS
THE NEW WAY OF PRODUCTION

VDID
VERBAND
DEUTSCHER
INDUSTRIE
DESIGNER

3D-Sprühkopf



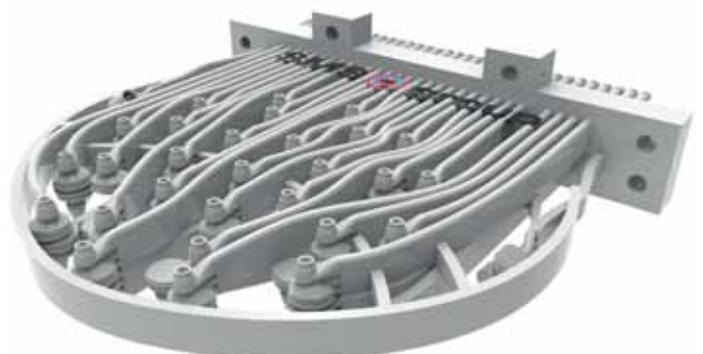
Description

Closed-die forging presses are used, for example, in the automotive industry. The spray head removes scale from the dies, cools the die surface, applies lubricants and dries the dies. SMS group now goes a step further with the new, additive-manufactured 3D spray heads: The external-mix two-fluid nozzles produce an extremely fine aerosol. Unmixing, as in internal-mix systems, naturally cannot occur with this technology. The homogeneous, constant-over-time spray pattern provides for a long tool service life and optimal spraying results. The nozzles can be switched individually or in zones and offset in time. To switch the nozzles, SMS group continues to use the tried and proven membrane material for the 3D spray heads. The membrane platelets are located directly at the nozzle. The short switching periods allow for high dynamics, while dripping is precluded.

Apart from these advantages, the new 3D-printed spray heads offer even more benefits:

- Extremely light design and low structure height
- Spatial nozzle arrangement customized to the client
- Low installation and maintenance costs
- Leak-free system in one-part construction
- Flow-optimized form to prevent deposits in the canals
- Prevention of spray medium collection on the spray head
- 3D print of customized nozzle forms
- Minor damage in a crash
- Fast acquisition due to automated construction
- Environmentally friendly production

We offer you an optimal, perfectly attuned 3D spray system consisting of spray technology, 3D spray head and spray automation. SMS group can deliver both new 3D spray systems or retool legacy spray systems with 3D spray heads. Upgrade your spraying technology to the latest level and invest in an innovative system that will pay for itself with low cycle times and high outputs.



Bionisch inspirierter Kombibrenner

Description

Additive manufacturing methods allow us to “reinvent” products and components and in so doing to make an important contribution to the efficiency and sustainability of future systems. This design study for a bionically inspired dual fuel burner shows how conventional components from the processing industry can be shaped into organic, functionally optimised structures. The dual fuel burner shown makes targeted use of the freedom offered by laser melting:

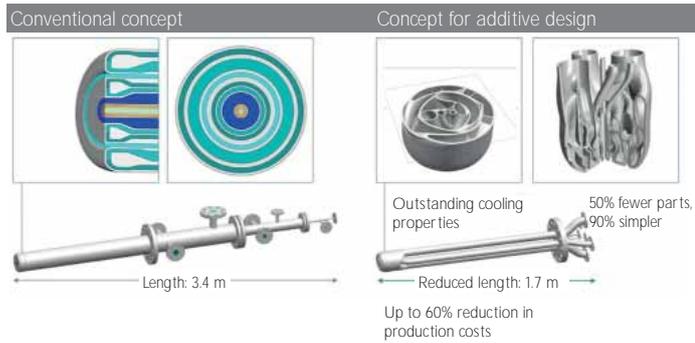
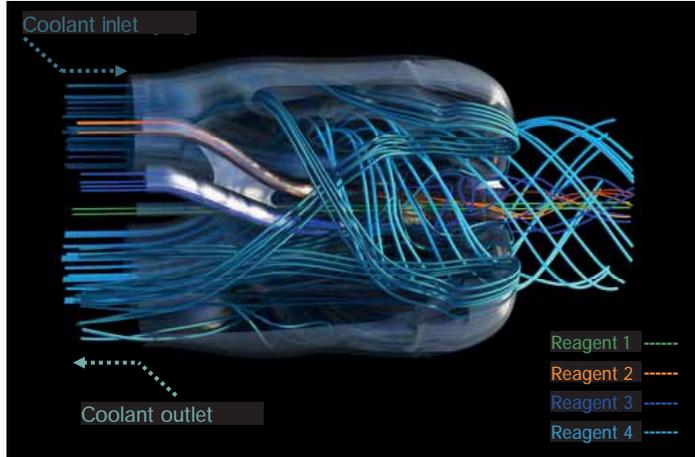
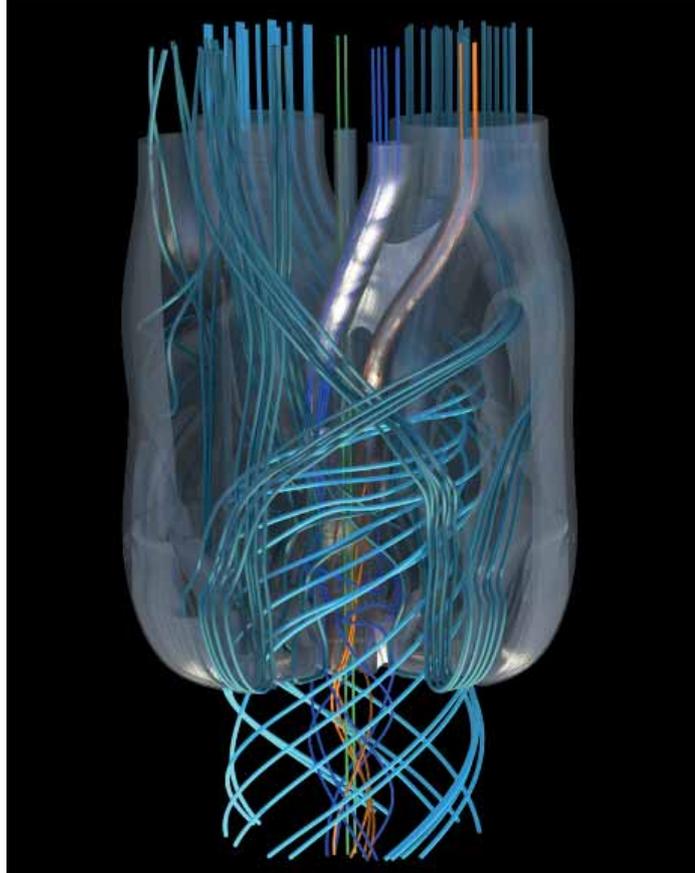
1. Wall structures with a thickness of just 1 mm in the hot bulkhead offer ideal cooling combined with a high degree of strength
2. Optimised fluid distributors channel coolant and reagent with minimal flow resistance
3. Pipe connectors allow the entire system to be assembled quickly and easily
4. These 3 perspectives are bundled together in a single component that follows AM design rules with no interior supporting structures

The function-based design process takes nature as its model and uses software-based, evolutionary algorithms. The uniform and efficient distribution of the coolant and reagents for the high-temperature application is optimised via a large number of simulations. This design results in the more efficient use of resources, more flexible and simplified production, and an extended useful life for the component in comparison to conventional design. This makes the contents of this design study ground-breaking for the future application of additive manufacturing methods to produce components for the processing industry.

An experiment illustrates how efficient the cooling is: Despite conditions that heat the conventional component to 600 °C and can therefore lead to stress-induced tearing, the 1mm-thick bulkhead with individual channels remains well-cooled while also maintaining mechanical stability and compressive resistance. The welding torch flame only warms the test object (for the purposes of the experiment the separately produced exterior ring) to about 180 °C with flowing coolant, which has also been verified by theoretical CFD calculations. Once the heat source has been removed the surface of the component cools entirely in a fraction of a second so that it can even be touched – making it much less susceptible to hot cracking under changing stresses.

The large number of small channels makes the structure highly resistant to compression. Under the testing pressure of 56 bar required for TÜV licensing the component was not destroyed despite internal pressure of 240 bar.

Experimental tests involving 5,000 hours of operation at a firing temperature of 1500 °C in industrial firing facilities with a thermal output of 200 MW have already been carried out using a component licensed by TÜV in accordance with the pressure equipment directive.



Spritzelement des Walzenkühlrings

Spray element for cooling rollers at a bar steel plant

The spray element is used in roller structures for the production of milled bar steel. It cools the rollers, which mill the hot bar steel into shape at temperatures of around 1,000 °C.

The spray element is part of the hybrid design of the roller cooling ring (see figure 2). This is a ring welded from a stainless steel pipe with two connection points. The stainless steel pipe has holes drilled into it to house the spray elements that have been produced by means of additive manufacturing. Clamps are used to attach the elements to the pipe.

The spray element's design is structured from the interior to the exterior, in keeping with its function (see figure 1). Three integrated flat fan nozzle geometries are arranged in set positions, from which a flow-optimised channel leads to the connecting hole in the stainless steel ring from a fixed-tangent fluid inflow. Creating a wall thickness around the channels means that material is only used where it is actually required in order to fulfil the element's function. The additional design ridges enhance the rigidity of the component.

An O-ring that is moulded to the curved surface of the stainless steel pipe is used to seal in the fluid between the spray element and the stainless steel ring. This O-ring is held in a trapezoidal O-ring nut to secure its position within the spray element during assembly. Clamps are used to connect tabs on the spray elements to the ring. The spray element is produced from Alumide® using the SLS process. The material, which is a combination of polyamide and aluminium, is suitably rigid, conducts heat well for cooling self-protection, and is low-friction so that particulates from the sintering process are less likely to accumulate inside the component.

Compared to a conventional copper roller cooling ring (see figure 3), the fixed-tangent fluid inflow ensures optimised flow with no right angles or internal edges that obstruct flow and therefore lead to flow losses.

The hybrid design not only reduces the weight by about 25% but also reduces the production workload, and therefore the manufacturing costs for the welded roller cooling ring. Switching from copper to plastic for the spray elements not only reduces the costs for the spray element itself but also for the entire roller cooling ring assembly. If a part needs to be replaced or if there is damage within the equipment, the spray elements can quickly be replaced.

The flat fan nozzles integrated into the design are another feature. With the conventional design they were screwed in and glued. Flat fan nozzles are set at a defined angle in relation to the roller in order to achieve the desired cooling effect. Aligning the nozzles during assembly often leads to misadjustments, however. The integrated nozzles make incorrect assembly impossible.

Additive manufacturing allows us to offer customers tailored solutions so that the spray pattern can be adjusted to their range of milled products, for example.

In addition to switching to a new design and manufacturing process, the material is also being switched from copper to Alumide®. Temperature measuring strips have been used to demonstrate that the temperatures of the plastic elements produced using additive manufacturing that are used in the milling process are well below 100 °C. This shows that self-cooling using internal fluid circulation and the thermal conductivity of Alumide® works, and that the material is suitable for this application in the severe conditions of a milling plant.

The first applications in practice at the customer Deutsche Edelstahlwerke in Siegen have shown good suitability for use to cool the roller ring, from both a short-term and a long-term perspective. Figure 4 shows photos of the spray elements in use.

The design developed for the spray elements can also be adapted to other applications involving SMS group machinery. There are similar applications in other sectors of industry, which this proven and resource-conserving AM design could be adapted to as necessary.



Figure 1: Two views of the design of the new spray element



Figure 2: Diagram of the roller cooling ring with spray element produced using AM



Figure 3: Conventional cooling ring design

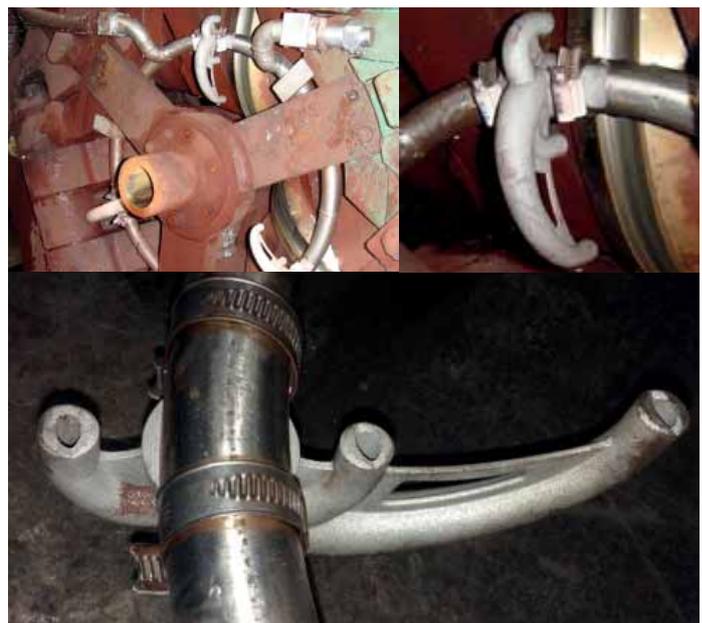


Figure 4: Spray elements in use

LightHinge+



Lightweight bonnet hinge produced using additive techniques

The new LightHinge+ bonnet hinge from Edag, voestalpine and simufact uses efficient engineering to take advantage of the potential offered by additive production. This reduces its weight by 52% and allows the integration of a pedestrian safety function using contour-optimised, toolless production involving limited finishing work.

Integration of functions

The most innovative feature of the bonnet hinge is the integration of an active bonnet function. Active bonnet hinge systems are highly complex due to the strict requirements in terms of safety and functionality. In the event of a collision with a pedestrian they increase the distance between the impacting body and the hard engine components by raising the bonnet. A pyrotechnically triggered actuator activates within a fraction of a second and raises the bonnet.

The geometric freedoms offered by additive production allowed Edag's engineers to develop complex weak point structures. These are designed so that a predefined exertion of force breaks the pyrotechnic actuator and releases a swivel joint, thus creating additional freedom of movement. This allows the actuator to raise the bonnet in the event of a collision with a pedestrian. The space that is created acts as a crumple zone, absorbs the impact with the pedestrian, and protects them from the hard vehicle components. This means that the kinematic system is not created until it is required. The connection point for the pneumatic suspension, the mounts for the windscreen washer fluid hose and the channel for the shoulder bolt have also been integrated into the hinge. This integration of functions reduces the number of parts by 68% compared to its metal counterpart, and more than halves the assembly's original weight. This highly-integrated hinge function can be used in the much more compact installation spaces of sports cars or other high-performance vehicles, where no solution has previously been found for the active bonnet function, usually for reasons relating to space. A component test confirmed whether the virtual development of the active bonnet function had been a success. A pyrotechnic test rig was set up at Edag, and a collision with a pedestrian was simulated. The results indicate that the bonnet was raised by about 50 mm within about 25 ms of the actuator being triggered. This is about a quarter of the time it takes to blink. The weak point broke as planned and the required freedom of movement was achieved.

The engineering

Edag started by conducting a competition analysis of various different hinge systems, before drawing up concepts for solutions. A multi-disciplinary team consisting of lightweight construction, safety and vehicle body experts from Edag, production specialists from voestalpine and simulation experts from simufact was brought together for this purpose. The strict requirements with respect to stability and rigidity despite the limited availability of installation space were met by opting for stainless steel 316L.

The second step was to optimise the topology, which involves calculating the minimum amount of material required based on the actual stresses. The complex geometries the result can usually only be produced by means of the powder bed-based metal laser melting process (SLM or LBM) with a significant need for a support structure. In the case of the LightHinge+, the support structures to be subsequently removed would have accounted for more than 50% of the total volume of material to be melted. Thanks to the close cooperation, this figure was brought down initially to 30% and finally to below 18% following multiple iterations by optimising the orientation of the components and implementing design measures. This almost completely eliminates the need for subsequent processing steps, and ensures the highly efficient use of materials. These post-processing measures typically account for around 30% of production costs.

Despite the extensive changes to the design in comparison to the topology optimisation in order to reduce post-processing, the application of bionic principles facilitated an overall reduction in weight of 52% compared to the comparable design using sheet metal. The tensile triangles method and Mattheck's principle of tree branching had a particularly favourable impact on weight reduction.



Bonnet hinge produced using additive manufacturing (left) and sheet metal (right) (© EDAG)

Summary

The project showed that additive production can be implemented cost-effectively if it facilitates a high degree of functional integration in a component and therefore benefit to the customer. The purely automated implementation of a topology analysis that does not take functional integration or an efficient manufacturing concept into account sets developers on the wrong mechanical track from the outset, and prevents innovative solutions from being found. What we now need to do instead is to leave old ways of thinking and designing behind, and completely rethink components in light of the opportunities offered by additive production. The hinge shows that additive production stands a good chance of overtaking rapid prototyping and rapid tooling, and adding a new dimension to traditional production methods and design possibilities.

New, simulation-based approaches throughout the development process are the key to a controlled, laser-based additive production process and compliance with tolerances. The LightHinge+ combines improved safety and lightweight construction in a production-compliant and appealing design.

Upper Engine Mount Bracket



Description

Motorcycle engine bracket subjected to fatigue and vibration loading has been lightweighted by 35% using ParaMatters Generative Design Technology. The design for targeted for AM, it was Additively Manufactured by Renishaw and installed in a running motorcycle.

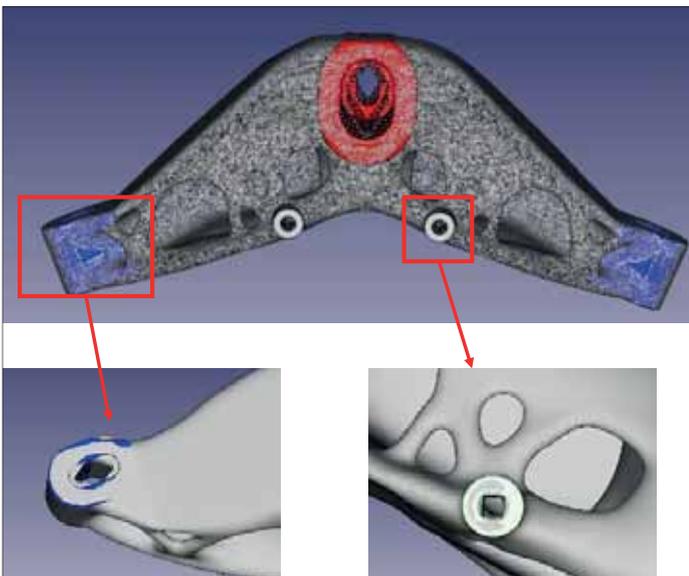
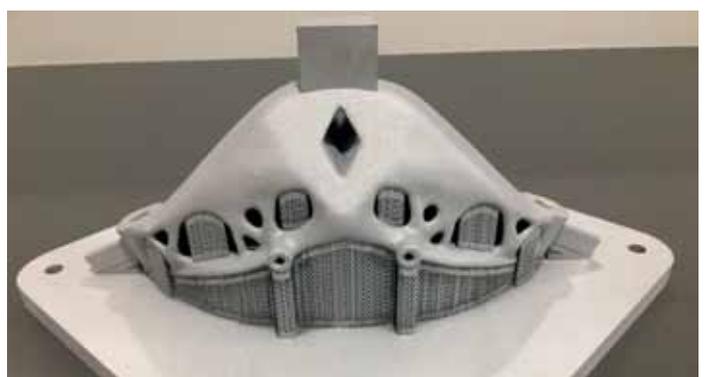
Re - Design Guidelines

Mechanical Performance:

- Weight Minimization
- Fatigue Constraints (static stress with safety factor 3.0)
- Vibration Constraints (1st frequency > 91 Hz)

Additive Manufacturability:

- Minimum Supports
- Post Machining for Tolerances
- Mass Production



Available Design Domain with Non-Design Features

CongiCAD by ParaMatters

Material: Aluminum alloy AISI10Mg

Loading: 6 Static and Vibration Load Scenario

Design Goal: minimize Weight

Constraints:
 max Stress < 75 Mpa (safety factor 3.0)
 1st Natural Frequency > 91 Hz

Optimized	Original
<p>Result:</p> <ul style="list-style-type: none"> • Weight reduction ~35% (520 gr. Vs. 823 gr.) • Stress reduction ~20% (safety factor 7) • 1st Natural Frequency 93Hz (>91 Hz) increased by ~2% 	

Trailing Arm Suspension



Mini Cooper Suspension System was re-design for Additive Manufacturing

47% weight reduction was achieved using ParaMatters generative design technology. Design is aesthetically very beautiful and functional. It was successfully 3D Printed.



Lightweight horse race stirrup optimized through generative calculation

During a horse race a professional jockey is allowed to weigh only 56 kg including equipment like clothing and saddle. The less heavy the equipment is the more a jockey is allowed to weigh. As the jockey stands in his saddle while riding the stirrup is a main connector between jockey and horse.

This stirrup's form is derived from a Möbius strip and affords a secure stability for feet whereas it doesn't catch the feet in the case of an accidental fall.

Regarding bionic examples the stirrup's Möbius-form was optimized through calculating the flow of forces. Reducing material at the discovered parts and inserting a lattice structure inside an integration of weight reduction is supported. Printing it in Ergal which is an extra lightweight aluminum alloy the stirrup performs least material weight with most stability, stiffness and security.

Sintered model in cooperation with



Frame One - das neu gedachte Fahrrad



FRAME One - the reinvention of the bicycle

A 3D-printed and tailor-made bicycle. A high-tech product with features such as GPS.

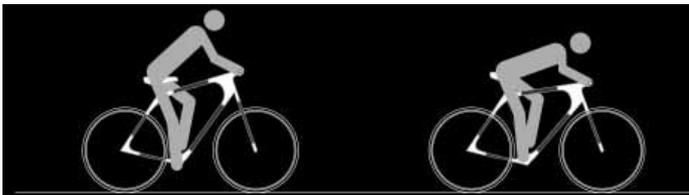
A new ecological challenge is looming in the field of mobility. One response is to get on our bikes. But conventional bicycles are produced cheaply in Asia, and are not tailored to cyclists' individual needs.

Our solution: FRAME One - a tailor-made bicycle that is produced locally for the price of a conventional bicycle. The high degree of customisation is made possible by a partially 3D-printed frame. The frame is made up of 3D-printed joints that are tailored to the rider as well as standardised carbon tubes that are connected using the joints to create a frame, fork and handlebars. The bicycle is tailored to the rider in order to achieve the best possible performance and facilitate healthy, ergonomic cycling.



FRAME One is THE alternative to industrial mass production, and it is made possible by additive manufacturing.

Variation



The bicycle is tailored to the rider in order to achieve the best possible performance and facilitate healthy, ergonomic cycling that avoids bad posture. FRAME ONE is personalised by the customer according to their aesthetic and functional requirements. Our production system allows any position or frame type to be created.

3D printing is not just the method of production but also the new aesthetic of the FRAME ONE.

Frame One Store

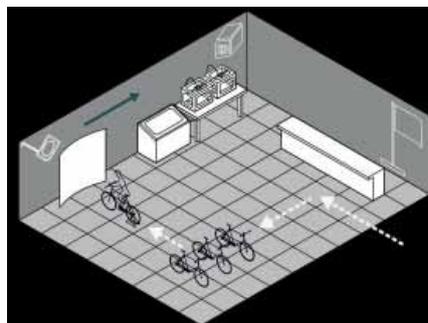


Instead of outsourcing production as usual, we would like to bring it back. That is why we want to produce and sell FRAME ONE in a dedicated store in the form of a glass production facility. This transparent method of production not only serves to enhance functionality and reduce costs, but can also be used as an outstanding aid for marketing purposes. The customer not only experiences their bicycle being produced locally, but becomes an active part of the process:

Financing and market launch:

Once a market-ready prototype has been completed:

1. In the early stage we mainly want to make use of family and friends for financing. Prorated financing with the help of peer-to-peer platforms in the field of crowd-funding and crowd-lending (e.g. Kickstarter) seems appropriate to us. Venture capital can of course also be used, but we want to retain majority control of FRAME One.
2. In addition to the market study, the sale of a bicycle that can initially only be customised to a limited extent (minimum viable product) through online distribution is to serve as an initial indicator for the realistic level of demand.
3. In the event of success, opening the first store with a broader range of products.
4. Bikes made to order and fully customisable. All components are printed by the customers themselves and assembled locally.



- Store:** The customer visit the local store.
- Selection:** Products can be tried and selected.
- Measurement:** The ergonomic dimensions are determined by means of playful cycling at a measurement station.
- 3D printing:** A personalised set of data is calculated and sent to the 3D printer. The tubes are cut to size.
- Assembly:** The 3D-printed joints and tubes are assembled to create a bicycle.

STEALTH ROLLATOR



Description

Maintaining personal mobility in old age is an important factor for the quality of our lives.

The aim of the project is to design a walking aid that appeals to a design-oriented, ageing society and offers assistance with mobility restrictions. The rollator with stealth or edge design is intended to differ significantly from the systems available on the market, and not give the impression of being a medical aid. Instead, it should be used as a modern accessory that the owner enjoys using in their daily life. The design reflects a sporty and active lifestyle with clearly defined lines and edges that are based on the design of Italian super sports cars.

The production of the extravagant design with different profile cross-sections and connections makes it possible to exploit the full potential of additive manufacturing.

The wheels have space for ball bearings with an external diameter of 22mm, an axle diameter of 8mm and a bearing width of 7mm.





Description

Flexa is a sports-bra, which is individually fitted to the breast by a body scanning method and 3D print. Two different textures allow flexibility on certain spots and support on others. By the scanning method body measurements are being captured. During the process an individual pattern is designed and stained with supporting structures employing 3D technology. Colors are freely eligible and various combinations are possible.

Especially in high-competitive sports we anticipate to push the athletes to even better performances through the use of new technologies.



Adidas Grit



MATERIALS, ASSEMBLY & RECYCLABILITY



RECYCLABLE CONSTRUCTION

Grit is designed to use sustainable, better-in-demand, and structures that functionally replace the need for several parts and materials.

Grit is manufactured in 2 main parts that allow the materials to be separated effectively post-use and recycled as they are not composite materials.



BENEFITS TO CLIENT

HIGHER PROFIT MARGINS

Grit is created based on learn (biometric data, Adidas interfaces directly with the user absorbing the relative energy, gaining the greater profit per pair.

UNTAPPED OPPORTUNITY

A new product opportunity for Adidas with no direct competitors.

DECREASED PRODUCT RISK

The shoes are manufactured after an order is placed, with no extra inventory. Tooling costs are reduced as molds for shoes of several sizes are not required.

BRAND REPUTATION

Innovation and recyclability play a big role in customer acquisition and adds to Adidas' brand.

Description

Grit is a pair of resistance training shoes, that replicates the experience of training on soft sand. Grits can be worn to by athletes to train on any running surface. The sole of the shoe mimics sand, it absorbs energy from the user, fatiguing the leg muscles faster through strenuous exercise. Studies have shown, through sand training, athletes build up leg strength over time and reduce post-workout muscle soreness. The shoes are to be used only in training sessions. Come game day, playing without Grits makes performing considerably easier for any athlete.

The concept of Grit is based on research conducted on sand dune resistance training. The world's greatest athletes, Kobe Bryant, Kevin Durant and other elite athletes, train on soft sand to increase their level of difficulty of exercise. Sand training slows them down considerably, training explosive muscle movements and strengthening specific muscles for acceleration. The goal of running with Grit's is to function and feel like running in soft sand. The foot is nested in a lattice sole. When the foot strikes the ground, the lattice collapses and dissipates the energy from impact. This experience feels extremely comfortable on the bones with the shoes absorbing a majority of the impact.

When the athlete transfers body weight to the front of the foot, the structure of the sole is designed to sink, countering the athlete's motion forward. When the foot has lifted off the ground, the lattice sole relapses to its original form, ready for the next step.

While exercising with Grits on any surface, the shoes aim is to increase the amount of energy required to train. This experience provides athletes with intense but effective training in a short period of time.

The design goals for Grit were:

- To create a resistance training shoe for athletes to train on any surface by replicating the properties of soft sand within a self-contained shoe.
- Dissipate energy when the foot strikes the ground, fatiguing the athlete's leg muscles faster. This is the opposite of training shoes in the market today that return energy to the user and make training easier.
- Increase resistance by the shoe and help athletes reach their previous limits much faster and improve on them.
- Design a shoe that embodies the mindset of an athlete that continuously pushes their limits.

I started to create prototypes that at first simply used sand. Using magnetic sand, I created a shoe with sand bags glued below the sole and rain in them. I quickly learned that a when a shoe has a soft base, the foot tends to rock and be unstable. For this reason, I incorporated the idea that the foot needs to nest and be wrapped around by the sole.

Some failed prototypes were made using materials like kinetic rock and playdough in the sole.

Working through materials, I realized the benefits of lattices in shoes not for the reasons they are being used in shoes today of boosting performance and returning energy. I believe lattices are good for being able to collapse and

dissipate energy. Printing various lattice structures and learning what their physical properties were good for, I then created a lattice prototype to test with different parts of the foot containing different structures. While the heel of the foot took the most weight and impact, the front of the foot sank softly to counter the running motion, as sand does.

This led to the final result of Grit.

Grit is unique in 5 ways.

- 1 No shoe in the market today address the need and benefits of resistance training. Grit is the first of its kind, creating a new category of training shoes that cater to the physical needs of athletes today.
- 2 Grit makes training for athletes harder not easier, this is a new philosophy for footwear where traditionally designs cater to enabling the athlete as much as possible.
- 3 The construction of the shoe in Grit is unique as the bottom sole nests around the foot. This essentially surrounds the entire foot with a soft and supportive sole that absorbs impact at all angles like sand does.
- 4 In manufacturing and assembly, Grit contains just 2 main pieces. A fabric knit sock is slipped into a 3D printed EPU recyclable lattice sole. The two parts are knitted together. The materials are easily separated and recycled post use. Traditional soles are made from composite EVA foam with the strong glues and a manufacturing process that renders the shoes non-recyclable.
- 5 The visual aesthetic of Grit pushes the boundaries of what is possible with emerging materials and production techniques.

Grit has many benefits for the client – Adidas.

- 1 Grit is based on a personalized fit using the biometric data of each customer. This creates a direct to consumer sales channel eliminating the need for the middleman retailer and increasing profit margins per pair significantly.
- 2 Grit does not require tooling molds for the outsole. Shoe outsoles usually cost several 1000 dollars per mold. Grits product process eliminates the need for creating molds in 20+ sizes. A heavy investment cost is removed, decreasing the risk of investing in this opportunity.
- 3 Leveraging Adidas' future craft 3D printing platform, the channel to create Grit is already in place, allowing a low-risk investment opportunity for Adidas. Each pair can be made after ordering, eliminating the need for inventory and receiving the payment before manufacturing.
- 4 Innovation plays a big role in athletic footwear brands image often resulting in excitement from footwear enthusiasts. This innovative product line adds to Adidas' brand reputation creates a trendsetter pushing the future of footwear.

Grit makes soft sand training, a coastal lifestyle experience- accessible to athletes globally. With the sole of Grit absorbing majority of the impact, bones and joints in the body take less impact. This allows athletes at older ages to continue to exercise on hard surfaces such as concrete.

In summary, Grit brings a new untapped opportunity to the landscape of sports and pushes the boundaries of how shoes function and are manufactured today.



Description

Ever dream of a shoe that fits you perfectly, can be easily repaired when damaged and if you throw it away, it just decomposes within a few years?

With the goal of creating more sustainable footwear, "Shoetopia" - an innovative sneaker production system, is proposing just the thing. Addressing problems such as excess and waste in production, pollution or labour exploitation, the designers try to reimagine what the distribution of goods could look like. Why not sell perfectly fitted shoes as a file, to be 3D-printed locally and personally, in just the amount needed?

The core of the project is a personalized parametric model, based on user's foot dimensions. It works within a dedicated web customizer and is complemented by a measuring app. Ultimately, users could personalize their shoes' visuals, materialize them in a local 3D-printing center or, optionally, print and assemble themselves,

at home. The base shoe design consists of a resilient openwork sole and an upper part, created by printing directly onto fabric. They're assembled without gluing or sewing, so that certain elements can be exchanged, when needed. The material combination used and recommended for this project is a starch-based flexible filament with natural textile, making it completely biodegradable.

What makes the idea stand out from the crowd of 3D-printed footwear, is the emphasis on taking the whole product life into account in the design process and encouraging active user participation. Behind it, stands the belief that if you participate in the product's creation, you are more attached to it and therefore more likely to respect its value.

"Shoetopia" is not just about the fancy looks, it's about putting innovative technology to a good use.

Customized 3D printed shoes

运动分析 Motion Analysis

反弹 Rebound
支撑 Support
缓震 Cushioning

缓震 Cushioning 支撑 Support 反弹 Rebound

数据与设计的关系 The relationship between data and design

	3D 足部模型 3D foot model		鞋面形状 Vamp shape
	足底压力图 Plantar pressure map		鞋底结构 Sole structure
	足底热力图 Plantar heat map		透气孔位置 Vent position
	鞋面形变图 Vamp deformation map		支撑位置 Support position

晶格构建 Lattice construction

点云框架 Point cloud framework
均匀晶格框架 Uniform lattice framework
扭曲晶格框架 Twisted lattice framework

鞋底功能分区 Sole function partition

- 外侧支撑区 Outside support area
- 减震区 Shock relief area
- 足外侧区 Lateral area
- 足弓区 Arch area
- 反弹区 Rebound area
- 脚趾活动区 Toe activity area
- 其他区 Other areas



定制化运动鞋消费生产流程 Customized sports shoes consumption and production process

消费者 Consumer 数据扫描 Scan 上传计算 Cloud computing 决策方案 Decision design

配送 Deliverer 成品 Finished product 3D打印 3D printing 付款 Merchandise

Description

Take the 3D printing-customized sports shoe design as an example, the design has been accommodated by weight, foot type and plantar foot pressure individually. The project creates the combination of the parametric design methods and analysis of human data in practical cases. It transforms the relationship between people and products into computer languages.

Taking data analysis as the design focusing point, the author achieves the design goal which is the functionality of products. The relationship between geometric shapes of the products and the structural performances are intensively studied and analyzed in this design

Alexis Walsh | Justin Hattendorf

APEX SERIES

Description

APEX SERIES is a 3D printed fashion collection featuring a custom software app to develop hardware.

Custom 3D printed hardware is revolutionizing the way fashion is designed. New expressions are possible through 3D printing that are either impossible or extremely difficult to attain in other mediums. With additive manufacturing, new material integrations can be utilized, combining traditional handcraft and hardware elements with modern performative materials.

Small studios and independent designers are now empowered to enact on new and disruptive design ideas with production on-demand. In the past, fashion hardware development required access to large scale manufacturing and would require extremely large minimum order quantities, which has often been unattainable for small businesses. Today we can use desktop 3D printers to prototype, and small fabrication companies to produce high quality hardware, allowing us to re-think old design standards and develop a new interpretation of fashion hardware.

Rather than prototyping for a specific, isolated design problem, we decided to prototype a process for making an expansive collection of fashion products. This allows us to focus on each new garment in the collection with a sharp attention to detail, ensuring that our designs maintain a high quality of craftsmanship while giving us full creative freedom when we have an idea for a new hardware application. Using a custom app that we built together, we mapped out the flattened pattern pieces and were able to engineer the exact placements of hardware to each specific pattern piece, before physically creating the garment. This efficient method allows us to rapidly test our designs until deciding on a final form, with absolutely no wastage of materials or labor.

APEX SERIES is a fashion collaboration by Alexis Walsh and Justin Hattendorf that marries handcrafted embellishment and generative digital form. The six piece collection incorporates traditional craft with a custom physics simulation to generate 3D printed hardware for garments.

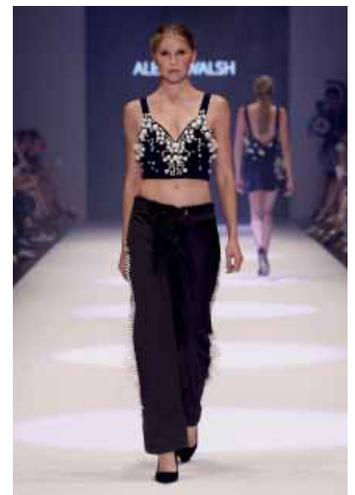
The 3D printed pieces were developed with a customized software, designed to merge complex, precise digital models with the tactile, intuitive nature of working by hand.

Once printed, the translucent hardware is outfitted with brass threads and manually screwed onto the garments. APEX SERIES explores this novel assembly technique through several variations: First, complex formations of studs are designed within the garments' flattened tailoring patterns. Bubble studs populate inside the boundaries of the top. Spiked studs augment the curvature of the pants. Randomized diamond forms placed on the dress guide the fabric draping, collapsing itself toward the body. The shoulder bag utilizes strategically applied hardware to create structure and embellishment. The coat uses dense, fractured elements to ergonomically drape along the body. The clutch bag hardware acts as a handle for the wearer to grasp the bag.

By infusing fashion design with 3D printing and simulation, the designs are able to be quickly modeled, iterated on, produced, and assembled. The custom software designed for this series efficiently maps out complex hardware assemblies within a flat tailoring pattern to eliminate excess plastic and fabric waste. By simulating how the hardware will physically interact with the body, the vast majority of the design prototypes can be iterated on and visualized digitally before manufacturing them. This process not only decreases the amount of physical prototypes needed to create a final design, but ensures that the physical prototypes made will be more successful and intentional. In addition to these benefits, APEX Series uses custom, interactive algorithms to advance hardware aesthetics and ensures that each stud variation is of the same formal language, yet each piece displays an entirely unique character from the last.

APEX SERIES is an exploration of 3D printed fashion and will continue in future iterations.

The full collection debuted at the Harvard Identities Fashion Show, held on April 8, 2018, curated and produced by Harvard. APEX coat and clutch were featured in GE's Industry in 3D exhibition on May 3 in NYC. APEX Series was most recently presented on the Platform Fashion X Lexus 3D Runway on July 21 in Dusseldorf, Germany.





Description

'Made in Belgium' 3D laser-printed eyeglasses made of titanium. The 3D technology offers a number of unprecedented options in terms of design and in addition, this technology is eco-friendly – a feature that must not be overlooked.

The Hoet Couture eyeglasses are modern and beautiful. Quality and comfort as always are the basic precepts. They are rust-proof and anti-allergic, light, yet durable and well-fitting and each available in 5 size combinations for nose and glasses.

A pair of eyeglasses, custom made and personalized with your own name engraved in the temple!

Design

The front part is made of titanium with an open structure that varies per model. When using only classical production techniques, it is nearly impossible to achieve similar frames. The 3D laser-printed HC collection includes 6 models. For the best possible comfort these eyeglasses are available in various lens and bridge sizes and are equipped with adjustable temples. The models H2, F2 and O1 even have moveable nose pads.

Eco-friendly

This technology produces eyeglasses without creating any waste, while using a very low amount of energy. An additional eco-friendly aspect is that there is no need for the production of stock.

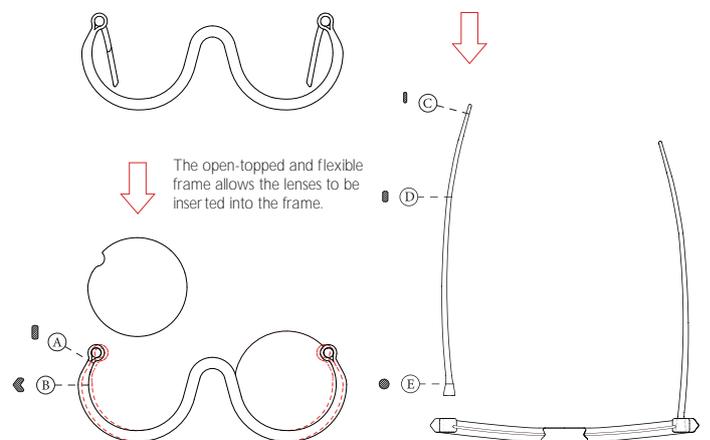
ÓCULOS

Description

It is not easy to find the right spectacle frame to suit your face shape. Because whether they are round, square or oval, every face is different. As a production process, 3D printing allows you to tailor your glasses to your face. This allows the perfect glasses to be found for any face, with almost limitless possibilities for colour, shape and style.

The formal design of the ÓCULOS spectacle frame is the result of an intensive examination of 3D printing. The printing process itself takes just a few minutes and the glasses come out of the machine ready to use. The open tops of the frames make it easy to change the lenses, which are inserted from above. This makes it possible to switch quickly between clear glasses and sunglasses.

The temples are made of brass and can also be snapped onto the frame, allowing the glasses to be taken apart and stored securely.





Necktie

The submitted file is a necktie printed in the form of individual parts to produce a flexible structure.

Because the design envelope for 3D printing is too small to print the tie as one piece, we incorporated segments and assembled them using positive locking and a snap-in mechanism. We looked at the following issues as part of this project:

Simplicity of separation from the plate

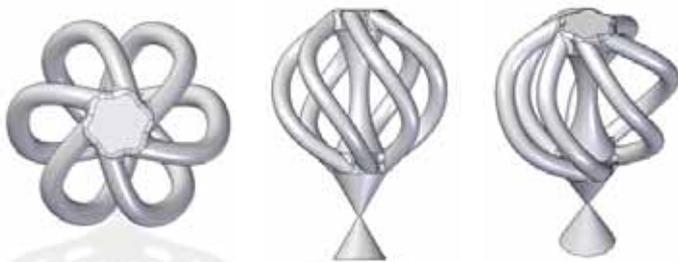
Printed metal parts are usually sawed or wired off the plate. We simplified this using a pyramid structure with a weak point of $\varnothing 0.05$ mm. This allowed us to separate the segments from the plate by hand.

Flexible structure

In order to achieve a structure that was flexible and lightweight, we designed a single piece with a helical geometry. This geometry comes into effect when reproducing the single piece, and holds it together. In this way, the SLM process produces a light, flexible but also hard structure that can be used in a variety of applications

including:

- Protective clothing (e.g. chain-link gloves for butchers)
- Jewellery (necklaces, bracelets)



Different functions

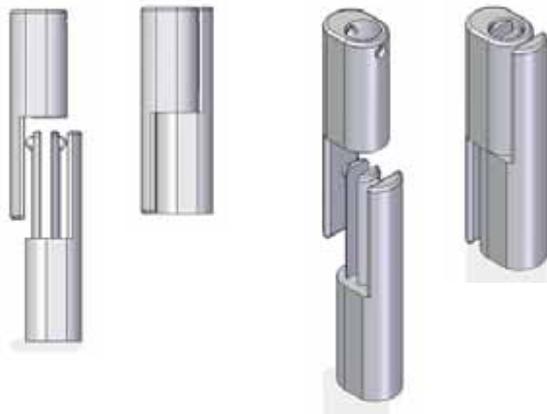
As product developers, we are always looking for solutions that fulfil multiple functions. Until now this has not always been easy in terms of producibility, and compromises were often necessary.

AM now makes it possible to focus primarily on the functions. The mindset has changed a lot, and is now very interesting for development projects!

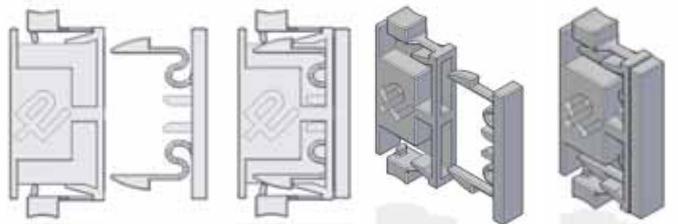
With the necktie, we want to demonstrate certain functions that can be easily and quickly implemented using SLM. Firstly there is the positive locking used to connect the upper and lower sections of the necktie.



Then there is the "hinge" solution in the neck area that links the upper section to the neck sections.



There is also the snap mechanism to connect and disconnect the two neck sections.



Finally there is the completed necktie as an image.



.step | Simon Boldrini



Description

Watch.step is a Unisex 3D printed PLA watch with a quartz Japanese movement Miyota Inside. The strap is in Polyester, made in Germany and the watches are printed and assembled in France (Lyon). 100% made in France

The watch's case has been specially designed for .step, it's a very simple and practical clip system.

Erlebnis der unbegreiflichen Dinge



alphabetum tactus

A pure and simple unit is a too specific and too general symbol for the sighted. Our senses draw us to symbols. Symbols serve as storage for mutual dialogue and for our ideas.

We have these kinds of symbols for our eyes: letters
And also for our ears: the articulated phonemes
But we don't have any symbols for our sense of touch!

Since we lack this language, the connection between us and those who are born deaf, blind and dumb is completely severed. There is the embossed printing invented by Louis Braille, but that is difficult for the sighted to read.

With a body of words that cannot be presented using objects that can be perceived and can therefore be described as intangible, we can only connect ideas by means of a series of fine and deep combinations of similarities that we perceive between these imperceptible objects and the ideas they engender.

All abstractions are merely symbols with no concept. The concept is excluded by separating the symbol or characteristic from the physical object, and it is only by reuniting the symbol with the physical object that the science once again becomes a doctrine of concepts.

That is why examples are so often required in discussions and in writing.
- Content, form, reality, concept



litterae odorum

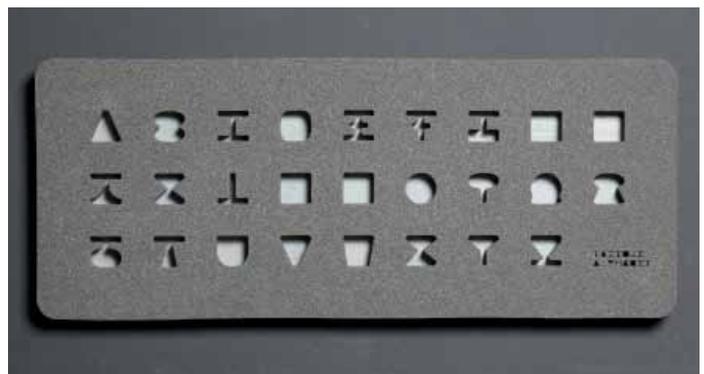
How do we distinguish a fragrant rose from a foul-smelling fish? What effect do odorant molecules have in the nose, and how does the brain recognise these stimuli?

Fragrances interact with receptors situated in the cell membrane of olfactory neurons. People have approximately 350 receptors. Rats and mice are the mammals with the best noses, with up to 1200 different smell receptors, followed by dogs and cats with around 800 to 900.

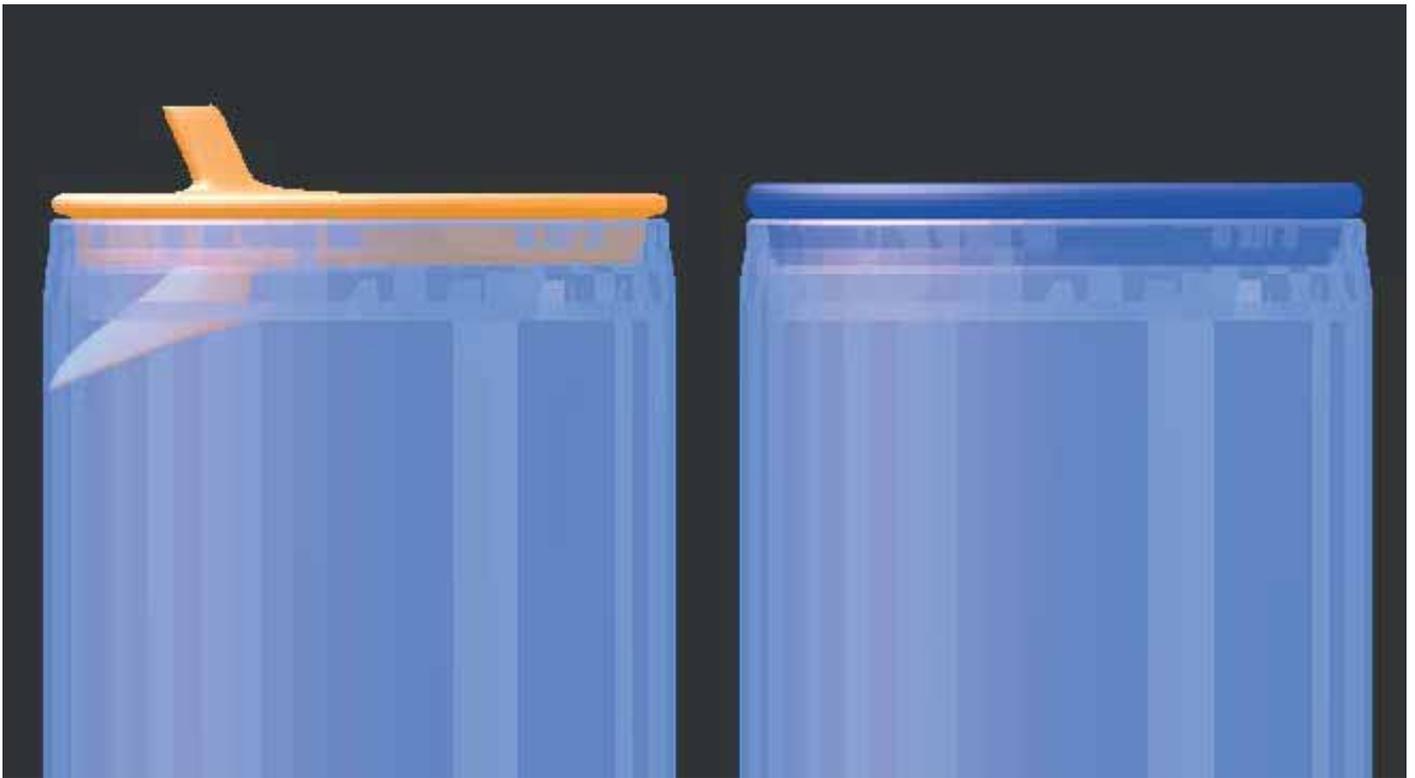
Olfactory neurons are responsible for translating the chemical structure of the odorant molecule into electrical nerve impulses.

The receptor proteins in the olfactory neurons only respond to those molecules whose shape and chemical properties match theirs. It is like finding the right key for a particular lock. When they find each other, the receptor and the molecule stimulate our olfactory neurons.

Each receptor is only ever used to define a single smell, similarly to the way that letters are repeatedly used to create different words. Only the alphabet of fragrances has 350 letters rather than 26.



Lid With Straw



Description

Disposable straws have caused issues for environment. With 3D printing people can customize the size as well as the material to have a unique non disposable straw lid. This straw in the lid will make it easier to get the liquids. If added a net at the entrance it can also serve as a filtered straw for loose leaf tea etc.

Also citrix drinks are said to cause damage to teeth. Using the straw will help.

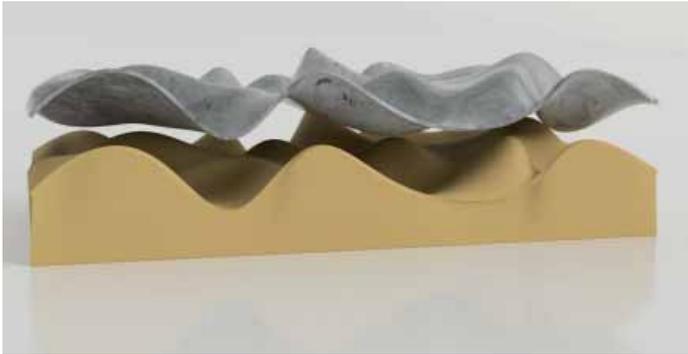
Mark Gottlieb

Interlocking Patterns



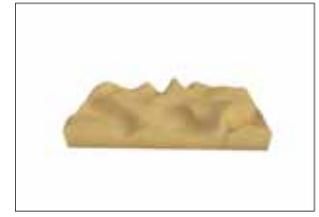
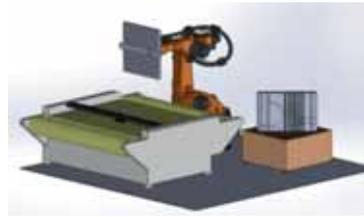
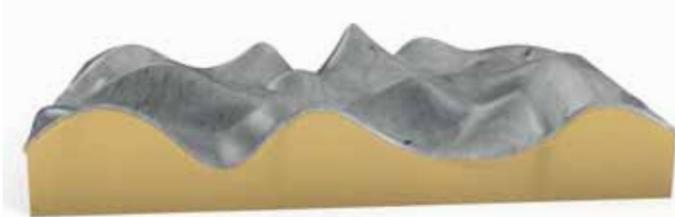
Description

Interlocking patterns 3D printed in stainless steel for beautiful shapes and are exceedingly strong. These shapes could not be made by normal fabrication techniques.



Description

INFAS is an innovative, customisable facade system that can be used both internally and externally. Thanks to its special material composition combined with an innovative new additive procedure, it offers the ability to creating free-standing organic forms out of concrete. INFAS is both a futuristic concrete facade and an insulator, making it a unique new addition in the future of architecture.



Production

The facade structure is first created using CAD. Two fundamental innovations make the creation of these customised facades possible.

First, there is the new method for the additive manufacturing of large objects (the automated Foam-Laminated Object Manufacturing (F-LOM) system). This system involves layering foam boards and bonding them together. The foam boards are automatically and precisely cut to size on a textile cutting table depending on the layer thickness used in the process.

This produces a three-dimensional foam object that recreates the surface structure created in the CAD process.

Foam-Laminated Object Manufacturing (F-LOM) offers us the opportunity to vary the material. This not only allows the product's visual characteristics but also its technical properties to be covered as well. INFAS therefore essentially consists of foam with insulating properties. The fire resistance also ranges from F30 to F90 depending on the insulating material and its strength, which means the system can be used in almost any field. Manufacturing process (substructure): Prof. Andreas Fischer, syncee UG

A special, hardening adhesive is applied to the foam body that provides the shape. Concrete Canvas is then laid on top and moistened using water. This makes the material flexible, and it takes on the form of the foam body beneath. Concrete Canvas is a flexible mesh with integrated concrete. In addition to the visual aspect, once it has hardened this mesh is also waterproof and fireproof and can therefore be of benefit externally, for example in an exterior facade. Concrete Canvas is water-resistant but a PU layer may be applied between the insulation and concrete for special requirements.

For the first time, a concrete facade can take organic, soft forms without interfering with the design. Minimal production costs for maximum effect. The original architecture is also often an obstacle to the ideal facade cladding since curved shapes such as bent walls present challenges.

The additive production process of INFAS now also allows such obstacles to be overcome. The angle of curvature is integrated into the model and production is tailored to the architecture without significantly adding to the time and money that needs to be invested.

INFAS is an innovative and modular facade system that offers technically useful and futuristic design in a way that saves time and money.

INFAS equips us for the future.

Voronoi Lampe aus dem 3D-Sanddruck



Description

The "Voronoi Diagrams" which date from the last half of the 19th century have been used extensively in engineering and scientific disciplines, and the possibility of using them for creating abstract ornamental designs has been lately world-wide explored.

They have some features that make them particularly useful artistic tools: their conservation of symmetry, and their continuity with respect to changes in the generators, which makes possible smooth, organic animations of tilings.

Following these principles and gathering them together with the Sandhelden philosophy, we create this Lamp in order to create a different atmosphere in terms of interior lighting.

Thanks to the 3D printing technology that we use, we achieved to create a family of lamps of different sizes and functions. The point of printing this lamp out of sand makes it a unique piece for elegant home interiors.

Die erste Badewanne der Welt

aus dem 3D Drucker



Description

Sandhelden is a revolutionary technology and design start-up from Bavaria. We use the latest techniques to develop 3D printed products. Until now we have been focused on the bathrooms and interior furnishing market. Here we present one of our first major success: the world's first printed bathtub made of sand.

Thanks to the technology that we use, we were able to create the very first bathtub printed out of sand in one only piece. Supported with our post process techniques, we achieved to endow it with the proper technical characteristics that this kind of products ask for.

The texture that this kind of material gives to the bathtub makes it an exclusive design piece unknown so far.



Keyed wind instrument



Wind instrument with integrated 3D printed keys

One crucial element for wind instrument development is the problem of being able to reach the holes with the fingers. As banal as this may seem the evolution of wind instruments has been molded by this technical limitation and as soon as new solutions became available new instruments immediately emerged completely changing the sound landscape available for performers and composers.

The first documented key used to extend the natural reach of the fingers in order to cover holes was used for the lowest note of the bombard, a late medieval double reed instrument. From that first step onwards instrument makers have expanded the same concept arriving to the modern saxophones, clarinets and oboes, where the fingers don't interact directly with the holes anymore and where through complex key systems holes spread apart on instruments reaching up to two meters in length can be reached.

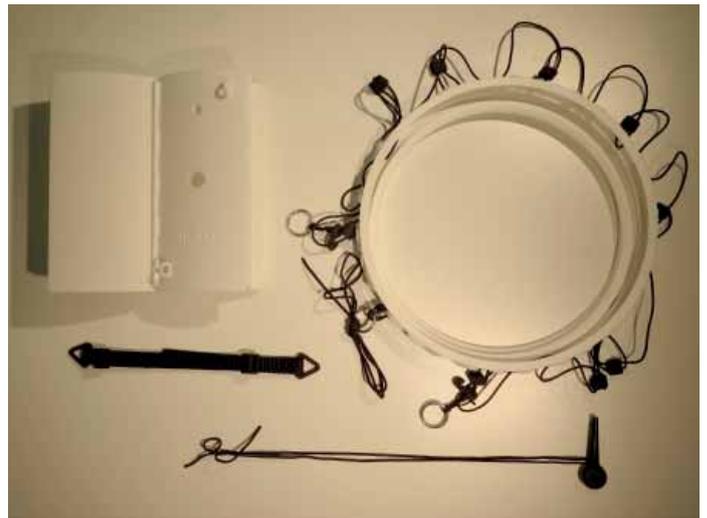
Nevertheless, the basic key concept has remained unaltered since its inception. An external mechanism added to the instrument and pushed by a spring covers and uncovers the holes. Modern and mass-produced versions of these instruments still copy the same principle, which implies that the majority of the instruments' production costs lies on the keys and not the body of the instrument itself.

My new approach to key design consists in integrating the keys to the instrument and using the flexibility properties of SLS 3D-printed materials in order to allow the production of functional keys without any additional mechanism nor spring. When carefully designed keyed instruments can be printed with incorporated keys.

As a prototype for this development I have chosen the cornetto, a renaissance wind instrument which disappeared too early from the musical landscape in order to be further developed by the addition of keys. Modern cornetto players must fight the instruments' length and unusual hole spread in order to perform. With the addition of these keys this instrument becomes for the first time in history more ergonomic. The only additional non 3D-printed element which this design requires to be added during postproduction are the silicon pads underneath the keys.

This concept is not limited only to this instrument but can be further developed for other wind instruments.

Foldable drum

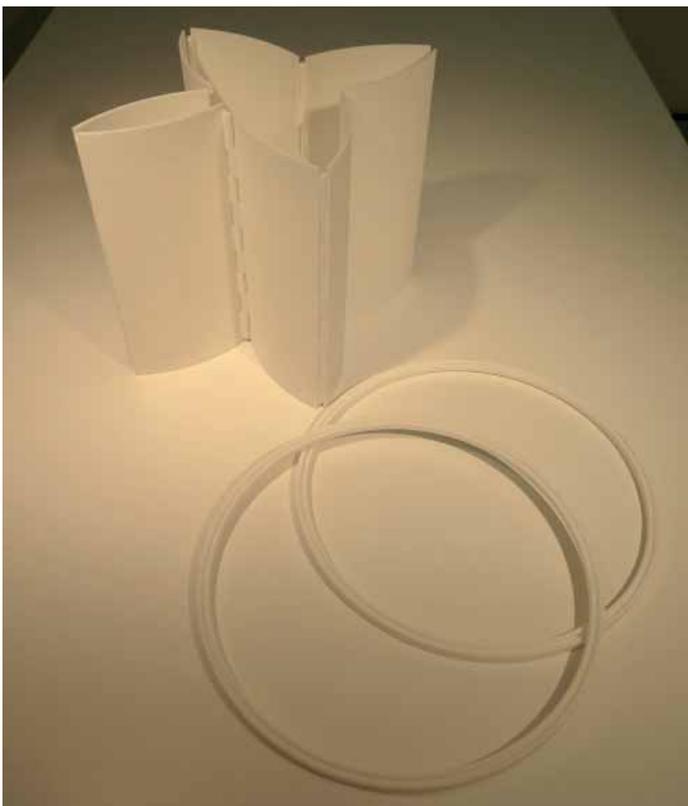


Foldable small drum for standard drum skins

Drums are basically empty resonating boxes, or seen from a different perspective, the most inefficient use of space in order to design a musical instrument. Even a small and light drum takes the space of an entire piece of hand luggage and becomes a challenge when it comes to transport.

The foldable drum simply tackles this issue by producing a compactable 3D-printed structure designed to fit standard drum heads. The only non 3D-printed elements of the design are the drum heads, the tension string, 3 metal rings and the metal axis for the hinges.

The prototype drum is a 10-inch diameter small drum for pipe & tabour use but the same concept can be easily scaled and adapted for other models and sizes.





FreeMove is equipping us for the future of medicine!

It is hoped that FreeMove will establish itself as a new, total wrist endoprosthesis that is 3D-printed from a material known as PEEK. It is to be tailored to each individual patient, and also produced on an individual basis (batch size $n = 1$) using affordable production methods (3D printing).

This customisation will above all have a positive impact on the fit, scope of movement and longevity of the prosthesis. This will facilitate a pain-free joint replacement for patients with the best possible scope of movement.



Concept illustration "FreeMove"

Description

As the central component of the wrist, the carpus is by far the most differentiated element of the human musculoskeletal system. What seem like minor injuries to this joint structure can impact the function of the entire hand, and thus reduce the affected person's quality of life. In a worst case scenario it can even affect their earning capacity.

In addition to injuries, rheumatoid arthritis (RA) is a big problem when it comes to the functionality of the wrist. Studies looking at the frequency of RA show that this condition afflicts between 0.5% and 1% of the global population. Women are about three times more likely to be affected than men. RA affects the wrist in almost two thirds of cases. If both wrists are affected and nearby joints are unable to compensate, the loss of function can only be improved by operating. Wrist arthrodesis (ossification) is the current "gold standard" for treating wrists with advanced damage. Ossification transforms the function of the wrist to one of holding and support only, and entails significant functional restrictions. Restoring the functionality of the wrist is therefore very important for the fine motor utility of patients' hands. This underscores the importance of the wrist endoprosthesis.

The positive results following the implantation of the Charnley hip prosthetics around 1960 as part of the treatment of COX arthritis led to a clinical breakthrough for endoprosthetics involving the musculoskeletal system. Endoprosthetics have not however achieved comparable status in field of hand surgery. This contrasts sharply with the current standards of treatment for analogous conditions of the major joints such as the hips or knees. The low number of prosthetic hand implants can be attributed to the limited longevity of the artificial joints as well as modest functional results in some cases following prosthetic implants.

The number of procedures or the demand for adequate treatment is set to rise in the future due to demographic trends, which point to the ageing of societies. This is having a corresponding impact on the socio-economic factors of our health system.

Principle

Previous prosthetic treatments always involved a massive loss of bone. The principle behind the FreeMove endoprosthesis envisages a kind of "pan" that takes in the nearby carpus bones and sets them in place using bone cement. This principle of incorporation is new, and has never been implemented in this way. It requires the prosthetic to be tailored to each patient.

The principle behind FreeMove also involves preserving substantial bone mass in order to have sufficient bone material available to attach a new endoprosthesis if revision is required. Existing concepts are applied for attaching the prosthesis to the underarm. This also involves tailoring the prosthetic to each patient's specific geometry.

There are also plans to allow the endoprosthesis to be secured using "artificial tendons". Printing different materials with different properties should make it possible to integrate a securing functionality into the endoprosthesis. Potential scenarios could include printing "artificial tendons" directly, or the process being split into two steps:

- Printing the prosthesis
- Then printing the "artificial tendons"

The two components are then joined together during the operation.

Additive production

Various different 3D printing procedures can be used and compared for this purpose. Implants are for example an important field of application for the high-performance plastic known as PEEK (polyether ether ketone). This polymer's popularity is due to its mechanical properties, its transparency in x-rays, and its organic compatibility. Unlike conventional materials, implants can be made from PEEK using injection moulding or 3D printing, which reduces the manufacturing costs.

One weakness of metals and ceramics is their rigidity. The implant assumes most of the mechanical stress in order to relieve the burden on the bone. This stress-shielding effect can have more far-reaching consequences. Bones need mechanical stress to regenerate and to remain strong in the long term. Bones that are not subjected to stress can even start to degrade - which is also a typical problem in the fields of orthopaedics and hand surgery. PEEK has a lower E modulus or greater elasticity compared to titanium and ceramics, which is roughly on a par with bone (i.e. isoelastic). This means that the mechanical stress on the bone is not alleviated completely.

Biomechanical testing

There are then plans to test whether the components of the prosthesis articulate harmoniously or whether improvements are required (iterative optimisation process). A test rig must be designed and created that should take into account the physiological motions of the wrist and imitate them as naturally as possible. Once the best components have been combined they can be tested together in order to make iterative improvements.

In order to take patients' individual needs into account, a variety of potential cases should be worked through such as patients with high mobility needs and patients who only require (reduced) functional movement. Each patient's CT data is required in order to ensure the best possible fit. This allows the joint surfaces to be specifically aligned. Initial trials are to be carried out using existing data for illustrative purposes. A number of different alternatives for joining the two components of the prosthesis are also to be drawn up and then compared in testing. It is important to ensure that they do not additionally provoke luxations. On the other hand, the joining alternatives should be designed so that they support the composition of the prosthesis and the movement can be modified if necessary.

Nina - eine Puppe mit Beinamputation

geht auf Reisen!



"Nina": For freedom in the mind. 3D printing as a catalyst for inclusion in practice.

OTWorld 2018 - The start-up Mecuris presented 3D-printed orthoses and prosthetics including the FirStep children's prosthetic foot, which won the 2016 Purmundus Challenge. Also there were Michi (aged 34) and Andreas (30), who presented the new prosthetic foot for adults developed by Mecuris. Michi lost his lower leg as a youth, while Andi was born with a deformity. Long trousers cover up the two men's prosthetics. But that's not what they want. They were wearing shorts. Open, confident and empowered.

"It hasn't always been like this," said Michi. "It wasn't until 10 years after the amputation that I started showing the prosthetic openly." Andi also waited until he was a young adult before he stopped hiding his prosthetic. Why so late? Why were even such young and athletic men not open about their disability? They both agree that society is to blame. A society that prefers to ignore and hide whatever isn't "normal". Children have the edge over us in this respect. They naturally act exactly right in situations that are often unpleasant for us adults. They look unabashedly, ask questions and are curious - openly and without inhibitions. Too often it is us adults who teach children that there is something about a particular situation that is "different" or should even be ostracised. We also want to know why. We were children once.

As is so often the case, we have learned this behaviour from our parents, who learned it from their parents, who learned it from theirs... without questioning it. This has to stop! We can break this vicious cycle. Now. We have the power - and the technology - to change the way we deal with disabilities. 3D technology, for example, makes it possible for anyone to turn their physical deficit into a genuine head-turner. But the scalability of this technology on the millimetre scale also allows us to work with children. This means that we can offer the smallest children cool, funky or playful orthoses or prosthetics that not only provide the best possible functional support but that they can also wear openly, with pride and confidence. This enables us to help children deal naturally and openly with their amputation or deformity from the start.

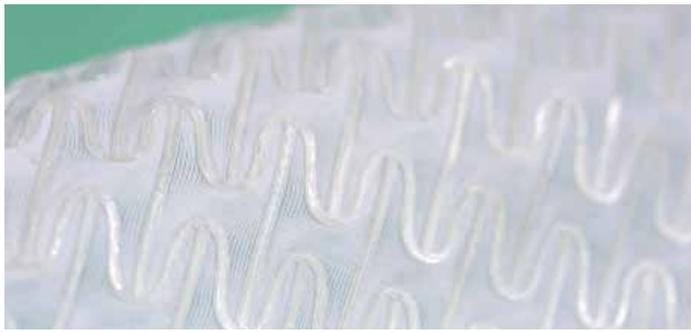
We believe it is important for the future of our children to promote acceptance among both those affected and society. Acceptance is actually not enough. We should go one step further to establish a new naturalness when dealing with physical limitations. Emma, for example, whose image was already shown here when the 3D-printed FirStep prosthetic foot for children won the Purmundus Challenge in 2016, is now wearing her third FirStep. Her tastes have changed since she had a pink unicorn on her first prosthesis. Her current one is clearly decorated with a blue butterfly. We will have to wait and see what ideas she wants to implement on her prosthesis when she is a teenager. In any case, she is fully involved in the design of her foot. This greatly enhances acceptance and identification with the necessary aids. Cool, hip, old school or whatever - the 3D-printed one-offs become an expression of the wearer's personality, as spectacles are. No-one would see those as a sign of an eye deformity that needs to be hidden.

There is now a friend to help overcome social anxiety, promote inclusion and give children the opportunity to deal with prosthetics in a playful manner from the start: Nina the doll! Nina is our little ambassador for this affair of the heart. She offers support to children by featuring a 3D-printed copy of their own prosthesis that is accurate down to the smallest detail. Nina gives them the opportunity to rediscover themselves, to accept themselves and to wear their prosthesis openly in a social setting. Nina is a friend who looks the same, who does the same things, who can be trusted and who gives you and your friends a natural way to access the topic of prosthetics.

We hope to make Emma and many other children strong for their future through this approach and with Nina as their soul mate, so that they don't have to wait until they are adults to learn to deal naturally with their disability but can instead wear their fashion statement with pride from the start.

Let's use 3D technology for more than purely functional products. Let's use it to preserve our children's inner equilibrium, for practical inclusion and openness towards every individual. This should be the norm. That is our incentive and our goal.

"Mit 4D-Druck zur Bewegung"



Printing dynamic, form-changing textiles

The focus of the Master's thesis on "Using 4D printing to achieve movement" was on developing dynamic, form-changing and smart textiles. The aim was to pick up on the idea of "4D printing" in order to create functional, adaptive and active properties in fabrics. A large number of experimental material studies were carried out using 3D printing in order to investigate how to finish a textile surface with a 3D imprint in order to create a particular movement.

This was implemented by means of a targeted combination of fabric tension and a corresponding 3D structure, as well as a "smart" printing filament that can remember its shape. Thanks to this combination of materials the entire fabric surface adopts the shape memory and material intelligence of the printed material, allowing us to specify precise movement patterns that it performs independently in response to certain changes in temperature. The designed geometry is printed, which gives it a permanent form. Increasing the temperature changes the structure of the plastic. What starts off as a solid object becomes soft and flexible, and can be reshaped. This temporary form quickly re-hardens into a solid object again. Increasing the temperature again causes the shape memory polymer and therefore the entire fabric to return to the permanent shape that was originally printed.

Because orthopaedics is a fascinating application for such fabrics, the design work is being carried out hand-in-hand with Otto Bock HealthCare GmbH. The comprehensive material studies served as the basis for working out two concepts showing how additive manufacturing could be used in the future to produce customised and adaptive bandages.

Concept: "The dynamic bandage"

The first conceptual approach is based on the idea of a simple and fast method for creating customised bandages. The procedure, which involves imprinting 3D structures that have been tailored to the patient onto materials produced using conventional methods, allows us to give the bandage a form-fitting shape and also to apply individual reinforcing elements directly. Bandages could conceivably be produced to order by orthopaedic technicians in the future. This would involve creating scanned 3D data for the patient's body part, using software to convert this into a customer-specific printing file, and then simply printing onto the pre-stressed fabric or fresh bandage. This creates a bandage with a good anatomical fit and secure positional stability, which supports the movements of the limb in question.

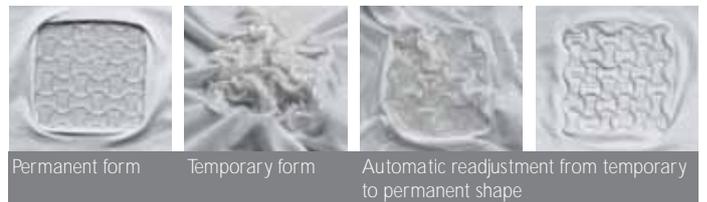


The textile is inserted into the 3D printer and subjected to a special stretching process
 A corresponding structure is printed onto the pre-stressed material
 The 3D-printed material takes on the desired geometry independently
 The "dynamic bandage" adapts to the patient's unique body shape.

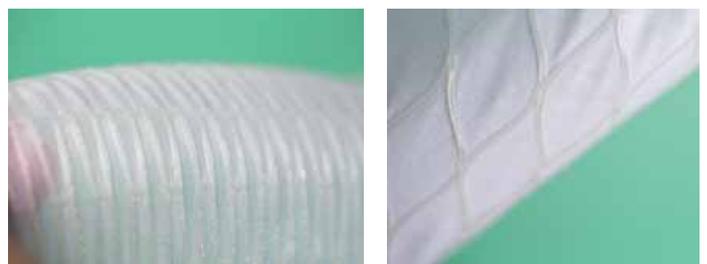
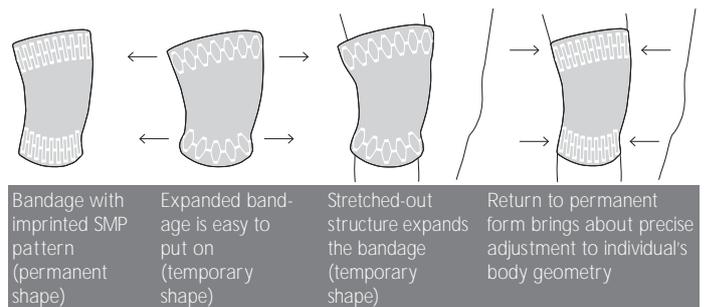


Concept: "The smart bandage"

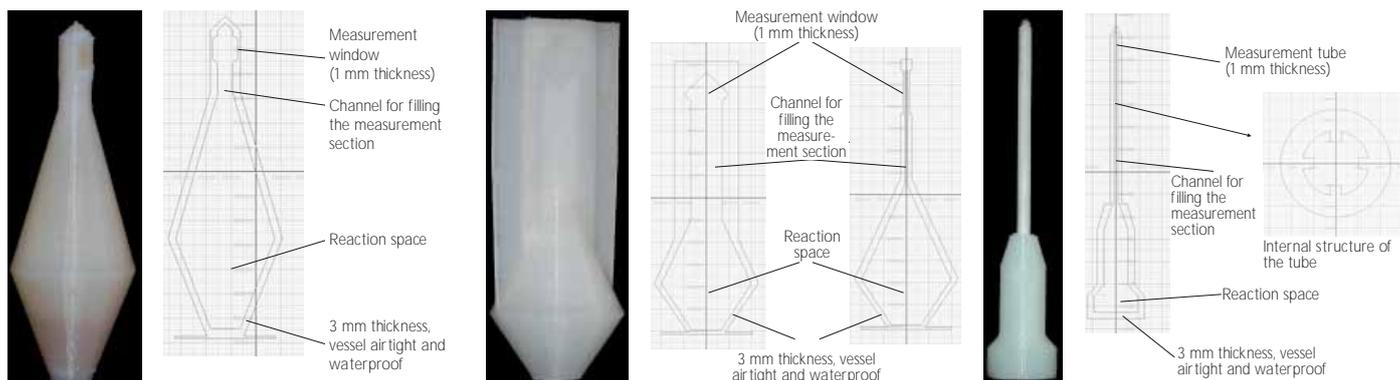
Adapting to the patient's body is a very important property for bandages in order to offer a pleasant degree of comfort and assist the healing process. As with the first concept the bandage is based on the 3D-printing of textiles, but unlike the "dynamic bandage", customisation comes after the manufacturing process. This means that it would be possible to have bandages in stock and customise them for specific patients as necessary. This ability to subsequently shape the "smart bandage" is achieved by using an intelligent printing filament with shape memory.



This principle would make it possible to transfer the smart behaviour of the printed material onto the entire bandage by applying a shape memory polymer structure. As a result, the "smart bandage" can easily be adapted to particular body geometries, making it more secure. The shape memory function of the imprinted plastic would theoretically allow the bandage to be readjusted over and over again in response to new requirements or the progress of the condition. The ability to use the "smart bandage" for longer could constitute an advantage over conventional bandages.



3D-gedruckte Reaktionsgefäße



3D-printed reaction vessels – the journey to the digital laboratory

The purpose of the fully 3D-printed items presented here is to fundamentally change the procedures and everyday activities in chemical research laboratories. This makes use of two unique options offered by 3D printing:

- The ability to produce highly complex, single-piece items
- The fact that 3D printing takes place "on site"

The principle of 3D-printed reaction vessels is based on printing the items directly in the laboratory and filling them with reagents during interruptions in the printing process. Unlike conventional production, this results in fully sealed systems with no openings (leakage). The reagents can only be added to a container that has not yet been finished, which is not possible with other production methods. Test fixtures (cells) are also 3D-printed in order to be able to conduct typical reaction monitoring measurements in laboratories. These sometimes involve complex geometries, which are no problem to implement using 3D printing. Monitoring measurements can now be carried out directly in the 3D-printed vessel without needing to open it and extract samples. The interior geometry of the vessel could conceivably be designed to allow further monitoring, for example by mixing the components.

Principle

The idea behind the concept of the 3D-printed reaction cells is to take advantage of 3D printing's ability to produce objects locally. This contrasts completely with the existing approach of purchasing laboratory equipment from a standard catalogue, or having special equipment produced by a glassblower. The desired geometry of a reaction vessel can instead be downloaded from a database. A decision is made regarding the size of the reaction (volume) and the method of measurement to be used (e.g. UV/Vis, IR or NMR spectroscopy). The 3D printing process is then started in the laboratory. The process is paused at a suitable point (usually once the reaction has been 2/3 completed) and the vessel is filled with the starting chemicals for the desired reaction (see figure 1). Printing then resumes exactly where it left off (and can potentially be paused again to add further components) and is finalised.

This creates a completely sealed reaction vessel containing the necessary chemicals but without any opening. In order to allow the usual analytical methods to be performed without the need to convert the spectrometers or other scientific or technical equipment, the 3D-printed measurement fixtures can be filled with the reaction solution by rotating the vessel 180°.

Product

3D-printed, combined reaction and measurement vessels for:

1. Infrared (IR)
2. Spectrophotometry (UV/Vis) and
3. Nuclear magnetic resonance (NMR) spectroscopy

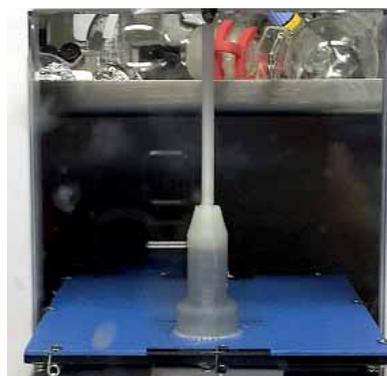


Fig. 1. Photo of an almost completed NMR sample tube/spinner combination (the lower section has been filled with the reaction solution).

Situation

The established procedure in laboratories at colleges and in industry is based on the use of standard vessels (flasks), which are available in different shapes and sizes. These are combined with standard fixtures (for example to add components one drop at a time) as well as the extraction of samples to monitor the reaction. This involves removing small volumes (samples) from the flasks and transferring them to a suitable test vessel. A decision regarding the progress of the reaction is made once the sample has been investigated (measurement). This procedure involving standardised vessels is limited in various different respects. It is for example not easy to handle the kind of chemicals commonly encountered these days that are sensitive to air or even combust upon exposure to air. This usually involves filling the flasks with all of the components in a "glovebox" with a non-reactive atmosphere, before the flask is ejected from the box and a reaction is brought about (through stirring and heating). It is then returned to the box (usually multiple times), a small sample is extracted, the sample is sealed in an air-tight test tube, the flask is sealed again and both the sample and the flask are ejected again (for testing and to continue the reaction). Although this procedure has become routine it is still complex, time-consuming and prone to error, as any contamination with air results in irreversible damage to a reaction that in some cases has been going on for weeks.

Investigating the direct mixing of components in the test vessel is even more complicated. This is of interest when it comes to investigating the progress of very fast reactions, for example. Since test vessels are designed for the investigation of samples and not mixing components, this usually requires complex measures to convert the test vessels or the spectrometers themselves. Particularly in cases involving a combination of investigating highly reactive chemicals in expensive testing equipment (one typical example is nuclear magnetic resonance spectroscopy as the most informative modern method of organic chemical analysis), such conversion measures can usually only be implemented with a lot of planning since only a few of these measuring devices, which are constantly in use and cost millions, are available, and are therefore reserved for other measurements. The successful approach described here is based on the 3D printing of highly optimised reaction vessels that combine the reaction itself and the analysis (measurements). It is also possible to incorporate chambers into the internal structure of the reaction vessels that allow the components to be mixed inside the measurement vessel.

Fungus-like additive materials



1.2m, 5.2Kg turbine blade fabricated entirely with cellulose and chitosan, the most ubiquitous biopolymers on earth and produced in large amounts in almost every ecosystem. Both ingredients are obtained from by-products of the industry, resulting in production with negative ecological footprint.

Description

The missing piece of circular economy: large scale and sustainable 3D printing with the most ubiquitous natural materials

Cellulose is one of the most abundant and broadly distributed organic compound and industrial by-product on Earth. However, despite decades of extensive research, the bottom-up use of cellulose to fabricate 3D objects is still plagued with problems that restrict its practical applications: derivatives with vast polluting effects, use in combination with plastics, lack of scalability and high production cost.

However, researchers from the Singapore University of Technology and Design (SUTD) have recently demonstrated the use of cellulose to manufacture/fabricate large 3D objects. Their approach diverges from the common association of cellulose with green plants and is inspired by the wall of the fungus-like oomycetes, which is reproduced introducing small amounts of chitin between cellulose fibers. The resulting fungal-like adhesive material(s) (FLAM) are strong, lightweight and inexpensive, and can be molded or processed using woodworking techniques.

This material is completely ecologically sustainable as no organic solvents or synthetic plastics were used to manufacture it. It is scalable and can be reproduced anywhere without specialised facilities. FLAM is also fully biodegradable in natural conditions and outside composting facilities. The cost of FLAM is in the range of commodity plastics and ten times lower than the cost of common filaments for 3D printing, such as PLA (polylactic acid) and ABS (acrylonitrile Butadiene Styrene), making it not only more sustainable but also a more cost-effective substitute. The researchers have furthermore developed an additive manufacturing technique specific for the material.

Co-lead of this research, SUTD Assistant Prof Javier Gomez Fernandez, also known for the development of Shrik said: "We believe this first large-scale additive manufacturing process with the most ubiquitous biological polymers on earth will be the catalyst for the transition to environmentally benign and circular manufacturing models, where materials are produced, used, and degraded in

closed regional systems. This reproduction and manufacturing with the material composition found in the oomycete wall, namely unmodified cellulose, small amounts of chitosan »the second most abundant organic molecule on earth« and low concentrated acetic acid, is probably one of the most successful technological achievement in the field of bioinspired materials."

Co-lead SUTD Assistant Prof. Stylianos Dritsas, added: "We believe the results reported here represent a turning point for global manufacturing with broader impact on multiple areas ranging from material science, environmental engineering, automation, and economy. As so far we have focused on fundamental technology development, little time has been invested in specific target applications. We are now at the stage of seeking industrial collaborators to bring this technology from the laboratory to the world."

With the increase in waste and pollution, the urgency for more sustainable manufacturing processes is growing. The establishment of a technology based on unmodified compostable polymers of great abundance that does not require cropland or forest resources, will foster the transition to environmentally benign manufacturing and a sustainable society.

Based on the principles of Shrik, we have developed the additive manufacture with the two most ubiquitous organic polymers on Earth. The Fungus-like additive materials enable 3D printing in any ecosystem of the world without the need to transport material, being factually the missing piece for the global development of circular manufacture models based on additive manufacturing. This extend has been demonstrated by the production of many different objects, recently a 1.2m turbine blade was produced by additive manufacture. The blade material has a cost similar to commodity plastics and 20 times cheaper than common printing filaments (PLA, PETG, ABS...) and what is more important, is produced entirely with natural components, without modification, enabling its production and degradation seamlessly integrated with ecological cycles.



Description

With the help of 3D printing, we combine design and environmental awareness to fight against the problem of plastic waste accumulation in our oceans.

3D printing technology can be an essential factor in solving alternative problems. The plastic we work with comes entirely from the oceans.

Our idea is to use this plastic to apply it to the Binder Jetting technology.

As far as the manufacturing process is concerned, the different waste products are categorized into different criterias. In the next step, the plastic is shredded into very small pieces about the grain size of 60 Mü. From this powder, we want to print our products. In the same way, as we usually use our sand.

A decisive advantage that we offer over other alternative technologies is that in terms of manufacturing processes through 3D printing with plastic materials, is the first process that uses up to 100% recycled plastic.

In addition, thanks to our technology, we have no secondary waste and no waste products are generated. By this, we contribute to perfect the product lifecycle. Once the useful life of the product has ended, we can shred most of it again in order to use the material to print a new product. Hereby we have a closed lifecycle.



What is AMPHIBIO?

AMPHIBIO is a light weight 3D printed amphibious gill garment to support underwater breathing, allowing the wearer to be more like a fish and breathe the oxygen dissolved in the water. The aim is to replace the heavy and cumbersome current scuba equipments and allow humans to breathe underwater with lighter equipment.

The white device that is positioned around the neck and chest functions as the gill. It is hollow inside and contains air, which can be breathed in and out via the mask, connected to the gill by a tube.

Context of the invention

By 2100, a temperature rise of 3.2 degree celsius is predicted to happen according to recent research by the IPCC, causing a sea level rise affecting between 0.5 - 3 billion people and submerging the megacities situated in the coastal areas, a future where humankind lives in very close proximity with water. AMPHIBIO provides daily comfort to people who spend as much time in the water as on the land.

Mechanismus of the gill

The gill accessory is 3D printed from a microporous hydrophobic material, which supports subaquatic breathing by extracting oxygen dissolved in the surrounding water and dissipating the carbon dioxide that accumulates in the system. The microscopic pores in the material allow gas molecules to pass through, but stop any water from penetrating it.

The technology was inspired by water-diving insects that survive under water by way of a thin layer of trapped air on the surface of their superhydrophobic skin, which functions in the same manner as a gas-exchanging gill^{1,2,3}. This new set of discovery meant it would resolve the basic reason of discomfort in water by creating a thin layer of air around the body to allow underwater breathing, protection from cold and staying dry in and out of water.



Advantage of 3D printability

The 3D printability of the material offer several advantages. As the gill requires an extensive surface area of 32 meter square to work for human oxygen consumption, a manufacturing technology which can be used to create a complex shape is required. Recent additive manufacturing technology makes this possible. The second advantage is in prototyping, as it enables the testing of different shapes of the gill for optimization. Finally, manufacturing directly from digital data allows the cost to be kept low compared to traditional methods.

Working prototype

The working prototype of AMPHIBIO is able to draw oxygen from an aerated water, which mimic the natural aquatic environment such as lakes and seas. The morphology of the gill was designed using parametric design in order to come up with high surface area to volume morphology, necessary in order to increase the oxygen replenishment efficiency of the gill. An oxygen sensor added to the system is able to measure the rate the gill draw oxygen from the surrounding water. From the result, 32 meter square of gill is needed in theory for human to survive underwater.



Manufacturing the full suit

The next step is to develop the device so that it can be tested on humans. It would require a gill of at least 32 square metres to support human oxygen consumption in water. The combination of additive manufacturing will be an advantage in prototyping the ultimate shape with high surface area and high gas exchange property. The prize will allow me to realize the full suit and to test it in simulated underwater environment. Access to large scale additive manufacturing facility will enable the suits to be printed in one of, a very attractive feature for AMPHIBIO.



CUDA Underwater Jetpack



Portable Powerful Propulsion

Be in control as the water forces over you enabling movements that, until now has only been available to the elite. Weightless flying is far from anything you've done before.

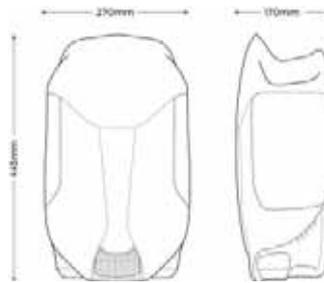
The Next Generation of Water Sports

The experience of ultimate freedom, whether it be gliding through the converging tectonic plates in the crystal clear waters of Iceland or off the coast of Bora Bora being accepted into a pod of wild dolphins.



Take it anywhere

Truly portable weighing under 10kg, you can take the Underwater Jetpack anywhere and never miss the opportunity for a great experience.



Lightweight

Continuous Fun

Don't wait for it to charge, simply exchange the battery packs when you run out of juice!



Instant Swap



Run Time 40min

