Insight SPECIAL
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16/2024

Transformation towards additives

CNC, HYBRID AND 3D PRINTING

Preview Meeting of Experts 4.0 in October 2024
Where are the developments in Additive Manufacturing heading?

Industrial high-end printing technology
The industrial printing of high-performance thermoplastics becomes a reality

Hybrid Production of Turbine Components
Laser Metal Deposition (LMD) and adaptive repair

HAMUEL REICHENBACHER
Members of the SCHERDELGroup

Forewort by Thomas Czwielong.

Transformation towards Additive Manufacturing

Dear customers, business partners and colleagues

This is the first issue to focus entirely on a fascinating topic: additive manufacturing and the development of hybrid systems. Four years ago, we set up our own competence centre for AM technology.

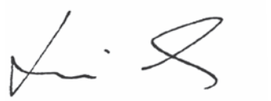
Our current development strategy not only focuses on the 3D printing process, but we have also developed several metal and plastic printing processes. These innovative production methods are trendsetting and, in combination with our proven milling systems, offer a long-lasting competitive advantage to our customers.

We are working together with renowned partner companies to achieve rapid progress in our developments. Apart from Siemens, Weber Additive and Solukon, we are now also cooperating with the experts from LehVoss, whose technical plastic granulate has opened up a completely new chapter in the construction of concrete formwork. Thanks to the Ophir BeamPeek analysis system from MKS-Instruments, we can make optimum settings in our large-format systems using multiple laser sources to ensure perfect production quality.

Another milestone is the collaboration with Multec, whose patented 6-fold printing head takes 3D printing to an entirely new level due to lightning-fast tool changes and automated filament tracking. The CAT Racing Team provides a vivid example for the results of additive manufacturing, as, with the help of a thermoforming tool developed by us, they have been able to make their racing car even more efficient and powerful.

Our expert meeting on 10 October will also address this topic in depth, as additive manufacturing has the potential to transform the production landscape of the future fundamentally.

I hope you will enjoy reading this issue,



Thomas Czwielong
Managing Director
Reichenbacher Hamuel GmbH

Imprint

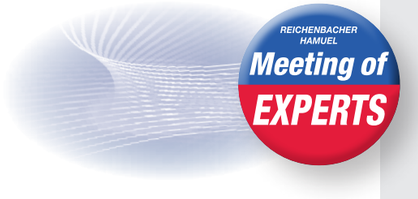
Publisher:
Reichenbacher Hamuel GmbH
Rosenauer Straße 32
D-96487 Dörfles-Esbach
Phone: + 49 9561 599-0
E-Mail: info@reichenbacher.de
Web: www.reichenbacher.de

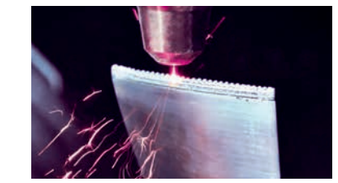
Responsible for the contents:
Mike Beier
Marketing Management
Reichenbacher Hamuel GmbH
Phone: + 49 9561 599-184
E-Mail: mike.beier@reichenbacher.de

Edited by:
C. WEGNER presse & public relations
Christina Wegner
Prader Straße 12/1
D-89233 Neu-Ulm
Phone: +49 731 25099273
E-Mail: info@wegner-pr.com

Layout:
me Grafik-Design
Moritz Eisentraut
Rennleinsweg 29
D-96215 Lichtenfels
Phone: +49 9571 6398
E-Mail: info@moritz-eisentraut.de

Print:
Schneider Printmedien GmbH
Reußenberg 22b
D-96279 Weidhausen near Coburg
Phone: +49 9562 98533
E-Mail: info@schneiderprintmedien.de





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Preview Meeting of Experts 4.0 in October 2024

Where are the developments in Additive Manufacturing heading?

Additive Manufacturing holds the potential to bring fundamental changes to the production landscape of the future. Innovative materials and advanced technologies provide entirely new possibilities for sustainable manufacturing processes. Our Expert Meeting 4.0 will take a look at trends and developments and shed light on what companies should pay attention to if they do not only want to keep up with their competitors, but rather become forerunners.

REICHENBACHER HAMUEL
Meeting of EXPERTS

Dr Alexander Kawalla-Nam
Head of Additive Manufacturing Technology, Reichenbacher Hamuel GmbH

Special machine construction is subject to a constant change characterised by the increasing integration of additive manufacturing technologies. This development does not only render production processes more flexible, but also results in considerably higher efficiency. This presentation will highlight both the challenges and the **opportunities** associated with the **transformation towards AM.** Moreover, Dr Kawalla-Nam will present current trends in market and industrial applications and will give an **outlook on the future** of Reichenbacher Hamuel in the AM sector.

Dr Karsten Heuser
VP Additive Manufacturing, Siemens Digital Industries

More and more, Additive Manufacturing is becoming a mature production technology. Dr Karsten Heuser will provide a comprehensive **overview of the dynamic market developments in the AM sector,** irrespective of technology and region. He will also discuss the integration of AM as a production technology in various industries and within Siemens. A cross-process analysis focussing on L-PBF (the most widely used industrial technology) and Large Size Pellet Extrusion (the technological field registering the fastest growth) will follow, where the Reichenbacher process chain constitutes an outstanding example.

Holger Stichel
Managing Partner, KOBRA Formen GmbH

The challenges involved in producing high-quality steel moulds for the concrete block industry are enormous. In his presentation **“Additive Manufacturing & Circular Economy in Mould Production“** Holger Stichel will discuss various aspects: He will examine the use of 3D printing with tool steel (1.7131) in the range from 0 µm to 1,000 µm and present his company‘s in-house circular economy, which aims at achieving waste-free production. This concerns the material machining process for the „in-house production“ of AM steel from 60 % waste material. He will also explain how additive manufacturing contributes to increasing the CNC productivity per employee through substitution and/or supplementation.

Dr Stefan Schulze
Head of 3D-Printing Materials, LEHVOSS Group

Although the technology of 3D printing with plastics has achieved industrial maturity, the application of the technology does not come up to earlier expectations, as the primary focus is still on prototyping and design. Dr Stefan Schulze will analyse the current state of **3D printing with plastics** and point out the challenges that need mastering to permit the successful use of this technology **in industrial production.** This will entail specific requirements that differ significantly from those in the areas of “prototyping“ and “design“.

Manuel Tosché
Managing Director, MULTEC GmbH

The presentation of the new M1000, **a high-performance additive industrial printer** that explores the physical limits of FDM technology, is the focus of Manuel Tosché‘s contribution. Being a serious competitor for Stratasys‘ target groups, he emphasises the potential and possibilities, particularly in the area of **large industrial formats in 3D printing.** Besides savings in material and labour costs thanks to quick tool changes and a wide range of nozzle variations, this also includes short printing times and the prevention of printing interruptions. Moreover, he uses a cost-benefit analysis to illustrate why net printing time is not the same as gross printing time.

Register now for the meeting of experts on 10 October 2024!

Scan here to register

Participation is free of charge.

https://expertentreff.reichenbacher.de

REICHENBACHER HAMUEL Cooperation PARTNER

Industrial high-end printing technology

The industrial printing of high-performance thermoplastics becomes a reality.

In high-tech industries, the demand for large, printed components made of high-performance plastics such as ULTEM® is constantly increasing. Systems that meet the high demands of industrial machine construction in terms of their building space dimensions, insulation, building space heating and innovative printing head technology, are central to economical production.

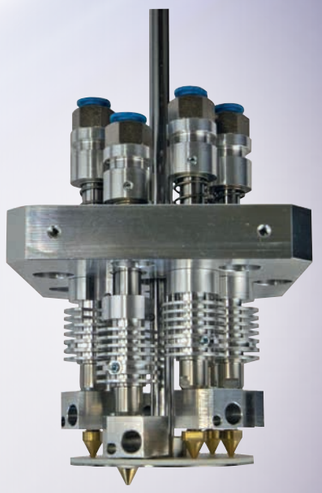
Reichenbacher and Multec have now succeeded in presenting the M1000, a large-format industrial 3D printer that combines the expertise of two worlds by bringing together Multec's patented HexaMove 6-fold printing head with a high-end machine from Reichenbacher. This system also permits the printing of ULTEM or PEEK, i.e. of plastics that combine exceptional strength with temperature resistance. The ULTEM filament also possesses a high impact strength and good resistance to chemicals.

The aerospace, medical engineering, railroad and military industries prefer these materials mainly for their technical applications. The demands placed on these high-performance components, such as wheel housings, air ducts or prototype components, for example in the engine sector of the defense industry, are immense. On the one hand, they must have a high temperature resistance of over 150 °C in continuous use and, on the other hand, good mechanical properties in terms of density, elasticity and yield stress.

Apart from its exceptional insulation, the strengths of the new system include effective heating of the printing space combined with powerful cooling of the printing head and drive components. For a good bonding of the first layer, heating of the building platform to 250 °C is possible, and heating of the building chamber to 350 °C. This prevents stresses when printing high-performance plastics processed with hotends that can be heated up to 400 °C. The cooling of the printing head, axes, and electronics as of 80 °C – in fact of all components that without insulation and cooling are subject to rapid failure at high temperatures – is important for the long-lasting functioning of the machine.

The multiple printing head transfers the flexibility, precision and efficiency of modern machine tools to 3D printing. The filament change takes place fully automatically via a magazine in which the printing head acts like a tool changing head. Multec has developed and had patented a special closing technology for the nozzles to prevent them from dripping and thus to avoid uncleanliness on the surfaces. This means that the printing head no longer needs any cleaning cycles and one hotend after the other can work without interruption. This magazine permits not only a wide variety of material combinations, but also the use of different nozzle types and sizes in a single printing process.

The new large-format, industrial 3D printer M1000.

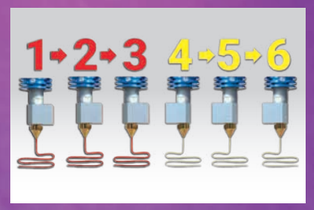


HexaMove
6-fold filament extruder

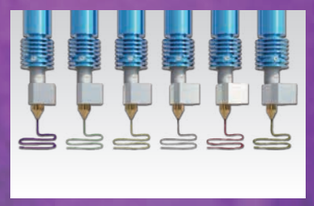
After all, the size of the building space is a decisive criterion for the high-tech industries, too. There is a great demand for large components, for example in the orthopaedics or aviation and rail vehicle industries. When you print smaller component geometries, you have to join them together afterwards, which means an additional work process. This step is often no longer necessary when the building space is 1,000 x 1,000 x 1,000 mm (W x L x H) in size. It is, however, important to be capable of filling a large building space quickly. The high-speed printing head with 6 hotends of the M1000 generates 3 to 5 times higher volume flows.

With its high degree of automation, the new M1000 industrial printer built to highest mechanical engineering standards guarantees flexibility in production, short lead times and low investment costs, both in terms of acquisition and follow-up costs, above all with regard to energy prices. The system can be used 24/7 for prototyping, but also for the small series production of large components. It is also just as interesting for the production of casting moulds or autoclave tools as it is for the use in tool, ship, aircraft or vehicle construction.

The closure and sealing of the nozzles ensures high quality multi-material printing.



Continuous printing with fully automatic filament change.



Extremely reduced set-up times - ready for printing at all times.

VARIOUS APPLICATION EXAMPLES:

Aerospace | **Automotive industry** | **Food industry** | **Shipping industry** | **Medical engineering** | **Railway vehicles**

Innovative measuring technology takes industrial AM to a new level

Reichenbacher relies on the Ophir® BeamPeek® System.

The metalworking industry is evolving. Additive manufacturing methods – even in combination with machining processes – are paving the way for more efficient processes and innovative designs. The 'Additive Manufacturing Technology' team at Reichenbacher had recognised the potential early on and in a very short time has succeeded in developing industrial additive manufacturing systems on the basis of the the laser-based powder bed fusion. The appropriate measuring technology is of decisive influence here: Reichenbacher relies on the compact Ophir BeamPeek system from MKS Instruments for beam analysis and power measurement in research and development as well as in quality assurance and maintenance.

Customised additive manufacturing systems
In cooperation with experienced partners, Reichenbacher realises customised systems that integrate the entire process chain of laser-based powder bed fusion (LPBF). It proved essential to know and verify the parameters of the laser beam at every development stage, as Dr Alexander Kawalla-Nam, Head of Additive Manufacturing, explains: "Laser systems for additive manufacturing are very complex.

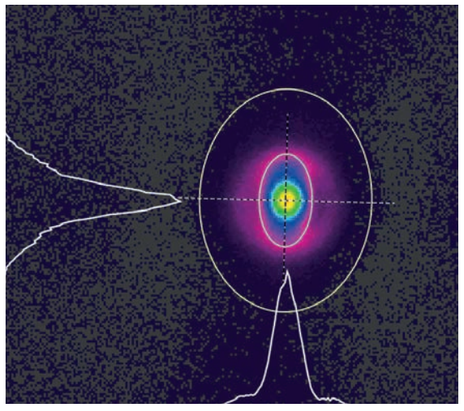
In order to ensure production quality, specifically our large-format systems with multiple laser sources require optimum settings. We were therefore looking for a measuring device for the entire life cycle of our products, from development to maintenance."

Handling without set-up changes
At the beginning of the collaboration, the team at Reichenbacher compiled all the requirements for the measuring device they were looking for. As far as the range of functions was concerned, this involved measuring individual beam parameters, such as the beam diameter, position, beam shape, power and power density, but also the visualisation of the beam caustics, i.e. the representation of the beam from the processing optics to the focus and any subsequent expansion. However, the ease of use of the system was just as important: "We work with fine metal powder in space-constrained building chambers and wanted to avoid water or air cooling at all costs in order to make the measuring device as easy as possible to use – also for the service technicians," explains development and application engineer Lukas Gahn.

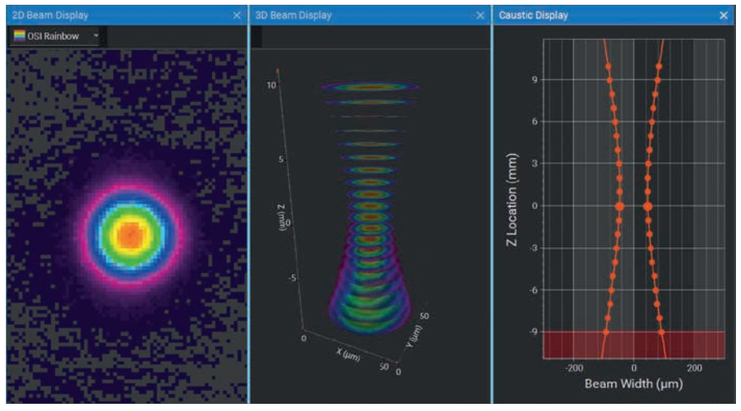
The readings from the Ophir BeamPeek system are transmitted directly to the BeamPeek software on the laptop outside the chamber (normally, the chamber is closed during active measurements).

Innovation at just the right time
Next was a market analysis and the evaluation of various measuring devices available. In this phase, MKS Instruments presented their Ophir BeamPeek analysis system specifically developed to meet the demands of additive manufacturing. For Dr Kawalla-Nam the timing was perfect. "The BeamPeek system appealed to us straight away: It is compact and requires neither water nor air-cooling. The semi-automated analysis software enabled us to calculate beam caustic parameters and graphically display the caustics in relation to the building plane in the AM chamber. As beta testers, we were given the opportunity to share suggestions for optimisation with the development team."

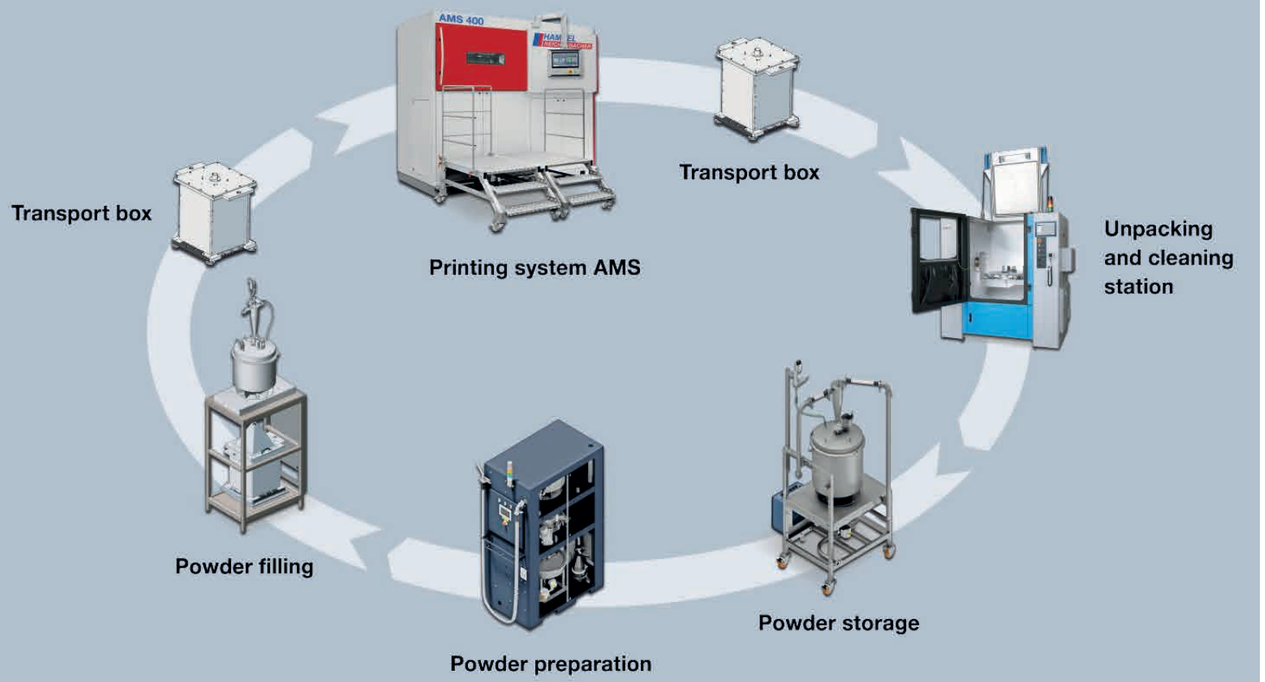
The innovative measuring device employs a patented concept based on replaceable cooling inserts to absorb the resulting laser power. This avoids downtimes between measurements without the need to use water or active fans for cooling in the building space. The BeamPeek system is therefore ideally suited for measuring the lasers in the Reichenbacher LPBF systems. In just a few seconds, it provides the beam profile, a focus analysis and power measurement as well as the beam caustics.



A contaminated protective glass causes an elliptical beam.



After cleaning the protective glass, the beam is round and symmetrical.



Reichenbacher implements customised systems that integrate the entire process chain of the laser powder bed fusion (LPBF) process.

Flexibility saves time and money
The additive manufacturing systems Reichenbacher builds individually according to customer requirements are open systems with respect to the materials they process. In order to find the optimum settings of the various laser sources, optics and materials with respect to each other, repeated measuring and comparing of the beam parameters will be necessary. At any rate, in the AMS 800 with a building volume of 800 x 800 x 500 mm and in the AMS 400 with a building volume of 400 x 400 x 500 mm four fibre lasers with a laser power of 1 kW, each, perform a common print job. The manufacturing quality of the component produced depends on the exact conformity of all laser systems with the specifications. Already during the development process, the team made regular use of the Ophir measuring device: ”As we give the customer a free hand in the choice of powder, the laser source used also varies. The BeamPeek system provides us with all the relevant parameters very quickly, both when evaluating the laser sources and when configuring the laser setup. This saves us valuable development time,” reports Dr Kawalla-Nam.

Ophir measuring devices are the key to achieving high product quality throughout the entire process chain.

Fast identification of sources of error
The beam analysis system also provides crucial information when it comes to troubleshooting, as the following example shows: After carrying out an optimisation measure on the protective glass for the optical systems of a plant, the team used the BeamPeek system to check the results. Essentially, the measurements taken were intended to record the laser beam parameters after the conversion in order to verify the success of the optimisation by way of a before/after comparison. Measurements took place for both the laser beam diameter in different planes and the laser power in the focus plane. This revealed inexplicable deviations in the measured values. The reason was quickly obvious, when they looked at the shape of the beam: it had suddenly become elliptical in the focus plane. An inspection of the optical components revealed that this was due to contamination on the upper side of the protective glass (not accessible from the building chamber). Once the contaminated protective glass had been removed and cleaned, a further control check after reinserting the protective glass showed an almost round laser beam in the focus plane over the entire power range.

A partnership with a future
The measuring of the laser beams at the building level is essential for Dr Kawalla-Nam‘s team. Beam shape, laser power and beam caustics are key parameters for ensuring the quality of the system and therefore also the production quality. When it is about laser power measuring alone, the team also uses the even more compact Ophir Ariel power metre. In the majority of cases, however, Lukas Gahn ultimately opts for the BeamPeek system: ”Ophir Ariel is top when it comes to measuring the laser power alone. However, as we are mostly interested in beam caustics, we often decide on measuring with the BeamPeek system. Here, too, the measurement setup only takes minutes and the measuring itself only seconds.”

”The BeamPeek system provides all relevant parameters very quickly. This saves us valuable development time.” Dr Kawalla-Nam, Head of the Additive Manufacturing department at Reichenbacher

LEHVOSS Group
REICHENBACHER HAMUEL
Cooperation PARTNER

How 3D printing is revolutionising formwork construction

New prospects thanks to customised designs.

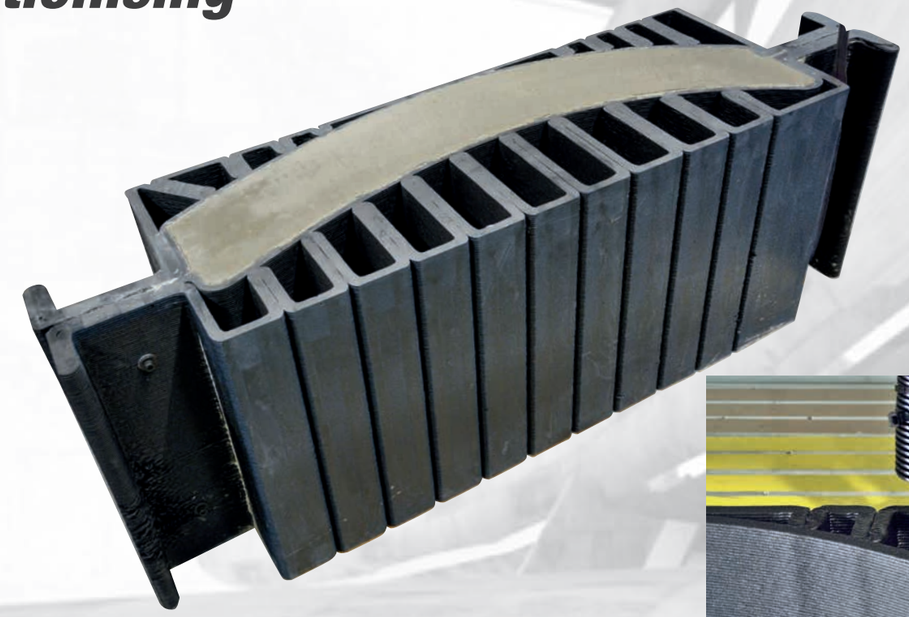
The groundbreaking development work of Reichenbacher and the LEHVOSS Group will open a new chapter in formwork construction by supplementing the conventional production of construction formwork with innovative 3D printing technology.

Future houses will look different than they do today. This refers both to the structural shape, i.e. the design concept of a building, and to the sustainability of the materials used. The construction industry requires formwork, as the use of concrete is still of great importance worldwide. Concrete generates heat during curing. This factor requires particular attention in the overall process, as otherwise uneven curing or cracks can occur, which might in turn impair the stability and quality of the concrete parts.

The conventional production of formwork made of wood reaches its limits where design freedom to cope with the complexity of the construction elements and flexibility in the production process are concerned. Thanks to the use of pioneering 3D printing technology, the two companies have now succeeded in producing concrete formwork on a CNC processing centre. The HybridDX-LT system from Reichenbacher ensures the quick and efficient printing of components up to a size of 1,700 x 900 x 600 mm. CNC machining with a 5-axis milling unit directly after printing ensures the necessary functionality in terms of accuracy and high-quality surface finish.

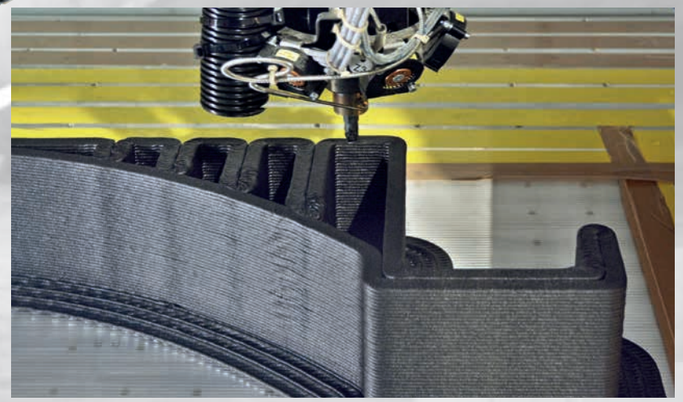
This hybrid manufacturing process will make it easy to produce complex building elements for stairs, balconies or walls, meaning that houses of the future without edges and corners are no longer a vision. After all, 3D printing is not limited to the reproduction of rounded or multi-curved contours, but permits also the easy and efficient creation of cavities or support structures. The surface finish, too, benefits from the new creative possibilities, as by applying the milling process you can create both smooth and roughened or individual structures in the surfaces. This is a decisive factor in giving buildings an individual appearance, especially in the case of fair-faced concrete.

As recycled material from post-production sources forms the basis of the LUVOTECH eco PC/ABS technical plastic granulate from LEHVOSS used in this process, the latter has a low carbon footprint. It is easy to process, allows for high component strength, has a continuous service temperature of around 120 °C and reaches an output volume of 8 kg/h via the printer's 8 mm diameter extruder nozzle. The printed formwork can sustain both the concrete working temperature of 70-90 °C and the concrete pressure of 50 kN/m². Moreover, the forms are extremely robust, even when concrete reinforcement steel is used, and withstand normal abrasion during concreting. The same applies to large-volume plastic formwork, which has no deficits in terms of stability and strength and can sustain the pressure of the fresh concrete without deforming or breaking.



Construction form that can hold 200 kg of concrete.

Concave and convex form part with a milled-in individual surface structure.



Output volume of 8 kg/h via the extruder nozzle with a diameter of 8 mm.

CNC machining centre HybridDX-LT for additive and subtractive manufacturing.

Another advantage is the newly gained flexibility in the overall process, as formwork is available for production directly from a CAD drawing now – anywhere in the world. For a construction form that can hold 200 kg of concrete, the printing times for a concave part with dimensions of 1,366 x 260 x 500 mm and 52 kg of material consumption are 6.5 hours on average and 8.5 hours for the convex part of 1,366 x 215 x 500 mm consuming 68 kg of granulate. The subsequent milling process takes 2.5 hours per component. The new process guarantees quicker production times or shorter throughput times, respectively, and lower costs.

Moreover, printed formwork also scores in terms of sustainability and the environment, as it is reusable several times and recyclable by returning old forms to the cycle, grinding them and printing new ones. In addition to plastics based on virgin materials and regrind, LEHVOSS also offers plastics based on renewable raw materials, such as castor oil. The seeds used for the oil come from the tropical castor oil plant, which grows on soil that is unsuitable for food crops and therefore does not supplant them.

The machine concept of the HybridDX-LT along with the use of the recycled plastic granulate LUVOTECH eco PC/ABS offers completely new perspectives to companies in the construction industry, as the possibilities of customised designs in combination with sustainable materials and far-reaching flexibility in the production process will revolutionise the industry in the years to come.

Transformation heading towards Additive Manufacturing Where will the journey take us?

Questions to the team in charge of Additive Manufacturing Technology at Reichenbacher Hamuel

F.r.t.l.
Dr. Alexander Kawalla-Nam (AKN), *Head of Department AM,*
Lukas Gahn (LG), *Metal-processing systems,*
Kai Hochberger (KH), *Hybrid systems,*
Jurij Welk, *PLC and hybrid,*
Dieter Zachau, *Assembly and mechanical tasks,*
Kevin Will, *Simulation and further developments,*
Johannes Karl, *Head of Design and Development*

Interviewer: What are the **long-term goals** of the Additive Manufacturing (AM) team?

AKN: We are concentrating our efforts on an increase in efficiency by optimising the processes, speed, automation, materials and by using specialised software solutions. In addition, we would like to familiarise our customers with the application potential and limits of Additive Manufacturing (AM).

One key objective is the seamless integration of additive and subtractive manufacturing processes in a hybrid machine and in the linked process chain. This integration ensures greater flexibility and efficiency, as it allows for the manufacture of the parts in a single operation, saving both time and material. Moreover, we are continuing to further the development of our machines, whether hybrid machines, laser powder bed fusion (L-PBF) machines or filament printers, in order to be able to work with a wide range of materials.

Interviewer: What **technological trends** do you expect to see in the next ten years?

KH: There will be multi-process machines that combine various additive and subtractive manufacturing processes. These hybrid systems permit the use of different materials and technologies within a single process, which significantly increases versatility. In addition, the machines will be capable of 5-axis printing and will be in modular design more and more. Thanks to this modular design, companies can flexibly adapt their machines to meet different production requirements.

LG: My cue „processes“ - AI will play a key role in machine development, especially in process monitoring and optimisation. Automation will also become more important. The development of advanced software, which optimises the workflow from design to production, will be a decisive factor. The growing demand for shorter production times will lead to the development of technologies that significantly increase printing speed. Among them are improved laser and innovative measuring systems providing higher accuracy.

AKN: We will see a significant refinement of materials, while the ability to combine multiple materials in a single printing process will gain in importance. This permits the production of complex components with a variety of mechanical properties and functions, which will be a great advantage in the aerospace and medical technology sectors in particular. Moreover, a greater number of standards and norms will be required to ensure the quality and interoperability of additive manufacturing processes and products.

Interviewer: In which **areas of application** do you see the greatest potential for growth?

AKN: AM offers outstanding possibilities for the manufacture of complex and large-format tools and devices in machine, tool and mould construction. In the aerospace industry, it enables the production of lightweight, complex components with high strength, and it opens up promising prospects in medical technology, particularly in the manufacture of customised implants, prostheses and surgical instruments. The automotive industry is already using AM for prototyping and for manufacturing lightweight components to improve energy efficiency; this calls for expansion. In the construction industry, too, AM is gaining greater significance, particularly in the production of construction elements such as concrete formwork.

Interviewer: What **challenges** need to be met to make AM attractive to customers?

KH: At present, the surface quality of 3D-printed components cannot yet keep up with that reached in conventional manufacturing processes, which makes additional finishing processes necessary. In addition, AM processes are still relatively slow in comparison to traditional methods. It is therefore necessary to increase production speeds without impairing quality. The scaling of AM processes for series production also presents a challenge. There is also often a lack of standardised procedures for monitoring and controlling the printing parameters. Moreover, improved interoperability is required to optimise the data exchange between different systems and make the workflow more efficient.

Interviewer: What is your strategy for **customer cooperation?**

AKN: One of the biggest challenges is to improve the acceptance of AM among our customers. It is crucial to approach customers proactively and show them how they can benefit from this technology. Consulting will therefore play a major part for us in the years to come. The approach that we take up contract manufacturing for the SCHERDELGroup enables us to gather valuable experience and to learn continuously. We see ourselves as pioneers for new technologies within the company and our aim is to make a significant contribution to sales in the medium term.

LG: In the future, AM will reach an industrial scale with a focus on high-speed printing; and AM will establish itself as a standard process – but this is still a bit up in the air.

Motorsport team at Coburg University of Applied Sciences?

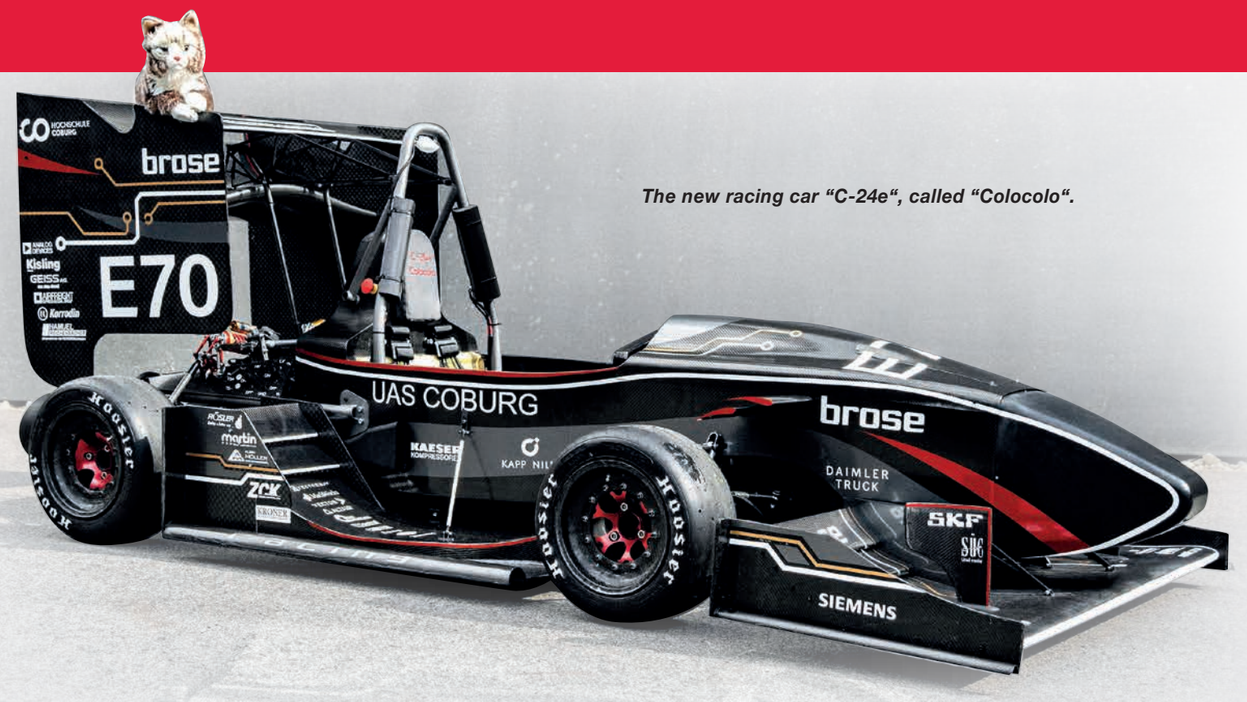
CAT-Racing – Optimum aerodynamics and performance.

In collaboration with the University of Applied Sciences in Coburg, 20 students launched the exciting “CAT-Racing“ project in 2007. “CAT Racing“ is short for Coburg Automobile Team Racing. One year later, as the result of many ideas, wishes and hard work they presented their first vehicle: the “C 08 Panther“. This was the car with which the newly founded team took part in its first Formula Student competition* in 2008.

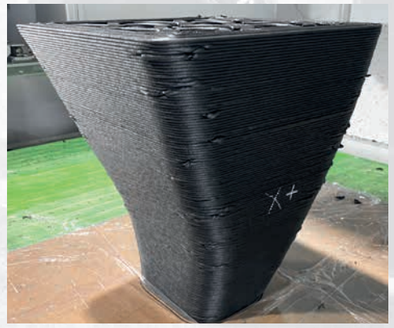
From these beginnings 17 years ago, CAT-Racing has developed into a well-organised team consisting of students from various disciplines. Every day, they work in their groups to continuously improve the vehicle and meet the latest trends, taking also into account energy efficiency and the environmentally conscious use of resources. The students combine their efforts in various vehicle construction groups to develop a new racing car. In doing so, they attach great importance to both the technical components and the business aspects.

Knowledge and skills are not the only things this project is about – there is also an emphasis on fun and team spirit. Apart from the willingness to compete, a passion for racing and joint learning are particularly important. CAT-Racing offers to its members the opportunity to develop their skills in many specialised areas. Here they gain experience often neglected during their studies. For example, they learn the virtual creation and simulation of CAD models and become familiar with project management, as well as business and marketing planning.

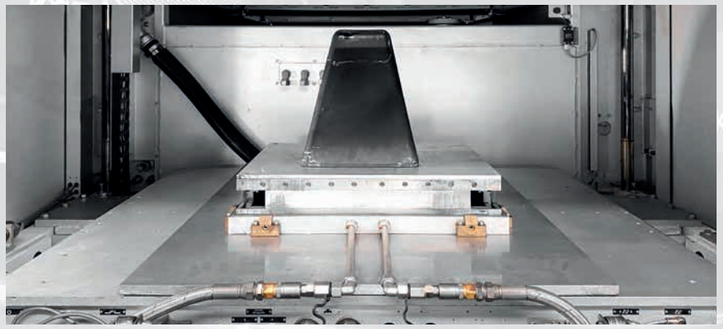
The best part about it? Every team member – whether with a technical or a non-technical background – finds his or her place and thus contributes to the success of the project. The highlights are always the self-reliant assembly of the racing car as well as the exciting test phases and racing events. In 2024, the time had come on 24 May and the team presented the new racing car “C-24e“, called “Colocolo“.



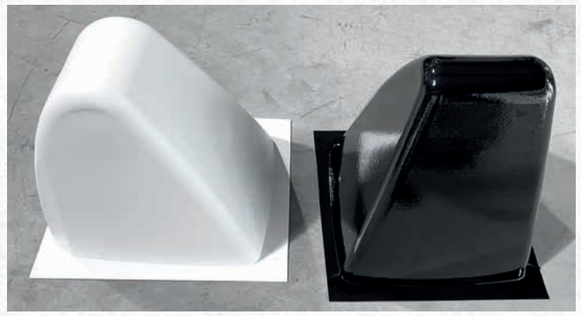
The new racing car “C-24e“, called “Colocolo“.



3D printed thermoforming tool for the production of the „nose of the monocoque“.



Machine for thermoforming: Mounted on the carrier plate, the tool is ready for the thermoforming process.



The deep-drawn “noses” from polycarbonate.

The CAT-Racing team further processed the deep-drawn parts, among other things carrying out grinding work to refine the surfaces.

An interview with Alexander Kawalla-Nam, responsible for Additive Manufacturing at Reichenbacher:

Interviewer: Why did the CAT-Racing team ask Reichenbacher Hamuel for support in the preparatory work for the new racing car?

AKN: This year, we had a decisive part in developing CAT-Racing‘s new racing car, which has been realised using a machine concept for hybrid manufacturing that combines the advantages of 3D printing with precise post-processing in a single machine. The cooperation with us enabled the CAT-Racing team to use our 3D printing technology to make the racing car even more efficient and powerful.

Interviewer: Reichenbacher acted as a sponsor. What kind of support did they provide?

AKN: Reichenbacher is one of the sponsors, as we have developed a thermoforming tool for the production of the “nose of the monocoque“ and manufactured it using hybrid production technologies. This tool permits precise forming and ensures the necessary strength and lightness that are crucial for racing. Thanks to the use of our modern production technologies, we were able to make a significant contribution to optimising the aerodynamic properties and overall performance of the vehicle.

Interviewer: Could you please specify your contributions?

AKN: For the CAT-Racing project, we enhanced the CAD model of the thermoforming tool for use in 3D printing, while optimising its geometry and structural integrity. We selected a suitable material that fulfils both, the thermal and the mechanical requirements encountered during the forming process. Then, we manufactured the tool and installed it in an industrial thermoforming machine.

The forming process took place at a temperature of 265 °C using a polycarbonate sheet with a thickness of 3 mm, from which we deep-drew four specimen of the “nose“. The CAT-Racing team then further processed these parts and integrated them into the racing car, which significantly improved its aerodynamics and performance.

* *Formula Student Germany (FSG) is an international design competition for students. Their objective as a team is to design and build a single-seater Formula Racing Car. Every year in late summer, groups of students gather at the Hockenheimring to compare their self-built racing cars. Formula Student rounds off their academic studies with practical experience in design and production as well as in the economic aspects of automotive engineering. The students develop a prototype for evaluation whose target group are non-professional weekend racers. A panel of experts from the motorsport, automotive and supplier industries assesses the teams in static disciplines in terms of design, costs and business plans. Moreover, testing of the vehicles’ driving characteristics in various dynamic disciplines takes place on the racetrack.*

Hybrid Production of Turbine Components

Laser Metal Deposition (LMD) and adaptive repair.

The energy sector, aerospace and the MRO market will expand considerably in the coming decades, which will in turn entail a significant increase in prices for nickel-based alloys, super alloys, titanium aluminide and stainless steel. The growing complexity of part geometries and the demand for improved product quality, more precisely machined components, shorter production times and lower scrap rates require a new strategy for production and processes. The combined production of complex turbine components such as blades and blisks represents a promising solution, as a hybrid-processing centre unites high-precision 5-axis simultaneous machining, laser cladding, in-process measuring, process control and adaptive milling in a single system.

Repair of a turbine blade.

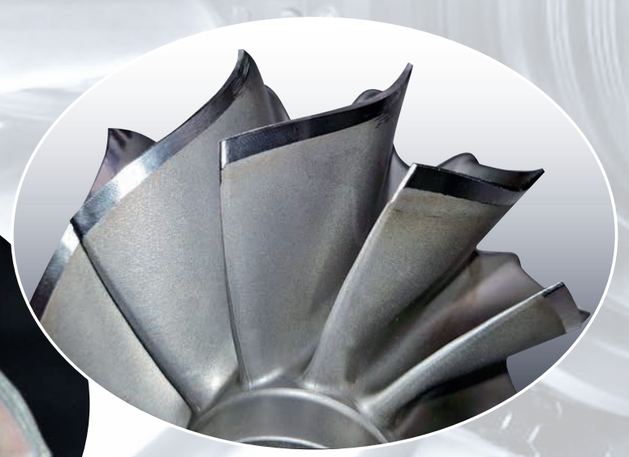
A new approach to efficient production
The HAMUEL HSTM hybrid machine combines adaptive and additive manufacturing in a single machine, with the laser cladding head being located in the tool magazine and exchangeable like any other tool. This seamlessly integrates the addition of material into the manufacturing process, allowing workpieces to be both, repaired and given additional features. A decisive advantage of this new generation of machines is the combination of several manufacturing processes in the smallest possible space. For the first time, a compact laser cladding head has been developed that, by means of a tool gripper, can easily be moved back and forth between its storage position in the magazine and the processing spindle.

Compact laser cladding head reduces risk of collisions
The standardised HSK63A interface permits the clamping of all tools in the milling spindle of the HSTM machine, with the spindle serving both for milling and for positioning the probe or the laser cladding head. Thanks to its compact design, the head's easy and flexible use within the typical working area of a synchronous 5-axis milling machine will be possible, which minimises the risk of collisions. The laser cladding head provides the laser beam, the powder and the inert gas. On principle, all types of laser welding materials can be used. The precise positioning of the material and laser focus keeps the heated area small, which minimises thermal deformation. The inspection of various test parts shows the excellent quality of the welding seam, which satisfies the stringent requirements for aerospace applications.

Considerable reduction in cycle times
The implementation of a fully automated process results in a considerable reduction in the overall throughput time, as it eliminates idle times between the individual processing steps. In addition, this approach allows for comprehensive documentation and traceability, which fulfils the aviation industry's requirements for process documentation in particular and ensures the repeatability of processes. The use of the HSTM hybrid machine with automated processes omits the challenges of manual working steps by covering all areas of laser processing and enabling operations such as laser hardening, component labelling and similar procedures.

HAMUEL HSTM 150 HD Hybrid machine.

Repaired compressor wheel.



Material applied using the LMD method.

Components can also be specifically reinforced or refined by applying additional or more resistant materials in very thin layers in areas prone to wear. Gear wheels in gearboxes are an example where regular wear occurs which can be calculated in advance.

Cost savings with hybrid technology
In comparison to conventional subtractive machining of a component with flanges, additive manufacturing by laser cladding permits a more efficient production process. To obtain the same flange, almost three times as much material has to be removed in subtractive manufacturing as has to be applied in additive manufacturing. This illustrates the considerable savings potential of the hybrid technology. Significant savings in processing costs are possible, especially so for expensive and difficult-to-machine materials. Moreover, laser cladding aims at producing parts with improved technical properties by combining many different materials in order to specifically optimise and influence the overall properties of the workpiece.

Compatibility of different materials
The bond between the base substrate and the added material is crucial, with the compatibility of the material combinations playing a central part. Numerous studies have shown that this process satisfies even the most stringent quality criteria of the aviation industry. The properties of the bonding areas are decisive for their quality and thus guarantee the final strength of the product. The hybrid system enables the repair of high-quality metal components and extends their service life, which results in considerable cost savings, especially so for complex components.

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Reichenbacher Hamuel GmbH
Rosenauer Straße 32 · D-96487 Dörfles-Esbach
Phone: +49 9561 599-0 · Fax: +49 9561 599-199
info@reichenbacher.de · www.reichenbacher.de

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