

# A2LT Whitepaper

Competence Map



## LIGHTWEIGHT CONSTRUCTION

Ecological and economic heavyweight

Image: Archer Aviation

[www.A2LT.at](http://www.A2LT.at)



## Concentrated lightweight construction expertise

Austria is home to a large number of companies in the lightweight construction sector. From SMEs to large global corporations, they are world market and technology leaders in many areas: materials development, process engineering, production of semi-finished products, 3D printing and much more. For example, they supply tanks for rockets designed to explore space or lightweight components for aircraft and the automotive industry. This concentrated know-how would be unthinkable without the research facilities and universities in Austria.

### Innovation through cooperation

The Austrian Advanced Lightweight Technology (A2LT) platform brings together a number of partners – both companies and research facilities – as members of the platform who pool their expertise and innovative strength in order to promote lightweight construction and, above all, make lightweight more sustainable, affordable and intelligent. A2LT members benefit from an exchange of knowledge and ideas and collaborate independently of materials. In this way, they jointly generate a level of innovation and competitiveness beyond the potential of any single enterprise.

### Competence map

On the following pages, our members introduce themselves with their products, services and key competences. This partner guide can therefore be read like a competence map of lightweight construction. If you would also like to become a member of our platform and help shape lightweight construction for the future, you are very welcome to join us! If you are interested, please feel free to contact our project managers.

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## Micro-sandwiches for containers

**CIMERA® micro-sandwiches allow Envirotainer AB to implement the new active cold chain containers for the state-of-the-art airfreight containers. Inside the container, the micro-sandwich walls control the airflow to ensure a homogeneous temperature. The requirements for a modern cooling chain airfreight container are very demanding.**

A special CIMERA® version has been engineered to support modern cool chain transport solutions. Especially for lightweight applications with the aim of achieving the greatest weight saving potential and with highest requirements regarding flexural stiffness, the CIMERA® sandwich material opens up a wide range of options thanks to various material compositions. By selecting the appropriate materials, many mechanical characteristics can be influenced and optimised: weight, flexural stiffness, formability and temperature resistance are just some of the tunable parameters. Suitable core materials are needed to realise material compositions with such a wide range of adjustable properties. MILLIFOAM® core material by 4a manufacturing offers these features (e.g. tight thickness tolerance) required for such innovative micro-sandwich solutions.

### The container

Envirotainer AB started the development of the new Releye® RLP a few years ago. The container itself is a temperature-controlled air cargo container which needs to meet the strictest requirements for pharmaceutical transport. The environment inside the container is controlled by the latest technology using a defined airstream inside the container. On the outside, the container is protected by an innovative vacuum insulated panel technology which protects the cargo against most extreme environmental conditions. This new container technology ensures an autonomy period of more than 170 hours of controlled environment inside the container; this can only be achieved by using CIMERA® micro-sandwich panels to precisely insulate and control the airflow.

### Internal panel structure

In the course of an agile development process, the 4a manufacturing team developed potential micro-sandwich flat panels



The Releye® RLP container provides new state-of-the-art temperature stability and lightweight construction at the same time.

that were able to fulfill all requirements. Two main objectives in the project were: to achieve the maximum lightweight potential and a high flexural stiffness. In addition, the panels have also to be very resistant against mechanical impact in the course of loading and unloading procedures. With a low coefficient of thermal expansion, the panels also withstand temperature gradients which gives additional stability. The result is a fiber-reinforced CIMERA® panel solution with a special MILLIFOAM® foam core material with properties that fulfill all aesthetic and technical requirements. Now, the CIMERA® panels were certified by FAA and EASA and are used throughout the complete Releye® container series.

### In physics we trust

4a technology group was founded in 2002 in Traboch, Austria. 150 employees worldwide focus on new technologies in the fields of mobility, communication, road and vehicle safety. Our key competency for

new customer products is our deep understanding of materials, plastics, composite materials, lightweight construction and mechatronics. The 4a companies share the motto "in physics we trust".



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# Tomorrow's lightweight alloys

The LKR Leichtmetallkompetenzzentrum Ranshofen (Light Metals Technologies Ranshofen) at the AIT is a research and innovation leader for tomorrow's lightweight design. The LKR covers the entire value chain: the development of high-quality light metal alloys, their sustainable and energy-efficient processing and the development of functionally integrated lightweight parts.

LKR researchers have long-standing experience in the design and processing of light metal alloys. Of special importance are material properties such as strength, corrosion and fire resistance, joinability, crash behaviour and processability. Services include alloy development and customisation, simulation, casting, homogenisation, extrusion, the forging and deep-drawing of test alloys, development of customised heat treatments and characterisation.

## Casting technology

The LKR researches into a variety of casting technologies for innovative light metal alloys. Systems for horizontal and vertical continuous casting, mould casting, die casting and low-pressure die casting are available. Our services include simulation-based component and process development, tool development, prototyping and the provision of plant capacities. We offer holistic solution approaches from the idea to the component suitable for series production.

## Forming technology

Research at the LKR leads to more efficient, stable, productive and cost-effective forming processes of innovative light metals and the optimal use of state-of-the-art materials. The services include developing new forming processes, optimising the process chains and ultimately extrusion, forging and rolling. The team also works on the accompanying heat treatment processes as well as on digitalising and evaluating the data from the individual process steps.

## Wire-based additive manufacturing

LKR experts explore new methods of wire-based additive manufacturing, a promising method for 3D printing of large parts made of light metals. The workpieces are produced under computer control, no forming tools are required. The services include developing special wires, optimising the hard-



The laboratory for additive manufacturing at the LKR Leichtmetallkompetenzzentrum Ranshofen GmbH.

ware and processes, concept development and producing specimens and prototypes.

## Numerical simulation

Simulations can help to predict, optimise and improve the understanding of material properties, processes and component behaviour in practice. LKR's expertise ranges from new theoretical concepts through to application-oriented simulation. The services cover the complete chain from atomistic alloy simulation, material modelling, and process simulations of the various primary forming and forming methods used at the LKR through to component simulation.

## Material testing and characterisation

The LKR deals with material, process and product analysis as well as damage evaluation. To do this, the researchers rely on state-of-the-art methods such as spectrometry, dilatometry, notched impact testing, deformation analysis, mechanical materi-

als testing, fatigue testing, metallography, differential thermoanalysis and electron microscopy using electron backscatter diffraction (EBSD) and energy-dispersive X-ray spectroscopy (EDX).



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# Lightweight made easy

Looking for a meaningful approach to innovative designs, intelligent safety or saving weight? ENGEL specialises in taking new approaches. The company is happy to collaborate with its customers to develop industrial injection moulding production solutions for special material combinations in composites and lightweight.

The experts at ENGEL combine comprehensive expertise in the field of thermoplastic-based composite lightweight construction with many years of experience in injection moulding and the automation of series processes. Precisely this is prerequisite to developing particularly cost effective series production processes for the automotive and aerospace industries, for example. In ENGEL, customers have a partner which not only offers complete production lines, but also process-specific expertise. ENGEL's focuses in lightweight:

## organomelt

Replacing steel and aluminium sheets with lightweight components: ENGEL organomelt is a composite technology for durable bonding of thermoplastic fibre semi-finished products with high-grade plastics and the ideal process for manufacturing parts with excellent stability and unbeatable mechanical properties. The highly integrated, automated thermoforming and injection moulding process for thermoplastic sheets enables the cost- and resource-efficient production of fit-for-purpose lightweight parts.

## UD tapes

ENGEL offers the optimum solution for the processing of UD tapes. The tapes are laid and consolidated in line with the cycle of the injection moulding process. A consolidation press can be seamlessly integrated into the overall process downstream of a pick-and-place tape laying cell with optical image processing. In this way, ENGEL enables a tape layout that is precisely tailored to the part geometry, which can then be followed by the next steps in the process – heating up in the IR oven, forming and functionalisation in the mould – without the need for trimming.

## Sheet Moulding Compounds

This technology involves processing a stack of typically carbon or glass fibre reinforced,



ENGEL relies on creating the latest technologies and ensuring sustainable global growth.

free-flowing prepreps in a compression moulding process. One of ENGEL's offerings here is the v-duo, which benefits from high closing speeds and active parallelism control – ideal conditions for fully automated and precise component manufacturing. As a provider of turnkey solutions – from the individual press to highly-integrated processing lines – ENGEL offers custom-built systems for efficient series production of SMC parts.

## HP-RTM

Large, stable and lightweight parts efficiently produced: ENGEL's HP-RTM fibre composite technology enables superior styling and premium properties for flat parts in the automotive industry. This process involves soaking dry, fibre preforms with injected resin and then curing under heat.

## In-situ

In-situ technology opens up new opportunities in the production of fibre-reinforced plastic components with a thermoplastic polyamide matrix. There are many options: The application spectrum ranges from particularly thin composite parts to highly-stressed structural elements. The in-situ

process combines polymerisation and the moulding process on the basis of dry, pre-shaped reinforcing fabrics.

## Success story

ENGEL Austria GmbH is an Austrian family business with a tradition. Ludwig Engel founded the company in Schwertberg back in 1945. The innovative injection moulding expert now has nine locations in Europe, North America and Asia. The global market leader is represented in 85 countries today. A workforce of 6,400 worldwide generates an export share of 95 percent.

# ENGEL

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# The future of aviation

FACC is a leading international technology enterprise in the aerospace industry with a focus on research and development into innovative lightweight components and technologies. As an aerospace pioneer, the company sets standards for a unique, sustainable and safe flying experience with its forward-looking products and services.

The Austrian high-tech enterprise FACC has become an international leader in the aerospace sector. With its components and services, it is an essential key supplier to all well-known aircraft and engine manufacturers worldwide. For more than 30 years, FACC has stood the test of global development trends and global competition. Growth through innovation has therefore become a tradition in FACC's history with a consistent investment into the research and development of innovative products for the aircraft industry through to new innovative technologies in the field of urban air mobility.

## Climate change: Full thrust for CO<sub>2</sub>-neutral flying

The reduction of emissions, the use of green technologies, the use of biological materials and comprehensive environmental responsibility are increasingly becoming determining factors in the aircraft industry. FACC has the right technologies to do justice to this trend. Thanks to its versatile lightweight solutions, the company has contributed to making air traffic more environmentally compatible for years. The daily mission: making products even lighter and more aerodynamic.

## High-tech for space travel

FACC's key competencies include lightweight innovations for commercial aircraft, business jets, helicopters, aircraft engines and drones. Now, FACC is also deploying its lightweight construction technologies in space travel. FACC AG has been awarded a significant contract for the development and production of the Astris Kick-Stage Main Structure for the Ariane 6 launcher family, which will open up completely new opportunities for the company in commercial space travel.

## Committed to the sky

FACC aims to be one of the 50 largest global aerospace groups by 2030; the company



The EHang autonomous aerial vehicle produced by FACC.

is currently in the top 100. Sustainability will be an important lever, in particular for the aircraft industry. An environment of climate targets offers a specific opportunity to re-think air travel with innovative technologies from FACC that make flying more environmentally friendly, quieter and more attractive for passengers.

## Innovative force as part of the DNA

Innovation is a central factor for FACC's success. With its more than 300 patents, the company is represented in the world's leading passenger aircraft models. This is an incentive for even more efficiency, safety, sustainability and comfort in air travel. FACC AG will continue to play a leading role in shaping the future of mobility and set new standards in areas of innovation such as new materials, drone technologies or the latest interior solutions.

## About FACC AG

FACC is a global aerospace leader in the design, development and manufacture of aviation technologies and advanced lightweight systems for aircraft. Around 2,700

employees from 41 nations are employed at 13 international locations worldwide. The company is listed on the Vienna Stock Exchange and is part of the AVIC Fortune 500 group, which provides access to the largest growth markets in the industry.



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# Research and education in lightweight design

The University of Applied Sciences Upper Austria, School of Engineering in Wels was founded in 1993 and is one of the pioneers in the UAS sector. With its focus areas and extremely successful research projects, it is one of the most renowned universities of applied sciences in Austria.

With around 150 scientific staff and a very high proportion of third-party R&D funding, Wels UAS has one of the best research track records of universities of applied sciences in Europe. Various research groups at the UAS Upper Austria focus their research activities on lightweight design and fibre composite materials. The launch of the "Lightweight Design and Composite Materials" Bachelor's and Master's degree programme in the winter term 2016/17, saw the UAS strengthen its focus on this promising field in education and research, making it possible to meet business needs in this sector.

## Comprehensive infrastructure in lightweight design

As a scientific and technical university of applied sciences with established degree programmes in the fields of materials engineering, mechanical engineering, lightweight design and composite materials, as well as several active research groups in these fields, the UAS has a very wide portfolio of software, metrology, testing and production technology. The infrastructure in the research area of lightweight design goes far beyond the state of the art.

## Versatile know-how

The aim is to research into the entire field, from manufacturing, and simulating the manufacturing process, through structural mechanics, material modelling, and non-destructive testing to optimisation. By way of an example: at the Upper Austria University



The Upper Austria University of Applied Sciences of Engineering in Wels Image: FH OÖ/Rupert Steiner



Weight-saving, high-strength composites are the ideal material for drones. Students at the University of Applied Sciences Upper Austria applied their know-how and expertise in lightweight design to develop a camera drone in a very integral design and enable a weight saving of more than 40 %.

of Applied Sciences research into FE-based draping simulations, the related material characterisations and their validation as part of the COIN development programme "Process Simulation for the Automation of Composite Manufacturing" (ProSim) has been on-going since November 2018. The acquired laying simulation know-how has already been applied in the "Fibre Composite Heat Treatment" (FIT) project, where a setup comprising a mechanical-thermal laying simulation for UD tapes coupled with an automated fibre placement (AFP) system was developed.

## Forward-looking research topics

In addition to research focuses in the field of structure and process simulation, research into the production and processing of thermoplastic composites in automated manufacturing processes has already been on-going in the scope of the ProFVK project since 2016, in close cooperation with the Transfer Centre for Plastics Technology (TCKT) in

Wels. Students are involved in all of these research projects right from the beginning to keep education closely practice-related.



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## Smart welding solutions

Passion for technology, revolutionary solutions and Austrian quality – this is what the Fronius brand has stood for since 1945. Fronius develops its tailor-made, innovative systems for welding technology for and with its customers. Both digitalisation and sustainability play a central role in high-end welding processes.

Fronius focuses on generating the perfect arc for consistently high welding quality. This is how the company became the innovation leader in arc welding and the global market leader in robot welding. Key sectors are the automotive industry and its suppliers as well as yellow goods and commercial transportation. Fronius's Welding Automation division also implements customer-specific, automated holistic welding solutions. Power sources for manual applications, welding accessories and a wide range of services round off the portfolio.

### The focus is always on the customer

The welding technology specialist sets great store by customer proximity in order to find the right solution for every welding challenge. With more than 1,000 sales partners world-wide, Fronius Perfect Welding is particularly close to its customers. In intense exchange, the team works together to develop new technologies and individual solutions. But Fronius is also about putting the spotlight on people and their needs. This is why high quality always goes hand in hand with reliability, health protection and ease of use in all Fronius products and services.

### Quality and sustainability

For Fronius, quality awareness is not just an empty promise, but a corporate value that is lived by and practised. The company puts its products through 13 different endurance tests during the development phase. This is the only way to guarantee a long working life. To ensure responsible use of resources, Fronius places emphasis on durability, reparability and recycling right from the development stage.

### High-tech and efficiency

Fronius shapes future trends in welding technology – with Cold Metal Transfer, for example. This process enables thermal joining of galvanised steel with aluminium sheets. Even wafer-thin aluminium sheets from a thickness of 0.3 millimetres can be



Fronius is the innovation leader in arc welding and the global market leader in robot welding. The focus is on the automotive industry and its suppliers as well as other industries.

joined in this way. And the Upper Austrians also seek to be the innovation leader in sustainability. Fronius welding instruments are characterised, in particular, by great energy efficiency: the welding expert was the first manufacturer ever to integrate transistor-based inverter technology. This translates to around one third lower electricity consumption and about 80 percent savings in terms of raw materials.

### Industry 4.0

Digitalisation influences joining technology in many ways. That's why Fronius develops software solutions to improve the performance of welding systems in terms of ease of operation, weld quality and speed. The documentation software logs all welding conditions. Software-based analyses enable an economical use of materials – filler wire and inert gas, for example. Cloud applications by Fronius help to evaluate data, and identify and immediately resolve weak spots. Remote access enables state analyses and service in real time to provide a basis for smart maintenance planning.

### Innovation leader on the global market

Headquartered in Pettenbach and with further facilities in Upper Austria, Fronius International GmbH with its 5,660 employees has global activities in the fields of welding technology, photovoltaics and battery charging technology. 36 international companies, as well as sales partners and representatives in more than 60 countries generate an export quota of 92 percent. 1,321 patents make Fronius the global innovation leader.



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## Where lightweight design meets mechatronics

Johannes Kepler University Linz (JKU) with its broad range of disciplines is a pioneer when it comes to new and innovative technologies. This is especially true for the Department of Mechatronics, which today already comprises 14 institutes with a wide variety of technical orientations. This interdisciplinary environment opens up a multitude of new avenues. One of these is the use of mechatronics for lightweight structures.

In an interdisciplinary research focus, the Institute of Structural Lightweight Design (IKL) is working on lightweight design solutions for industrial applications which use embedded sensor technology to monitor the component's condition during operation. These Structural Health Monitoring (SHM) systems are intended to ultimately guarantee the reliability and safety of optimised lightweight constructions and, by doing so, pave the way to further weight savings. Pertinent research topics from the perspective of lightweight structural engineering include analytical and computer-aided prediction methods for static strength, fatigue and damage tolerance of lightweight components or specifying load tests for the validation of models.

### Interdisciplinary research

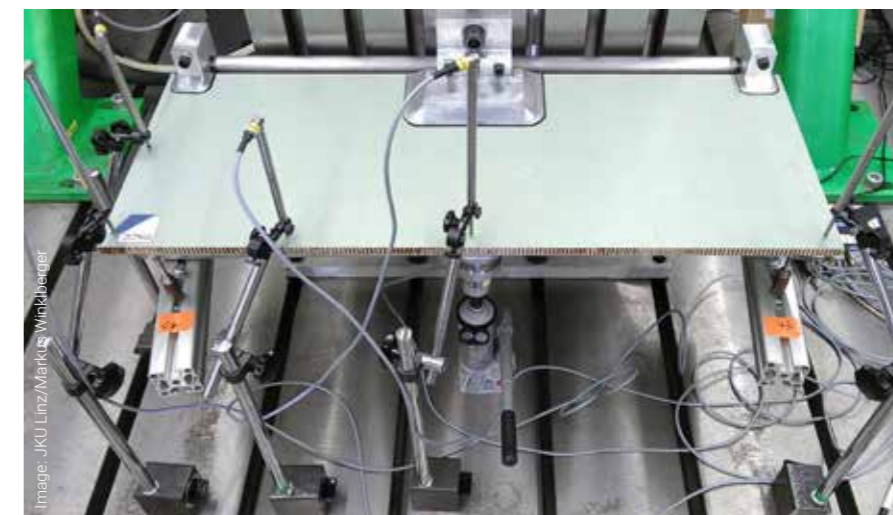
From the perspective of mechatronics, topics of great importance are ranging from sensor and measurement technology to machine learning and statistical data evaluation. In this context, cross-disciplinary research questions arise, such as: What information needs to be continuously collected with an SHM system and how can this information be used to evaluate and predict structural damage and structural integrity?

### Sustainability as the goal

Economic considerations have always been a strong motivator for lightweight design. Today, the focus lies also on the sustainability of a mechanical structure. Following this demand, the IKL is, for example, involved in a funded H2020 project entitled "SUSTAINability increase of lightweight, multifunctional and intelligent airframe and engine parts" (short title



The Institute of Structural Lightweight Design is located in Science Park 1.



Idealised demonstrator of a civil aircraft wing spoiler scaled to 1:2.

"SUSTAINair") together with twelve European companies and research facilities. The aim of this project is to design new types of bonded joints, to equip these joints with state-of-the-art sensor technology for damage diagnostics, and to take into account the sustainability of all components involved throughout the entire life cycle – from design until disposal.

### Affordable safety

SHM aims to enhance the reliability and safety of optimised lightweight components. Safety-relevant issues therefore play an important role in the development of the systems. Experimental validation is essential. This often proves to be a showstopper for the introduction of new technologies, as demonstrating reliability typically requires expensive test campaigns on physical parts. Here, the IKL follows a building-block approach for cost-efficient verification of SHM systems. This approach is similar to the one known from certification of mechanical structures in aerospace industry.

The building-block approach aims to largely replace expensive experiments on physical parts with inexpensive, easily reproducible experiments on structural demonstrators.

For this purpose, the IKL has developed, for example, a highly idealised model of a wing spoiler of a large civil aircraft on a scale of 1:2 (see figure). A simple, but numerically optimized load introduction frame simulates real aerodynamic load cases (see figure). This platform enables now the cost-efficient investigation of strain-based SHM methods under realistic conditions.



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## Innovative lightweight fastening

KVT-Fastening, as part of the Bossard Group, has been a leading specialist for industrial fastening and assembly technology since 1972 and offers sophisticated, high-quality individual components and customer-specific solutions for applications in a variety of sectors. Innovative MultiMaterial-Welding (short MM-Welding) is particularly important for lightweight construction.

The most fundamental challenge faced by e-vehicle producers is that with porous materials, which play a central role in lightweighting, the lack of solid material makes it difficult or impossible to use conventional fastening methods. This is where MM-Welding comes in. MM-Welding technology employs an ultrasonic process to partially liquify a thermoplastic fastening element (LiteWWeight® Pin) to create a positive-locking connection in a fraction of a second. In another type of MM-Welding fastening method (InWVerse®), an ultrasonic process is used to partially melt two polymer components connected by a metallic fastener.

### More design without increased costs

Apart from overall weight reduction, MM-Welding fastening methods provide numerous design options, without any performance restrictions (pull-out strength) or increased cost. For high-end automotive interior designs, the fastener's aesthetics are as important as its technical features. The LiteWWeight® Pin ensures invisible fastener heads from above, for a clean and attractive appearance. And it especially excels in applications with standard honeycomb materials and honeycomb materials with pre-moulded holes.

### Solution for fibre and textile components

MM-Welding also offers LiteWWeight® Lotus fasteners for woven or non-woven fibre or textile components. It is an excellent substitute for conventional technologies such as rivets, staples, or adhesives, thanks to the strong integrated connection in the substrate. To overcome the dimensional constraints, LiteWWeight® zEPP, used for joints in EPP or similar foams, is a strong solution also available with a small footprint and therefore particularly suitable in limited space. Its special anti-twist elements offer high torque resistance, and the pull-out strength is high across a wide range of foam densities, without the need for predrilling.



MultiMaterial Welding: KVT-Fastening GmbH portfolio

### Optimised production processes

One way to streamline production processes is by reducing the number of steps. Switching from adhesive bonding to an ultrasonically joined metallic InWVerse® fastener, with fewer preparatory steps of the workpiece surface and less follow-up time (adhesive curing time), can significantly reduce the number of process steps. Long cycle times could impact on economies of scale. When used with fibrous materials, LiteWWeight® Lotus fasteners can help to speed up processing times, since access is only required on one side during production.

### Continuous development

Reducing the number of items in inventory is another viable approach to streamlining operations. While the conventional clip solution consists of two separate components, the LiteWWeight® Lotus Abalone fastening element is welded into the floor mat's fibrous substrate as a single element. Fewer parts in inventory can add up to significant cost savings in large production runs. Furthermore, the pre-treatment process, such as

drilling/punching holes, is not necessary. MM-Welding has been broadening its portfolio of standard fastening solutions for the mobility industry and is pushing forward with developments for boosting customer productivity. Vehicles containing MM-Welding fastenings are already on the road.



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## Modern expert machining

With its extensive material and process expertise and its tool solutions designed for quality and performance, Leitz offers a perfect package of products and services for machining modern materials. Leitz products are used in more than 150 countries globally, and on all continents.

Tools and application parameters which are matched to the material are essential to achieving optimum quality, cost-effectiveness and production reliability during machining. Aluminium, plastics, lightweight and composite materials are versatile in terms of applications but also pose a variety of requirements.

### Aluminium

Machining aluminium and non-ferrous metals repeatedly confronts processors with situations which require special solutions. Thin-wall profile are prone to vibrations, whereas solid materials exhibit a totally different behaviour during machining. Leitz has enhanced its range of tools through its many years of experience in professional machining of non-ferrous metals and is therefore able to offer solutions for the many challenges in machining profiles, blocks, plates or sheets.

### Plastics

When machining thermoplastics, both special tooth geometries and chip spaces, and the choice of process parameters are decisive. Leitz offers a wide range of tried-and-tested tool solutions in the field of panel cutting, shape and contour milling or also for blind and through holes for acrylic sheet (PMMA), polycarbonate (PC), polyvinyl chloride (PVC) or polystyrene (PS). Typical examples of duroplastic materials include, for example, compact laminated sheets, high-pressure laminates (HPLs) made of melamine or phenolic resin impregnated papers or printed circuit boards (PCBs) made of paper-based laminates. Here, too, Leitz tools guarantee the best possible results for panel cutting or for jointing and rebating.

### Lightweight and composite materials

Lightweight and high-strength materials are indispensable for high-end applications in the aviation, automotive and leisure industries as well as in boatbuilding. Fibre com-



More quality, efficiency and productivity in machining aluminium, plastics, and lightweight and composite materials with tool solutions by Leitz

posites play to their strengths, particularly in multi-material lightweight construction. And it is important to avoid compromising this potential due to complex machining. This is why tool solutions which optimise the processes are in demand. The Leitz tool program contains powerful milling and drilling tools for machining fibre reinforced plastics. This is underlined by a recent fibre cutting benchmark by the Technical University (TU) of Vienna, in which tools by 16 different manufacturers were used to machine carbon fibre, glass fibre and aramid fibre sheets. In 124 individual tests, tools by Leitz offered the best performance for all three materials.

### Company

Founded in 1876 in Oberkochen in southern Germany, the Leitz Group is the world's leading manufacturer of tools for professional machining of wood, wood-based materials, plastics, composite materials and non-ferrous metals. The product spectrum covers the complete range of precision tools for automated machines. 3,000

Leitz employees implement the ideals of the complete solution provider and manufacturing service provider every day. With seven production sites in Europe, Asia and America, sales and service companies in 36 countries, 120 service stations with rapid production facilities and sales partners in all relevant markets, Leitz is represented on all continents.



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# Lightweight cylinders for everyone

The MARK Group can look back on an innovation track record that goes back nearly 100 years. The company revolutionised skiing with the invention of the ski boot buckle. By entering the automotive market, MARK Hydraulik GmbH created the basis for sustainable entrepreneurial activity and therefore the foundation for the on-going development of groundbreaking technologies and products.

The idea came first: innovative ultra-lightweight hydraulic cylinders for all industries. Market research and continual investment in research and development led to a new product. Ultra-lightweight hydraulic cylinders by MARK are between 30 and 70 percent lighter than comparable legacy cylinders. Scientific computations, test bed testing and practical use in tough everyday conditions demonstrate their outstanding performance. "If you've ever climbed a mountain with a rucksack on your back, you will understand what it's all about: the lighter the load, the less strength you need," says owner Rudolf Mark.

## Carbon creates weight advantage

There is no area of the cylinder that is not critically scrutinised for its weight-saving potential. Carbon and its processing is one of MARK's key competencies. When selecting substitute materials for conventional steel, MARK relies on the specialist knowledge of its metallurgists. MARK can draw on decades of experience here.

## Cost-effectiveness

The improved functionality and energy savings in the application can help to save costs in the long term. Cost-effectiveness is a general measure of efficiency or the rational use of scarce resources. The ability to use ultra-lightweight and corrosion-free hydraulic cylinders with enormous weight savings not only translates to economic benefits but also the lead in terms of engineering development.

## Freedom from corrosion and reduced emissions

Carbon cylinders are corrosion-free. This is an enormous competitive advantage in terms of wear and costs. And this is an interesting aspect, especially in chemical and maritime applications. Reducing the weight automatically means emissions savings. In all applications, the lighter basic design re-



MARK produces ultra-lightweight, corrosion-free hydraulic cylinders.

sults in longer ranges, lower operating costs and a huge increase in energy efficiency.

## Interdisciplinary product

Carbon hydraulic cylinders by MARK are suitable for a very wide range of applications. They are used in vehicle transporters, aircraft and cranes. Offshore plants, robots and ships also rely on hydraulic cylinders from Upper Austria. And not only domestically, but worldwide. And, as a brand new development, also on the Chinese market. This is because cylinders of any size, length and diameter can be manufactured – as a function of the requirements for the application in question.

## Reduced to the essentials

The hydraulic cylinder liner needs to be able to withstand the internal pressure without any major deformation. To ensure this, MARK relies on a thin liner made of steel. The mechanical load is absorbed by a CRP jacket made of prestressed carbon fibre rovings, which is mechanically wound around the liner. In order to fully automate

the manufacture of the CRP cylinder liner, all connections have been moved to the end pieces. Advanced high-strength aluminium alloys bear the loads and reduce the weight. The significantly lighter composite cylinder is mechanically rugged and can be produced in large quantities.



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# Lightweight polymer construction

The Montanuniversität Leoben (University of Leoben) works on polymer lightweight construction with a sound understanding of the materials, micro- and macromechanical modelling expertise and on the basis of broadly based processing technology.

The Polymer Engineering and Science department at Leoben recently celebrated its 50<sup>th</sup> anniversary. The University of Leoben has a long tradition of research into plastics as a lightweight material in line with the guiding principle "From the raw material to the finished product". One particular focus is fibre-reinforced polymers, especially continuously and oriented reinforced high-performance composites. The Polymers and Composites Design, Composite Materials Processing and Materials Science and Testing of Polymers groups collaborate in line with the A2LT focus topics, on making lightweight construction affordable, sustainable and intelligent. Optimised, innovative materials, test methods and parts are developed here. To this end, work on modelling and simulation for component design is performed on a wide range of length scales – from the micro to the part level – for a variety of application areas. Structural mechanical analyses based on finite elements, optimisation methods and analytical approaches provide the information on the required material structure. Implementing this relies on a wide range of different processing technologies, which are upgraded for improved efficiency through the development of smart monitoring and control solutions.

## Focus on sustainability

Alternative raw materials as a replacement for fossile basic materials are hugely significant. Matrix materials where virtually 100 percent of the carbon content comes from regenerative sources, in combination with textile reinforcements made from nat-



Alternative raw materials as a replacement for fossile basic materials are hugely significant.



Lightweight construction affordable, sustainable and intelligent: Small sized wind energy rotor blade made of bio-based materials

ural fibres, enable lightweight construction properties that are fully competitive with conventional fibre-reinforced plastics. Accompanying profitability studies and life cycle assessments help to ensure that the developments not only deliver maximum feasibility, but also affordability and sustainability as a result.

## Understanding of fundamentals and application orientation

With the aim of developing a sound understanding of the fundamentals and deriving methodological competence from this, a major part of the research takes place in cooperation with industrial partners. Focus-

ing on the questions arising from the applications guarantees high implementation potential for the research results.



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# A success story, since 1985

With high tech, high speed and high quality, Pankl Racing Systems has been one of the world's leading developers and producers of engine, chassis and drivetrain components since 1985. Pankl not only supplies the racing industry, but also the sports car and aviation industries with innovative products.

Pankl Racing Systems AG specialises in the development and production of engine, chassis and drivetrain systems for racing, high-performance vehicles and the aviation industry. The company impresses with lightweight components made of high-quality materials and designed for extreme mechanical loads. The parts are manufactured completely in-house – from the initial design, through finite element analysis, to production and test beds, Pankl covers the entire product development process. Thanks to its years of experience and the expertise of the entire team, Pankl is regarded as a technology leader, and supports its customers with innovative solutions to become even better.

## One-stop-shop for racing, high performance and aerospace

Quickly adapting new technologies, production methods or materials and incorporating them into existing processes is probably one of Pankl's greatest strengths. With this competitive advantage, the company regularly establishes new benchmarks in the field of lightweight construction. High-precision measuring and production facilities, as well as the various engine and drivetrain test beds, ensure that lightweight components can be manufactured and validated to meet the customer's toughest performance requirements.

## Additive manufacturing:

### Future technology in series production

Pankl Racing Systems uses state-of-the-art production technologies in many areas. When it comes to innovative lightweight solutions, 3D metal printing in particular offers a huge amount of potential. Pankl



Validating lightweight components on the engine and drivetrain test beds.



Pankl Racing Systems is headquartered in Kapfenberg.

has succeeded in bringing together what is to date the largest cooperation between leading technology enterprises under a single roof in the form of the Pankl Additive manufacturing competence center in Kapfenberg, with a view to establishing additive manufacturing technologies in new applications.

## From track to road

In cooperation with voestalpine Böhler Edelstahl, EOS and Quintus Technologies, Pankl Racing Systems is pursuing the goal of expanding the boundaries of lightweight construction and specifically deploying this technology in the high-performance automotive and aerospace sectors. For years, Pankl has used motorsport as its playground for developing and testing new ideas. Combined with expertise from the field of industrialisation, lightweight construction innovations in motorsport can be quickly adapted for the sports car sector. This means that Pankl can serve a wide range of industries with its entire product range – from prototype building to series production.

## Targeting the next sustainability goals with lightweight

All state-of-the-art mobility strategies now require a high lightweight component con-

tent in order to meet sustainability goals. With its development know-how and modern manufacturing technologies, Pankl helps its customers to achieve these targets and has therefore become the leading technology partner for engine, chassis and drivetrain components in the racing and automotive sectors. Pankl Racing Systems is headquartered in Kapfenberg in Styria, Austria. The company's ten facilities worldwide are managed from there. Pankl's technological expertise encompasses machining technology, heat treatment, forming technology and additive manufacturing.



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# Research on Lightweight Technology

The Polymer Competence Center Leoben GmbH (PCCL) is a collaborative research institute focusing on polymer science and technology. Hereby, the main focal points are polymer based, functional and structural materials as well as production and processing technologies. These are intended as the basis for future innovations in a wide range of applications.

The PCCL-K1 has established itself as an "Austrian Centre of Excellence". The declared goal for the coming years is to further evolve to an internationally recognised player with high visibility in selected areas of plastics technology and polymer sciences. PCCL is supported by the scientific expertise of three Austrian universities (MU Leoben, TU Graz, TU Vienna), of several international research partners (e.g. TU Munich, Politecnico di Torino, Czech Academy of Sciences, University of Budapest) as well as of the technological and market know-how of its 50 partner enterprises and the skills of the 122 employees.

## Environmentally compatible lightweight construction

The competence centre combines the high demand in the plastics industry for the development and establishment of pre-competitive research activities for the implementation of existing market potentials with the scientific ambitions of an internationally recognised research programme. New and strategic research focuses concerning lightweight construction, such as frontal polymerisation in composite structures as well as soluble and reusable resin and adhesive systems, have been added to PCCL's R&D programme. Environmentally compatible polymers, bio-based fibre composites and the recycling of polymers are significant future research topics, not only in the PCCL's lightweight construction projects. In this context, PCCL's contribution is essential to the circular economy and ecological compatibility of plastics.

## Research for more sustainability

Modelling and simulation approaches are applied in all areas, for example, in the efficient processing of elastomers and dielectric reactive resin, in predicting the mechanical properties of polymers and composites, and in fracture mechanics approaches. Furthermore, projects on the use of polymeric components in photovoltaic modules also contribute to the achievement of sustainability goals.



The Polymer Competence Center Leoben researches into polymer structural and functional materials, and the matching technologies for their production and processing.

## Forward-looking research topics

In 2020, the PCCL and its partners additionally started working on both of the COMET modules approved by the FFG. Within the framework of these COMET two modules, institutes of the MU Leoben are involved as research partners. The COMET "CHEMTECTURE" module (Digital materials for a personalised world – Artificial engineering of polymers along the whole value chain) targets 3D printing of individually functionalised parts. Especially in this project, PCCL bridges the gap between the chemistry of functional materials at the molecular level and the architecture of additively manufactured polymers at the macroscopic level.

## Interdisciplinary approach

Polymers for hydrogen technology are the topic of the COMET "Polymers 4 Hydrogen - Decarbonizing of energy infrastructure using novel polymers" module. The PCCL is developing polymeric materials and sealing solutions for the use under high hydrogen pressure (up to 1,000 bar) and in extreme application conditions, thereby turning visionary

applications in hydrogen technology into reality. Following an interdisciplinary approach with topics ranging from polymer chemistry and polymer processing to the characterisation and simulation of material behaviour, the PCCL is taking a pioneering role here. Since its foundation in 2002, PCCL's employees have published 453 scientific articles in peer reviewed journals. Moreover, 15 patents have been awarded to PCCL. The current workforce of 122 employees generates an annual turnover of nearly eleven million Euros.



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## Innovation in composites

Peak Technology GmbH's products launch rockets into space, move satellites into the right orbit, propel formula 1 cars, electrify air travel, store hydrogen, and win the 24 Hours of Le Mans. It is the challenge that drives the Upper Austrian lightweight construction specialist.

In 2007, Managing Director Dieter Grebner founded Peak Technology GmbH with the aim of offering innovative lightweight solutions for racing and industrial applications. Right from the outset, he set store on the use of fibre composite materials and on close cooperation between development and production. Today, Peak Technology employs some 130 staff, developing a wide variety of products for customers in the motorsports, aviation and aerospace industries worldwide. The company implements specific customer projects in the shortest possible time, starting with the design and construction through to prototype development and quality validation. It is also possible to produce short runs directly on site. Peak Technology relies on the latest composite technologies in processing and develops its expertise in the fibre composites field through on-going training and cooperation with research facilities.



Wound and laminated parts are cured under pressure in the autoclave.

### High-pressure tanks for space travel

Ever since the company was founded, Peak Technology has produced high-pressure tanks for gases for motorsports and various industrial applications. The team started producing high-pressure tanks for space travel in 2009. These tanks are subject to the strictest safety criteria and are used, for example, in satellite drive systems. Tanks by Peak Technology are used in the Galileo navigation system, acting as fuel tanks for carrier rockets such as the European Vega-E. The Upper Austrian company develops and produces tanks with a weight-op-

timised design. The right choice of material and the production method help to massively reduce the unit costs, which benefits customers on the constellation market.

### Sustainability as a philosophy

Peak Technology also focuses on the sustainable development of the aerospace industry. For example, engineers are also working on strategies to support the recycling of the fibre composite components. Avoiding space junk is also a major topic. The possibility of thermal degradation (demisability) of the tanks at the end of the satellite's service life is at the forefront of new development projects.

### Committed to progress

"Our greatest motivation is the will to always do even better," as Dieter Grebner emphasises. "That's why we constantly optimise our methods and processes and invest huge amounts of time and resources in the further training of our already highly-trained staff. Because they are the only people who can guarantee maximum

quality without compromises – from 3D design and simulation, through to production and our consistent quality management." In close cooperation with customers, Peak Technology creates individual and flexible solutions which complete the transition from initial prototypes to series production in record time. In intensive work processes, the Peak Technology team looks for the best solution and works with vision and the highest precision.

**PEAK**  
TECHNOLOGY

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Automated winding process for manufacturing carbon fibre reinforced lightweight parts.

## Innovative surface coating

The RUBIG Group is consolidating its Laser Technology and Surface Coating divisions with its latest subsidiary, RUBIG Technology. This increases the field of application for lightweight parts at the same time. The surface coating technology is individually adapted to the customer's requirements. And RUBIG has even found a formula to fight viruses and bacteria.

Materials typically used in lightweight construction, such as aluminium, titanium or plastic, have special properties that make them particularly attractive compared to steel: density, specific strength and suitability for mass processing are just a few examples. On the downside, these materials have a few disadvantages in terms of their surface wear resistance. And this, in turn, restricts their potential uses in the component application. At RUBIG Technology, the latest addition to the RUBIG Group, the portfolio focus is on growing these fields of application.

### Improved protection against wear

Using laser deposition welding or laser alloying, hard material particles such as silicon and tungsten carbide can be integrated into the surface. These highly durable materials significantly improve the resistance to adhesive and abrasive wear and make surfaces even more stable than that of steel. The hard material phase components are adapted to the customer's needs as a function of the respective type of stress and the production process. This ensures that the use of lightweight materials is optimised in terms of machining, resources and stress.

### Individual coating recipe

PVD – Physical Vapour Deposition – is a surface coating technology based on physical impact. PVD coating systems are well-known for their excellent wear resistance and are therefore often used for machining tools. But they are equally useful for the surfaces of plastics. RUBIG Technology tailors both the design of the coating system and



The RUBIG 5-axis laser processing centre offers virtually unlimited options true to the motto of "4 lenses and 4 technologies".

the coating recipe specifically to suit the plastic components or meet concrete customer requirements. Standard wear protection coatings but also functional, decorative coatings with a variety of coating compositions can be implemented.

### Fighting viruses and bacteria with Pep

Corona taught us a great deal about the presence, role and spread of viruses and bacteria and clearly showed us the limits of our infrastructure. Since the beginning of the pandemic, the RUBIG Group has concentrated on improving this infrastructure with new technologies. RUBIG NitroPep is a non-toxic coating developed for metals and plastics that contains disinfecting and antimicrobial agents such as chlorhexidine. Viruses and bacteria are killed within minutes after contact with a surface treated with NitroPep. Additional actions such as light irradiation are not required.

### Effective and non-hazardous

Targeted use at neuralgic points such as entrance doors to kindergartens, schools

or care homes can effectively reduce the transmission of pathogens. The coat is firmly bonded to the surface of the coated object and can only be removed mechanically, i.e., by destroying the surface. It is non-hazardous in terms of sensitisation and cytotoxicity. An accredited Austrian laboratory has demonstrated the effectiveness and non-hazardous nature. Chlorhexidine is also approved by ECHA as an active substance and in the pertinent product groups in line with biocide legislation.

**RUBIG** DRIVING SUCCESS

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RUBIG NitroPep rules out surface recontamination. Handles, for example, are no longer key interfaces in the chain of infection.

# Sustainable composites

At the Transfer Centre for Plastics Technology in Wels, experts are working on fibre-reinforced plastics for lightweight construction. Sustainability and recycling are the future focal points. Research is being conducted on innovative recycling solutions for customers who can also have their materials and components tested.

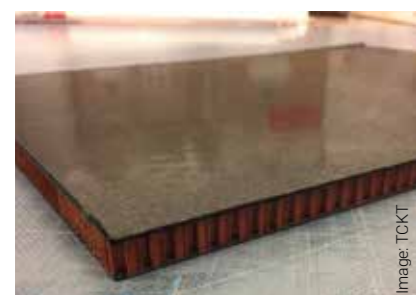
The TCKT – Transfer Centre for Plastics Technology is the specialist for fibre reinforced plastics applications in tomorrow's lightweight construction. Whether the aircraft, automotive or the cycle industry, the business lines and applications are varied, particularly when it comes to mobility, where everything needs to be lightweight and rugged, and fibre reinforced plastics (FRP) are used. This composite material has huge lightweight construction potential and will see increasing use in other industries, such as mechanical engineering and the building sector, in the future.

## Material development

The TCKT has many years of experience in plastics development, and particularly for lightweight applications in combination with short or continuous filaments. In the past few years, work has focused primarily on the subject of thermoplastic composites and recycled carbon fibres (rCF) – starting with the evaluation of different fibre-matrix combinations, process and property optimisation of tapes and thermoplastic sheets from in-house production, through to the production of various test specimen geometries for material characterisation tasks. TCKT is also trying to make the future of FRPs more sustainable with biopolymers, which are already being used successfully in the packaging industry and agriculture, in combination with natural fibres.

## Smart production

The magic word for smart and resource-conserving composites production



Sustainable rCF sandwich sheet



Automated tape laying

is Automated Fibre Placement (AFP). The TCKT takes deep insights into the entire spectrum from producing the tapes and fabricating them downstream up to the finished preform by means of an automated laying process on the AFP plant. A modern thermoforming station is then used for forming into finished parts or demonstrators. The experts can process both thermoset and thermoplastic unidirectional tapes for customers.

## Recycling of composites

Plastics recycling is one of the biggest challenges of our age. Unfortunately, there are very few economically and ecologically meaningful recycling techniques for fibre reinforced plastics so far. This is why the TCKT is researching innovative solutions for recycling these waste flows to create high-quality recycled materials, which in turn can be used to manufacture new, equally high-quality products. Among other things, tests are being carried on introducing pyrolysed rCF into new applications in the form of nonwovens. Glass-fibre reinforced plastic (GRP) waste can also find

its way back into new parts after shredding and reprocessing with a compatible matrix.

## Material testing and characterisation

When characterising materials, TCKT employees test both plastics and parts for customers in line with a wide range of standards and processes for mechanical, thermal, rheological or physical characterisation. The plastics experts draw on years of experience, especially in material testing of composites, coupled with expertise in the interpretation of the results, for the benefit of customers and purchasers alike.



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# Lightweight materials and technology

At Graz University of Technology, several research groups focus on the design of metal and hybrid lightweight materials, advanced materials processing and manufacturing, and fatigue design issues. We are frontrunners in the additive manufacturing of metals and composites for ultra-lightweight structures in mobility applications.

The demand for lightweight-driven material combinations, designs or maintenance strategies can be met by modern AM technologies. Based on systematic experiments with a view to optimising the parameters for part properties, integrity and economic aspects, we create solutions using wire arc additive manufacturing technologies. Beyond standard processes like CMT, our research also covers plasma and electron beam based processes.

## IMAT – lightweight, high-performance materials

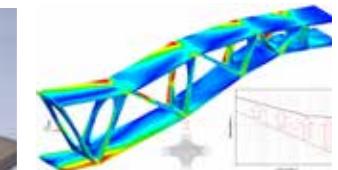
In addition to innovative and novel engineering approaches to producing lightweight, high-performance metal-composites, we also develop hybrid structures with a focus on sustainable materials with improved recyclability that support the circular economy. Examples of these include carbon and glass fibre reinforced thermoplastic composites, which can be combined with lightweight, high-strength metals to reduce aircraft or vehicle weight without compromising passenger safety. The integration of different lightweight materials such as high-strength steels, aluminium alloys and bio-based composites in modern vehicle bodies requires reliable processing technologies, and forming and joining technologies in particular. Proving the general feasibility of such designs requires comprehensive experimental and numerical investigations that are based on the detailed characterisation of the mechanical properties and the failure behavior of the lightweight materials.

## IFT – design and production of lightweight parts

The topics of sustainability and optimal material utilisation are becoming increasingly important in the production engineering sector, and, if you consider the entire product lifecycle, lightweight construction has a lot to offer. We need to develop new and adapted production processes and machine tools to achieve the goals of modern lightweight design, all the while increasing



Ultrasonic Joining of FFF-PEEK with LPBF 316L stainless steel



Fatigue design of lightweight structures



Topology Optimization in Aerospace

flexibility in production. One such tool for designing weight-optimised structures is topology optimisation. Generating lattice structures, for example, opens up completely new possibilities for lightweight construction in application areas such as automotive engineering, aerospace or medicine. Despite the many advantages of additive manufacturing, conventional processes such as milling, turning or grinding continue to play an important role in production engineering for the finishing of precise lightweight structures with optimal surface qualities and geometries to ensure perfect functionality and reduce the energy requirements for production as much as possible. At the AddLab (IFT & IMAT), research is focused on metal-additive manufacturing processes. Along with the production of weight-optimised components using LPBF or the newly developed SLED process, research also includes the testing of new material alloys and their economic use in AM.

## BST – fatigue design of lightweight structures

Manufacturing processes and other post-treatment methods significantly affect the local material properties and the fatigue life of components exposed to cyclic loads. Investigating such technological effects is fundamental to ensuring safe and reliable fatigue design in modern lightweight structures. Numerical and experimental analysis

at the level of representative specimens, and at structural size, facilitates a local assessment and further lightweight optimisation, taking load influences and manufacturing processes, such as welding, casting or additive manufacturing, into account. This, in turn, has enabled the implementation of durable lightweight parts in modern automotive, rail vehicle and aerospace structures.



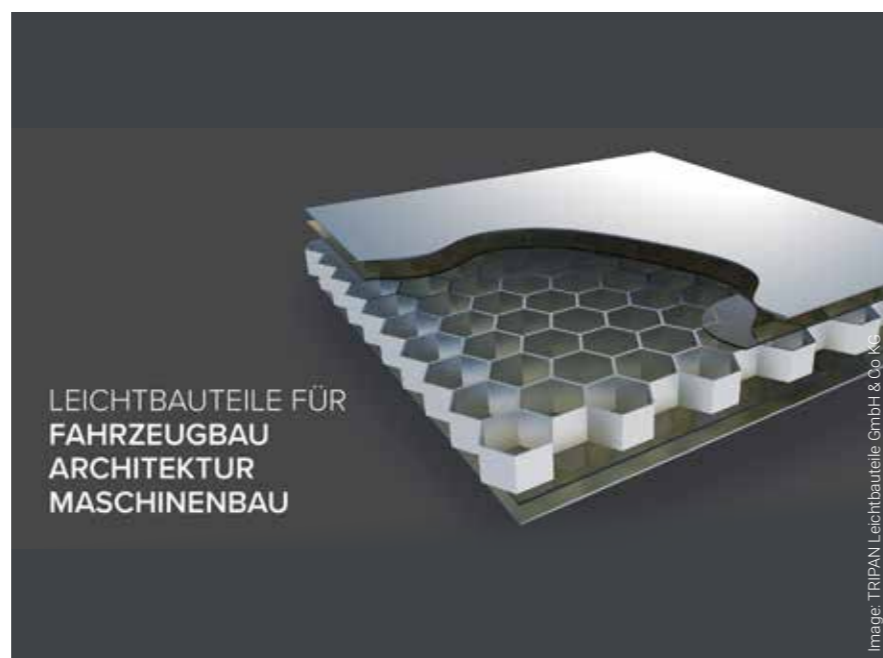
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# For 20 years a pioneer in innovative lightweight construction

As a specialist in the lightweight construction industry, TRIPAN Leichtbauteile GmbH & Co KG has been a reliable partner for unique lightweight solutions for more than 20 years. The Upper Austrian pioneer produces individual panels for today's daily needs and for industry – tailor-made for a wide variety of requirements and applications. Innovation made in Austria.

Flexible surface design combined with an interior structure capable of bearing extreme loads – this is what characterises lightweight parts by TRIPAN. "Ultralight and extremely rugged in use" is the guiding principle in product development. The reliable, premium quality of the lightweight parts is valued equally in machine and vehicle construction, aircraft, cable car, and rail vehicle construction, as well as in shipbuilding and architecture. TRIPAN is a company with international activities, but generating domestic value and quality craftsmanship form the foundations on which the company stands. Regional production at the Hösrsching location is an integral part of the company's philosophy.



Lightweight panels by TRIPAN Leichtbauteile GmbH & Co KG in Hösrsching.

## Unique panel solutions

A lightweight panel fulfils many functions: providing protection, bearing loads, and creating space. The details of the implementation and the design of the finishes and edges are individually adapted to the customer's needs. True to the motto of: create your panel. The bionics of TRIPAN lightweight parts – gleaned from our natural surroundings and systematically enhanced – are a very important aspect. This is why the aluminium honeycomb core has been integrated into the composite parts. The core ensures a high load-bearing capacity with a low dead weight and eliminates the need for elaborate substructures.

## Applications

Innovative lightweight parts by TRIPAN are used in a wide variety of industries. In vehicle construction, the specialist manufactures, e.g., parts for special vehicles. Sandwich sheets are manufactured for superstructures, bulkheads, storage compartments, underbodies, crash absorbers or for reinforcing vehicle bodies. For mechanical engineering, TRIPAN produces parts that combine low dead weight with high flexural stiffness and/or heat resistance. TRIPAN

also offers countless options for architecture. TRIPAN's innovative ceiling and wall panelling can be equipped with acoustic, heating or cooling functions, for example.

## TRIPAN CUBE Tiny House – The new standard of living

Dining room, living room, bedroom, office, kitchen and bathroom - the TRIPAN CUBE can be almost anything. Thanks to perfect lightweight construction technology, the Tiny House developed by TRIPAN is mobile and flexible. The carefully considered room layout allows for a wide variety of usage concepts and offers "living space" for up to three people. There are three living cube models that can be individually adapted to the customer's wishes. From the floor through wall design to the interior design, no limits are placed on the imagination.

## Research for the future

Collaboration with research partners and platforms such as A2LT allow the compa-

ny to share knowledge widely. Research is already underway into the further development of lightweight manipulators in robotics and multifunctional climate sails in architecture. And the on-going development of Tiny House solutions also offers new potential and inspiration.



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# Sustainable solutions for mobility

Ultimate Europe was founded in 2003 and develops, services and sells automatic door systems, gangways and interior equipment for rail vehicles. To find these three product areas combined in one company is unique in the industry. The international company has four branches in Austria, Poland, Romania and Turkey with a total of 330 employees, 150 of whom are employed in Austria.



The new headquarters is a climate-friendly building with a heat pump and photovoltaic system.

Ultimate Europe's new headquarters is in St. Georgen am Ybbsfelde, Austria. Where the company was previously spread across three locations in Amstetten, the new location is a state-of-the-art future-orientated facility with production and development areas, and a product showroom for customers. The climate-friendly building is equipped with a heat pump and a photovoltaic system. In addition to green outdoor areas and atriums, the employees also have access to their own fitness room, activity-based workspaces, a relaxation area, roof-top terrace, and a large number of charging stations. This environment empowers the workforce to collaborate on our sustainable, lightweight solutions.

## Railway meets Aerospace

There are a number of challenges that shape the rail vehicle industry, including the long service life of up to 40 years, maintenance-free products, condition-based maintenance and the need for a holistic recycling strategy at the end of the service life. It is no surprise that ongoing development is always driven by these consid-

erations. Ultimate Europe fundamentally revised its door system for trams in terms of size, weight and cost, and the system has now seen successful use on the market for more than 20 years. The more compact design was achieved by optimising the weight, using finite element analysis to design the guide systems and installing new, patented locking mechanisms. Thanks to our cooperation with a supplier from the aerospace industry, we achieved a weight reduction of up to 50% by installing special rail industry-approved laminated safety glass.

## Interior design is key to success

While door systems and gangway systems have already been optimised in minute detail, there is still huge potential when it comes to interior solutions. Ultimate Europe has developed a proprietary lightweight sandwich panel that meets strict European fire standards up to HL3 while being 30% lighter than conventional GRP. This material can be adapted to the specific requirements of individual projects and is suitable for exterior and interior applications.

## Lightweight couplings

Faced with many customer-specific requirements, Ultimate Europe has switched from castings to welded parts in the development of couplings. The use of state-of-the-art computer programs has enabled geometry and shape optimisations to ensure substantial weight savings, while production and delivery times have been optimised by the use of standard parts.



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## Forming superior solutions

The Metal Forming Division is the competence centre of voestalpine for processing nearly any metallic material. With an industry-unique combination of material and processing expertise and worldwide presence, the division is a partner for sustainable lightweight solutions in the fields of mobility, renewable energy as well as construction and storage technology.

In the mobility sector, Metal Forming Division supplies tailor-welded blanks to reduce component weight by at least 15% through the optimum combination of the material and sheet thickness. Cold- and hot-formed structural parts made of advanced high-strength, ultra high-strength or press hardening steels are used for our customers to make lightweight components and improve passive vehicle safety with assemblies made of these high-tech materials. Especially in the field of hot forming, the division has a USP in the area of corrosion protection and sustainability with galvanised steels up to 2000 MPa.



Tailor Welded Blanks by Metal Forming Division of voestalpine

### Mobility

Expertise in lightweight design continues in the body shell area with the production of doors, bonnets and tailgates, side panels and roofs made of high-strength, thin steel and aluminium. The engineering experts of Metal Forming Division develop the required tools and jigs and, together with our production experts, the most sustainable component manufacturing processes such as deep drawing, hot forming or roll forming.

### Sustainability

Sustainability also plays an important role at Metal Forming Division, which is reflected in our products and manufacturing processes. We developed and produce parts of modular battery boxes made of UHSS multi-chamber profiles and pressed parts for the e-mobility sector. The battery boxes are benchmarks in terms of weight and crash performance. We are also very proud of our highly efficient rotor and stator stacks for



Additive Manufacturing by Metal Forming Division of voestalpine.

electric motors. For the sustainable electricity required in operations, s.o. develops and supplies elevated PV systems and substructures and reduces its own CO<sub>2</sub> output at most locations (largest PV system in the Netherlands). A combination of sustainability and lightweight design is also found in hybrid structures for construction and storage with the reduced use of steel combined with renewable raw materials such as wood.

### Additive manufacturing

Finally, for our costumers in every segment, develops and manufactures 3D-printed prototypes based on metals (steel, aluminium) and plastics. In addition to the classic powder bed fusion process, this is accomplished by means of wire-arc additive manufacturing (WAAM).

### About the Metal

#### Forming Division of voestalpine

The Metal Forming Division was established in 2012 when the voestalpine Profilform and Automotive divisions merged. The headquarters is located in Krems on the Danube in Lower Austria. More than 11,500 people are employed at more than 50 locations worldwide. The division comprises the business units Tubes & Sections, Automotive Components, Precision Strip and Warehouse & Rack Solutions. The

Metal Forming Division works with the following technologies: machining, cold-, hot- and rollforming, welding (for assemblies), (cathaphoretic and powder) based coating, heat treatment and additive manufacturing.

### The voestalpine Group

voestalpine is a leading global steel and technology group. The company group consists of some 500 group companies with locations in more than 50 countries on all five continents. It has been listed on the Vienna Stock Exchange since 1995. voestalpine is the world market leader in railway infrastructure systems, tooling steels and special sections. As a company, voestalpine is committed to global climate goals and is pursuing a clear plan for the decarbonisation of steel production with greentec steel.



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## Green lightweight materials

W.E.I.Z. Forschungs & Entwicklungs gGmbH is a non-university research facility dedicated to researching and developing products, technologies and services in the higher-level fields of energy, sustainability, environmental protection and climate action.

As one focus of its R&D work, W.E.I.Z. collaborates with partner networks on topics related to creating sustainable technologies and materials centred on ecological lightweight construction for the mobility industry. Especially in mobility, where things need to be light, stable and sustainable, nothing beats wood as the material of the future. The demands imposed on materials in terms of affordability, sustainability and repeatability are only becoming stricter, which makes gaining in-depth knowledge of wood as a material and its behaviour under various conditions essential. With a view to developing a sound fundamental understanding of the material and deriving methodological competency from this understanding, a large part of the research takes place in cooperation with industrial partners. The focus on issues that arise from the applications guarantees a high level of implementation potential for the research results.

### Focus on sustainability

The use of lightweight components made of wood offers a number of implicit ecological benefits, such as the potential to reduce the weight of a vehicle's components by around 20 percent, leading to lower CO<sub>2</sub> emissions in operation. Across the entire life cycle, the



Side impact beam



Aircraft flap

use of wood as a substitute for individual components and in smart wood-hybrid designs generates direct ecological, social and economic benefits in the whole of the mobility industry as well as in the mechanical engineering or consumer goods sectors.

### Affordable ecological lightweight components

Linking digital engineering to manufacturing processes makes it possible to allow for manufacturing constraints from the start, during the design and layout process. By establishing hybrid processes, digital segmentation of the products and processes enables efficient use of raw materials in the production of the new components. What makes this process innovative is that all the central questions arising in the context of designing components made of sustainable raw materials are answered at a very early stage in the component development. Matching lightweight design potentials are identified, taking manufacturing restrictions into account, and transferred

to resource- and cost-efficient manufacturing processes. This optimisation-driven process ensures that design and performance requirements on the one hand and manufacturing constraints on the other are addressed throughout, from project conception to the finished product, and that the best possible compromise between component weight, component cost and manufacturability is found.



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