Smart Products from Smart Factories

Research is conducted on materials in the laboratories of the Institute of Materials Science, Joining and Forming.

If we think today about the factory of the future, robots, artificial intelligence, resource-efficient production methods and new materials have a firm place in it. At TU Graz, research is being carried out to turn this vision into reality.

Birgit Baustädter

Already today, not only people but also countless collaborative tools work in factories. The goal is to create higher flexibility and customer orientation (down to batch size one production), more efficiency and faster production speed. These targets are mainly due to the increased demand for environmentally friendly production of green products, the circular economy and the high speed of innovation in new products. The factory of the future must be agile, in other words, it should be able to adapt very quickly and flexibly to changing production tasks and must remain competitive despite rising costs for personnel, raw materials and energy.

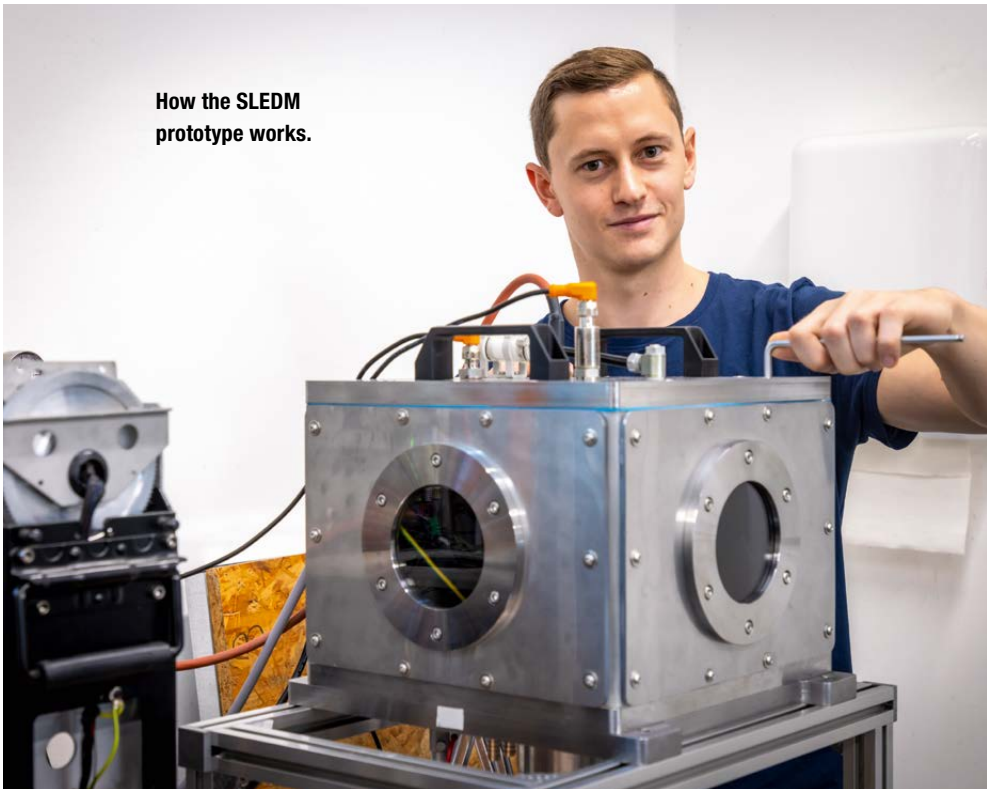
At TU Graz, research is being carried out on several fronts, but above all together on the production of the future. The researchers working on this topic already linked up several years ago in the Research Center Smart Production Graz. Research Center head Christof Sommitsch: “We’re concerned with the close networking of available forces, joint projects and the best possible proposals for the business community, which is urgently looking for solutions.”

LIGHTWEIGHT CONSTRUCTION

Christof Sommitsch himself works in materials science and, together with his team at the Institute of Materials Science, Joining and Forming, is investigating how different materials can be effectively additively manufactured, joined together and formed. This is especially important also for environmental protection. Sergio Amancio holds the BMK Endowed Professorship for Aviation at the Institute and works on lightweight materials for aviation. “Of course, our technologies can also be used in any other transport sector,” explains the professor. He is mainly involved with the joining of composite materials, i. e. fibre-reinforced plastics, and metals. Two materials that traditionally cannot be mixed, but which can make aircraft components considerably lighter when combined. Lighter components mean less weight to transport, >

Sergio Amancio on new joining techniques.

Christof Sommitsch on smart production.



How the SLEDM prototype works.

which means less fuel is needed, thus causing less impact on the environment. But: “Metal and plastic behave like water and oil. They don’t mix. The liquid metal forms small beads in the plastic but does not bond with it.” Amancio and his team are therefore, among other things, changing the surface structure of metal components in a newly developed process in order to be able to produce stable connections. The metal component is produced with a 3D printer. Its surface structure is designed in such a way that the liquid plastic can be deposited in it and “get a grip”. “We were inspired by geckos’ feet. They look like microscopic mushrooms that can insert themselves into the surface structure of walls, for example, and thus get a secure hold,” explains Amancio. These surface-structured, 3D-printed, metal components are joined in an energy-efficient way using ultrasonic joining with the composite materials or hybridized with other novel additive manufacturing processes to form a lightweight macro-composite structure.

This is how joining is done by means of ultrasound.

3D PRINTING

3D printing is an important topic in the factory of the future. It allows the production of precisely planned individual pieces that are stable, light and precisely built. For example, at the Institute for Chemistry and Technology of Biobased Systems, where a bio-printer is doing its job. The GeSiM BioScaffolder BS 3.2 is capable of 3D printing organic materials and is unique in this form in the Alps-Adriatic region. Forward-looking research projects on this device are already being planned – from the production of functional materials for an artificial aorta to alginate hollow fibre membranes or printed polysaccharides for tissue cultivation. Or with plastics in the Schumpeter Laboratory for Innovation, where above all product innovations can be developed and prototypes built.

But metallic 3D printing is also a central topic. Franz Haas from the Institute of Production Engineering has delved into this topic with his team. Metallic 3D printing traditionally uses a powerful laser light source to build up the material in a box full of metal powder layer by layer with extreme precision. Of course, such a powerful light source cannot be used in every environment in terms of safety. For example, in an operating theatre, where individually printed metal parts could be useful during operations, its use is not possible. That is why Haas and his colleagues developed the SLEDM method, as he explains: “Instead of a laser, we use a very powerful LED array whose individual LEDs can be specifically controlled and thus the energy density in the melting zone can be optimised. This can decisively improve material properties and energy efficiency. We have been granted a patent for this process and have built a prototype for LED melting tests. This lays the foundation for basic experiments and modern process monitoring through the use of numerous sensors in the demonstrator.”

BATTERIES

However, Franz Haas is also working on other areas to make the factory vision of the future a reality. His institute also works with the AVL company at the Battery Innovation Center – a battery research infrastructure on the AVL premises. For a few months now, there has also been a smaller assembly line for the robotic

The Battery Innovation Center is researching the automatic testing and stacking of battery cells.
Lunghammer – TU Graz

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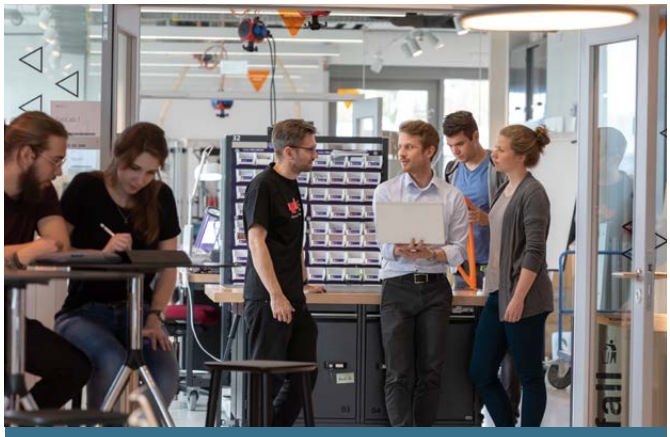
Franz Haas on future production.

construction of battery modules at TU Graz. In the future, batteries will play an increasingly important role in mobility, which is why the demand for factories and automation solutions in this area is already very high now. “For me, the battery cell in all its diversity of types and geometries is the screw of the future,” is how Franz Haas describes it. “It is already in high demand now and will be more and more so in the future. Be it a button cell in electronics or as a pouch cell installed in modern battery packs in the floor plates of current e-vehicles.” Due to the increasing demand for electrical storage media, their production must also be raised to a new level. And that is exactly what is happening at the Battery Innovation Center. The production line located at Campus Neue Technik automatically recognizes which battery cell is to be processed. The right gripper which was previously produced next door using 3D printing is automatically selected. The gripper guides the battery cell to the test station, where it is first checked visually and then mechanically. An important factor in smart production is the automated quality check of all products. “Metrology is a big issue. In this way, we guarantee the service life, energy efficiency and create the data basis for the return of the value stream at the end of the service life,” reveals Haas. >



SCHUMPETER LABORATORY FOR INNOVATION

Equipped with the latest digital manufacturing technologies and appliances for the production of prototypes and innovative product designs, the Laboratory for Innovation offers everything a maker’s heart desires: from cutting-edge 3D printers for FDM, STL and CFF methods, CNC 4-axis and 3-axis milling machines and appliances for laser cutting and laser engraving, to water-jet cutting, sand-blasting, circuit-board printing and vinyl cutting. Here, students and researchers engage in multidisciplinary cooperation, as do start-ups, SMEs and established industrial companies involved in joint innovation work.

To Schumpeter Labor for Innovation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DIGITAL & SUSTAINABLE PRODUCTION

TU Graz offers the focus Digital & Sustainable Production in the university course Leadership in Digital Transformation as a continuing education programme of Life Long Learning. All information can be found on the course website.

Rudolf Pichler on the smartfactory@tugraz.

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"If a single cell in a battery pack is defective, only that single cell needs to be replaced. But we have to create the conditions for this," says Haas. "Today a battery has several lives. The first, for example, in an e-vehicle. And when the required storage capacity can no longer be provided or meet the safety standards of mobility, then it can take on another life as a storage unit in the home or in industry to store solar energy for example." In future, it will also be possible to test and assemble fuel cells in the lab and in the adjacent mini clean room.

Pro²Future

The COMET competence centre Pro²Future, which is located between Graz, Linz and Steyr, also has a strong connection to industry – with a central focus on cognitive products and production systems. Pro²Future is shaping such cognitive systems and implements them both in products and in production systems as well.

The core topics of cognitive products and cognitive production systems are supported by the foundational areas around machine perception and awareness, cognitive robotics and shop floors, and cognitive decision support systems.

SMART FACTORY

The Institute's second location, at Campus Inffeldgasse, is home to the smartfactory@tugraz, a learning factory managed by Rudolf Pichler and equipped with state-of-the-art production and communication facilities. In the smartfactory@tugraz, disruptive technologies, the networking of IT and OT levels and the safe interaction of often highly heterogeneous aggregates are tested and demonstrated on the basis of show cases. Several production robots are ready for this, communication can run quickly and securely via the campus's own 5G network, and Rudolf Pichler's constant message applies: "We are happy to invite companies to implement and test out their ideas in the smartfactory. Smart production systems are not only useful in large industrial companies, but also offer small and medium-sized enterprises in particular valuable opportunities to improve performance."

DIGITALIZATION

Easily recognizable, the topic of smart production is closely linked to advancing digitalization. This is why, in addition to the production-focused institutes, several other institutes at TU Graz also address the topics of cybersecurity, safety and the Internet of Things (IoT). For example, the Institute of Technical Informatics, the Know Center and the Institute of Engineering and Business Informatics. The topic will also be central to the GraML Research Centre – Graz Center for Machine Learning.

SPACE FOR PEOPLE

There is one very big prejudice that Franz Haas would like to decisively counter: the deserted (i.e. humanless) smart Factory. "Production without people can never be smart. On the contrary, we are faced with a shortage of skilled workers in this field despite the many developments around Industry 4.0." ■