MOBILITY & PRODUCTION

Fields of Expertise TU Graz

Source: istockphoto.com/fotolia.com

Helmut Eichlseder, Mobility & Production
Source: Lunghammer – TU Graz

Most of the research activities in the fields of both mobility and production are dedicated to the technological change required from an environmental perspective. So we are glad that the FoE Mobility & Production, for instance, plays an essential role in the field of hydrogen research across faculty boundaries. Basic and application-oriented research into hydrogen as an energy carrier in the industry, energy and mobility sectors is a strategic focus of the Center of Hydrogen Research at TU Graz. The centre, by far the largest in Austria, deals with the entire value chain of the renewable hydrogen economy, from production to storage and distribution to application. There are already plans to expand the present unique research infrastructure in the foreseeable future.

The next step in the development of the smartfactory@tugraz is the required networking with other pilot factories and scientific units in Austria in order to serve as a role model for SMEs as regards interconnecting and creating powerful and effective manufacturing value chains. The services of Gaia-X are going to be used to generate a common and pure European data base and to establish specific manufacturing-oriented platforms. An application for funding is going to be submitted for this initiative.

The Battery Innovation Center (BIC), which was completed in February 2022, is a funded research project in cooperation with AVL List GmbH, Rosendahl Nextrom GmbH, Virtual Vehicle Research GmbH and the Institute of Production Engineering of TU Graz. The goal of the project was the establishment of a research factory to produce and carry out research into modern electric vehicle batteries (EVB). Taking into account the rapidly changing EVB architectures based on new market demands, battery developments and increasing OEM knowledge, the facility is highly flexible and makes use of a matrix layout for all the different types of battery cells (cylindrical, prismatic and pouch cell), modules and packs.

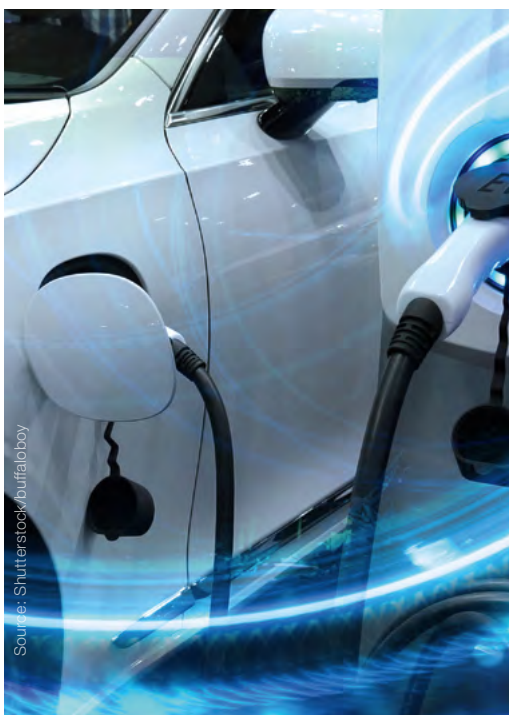
The task of the Institute of Production Technology was the development of new concepts and methods in order to increase the required flexibility of the research factory. After the successful completion of BIC, new projects are planned and some are already in progress.

Franz Haas, Mathias Prechtl, Gernot Schlögl, Martin Weinzerl

Battery Innovation Center – Research in Battery Production

Electromobility is becoming increasingly important in the automotive industry, with energy storage being a key issue.

AVL List GmbH is establishing the Battery Innovation Center (BIC) in Graz to address this topic and to offer appropriate solutions for the automotive market in the future. At the BIC, various battery cell types (Figure 1) are assembled into battery modules in the area of prototype and small series production for a wide range of vehicles, from electric scooters to passenger cars and heavy vehicles. Finally, the modules are connected and finished into compact battery packs for installation in the vehicle. The unique aspect of the BIC is that it allows a flexible production line for the assembly of battery modules for all variants in an automated manner. >



Source: Shutterstock/buffaloboy

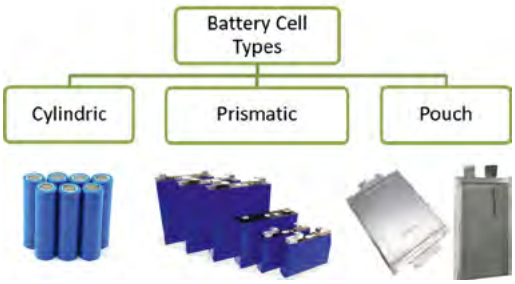


Figure 1: Cell types.
Source: IFT

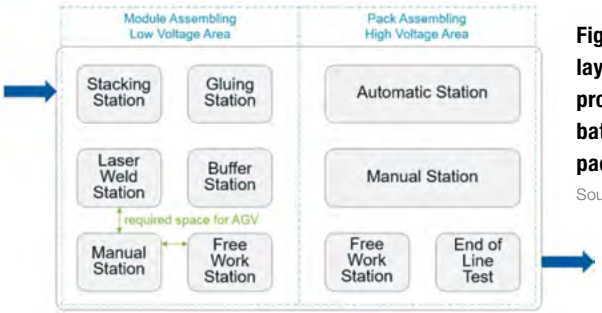


Figure 2: Principle layout matrix production of battery module and pack production
Source: IFT

The Institute of Production Engineering operates as the TU Graz scientific project partner and works on different research topics that are essential for a high-quality, economic and ecologic production of battery modules.

The high number of variants required at cell, module and pack level cannot be cost-effectively produced by a standardized, classic production architecture with rigid linkage of the process steps. The concept of matrix production (Figure 2), on the other hand, offers the possibility of tailoring production to the processes actually required with a minimum of effort. The design of the layout and the stacking, welding and quality assurance processes of battery modules is primarily influenced by the cell types used. Thus, a process evaluation for prismatic cells, pouch cells and cylindrical cells was carried out at the Institute of Production Engineering taking into account all electrical, geometric and mechanical attributes. The development of quality assurance procedures for the assembly of battery modules by using flexible stacking processes was an essential part of the research project. An in-depth analysis of cell handling with subsequent development, production and verification – including additively manufactured grippers for all cell types and other module components – formed the basis for holistically designed concepts. Thus, the BIC became a worldwide unique production facility that successfully solved the dilemma between research and production location in the low-volume segment.

The design, realization and operational start-up of a test bench (Figure 3) for the analysis of the quality of battery cells and a flexible stacking device with the focus on fast reconfiguration was one of the major elements of the project. At the Institute of Production Engineering (IFT), a test rig was set up for the detailed investigation of battery module production to show both quality assurance and battery cell stacking. Different applications of robot gripper variants produced with different additive manufacturing techniques (Figure 5) are demonstrated and evaluated. Due to its long-term expertise in robotics, the IFT investigated HRC (human-robot collaboration) in battery production and developed an HRC implementation process as well as further concepts for the use of HRC in automotive battery production.

Implementing traceability of battery cells over their entire life cycle has been a major aspect of the project. Numerous parties are involved in the various life cycle phases

Figure 3: BIC at IFT.
Source: IFT

Source: BIC

of battery cells, from the cell manufacturer through the OEM to the secondary user and recycling company. The quality checks to be carried out at each instance are time-consuming and expensive (Figure 6). In collaboration with Block42 GmbH from Graz, the applicability of blockchain technology that is normally used in the financial sector has been investigated. Distributed ledger technology (DLT) was selected as the most potentially promising solution. To test the suitability of the technology as a trusted data network in the battery lifecycle, a use case was created as part of the research project. Pre-marked battery cells are identified with a code reader. The measured parameters as well as the performed handling operations are recorded and uniquely assigned to each cell. The information already assigned to the cell is important and is characterized by unambiguously secure decision criteria for subsequent instances in the supply chain or subsequent life phases and can no longer be manipulated. DLT offers an attractive opportunity to make the supply chain in the life cycle of batteries safer, more resource efficient and more economical.

With the Battery Innovation Center, the Institute of Production Engineering has significantly expanded its expertise in the direction of e-mobility and has been able to build up a deep understanding of the topic of battery production. In a follow-up project called “CERES”, an automated cell tester is being developed and built. In addition, we are training students in this new field of research, thus educating them for their careers in this rapidly growing industry segment. The BIC project was implemented under the consortium leadership of AVL List GmbH in cooperation with the Institute of Production Engineering at Graz University of Technology and the project partners Virtual Vehicle Research GmbH and Rosendahl Nextrom GmbH (Figure 7). This project is funded by the Austrian Research Promotion Agency (FFG) and carried out as part of the Mobility of the Future program.

The AVL project was granted with the Styrian Innovation Award in 2022.

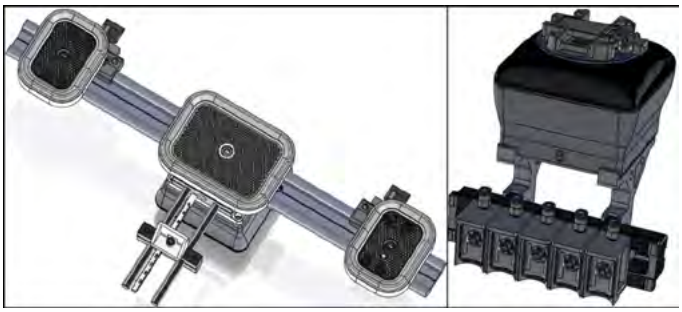


Figure 5: Additively manufactured and modular grippers for flat cell (left) and cylindrical cell (right)
Source: IFT

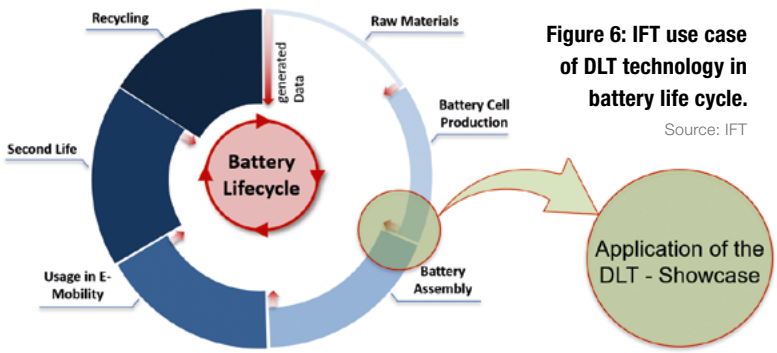


Figure 6: IFT use case of DLT technology in battery life cycle.
Source: IFT

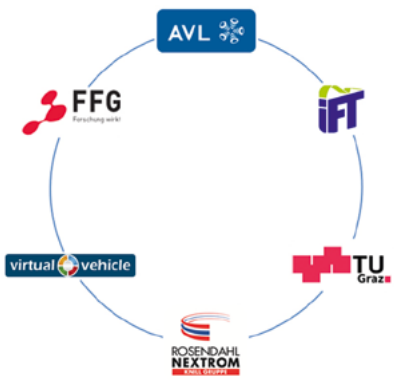


Figure 7: Project team.
Source: IFT

Franz Haas, Faculty Dean and head of the Institute of Production Engineering
Source: Lunghammer – TU Graz

Gernot Schlögl, project assistant at Institute of Production Engineering, PhD student.
Source: TU Graz

Mathias Prechtl, project assistant at the Institute of Production Engineering, PhD student.
Source: TU Graz

Martin Weinzerl, project manager R&D in area of research and technology development, responsible project manager at AVL List GmbH for production-oriented national and EU funding projects.
Source: TU Graz