aft automotive

BUYER'S GUIDE

Battery cell housing: Systematically successful

What matters in system development and production

CONTENTS

Management summary

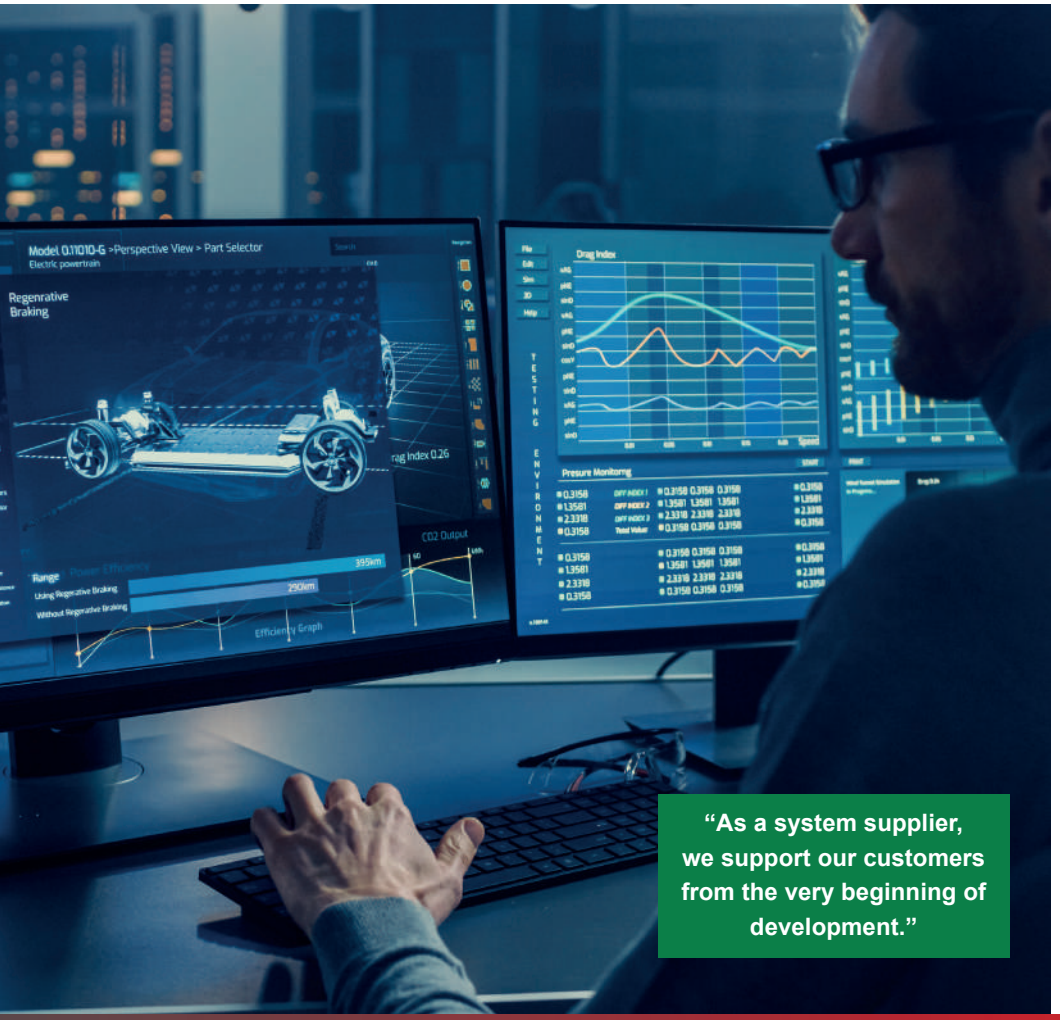
For battery cell housings, OEMs and battery manufacturers need a system supplier who already provides intensive support during the development phase and, building on this, establishes custom-fit production solutions – and within the framework of an iterative process.

Every decision is reviewed holistically, alternatives are worked out and corresponding results are integrated. We apply our many years of engineering experience and focus on an agile process as well as careful project and production planning.

In addition, aft automotive takes a technology-independent view of challenges and - if necessary - takes new paths in production.

Always one (technological) step ahead

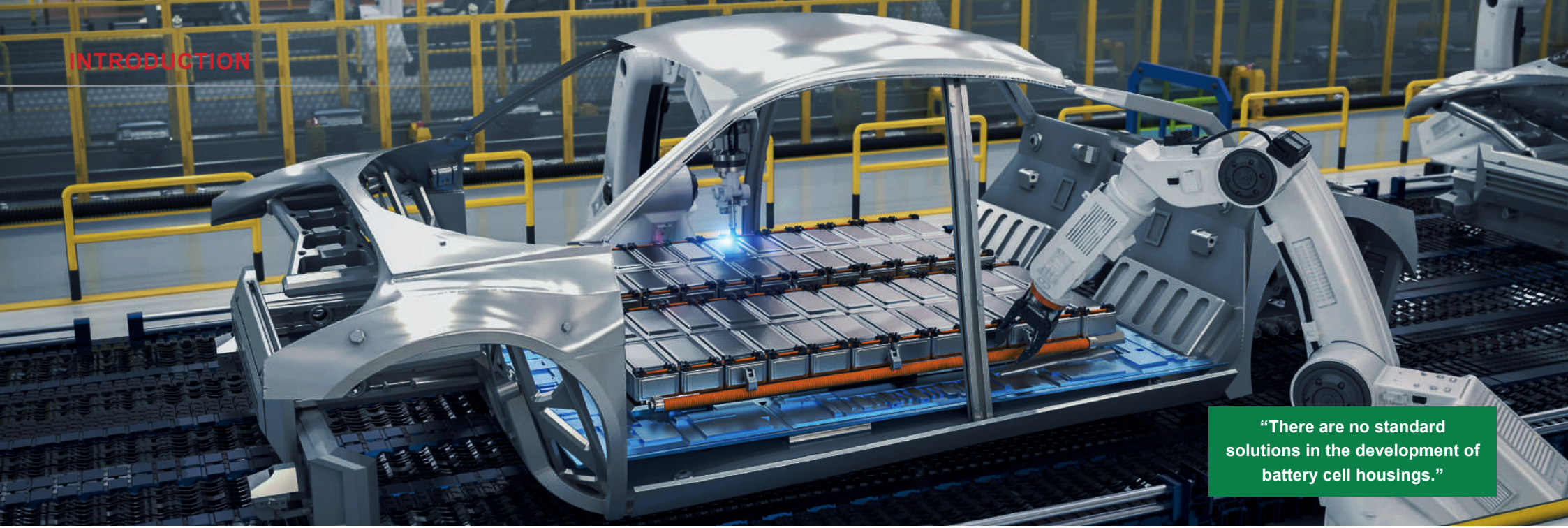
Why the battery cell housing is a complex task for system suppliers



“As a system supplier, we support our customers from the very beginning of development.”

Funding initiatives such as the European Battery Alliance or research into energy density and charging times make it clear: The battery is a key task area in the automotive sector. However, the task is exceptionally demanding, which is particularly evident in the battery cell housing. To establish their production processes, OEMs and battery manufacturers need a system supplier who already accompanies the development of the battery architecture and iteratively checks each planned production step.

It is a gigantic industrial transformation at an unimagined pace: According to “batterie-news.de”, around 60 production sites for battery manufacturing are currently being planned in Europe alone. In future, a huge number of battery cells will be produced here with a forecast total capacity of almost 2,000 GWh per year.
The associated economic and technical requirements are well known: It is a question of low production costs with simultaneously increasing energy densities as well as the smallest possible size and low weight.New concepts such as “cell-to-chassis” (the battery cells are integrated directly into the car body) and “cell-to-pack” (the cells are part of the battery pack without the use of modules) are competing with the traditional modular basic structure. While progress has been made in recent years primarily in cell chemistry, the focus is now shifting to the battery architecture.



“There are no standard solutions in the development of battery cell housings.”

Individual requirements of the housing

But what does that actually mean for OEMs and battery manufacturers? What does efficient battery construction, which can be implemented within the scope of streamlined production processes, look like? An important part of the answer concerns the battery cell housing as mechanical protection of the cell interior from external influences. On the one hand, it is needed in huge quantities. On the other hand, its production requirements are complex, because the final system must guarantee absolute tightness, must not show any contamination – and has a different geometry depending on the battery architecture.

Against this background, there are consequently no standard solutions for the development of battery cell housings and the establishment of production. In the latter, for example, various metal forming and stamping processes, plastic injection molding, automation technology, testing processes and IoT solutions flow together intelligently - but in a completely different way depending on the component design envisaged. In addition, factors such as number of units and costs, cycle times, personnel deployment, energy consumption and floor space influence the planning. In other words: An open mind for the technology is essential. Only those who keep the overall battery system in mind during development can guarantee high process reliability and quality – and select the manufacturing processes required for this in an unbiased manner.

System expertise combined with innovative strength and speed

aft automotive sees itself in this context as part of a larger whole: We are a system supplier and support our customers right from the start of the technical development of the battery. The resulting production solutions are created as part of an iterative process: Every decision - about the mechatronic concept, for example - is holistically reviewed, weighed up against alternatives and, depending on the result, adjusted again and again.

For this, all the necessary skills come together in a bundle: We combine innovative system development with meticulous engineering craftsmanship, agility with reliable project management and comprehensive production planning with careful quality planning. The end result is highly efficient production sites with performance benchmarks. In short: aft automotive focuses on “out-of-the-box” system thinking without barriers. Flexibility and independence come out on top!

Continue reading online:
Why we stand for quality

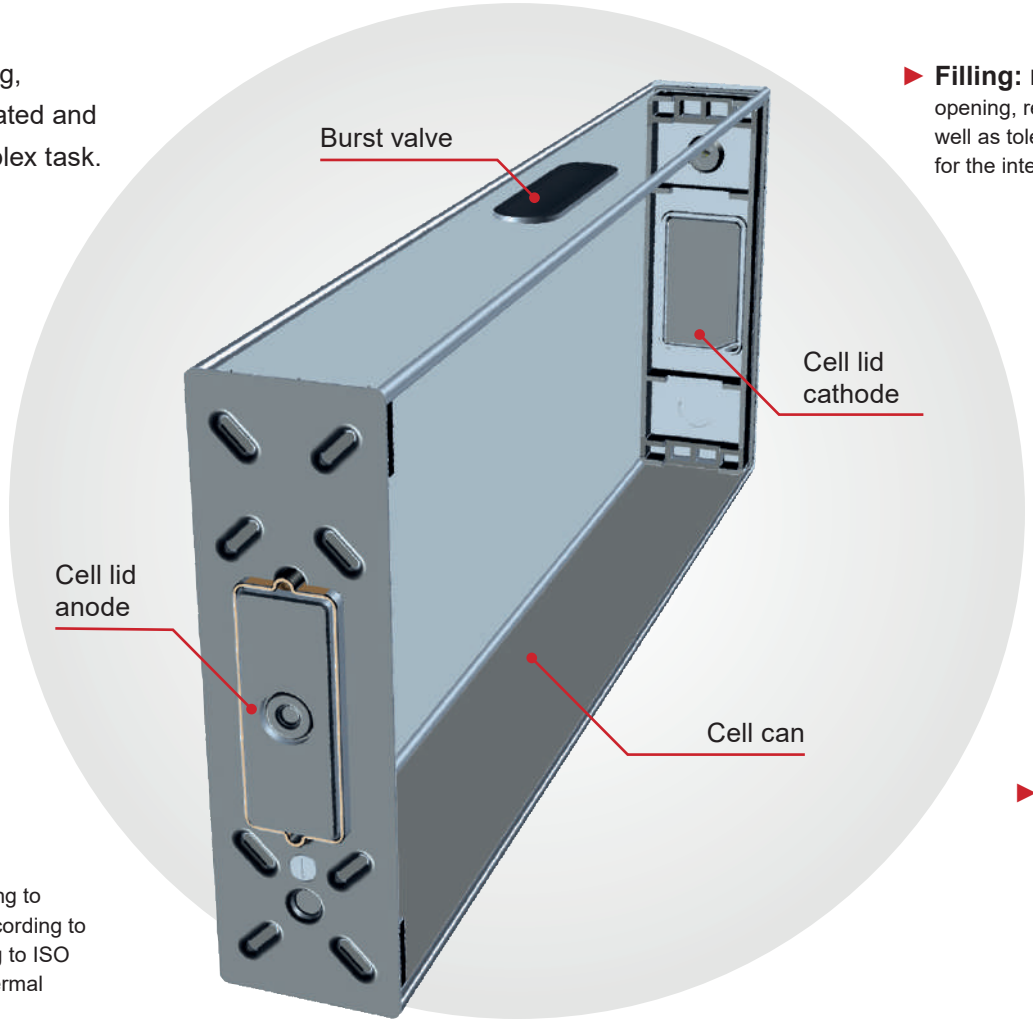
On the following pages of our Buyer’s Guide, we present our know-how as a system developer and also make clear what you should pay attention to in the development of the battery architecture and in production planning around the battery cell housing - as a first orientation for OEMs and battery manufacturers

A sophisticated system

The varied requirements of the battery cell housing

In the development of a battery cell housing, you have to meet the functional, safety-related and production-specific requirements – a complex task. The most important features at a glance:

- **Bursting behavior:** Adherence to the opening pressure of the predetermined breaking point and large, continuing tearing opening cross-section through simulation-supported and material-tested design
- **Tightness:** Electrolyte-resistant seals and helium gas-tight cell can and lid due to elastomeric sealing and iterative design and material selection
- **Heat development:** Simulations for avoidance of heat transitions to attachments parts with short-term high power loads
- **Safety:** Low flammability according to UL94, cleanliness requirements according to VDA 19.1, safety integrity according to ISO 26262 and measures to prevent thermal runaways



- **Filling:** Perfect filling with burr-free filling opening, reliable welding of plugs and covers as well as tolerance management and tightness tests for the interface
- **Insulation and conductivity:** Prevention of leakage via the cell housing as well as minimum contact resistance at cathode/anode through suitable materials and joining methods
- **Electrolyte resistance:** Laboratory determination of electrolyte-resistant materials while maintaining the required mechanical and electrical properties
- **Assembly:** Easy assembly due to design-for-assembly as well as ensuring a high number of pieces/short cycle time due to dovetailing industrial engineering and technical development
- **Joining and welding:** Optimal welding and joining parameters (e.g. small welding gap between cover and cell cup) through suitable material and tolerance pairing

Everything from a single source

5 questions for Jörg Hellwig, strategic product alignment

Mr. Hellwig, how would you outline the “battery cell housing” task?

Let's be clear about the starting position: For many years, the combustion engine was the core know-how in automotive engineering. So many decades of knowledge from experience have been put into it. In electromobility, the battery now plays a similarly important role. However, we are still at the beginning of a technological development – and the cell housing is a key jigsaw piece in this overall picture.

What does that mean for development and production?

There is no one battery cell housing, because the different battery concepts such as cell-to-chassis or cell-to-pack influence its geometry. On the other hand, many manufacturers are now planning and implementing the industrialization of cell housings and the like - and doing so with a high degree of efficiency.
System providers like aft automotive help with this task, because you can, in a sense, outsource the complexity of a task to them.

What know-how can aft automotive contribute?

We have all the know-how for this task and are constantly developing in leaps and bounds. We have stood for integral system solutions for many years. Consequently, we support the development of the battery cell housing in every detail, and use it to derive functional requirements and create mechatronic concepts that are backed up by virtual analyses, for example - and we do all of this in an iterative process. We can also make adjustments to everything as required. At the same time, an independent view of all challenges is important to us. In this way, we also open up new technical production solutions. We call it “smart innovation”.

How do you make the right choice in production methods?

Each process is assessed according to whether it fits the requirements of the system – such as stability and thermal conductivity. Let’s take the burst valve as an example: During its development, we first validate the tightness and opening behavior and, based on this, we design the forming tools and the required laser welding systems. This involves criteria such as welding depth, temperature and much more.

And at the end, everything comes together in an integral production solution?

Exactly. That is our promise, as a system supplier. We plan and operate the complete factory for battery housing groups, including all production facilities, quality assurance and logistics. OEMs and battery manufacturers get an efficient solution from a single source in terms of development, planning and production.

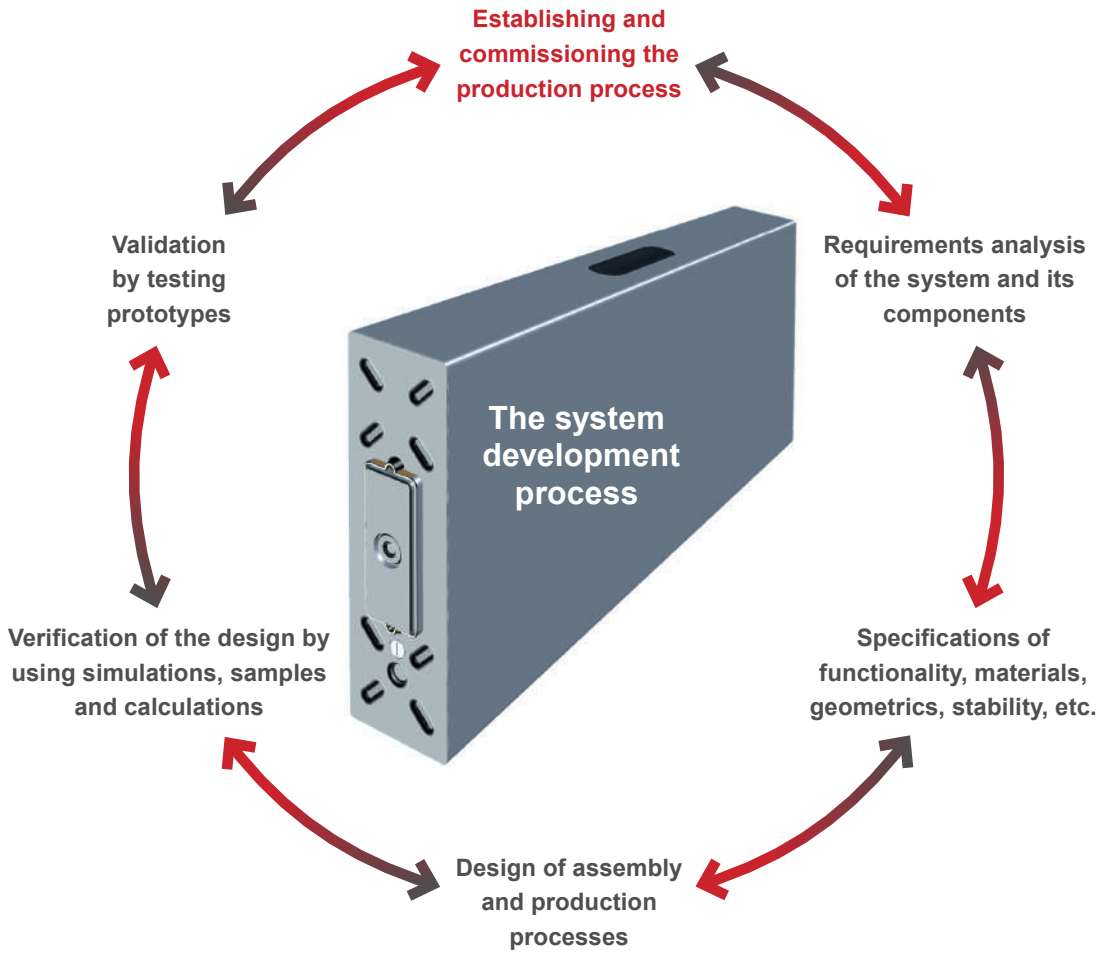
The systematic way to efficient processes

From requirements analysis to production

The high demands on the battery cell housing require the know-how of a system provider: From the analysis of the technical requirements to the final production, everything is planned and executed by us from a single source.

The complex system of the battery cell housing has a decisive influence on the functions of the battery – consequently, criteria such as leak tightness, safety integrity or the ability to process further are at an extremely high requirement level.

How can the technology be industrialized within the framework of efficient processes? Our answer is based on the classic V-model for structuring development processes, whereby we intelligently extend and adapt this approach. In doing so, every partial step is validated and then it is all further developed within the framework of a process.



“During development, we carry out FEM simulations and continuously adapt the size and design.”

Some examples to clarify this task:

► Load-bearing capacity

In order to ensure the load-bearing capacity of the cell system in the safe elastic range, we carry out FEA simulations (Finite Element Method) during its design – and keep adjusting the size and design throughout. In the next stages, the result is validated based on samples. The knowledge gained - for example on achievable tolerances or flatness - flows back into the requirements process. We use this as a basis to design the production and assembly processes. Later on, testing is carried out before production starts in the last step.

► Manufacturing

The optimization of the housing and its production process is comparable to the previous description. The interesting thing here is that you have to ensure the ability to manufacture a certain housing geometry by forming process at an early stage. For this, we carry out forming simulations and produce samples.
Our aim is optimized components, which correspond with the requirements exactly.

► Resistance

The materials used must have a high resistance to specific electrolytes - without any change in their mechanical and electrical properties. For this, we carry out intensive examinations on our test field.

► Further processing

The lid and cell can are joined and welded later on in the process (before filling), which in turn needs the fulfillment of numerous requirements – for example with regard to the required tolerances for the welding gap. To manage these tolerances, we recommend the production of covers and housings from a single source.

What ultimately makes the difference in the production line?

Production process of the battery cell housing

When producing quantities reaching into the millions, it is important that all processes interact optimally – and so, we set up an integrated production process in the lead plant in Greven and then scale the solution in worldwide production.

1. Logistics

Incoming and outgoing goods are optimized directly in the factory at the associated interfaces, so that subsequent or previous production steps benefit. Our supply concepts are backed up digitally and any occurring risks in supply are recognized in good time. All logistics and packaging processes are subject to quality and availability requirements.

2. Cycle times

Highly interlinked production processes ensure a qualitative and optimized process – both for the lid and for cell can production. The cycle times and the clock times are “mapped”, which means, for example: A highly automated production process considers the agility in the individual production steps to maintain the speed and allow ideal process cycles.

3. High yield

The “cost per piece” is the focus of planning. Consequently, technical development, industrial engineering and quality management work hand in hand to define an optimal process sequence depending on the component geometry. Moreover, our aim is to integrate as many functions as possible in a single process step to further reduce the piece costs.

4. Test processes

Our objective is “0-error production”. High-resolution camera monitoring, in-line and in-process measurements and regular requalification and audits are used to achieve the goal.

5. Cleanliness/cleaning

Cleaning and drying processes ensure high component cleanliness. Production and assembly take place under cleanroom conditions according to the particle sizes. This requirements also apply to supply chains and packaging.

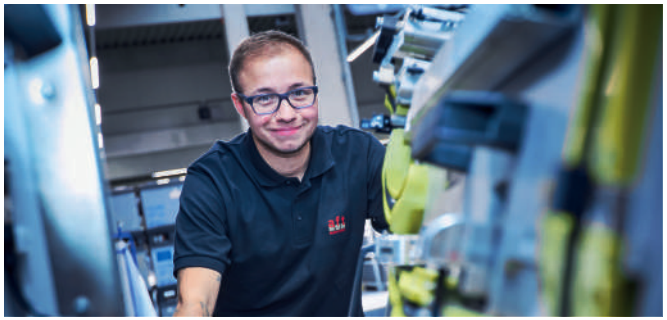
The route to the optimum production system

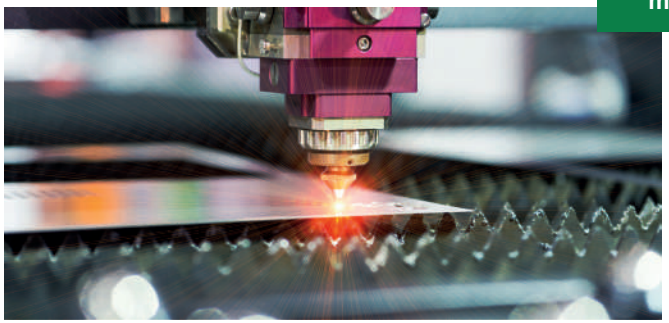
Integral comparison of alternative manufacturing concepts with regard to:

- Costs
- Yield
- Personnel incl. servicing
- Surfaces
- Sustainability (e.g. energy consumption, waste/recycling, supply chain law)

Thinking outside the box

Aligning production methods





“Depending on the quality requirements and design decision, the production methods must be aligned accordingly.”

Which processes are used in the “battery cell housing” system and what influences their configuration?
Our approach is characterized by an open mindset.

Whether tolerances in the welding gaps, permissible forming criteria on the housing or ensuring cleanliness: Depending on the quality requirements and design decision, production methods must be aligned accordingly.

Developing tools in-house

Example “injection molding”: The housing cover includes inner and outer insulators that are made of plastic and have a complex geometry with minimal tolerances. This is where our good production depth scores points, because we develop and produce the injection molds in-house, which ultimately improves the quality of production.

Innovative thinking

Similar challenges can be seen, for example, in the assembly of the cell cover using a joining process or in the laser welding of the housing. Here it is important to ensure a very precise design due to the required tightness.

And, in each of these individual cases, it is a question of maintaining the integrity of the overall “battery cell housing” system. Therefore, you have to keep any eye on the big picture, and that means that our know-how in areas such as plastic injection molding, laser welding or automated assembly only forms the basis, because we always think outside the box. We develop new skills, expand on established processes or develop innovations specific to the requirements. To sum up: The envisaged result determines our actions.

Digital through and through

IoT in the complete process world

aft automotive relies on end-to-end digitalization for all processes and systems.
This offers significant advantages in system development, production and downstream processes involving the battery cell housing.
How exactly do OEMs and battery manufacturers benefit from our digital twin? Five questions – five answers.

How does the aft automotive digital twin work?

It provides for the documentation of all data produced in the development or production of battery cell housings in the machines used. The data can be retrieved for each component using clear IDs for which we use intelligent QR codes.

Which information is mapped?

All process and testing parameters are fully recorded as well as the corresponding results at component level – such as when welding or joining components. In addition, information on input materials is also recorded.

How can OEMs and battery manufacturers use this data?

They allow complete and unambiguous traceability. This means that the manufacturing conditions for individual components or complete batches can be traced at all times.

How is the data used in system development by aft automotive?

Data is used for iterative improvement of the entire process.
Thereby, based on the analyzed process data, it is possible, for example, to adjust the design and production of a component in stages for an optimum production result.

How does ongoing production benefit?

The complete analysis of all process and machine parameters of a production line allow integral optimization of the production and AI-based innovations such as predictive maintenance. This ensures particularly efficient and smooth processes in production

Three arguments in favor of system development with aft automotive

The efficient development and production of battery cell housings is only possible with a partner who has the entire system in mind, and aft automotive is an established system developer in the automotive sector. We currently employ around 850 people at four locations worldwide, with a further location in Mexico in the planning stage.

Continue reading online:
The history of aft

The aft automotive difference:

1.

Agility

We stand for flexible processes, short paths and scalable solutions.

2.

Innovation

We take a technology and process-independent view of challenges and choose new paths

3.

System perspectives

We follow a holistic approach, whereby each system development is backed up iteratively.

Do you have any questions about the development and production of your battery cell housing?

Get in touch; we look forward to talking with you.

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