

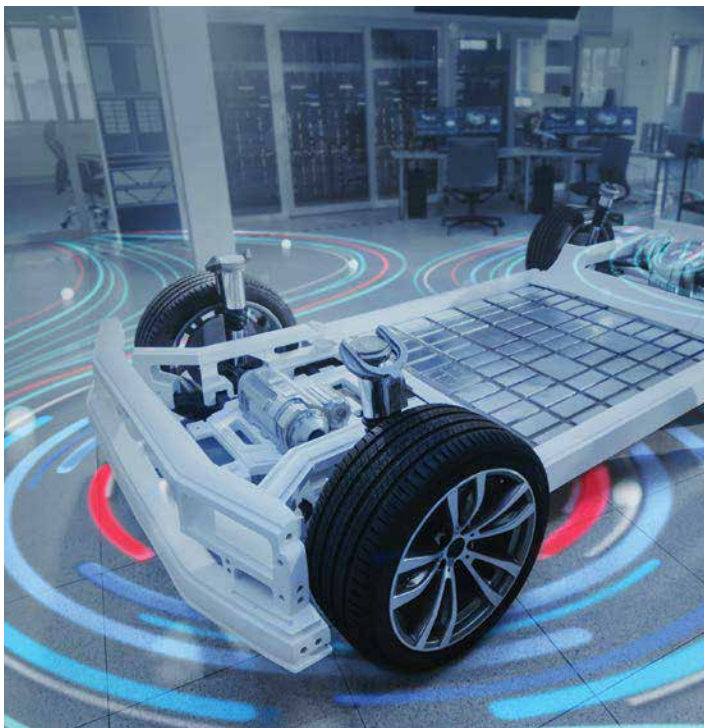


Improving Speed to Market: Navigating Electric Vehicle Assembly Challenges

The electric vehicle (EV) revolution gains more momentum every day, driving change to automotive manufacturing in unprecedented ways. With rapidly growing demand comes the need to rapidly scale assembly operations – and that can create significant challenges.

Vehicle manufacturers constantly seek new, more productive automation technologies to boost their quality and productivity. Along with many common assembly workflows, they face new challenges associated with scaling up battery pack and e-axle production. They need automation solutions to help integrate electric battery and powertrain production seamlessly into overall assembly processes.

Bosch Rexroth has an industry-leading portfolio of automation technology to satisfy these needs, whether building new production lines or (as some manufacturers are doing) converting existing internal combustion (IC) assembly facilities to EV production. We have decades of experience providing manufacturing and automation solutions to leading automotive OEMs as well as Tier 1 and Tier 2 suppliers. In addition, as part of the Bosch Group of companies, one of the leading manufacturers and suppliers of components for passenger cars, commercial vehicles and more, our automotive “DNA” runs deep.



As electric vehicle manufacturers strive to expand production to meet surging demand, Bosch Rexroth has complete, open, innovative automation solutions to revolutionize EV manufacturing.

BROAD RANGE OF ASSEMBLY CHALLENGES

Electric vehicles have replaced engines, gas tanks and transmissions with electric motors, regenerative braking technology and advanced battery packs. Assembling these new components presents unique challenges; at the same time, there are assembly processes common to both EV and IC assembly lines – with similar challenges.

For example, EVs have body parts that are welded using high-speed six-axis robots with advanced welding controls. Extremely precise control of weld quality is critical to the long-term performance of the vehicle; poor welds can lead to separation and vibration in body parts over time.

Also, EV manufacturers are using more high-strength steel, aluminum and next-generation materials to help reduce weight and improve run time per battery charge. To solve these complex welding challenges with maximum speed and absolute quality control, Bosch Rexroth has introduced a new generation of welding controllers, the PRC7000.

This advanced platform expands the number of heat blocks available, so plant operations can customize welding to specific throughput and material characteristics – a major advantage over older generation systems. The PRC7000 can store up to 10,000 welding programs that can be easily built via a drag-and-drop interface to incorporate more sophisticated welding sequences.

The PRC7000 can help manufacturers improve welding throughput and quality. It can also help support novel body designs under development, such as structural batteries. With this body design, the battery pack itself is welded with a front casting and a rear casting, simplifying the frame design, reducing the number of parts needed and potentially further reducing weight.

IMPROVING MANUAL ASSEMBLY AND INTRALOGISTICS

Advanced resistance welding controls are one way manufacturers use state-of-the-art tools to respond to manufacturing challenges. And just like traditional vehicle

builders, EV production processes use the latest manual assembly methods to install a wide range of components and systems.

Expert assembly personnel install headlights, windshields, retractable sunroofs, center consoles, seats and door and window controls, often also connecting them to the vehicle's control module. Exact precision in this process is critical to deliver vehicles that operate as flawlessly as possible. Bosch Rexroth offers an advanced portfolio of intelligent tightening tools to provide the productivity and quality control needed for these manual processes. They provide the precise, repeatable performance crucial to high-volume assembly lines. The portfolio includes the EXACT ION series of cordless screwdrivers, offering industry-leading accuracy, durability and energy efficiency, as well as ergonomic design and lower weight to enhance worker comfort.

The portfolio also includes the Nexo cordless Wi-Fi nutrunner, which integrates the controller directly into the tool – an industry first. This design enables high-quality measurement of torque and angle for every fastener, ensuring correct assembly of every component while providing full traceability.

Wider use of these kinds of i4.0-ready tools helps assembly lines increase throughput and operate with greater flexibility as different vehicle models move through the line, while at the same time generating critical data that plant operators can use to improve training, adjust workflows and apply lean manufacturing principles.

Manufacturers are also making expanded use of intralogistics robots to speed delivery of parts, components and other materials to manual workstations and production cells. Autonomous mobile robots (AMRs) are faster and easier to implement than more static delivery systems and don't require delivery personnel with powered industrial trucks to move material from production inventories to assembly lines.

Bosch Rexroth's expanding portfolio of AMRs help improve material movement efficiency and worker safety in intralogistics applications, without additional infrastructure. The ActiveShuttle supports moving dollies at 1.0 meter per second maximum driving speed, a 260-kilogram maximum payload and advanced safety features such as reactive collision avoidance.

The company's compact MP1000R is ideal for tight spaces. With a zero turning radius and 1.5 meters per second driving speed, it can handle payloads up to 1,000 kilograms. It can be used to move pallets or shelves so that fully filled flow racks can be delivered to manual workstations to keep assembly operations on track.

Both AMR solutions utilize the Rexroth Locator software for easy facility mapping and accurate robot localization. The dynamic map update feature allows Rexroth AMRs to operate efficiently in environments with high rates of change.

MULTIPLE TECHNOLOGIES TO BOOST BATTERY PACK PRODUCTION

EV battery packs are complex systems incorporating control electronics, cooling systems and other technology. There are four major steps in battery pack production common to most operations: electrode production, cell assembly, module assembly and pack construction, which also typically includes end-of-line battery testing.

Each stage uses a complex array of automation technologies to go from raw materials to completed packs. Given the critical role of the battery, its production requires high throughput rates combined with extremely tight assembly tolerances and quality control systems.

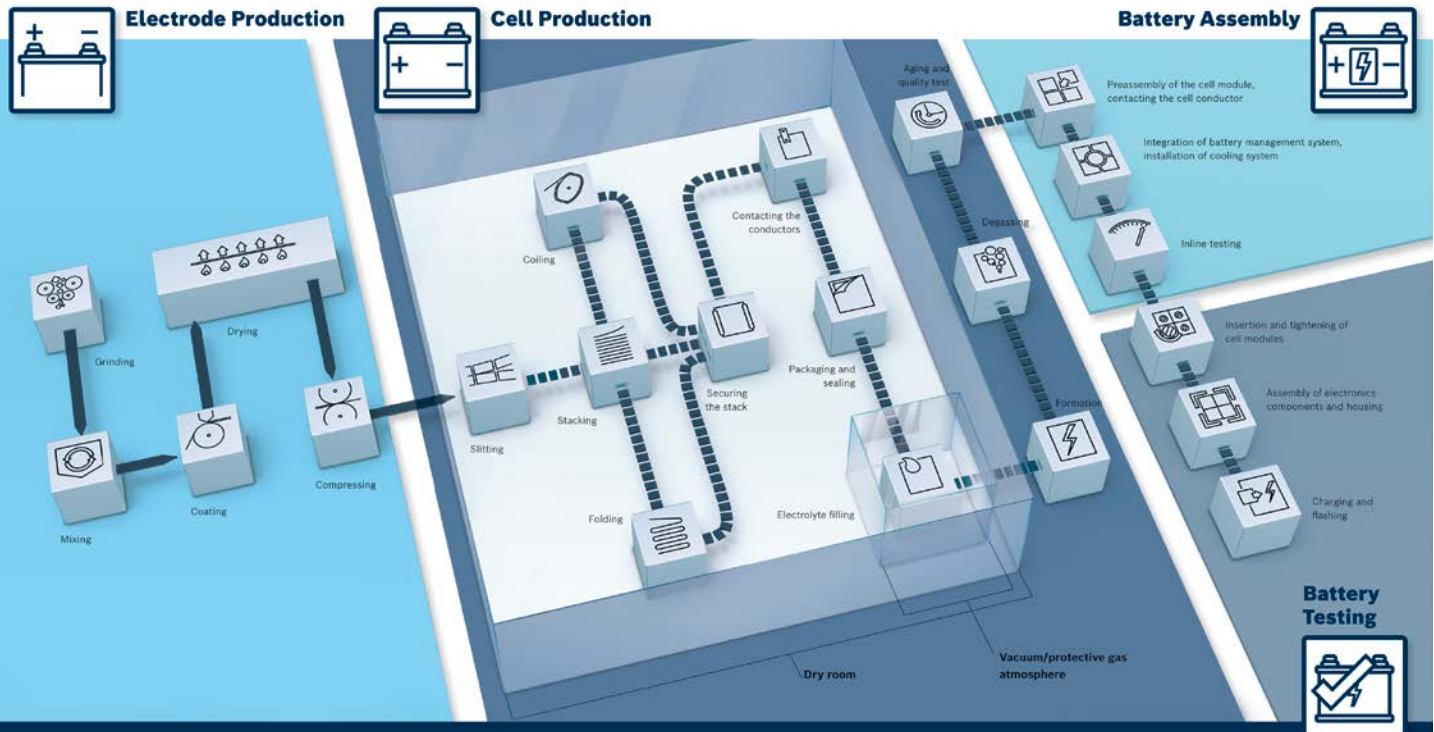
In electrode production, raw materials move through multiple automated processing steps. Maximizing control over these processes requires technologies that ensure cells are created with desired electrochemical properties, life cycle and energy density.

Advanced Technologies

for all core processes

Custom solutions

for your battery technology



Electric vehicle battery fabrication is a complex multi-step process, and Bosch Rexroth's complete automation solutions for EV manufacturing incorporate advanced controls platforms, plug-and-produce mechatronics systems and a complete array of material movement and transport systems.



Our cross-technology portfolio for EV manufacturing features best-in-class products combined with leading technology to drive higher machine value, streamline operations and ensure seamless integration.

pressure in the calendaring process to fabricate the battery electrode. The ctrlX CORE controller provides advanced closed-loop sag and loop control to eliminate breakage and minimize waste. It also supports high-speed multi-axis synchronization for web speed and position alignment.

ctrlX CORE features a modular software toolkit using the latest app technology so that, as battery manufacturers work to improve electrode production or add features such as real-time video inspection, new apps can be easily added to the controller. The result? Reduced engineering time, fewer components and higher productivity.

In cell production, individual batteries – cylindrical, pouch or other format – are combined into cells. Many manufacturers are working to optimize the stacking process in this step because streamlining stacking can improve the throughput of the entire line.

High-speed robotic handling systems, either delta robots or linear robots, are essential tools in this stacking process. The Smart Function Kit for Handling, part of Bosch Rexroth's Smart MechatroniX family of plug-and-produce mechatronics systems, is one highly efficient linear robot option for this challenge.

Bosch Rexroth's ctrlX AUTOMATION platform features advanced controller and drive systems designed precisely for these high-throughput production processes. For example, multiple material layers are coated and combined under tight

It features the ctrlX DRIVE servo drive with integrated ctrlX CORE system control and an open interface to higher-level industrial networks. Like the other Smart MechatroniX systems, it is truly plug-and-produce: modern online tools support quick and intuitive component selection and configuration, and the pre-installed software allows for easier commissioning, supporting faster production start and helping speed to market.

Once each cell is stacked into the cell module, multiple processing steps are needed: electrolyte chemicals need to be dispensed into each cell; the cell caps are placed and welded on; and then positive and negative poles are added – and finally, all the cells in the module are wired together.

The Smart MechatroniX platform includes Smart Function Kits for pressing and dispensing, offering precise operation and high throughput rates. Proven Rexroth linear axes are combined with servo drive and control technology to create production tools with common interfaces and operating software, and simplified ordering and commissioning.

Drag-and-drop motion functions are easy to parameterize and program, regardless of whether the Smart Function Kit is pressing, welding or dispensing. Each kit includes pre-installed software that tells the ctrlX DRIVE how to parameterize itself to perform its function, saving valuable setup time.

MODULAR MOVEMENT AND TRANSPORT SOLUTIONS

Going from raw materials to a tested and installed battery pack presents a major automation transport challenge. With each assembly step, weight and component size increases, so a range of material transport conveyors and other systems is necessary.

Bosch Rexroth offers multiple transport and conveyor systems with a range of speed and load capabilities to suit each of these challenges – several of which are already in use in battery production lines. From transfer systems for rapidly moving products weighing a few grams to linear motor-driven systems that can precisely transport up to over 400 kg, they maximize efficient use of factory floor space and harmonize their operation to enable smoothly flowing, intelligently connected production.

VarioFlow plus plastic chain conveyors are proven systems that rapidly move cell assemblies horizontally, vertically, around obstacles or integrated with other process flows. These also support workpiece pallets to convey cell components where positioning or higher stopping precision is needed.

Further down the line, Bosch Rexroth offers the linear motor-based Flexible Transport System FTS. It supports pallet-based transport and allows for individual carrier control for more complex movement at faster throughput rates.



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Bosch Rexroth can help with EV battery and e-axle testing systems with scalable DC power solutions that include power supply and management components, IndraDrive ML DC inverter power stacks, capacitors, cooling systems and necessary accessories, as well as design and commissioning support.

As a leading supplier of transport solutions, Bosch Rexroth's portfolio encompasses a full range of systems, including the proven TS family of chain conveyors and the ActiveMover linear motor transport system. Combined with our intralogistics AMRs, Bosch Rexroth is uniquely equipped to address virtually every battery production transport challenge.

Successful assembly lines design conveyor and material transport solutions early in the development process, not as a final step once all the production machines and cells have been defined. This helps ensure productive movement of products and materials through every process step and prevents building in non-value-added transport time. Bosch Rexroth has deep experience helping select and connect different transport systems so the right material flow is established – and can be easily modified as production requirements evolve.

COMPLETE END-OF-LINE BATTERY TESTING

A final, critical step in EV battery pack manufacturing is end-of-line (EOL) testing. Before every vehicle is released, the performance of each pack must be tested and documented. A plant producing 50 cars per hour needs to test a new battery pack every 72 seconds, so EOL battery testing systems must be extremely reliable and highly automated to match assembly line production rates.

Bosch Rexroth's IndraDrive ML family of power converters provides very precise and accurate control during testing of the battery pack output by providing constant voltage, current and power according to the required test cycling. It features a scalable DC/DC drive design with the industry's smallest footprint, helping conserve valuable space in the control cabinet and, ultimately, product floor space.

In addition, the versatility and modularity of the IndraDrive ML platform makes it easier for EV and battery manufacturers to select one common hardware power stack for power supply, inverter and DC/DC converter to support both battery pack and e-axle testing systems.

AUTOMATION INSIGHT TO IMPROVE EV ASSEMBLY PRODUCTIVITY

As EV manufacturers are under pressure to expand production, they run risks by simply throwing technology at their throughput challenges, rather than considering how well their technology and component choices work together. All this assembly technology should be engineered and harmonized to maximize throughput without sacrificing the quality of the end product.

Bosch Rexroth can leverage its industry-leading automation portfolio and deep automotive manufacturing expertise to help prevent this risk. We draw on our deep, crossover expertise in battery production and automotive assembly to expertly evaluate and solve complex automation challenges.

We have productive partnerships with leading factory automation specialists. They work with our experienced automation technology experts, following a unique, concurrent engineering approach. Using this approach, we partner to conduct system design, programming and component acquisition and integration in tight, overlapping time frames to deploy complete automation solutions more rapidly.

Our concurrent engineering methodology succeeds because we back it, and all our complete automation solutions, with global engineering, service and technical support resources. Proven, innovative technology to advance assembly productivity is widely available. Making the best selections is made easier and more efficient by choosing to work with a technology supplier with a broader range of technologies, providing the flexibility to configure new assembly lines with the right technology to meet each EV manufacturer's speed to market and production expansion goals.

Images and Captions:

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