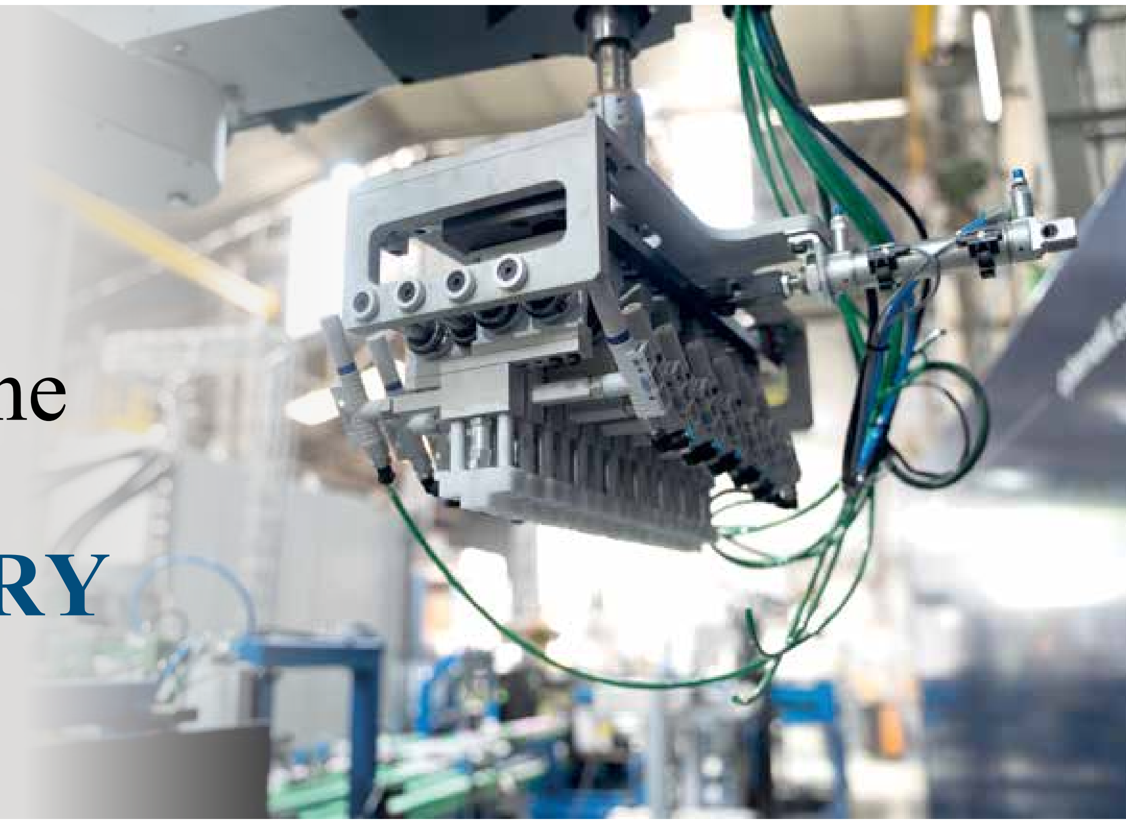
Flexible Automation: Adapting Efficiently to the Evolving EV INDUSTRY



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The Need for Flexible Battery Assembly Automation

Electric Vehicles (EVs) are a strategic tool in the quest for sustainable development for they decarbonize transport, an area traditionally tough to rid of emissions. Policy support and stricter emission norms combined with rising consumer awareness and substantial investment in technology by manufacturers were instrumental in the recent rapid growth of the global EV market. Sales hit 3, 6.6, 10, and 14 million respectively in 2020, 2021, 2022, and 2023. The expected sales volume for 2024 is 17 million.

However, range anxiety is the primary technological factor restricting the sales growth rate of battery electric vehicles (BEVs). Limitations of battery capacity and charging infrastructure are the two causatives for range anxiety. This partly explains the rising sales growth rate of plug-in hybrid electric vehicles (PHEVs) and hybrid electric vehicles (HEVs), which enable motoring even after battery power is exhausted.

Battery manufacturers are working to overcome this challenge by adopting newer and more efficient cell chemistries and formats. This creates the need to develop automation setups that are flexible enough to accommodate changes with the least downtime. Battery assembly is best done via automation that delivers batteries with high capacities and lifespans while maintaining the productivity, efficiency, and safety of the process.

Dynamics that Flexible Automation Needs to Handle

Cell parameters that have evolved as a result of technical and non-technical developments seeking to endow EV batteries with more capacity and lifespan are:

- Chemistry with a definitive shift from NMC (Nickel Manganese Cobalt) to LFP (Lithium Iron Phosphate).
- Size as cells get larger from 18650 to 21700 and beyond.
- Scalability for the demand might fluctuate based on changing market conditions.

Flexible automation should easily adjust to these factors without extensive manual reconfiguration. Let us consider the chemistry factor given its importance in determining the electrical parameters of the cell. While NMC cells are known for their higher energy density, LFP cells offer longer cycle life and increased safety. LFP cells are becoming increasingly popular for applications where longevity and stability are crucial. LFP batteries already hold a 30-40% share of the global market due to their safety and cost considerations.

Detailed differences are as follows:

- **Composition:** LFP uses lithium, iron and phosphate as cathode material. NMC batteries utilize nickel, manganese, and cobalt.
- **Energy Density:** NMC's higher density

makes it ideal for maximizing EV range, whereas LFP, with lower energy density, offers better safety and longevity.
- **Cycle Life and Safety:** LFP excels in cycle life and thermal stability, reducing risks such as thermal runaway, making it suitable for energy storage. NMC comes with higher risk under extreme conditions.
- **Power Density:** NMC's high power density supports rapid energy bursts for high-performance applications, while LFP is better for steady power output, aligning with applications focused on stability and endurance.

Some of the features that make an EV battery assembly automation flexible are:
- Recipe Selection to modify process parameters according to the cell type. For example, NMC batteries require stricter quality controls due to their sensitivity to overheating.
  Again, welding parameters may change with variation in cell chemistry. Welding is a critical operation as it ensures proper current flow, which influences the battery capacity. Besides, it impacts battery safety and structural integrity.
- Quick Setup Changeover to switch between different cell types.
- Robotic Grippers with Changeable Pitch to accommodate different cell types and sizes via same gripper.
- Swift Robot Tool Changeovers when handling cell variation with the same gripper is not feasible.
- Carton Size Flexibility is needed to utilize cell variants placed in cartons of different sizes.

Cybernetik in Flexible EV Battery Assembly Automation

Cybernetik's solution for cylindrical cells accommodates cells with 32, 33, 35, 40, 42, and 46 mm diameter. Scalability and adaptability are designed into the solution. Ergonomic and simple, the total quality parameter tracking feature ensures stringent quality checks. Throughput is high as a result of multiple innovative features. Interlocks and protocols take care of safety.

Details are as follows:
- **Flexibility:**
  - » Rapid changeovers for Gripper pitch, Robot Tool, and setup
  - » Scalable Air Handling Systems for extra Valves addition
  - » Carton size adaptability
- **Quality:** Total quality parameter tracking:
  - » Electrical parameter based cell sorting
  - » SCADA for recipe selection and track & trace
  - » Barcode scans and Vision System checks
- **Speed:** Rapid operation via:
  - » Python / MATLAB for quick, accurate test data capture
  - » On-the-fly plasma cleaning of cell terminals
  - » Simultaneous barcode scanning of multiple cells
  - » Multiple Vision Systems
- **Operational Simplicity:**
  - » Customized design
  - » Plug & Play for Control Panel for easy on-site installation.
- **Safety:** Enclosure Safety Protocol and Robot Safety Interlock with Door
- **Ergonomics:** Large HMI screen sizes

Finally

Considering the immense value that EVs bring to the table in the mission for a greener planet by decarbonizing transport, technological developments will continue to improve various aspects of battery cells. The evolution will mean that automation systems have to be adaptable in order to survive and thrive in a fluid market. ■

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