Five Software Characteristics Battery Manufacturers Need to Succeed

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What one discipline do advanced chemistry battery manufacturers need to master to thrive and grow over the long haul? *Manufacturing.* In particular, you need operations that can keep up with innovation.

As electrons take over from heat as the primary energy source, opportunity is skyrocketing for battery makers. New applications pop up every day, it seems, encouraging growth. Yet, succeeding means innovating to meet new applications while ensuring reliable, repeatable, high-quality, and ever-lower-cost manufacturing. For specialty battery companies, this is neither easy nor simple.

Lithium-Ion and batteries with other advanced chemistries are inherently complex. Making them at consistently high quality under conditions of constant innovation in materials, form factors, and customer requirements and applications is an enormous challenge. Doing it well could differentiate a company and set it up for success.

Why MES is Essential

Typically, companies with complex products and processes have turned to manufacturing execution systems (MES) to support their production operations. MES models the manufacturing process and has an array of application functions on top of that to guide the process.

For many companies, MES is the missing link between what's planned for products and orders and what actually happens. It helps ensure reliable production and creates a complete detailed data set that can flow across the lifecycle and supply chain functions. This is essential in an environment with as many steps and processes as battery making.
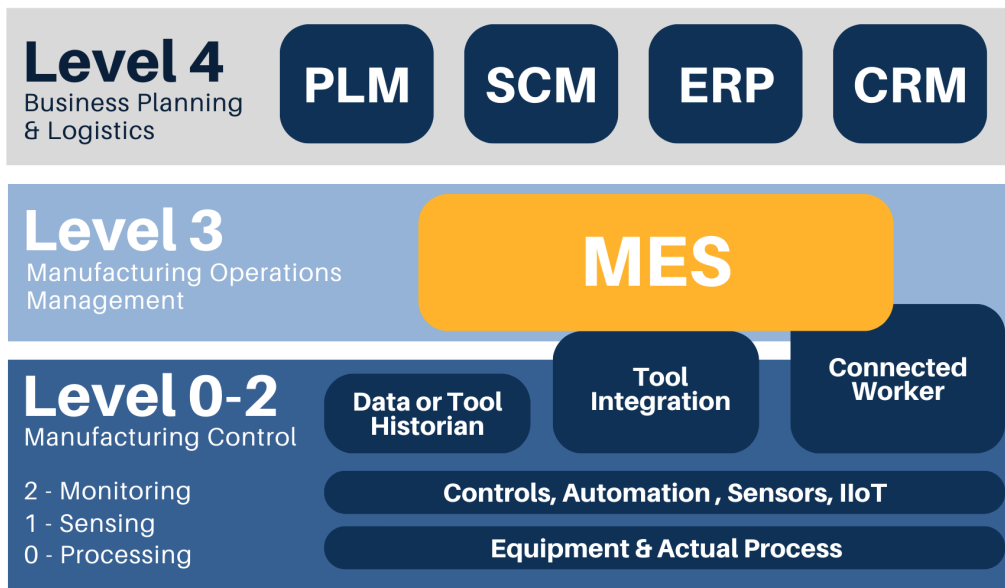
MES in the Application Landscape

MES is an enterprise application but differs from any other in focus and capabilities. MES can rapidly create information from massive quantities of data in varied formats from equipment, sensors, IIoT (industrial internet of things), user inputs, and other applications. It has a unique role in manufacturers' IT landscape. The ISA-95 standard for plant-to-enterprise integration captured MES' position between other enterprise applications, the production process, and related equipment. Our vision here uses the layers from that standard but includes more detail about where other applications fit as well.

As the definition suggests, MES feeds to and from other enterprise systems. For example:

> Tech-Clarity defines MES: *"Systems that deliver information to optimize production activities from order launch to finished goods. MES guides, initiates, responds to, and reports on plant activities as they occur. To do so, MES puts into context a wide array of current and accurate data from both operations technology (OT) and information technology (IT). MES can deliver mission-critical information about production activities across the product lifecycle, enterprise, and supply chain via bi-directional communications."*

- **ERP** typically feeds customer orders and materials expected into MES. In return, MES feeds actual results into the ERP for materials backflushing, actual vs. planned production, quality results, order status or delays, and more.
  - Note: The main objective of ERP's shop floor management is to account for materials and other resources, which is only a tiny portion of what MES does.

- **PLM or PDM** (Product lifecycle or data management) typically provides product specifications and sometimes process specifications to MES. PLM also provides excellent control of many types of product data. MES delivers back to PLM data about any issues that arise, often triggering engineering change requests to product or process specifications.

Level 4 Business Planning & Logistics — PLM, SCM, ERP, CRM

Level 3 Manufacturing Operations Management — MES

Level 0-2 Manufacturing Control — Data or Tool Historian, Tool Integration, Connected Worker
2 - Monitoring
1 - Sensing
0 - Processing
Controls, Automation, Sensors, IIoT
Equipment & Actual Process

○ Note: PLM may offer process planning, but it's often not ready to cope with differences in facilities and equipment or deliver all the detail employees need in work instructions.

• **SCM** (Supply chain management) typically plans materials and production, critical inputs for MES to execute. MES tracks and reports back actual materials, completions, and the process status at all times. MES becomes a foundation for accurate order promising and ensuring special customer needs are met, which might also be stored in a **CRM** (customer relationship management system).

MES vs. Alternatives

Over the decades, manufacturers have tried to use other approaches to manage their manufacturing operations. MES has benefits in every case. Here, we list MES' benefits over a few common alternatives.

Tool Integration – With the advent of intelligent equipment and IIoT,

manufacturers may be tempted to feel that getting data from the tools is enough. Tool integration may log all the tool information somewhere, which is crucial for battery manufacturers. However, it cannot do what MES does: correlate and relate the datasets from all the various tools in the process flow to ensure that the entire end-to-end production process is effective. With so many interdependencies between steps, battery makers need this MES capability.

Historians – Data or tool historians are excellent for capturing time-series data from mixing, coating, pressing, and testing processes. They can capture enormous amounts of tag data from equipment, controls, or sensors. A value of X ohms ACR or ACZ (Alternating Current Resistance/Impedance) may be good at one point in the battery assembly process but bad at another point in the process. Only an actual MES can provide the process-flow context to make sense of the data a simple historian or integration system may be logging. In addition, MES is designed to help prevent errors or guide each aspect of the production process.

MES can use data from a historian to manage the entire process, including steps where data is manually entered or reviewed.

Excel – Nearly every company uses this versatile tool for storing, manipulating, and making calculations on data. However, it is not a multi-user system designed to add intelligence or context to data. MES is a function-rich application set that can do those things in the larger context of your entire production facility or group of facilities.

Connected Worker – This new software category may appeal as it is lightweight and supports frontline workers. However, these tools do not have the data management architecture that enables solid context for data or a foundation for data analytics. MES does all that, which is crucial for complex, innovative, fast-moving industries such as battery manufacturing.

Five MES Characteristics for Batteries

MES is a foundational application for manufacturers to succeed. More and more manufacturers use it to accommodate smart manufacturing and Industry 4.0 initiatives. However, not all MES is well suited to managing the complexities of battery-making. I have identified five key characteristics that MES needs to support Lithium-Ion and other advanced battery manufacturers.

1. **Multi-Mode support** is a foundation to support the many different types of processes for both the electrodes and the battery assembly. Major processes range from mixing slurry to roll coating, slitting, to drying, punching, winding, assembly, and filling. Most manufacturing software is designed to support only a subset of these process types. Some are for batch processes, some for roll-based, and others are good at discrete assembly processes. Only a few can inherently support all of those types of production.

2. **Flexibility** is essential for high-mix and constant R&D. The MES must be able to model and manage experimental runs to support constant innovation in products, materials, and processes. Look for MES that enables creating unique routes, individual instructions for observing specific sub-steps, and data structures designed to support experiment management.

3. **Complex splits & merges** happen at multiple stages of the battery production process. Accurately tracking these is essential. However, if the software is a good fit, it will accurately reflect the physical processes and allow simple consumption processes with as few splits and merges as possible. Splits and merges are crucial to R&D and experimental lots – but they also apply to every battery manufacturer. Electrode coating to slitting, rolls to winding, and binning after final test all require this capability in the MES. for accurate traceability and production management.

4. **Traceability** of materials must be complete, down to the source vendor lot and unit level. The MES ideally maintains the history of all material activity, including splits, merges, reworks, batches, and usage of materials, durables, and equipment. Check that 100% traceability data is easy to access and report. Consumption reporting is only one aspect. Contamination is a common challenge in battery-making also. For example, a brass bearing in a mixer could allow copper to go to the wrong side of the battery, causing a failure.

5. **Equipment Integration:** Tool integration is a foundation for battery-making software success. As indicated above, however, this is ideally a part of the MES and not a standalone system that cannot deliver context and ensure the end-to-end process is sound. There are examples where one flawed process doomed a battery company. Integration of testers is a clear winner since manufacturers must conduct 100% testing on advanced batteries. Binning might result in some units from the same shift's production on a line ending up as different products with varying specifications, again requiring effective lot splits. Interdependencies between the processes, materials, and equipment require intelligence and a data structure to examine those issues. This will feed asset management to maintain equipment, a set of functions best-fit MES may also offer.

When diving deep to ascertain MES fit, use these five characteristics as foundations. If any of these is missing, the solution will likely disappoint.

Success in Manufacturing

Thank you, battery makers, for making our world a more energy-effective place. I don't wish you luck. Instead, I hope you leave nothing to luck. Please use diligence to understand what information systems support your process needs. I would suggest MESA International's education program if you don't have MES expertise.

To innovate and create high-quality, high-yield products, battery companies must fully support their manufacturing process. MES is the unified way to do it – but only certain MES products can support your industry's needs.

About the Author

Julie Fraser joined Tech-Clarity in 2020 and has over 35 years of experience in the manufacturing software industry. She is an enthusiastic researcher, author, and speaker. She has a passion for manufacturing progress and performance gains through Industry 4.0 strategies and supporting software technology.

Julie is actively researching the impact of digital transformation and technology convergence in the manufacturing industries, with a focus on supply chain and plant floor and how to use manufacturing data in conjunction with data from offices, labs, and the ecosystem.

About Tech-Clarity

Tech-Clarity is an independent research firm dedicated to making the business value of technology clear. We analyze how companies improve innovation, product development, design, engineering, manufacturing, and service performance through the use of digital transformation, best practices, software technology, industrial automation, and IT services.