THE CONNECTED FUTURE OF HIGH-VOLUME BATTERY PRODUCTION

How can a connected quality management system (QMS) enable real-time costing for more competitive high-volume production of Lithium-ion batteries?

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The greatest hurdle confronting the electric vehicle market is the need to reduce the cost of vehicles to broaden their mainstream adoption. In turn, Lithium-ion battery (LiB) manufacturers face acute pressure based on commitments to produce reliable quantities of high-grade batteries at the lowest possible cost.

To become a leading high-volume LiB producer, a company must overcome the considerable operational challenges of battery production to achieve the desired financial results. In a conventional Gigafactory, the levels of automation are generally low when compared with more mature industries. As a result, thousands of manual operations are required to produce hundreds of thousand cells per day with quality control procedures that primarily consist of after-the-fact tests done in a laboratory. Reducing high scrap rates and mitigating the risk of product recalls requires a paradigm shift in how gigafactories manage quality.

In this overview, we introduce the role of connected QMS with the Manufacturing Execution System (MES) in overseeing battery production and delivering real-time operational data for consolidation into financial metrics, such as in an Enterprise Resource Planning (ERP) system. This enables near-real-time costing, which has empowered business decisions in other industries and can now be deployed in the LiB industry.

**RECOGNIZING THE RISK OF INCOMPLETE AND FRAGMENTED DATA**

LiB manufacturers have been suffering from data that is often incomplete, obsolete, and stored in stand-alone data silos such as spreadsheets. Systems have yet to be put in place to obtain timely information on materials, production, quality, and finished goods. Managers of gigafactories need this information to understand production results, mitigate risks and obtain an accurate snapshot of the financial health of their operation.

As the activities involved in production are dynamic, managers need coordinated quality information at each step in near-real time, not in days or weeks. Without this information, managers have few options but to rely on their business systems, primarily their ERP system, to guide their decision making. This is usually in the form of financial reports based on production data available in the ERP. These reports, however, suffer from production data that lacks the granularity of factory-floor realities, and it is typically days or weeks by the time ERP reports are created.
Imagine a scenario in a gigafactory coating line where the operator notices that electrode thickness values are lower than the desired value. The operator corrects that discrepancy with a simple turn of a mechanical or software “dial” by entering a new setpoint for the relevant parameter. Changing a single process parameter at a single station (mixing, coating, drying, calendaring etc.) may constitute a correction, but lacks a view of the bigger picture and may have both upstream and downstream effects.

Such near-term corrective actions at a single process station can be thought of as a “Little C,” as shown in Figure 1. On the other hand, the “Big C” (marked gray) represents systematic actions that are corrective and preventive (CAPA) when viewed from the perspective of all processing stations and processes — or perhaps all the similar events that have occurred in the past six months.

An integral part of this holistic quality view is to systematically document defects, corrective actions, and all the data associated with them. Today, this is typically undocumented or insufficiently recorded in isolated spreadsheets or via electronic messages to management. This opens the door to recurrences of the defect because it doesn’t provide the information needed to answer questions surrounding the defect at “Station A” such as:

- What conditions led to the process deviation?
- What factors upstream of “Station A” may be causing it?
- Has this happened before? Where? How often?
- What can be done to prevent it from happening again?
To answer these questions, it is essential to understand the difference between quality control (QC) and quality management (QM). QC is neither comprehensive nor proactive, because deviations are detected after they have occurred, for example, through sample analysis at isolated steps in the production process. In contrast, QM provides a proactive, CAPA-based view of all operations. Among the benefits, it permits identification of low-risk suppliers based on quality, price, and/or availability – and carries that same level of scrutiny throughout production and the shipment of finished product.

Honeywell Process Solutions offers a connected QMS as part of a digital production management system that connects multiple systems and applications into an integrated, online environment. For example, it allows QMS to connect with MES data to assess quality in all forms at every step of the production process. This provides a real-time view of the plant’s quality position, which in turn connects with and improves ERP financial projections (discussed below).

In battery production, a connected QMS can significantly reduce scrap rates compared to facilities that lack such a system, because a connected system can identify and systematically address defects in real time. This and other benefits have been documented across a 28-year track record of QMS success in industries ranging from aerospace and defense to pharmaceutical production. By leveraging Honeywell’s expertise in other industries, the connected QMS has been adapted to address the industry-specific challenges prevalent in LiB manufacturing.

**QUALITY MANAGEMENT’S FOCUS ON PREVENTION & RECURRENCE**

Root cause is often thought about simply as why this issue has occurred and may not lead to the identification of the true root cause. Many companies without a connected QMS that provides the data required to get to a true root cause will often make “gut” decisions on why something happened. This approach is not sufficiently reliable within the context of complex interrelated gigafactory operations, even if there is an expert at each area with a great understanding of these quality issues.

Data based decision making and investigations around root cause will enable faster scale up and avoidance of redundant work fixing the same problems multiple times. Root cause identification is the foundation for truly preventive CAPA, which when implemented on Day One of operations will lead to long-term operational excellence.

**THE FUTURE OF GIGAFACTORY QUALITY & COMPLIANCE**

Quality management begins as far upstream as mining and supplier selection; continues across gigafactory operations; and completes at the delivery of finished product (see Figure 2).
A connected quality system goes way beyond the tools required to achieve compliance. It’s an integral part of improving product quality in a proactive way, to coordinate all the moving parts related to a comprehensive quality program.

Honeywell’s connected QMS, called TrackWise Digital includes QM tools enhanced with artificial intelligence (AI) and machine learning (ML) for root cause analysis. The cloud-based, connected, TrackWise Digital QMS provides integrated modules that work together to support quality, compliance, and more effective decision making with reporting and advanced analytics (see Figure 3).

TrackWise Digital brings together critical quality events and processes such as deviations, change controls, procedure changes, and approvals – as well as training and validations that occur in the production process. The unique advantage of TrackWise Digital is the ability to connect these steps and provide digital proof on how and when decisions were made. The digital closed-loop system in TrackWise Digital empowers the user with confidence in their product and processes. It ensures:

- All trainings were completed,
- All material qualifications were closed,
- Validations were closed,
- Edited SOPs were implemented, and
- Everything was effectively managed on a single system.

The connected QMS system manages all operational data from MES (e.g., Honeywell’s Manufacturing Excellence Platform). In turn, it delivers this data to plant and top management where production data along with quality position are critical for financial reporting.

**Figure 3:** A cloud-based system uses integrated modules that work together to support quality, compliance, and more efficient decision-making with reporting and advanced analytics across all quality processes.
CLOSING THE LOOP WITH REAL TIME COSTING

Up to the present, gigafactories have had little choice but to try and manage their monthly financial reporting based on their ERP system. For instance, processes in gigafactories such as formation and aging take several weeks for completion. In such scenarios, the real-time cost burden from the scrap that could arise after formation or aging is not readily available to management. This uncertainty is highly problematic. While ERP holds the totals on raw material procurement and finished goods shipped, it cannot understand what is being produced, and released at every step from stations “A to Z.”

In contrast, Honeywell’s QMS integrated with MES and the controls below that, offers the solution for providing data on all those steps. It gathers production metrics across operations from tracking of incoming raw materials through station-by-station performance metrics and finished goods shipment.

With the connected QMS drawing data from MES, which is in turn connected to production equipment, production data at every step can be combined with ERP financial parameters to create a real time view of the cost of production. Net and overall production plant cost indexing can then be visualized to include raw material price changes, energy changes, yield changes, and other key indicators.

The maturity of costing framework as shown in Figure 4 scales from applying basic costing methods to on-line cost computation, driving cost-consciousness and agility:

• Standard costing: At the basic level, standard costs are used as building blocks (e.g., cost against each raw material quantity mentioned in recipe) to arrive at final cost of the unit cell.

• Actual costing: The next level of maturity is where actual measurements of raw material consumption is recorded to compare against standard values to identify and analyze deviations.

• Real-time costing: Finally, real-time costing takes this to one higher level of maturity, where costs are computed as production happens in real-time to realize deviations and initiate corrective actions.

CONCLUSION

Honeywell’s Manufacturing Excellence Platform with connected QMS tracks production process, identifies deviations and anomalies, and provides real-time “cost-based” feedback. This helps to reduce quality deviations and the risk of production errors. Manufacturers can improve the efficiency, quality, and safety of their production processes, ultimately leading to increased productivity and profitability. This integrated approach of operational and quality management along with financial cost effectiveness is a key differentiator for gigafactories seeking to be successful in this rapidly expanding global industry.
For More Information
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