GE
Intelligent Platforms

Achieving Operational Excellence in Consumer Products Manufacturing

The Foundation of Sustainable Productivity and Profitability

Introduction

Faced with increasing global competition, evolving consumer and regulatory demands, and shrinking profit margins, consumer companies are being forced to deliver a growing mix of different products more quickly and at lower cost into the market place. There is intense pressure to optimize production efficiency with greater agility and control than ever before, and without large capital expenditures.

However, addressing these multi-faceted challenges is no easy task. Manufacturing processes are complex, and they can differ even between sites for the same company. In addition, manufacturers typically have a myriad of disparate legacy control systems as well as newer systems, making it difficult and expensive to replace or upgrade.

Implementing Operational Excellence programs has been a key strategy for many companies due to the known benefits, including increased productivity and reduced costs. Operational Excellence is based on applying the concepts of Lean/Six Sigma to areas of an operation to ensure they are performing in the most efficient manner—providing companies with a competitive advantage as they extend these solutions across the supply chain to meet key business objectives.

Optimizing Excellence for Continuous Improvements

Many manufacturers are implementing some type of Operational Excellence program across their sites. Some have taken a "band-aid" approach, whereby they develop a short-term, standalone strategy to address a particular issue such as machine downtime or quality; but it is not based on a holistic plan or long-term vision that delivers sustainable results. Others have taken a much more invasive "rip and replace" approach, taking out their existing systems and applications, which has the disadvantage of high risk and costs, and forgoes capitalizing on as-is improvement opportunities.

To achieve true Operational Excellence, manufacturers need a flexible, integrated, and holistic approach that leverages open technologies and enables incremental improvements across the operations over time, minimizing risk and ensuring return on investment. A proven framework such as GE Intelligent Platforms' "Operational Excellence journey" offers companies with a roadmap to help them align current individual plant/area capabilities and apply an integrated step-by-step strategy for measurable results that build off each other.

Operational Excellence can help manufacturers increase both flexibility and profitability without large capital expenditures. When implemented successfully, these goals can be achieved while also protecting the most critical assets to the business—brand equity and brand quality.

The Operational Excellence Journey and Key Capabilities

Rather than trying to "boil the ocean" and tackle everything at once, GE's Operational Excellence journey enables a phased approach with sequential steps—starting with process visibility for quick wins and scaling up to enterprise-wide integration for a long-term competitive edge—that allow different sites to focus on the areas that are going to provide the best performance improvements.

Each step has clear tactical goals for a focused, contained program to meet those goals, as well as corresponding technologies from GE's open and modular Proficy software suite to achieve each step. A key advantage is that companies can jump straight in at any step and improve from that point, depending on what continuous improvement programs may already be in place.

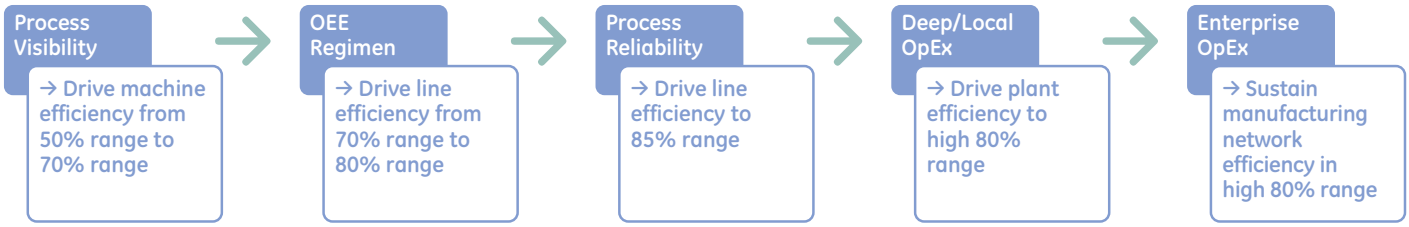

Figure 1 The Operational Excellence Journey

Step 1: Process Visualization

The first step of the journey is to gain visibility into your process by automating data collection for visualization to drive process improvements and centralized control and analysis. To take advantage of this step, you will need to have your automation controllers networked to capture and analyze your data. Using this information to develop baseline downtime metrics will allow you to target Operational Excellence improvements for increased machine uptime, which has been as high as the 70% range for GE customers, whereas the average for consumer customers is in the 50% range.

Implementing an open visualization system is extremely important because it will need to communicate with many different vendor systems, and must have a robust history of doing this. Scalability in both capability and price, from a single machine to a centralized control system, will also provide a key advantage for maximum flexibility and ease of use. Typically, most manufacturing sites will have both batching processes and packaging processes and will apply both Supervisory Control and Data Acquisition (SCADA) and Batch Execution systems across the plant.

Supervisory Control

An HMI/SCADA system should provide an easy-to-use, flexible graphical interface and robust SCADA engine; it can be deployed on a single machine, although a client/server configuration is more typical across multiple machines. Choosing a product that is designed with built-in client/server functionality as well as failover capability will reduce both implementation and support costs. The HMI/SCADA system helps develop baseline metrics that provide a starting point for measuring reductions in downtime by providing superior process visualization, data acquisition, analytics and supervisory control of your operations.

Batching Process

Batch execution systems can provide an ISA-S88 based solution for managing the batch processes within the plant, optimizing the execution of batches and monitoring the execution performance in real time for operational improvements. By combining a recipe management solution along with a batch execution engine, the system is automated yet flexible so operators can take control and monitor complex batching processes with ease.

In addition, products such as Proficy Batch Execution provide an integrated development environment with HMI/SCADA applications, which can help operators monitor the progress of a batch and control the execution of a recipe. It also helps monitor the status of the process from the same supervisory and control environment, allowing for better quality control and increased batch yield.

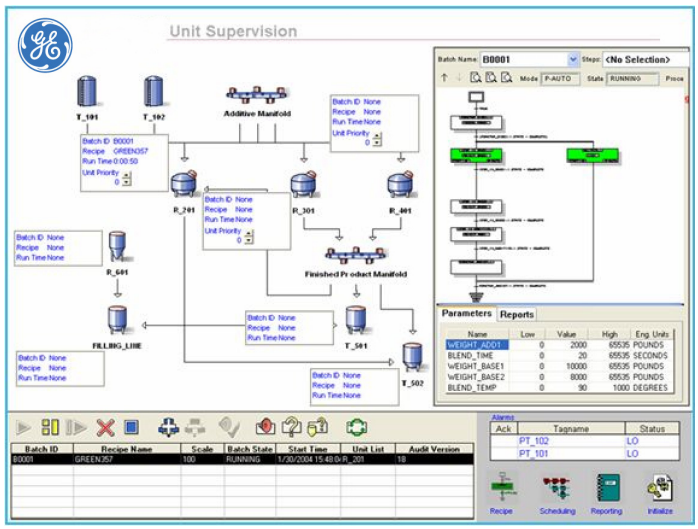

Figure 2 An integrated operator display for Proficy Batch and Proficy HMI/SCADA - iFIX delivers process visibility.

Data Collection & Analysis

Built specifically for high-speed process data acquisition and retrieval, data historians enable storage and trending of baseline performance metrics over long periods of time. It should offer scalability from a single machine to plant-wide data collection and be tightly integrated with an analytic software suite, as it is the foundation of additional steps of the Operational Excellence journey. The data historian helps you leverage increased process visibility for better and faster decisions, increased productivity, and reduced costs.

Step 2: OEE Regimen

One of the fastest return-on-investment areas of the Operational Excellence journey is maximizing the utilization of existing equipment. Basic downtime issues will have been addressed in the Process Visualization step of the journey, so the focus in this step shifts from runtime efficiency to throughput efficiency. By contextualizing data from several dimensions such as machine, product, and shift, and performing trending and correlation analysis, you can gain deeper insight into all the factors that combine to cause productivity losses. You can also act on critical process parameters related to throughput and quality to improve production capacity, reduce running costs, and offset capital expenditures for new equipment.

Overall Equipment Effectiveness (OEE) takes into consideration three key aspects of the machines/lines: Availability, Performance, and Quality.

Availability Rate = (Gross Running Time / Loading Time) x 100
Performance Rate = (Total Production / Ideal Production) x 100
Quality Rate = (Good Production / Total Production) x 100
OEE = Availability x Performance x Quality

Availability is a measurement of when the asset is actually producing product and how well it meets business expectations; performance is a measurement of the actual machine throughput against the theoretical achievable throughput for a specific product; and quality indicates adherence to consistency and safety, since quality must be protected regardless of process changes.

The basis of this step is to measure, analyze, and improve, and companies typically aim for OEE metrics in the 70-80% range. To accomplish the accounting of downtime, you need to take advantage of the automation within your pieces of equipment. By ensuring that simple trigger signals like run/fault exist, operations software that exposes efficiency are faster and easier to install. The good news is you just need the basic trigger tags because the software handles the more complex work of managing fault trees and reason trees, and you can make changes dynamically without impacting the lines.

Equipment Efficiency

Equipment efficiency software such as GE's Proficy Plant Applications Efficiency provides the OEE functionality required to complete this Operational Excellence step. Many machine companies provide machine-level efficiency software products, but the real payback is seen when it can expand across multiple machines and lines. Selecting an efficiency solution that can support hardware and historians from multiple vendors allows for expansion of the solution across the plant, enabling you to layer a common software platform on top of the standalone machine solutions for "one version of the truth" to the business.

Operators should easily be able to drill down into the information provided, allowing them to identify areas for improvement and also add their own comments. Using causal analysis to drive process improvements can increase production throughput without adding equipment or people, while also reducing scrap material costs.

Selecting an efficiency solution that provides integrated client controls, allowing HMI/SCADA applications to include the efficiency displays within the application, reduces the number of touch points that operators will have to make with the system. Thus, operators can monitor and analyze the OEE of the assets, as well as the status of the process from their existing production display. Furthermore, out-of-the-box analysis applets and custom reporting capabilities can drive better decision making that accelerates ROI.

Process Quality

Process quality software helps maintain quality and consistency of manufacturing and packaging operations by managing quality information, automating quality control decisions, and analyzing quality and process performance. The quality software should support both automatic data collection from control systems or external interfaces, and manual entry of quality or test information.

Like the efficiency solution, quality software should have integrated client controls and "out-of-the-box" standard reporting capabilities as well as tools such as Microsoft Excel add-in for ad-hoc analysis to best manage quality measurements for improvement.

Unit Name	Net Production	Actual Speed	Ideal Speed	Performance Rate %	Waste	Quality Rate %	Run Time	Loading Time	Available Rate %	OEE %	Alarms
Mixer 1	28,051.8 Pounds	2481.73 Pounds/hr	999.9999	100.0%	0.0 Pounds	100.0%	11:18:12	16:41:49	67.7%	67.7%	46 4 0
Pkg 1	3,833.49 Cases	199.91 Cases/hr	100.0000	100.0%	18.58 Cases	99.5%	19:16:07	22:42:07	84.9%	84.5%	27 0 2

Time: 6/2/2010 9:07:00 AM To 6/3/2010 9:07:00 AM

Figure 3 Proficy Plant Applications displays real-time data for the OEE calculation, allowing operators to monitor and analyze assets.

Step 3: Process Reliability

The next step focuses on ensuring end-to-end, stable, repeatable manufacturing processes by correlating first-pass yield to throughput and improving maintenance practices by using MES data to support plan definition and scheduling. The typical mix of both manual and automated processes that most manufacturers have requires solutions that ensure repeatability in recipe execution, work practices, and material flows.

Implementing process reliability in the Operational Excellence journey, companies can drive line efficiency to the 85% range, and completing the previous step ensures that changes you make do not impact the quality of the products you are producing.

Work Process Management

Work process management software digitizes both manual and automated work steps, which can be replayed to guide operators interactively and orchestrate production—solving problems faster. Domain experts can create a production "flowchart" and digitize it across people, systems and equipment, and without demands on IT. For example, GE's Proficy Workflow software guides operators through step-by-step instructions, ensuring compliance with SOPs (standard operating procedures) and consistent execution to improve Operational Excellence.

A work process management system also captures the manual data entry that is necessary on the plant floor. You can track both manual and automated processes in real time, collecting data and creating a critical infrastructure for immediate corrective action. By analyzing manual work tasks and identifying where cycle times can be improved, wasteful tasks can be eliminated.

Process Scheduling

Most production scheduling is done inside either ERP (enterprise resource planning) or enterprise finite capacity planning software, which can present a challenge because the information is a "static view" of a schedule based upon standards entered into the software. These standards are developed from historic data of prior runs and are an average rate of throughput and yield, which does not account for the inevitable changes that will occur in the run at hand.

Process scheduling, as the name suggests, takes into account the actual dynamics of the manufacturing process. As variances occur in the production such as downtime, waste, quality and rejects, the in-process scheduling software automatically recalculates, and based on your current run rate, provides an accurate prediction of process order completion. The more proactive solutions also have alarming capabilities based upon conformance to factors like time or quality—providing information to not only the production line, but also the material managers, schedulers and logistics managers that allows them to optimize the supply chain.

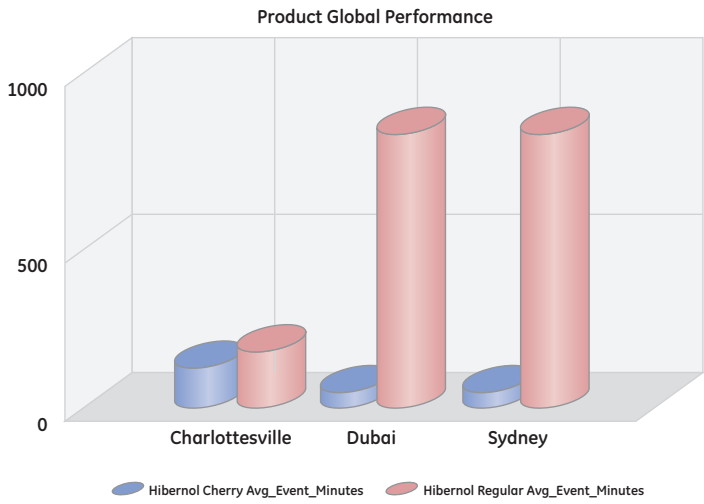

Figure 4 Gaining visibility into batch cycle times for similar products made across different global manufacturing locations can support decision making to achieve process reliability.

Step 4: Deep, Local Operational Excellence

Understanding and controlling the impact that different suppliers of raw materials have on process quality and yield are the main drivers for this step of the Operational Excellence journey. The ability to predict and react to changing materials and process dynamics ensures first-pass quality every time and helps determine the ideal conditions to generate the most yield.

End-to-end batch traceability from raw material receiving through to finished goods and the ability to automatically associate process quality, efficiency, and production date to these batches is critical to better coordinate operational activities. By focusing on deep, local Operational Excellence, companies have increased plant efficiency into the 80% range.

Tracking and Traceability

The ability to automatically correlate the process data captured in the earlier steps of the journey and contextualize it with the inventory consumptions in real time allows you to tie together plant operations by exchanging key production and status information with customers and internal business systems as well as between plant processes. The operator needs the expected end-of-a-process order and visual family tree of all components that make up a product genealogy to trace a product through all the steps associated with manufacturing the product. Materials used and quality characteristics at each production step can be identified and used to drive Operational Excellence improvements.

For example, GE's Proficy genealogy capabilities deliver information that helps create quality certificates and Certificates of Analysis (COAs) for individual products and/or production lots and track production against schedule requirements. As this information can be very complex and have many layers, "ready-to-go" operator displays and reports are critical to time to value. Also, as with other steps of this journey, the ability to harmonize these displays and reports in a single operator interface reduces the touch points and increases operator productivity.

Advanced Analytics and Reporting

The more complex the data in the manufacturing systems becomes, the more user friendly the reporting solution needs to be. It has to be able to aggregate the complex data elements from the production system and allow novice users to easily and quickly develop custom reports. The reporting solution should deliver easy access to relevant production information across all production environments and sites, providing the context needed to turn real-time data into meaningful information about order, asset, production, and yield.

One of the best options to implement in a reporting solution is an OLAP (Online Analytical Processing) cube. These data stores have the granular data required for causal analysis, and they also aggregate production information into logical chunks that executives or other stakeholders can use. They provide the ad-hoc ability to "slice and dice" the information, providing users with a customized view of their data instantaneously.

Lastly, it is vital that the reporting solution provide high-performance enterprise analysis that reaches deep within the operations and across the business to provide a single, unifying view into Operational Excellence. It can be used to deliver benchmark key performance indicators (KPIs) across the enterprise, empowering users to make educated business decisions and work toward common goals.

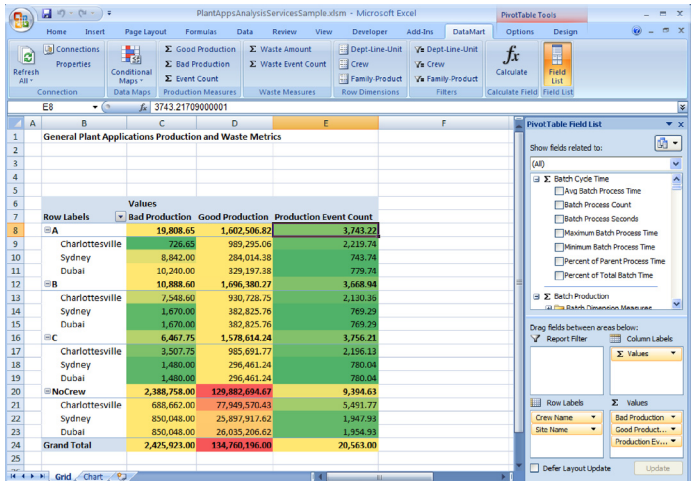

Figure 5 Perform ad-hoc analysis against Proficy DataMart on site production for deep local Operational Excellence.

Step 5: Enterprise Operational Excellence

The final step in the journey is to achieve Operational Excellence across the extended supply chain. Manufacturers are driving supply chain excellence by coordinating the real-time status of orders, inventory changes, and overall process performance with their ERP systems, including Warehouse Management, Production Planning, and Maintenance. In addition, integrating the extended supply chain allows better forecasting and logistics planning for both raw material suppliers and outbound shipments to co-packers/distributors. In GE's experience, the benefits realized from this step can help companies sustain manufacturing network efficiency in the high 80% range.

There are two key factors in moving the business toward an agile supply chain, which are the result of achieving the previous steps in the Operational Excellence journey.

- The first is having process reliability (Step 3); until your manufacturing process is stable and consistent, you will not be able to recognize the incremental supply chain improvements due to the variations in the manufacturing process

that make it impossible to accurately predict when you need to ship product or require raw material replenishments, as everything will be "as needed."

• The second is having accurate real-time inventory consumption data, which impacts other areas of production efficiency and supply chain management. Some GE customers have managed to take out 30% excess capacity by implementing an agile supply network, which translates into six figure savings annually.

Supply Chain Integration

By integrating real-time production information into the enterprise, you can achieve greater agility and accuracy by using the "what we're doing "data rather than the "what we think we can do" data. The key to success is implementing a standards-based interface that can reduce deployment time and maintenance costs.

ISA-95 is one of the key standards for interfacing production information between manufacturing and enterprise systems. Its B2MML schemas allow standard naming conventions and terminology to be used to develop documents that can be both produced and consumed by MES and ERP systems. It enables real-time orders to be downloaded into the MES layer from the ERP system and for performance information to be uploaded to ERP—allowing you to know the accurate current run rate of consumption and production.

Using historic data mixed with the current run rate and a repeatable process allows a projection of when you are available to ship and when raw material replenishments are required. This information enables reduced inventory turns and optimized logistics for raw material and finished good shipments—resulting in significant financial savings.

Asset Maintenance Costs

In the same way that using MES to integrate the production information between manufacturing and the enterprise can generate financial savings, integrating plant assets and corporate maintenance systems by using the same MES solution provides accurate, timely information to improve Operational Excellence in machine reliability. Optimizing the health of your assets reduces downtime on manufacturing equipment—delivering better return on investment and helping to move the process from a reactive to a reliability-centered maintenance strategy.

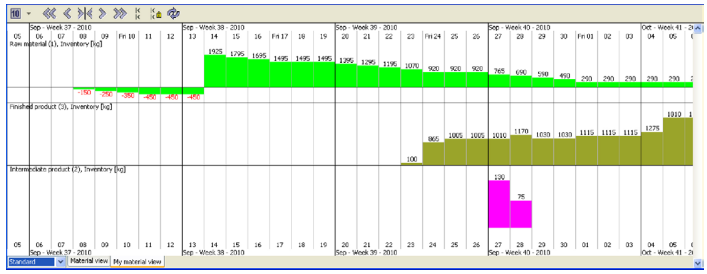

Figure 6 Proficy Scheduler calculates predicted material consumptions for Operational Excellence across the enterprise.

The two most important capabilities are standard, out-of-the-box connectivity to the Enterprise Asset Management (EAM) used in your business and effective root cause analysis tools to drive predictive rather than reactive strategies. By choosing an MES platform that already offers this capability, you will greatly reduce the lifecycle costs of supporting and upgrading the connectivity to your EAM software compared with custom interfaces.

Conclusion

Manufacturing companies that leverage a flexible, holistic approach with standards-based, tightly integrated technologies are reaping the full potential of Operational Excellence. They recognize that driving productivity and reducing costs is not an event but a journey, whereby they need to plan, execute, and focus on each step to maximize return on investment and drive continuous improvements. Until more companies catch on, they will continue to gain a sustainable advantage over their competition with increased productivity, reduced costs, and improved quality control—all of which help protect brand equity to drive profitability.

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