MES

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- Deliver enterprise visibility
- Achieve production and quality control
- Step into smart manufacturing

Plex Systems 2nd Special Edition

Ben Stewart

About Plex

Plex Systems, Inc., a Rockwell Automation Company, delivers the first smart manufacturing platform that empowers the world's leading innovators to make awesome products. Plex gives process and discrete manufacturers the ability to connect, automate, track, and analyze every aspect of their business — from the shop floor to the top floor — to drive business transformation. The Plex Smart Manufacturing Platform includes solutions for manufacturing execution (MES), ERP, quality, supply chain planning and management, asset performance management, production monitoring, process automation and analytics to connect people, systems, machines and supply chains, enabling them to lead with precision, efficiency and agility. Learn more at www.plex.com.

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Plex Systems, 2nd Special Edition

by Ben Stewart

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MES For Dummies®, Plex Systems Inc., 2nd Special Edition

Publisher's Acknowledgments

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Introduction

"My manufacturing plant is running okay. I track production costs and try to optimize efficiency following lean principles (Chapter 2), but most tracking is manually done on paper, or spreadsheets. Sometimes it's hard to trust the numbers and take our performance to the next level, let alone satisfy customers that are requiring more sophistication in controls and capability. I've heard about manufacturing execution systems (MES), but they've appeared out of reach due to the cost or complexity. Add to that the talk about Industry 4.0, smart manufacturing, and the Internet of Things (Chapter 5), and I think I may be getting left behind. Where do I start?"

If this sounds like you, you are not alone. Sorting out all this seems complex, but a practical approach to solving real-world problems is what manufacturing is all about. This book is your guide to doing just that!

The manufacturing industry is ever-changing and highly competitive, so companies must be agile and continuously improving to thrive. By adopting the latest technology alone, manufacturers may not always increase production rates, improve quality, or profitability. To achieve these changes, operations managers need to create an environment that allows them to precisely control production while expanding visibility into their critical processes. Extending that visibility and control outside their four walls to sister plants running common best practices, to corporate management, to customers, and to the extended supply chain adds to the complexity.

An MES can provide these benefits and more. From production control and monitoring, machine connectivity, equipment and asset health, process automation, embedded quality controls, and real-time analytics, an MES can coordinate and provide visibility to all the critical functions necessary to make better decisions and implement continuous improvement initiatives, based on accurate data.

In this book, you learn what an MES is and how manufacturers use these systems to drive operational excellence.

About This Book

MES For Dummies, Plex Systems 2nd Special Edition, consists of seven chapters that explore

>> Why manufacturing companies need an MES (Chapter 1)

>> How business processes are being digitized (Chapter 2)

>> Keys to controlling factory operations (Chapter 3)

>> Ways to improve production visibility (Chapter 4)

>> How manufacturing is getting smarter (Chapter 5)

>> How to drive value by adopting an MES (Chapter 6)

>> Ten ways an MES drives your bottom line (Chapter 7)

Icons Used in This Book

Icons emphasize a point to remember, a danger to be aware of, or information that you may find helpful.

The Tip icon marks tips (duh!) and shortcuts that you can use to make MES implementations easier.

Remember icons mark information that's especially important to know. To siphon off the most important information in each chapter, skim the paragraphs that have these icons.

The Technical Stuff icon marks information of a highly technical nature that you can normally skip.

The Warning icon tells you to watch out! It marks important information that may save you headaches.

Chapter **1**

Improving Performance with a Manufacturing Execution System

nformation technology is transforming the way companies are managed, as well as creating new opportunities to improve manufacturing. Production facilities must stay abreast of these advancements to be competitive. The key to success in this challenging environment is to recognize important trends and implement the right technologies at the right time to keep your company ahead of the game. This is true for small- and medium-sized manufacturing firms as well as larger, more established companies that may have been using manufacturing execution systems (MES) for decades. MES delivers greater efficiency, automation, and visibility on the plant floor that translates into faster response times, lower costs, and higher profits — all the things any manufacturer needs to be competitive. Choosing the best technologies to manage your manufacturing processes starts with understanding what these systems do and how they do it.

Pushing for Improved Manufacturing Efficiency

Today's production facilities are amazing. They transform raw materials into useful products, across both discrete and process industries.

But what *is* a production facility, really? Many people only see plants as buildings, but in reality they are a complex web of raw materials, tools, equipment, plant floor, and office staff all working to solve daily challenges and get product out the door.

Experienced operations managers understand that those machines, the people, the processes, and the raw materials must be synchronized, because you can't efficiently make finished products without them working on the right things at the right time — in unison. Those resources all cost money, and companies need to ensure that those resources aren't being wasted as they compete in a global business environment.

In the past, many companies relied on simple, manual systems and spreadsheets to manage their plants. (*Note:* MES ≠ Microsoft Excel Spreadsheets.) Now, with declining technology costs and software as a service (SaaS), manufacturers of all sizes are implementing specialized software solutions to automate and orchestrate the systems and processes in their facilities.

MESs can communicate with equipment and machines on the production floor and with corporate planning systems. The result is greater process automation, better control of what's really happening in the plant, and the ability to adapt to changes more quickly.

The IT services management company, Gartner, defines *MES* this way:

Manufacturing execution systems (MESs) manage, monitor and synchronize the execution of real-time, physical processes involved in transforming raw materials into intermediate and/or finished goods. They coordinate this execution of work orders with production scheduling and enterprise-level systems.

Until recently, many MESs were so expensive and complex that they were practical only for large international companies. (*Note: MES ≠ Massive Expensive Solution.*) Today, these solutions have become more mainstream and, as a result, subscription and implementation costs are much lower. Furthermore, MES delivered in the cloud *democratizes* technology, delivering equal levels of security and uptime for companies big and small. Finally, increasingly modular MES design enables manufacturers to address their immediate needs (for example, quality), and scale to full MES later. These factors provide huge efficiency improvements with low risk and a high return on investment!

Identifying Opportunities for Improvement

To make improvements in any process, you need to know where to start. Four of the biggest opportunities for improvement in most manufacturing facilities are:

- » Speed of reporting and decision making
- » Control over material and labor costs
- » Operational visibility and efficiency
- » Improved quality

Speed of reporting is important to make companies agile and allow them to respond quickly to changes. Whether it's an increase in a downstream customer order, a disruption in the upstream supply chain, or a surprise breakdown in production operations, a manager's ability to respond is only as good as the information at her fingertips. Faster reporting means that the facility is more flexible, and managers can be more responsive and proactive instead of always being reactive.

Controlling material costs requires not only diligence and strong negotiation from purchasing but making sure the right material is available at the right time. Not coincidentally, one of the most common labor costs is idle time wasted looking or waiting for material. An MES provides insight into what your equipment and people are producing, or more importantly *not* producing and how that will affect incoming inventory needs.

Operational visibility is critical for helping managers be effective. Managers need information that is both accurate and complete to truly understand what's happening inside of their operations. MESs that provide real-time data gathered from multiple shifts and production points drive predictive and prescriptive behavior that deliver better uptime immediatly, and can help avoid future downtime.

The last area in which many plants can find huge benefits is improving quality. Whether you're looking at rework or ultimately wasted material or product, the result is the same — higher costs and lower profits. With the continuous demand to produce more products faster, control of the processes and resulting quality can suffer. Shortages of skilled labor, as many manufacturers experience, require even tighter process controls to ensure high quality standards are achieved. With greater control comes greater quality and less waste; that goes right to the bottom line.

REMEMBER

Facilities that focus on continuous improvement or lean manufacturing (Chapter 4) have an infinite number of opportunities to look for adding value. But one thing that these efforts have in common is the need for accurate data and consistent execution of manufacturing processes. Virtually any improvement initiative that you can pursue in production can be more effective when you're using an MES.

Understanding the Evolution of Manufacturing Execution Systems

Lots of MESs are available in the marketplace. To understand what they do, you need to understand where they came from. Today's MESs have their roots in different parts of the business. There are enterprise resource planning (ERP) add-ons, supervisory control and data acquisition (SCADA) add-ons, and native MES solutions.

The plant floor had traditionally been a "black box" from the point of view of the ERP, so executives relied on manual reports from plant managers. ERP add-ons started as modules that provided better reporting. They focused on providing corporate leaders with summarized information from production that is relevant for planning and strategic decisions. But this information tends

to be too general for process improvement, and its availability is often delayed too long for it to be used in making day-to-day operational decisions. Remarkably, the life blood of a manufacturing company, the plant floor, has been generally neglected, if not completely ignored, by most ERP software.

SCADA add-ons evolved from manufacturing equipment control systems. These MESs were created to provide a visibility layer above the programmable logic controllers (PLCs) and SCADA systems on the production floor. They provide a detailed view of equipment utilization and performance. Unfortunately, this information can be so focused on machine performance that it's hard to see larger patterns and trends across the plant. This information is rarely integrated into other corporate systems, and usually implemented uniquely at a plant or even a subset of production lines.

The third group of MESs was designed from the ground up to provide a flexible interface between the plant floor processes and management reporting. These native MES solutions focus on logging each event as it occurs, and then monitoring the flow of products through the steps in a manufacturing process.

GOING DIGITAL

American Axle and Manufacturing (AAM) is a multi-billion-dollar, Tier 1 supplier to the automotive industry, with more than 30 locations, nearly 13,000 associates, and more than 100 customers including General Motors, Fiat Chrysler Automobiles, Ford Motor Company, and Honda.

AAM found it challenging to gain real insights into business performance, quality, capacity planning, and how to get a real-time understanding of its financial status. AAM rolled out Plex MES capabilities including engineering, quality, inventory, and production along with top-floor modules such as accounting and supply chain, automating its operational processes.

AAM has experienced a 5 percent increase in manufacturing output, and has seen an improvement in inventory turns of 5–10 percent with a positive impact on cash flow.

TIP

Solutions like Plex MES are purpose-built to support plant floor manufacturing integrated into existing corporate software or as part of the larger Plex Smart Manufacturing Platform including quality management systems (QMS), asset performance management (APM), production monitoring, MES automation and orchestration, ERP, and supply chain planning.

The Scoop on MESs and MOMs

The term "manufacturing execution" implies that you're controlling what each of the machines in a plant is "executing," but to truly manage execution across the entire facility you also need to address other critical aspects of your manufacturing processes, such as quality and inventory.

Some people argue that these additional functions should be part of traditional MESs. Others claim that manufacturers need a different name to describe software that integrates these processes. Analysts have begun calling MES and its extension *manufacturing operations management* solutions — or *MOM.*

Whatever you want to call it, this category of software is designed to give you better information about what's happening in production and make managing your manufacturing processes easier.

REMEMBER

Some people prefer the term MOM because it implies a broader, more complete solution than an MES, and is likely the trending term going forward. Although MES is historically the more common term, in most cases the two terms are interchangeable.

TECHNICAL STUFF

You can learn more about MESs and MOMs from the Manufacturing Enterprise Solutions Association (`www.mesa.org`), a not-for-profit organization that brings manufacturers together with solution providers so that they can develop common approaches and terminology for manufacturing automation technology including smart manufacturing.

Deciding Whether You Need an MES

Experienced operations managers sometimes feel like their facility is too small for an MES, or that the software they need is too complex and too expensive. That may have been true 20 years ago, but not today.

Companies of every size are now finding that MES solutions can deliver real benefits and compelling return on investment (ROI). That's because MES solutions (or individual modules of MES like quality management or production monitoring) with lower startup costs are now available, and some of them (cloud options) don't even require installing a new server or performing software updates.

You can read more about these options in Chapter 5.

Whether your goal is to improve quality, reduce inventory, digitize and automate your processes to help offset labor shortages, mitigate risk with supply chain agility, or all of the above, implementing an MES is probably the most important step your plants can take toward achieving success.

Chapter **2**
Digitizing Manufacturing Processes

New technologies are changing the way manufacturing plants are designed and operated. These aren't small, incremental changes. In fact, the impact is so radical that many experts describe it as a modern industrial revolution. To guide a manufacturing company through this disruption, you need to understand how these changes will affect your industry. Then you can begin a process of transforming yesterday's manual, paper-based workflows into tomorrow's digitized business processes.

Understanding the Fourth Industrial Revolution

Most people learned about the Industrial Revolution in school. Back then, history textbooks explained how economies shifted from agriculture to manufacturing as a result of steam power and mass production.

Today, many people believe that *three* industrial revolutions have already taken place. And you're living in the middle of a fourth industrial revolution right now!

The first industrial revolution was the rise of mechanization in the 1700s. During this period, economist Adam Smith began to promote concepts such as division of labor, specialization, and measuring industrial productivity.

The second industrial revolution came in the 1800s with the introduction of new power sources such as coal, gas, petroleum, and electricity. Electrical power stretched across continents, and factories moved to mass production.

The third industrial revolution came in the 1900s with the introduction of nuclear power along with a range of other technologies such as electronics, computers, and automation.

And the fourth industrial revolution — the one you are living through right now — is about greater connectivity and process automation and includes the emergence of sensors, high speed wireless communications (including 5G), artificial intelligence, and the cloud. Each has revolutionary power on its own, but in combination is enabling manufacturing to become smarter and more productive than ever before.

Every one of the previous industrial revolutions involved the introduction of new technologies that created enormous opportunities for the early adopters. But they also led to the collapse of many previously successful companies that missed the changes and became obsolete.

WARNING

The current revolution is called Industry 4.0. No one knows exactly where Industry 4.0 will lead, but by studying today's emerging technologies you can start to see how to embrace it, and take a practical approach to determine which of today's technologies will address the critical business needs that you have. Start small, in the highest value area, to see if the return on investment (ROI) is there before fully committing.

Introducing Smart Manufacturing

Industry 4.0 is being driven by the development and deployment of a broad range of technologies that will create smart cities, more connected employees, and greater mobility. Smart factories will take advantage of:

>> Industrial Internet of Things (IIoT)

>> Asset Performance Management (APM)

>> Process automation

>> 5G cellular communications

>> Cloud computing

>> Blockchain

>> Virtual and augmented reality

>> Autonomous vehicles (and drones)

>> Robots and cobots

>> Artificial intelligence (AI) and machine learning (ML)

As these technologies become more common, their connectivity will deliver data in faster and more contextualized ways to enable better, more confident, data-driven decisions, thus making manufacturing "smart." When these technologies are combined, the result is a completely different approach to manufacturing, operations management, and supply chain optimization. Think better connectivity, more automation, more precise tracking, and deeper data analysis. These technologies deliver better, more accurate information to people in real time as they need that data to make better decisions and execute more efficiently.

REMEMBER To be competitive in this new smart manufacturing environment, companies need to start preparing for these changes today.

Preparing for Digital Transformation

When you think about Industry 4.0, you see new technologies continuously emerging, but they're coming so fast that companies don't know exactly which technologies will make sense for their particular business needs, or in what order they should be implemented. For most manufacturers, digitization comes first and a

manufacturing execution system (MES) is considered a foundational component upon which to build. Then, rather than trying to do everything at once, companies need to start small with individual transformational solutions that can be implemented and reconfigured quickly and easily. Most industry experts recommend a crawl, walk, run approach versus the "big bang" technology implementations of the past.

Many experts describe this change as "digital transformation." Digital transformation isn't about installing a particular piece of software or hardware — it's much bigger than that. Digital transformation is part of the larger trend of "business transformation" that involves reimagining your business. It's taking manual and paper-based processes and moving them to electronic mediums, so that the information is immediately available and centralized for use by other supporting systems and decision makers.

INTEGRATING BUSINESS INFORMATION

Kendrick Plastics is a Michigan-based tier 1 and tier 2 supplier of interior decorative trim components and assemblies to the automotive industry. Their 300,000 square foot engineering and manufacturing facility has more than 50 presses serving fully automated paint lines and assembly stations.

Before Plex, Kendrick Plastics was using 27 different pieces of software that created major data silos within their organization. Using so many systems made it difficult for them to sync data and it required a lot of manpower to update and maintain their infrastructure. They lacked a large local IT team to manage their complex network and paying so much attention to their business systems hindered their ability to innovate.

Kendrick Plastics set out to consolidate onto one platform that would provide real-time data on manufacturing and financial performance, allowing them to focus on producing great products and creating innovative solutions to problems. In just seven months, Kendrick Plastics seamlessly integrated a single MES that provides real-time data, improved traceability, and increased efficiency in their production operations. As a result, they eliminated 40 hours per week of data entry, reduced scrap by 33 percent, and streamlined their purchase order process from multiple days to just 5 minutes.

The digital transformation of entire industries is happening all around you. With technology, Amazon has transformed the retail industry, Uber has transformed transportation, and Airbnb has transformed lodging. However, none of these companies really created a new technology. Instead, they used existing technologies to create, optimize, and manage business processes differently than anyone else. In the process, each of them has changed customer expectations and disrupted their well-established industry.

Beginning Your Digital Transformation

Manufacturers can take five steps immediately to begin their digital transformation. Each of these initiatives is important for ensuring that you can identify opportunities and implement improvements. Many of them likely align with process improvement programs that are already underway in your organization, such as lean manufacturing (see Chapter 4) or Six Sigma. These steps are:

1. **Standardize processes.** Digitization creates scalable, repeatable workflows to execute processes the same way, every time. Process standardization will often uncover sources of waste, as well as the root cause of quality issues.

2. **Pick low-hanging fruit.** Before people will support a major digital transformation initiative, they need to see how small changes can deliver big improvements. Showing success from projects that can be completed quickly and easily — and then scaling across multiple facilities — is a way to inspire confidence to tackle larger, more complex changes.

3. **Embrace innovation.** Encourage your team to explore new technologies and experiment with new ways to do things as part of a "fail fast, forward" culture that can create value and reduce waste.

4. **Lead and empower.** Culture is one of the biggest barriers to digital transformation. Leaders need to embrace and communicate the strategic importance of getting everyone involved in preparing the company for Industry 4.0 and giving people more control and responsibility over the data with which they are entrusted.

5. **Improve project management.** Digital transformation may involve lots of experiments, so you can increase your chances of success by training your team in project management techniques to drive successful completion of business goals and key deliverables.

Chapter **3**
Controlling Manufacturing Operations

A typical production facility may be made up of thousands of people, processes, and machines that are in constant motion, and careful planning helps to ensure that those resources are available and safeguarded. Real-time visibility and communication are essential for understanding whether your manufacturing operation is working as planned and finding new ways to make it work even better.

Reducing Risks

You know the saying, "Life is what happens while you're making plans." Companies can be extremely precise in planning every part of a manufacturing operation, from budgets to staffing and inventory, but those plans are only as good as the information and assumptions that are used to create and monitor them. Then there's Murphy's law: If something can go wrong, it will.

Although you can't eliminate all risks from a manufacturing operation, a manufacturing execution system (MES) can help you reduce them.

First, the MES ensures that processes are executed consistently. By doing things the same way every time, you are eliminating variations that are known to lead to issues with quality and safety.

Second, an MES consolidates the visibility of individual plants into a broader view of your entire manufacturing operation. By monitoring your manufacturing processes, production, and asset performance in real time, you are reducing the risk that a problem in one part of your operation flows downstream. Instead, you can identify issues immediately and correct them before they result in unexpected — and potentially expensive — waste.

TIP

"Jidoka" is a four-step process that is an important part of lean manufacturing (see Chapter 4):

1. Detect the problem.

2. Stop production.

3. Correct the problem.

4. Find the root cause and prevent it from occurring again.

Eliminating Errors

Many manufacturing waste issues boil down to simple problems: human errors, insufficient or inadequate process design, or machine malfunctions. Because an MES addresses all these root causes, it can eliminate many of the errors that occur in facilities of any size. Here are six examples of error-proofed processes that would benefit most plants:

>> Material tracking technologies such as barcoding and RFID that connect to a central system in real-time at every point where material is received, split, consumed, or moved. This integrated inventory control protects against using the wrong material for the required operation, bill of materials (BOM), or recipe.

>> Disciplined inventory management that gives the business clear visibility into work-in-progress material resulting in

higher confidence to reduce excess inventory, obsolescence, and associated carrying costs.

» In-process inspection that provides real-time feedback to the operator in the case of a quality problem. With integrated, lineside statistical process control (SPC), the operator can see when inspection measurements are trending toward specification limits in real time.

» Central data management that serves as the single version of truth for all elements of the system. When properly integrated with quality, changes to BOMs and recipes, specifications, or routings are automatically communicated through a paperless system directly to affected departments and work centers, eliminating delays that could result in waste.

» Integral maintenance management that ensures that machines have proper maintenance and restricts jobs from being scheduled before machines are properly set up. Inspection controls on measurement systems ensure devices are within calibration before they are allowed to be used in production.

» Digital work and set-up instructions that are integrated with production processes to eliminate errors and support safety initiatives. These documents educate operators on proper setup and process procedures and can be communicated to all work centers immediately if changed.

Optimizing Schedules

Customer demand for what to make, and when to make it, drives your operations team. These decisions drive work for other parts of the business, too. For example, production orders drive material requirements planning (MRP) up the supply chain for raw materials and components, and manufacturing capacity drives "capable to promise" dates for prospective sales. An MES that is synchronized with planning empowers everyone in the business with real-time data to make decisions using the right information. An MES can offer the following features:

» Finite scheduling
  • Schedule operations based upon available work center loading and capacity.

- Plan resources to ensure or account for availability of employee skills, tools, work center size, and other factors.

- Group operations to run from the same raw material or work center setup as appropriate for related jobs.

- Sequence production processes to overlap or run in parallel.

- Calculate "capable to promise" dates (the earliest time an order can be completed based on material or resource constraints on the plant floor).

- Have clear visibility into the impact of material availability, labor shortages, or downtime on the production schedule.

» "What-if" analysis

- Create a variety of scenarios to explore scheduling options before deciding which to implement.

- Explore the impact of changes in labor (such as an additional shift) and equipment availability (due to maintenance) as well as work center capacity (such as buying an additional machine).

- Review and evaluate the performance of different scenarios using quantitative metrics.

- Implement the most optimal schedule and monitor success for future plans.

Many MESs can display production schedules in ways that make it easy for anyone in the company to understand, such as Gantt charts or other visuals.

Improving Quality and Compliance

Many industries are trending toward risk-based quality compliance that focuses on mitigating quality risks through prevention versus detection. That could be compliance for government regulations, industry standards, or customer requirements. A few common industry regulations include:

» The ISO 9001:2015 standard for quality management systems (QMS) — which has been the basis for quality

standards across most manufacturing industries — has been revamped after 25 years of use.

>> Many OEMs in the global automotive industry came together as the International Automotive Task Force (IATF) to develop more detailed quality management guidelines on top of ISO 9001:2015 specific to their automotive supply chains. The IATF 16949 went into effect on September 14, 2018.

>> The food and beverage industry is experiencing monumental changes with the Food Safety Modernization Act (FSMA) to give the U.S. Food and Drug Administration (FDA) greater authority over how food, both human and animal, is grown, harvested, and processed. The FSMA follows the ISO example by focusing on protective and preventive approaches with hazard analysis and critical control point (HACCP), current good manufacturing processes (cGMPs), as well as hazard analysis and risk-based preventive controls (HARPC).

In all these standards, increased accountability is being passed on to manufacturing suppliers.

REMEMBER

Quality is important for any manufacturer. For some companies, quality and compliance are governed by industry standards, customer requirements, or government regulations.

An MES can help to assure that quality standards are being met throughout the manufacturing process. In the event that there are questions about a product or a recall is issued, an MES can help you quickly locate and isolate the affected products.

Achieving Operational Excellence

What gets measured gets done. One of the most common metrics for manufacturing facilities is overall equipment effectiveness (OEE). OEE is calculated by multiplying three other metrics together:

OEE = Quality × Performance × Availability

Quality (percent of usable parts)

Performance (percent of maximum speed)

Availability (percent of possible time)

In theory, when a factory has an OEE of 100 percent, it's producing only usable parts (no defects) as fast as possible (maximum speed) using all the time that is planned for production. In reality, world-class facilities average an OEE of 85 percent.

Unfortunately, for smaller facilities, OEE is often difficult to measure because the data is stored in different systems or may not be captured at all. That makes it hard for operations managers to see trends and identify opportunities for improvement.

Implementing an MES solves this problem because it captures all the data needed for an OEE calculation in one place. Managers can see what's happening in real time and know exactly where they need to concentrate their efforts to raise the OEE and achieve operational excellence. OEE is typically monitored by executives from a "trending" point of view with an obvious focus on continuous improvement represented by an upwardly trending OEE.

TASTING SUCCESS

Hausbeck Pickle Company produces pickles and peppers for fast food restaurants, such as Subway, Burger King, Domino's Pizza, Papa John's, Taco Bell, and KFC. Hausbeck had numerous challenges:

- Paper-based processes caused errors, limited real-time visibility, and led to inconsistent reporting.

- The company couldn't track inventory cost from receipt of inventory to finished product.

- Audit compliance required better ingredient tracking and traceability.

After implementing the Plex Smart Manufacturing Platform, Hausbeck achieved:

- Inventory accuracy of 99.6 percent, as compared to 70 percent prior to Plex.

- Easy compliance with customer scorecards — demonstrating the ability to be a strategic business partner.

- Ability to determine the ratio needed between pickles and brine, thus maintaining the highest quality.

Chapter **4**

Providing Visibility to Manufacturing Flow

One of the principles of lean manufacturing is to create a steady "flow" through every process. If you imagine your products flowing through your plant like a river, then improving flow involves constantly removing obstacles such as rocks, bends, and especially dams. When flow improves, you can easily eliminate many forms of waste in a manufacturing process, from work-in-process (WIP) inventory to idle time for machines. A manufacturing execution system (MES) can supercharge efforts to improve flow and eliminate waste by providing complete visibility into how well the machines, the people, and the inventory in your plant are synchronized.

Fixing Your Flow

Manufacturing companies typically invest a large amount of money in three areas: equipment, inventory, and labor. The more optimized these resources are, and the more efficiently you can use them, the more profitable your operation will be. As previously mentioned, the practice of lean manufacturing can be helpful in uncovering opportunities for improvement and optimization.

Lean manufacturing is a continuous improvement philosophy that was developed by Toyota as part of the Toyota Production System. It became especially popular throughout the automotive industry but is now common in other industries, such as food and beverage, as well. Any smart company trying to increase profitability will look to lean as a first step.

An important part of lean manufacturing is to smooth the flow of products through a production facility. The goal is for products to move steadily from one step in a process to the next without needing to stop anywhere in the middle.

Achieving stable flow leads to a surprising number of benefits. For example, because product is always available at every step in the process, increased utilization of manufacturing equipment is possible resulting in higher OEE (see Chapter 3). And, because products never have to wait at the end of a manufacturing step, flow can also reduce the amount of WIP inventory throughout your facility.

Solving Problems Proactively

An MES makes identifying problems easier and can eliminate many issues that interfere with flow in a plant.

For example, by converting paper-based checklists into automated procedures, the MES eliminates the need to stop a process to ensure that steps are being completed in the right order. Instead, the MES enforces rules that ensure everything happens in the right sequence, that it happens at the right time, and that it is done correctly, every time.

Because many MESs can communicate directly with programmable logic controllers (PLCs) and sensors, they can collect huge amounts of data (eliminating the risk of human error, data input, or transfer errors), easily contextualize that data, and deliver that data visually with meaningful analysis and insight. This gives managers access to real time, reliable data in the context of the process, so they can isolate and resolve problems quickly.

For lean manufacturing experts, MES can even be used as a countermeasure to correct the root cause of a problem and to prevent it from recurring in the future.

Tracing Product Flows

Monitoring the flow of products is like visualizing digital threads that run through your facility. To see these digital threads you need to scan products at critical points along their journey. Several technologies can be used to quickly and easily identify each product, and the MES acts as the single system of record for this "traceability" data. The outcome of collecting data at different points throughout a process is the ability to trace back to any point to understand what happened at that point.

Barcodes convert numbers and letters into vertical lines that can be read instantly by an optical scanner like the ones you've seen in grocery stores. Barcodes are common in manufacturing because they can be read quickly and with fewer errors.

An optical scanner is just a camera and decoder attached to a computer or handheld device that can read a code or symbol like the one in Figure 4-1.

FIGURE 4-1: A bar code.

Quick Response (QR) and data matrix codes (Figure 4-2) are two-dimensional patterns for storing data that can be read by many devices, including smartphones. QR codes can store more data than barcodes and can include error correction features that make them more resistant to damage.
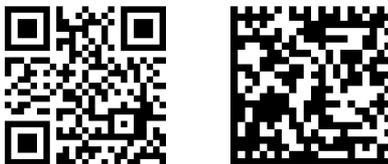
FIGURE 4-2: QR code and data matrix code labels.

TIP

The easy way to tell the difference between a QR code and a data matrix code is to look for the three big squares in the corners. QR codes have these squares, but data matrix codes do not.

These labeling technologies capture point data along the flow through the manufacturing process. Then as inventory is consumed and produced, the MES can display traceability information in a report like the one shown in Figure 4-3.
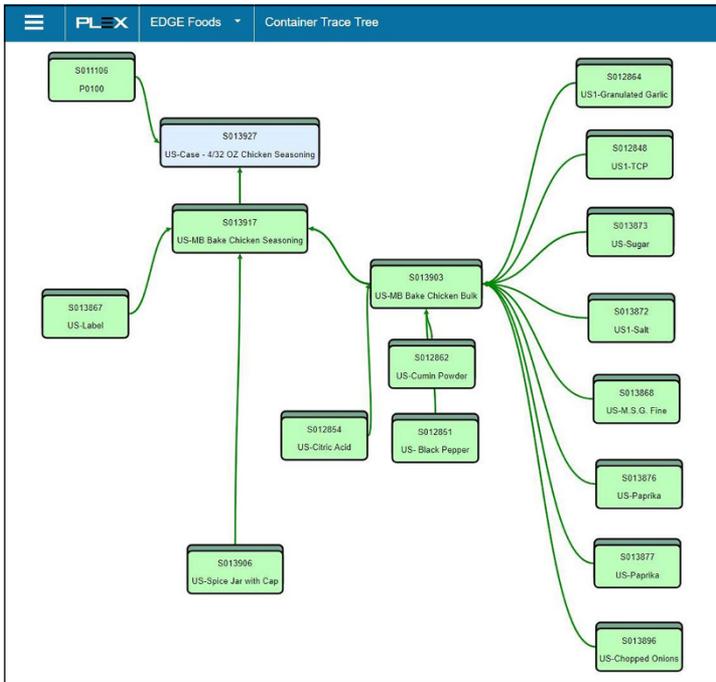
FIGURE 4-3: An advanced traceability tree.

These labeling technologies can also be used to track assets in your facility such as pallets, containers, and tooling. Storing this information in your MES helps you easily locate these assets when you need them, eliminating the time that was previously wasted looking for them.

Having this detailed visibility into inventory is an extremely important capability of an MES because it's generally lacking in an enterprise resource planning (ERP) system. Without an MES,

the "black box" over manufacturing operations (as described in Chapter 1) hides the WIP because an ERP is designed only for the shipping and receiving processes. At a minimum, the company needs to know when it has received raw materials, ingredients, or components because those costs are now on the books. The company must also know when finished goods are shipped because it can then invoice the customer to get paid. Thus, most ERPs simply backflush the consumed inventory in the manufacturing process at the end, ignoring all detailed activity in the plant, where most efficiency opportunities exist.

Not only does inventory cost money to procure, but it takes up space in the facility for storage. That floor space, and the climate controls required — or even lights and other safety equipment — cost money. So the goal of most businesses is to minimize inventory on hand by moving material from receipt to shipment as fast as possible. This process is called "inventory turns." The fewer days or weeks you take to turn inventory, the more inventory turns you record.

With most ERPs, work-in-progress inventory — for many industries the largest cost to the business — is largely invisible and results in a fair amount of uncertainty. With an MES that tracks inventory on the floor, manufacturers can "see" the inventory and its value. Thus, they can minimize the need to procure extra (or excess) material to ensure having enough to avoid stockouts or starving production.

Reporting Meaningful Insights

Collecting high quality data is essential for understanding what is really happening in a production facility. But for that data to be useful, you need to share it with the right people, at the right time, and in a way that is meaningful for them. Business intelligence tools can mine the data in an MES and generate dashboards for users throughout the business, as shown in Figure 4-4.

TIP

Business intelligence software is designed to make it easy for users to connect with multiple databases and translate large amounts of data into easily understood graphs and charts for decision making.
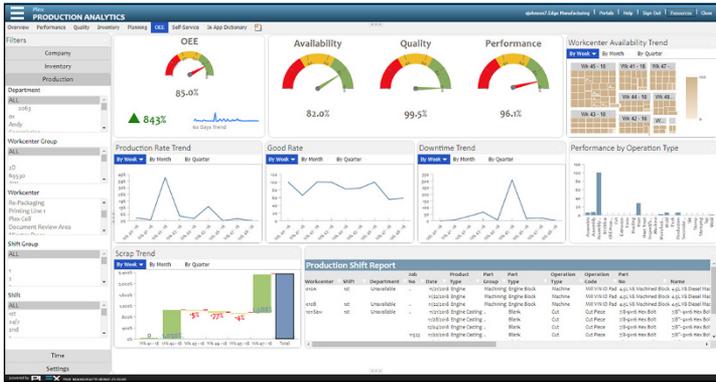
FIGURE 4-4: An MES dashboard.

For operations managers, these dashboards might include metrics showing the quantity of parts produced, the production time for each part, equipment downtime, scrap, the time for total production, the quality of the produced parts, the number of parts with issues, the time spent by the operator, and the associated cost.

Getting the right information, at the right time, to the right decision-maker is essential. Without it, manufacturers do not have the insight to improve planning, forecasting, production scheduling, costing, and more.

Chapter **5**
Enabling Smart Manufacturing

Whether you call it smart manufacturing or Industry 4.0, the future of manufacturing involves automating many of the mundane, error-prone processes that are being done by people today to free them up for higher-value work. In the near future you may use autonomous robots to perform many manufacturing functions and use artificial intelligence to make decisions in the plant.

A *smart manufacturing platform* is a digital system of record that connects people, systems, machines, and supply chains while automating business processes, tracking data from the plant floor to the top floor, and delivering analytics for unmatched visibility, quality, and control. Today and going forward, that platform can leverage cloud and edge computing to give manufacturers maximum flexibility and growth potential.

Building Your Foundation for the Future

As companies added programmable logic controllers (PLCs), sensors, and communications throughout a plant, they began collecting the data that is now fundamental to this generation. The

devices and data can work together to make the processes and the plant *smarter*, when not left siloed on those machines.

The trend toward automation and data-driven decision-making is only getting stronger, and to take advantage of these capabilities, plant operations leaders and their teams need to get smarter, too.

A manufacturing execution system (MES) acts like the central nervous system for operations, enabling you to easily connect and control devices and processes that transform the way manufacturers make things. The addition of the Industrial Internet of Things (IIoT) applications — defined in the section of this chapter titled "Adopting Industrial IoT" — adds another layer of connectivity, production and asset health monitoring, automation, contextual data, and insight that takes digital transformation to another level.

Understanding the Four Pillars of Smart Manufacturing

Smart manufacturing is emerging as a movement for manufacturers. The following characteristics define the categories of value it can deliver:

» **Connect:** Two hallmarks of smart manufacturing are full connectivity within an enterprise system — no more silos — and extensions enabling systems to connect to each other to create an integrated network of capabilities. Modern cloud architectures make connectivity between systems much easier via application programming interfaces (APIs). For example, connecting IIoT applications to an MES can help avoid unplanned downtime, and connecting both to enterprise resource planning (ERP) provides immediate visibility into asset status throughout the business.

» **Automate:** In addition to the ability to automate mundane or error-prone tasks such as labeling or counting, production technology can accurately inspect products and record scrap reasons. Software can automate paper or email-based business processes with electronic workflows. Further, robotic process automation (RPA) can then automate repetitive workflow tasks, and coupled with machine

learning, continually improve the process over time. For example, on detection of non-conforming products or materials, the system can trace that source material back through the production line and to a place where it can be automatically rejected or marked for removal, also streamlining the approval process.

» **Track:** Tracking inventory and processes isn't a new concept, although leveraging the digital thread of the resulting electronic "paper trail" has become a fundamental component of smart processes and smart factories. Full track and trace with complete genealogy and history from raw materials to finished goods can shorten recall time to minutes versus the typical days or weeks common with paper processes.

» **Analyze:** Real-time manufacturing intelligence helps to report and visualize critical key performance indicators (KPIs) for quicker, more confident decision-making. Powerful, analytics contextualize data between systems to drive informed decision-making from asset performance on the plant floor to business performance on the top floor and maintain detailed historical records for future trend analyses. Coupled with artificial intelligence (AI), the platform can discern and report patterns in the data that humans would be unable to see. Unlike AI in the movies, the platform provides humans with better data to make smarter decisions.

Implementing Automation Tools

Manufacturers' top focus areas tend to be productivity, efficiency, quality, and safety. Technology should be about driving value for these business issues rather than technology for technology's sake.

One of the increasingly common ways to drive value is taking the data from machines, people, and processes on the plant floor and using it in conjunction with an MES to more efficiently manage manufacturing operations. Manufacturers have been collecting data for in-process control for decades, but without the means to analyze it or well-defined use cases for the data, they have

traditionally let it "fall on the floor" or at best they've stored it somewhere "in case we ever need it." This practice created multiple data siloes, making it even harder to use the data because it lacked context.

This real-time data has always been valuable for supporting a level of control, synchronicity, and accuracy with production, inventory, and quality. With the advent of industrial automation and the IIoT, use of real-time data is accelerating rapidly. An MES provides inherent context to this data, as to the customer, job, and work center as well as the operator and time of day. This information was lacking in the past.

Automation, such as robots or *cobots* (rebots designed to work alongside human employees), have taken over the mundane "pick things up and put things down" jobs, and other technologies are replacing more difficult or error-prone tasks such as counting parts or identifying defects. A visual inspection system can review hundreds or thousands of parts a minute and record both good and bad parts in the MES in real time.

Automation is also process automation, for example automating work center or job set up, automating quality management and lineside labeling, and automating data collection and input, providing *poka-yoke* (mistake-proofing) capabilities inherently. These tasks are being automated to free human operators to perform higher value jobs where their critical thinking skills can be used for greater benefit.

WARNING One of the greatest challenges for manufacturers today is attracting people for production work. People come to work from a technology-connected home life where everything has "an app for that." Manufacturers compete against all other industries for these workers. Companies need to digitize their environments and provide data, methods, and responsibility for workers to use that data. This makes a modern, compelling environment to attract today's connected worker.

Finally, the newest opportunity is taking all this data from machines, the plant floor, and the top floor and adding a manufacturing analytics layer that helps you visualize and make sense of the data in context. The ability for analytics to deliver insight through dashboards has been around for years, but with advanced analytics, manufacturers can visualize real-time trend

analysis from algorithms that can identify and present non-obvious insights such as answering questions you didn't even know to ask. For example, correlating delivery schedules to a quality issue uncovered a humidity increase caused by the receiving door being opened at the same time that parts were failing. These analytics, when applied to business processes across the enterprise, begin to make manufacturing smarter than it's ever been.

TIP

A real-world use case: Your plant in China and your third shift in the U.S. have been underperforming, and customer orders are going out late. The production supervisor says his team is running around the clock but can't keep up with demand. With a new MES installed, you've connected the production equipment PLCs and can now see whether the machine is producing parts or is idle. Unfiltered data shows that the machines stop for 30 minutes at each shift change, and additional downtime occurs at breaks during the third shift. Armed with this data, you add three hours back into the production schedule by staggering worker breaks and avoid purchasing another expensive piece of equipment!

Connecting the plant floor gives you tangible, real-time data you can use to make objective decisions in time to effect real process improvement. An MES can proactively enable you to instill discipline and rigor so that production only happens when the right processes and specifications communicated from the control and quality plans are followed, and can alert you proactively before something is produced out of tolerance or spec. An MES can also enable you to automatically shut down a machine when production or machine tolerances trend out of specification or send a notification or alert to a supervisor to intercede.

REMEMBER

Every action in production from moving inventory, to consuming it at each work center, to inspections, to assembly, to staging finished goods can be captured in an MES. The MES becomes your digital system of record to sustain and maintain processes.

Adopting Industrial IoT

Once manufacturers realized how much value their real-time production data contains, they began using it to address real problems and to uncover even more opportunities for continuous improvement.

Enter the Internet and low cost technology. Billions of devices of all kinds — from smartphones to appliances to automobiles — are now being networked and connected to the Internet so that they can share data and respond to instructions. This trend is broadly called the Internet of Things (IoT). In manufacturing, the low cost of sensors and increasingly more networked plant-floor equipment offers tremendous data-gathering and data-sharing opportunities. When sensors connect to devices or epuipment in a manufacturing environment, it's called the Industrial Internet of Things (IIoT).

IIoT devices capture volumes of process and environmental data about manufacturing from sensors, PLCs, and machine controllers, and communicate that data to a gateway that can be accessed by monitoring and analytic software. For example, vibration and temperature sensors can detect changes in machinery/asset performance and send alerts if preventive maintenance is required. When data is collected and analyzed — with all the context provided by the MES — you can see what's happening with your production equipment, review what happened last shift, last week or last year, and predict what will happen in the future to circumvent unplanned downtime.

This is a boon to MES because uptime is a key contributor to overall equipment effectiveness (OEE). IIoT thus plays a critical role in the automation of your entire facility to extend a higher level of visibility to the performance of critical manufacturing assets. With IIoT, the traditional practice of scheduled maintenance can be augmented with performance-based maintenance, performing work when the device shows signs that it needs maintenance. IIoT monitoring and analytics can identify a performance issue *before* a failure occurs that may disrupt production. With advanced predictive algorithms, your system can not only predict a failure, it can identify performance improvements and ultimately prescribe a fix (or repair) that can be cascaded across the enterprise and related systems (ERP or planning systems) to increase productivity at a larger scale. These systems can then determine the least impactful downtime windows for making repairs. When further coupled with computerized maintenance management system (CMMS) capabilities, maintenance is even more automated and a closed-loop process. Moreover, with context applied from the production, supply chain, and even business management perspectives, IIoT data supports broader decision-making, such as which customers are most at risk for a late delivery or a quality issue.

TIP

In this new world of smart manufacturing and IIoT, connectivity to the data is key. Automation helps you unlock the potential of your people. Imagine the hours of your people's time that can be freed up by eliminating manual data collection and integrating the data from all your machines and information systems into a unified solution to drive the business. When they're freed from mundane tasks, they can focus on mining the data and analyzing it for valuable business insights.

Connecting People with Information

All this data is just data until it is connected to people who can act on it in the proper context. That "black box" within the plant as described in Chapter 1 contains a lot of pertinent information that is waiting to be unlocked but is invisible to managers and executives outside of production. Planners in the back office, preparing the production plan, need visibility into shop floor resources to deliver an achievable master production schedule. Production updates might only be reported to the business at a designated frequency — leaving hour-by-hour operations disconnected from reports. Without an MES that works with your ERP, big gaps in critical business information may result, making timely decisions difficult.

The production analytics dashboard in Figure 5-1 provides insights about production rates, inventory turnover, scrap, waste, and more.
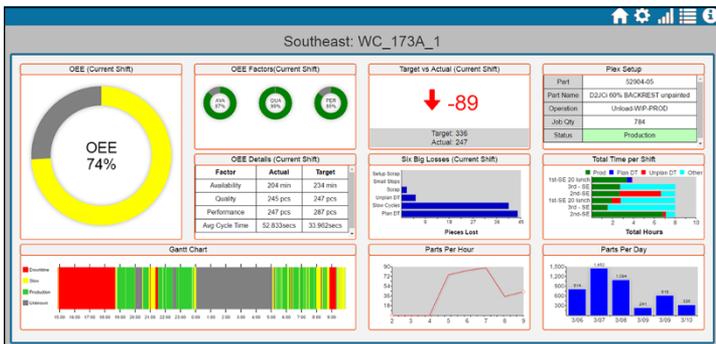

FIGURE 5-1: A production analytics dashboard.

By integrating an MES with your ERP software, you can better choreograph business processes and be more proactive in delivering quality products in a timely, cost-effective manner.

One of the new dimensions of business success — beyond time/cost/quality — is visibility. Sharing process information such as quality and delivery performance with customers has become a key differentiator. Imagine getting access to all the real-time control parameters that are required to produce a product but are not inherently "inspectable." A shipment of products with that degree of accountability surely will enable that manufacturer to win the day over competitors who cannot provide it.

Consider a production supervisor who is notified of non-compliant parts produced yesterday on second shift. Armed with MES data, they can see which operator made the parts, at what time, and on which piece of equipment. That's good, but to be great, IIoT technology can gather data from the two machines producing the parts indicating that the conveyor belt was turned up to a faster speed to increase production counts. Parts then were moved through a furnace too quickly and never reached the required temperatures according to the sensors being monitored. By *putting the MES and IIoT data in context with each other,* the supervisor can see when machine performance is out of spec, can determine how many parts are affected and can contain them all for re-work before anything leaves the plant! In advanced use cases, IIoT technology detects the issue, works with an MES to alert the operator, and prevents any bad parts from being produced. This type of real-time manufacturing intelligence lets you monitor critical KPIs for quicker, more confident, and more informed decision-making. Exposing the operational characteristics of your shop floor assets helps improve performance and reduce unplanned downtime.

Managing Your Plant(s) from the Cloud

For many facilities, the ability to adopt new information technologies is limited because companies don't have capital in the budget to invest in computers, servers, and software, let alone the IT staff to configure, install, and maintain such technology. This approach to installing servers to host software in your facility is called an *on-premises* — or "on-prem" — solution.

With an on-prem solution, you install a server inside the plant to host your MES. In addition to installing the hardware and software, an on-prem server also requires maintenance and support. And, the server must be stored in a clean, climate-controlled room where it is protected from a potentially harsh environment or physical damage. Moreover, the burden of data security, patches, and upgrades falls on your IT teams or an outside managed services team to keep up with. In an age of limited resources and cybersecurity/ransomware attacks, on-premise software deployment is increasingly problematic and poses high business risk.

Many manufacturers are now using a different, cloud-delivered approach, called Software as a Service (SaaS) for their MES solutions.

With a SaaS solution, your MES is managed by a cloud software provider who delivers software from a remote data center, connected via the Internet or wide area network (WAN). Because the solution is offered from the cloud, you have no server hardware or software to maintain, and no special storage space is required. In addition, enhancements, bug fixes, and even upgrades are delivered automatically. This arrangement reduces disruption and downtime compared to legacy on-prem system upgrades. Cloud solutions also eliminate the extra costs of maintaining a separate "off-line" testing environments and the IT effort to test new versions before implementing them into your "on-line" production environment.

With MES in the cloud, manufacturers off-load a significant IT burden that frees IT professionals to add higher value to the business as data and process analysts. Cloud solutions typically deliver significantly higher levels of uptime with service level agreements guaranteeing 95 percent uptime. Best-in-class providers tout 99.9 percent! Cloud MES software providers are experts at delivering robust solutions with much higher levels of security and uptime than any individual manufacturer can provide. Finally, cloud MES is faster to deploy, delivering faster ROI than on-premise solutions.

TECHNICAL STUFF

SaaS is different than legacy software that is simply hosted with a cloud provider such as Amazon Web Services or Microsoft Azure. With SaaS, all aspects of running the solution are delivered by the MES provider, versus hosted solutions where you are still responsible for installation, testing and maintenance of the software, although not the servers and associated infrastructure.

Besides reducing capital investments by delivering software on a subscription basis, SaaS solutions provide many other benefits. For example, with SaaS solutions, you don't have software versions to keep track of, or updates to perform. Instead, all software maintenance is handled by your software provider. Some systems offer "version-less software" because a vendor's customers may be using one always-current version, securely partitioned for each company. This makes support easier and encourages best practice sharing between customers.

With cloud-based systems you can access your MES securely from any device that is connected to the Internet. So whether your employees are working in the factory, traveling around the world, or just working from home, they can log on and see what's happening.

Cloud-based MES solutions also change your approach to security. With an on-prem solution, you are relying solely on your internal IT team (or an expensive managed services provider) to manage access to your system and prevent hacks and viruses. This is a risky proposition as ransomware and cyberattacks are increasing, cost manufacturers millions of dollars per year in ransom payments, can shut down production, and have even caused businesses to fail. With cloud-based systems, however, these responsibilities are shared with experts at your cloud software vendor. This larger team often has greater breadth and depth to identify security concerns and resolve them quickly. A helpful site for checking vendor security is SecurityScorecard.com, to see how they perform against various security tests and criteria.

Another advantage of cloud-based systems is scalability. With on-prem solutions, you have to buy more hard drives and more servers as you accumulate data and as you install MESs in new plants. With cloud-based solutions, adding data storage or bringing a new manufacturing plant online is handled by the cloud software vendor. Instead of making a capital investment in hardware and software, you just change the terms of your subscription.

One final advantage of running your MES in the cloud is that it can make it easier to integrate with other software, including ERP systems and business intelligence tools.

For many manufacturing facilities, the advantages of cloud-based MES are an important factor to consider when evaluating possible solutions.

MOVING TO THE CLOUD

G&W Products is a manufacturer that wanted to boost growth. When a new CEO took the helm more than a decade ago, he saw something that could get in the way: the company's legacy on-prem ERP system.

Unlike many small manufacturers, G&W didn't believe the myth that the cloud is limited to large enterprises. The company sees itself as a leader by using technology to completely transform its business, and for good reason. G&W Products went from mostly manual, paper-based manufacturing operations to modern, lean, world-class production in nearly one year.

G&W chose a cloud solution that had MES included as a unified component of its new ERP. The company had two facilities to get online. The project took about four months, due in part to entering 18,000 part numbers manually rather than using data migration. The team learned a lot about the importance of "good data in, good data out" during the implementation resulting in catching a welding error that resulted in 100 percent certainty that no defective products made it to the customer.

G&W has found ways to continually improve processes. It has streamlined auditing from reviewing six or seven screens per question to completing audits instantaneously from a single query. Data resolution goes down to the raw material, which has enabled the company to pass all 300 audits since installing Plex. G&W has also reduced inventory by 25 percent and has increased on-time delivery from 80 to 98 percent. Now G&W is addressing issues that go right to the bottom line because the company has valuable details it never had before.

Chapter **6**

Using MES to Drive Value for Your Business

The decision to implement a manufacturing execution system (MES) should be based on a well-understood business case with success metrics and a commitment to measuring and reporting progress to achieving the target metrics. The business case and success metrics should be the outcome, a result of business process transformation, with MES being the enabler ("the what").

Enabling Process Transformation

When choosing an MES, let process transformation be your guide. Avoid diving into capabilities at this point, and instead focus on where your operations need to improve ("the why"). Consider these needs:

» More control over operator tasks, with improved efficiency

» Real-time visibility to work-in-progress (WIP) and production output

- » Reduced inventory and scrap
- » Traceability from finished goods back through the manufacturing process and supply chain
- » Integration between formal quality procedures and operating processes
- » Alignment of production and maintenance

Document the prevailing issues and business impact for each improvement area and create a vision for what you want to accomplish in the short, medium, and long term. Staying focused on operational improvement or outcomes at this point helps you maintain priority when you begin exploring solutions (the "how").

Assembling Your Team

An MES project will transform your production operations, but it also affects many other functions. Managing the project correctly with a cross functional team of stakeholders focused on value can shorten the time needed to select a solution and get it implemented.

Within your company, you need buy-in and engagement from stakeholders. Stakeholders can be viewed in two buckets:

- » The business benefactors of the process improvement
- » The system users most directly affected by process change

For example, finance might be a benefactor while operations would be affected by the change. Don't ignore the requirements from IT and plant operations technology (OT) aligning with both during implementation and for long term support.

Assemble a project team that includes representatives from the affected functions. Strong executive sponsorship is also paramount. Without support for this business transformation from the top, roadblocks and resistance to change might stop the project.

Once you've recruited the right process owners and subject matter experts for your team, you can document your business requirements, metrics, and start your search for your new MES system!

Creating an Implementation Road Map

Many strategies and frameworks are available to guide you through a selection process and help you build a value-driven road map that defines how your company will transform over a set time period. What is most important early on is that you get a good understanding of what is possible and what potential solution providers are offering. Avoid relying solely on what you currently know, because technology changes rapidly and you want to avoid preconceived ideas.

Assessing your risk tolerance

As you work through what is possible, assess your tolerance for risk and the specific risks you want to avoid. Most companies are not interested in building and supporting one-off custom solutions because of the high cost to support and the inevitable cost of obsolescence when it comes to upgrades. Many companies have come to appreciate the value of software as a service (SaaS) solutions. When a mission-critical solution must be reliable, IT costs can skyrocket to maintain the redundancy and security required. SaaS solutions distribute these costs across all their customers and therefore significantly reduce the burden on the individual company. Finally, what checks and balances will be put in place to avoid customization? Many companies have found that SaaS offers best practice approaches to business process automation and provide the value they are looking for without the fear of the project team introducing customization, leading to a high ownership cost in the future.

Choosing a vendor

Now that you understand your priorities and potential enabling strategies, build a value-based road map that allows you to put focus into what you want to enable over time and uses business value as the means for prioritization. Use this to guide your selection criteria when choosing an MES.

Lean on your trusted software partner to help you articulate what is possible in the context of the value or process improvement you are looking for. Avoid focusing too much on features and functions.

WARNING

At times, formal requests for proposal (RFPs) are unavoidable, but they can create a behavior that serves no one. Vendors end up representing something more than they offer. Customers define requirements for what they think they need, based on what they have always known, leaving little opportunity for innovation. Customers end up buying more than they need and customizing to get what they think they want. And the vendor cannot push back because it is held accountable to the original RFP!

Building a governance model

Now that you have a road map and have selected your solution provider, the next step is to build your implementation team's governance model. It is critical to have a team that understands current operations and systems and one that can dedicate enough time to the project. Equally important is to have an executive stakeholder actively engaged and available to make key decisions when needed. Often multiple stakeholders are assigned. This is not a bad thing. Although having more stakeholders generally means more conversation and a slightly longer timeline, it will lead to better adoption.

Your implementation partner will provide the best practice and the know-how beginning with a project charter or execution plan.

In parallel, if you're selecting a SaaS solution, the core team should attend comprehensive product training. The goal is to give an introduction and overview of how the software works and is configured so the team is better prepared for implementation activities.

The implementation team will then have a point of view on how your use cases can be implemented within the software solution. This is a critical first step to gain alignment on best practice capabilities and minimize the risk of customization. It also provides an opportunity to identify connection points that will provide input to the integration strategy.

Preparing for integration

Then comes the bulk of work, which includes configuration activities and preparing master data to load in. In parallel, the IT team should be working with the solution provider to execute on the integration strategy to exchange information with ERP and/or other systems on an on-going basis.

The next critical step in the process is to determine readiness. This generally involves a pilot or trial end-to-end run of the solution to confirm operation and introduce a broader team of operators to the new processes.

Maintaining success

Finally there is the "go-live" moment when the system is made available to support production operations. The work should not end there, however. It's critical that you think about and plan for change management when deploying MES to ensure that your entire team adopts the solution and the refined processes that it enables. Once the team has adopted the software, team members can participate in continuous improvements efforts to improve performance.

Change management, including user adoption, has three critical focus areas for ensuring and maintaining success: 1) creating a change management model, 2) driving messaging, and 3) ensuring you have sponsors to drive those messages, make decisions, and ensure accountability.

First is creating an overall change management and progression model that serves as a readiness checklist. One example is ADOPT:

- » **Awareness**: People are aware of the reason for the change
- » **Desire:** People will participate and contribute to the change
- » **Onboard:** People receive proper training and communication
- » **Practice:** People can use the change in practice with a support staff if they need assistance
- » **Teach:** People become experts and can mentor and support others

The last two, messaging/communication and sponsorship, are linked to each other and to the change management model. Consistent, ongoing communication and messaging are critical to ensuring that people are informed and have the information they need to progress through change.

Sponsorship is not one person; it's actually multiple roles. Executive sponsors, for example a CEO/president or other executive, set the overall course and consistently communicate; front line managers communicate at the department or team level.

Have a model to follow, a set of sponsors to communicate consistently, and well thought-out, helpful messages that enable people to progress greatly increases a successful change management effort.

Measuring MES Results

Many companies are surprised to see how quickly they can generate benefits from an MES implementation. Therefore, it's important that key performance indicators (KPIs) are determined early to measure success. This allows the project team to prove progress and build on it. A recent survey from IT analyst firm Gartner found that nearly one-third of the companies that implemented an MES saw many of the benefits they were targeting in less than three months. These benefits included:

>> Reducing reporting latency

>> Increasing inventory turns

>> Improving quality through shop floor control

>> Regulatory compliance and traceability from finished good back to the supply chain

>> Improving performance and operational visibility across sites

These benefits are clearly valuable for operations managers and supply chain professionals, however the ability for a company to invest must also be addressed. Executives often rely on specific financial criteria when choosing between alternatives and measuring the value of an MES implementation:

>> Initial capital expense (CAPEX)

>> Ongoing operating expense (OPEX)

>> Return on investment (ROI) and time to value (TTV)

>> Expected reduction of inventory and increased turns

>> Reduced scrap or waste

>> Improved equipment utilization and plant throughput

Differences in the way an MES solution is designed can have an impact on these metrics.

For example, on-premises MES solutions require an initial CAPEX investment to install servers, purchase user licenses, and account for the cost of personnel to maintain the server hardware and software. SaaS solutions, on the other hand, don't have any initial capital expense but are funded using a subscription OPEX model, which often aligns better to business performance. SaaS solutions also tend to be easier to scale up or down.

Business operations related improvements in inventory and efficiency can then offset the costs to implement the system, providing a strong ROI in the shortest possible time.

REMEMBER

Although showing a short-term ROI for an MES implementation is important, you also need to think about the long term. An MES system opens the door for integrating new technologies that can deliver even greater value down the road. To take advantage of many Industry 4.0 technologies, it will be essential for your facility to be equipped with a robust and flexible MES — a foundational element of a smart factory.

Chapter **7**

Ten Ways an MES Adds to Your Bottom Line

Clearly an MES can impact your ability to transform your manufacturing operations. You can expect these benefits:

» **Improving manufacturing quality and control:** MESs deliver value by orchestrating and error-proofing the processes from raw materials to finished goods.

» **Ensuring regulatory compliance:** MESs mitigate the risk of recalls by providing precise information about the components used in products you make.

» **Synchronizing processes:** MESs can help you monitor and adjust the cycle time for each step to minimize WIP and accelerate your production.

» **Increasing visibility:** MESs provide dashboards with relevant information about what's happening in real time, so that you can spot problems early and keep the operation running smoothly.

- ❯❯ **Accelerating management reporting:** MESs can make sure that everyone in the company can access the insights they need when they need them.

- ❯❯ **Increasing asset utilization:** MESs can increase asset utilization by optimizing schedules and maintenance to eliminate unplanned downtime.

- ❯❯ **Reducing costs:** MESs can provide direct savings by reducing the time required to produce each unit and ultimately contributes directly to the bottom line.

- ❯❯ **Streamlining engineering changes:** MESs can help you identify all modifications that are required in order to implement an engineering change, and it can help you make sure that everything gets updated correctly.

- ❯❯ **Improving supply chain collaboration:** MESs make sure that suppliers have access to accurate data, so they can more easily collaborate and align their deliveries to support production processes.

- ❯❯ **Simplifying system management:** A cloud MES can simplify IT by offloading system maintenance to the cloud MES software provider, removing a tremendous IT burden from the manufacturer.

Glossary

asset performance management (APM): Proactively monitoring machine and plant health using Industrial IoT technology to ensure optimal uptime, throughput, and maintenance needs.

cloud computing: The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

digital transformation: The process of using digital technologies to create new — or modify existing — business processes, culture, and customer experiences to meet changing business and market requirements.

enterprise resource planning (ERP): A process (and software) used by companies to manage and integrate the important parts of their businesses. ERP software applications help companies integrate all the processes needed to run their companies into a single digital system of record.

Industrial Internet of Things (IIoT): Interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, facilitating improvements in productivity and efficiency as well as other economic benefits.

inventory turns (or turnover): A measure of the number of times inventory is sold or used in a time period such as a month or year.

lean: A manufacturing process focused on continuous improvement and minimizing waste within manufacturing systems while simultaneously maximizing productivity.

manufacturing execution system (MES): A computer system that provides visibility and control over the work in a manufacturing facility.

manufacturing operations management (MOM): A collection of systems for managing end-to-end manufacturing processes with a view to optimizing efficiency. Often used synonymously with MES.

manufacturing resource planning (MRP): A production planning, scheduling, and inventory control system used to support procuring the right raw materials at the right time.

on-premises ("on-prem") computing: Using computer servers located at the manufacturing facility to store and process information.

overall equipment effectiveness (OEE): A factory metric that combines the key performance indicators of production output, machine availability, and acceptable quality.

production monitoring: Transparent, real-time operational KPIs derived from connectivity to machines on the plant floor to drive continuous improvements.

programmable logic controller (PLC): An industrial device for the control of manufacturing processes, such as assembly lines, robotic devices, or any activity that requires high reliability control.

quality management system (QMS): A formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives.

Quick Response (QR) code: A machine-readable code (similar to a bar code) consisting of an array of black and white squares, typically used for storing web URLs or other information to be read by smartphone camera or scanner.

software as a service (SaaS): A software licensing and delivery model in which software is licensed on a subscription basis and is delivered over the Internet from a centrally hosted data center.

Six Sigma: A process improvement technique that uses statistics to measure processes and reduce variations.

smart manufacturing: According to MESA.org, smart manufacturing is the intelligent, real-time orchestration and optimization of business, physical, and digital processes within factories and across the entire value chain. Resources and processes are automated, integrated, monitored, and continuously evaluated based on all available information as close to real time as possible.

work in progress (WIP): A term to describe partially finished goods that started as raw materials but are at various stages of the production process prior to being considered a finished good.

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Drive operational excellence with MES

To keep up with rapid change, operations managers need an environment that allows them to precisely control production and maintain visibility into critical processes. A manufacturing execution system (MES) can provide these benefits and more. This book shows how an MES can integrate the critical functions in your facility so you can make better decisions and implement valuable continuous improvement initiatives.

Inside…

- Understand smart manufacturing
- Digitize process
- Encourage continuous improvement
- Uncover meaningful insights
- Enable data-driven decision making
- Create an implementation plan

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