October, 2006
A White Paper by Stratus Technologies

Manufacturing IT Infrastructure – Ready or Not for MES?

Stratus Technologies

Continuous – Availability Systems are the Key for Companies' Long-term Success with Manufacturing Execution Systems

Abstract

When the first manufacturing execution systems (MES) hit the market more than a decade ago, they were a good idea whose time had not come. While they promised great efficiency and quality improvements, MES systems were too immature and expensive to make good economic sense.

Today, MES solutions are the difference between manufacturers who will prosper in the near future, and those who won't. As market dynamics continue shifting toward shorter product lifecycles, smaller production runs, greater emphasis on quality and more complicated regulatory requirements, only automated data collection and processing in a proactively managed continuous-availability environment offers the management agility manufacturers need to survive.

Contents

I. Introduction

When the first manufacturing execution systems (MES) hit the market more than a decade ago, they were a good idea whose time had not come. While they promised great efficiency and quality improvements, MES systems were too immature and expensive to make good economic sense.

Much has changed since then. Product lifecycles are shorter, profit margins tighter and regulatory environments tougher. Manufacturing companies that plan to be thriving in five years have no choice other than to deploy an MES. That's a widely accepted truth. As the pace of business grows ever-more frenetic and regulatory environments so Byzantine, attempting to control manufacturing processes through traditional paper-based systems or patchwork technology systems puts companies at a serious, if not fatal competitive disadvantage.

MES as defined by the ISA SP95 Committee covers a wide swath of shop floor functionality including functional areas like recipe management, recipe execution, quality management, and finite scheduling. Addressing all these functional areas often requires several software packages that are then integrated to function in concert. Today the maturity and functionality of these off-the-shelf applications has made the possibility of paperless manufacturing a reality. Eliminating manual paper processes translates into recipes that automatically enforce adherence to the approved procedures, materials that are available when and where they are needed, and a wealth of data that can be mined for Operational Excellence initiatives and to drive process improvements across sites.

"I want to understand what the key performance indicators are across the entire company," said Misha Rozenberg, senior vice president and chief quality officer at international contract manufacturing company Solectron. "The MES system will let us look across all of our facilities to find out what's causing poor yields, excess scrap and rework across our manufacturing sites. We'll be able to identify best practices and implement them throughout the company. I can only do that today by utilizing spreadsheets and manual data entry processes. Even if the factories have identical production line design and equipment, I can't easily identify best yields and practices for similar products and customers. I can eventually figure it out, but it's a very labor and time consuming process. The common MES solution will provide fast and definitive answers."

Solectron has more than 50 manufacturing facilities all over the world, many of which were acquired with components of different MES systems already implemented. Solectron has undertaken the implementation of a standardized, enterprise-wide MES that will provide a strategic view across all

manufacturing operations so management can make fast, accurate inline process modifications to reduce spoilage while improving quality. The MES will help enforce production procedures so no steps are skipped or done out of order. In addition to its bottom-line benefits, the MES also has top-line revenue-driving benefits. The data the MES yields will help Solectron attract and retain customers by providing detailed production information customers need to manage their quality and costs.

"The MES automatically tracks genealogy metrics that our customers want, from the shop floor right up the line to management, and processes the data into information we can immediately use to identify trends, issues or superior performance. It also helps us make real-time adjustments to production processes," Rozenberg said. "For example, if the MES shows us excursions at any given factory – high yield fallout or other unusual trend– we can track it to the root cause, be it process steps, bad batch of material, test or design issue. We can track all our material by lot, in case we have an issue with incoming components, and will be able to alert all the plants with parts from that lot of the potential issue before they use the parts. Our old system of local data collection never would have been able to prevent other facilities from using the bad material, except by SQE e-mails or phone calls. We're potentially saving in the tens of millions of dollars in preventing bad material alone."

In many respects, MES deployments are similar to enterprise resource planning (ERP) systems that preceded them. MES brings to manufacturing operations the efficiency and data analytics that ERP brought to financial systems. A key difference that is sometimes overlooked, however, is the difference in transaction timeframes. ERP system transactions are measured on a time scale of months, weeks and days. Manufacturing systems have much shorter transaction timeframes that are measured in hours, minutes and seconds. This is why an MES must be designed for continuous availability. Even a brief outage can break vital record chains that determine whether a product can be sold, or whether it is written off as spoilage. MES solutions also support real-time, strategic decision making, which depends on uninterrupted data collection and processing.

The reliability required to properly support an MES comes from an IT infrastructure designed for availability, taking into account the people, processes and technologies impacting the system. So much rides on MES systems operating without interruption that the usual corporate IT reliability standards aren't sufficient. The IT infrastructure that supports MES systems must adhere to a greater standard of reliability.

Many forward-thinking companies are already beginning to implement MES systems. But they're not thinking forward enough – beyond implementation to ongoing operation and maintenance. Solution availability and performance are attributes that require ongoing management over the lifecycle of the solution. Remote monitoring and managed services are filling a gap in expertise in an innovative, cost-effective way.

II. Market Dynamics Driving MES Adoption

The manufacturing industry's current economics favor everyone except manufacturers. Shareholders and financial markets place a higher value on brand management, product development and marketing than the actual production of goods. Many brand name companies have cut their overhead by either shuttering or divesting their manufacturing operations in favor of outsourced manufacturing.

The outsource manufacturers who do most of the fabrication are at the low end of this ecosystem. They carry a disproportionate share of financial risks as the brand name companies – their primary customers – demand a steady stream of concessions. As material and overhead costs rise, the brand name companies want price cuts to improve their own margins. The brand name companies are also increasingly demanding shorter production runs on faster turnarounds to keep their inventory low and avoid write-downs. They want outsource manufacturers to invest in closer integration with their inventory, logistics and billing systems to streamline business processes.

Though most acute in the consumer goods industries, these dynamics even affect industries that do not outsource their manufacturing as extensively – pharmaceuticals, medical device, etc. Their pressure is internal, but it's pressing the same issues: efficiency, quality and speed. Looming above all of those market factors are regulatory and liability concerns that require intensive record keeping and unbroken audit trails.

Though most acute in the consumer goods industries, these dynamics even affect industries that do not routinely outsource their manufacturing – pharmaceuticals, medical device, etc. Their pressure is internal, buts it's pressing the same issues – efficiency, quality and speed. Looming above all of those market factors are regulatory and liability concerns that require intensive record keeping and unbroken audit trails.

Today's paper record-keeping systems that are used to support production processes and regulatory compliance cannot deliver the required results. New MES tools can empower plants and management to meet the demands for efficiency, quality, and regulatory compliance sought in a competitive marketplace.

III. Continuous Availability's Role in the New Manufacturing IT Landscape

Like most other enterprise applications, MES solutions are sold on their functionality. In the real world, however, functionality is useless if the solution is not available when and where it is needed. Uptime reliability in the MES world is not synonymous with reliability in mainstream corporate IT. MES-grade reliability means not only simple uptime versus downtime, but adequate performance as well. Poor performance (i.e. slow response times) can render a shop floor application just as useless as a server crash.

The scope of MES as defined in the S95 standard covers a broad set of shop floor activities. These functions are not all covered in any single applications. Typically an MES team will define the scope of the project and then select applications that deliver the required functionality. These applications are then integrated to share needed data between them. However, when a dependency is created for sharing information between applications there is an increased risk that the entire system will be rendered ineffective by failure of a single application.

Companies implementing electronic batch recording (EBR) systems and connecting them to equipment calibration systems demonstrate how data integration affects solution availability. An operator would use a barcode to scan a piece of equipment prior to using it. Upon scanning the equipment the EBR system would query the calibration management system to confirm the equipment has been calibrated and is in the right state prior to allowing its use in manufacturing. This has a clear quality advantage, but if the calibration system is ever unavailable then the EBR system could be rendered inoperable as well.

To justify the investment in MES and realize their full value, companies must be able to depend on the systems to provide a continuous flow of data from the production floor to management and quality management applications. Well-maintained corporate infrastructures can keep data and applications available 99.9 percent of the time. That's not good enough to support an MES implementation, however, because:

- 99.9 percent uptime equates to more than 8.7 hours of unplanned downtime per year for a single application. If there are dependencies for data sharing between applications then the solution

availability is further reduced. The impact of downtime means lost production time, ruined product, lost traceability and, in some industries, non-compliance with regulatory mandates.

- Companies that use MES systems to replace paper regulatory compliance records cannot afford breaks in the record chain. Products in many markets, such as food processing and pharmaceuticals, are legally mandated to maintain an unbroken record chain from raw materials to shipping for each batch of product. A record-chain break caused by a server outage, application failure, etc., can mean a total loss of a multi-million dollar batch.
- The agility that manufacturers expect their MES solutions to provide depends on a constant flow of data from the production lines to the managerial level, where capacity and utilization planning happen. Companies implementing new applications such as radio frequency identification (RFID) inventory control to streamline production processes cannot afford outages that cause them to lose track of material status or location. Manually updating and resetting a system after a failure can be a lengthy process.
- MES solutions are typically an integrated set of shop floor applications, which can act much like a line of dominos. When one goes down, it takes the others with it. The availability of the entire, interdependent set of applications must be considered. If your MES is designed to rely on access to otherwise "non-critical" systems (i.e. document management systems for access to standard operating procedures) then their reliability should be considered in the design of the IT infrastructure.

A full consideration of the cost of downtime has led many MES teams to specify very high levels of availability in the project requirements – beyond 99.999 percent, or in other words "continuous availability."

IV. Continuous Availability Defined

Continuously available infrastructure resembles conventional infrastructure, at least outwardly. They both consist of servers running applications, databases and networking software. The servers are linked with storage arrays by router-based networks running protocols over hard-wired and wireless connections.

Downtime prevention is the primary difference between a continuously available infrastructure and traditional office IT environments. This differs from the prevailing attitude in conventional IT design, where the focus is on *recovery* from errors and failures. Recovery-oriented solutions assume downtime, even if it's only a few minutes during failover from one server in a cluster to another. That downtime is a serious threat to an MES solution's effectiveness.

"If our MES experiences downtime, our losses would mount quickly," said Solectron's Rozenberg. "Our customers are rejecting units that don't have accompanying data, so just one hour of downtime can cost us millions."

Following are attributes commonly found in continuously available IT environments:

1) Solution availability of 99.999%+;
2) Individual failure points have been made redundant;
3) Redundancy is designed so that no data is lost in the event of individual component failures (memory protection);
4) Solution performance (i.e. response time) is tested prior to deployment and is monitored over the life of the solution;
5) Solution health is monitored, enabling proactive action;
6) Maintenance and problem resolution procedures are written;
7) Training is developed and conducted;
8) A separate test environment is maintained for patch testing;
9) Disaster recovery is designed into the architecture and documented.

Many studies have shown that human error accounts for a sizable percentage of IT downtime incidents. Reducing complexity of IT design, creating clear procedures and training can dramatically improve solution availability.

V. Continuous Availability Roadmap

Continuous availability doesn't happen by accident. It must be designed into an MES project. Design of the IT infrastructure is best approached as a project, or sub-project, to the MES initiative. The IT infrastructure project will follow the typical steps found in a project including development of requirements, assessment of current infrastructure, design, implementation, and planning for lifecycle management. The scope will take into account people, process, and technologies that will impact your solutions accessibility.

Just as a natural ecosystem is affected when a new species is introduced, so is a continuously available ecosystem. Application upgrades, patches and routine maintenance can cause slowdowns and crashes, as can simply plugging an unauthorized laptop into the network. Every element introduced into the network must be tested and, if necessary, modified before it is implemented to ensure compatibility.

A major life sciences company that recently implemented an MES to control its mission-critical production operations is a good case study in the proper way to conduct the process. Experiencing double-digit growth, the company needed to:

- Improve productivity and yields;
- Reduce errors leading to lost batches;
- Shorten cycle times;
- Streamline regulatory reporting.

Once they determined their business needs, the company evaluated the technology needed to meet them. An electronic batch record (EBR) system was one of the components selected, and the company's IT staff decided it had to be continuously available. As a platform for the EBR system, the company explored high-reliability solutions such as server clusters, standby server arrays, and fault tolerant servers. The IT staff eventually decided on fault tolerant servers because they eliminate downtime and protect data (even in-memory data) while also being simple to implement and maintain.

After implementing the EBR system, the company created procedures to minimize the chances of operator-caused downtime. Operators are not allowed to plug any unauthorized devices – personal laptops, PDAs, flash drives – into the infrastructure that supports the EBR to reduce that chance of outages from viruses and worms. No upgrades or software patches are applied until they've been vetted in a test environment to ensure they will operate as expected. The company has also contracted with an outsource service provider to remotely monitor the EBR infrastructure so that problems can be addressed proactively before they lead to a system failure.

The result of this implementation process is an EBR system that reliably controls production processes with more accuracy and agility than the previous paper-based system.

"Continuous availability was essential for our EBR implementation to succeed," said the company's project leader. "Downtime has a dramatic impact on our processes. We can't sell our product without an unbroken record chain, so every outage is a potential loss of several hundreds of thousands, if not millions of dollars. The biggest positive impact will be on process control, however. Paper records can't prevent people from making mistakes, like skipping a step or mixing up steps. The electronic system won't allow a technician to go on to the next step if they haven't completed the previous step. Eliminating simple mistakes like that saves us the hours of time it takes to go back through the records, determine if the error

was fatal, and decide whether to scrap the batch or continue. We only realize that benefit if the system is running constantly, though. Any break and we're right back where we started."

VI. Continuous Availability Resources

The cost of developing internal continuous availability competence is an obstacle to MES adoption. The constant diligence needed to guard against failures extends to even routine tasks such as backups, upgrades and, increasingly, software security patches. Although most companies can afford to build a highly available infrastructure, the effort and cost to maintain these systems can be significant.

A growing group of outsource service providers offer specialized "continuous availability" services. They provide companies an affordable way to access expertise from design (or analysis of existing infrastructures, people, and processes) to deployment, verification, and on-going management of the infrastructure. Modern network technologies have also provided opportunities to leverage expertise and testing through remote monitoring and life cycle management services.

Proactive remote monitoring of infrastructure can pinpoint problems before they create service outages. All necessary resources from hardware and application vendors can be given secure access to view problems and provide real-time diagnosis without having to send someone on-site. The ability to deliver expert help in real time and in a cost-effective manner is currently a hot topic in the manufacturing IT world.

VII. Conclusion

MES solutions are the difference between manufacturers who will prosper in the near future, and those who won't be in business. As market dynamics continue shifting toward shorter product lifecycles, smaller production runs, greater emphasis on quality and more complicated regulatory requirements, only automated data collection and processing in a proactively managed continuous-availability environment offers the management agility manufacturers need to survive.

About Stratus Technologies

Stratus Technologies is a global solutions provider focused exclusively on helping its customers achieve and sustain the availability of information systems that support their critical business processes. Based upon its more than 25 years of expertise in server and services technology for continuous availability, Stratus is a trusted solutions provider to customers in manufacturing, life sciences, oil & gas, utilities, telecommunications, financial services, public safety, transportation & logistics, and other industries. For more information, please visit http://www.stratus.com.

# # #