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## Increase Performance of Global Supply Chains and Operations with Manufacturing Execution Systems

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Globalization is no longer a novel strategy; it has become a critical enabler for manufacturers' business success. As long as it makes sense, operations, customers, suppliers, and other trading partners are now located anywhere and everywhere. The Internet and other telecommunications advances make this distribution of operations not only possible, but common.

However, traditional communication may not be enough to ensure the success of global ventures. Speed and flawless execution have become necessary requirements, and these often suffer in a distributed environment. Manufacturers must control the processes of global operations and partners to ensure consistency, compliance, coordination, and visibility. Companies that are not careful will find that these challenges may offset the benefits of globalization.

There is no suggestion here that companies move away from globalization. Globalization brings advantages in costs, and low-cost country sourcing and production have taken hold in nearly every industry. Having operations or partners helps ensure market coverage in both established and emerging growth markets for manufactured goods. The advantages of local knowledge that in-market operations and partners bring can hardly be overstated.

*Speed and flawless execution have become necessary production requirements, and these may suffer in a distributed environment.*

Another benefit that distributed global operations and supply chains offer is specialization by site or by partner. In some cases, an entire region has developed specific competencies that allow faster and more effective processes based on known best practices. These regions may also offer staffing benefits. Examples include semiconductor foundries in Taiwan, electronics manufacturing services companies in Singapore, and medical devices makers in Massachusetts, USA.

The disadvantages of distance are dropping away. As global trade has flourished, transportation options have also improved. Intermodal shipments allow materials parts, sub-assemblies, and products to move rapidly and effectively between ship, rail, and truck. The many electronic components and sub-assemblies in today's consumer and industrial goods are often moved as quickly across the world as they recently were across a state, thanks to effective air freight links. Even when production sites are far from customers, companies can achieve fulfillment speed.

In this distributed environment, companies must be equipped to answer tactical questions about the status of inventory and operations. They must also make ever more complex strategy decisions about not only whether to make or buy, but where to make or buy based on costs, reliability and cycle time. Manufacturers need feedback on both suppliers and their own design engineering and logistics processes.

To gain the full benefit of globalization opportunities, companies must create business processes that span multiple facilities, regions, and company boundaries. Each manufacturer needs to gain some visibility and control not just of their enterprise, but of their network of global operations.



## The Challenges of Globalization

Despite all of this opportunity, challenges remain with globalization. The many recalls and safety issues in the news these past few years indicate how easy it is for even the best-run companies to lose control over their suppliers and outsourcing partners.

Simply put, companies must gain and maintain control over distributed operations. We will break this down into four major areas: consistency, compliance, coordination, and visibility.

**Consistency of Operations:** Customer expectations of product quality continue to rise. While most companies have developed best practice procedures for operations in a single facility, many have not done so across facilities and trading partners. Companies unable to enforce consistency at every site and with every partner face the risk of lost customer satisfaction and business.

Consistency enables acceptable margins on order quoting and is key to predictable costs. Profits are at risk when global operations are not reliable and consistent.

*Simply put, companies must gain and maintain control over distributed operations.*

**Compliance:** While aerospace has long been regulated, now automotive, electronics, and other industries are also. Most of these laws require a full product history, with the ability to track and trace products through every level of the bill of material (BOM) and stage of the product lifecycle through to recycling. In addition, major customers often have specific requirements to which suppliers must comply. A common requirement is “information as product.” In other words, companies must ship complete information about the product and production process along with the physical product. Many companies have not yet fully mastered the practices of ensuring and documenting compliance for widely distributed operations and trading partners. Until they do, compliance can become a nightmare of paperwork and high risk.

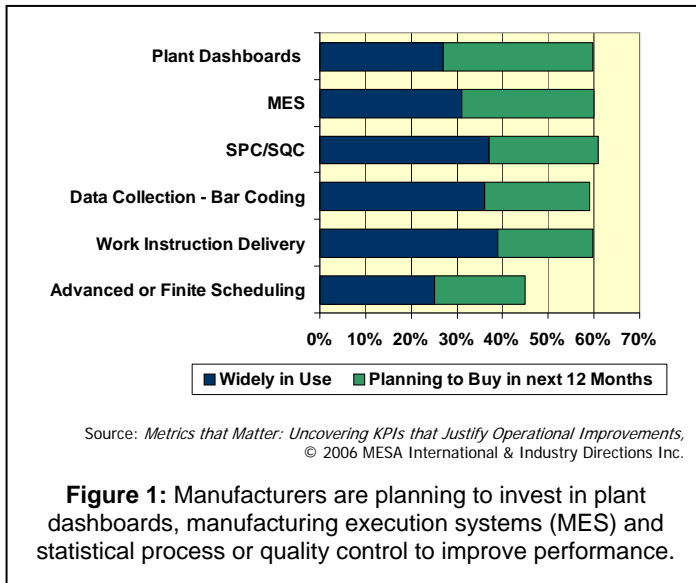
Compliance may also require special levels of security to ensure the data delivered as a product is accurate and protected. One commercial MES supplier provided an airframe manufacturer with encrypted XML messaging linking to a direct sub-assembly provider also using their software. Variable encryption processes were layered with secure FTP site user sign-on, to ensure information does not get into the wrong hands.

**Coordination:** When operations feed each other, they need to coordinate activities to stay lean and profitable. Globally distributed colleagues cannot physically have ad hoc meetings in the break room to resolve current issues. Differences of native languages, time zones, and cultures may challenge clarity and timeliness of communication. Companies are learning to collaborate with strategic partners, but non-strategic partners may be just as critical to achieving on-time orders. Few companies have strong links to these other partners.

**Visibility:** Managers in globally distributed, networked manufacturers do not have visual cues about priorities as they do in their local operations. Gaining a full and timely understanding of status and priorities is not easy in a complex production network. Yet coordination, consistency, compliance and good business decisions often rest on it.



Distributed companies cannot expect to succeed without making progress in all of these areas. Enterprise systems have helped companies gain consistency, compliance, coordination and visibility within their offices. However, many have realized that those systems don't necessarily provide the visibility and detailed oversight of production operations. Enterprise systems are not granular enough, nor designed to handle the volume and timeliness of data required to enforce good practices at operating plants.



**Figure 1:** Manufacturers are planning to invest in plant dashboards, manufacturing execution systems (MES) and statistical process or quality control to improve performance.

### MES: Production Management

Increasingly, companies are turning to manufacturing execution systems (MES) to gain the visibility and control they need over and global production operations. Recent Industry Directions studies indicate that plant intelligence and MES are the two top IT applications investments in manufacturers' current plans. (See Figure 1.) Dashboards and MES provide visibility into performance as it happens. MES also guides and tracks operational processes to better ensure employees follow best practices.

So what is MES? It is a plantwide information system that collects data from all steps of

production to create full product histories for the information component of product shipments. It also uses displays and workflow to guide operators through tasks to ensure first-time right quality. MES manages data from throughout the plant, including data from controls, machines, employees, and automated data collection, and delivers it to stakeholders as useful production information.

*One of our studies showed that companies using MES were able to increase profitability at four times the rate of their peers not using this plantwide software.*

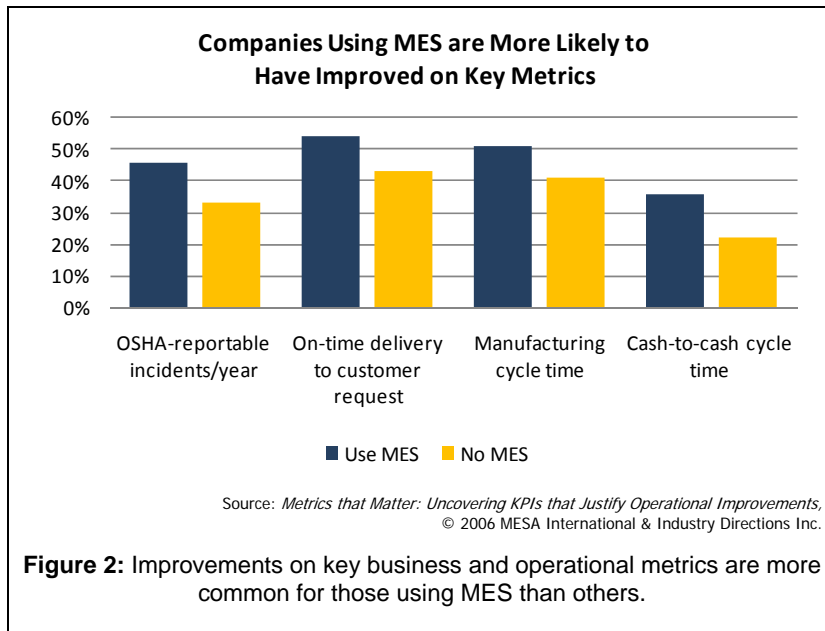
MES provides two-way integration with engineering and product lifecycle management (PLM) systems to ensure that engineering change requests can move instantly between the plant floor and the design groups. If engineering changes are not implemented at the right moment across all stages of production, when products go through final testing, product often include obsolete components, software or firmware. MES can prevent the costly rework and shipment delays that result. In fact, one company used MES data to evaluate why it was creating so many engineering change orders (ECOs) and led it to a cost-saving postponement strategy.

MES also integrates with enterprise resource planning (ERP) systems to manage orders and trigger supply chain activities. With MES in place, the plant becomes a more effective and transparent link in the supply chain, delivering up-to-the minute status not only of production activities, but also of the plant's receiving and shipping.

Industry Directions and others have conducted research that shows significant benefits for those using MES. An AMR Research study showed positive ROI in a year and an order of magnitude ROI



annually once the systems are fully integrated with others and become part of a larger strategy. One of our studies showed that companies using MES were able to increase profitability at four times the rate of their peers not using this plantwide software. That study, *MESA Metrics that Matter*, shows that companies using MES are more likely to have improved on a range of operational and financial metrics (see Figure 2.)



The financial gains likely came because companies using MES were more likely to have improved in operational areas that support business strategy. Companies using MES generally find improvements in productivity, process reliability, and employee ability to respond to changing conditions effectively and keep production flowing. Some specific areas of faster improvement by those using MES were upside production flexibility, planned vs. emergency maintenance, inventory levels and first-pass yield.

A previous Industry Directions Inc. paper, *Accelerate Business*

*Performance Gains with Manufacturing Execution Systems*, explains in more detail how MES boosts performance. It outlines mechanisms by which MES improves quality, customer service, throughput, asset utilization, compliance, flexibility, inventory, lean, six sigma, and innovation.

While many companies in the past implemented MES as a one-plant strategy, the first plant is now increasingly viewed as a pilot for a larger roll-out. Now that benefits are proven, many companies are viewing MES as an enterprise-wide system. Broad implementation means all plants can leverage each others' best practices and management knows where to focus attention as they spot challenges and opportunities across all or in any one of their operations.

MES is now playing a more significant global role in two types of operations:

- Multi-site production
- Supply chain operations with partners

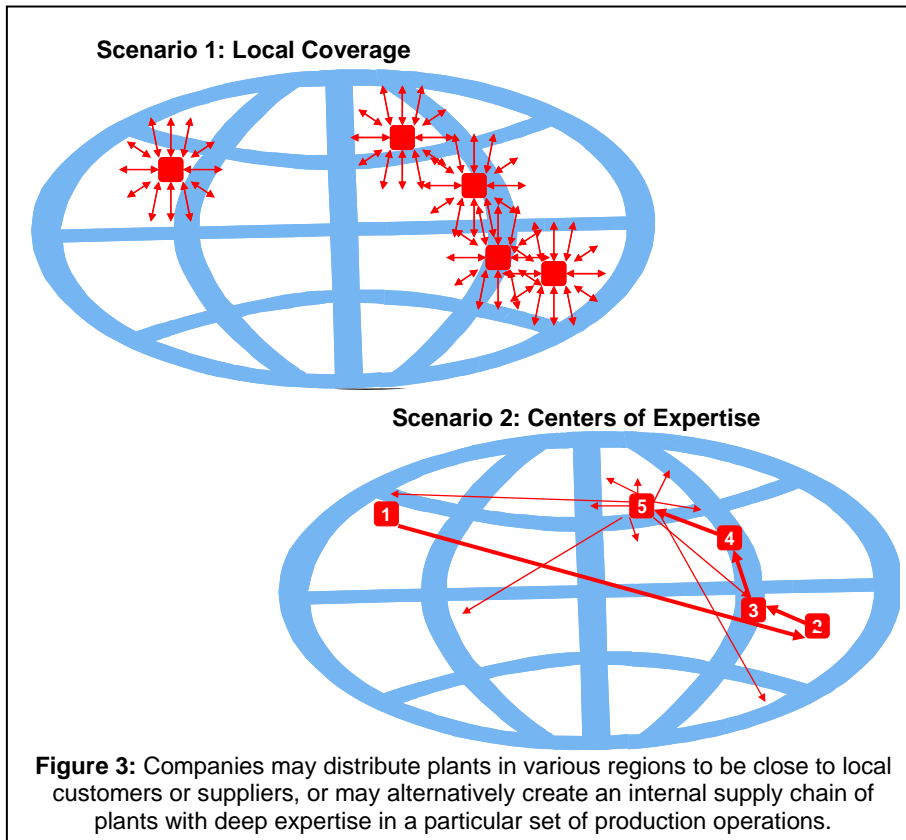
We will discuss both of these situations, as most major manufacturers have multiple internal and externally-owned production activities. Today's MES can support operations wherever they are in the world.



## Managing Multi-Site Production

Most manufacturers have distributed operations in multiple geographies today. For many companies, this is a core aspect of their globalization. To serve global markets and to have a strong presence, companies are not just selling and distributing, but also producing at multiple sites in various geographies.

There are a few main strategies for how these many sites work together. Depending on the situation, geographically distributed sites may be situated to be close to customers or close to



sources of supply, becoming a source of required “local content.” Alternatively, each site may be designated as a specialized center of excellence, gaining a deep competence in certain stages of production. (See Figure 3.)

By using MES fully and effectively integrating information across all sites, companies may benefit more fully from any of these strategies. Some of the core capabilities companies may want to leverage as they plan for a global MES investment and roll-out include:

- standardizing on best practices
- streamlining and ensuring effective site-to-site transfer
- creating common performance metrics that are measured and calculated to be truly comparable.

**Standardize on Best Practices:** One of the largest challenges most companies face in achieving operational excellence is ensuring that the manufacturing processes are truly standard and repeated. As plants gather data, they can also begin to correlate processing conditions to product quality and consistency. These become best practices, and can be incorporated into work instructions and other expectations that the system will have for the process. In many cases, the

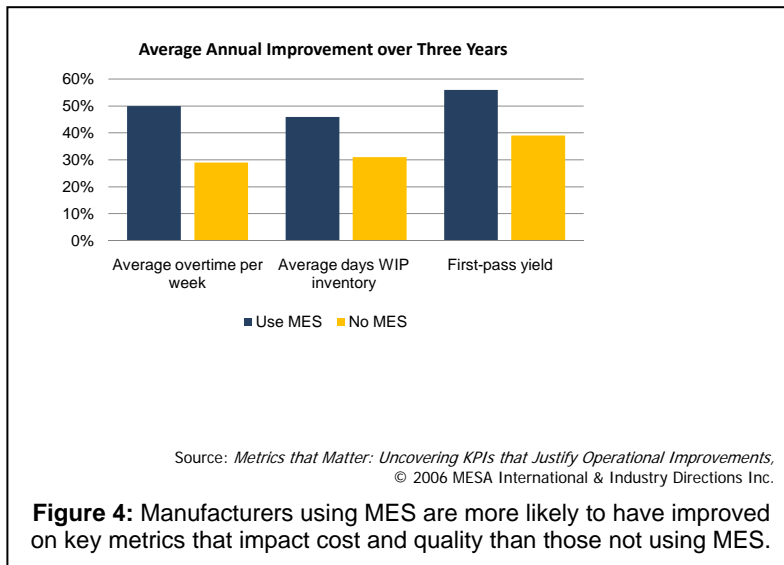


MES can disallow further work on a product if the process is not followed or signed off on as required.

*Our research shows that companies using MES are more likely to have improved on operational as well as financial metrics.*

**Transfer from Site to Site:** The ability for the system to treat multiple plants as part of the same product routing and production process can be critical, particularly when sites are specialized and act as suppliers and customers to each other. Some of today’s best MES products include specific functions to move full product history and status with the product from one plant to another. This is, in effect, the multi-production site stages of a supply chain.

**Meet Performance Targets:** Every manufacturing operation is measured in areas such as productivity, throughput, and quality. Our research shows that companies using MES are more likely to have improved on operational as well as financial metrics. Figure 4 shows just three examples of areas where companies using MES were more likely to have improved by at least 1% per year-over-three years than others.



These organizations reduced costs of overtime, work-in-process (WIP) inventory, and improved process reliability to put out products that meet specifications with no rework or first-pass yield.

Ensuring that the data by which a company measures performance is accurate and timely can prove a challenge. In multi-site environments, there is often competition on performance; so ensuring that metrics are equivalent is important. This is particularly true in situations where the sites are distributed to better serve local markets with the

same products. Clear performance measurements are also critical in site-to-site transfer situations, where one plant is measuring the other as a specialized supplier. The enterprise MES strategy serves all of these purposes well, by creating a single repository for not only the data, but the practices and processes by which they are measured and by which those results are accomplished.

One major electronics contract manufacturer uses a homegrown plant system in Asia and has standardized on a commercial MES package everywhere else in the world. In Asia, it manufactures product for Asian shipments as well lower level assemblies in Asia for products assembled, tested and shipped worldwide This company uses its commercial MES to integrate all of the product data from the two disparate databases to ship full serialized product genealogy and production history with every product shipped anywhere in the world.

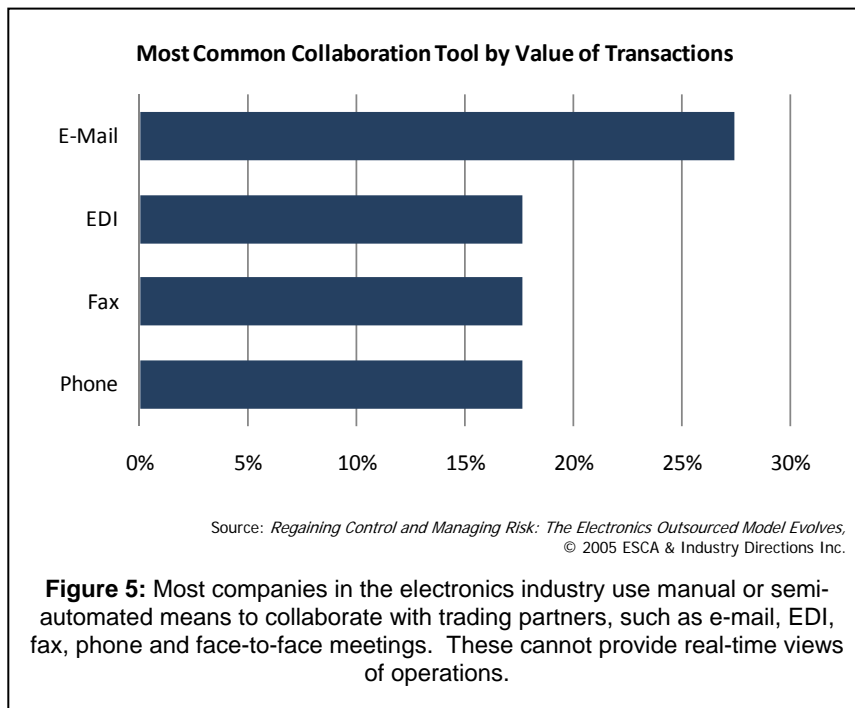


## Managing Supply Chain Operations

Today's networked manufacturing operation is generally far broader than an enterprise, often with many suppliers of goods and services involved. This multi-company coalition or supply chain operation may be for just one product or contract or common to many. Either way, everyone participating must collaborate effectively to have a better outcome than a single vertically-integrated company. While the original equipment manufacturer (OEM), prime contractor, or company whose brand ends up on the product generally coordinates much of this, every player needs to be able to communicate and provide visibility.

**Product History:** One of the most obvious challenges for many manufacturers in this environment is ensuring compliance and creating a full product genealogy for every item. Governments and customers now require that a product history allow precise tracking of every component in a product. To get beyond vendor lot codes and to serial number tracking of every specific procured and produced item, companies need MES ready to receive, store, and process both internal and external data to create a detailed product history.

**Integrating with Suppliers:** Companies need a firm grasp of what suppliers are doing and what the



status of their operations are, just as they need that view for their own plants. Our previous research shows that most companies use very rudimentary means to communicate with suppliers, even their strategic partners. Even in electronics, where outsourcing has been in place for many years, this is the case, as shown in Figure 5. At best, EDI provides only order, not operations, data. This is a critical missing link that companies must resolve not only to operate efficiently, but to ensure compliance with regulations worldwide.

One medical devices manufacturer found they could work with an electronic contract manufacturer

supplying them boards very easily, since they both use the same commercial MES. The medical devices company can not only track and trace serialized components, but also better troubleshoot product quality. The MES actually shows how many non-conformances were logged against the sub-assembly and how long each component has been under power, how many power cycles it's been through, and what rework loops the supplier performed.



**Visibility into Partner Operations:** As a result of these poor communication mechanisms, companies rarely have good visibility into even the most critical of supplier or outsourced operations. This is starting to change as more and more companies in each value network use MES in their production facilities. If partners use the same MES, the visibility can be made relatively seamless with multiple companies' facilities appearing in the same production model. Even if partners don't use the same MES, but each has a plantwide information system, outsourcing suppliers can provide customers with a full view of current status of materials, resources, and orders. Putting it in a standardized data format can further streamline partner collaboration. Companies are finding it easier to win business if they can deliver this real-time status information cleanly and easily to customers.

**Triggering Supply Chain from Plant Activities:** With MES, companies have detailed visibility into their trading partners' activities and production status which they can use not only for production planning and scheduling, but for other supply chain operations. Procurement is a good example.

*MES has transcended its beginnings as a plant-level or even an enterprise-wide system. It can now play a crucial role in creating effective supply chain operations.*

Often the OEM owns materials and/or relationships with lower-level suppliers, distributors and customers. Full transparency to outsourced production or first-level partners can deliver the ability for that supply chain master company to initiate materials orders, transportation pick-up and drop-off times, and to set logistics or processing partners' expectations far more accurately than most companies can today.

A high tech company uses MES to send orders directly to a contractor's plant. A medical devices company uses MES to replenish a custom ASIC it procures itself. With visibility into the contract manufacturers' operation, the OEM can trigger timely replenishment of the custom chip to the supplier.

So MES has transcended its beginnings as a plant-level or even an enterprise-wide system. It can now play a crucial role in creating effective supply chain operations. Suppliers and outsource partners can all stay synchronized with the OEM and, in some cases, with each other.

## MES Requirements for Global Use

Companies seeking to create or be an effective part of a global supply chain need sound information systems and a viable approach to sharing information. One common approach is for the OEM to create content requirements for the information that contractors must provide with every shipment of products or materials. To gain even better visibility, some powerful OEMs are now pushing all of their key suppliers and outsource partners to use the same MES platform.

MES in a multi-site, multi-partner supply chain operation has some critical requirements (see Figure 6). In theory, any MES can provide consistent availability and views of data from any plant anywhere owned by any partner in the network. In practice, there are certain attributes that make a software solution best suited for this type of environment.



Business Needs	MES characteristic
Management decisions Coordination of operations Synchronization of plants & other groups	Real-time multi-site visibility in a single management console
Specialized plants Smooth integration with partners Full in-plant troubleshooting	Capability to transfer work from one plant to another
Need to use materials customers want Use best available supplied parts Improve product quality & performance Increase manufacturing reliability	Two-way communication & enforcement of engineering changes
Prevent product problems Keep production costs low	Integrated Execution & Quality
Smooth information flow with process Need to work with partners' systems	Data mapping & dictionary linking

**Figure 6:** For MES to truly support global supply chain operations, it needs certain characteristics to streamline the integration and visibility between partners.

**Console View of Network:** One capability that helps manage a complex networked operation is visibility into multiple sites in real time from a single management console. This allows a coherent view for decision-makers and tacticians alike. This can be important in any global environment as a means to coordinate and synchronize activities in plants with the design, sales order management, customer service, and logistics operations.

**Site-to-Site Transfer:** The ability to enable a smooth hand-off of information from one site to the next is fundamental to global MES success. This capability is particularly critical for operations where sites are specialized centers of excellence and serve each other in supplier-customer relationships. Even in other instances, this capability allows

companies and trading partners to work together more effectively. Ensuring every player in the production process knows everything relevant that occurred in earlier operations is a key to good quality and low warranty liability risk, as well as rapid and effective new product introduction.

**Engineering Change Management:** Most discrete manufacturing operations deal with many changes in the engineering specifications of products, subassemblies, and materials. These can be driven by customers, supplier changes, or the production operation itself. So engineering change management is a multi-directional flow of information into and out of the plants and other departments including engineering, procurement, customer-facing sales or service, and others. While product lifecycle management may own the core process, the MES must be adept at handling and tracking requests as they go out from plants and changes as they come back. Engineering changes often have very specific effectivity dates or trigger conditions, which an MES can build into the workflow and enable changes automatically.

**Quality Integrated with Execution:** Since quality at every stage and in every component is so critical to the usability of the final products, the ideal scenario is to have quality management capabilities integrated with the MES. This allows a much more effective closed-loop system than having those two systems separate. Quality system alerts can go directly to the operators using MES, and corrective actions can be built into the MES workflow and enforced. As the MES encounters difficulties, it can trigger the quality system's non-conformance and corrective actions capabilities. In a complex multi-site, multi-company environment, this saves invaluable time.



**Linking Data Dictionaries:** In most complex supply chain scenarios, there will be more than one MES system involved. In this case, all MES products involved must also provide clear access to the data dictionary to map terminology and models from one system into another effectively. Each software solution may work differently, and the configuration for each plant is almost certain to be unique. So administrators must link the systems' data dictionaries to create smooth information flow.

## Leveraging MES in Global Supply Chains

Clearly, MES can play a significant role in companies' ability to succeed with their globalization and outsourcing strategies. It can increase consistency, compliance, coordination and visibility across all of the sites and trading partners involved in today's networked environment. Leaders across many industries are beginning to gain these capabilities today as they roll out MES across their network.

However, there are further opportunities that few companies have imagined. Having this detailed operational visibility across an entire network opens new opportunities for both tactical and strategic decision-making. While business intelligence is taking hold to leverage information from supply chain and enterprise systems, operations intelligence becomes part of this picture with a global MES implementation.

**Tactical Decisions:** While companies are using MES to understand production status more precisely, there are other ways that companies can further leverage it going forward. Global MES with a single console can help answer questions such as:

- Where is inventory at a given point in time? Do we need to re-order certain materials? Are there problems with a lot of material from a particular supplier that we should address?
- How far through the process are materials in each facility or supplier? Are we likely to meet each planned shipment from one plant to another? Can the customer still change their order without extra cost?
- How soon could we complete a new order coming in based on capacity at each facility and each supply level? Do we collectively have the capacity to promise order delivery when the customer wants it? What other orders might be delayed and if we take on a rush order?

**Strategic Decisions:** In addition to these types of day-to-day decisions, companies can benefit from detailed global MES data to support longer-term business decisions such as:

- Where to make various products? Where to make a new products based on production capabilities? Where do we have capacity to increase output?
- Which suppliers are best supporting our global sourcing needs for quality? Who is shipping us good quality or poor quality products – as judged by their track record through all plants in the network? What have the non-conformances been in every level of a product line's BOM?



- Do we have on-time shipment problems? Are certain facilities shipping on time but due to their location not achieving good on-time receipt? Are goods being delayed or damaged in transit?
- Are our engineering specifications working to enable good throughput for us and our suppliers? Can we maintain reliable product quality? What engineering changes might improve profitability?
- What are our total production costs? Do our anticipated costs match up with reality in production across the network? If not, where are the problems occurring and how can we improve that record?
- What contract terms are effective for various partners and types of partners? How high a service level can we expect? Did we set expectations effectively so that when problems arose we could resolve them?
- Did changes ripple through the supply network rapidly and effectively? Where did the communication break down? How do we manage change to gain larger strategic benefits?

*MES can enable companies to move closer to a global demand-driven environment. Partners can promise orders more realistically through production visibility. Every level of supply and production can pull from the previous supply level as they use materials.*

In fact, MES information can enable companies to move closer to a global demand-driven environment. The partners taking in the demand signals can promise orders more realistically through production visibility. Every level of supply and production can pull from the previous supply level as they use materials. Suppliers can communicate any issues instantly to buyers so they can avoid deeper problems that impact end customers.

No single information system can eliminate problems from complex global companies and their network of partners. However, global MES implementations can support the infrastructure for enterprise activities and for management decision-making with real-time, accurate, and detailed views of actual production operations.

Global networks are a fact, and they are not likely to become simpler. So global MES to manage the massive amount of detailed information and provide appropriate visibility becomes a lynchpin to effective manufacturing supply chains. Disconnected or piecemeal systems relying on people to send e-mail, fax or EDI messages will not be adequate.

Leaders have already begun their global MES rollouts. They are gaining some of the benefits as their partners also become enabled with this level of plant data. Over time, further leverage will come from better support for decisions at all levels, capable of keeping up with constant change throughout the world. No company can afford to be left behind in this new global network-wide MES empowerment play.



## About Cambashi

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