

July, 2009

## High Efficiency in Manufacturing Operations

It can be very challenging, even for Best-in-Class manufacturers, to both drive efficiency gains and then translate these gains to bottom line results. In this Analyst Insight, Aberdeen will examine what is driving manufacturers to focus on creating more efficient manufacturing operations and which manufacturers are most successful in achieving these efficiency gains. The analysis will then continue with identifying the mix of strategies, business capabilities, and technology enablers that are most likely to ensure long term success; ending with specific and actionable recommendations to achieve more efficient manufacturing operations.

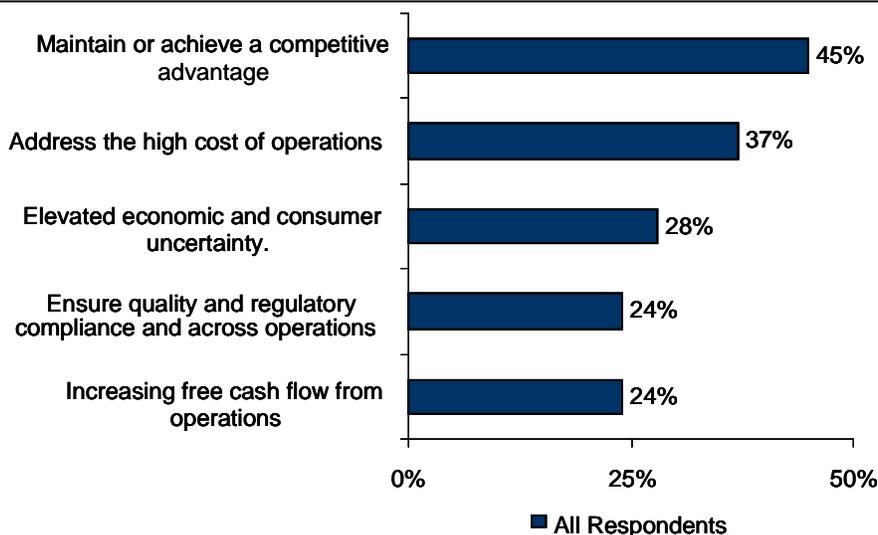
### Analyst Insight

Aberdeen's Insights provide the analyst perspective of the research as drawn from an aggregated view of the research surveys, interviews, and data analysis

## Achieving a Competitive Advantage

In Aberdeen's May 2008 benchmark report, *A Platform Approach to Manufacturing Operations Management*, it was shown that there are a number of different reasons executives are focusing on manufacturing operations. First, the top pressure driving these executives is to achieve a competitive advantage. At first, this may be surprising given the current state of the economy but many executives do believe that the bottom is nearing and are beginning to lay the plans for gaining market share in the recovery. Second, addressing the high cost of operations is also top of mind for many executives. Clearly, reducing manufacturing costs can have a direct and immediate impact on corporate margins and much of this research will be focused on how to achieve these cost savings.

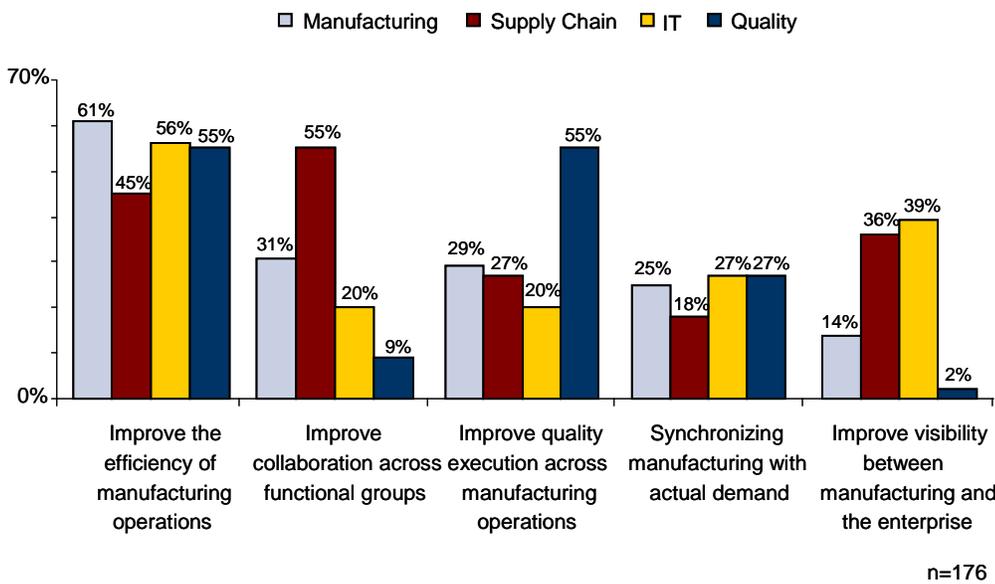
**Figure 1: Pressures Driving Focus on MOM**



Source: Aberdeen Group, July 2009

To address these pressures, there are a number of different strategies being deployed; all of which are highlighted below in Figure 2. Not surprisingly, when the strategic actions being taken are analyzed by role in the organization, achieving efficiency in manufacturing operations bubbles to the top for every role. Essentially, all stakeholders in the organization agree that driving efficiency will drive long term value and should be a cornerstone of the overall agenda. However, beyond achieving efficiency we see that different roles in the organization have different priorities; all of which generally align to the charters of each department. This in turn implies that at a high level, the overall organization has to understand how to deploy multiple strategies, in synch with each other, across the organization.

**Figure 2: Strategic Initiatives by Role in the Organization**



Source: Aberdeen Group, July 2009

To dive into a little more detail, clearly the majority of Supply Chain stakeholders would like to foster more collaboration across disparate groups and the overall design-make-deliver business processes. Similarly, the majority of Quality stakeholders have the strategic initiatives to improve quality execution from development to delivery. In regards to enterprise visibility, both Supply Chain and IT stakeholders are considerably more likely than other stakeholders to have this as a strategic initiative. Finally, across all roles, approximately 25% of the overall market place is currently focusing on value stream transformation at the strategic level by synchronizing real-time demand with manufacturing operations.

There are obvious synergies between these strategies; as well as a core set of KPIs that should be measured to identify how effectively these synergies are being captured to drive value for the organization. In the following section we will identify these metrics as well as provide benchmark analysis showing the overall market brake down of performance across these

metrics. Which will leave us with the following question: Which specific manufacturers are most successfully deploying these strategies and what business capabilities and strategic enablers can be attributed to these successes?

## The Maturity Class Framework

To identify which manufacturers are most successful in deploying their strategic objectives, Aberdeen uses three key performance criteria to distinguish the Best-in-Class from Industry Average and Laggard organizations.

- **On-Time and Complete Shipments** – Products delivered on time and complete as compared to total original commitment
- **Overall Equipment Effectiveness (OEE)** – Composite metric accounting for availability, performance, and quality
- **Production Compliance** – Measured as a percentage of products produced that were in compliance to relevant processes regulations (documentation, ISO, GMP, et cetera) vs. total products produced

Respondents have been divided among three categories based on their aggregate performances in these three metrics: Table I displays the average performance of Best-in-Class, Industry Average, and Laggard organizations. The remainder of the analysis will be based on identifying gaps between the Best-in-Class and those organizations that are underperforming. This approach also gives readers an opportunity to benchmark their own performance against industry standards

**Table I: Top Performers Earn Best-in-Class Status**

Definition of Maturity Class	Mean Class Performance
<b>Best-in-Class:</b> Top 20% of aggregate performance scorers	<ul style="list-style-type: none"> <li>▪ 92% OEE (Overall Equipment Efficiency)</li> <li>▪ 97% On-Time and Complete Shipments</li> <li>▪ 99% Production Compliance</li> </ul>
<b>Industry Average:</b> Middle 50% of aggregate performance scorers	<ul style="list-style-type: none"> <li>▪ 81% OEE (Overall Equipment Efficiency)</li> <li>▪ 94% On-Time and Complete Shipments</li> <li>▪ 95% Production Compliance</li> </ul>
<b>Laggard:</b> Bottom 30% of aggregate performance scorers	<ul style="list-style-type: none"> <li>▪ 71% OEE (Overall Equipment Efficiency)</li> <li>▪ 84% On-Time and Complete Shipments</li> <li>▪ 82% Production Compliance</li> </ul>

Source: Aberdeen Group, July 2009

## Supporting Strategic Initiatives

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In this section each of the major strategic initiatives identified above will be analyzed through the lens of the Best-in-Class. The analysis will highlight the diverse set of business capabilities, including process, organizational, knowledge management, and performance management capabilities, the Best-in-Class are bringing to bear in achieving success.

### **Efficient Manufacturing Operations**

Achieving efficient manufacturing operations is arguably the most important of all the strategic initiatives discussed and subsequently our analysis starts right with executive focus. Aberdeen sees that organizations which treat manufacturing operations as a competitive weapon are much more likely to achieve Best-in-Class performance. This point goes straight to the soul of an organization and the research shows that organizations lacking this focus will continue to flounder with Industry Average and Laggard performance. As organizations consider focusing on efficient manufacturing operations, these organizations should seriously question their core competency in manufacturing; with an outsourcing model such as Cisco or Apple uses as a realistic option for those not truly ready to make the commitment.

For those organizations with executive focus on manufacturing operations, this can positively impact the efficiency of manufacturing operations in a number of ways. First and foremost, the Best-in-Class are successfully rolling out best practices across the organizations and then updating these SOPs as new best practices emerge. Second the Best-in-Class are more likely to standardize optimization procedures across the organization, which can take many forms. For instance, the Best-in-Class are more likely to be able to standardize the way WIP inventory is optimized from plant to plant, or are more likely to optimize the way cad/cam visualization is delivered to the shop floor in assistance with work instructions to improve workforce productivity and creating a true visual management environment. Finally, the Best-in-Class are more likely to be able to link financial and operational metrics, which to a large degree improves the sustainability of these initiatives. If shop floor personnel have no visibility into how their efficiency gains impact the organization any gains will be short lived. By tying the shop floor to the enterprise, efficiency gains are more likely to be sustained.

To bring all of the above capabilities together in a cohesive way many Best-in-Class manufacturers overlay a high level initiative around Lean or Operational Excellence. This allows the organization to talk a common language across plants and effectively communicate the strategic direction to all levels of the organization. When embarking on one of these initiatives it is crucial to maintain focus, we see the most successful initiatives lasting well over 5 years and are generally supported with knowledge centers and centers of excellence. Finally, organizations that truly engrain these initiatives and a core competency in manufacturing eventually institutionalize these capabilities, there is no better example than Toyota and the Toyota Way but others have also been successful in such initiatives like Motorola, DuPont, Danaher, GE, and others.

Endicott Interconnect Technologies, Inc. has had many successful years utilizing SAP together with internally developed data collection and reporting systems. We began using SAP Manufacturing Execution solution approximately two and a half years ago, when one of our largest customers requested that we start using the program to provide component traceability and real time visibility into process quality. To address this request, we focused on implementing complete shop floor control capabilities, as well as machine integration through SAP Manufacturing Execution solution and enterprise integration through SAP Manufacturing Integration and Intelligence solution for this customer's products.

We believe extending the use of this initiative will help our manufacturing organization mature and are now extending the rollout to the entire business unit. We plan to focus on improving operational efficiencies by creating role based reports and analytics through SAP Manufacturing Integration and Intelligence solution. We also plan to improve our integration between SAP Manufacturing Execution solution and SAP's ERP (Production Planning), including the creation of bi-directional visibility between the supply chain and manufacturing, ultimately helping our drive towards a true make-to-order production system.

~David Kennedy  
SAP Manufacturing Execution &  
Manufacturing Integration and  
Intelligence Analyst  
Endicott Interconnect Technologies,  
Inc.

**Table 2: Supporting Efficient Manufacturing Operations**

	Best-in-Class	Industry Average	Laggard
<b>Business Capabilities</b>	Executive sponsorship for initiatives on improving manufacturing operations		
	91%	75%	65%
	Manufacturing business processes are dynamically updated as new best practices emerge		
	50%	32%	25%
	Standardize processes across the enterprise for optimizing manufacturing operations		
	64%	37%	30%
	Operational metrics are linked to financial metrics		
	68%	60%	51%

Source: Aberdeen Group, July 2009

**Effective Collaboration**

Effective collaboration is top on the Supply Chain Executive's strategic agenda as they strive to optimize overall supply chain processes. To achieve this collaboration Aberdeen sees the Best-in-Class taking a two pronged approach, neither of which are new in theory but both of which are often overlooked in practice. First, Best-in-Class manufacturers are more likely to engage with System Integrators at the senior level and leverage this relationship to assist in the design and deployment in manufacturing systems, which in turn goes a long way in enabling these systems to support more than just core production functionality and extend into adjacent processes, ultimately helping to foster collaboration. Second, the Best-in-Class have focused on Continuous Improvement teams and more likely to have deployed these teams in a cross-functional way and are also more likely to enable the collaboration of these teams across disparate geographies. The connection between these capabilities and collaboration is immediately clear but it is very surprising how often organizations overlook such important areas of the business.

**Table 3: Enabling Effective Collaboration**

	Best-in-Class	Industry Average	Laggard
<b>Business Capabilities</b>	System Integrator engage at the executive level		
	50%	32%	20%
	System Integrators are viewed as strategic partners in the design and deployment of manufacturing systems		
	50%	30%	36%

	Best-in-Class	Industry Average	Laggard
	Cross Function Continuous Improvement teams are focused on improving manufacturing operations.		
	75%	73%	53%
	Cross Function Continuous Improvement teams collaborate across geographies		
	77%	54%	32%

Source: Aberdeen Group, July 2009

### Improve Enterprise Quality Execution

Quality is a large topic and we are not doing full justice to it in this section but within the context of this research there are some key business capabilities that the Best-in-Class leverage to achieve flawless quality execution. First quality is about process enforcement, controlling the way in which people and processes behave and ensuring these behaviors ensure a quality product and quality processes. The second and probably more important area of quality execution is ensuring that variability and non-conformance to standard is dealt with in a way that ensures the integrity of the product and process. To ensure this integrity, Best-in-Class manufacturers are more likely than the Industry Average and Laggards to automate these non-conformance workflows and the way in which the occurrence of such events is communicated with stake holders. This approach is critical to and has far reaching consequences in the organization from customer satisfaction and warranty management, to compliance and traceability, all of which can impact an organization at the very highest level.

**Table 4: Enterprise Quality Execution**

	Best-in-Class	Industry Average	Laggard
<b>Business Capabilities</b>	Automated work flows to manage manufacturing non-conformance and non-compliance across the enterprise		
	50%	32%	17%
	Adverse events are monitored and escalated in real time to decision makers.		
	68%	54%	27%

Source: Aberdeen Group, July 2009

### Synchronize Supply and Demand

Synchronizing supply and demand is not a strategic initiative that bubbled to the top for any one job role but was consistent across every job role at about 25% and for this reason it deserves serious consideration. Furthermore, as the consumer continues to remain fickle and as more

industries begin to focus on Lean that traditionally have not; successfully becoming demand driven will become more and more critical for more and more organizations.

In accomplishing this synchronization we again see a two fold approach, where the Best-in-Class are more likely than the Industry Average and Laggards to both become a demand driven organization as well as provide both upstream and downstream visibility. Both of these capabilities are vitally important to achieving supply and demand synchronization; because as WIP inventories are reduced, reaction time to adverse events often becomes the determining factor in the ability to deliver against commitments. Furthermore, up and downstream visibility is often the most effective way to improve this reaction time.

**Table 5: Synchronizing Supply and Demand**

	<b>Best-in-Class</b>	<b>Industry Average</b>	<b>Laggard</b>
<b>Business Capabilities</b>	Demand Driven Supply Chain, inventory pulled from one stage to the next based on real time demand		
	50%	32%	25%
	Ability to manufacture products based on demand from the next stage in the supply chain		
	50%	32%	17%
	Real-time visibility between manufacturing operations and customer orders		
	73%	49%	35%
	Real-time visibility from manufacturing operations into supplier performance		
68%	32%	3%	

Source: Aberdeen Group, July 2009

### **Bi-Directional Visibility**

It may be surprising to many that creating bi-directional visibility between operations and executives was not only a top strategic initiative for the Supply Chain but also IT; which goes a long way to demonstrating that for many organizations the top charter from executives to IT is the creation of such visibility.

In creating bi-directional visibility, it is important for organizations to focus on creating executive visibility. In less mature organizations, it is often accessible to both manufacturing personnel and executives to initiate an "executive flash" report or other such preconfigured backward looking reports. However, this is not what should be considered bi-directional visibility and the Best-in-Class are moving quickly beyond static reporting to real-time executive visibility that is integrated with the shop floor. The Best-in-Class are also coupling this real-time visibility with analytical capabilities,

all of which is enabled by a collaborative approach to the deployment of these systems between many of the stakeholders discussed in this analysis.

**Table 6: Real Time Bi-Directional Visibility**

	Best-in-Class	Industry Average	Laggard
<b>Business Capabilities</b>	Executives have real-time visibility into the performance of global manufacturing operations.		
	64%	45%	9%
	Line of business manufacturing, engineering, and IT work collaboratively to implement manufacturing technology		
	68%	40%	37%
	KPI drill down by geography, product line, mix, etc.		
	50%	32%	18%

Source: Aberdeen Group, July 2009

## The Role of a Manufacturing Platform

The above analysis has hopefully imparted the impression that there are a broad set of strategic initiatives and supporting business capabilities that all play a role in successfully wielding manufacturing operations as a competitive weapon. In this section, Aberdeen will provide analysis showing how Best-in-Class manufacturers are transforming how they leverage enabling technologies to deliver more functionality, to more job roles, across more facilities, at a lower cost with more benefit.

First it should be stated that there is a strong correlation between the technologies a manufacturer adopts, and achieving Best-in-Class performance. The technologies that correlate to Best-in-Class performance span the ISA-95 technology stack; starting at the data and controls layer, moving up through manufacturing operations with MES or MOM, and ending with enterprise applications focused on interdependent functional areas including engineering and distribution.

Such a technology strategy complements all the strategic actions discussed above by connecting manufacturing to the rest of the enterprise and through our remaining analysis, it will be shown that these strategic actions and business capabilities are best supported by a holistic approach to manufacturing operations management. The following section will discuss in more detail the functionalities this technology stack provides, specifically how they best can be used, best practices for deploying this solution, and benchmark data for the specific benefits that can be expected.

**Table 7: Technology Enablers**

	Best-in-Class	Industry Average	Laggard
<b>Technology</b>	MOM* (Manufacturing Operations Management)		
	58%	26%	25%
	QMS (Quality Management System)		
	79%	69%	56%
	ERP (Enterprise Resource Planning)		
	81%	81%	62%
	SCM (Supply Chain Management)		
	55%	40%	31%
EMI (Enterprise Manufacturing Intelligence)			
25%	6%	6%	

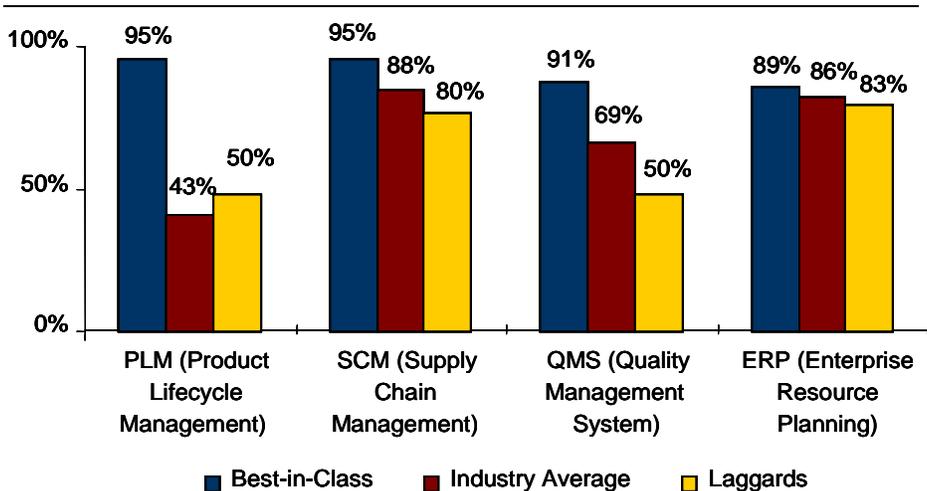
Source: Aberdeen Group, July 2009

\* Survey respondents using what they understand to be a MES (Manufacturing Execution System) were instructed to choose MOM (Manufacturing Operations Management). Aberdeen has chosen to make this distinction because of the broad range of understanding in the market place over what is considered MES. In this report Aberdeen will be using the term MOM to include MES systems along with all other systems designed to control and optimize production at the execution level. EMI will still be analyzed separate from MOM and includes systems designed to aggregate data, abstract data, analyze data, and ultimately deliver data as contextualized intelligence to decision makers in a role-based way.

**Integrated Operations for Higher Efficiency and Visibility**

To start this analysis we will begin by examining how organizations are interoperating across the technology stack described in the previous section. First and most importantly Best-in-Class manufacturers are more likely than both the Industry Average and Laggards to be investing in real-time interoperability across the technologies they have adopted. This allows the Best-in-Class to more easily create real-time visibility and automated workflows to manage manufacturing operations and connect manufacturing operations to the supply chain. It also helps Best-in-Class manufacturers deliver the entire range of functionalities needed on the shop floor that generally spans engineering, manufacturing, quality, and logistics.

**Figure 3: Real-Time Interoperability with MOM**



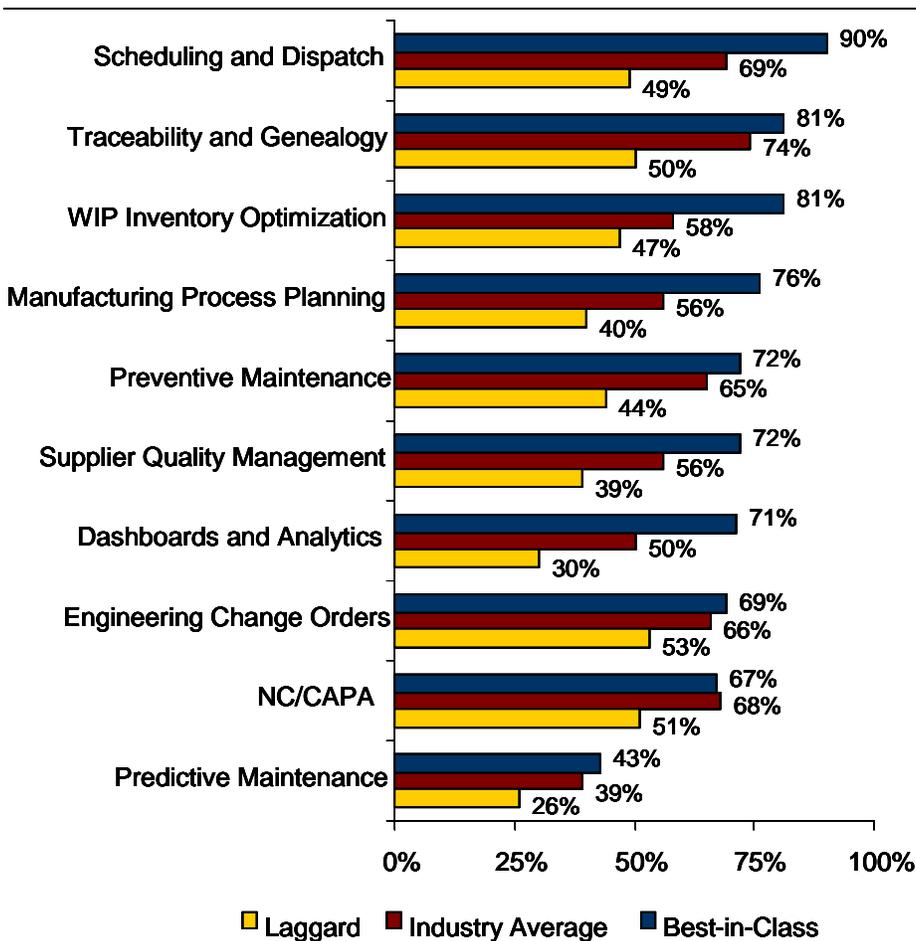
Source: Aberdeen Group, July 2009

Another point worth mentioning is PLM and MOM interoperability. In the previous section, PLM was noticeably absent but this should not be a surprise given the KPIs used for the Maturity Class Framework were not the traditional areas of strength for PLM. However, PLM does play a critical role in how well it enables manufacturing and vice versa. Clearly, the Best-in-Class are enjoying better performance, which is in no small part due to increased collaboration and a closed feedback loop between design and manufacturing. Finally, before moving on, interoperating with QMS and SCM can't be ignored. Ensuring quality and effective distribution are critical to the success of any manufacturing organizations and bringing manufacturing operations into these workflows will help to improving these areas of the business. Furthermore, in the next section we will see how quality and distribution functionalities are key enablers of Best-in-Class performance.

### Drill Down on Functionality

In general, the technology enablers that are more likely to be used by the Best-in-Class are broad based and extend beyond a production focus.

**Figure 4: MOM Functionality**



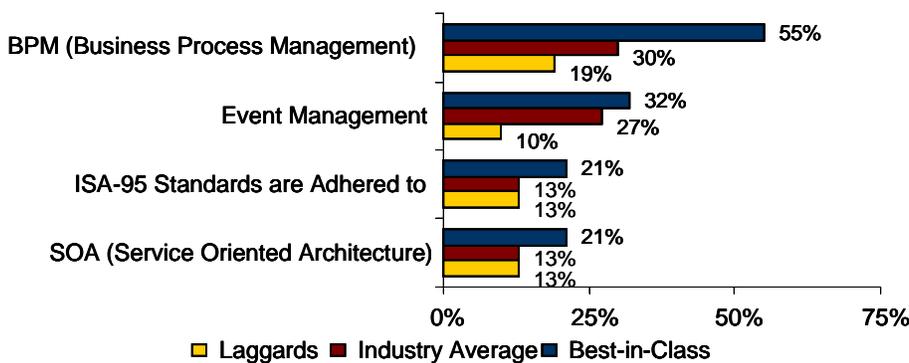
Source: Aberdeen Group, July 2009

When the set of functionalities shown in Figure 3 is looked at holistically it turns out that it spans all aspects of manufacturing operations, including: maintenance, production, quality, and inventory. Furthermore, it also extends out beyond manufacturing operations to begin synchronizing manufacturing operations with the supplier network and helping to close the loop between design and manufacturing; further highlighting the need for interoperability between enterprise applications like SCM, PLM, QMS, ERP, and MOM.

### The Role of IT Tools and Standards

The roles real time interoperability and a broad set of functionality play in achieving Best-in-Class performance are clear. However, achieving this interoperability is no small feat. Often the road to getting there is paved with mistakes including the over use of costly professional services or an overall system architecture that ends up being inflexible when changes are needed. Again, looking to how the Best-in-Class have already travelled this road, we see they are more likely to have leveraged a number of IT tools and open standards like BPM, SOA, and ISA-95 compliance that reduce the risk of these mishaps occurring.

**Figure 5: IT and Standards Used to Support MOM**



Source: Aberdeen Group, July 2009

### Additional Benefits

Finally and perhaps most importantly, it should be noted that the Best-in-Class are enjoying success outside of the previous analysis and truly creating a competitive advantage. The previous analysis has been focused on showing the benefits Best-in-Class manufacturers are experiencing by achieving operational excellence in manufacturing. However, Table 9 shows that the Best-in-Class enjoy more; the Best-in-Class are able to translate this into success for more market facing areas like new product introductions and operating margins. In fact, this elevated performance is the reason and justification of why executives are now focusing on manufacturing operations management.

The primary pain we feel today is time to volume. We provide complex and highly engineered audio systems to consumers and automotive OEMs among others. Specific to our automotive business unit, collaborating with OEM customers and bringing the agreed upon design to volume quickly is the number one demand these customers place on us.

To address this demand, we have focused on integrating our MES solution from SAP with our PLM solution. Currently, we have fully integrated this solution in our prototyping factory and are rolling this out to our other factories across the globe. The benefit so far has been considerable reductions in time to volume and we are looking forward to continued gains as we roll out across the manufacturing network.

Director, Multi Billion Dollar  
Consumer Electronics  
Manufacturer

**Table 8: Benefits Analysis**

	Best-in-Class	Industry Average	Laggard
<b>Additional Benefits</b>	Share of NPIs hitting time, quality, and volume targets		
	91%	86%	81%
	Operating Margin		
	20%	18%	14%

Source: Aberdeen Group, July 2009

### **Summarizing a Competitive Advantage in Manufacturing Operations**

To summarize, a competitive advantage in Manufacturing Operations is achieved through more than a single software application or set of functionalities and work flows. It involves the use of IT tools and best practices, conformance to standards, interoperability across the entire manufacturing technology stack and more. Based on the how the Best-in-Class are differentiating from the Industry Average and Laggards, the following points largely characterize how the Best-in-Class achieve a competitive advantage in manufacturing operations:

- Focus on continuously improving efficiency and visibility in manufacturing operations
- Functionality that spans production, inventory, quality, and maintenance management
- Functionality that focuses on improving collaboration between product development and engineering, procurement, and distribution
- Real time interoperability between MOM and PLM, SCM, QMS, and ERP
- IT tools such as BPM, SOA, and event management are leveraged
- ISA-95 Standards are adhered to

### **Laggard Steps to Success**

- **Executives need to focus on manufacturing operations.** Organizationally, focus has to start right at the top. Executives can not fear their manufacturing operations but rather must view them as a competitive weapon. This attitude should flow through the organization and drive a collaborative environment connecting manufacturing to the rest of the organization. Best-in-Class manufacturers are 40% more likely than Laggards to have executive sponsorship of initiatives focused on improving manufacturing operations.

- **Extend manufacturing best practices across the enterprise.** This can take the form of standardized production optimization, KPI measurement, or adverse event management processes across the enterprise. Such best practices sharing is critical for gaining the full benefits of further investment in enterprise wide MOM. Best-in-Class manufacturers are twice as likely as Laggards to have extended manufacturing best practices across the enterprise.
- **Look beyond just manufacturing efficiency.** From a strategic perspective do not overlook the importance of achieving efficiencies in manufacturing but many Best-in-Class organizations have moved beyond efficiency to focus on synchronizing demand with production or collaborating across disparate groups like engineering quality, the Supply Chain, and IT. These strategies are the cornerstones of Best-in-Class organizations.

### Industry Average Steps to Success

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- **Establish an executive vision for manufacturing operations.** To help shape the enterprise vision for manufacturing operations, executives should engage with systems integrators and software vendors to help understand the design and deployment of a Manufacturing platform and how this can deliver value to the organization. Best-in-Class manufacturers are over twice as likely as Laggards to engage with System Integrators at the executive level.
- **Extend the Manufacturing platform across multiple facilities.** Leverage a collaborative approach between line of business manufacturing, engineering, quality, and corporate IT to begin standardizing multiple plants on a single Manufacturing platform, holistically managing maintenance, production, quality, and inventory. Best-in-Class manufacturers extend their Manufacturing platform across 70% more of the manufacturing facilities in their organization than the Industry Average and Laggards
- **Extend shop floor functionality beyond the traditional definition of MES.** At the functional level, focus on spanning the full suite of manufacturing operations management. Best-in-Class manufacturers differentiate by going beyond scheduling and dispatch, traceability and genealogy, and WIP optimization; Best-in-Class manufacturers also focus on advanced maintenance and quality capabilities.

### Best-in-Class Steps to Success

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- **Create real time interoperability between Manufacturing Operations and other enterprise applications.** With an enterprise-wide MOM solution in place, begin to interoperate in real-time across other enterprise applications such as PLM, SCM, QMS, and ERP. Use this interoperability to create real-time visibility and automated workflows to manage handoffs between design and

manufacturing and both quality and inventory across suppliers and customers.

- **Don't build a Manufacturing platform without a clear IT architecture established first.** To increase the flexibility of global deployments, increase time to deployment and minimize the cost of both software and services; leverage IT tools such as BPM, event management, and SOA, along with remaining compliant to open standards such as ISA 95.
- **The ultimate goal should be improving market facing deliverables.** Focus on both internal operational excellence as well as improving market facing performance like profitability and new product introduction. By achieving Best-in-Class performance in Manufacturing organizations are much more likely to achieve a competitive advantage in these regards. Best-in-Class manufacturers enjoy 12% more successful NPI's and 43% higher operating margins than Laggards.

For more information on this or other research topics, please visit [www.aberdeen.com](http://www.aberdeen.com)

Related Research	
<a href="#"><i>Global Manufacturing: MES and Beyond</i></a> ; March 2006	<a href="#"><i>There is No Execution without Integration</i></a> ; May 2007
<a href="#"><i>Manufacturing Operations Management: The Next Generation of Manufacturing System</i></a> ; January 2008	<a href="#"><i>Global Manufacturing Operations Management</i></a> ; August 2008
<a href="#"><i>A Platform Approach to Manufacturing Operations Management</i></a> ; March 2009	<a href="#"><i>Lean Manufacturing: 5 Tips for Eliminating Supply Chain Waste</i></a> ; April 2009
<p>Author: Matthew Littlefield, Sr. Research Analyst, Manufacturing Operations and Industrial Automation (<a href="mailto:matthew.littlefield@aberdeen.com">matthew.littlefield@aberdeen.com</a>)</p> <p>Mehul Shah, Research Analyst, Manufacturing Operations and Industrial Automation (<a href="mailto:mehul.shah@aberdeen.com">mehul.shah@aberdeen.com</a>)</p>	

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