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Operational Excellence in the Process Industries

Driving Performance through Real-time Visibility

September 2008

David Fonzi

Executive Summary

To achieve operational excellence, process manufacturers must be able to keep control over cost structures while meeting customer expectations. Prior Aberdeen research has shown that Best-in-Class companies provide visibility into manufacturing operations while using real-time interoperability between manufacturing systems and business systems. In this study, we will benchmark how the companies in the process industries accomplish this.

Research Benchmark

Aberdeen's Research Benchmarks provide an in-depth and comprehensive look into process, procedure, methodologies, and technologies with best practice identification and actionable recommendations

Best-in-Class Performance

Aberdeen used four key performance criteria to distinguish Best-in-Class companies. Across these metrics, Best-in-Class manufacturers averaged:

- 99% manufacturing schedule compliance
- 99% perfect orders
- 97% overall yield
- 94% Overall Equipment Efficiency (OEE)

Competitive Maturity Assessment

Survey results show that the firms enjoying Best-in-Class performance shared several common characteristics:

- Best-in-Class process manufacturing executives are more than two-times as likely to have real-time visibility into manufacturing operations as Laggards
- Best-in-Class process manufacturers are 63% more likely to have role based visibility in all levels of the organization in the case of an adverse event than Laggards
- Best-in-Class process manufacturers are five-times as likely to integrate product design systems with business systems than all others

"We have assembled a cross functional energy reduction committee. This committee is working toward optimizing off peak consumption, reducing overall consumption of natural gas, water and electricity. The committee has also brought in outside energy experts to help the process along. We anticipate significant savings in this fiscal year."

~ Ron Bedard, Vice President, Operations, Engineering and Maintenance, Lakeside Steel

Required Actions

In addition to the specific recommendations in Chapter Three of this report, to achieve Best-in-Class performance, companies must:

- Focus on cost reduction measures which can reduce the overall energy consumed within operations
- Provide role based visibility and well defined responsibility in the case of an adverse event, and use non-conformance alerts in real-time to enable optimal decision making
- Provide real-time interoperability between critical systems to gain visibility between different functional areas: design systems with business systems; supply systems with manufacturing systems; manufacturing systems with Enterprise Resource Planning (ERP)

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Chapter One: Benchmarking the Best-in-Class

Business Context

Companies in the process industries are generally managing enterprises that are global, asset intensive, and face both low margins and high variability. In today's economy with a backdrop in rising energy costs, and soaring prices for natural resources, companies must find ways to reduce operational costs as a means to stay competitive while also growing revenues in an increasingly global marketplace. To be successful, it is important to understand how to leverage automation, manage compliance, provide visibility, and squeeze efficiency out of process operations.

Prior Aberdeen research has shown that one of the key differentiators for the Best-in-Class is the ability to use technology within many aspects of manufacturing to gain visibility into operations. In Aberdeen Group's August 2008 Benchmark Report, *Global Manufacturing Operations Management*, Best-in-Class companies had higher levels of interoperability between Manufacturing Execution Systems (MES) and other enterprise systems such as Product Lifecycle Management (PLM) - three-times more than Laggards; Enterprise Resource Planning (ERP) - 33% higher than Laggards; and Supply Chain Management (SCM) - almost three-times that of Laggards. The process industries often use other systems to help manage manufacturing which are more closely tied with the automation layer. Control systems such as Distributed Control Systems (DCS) and Human Machine Interface / Supervisory Control and Data Acquisition (HMI / SCADA) are used in conjunction with data historians to control product flow in the plant. How these systems are used as part of the overall business solution count as much as the technology itself.

This Benchmark Report will determine the pressures faced in the process industries and outline the strategic actions which Best-in-Class companies are taking to address these pressures. It will then show how the Best-in-Class achieve capabilities to give them competitive advantages in process manufacturing operations. This will be complemented by our investigation as to how the Best-in-Class connect manufacturing and business systems together to drive better performance. In addition, specific technology enablers such as advanced control techniques for continuous operations and recipe management for batch operations will be shown to help Best-in-Class improve performance.

Fast Facts

Best-in-Class process manufacturers:

√ Achieve 22% better manufacturing schedule compliance than Laggards

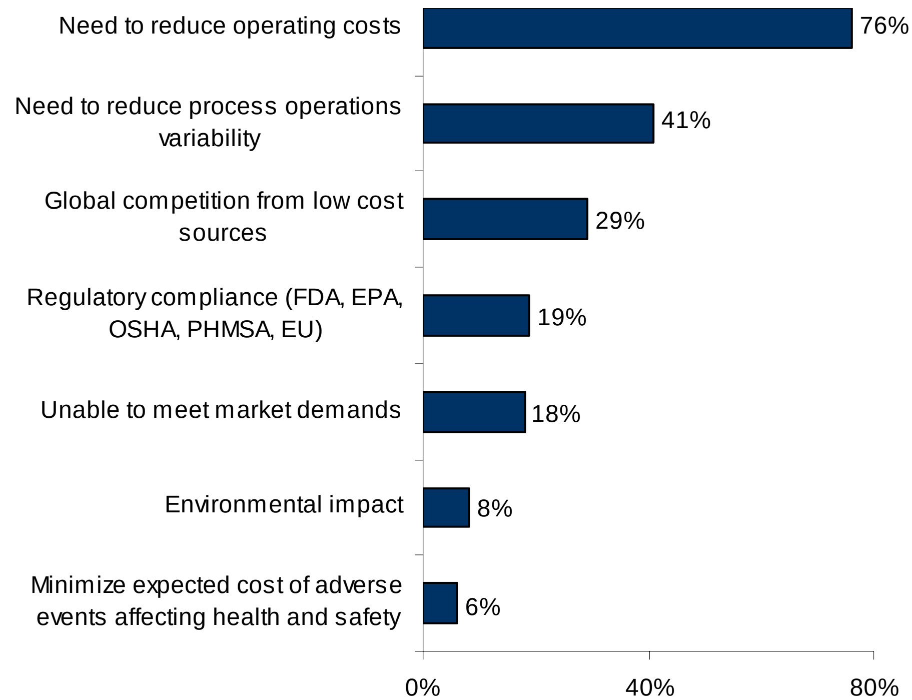
√ Are 61% more likely than all others to take the strategic action to synchronize operational performance with corporate performance

√ Are 83% more likely than all others to take a strategic action to reduce energy consumption

Pressures Affecting Manufacturers in the Process Industries

As Figure 1 shows, we find that the top pressure faced by manufacturers by almost a two to one margin was the need to reduce operating costs. An additional cost pressure was competition with low cost producers from other regions (29%). As the global markets mature and supply chains become increasingly spread out, manufacturing companies are aware that if they cannot match prices of global competitors or do not have sufficient differentiation in other capacities they can quickly lose market share.

Figure 1: Top Market Pressures



Source: Aberdeen Group, September 2008

With the need to reduce costs paramount, process manufacturers can turn inward towards operations to address the additional significant pressure felt, the need to reduce process operations variability. The process industries have significant variability in feedstock and in operating conditions which force companies to systematically compensate for these variations to maintain quality in production.

The Maturity Class Framework

Aberdeen used four key performance criteria to distinguish the Best-in-Class from Industry Average and Laggard organizations.

- **Manufacturing schedule compliance** defined as percentage of work completed per schedule
- **Perfect orders** defined as 100% complete and on-time with no errors
- **Overall yield** defined as actual yield / theoretical yield
- **Operational Equipment Effectiveness** (OEE) defined as availability x performance x quality

These metrics not only provide a basis for measuring internal operations but also serve to ensure that while manufacturing operations are optimized they are still satisfying the business need to keep customers happy by delivering what they promise on time and with no defects.

Respondents were divided among three categories based on their aggregate performances in these four metrics: Table 1 displays the average performance of Best-in-Class, Industry Average, and Laggard organizations.

Table 1: Top Performers Earn Best-in-Class Status

Definition of Maturity Class	Mean Class Performance
Best-in-Class: **Top 20%** of aggregate performance scorers	▪ 99% manufacturing schedule compliance ▪ 99% perfect orders ▪ 97% overall yield ▪ 94% overall equipment effectiveness
Industry Average: **Middle 50%** of aggregate performance scorers	▪ 94% manufacturing schedule compliance ▪ 96% perfect orders ▪ 91% overall yield ▪ 85% overall equipment effectiveness
Laggard: **Bottom 30%** of aggregate performance scorers	▪ 81% manufacturing schedule compliance ▪ 78% perfect orders ▪ 84% overall yield ▪ 71% overall equipment effectiveness

Source: Aberdeen Group, September 2008

The Best-in-Class PACE Model

Reducing manufacturing operating costs in the face of increasing energy, raw material and transportation costs requires a comprehensive set of strategies aimed at improving manufacturing operations. Table 2 details the Best-in-Class strategic actions, organization capabilities, and enabling technologies that are in place to achieve superior performance.

Table 2: The Best-in-Class PACE Framework

Pressures	Actions	Capabilities	Enablers
▪ Need to reduce operating costs	▪ Synchronize operational performance with corporate performance objectives ▪ Reduce energy consumption ▪ Increase capacity via optimizing production throughput	▪ Standardized processes for optimizing operational performance across manufacturing operations ▪ Cross-functional continuous improvement teams are responsible for improving operational and corporate performance ▪ Measure energy consumption	▪ Simulation and modeling (process characteristics and system dynamics) ▪ Analytics (dashboards, EMI) ▪ Advanced process control (loop tuning algorithms, adaptive algorithms, model based control) ▪ Automated controls to minimize off-spec material ▪ Automated controls to optimize grade transition

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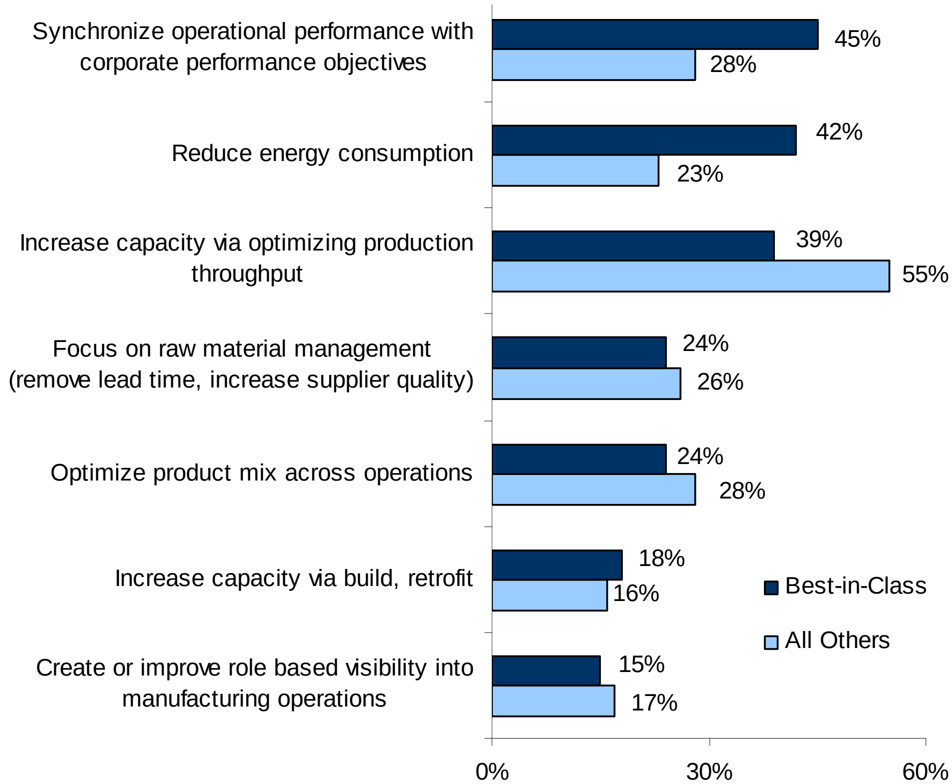
Pressures	Actions	Capabilities	Enablers
		▪ Executives have real-time visibility into the operational performance of manufacturing operations ▪ Performance can be compared across plants	▪ Distributed Control Systems (DCS) ▪ HMI / SCADA ▪ Data historians ▪ Statistical Process Control (SPC)

Source: Aberdeen Group, September 2008

Best-in-Class Strategies

Figure 2 shows that there is a difference in the strategic actions which Best-in-Class are taking to address market pressures.

Figure 2: Best-in-Class Focus on Multiple Strategic Actions



Source: Aberdeen Group, September 2008

"Melting, heat treatment and plant maintenance account for roughly 70% of our total energy consumption. While our customers have been able to absorb about 80% of these costs, the remaining 20% has put severe pressure on our operating margins. In order to manage these cost increases we are focusing our efforts on ensuring better controls, lesser disruptions and fewer changes in operating conditions. Through executive guidance our industrial engineering and production shops have begun to work collaboratively with plant engineers to audit and ensure better controls in the manufacturing process."

~ Shashank Tilak, Consultant, Steel Foundry

The top three actions of the Best-in-Class have similar adoption rates, one focused at the organization, one on manufacturing and the other in direct response to the current three year rise in energy costs. Other process manufacturers tend to be more single-minded in focusing on just the purely manufacturing objective of increasing capacity via optimizing production throughout.

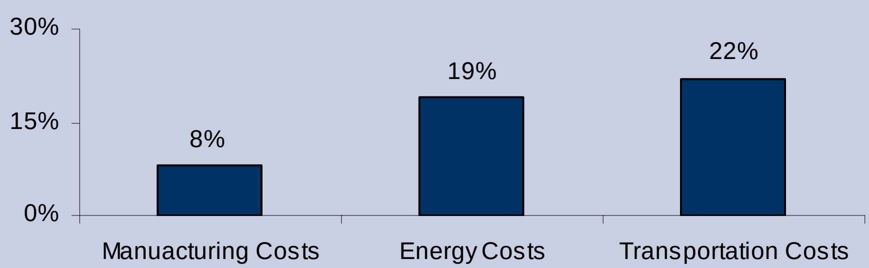
The Best-in-Class complement this by synchronizing operational performance with corporate objectives so that the business and manufacturing operations are focused in the same direction. They still bolster capacity by optimizing production throughput allowing them to spread fixed costs over more volume produced, but give special focus to reducing energy consumption within operations.

Of significant note is how Best-in-Class companies recognize that reducing energy consumption is a priority, taking this action 83% more than other companies, the Best-in-Class realize that profits are being eroded by the high cost of energy and its connection in driving other costs up such as raw material prices and transportation costs.

Aberdeen Insights — Strategy

Reducing costs has been a consistent theme in prior Aberdeen manufacturing Benchmark Reports. In this survey we find that reducing energy consumption was a top strategic action that Best-in-Class process manufacturers are taking to address this pressure. We asked process manufacturers how specific costs affected by energy increases have changed over the past year and present the results in Figure 3.

Figure 3: Increase of Energy Related Costs, Year Over Year



Source: Aberdeen Group, September 2008

We find that Best-in-Class companies were able to partially offset this rise in costs by increasing plant throughput by 12.6% year over year. This was 54% higher than Laggard manufacturers which had an increase of 8.2%. The Best-in-Class are able to spread these 8% higher total manufacturing costs over a higher volume, effectively reducing impact to unit costs.

In the next chapter we will discuss the business processes and technology which Best-in-Class find critical to achieve superior performance.

Chapter Two: Benchmarking Requirements for Success

The capabilities Best-in-Class achieve are giving them a competitive advantage over their peers. Aberdeen uses a competitive framework to describe these capabilities with respect to Best-in-Class performance.

Fast Facts

Best-in-Class process manufacturers are:

- √ 63% more likely to have role based visibility into manufacturing operations than Laggards
- √ 77% more likely than laggards to put in place cross functional teams to improve corporate metrics
- √ 56% more likely than Industry Average to compare performance across plants and more than twice as likely to do so than Laggards

Case Study — SABIC Innovative Plastics

SABIC, the Saudi Basic Industries Corporation is a leading global manufacturer of chemicals, fertilizers plastics, and metals. Since acquiring General Electric's plastics business in May 2007, one division, SABIC Innovative Plastics (SABIC-IP), has continued to address two of its major business pressures by instituting extensive performance management initiatives in manufacturing operations across its portfolio of over 60 plants.

Building on a prior corporate directive to reduce operating costs and improve equipment uptime, SABIC-IP continued performance management initiatives centered on operational performance within plant operations. The initiative, at one plant, tackled over 1,700 process control loops. "We originally started this project three years ago because management knew we needed to reduce instability caused by the variability of our operations," said Keith Phillips, a process control engineer and team lead on the project in Burkville, Alabama.

Gathering data from control systems and data historians wasn't enough to address operational performance. SABIC-IP needed to make informed decisions on how to reduce oscillations in the system, as well as tighten control limits. Operators did not have a good feel for how problems in one upstream process could affect a downstream one. Prior to this initiative SABIC-IP tuned most of its process control loops by "feel" and soon recognized that advanced control monitoring capabilities would solve many of their problems.

"One critical loop was for our hydrogen compression process, which is partially used to offset natural gas as an energy source," explained Phillips. "Once we used our new software to analyze loop interactions, we realized that a simple on / off control for an upstream fan was causing a temperature spike carrying through to our hydrogen compressor. By re-tuning our fan control loop, we were able to tighten our control limits and reduce the impact downstream. We recognized that because we had such large control limits before in the hydrogen compressor, we were not maximizing our hydrogen recovery. By tightening this upstream control and optimizing the hydrogen process we are able to save over $1 million per year in energy consumption."

continued

Case Study — SABIC Innovative Plastics

By having control data and results to reference, process control engineers can communicate benefits to plant management and to the executive staff. Phillips explained, "In the past we had to use qualitative arguments to explain where we could reduce operating costs, but now we have the data to back it up. We can now show how tightening control with smaller tolerances can save money."

In an effort aimed at continuous improvement, SABIC-IP is now looking at how they can better manage asset performance. "We are trying to address the link between a process operation problem and the way in which an asset might have been installed or how it is maintained. When we find a new problem using our performance management initiative we are connecting this to an asset performance program to address the root cause. We are also creating a reliability center for asset management to drive uptime. Operations will identify and prioritize the culprit and maintenance can then address it."

Competitive Assessment

Aberdeen used the Best-in-Class framework in the previous chapter to study the capabilities which set the Best-in-Class apart from Industry Average and Laggard companies. In addition to having common performance levels, each class also shared capabilities in five key categories: (1) **Process** (standard procedures in place to run the business effectively); (2) **Organization** (how members from different parts of the organization work together to drive corporate performance); (3) **Knowledge Management** (What data is used as actionable intelligence); (4) **Technology** (the software and tools which are needed to enable superior performance); and (5) **Performance Management** (how organizations use data for decision making to improve operations).

These characteristics shown in the following section serve as a guideline for best practices, and correlate directly with Best-in-Class performance across the key metrics of the study.

Capabilities and Enablers

There is one central theme which resonates throughout the top three strategic actions of Best-in-Class manufacturers. These actions are synchronizing operational performance with corporate performance, increasing plant throughput, and reducing energy consumption. The central theme is to provide visibility across the enterprise at each stage of operations in order to minimize the effect of adverse events, improve local performance and foster a cooperative environment so that corporate objectives can be met. The Best-in-Class are providing visibility in many ways through the capabilities they have instituted and the technologies they have implemented.

Process and Organization

As shown in Table 3, Best-in-Class companies are standardizing the measurements of Key Performance Indicators (KPIs). Industry Average companies have begun to recognize this as well and are 23% more likely than Laggards to do so. In an effort to synchronize operational and corporate performance, the entire business must use the same yardsticks. Large multinationals, especially with manufacturing operations across the world, have challenges to make sure that performance in all plants is measured in the same way so that the best business decisions can be made for the organization. When executives have the same understanding of how operations are performing in each location, they can take steps to address any shortcomings and ensure that Laggard plants improve performance to meet corporate goals.

Table 3: Process and Organizational Capabilities

	Best-in-Class	Industry Average	Laggard
Process	Standardize measurements of KPIs across enterprise		
	58%	**53%**	**43%**
	Standardized processes for response to adverse events		
	59%	**48%**	**44%**
Organization	All levels of the organization have role based visibility and defined responsibility in the case of an adverse event		
	65%	**44%**	**40%**
	Cross functional teams formed to respond to executive directives		
	68%	**44%**	**44%**
	Cross-functional continuous improvement teams are responsible for improving operational performance		
	73%	**62%**	**52%**
	Cross-functional continuous improvement teams are responsible for improving corporate performance		
	55%	**38%**	**31%**

Source: Aberdeen Group September 2008

The Best-in-Class also are more likely to standardize how they respond to adverse events, such as equipment failure and operational emergencies. Each role in the organization should know how to respond to an adverse event so that interruptions in production are minimized, loss of in-process materials is minimized, and operational efficiency is not drastically affected. Standardization can include how to contact and mobilize members of different teams to solve complex operational problems, escalation procedures, and how to conduct plant-wide emergency shutdowns to protect plant equipment and ensure employee safety.

Best-in-Class companies build on the standardization of how they respond to adverse events by then providing role based visibility and defined responsibility in the case of an adverse event within the organization.

In some cases, to direct the energies of the organization, executive directives are made so that everyone has a common understanding of how they can help the corporation address a systemic problem. With the correct process in place and the same organizational mindset, the Best-in-Class can respond to these executive directives more effectively than others. They are more than 50% more likely to be able to do this as compared to Industry Average and Laggards.

The Best-in-Class are also more likely to institute a cultural shift within the company. They institute cross-functional continuous improvement teams to improve operational performance, but they also recognize that they should couple this with helping employees understand how individual actions affect corporate performance. Best-in-Class companies are 45% more likely than Industry Average and 77% more likely than Laggards to put in place cross functional teams to improve corporate performance.

"As part of our strategic plan, we decided to roll out one solution to all of our 52 manufacturing locations to combine product formulation, manufacturing and business systems. With one standard system, we expect to be able to provide much better customer service knowing we have full visibility into our financials and operations."

~ Jeff Kadlec, Head of Information Technology, Ridley Inc.

Knowledge and Performance Management

In Table 4, we present the key areas that Best-in-Class companies focus on in collecting information and how they use that information. As a baseline, Best-in-Class companies have more automated data collection as a necessary part of operations.

Table 4: Knowledge and Performance Management Capabilities

	Best-in-Class	Industry Average	Laggard
Knowledge Management	Executives have real-time visibility into the operational performance of manufacturing operations		
	60%	**32%**	**30%**
	Automated data collection		
	81%	**64%**	**61%**
	Measure energy consumption		
	81%	**66%**	**66%**
Performance Management	Energy consumption and cost used as KPI for decision making		
	48%	**46%**	**37%**
	Non-conformance alerts are used in real-time for optimal decision making		
	55%	**40%**	**34%**
	Performance can be compared across plants		
	81%	**52%**	**39%**

Source: Aberdeen Group, September 2008

Consistent with the recent rise in energy costs we find although most companies also track energy consumption, Best-in-Class are 23% more likely to do so than either Industry Average or Laggards. There is however a gap in the performance information being passed up the chain to the level where some operational decisions are made. The Best-in-Class are almost twice as likely as the Industry Average to bring this operational performance data to the executive level and more than twice as likely as Laggards to do so.

When we look at what companies are doing with energy data however, we see that even the Best-in-Class are not executing as well on the strategic action of reducing energy consumption as they could. Only 48% of the Best-in-Class are using energy consumption and costs as a KPI for decision making. Best-in-Class companies are however using information to keep non-conformances in the front of mind so that they do not produce problems in production whether in material loss, or an adverse event. These performance capabilities do help explain however how Industry Average companies are able to outperform Laggards because they are using the information they gather as actionable intelligence.

Perhaps the most striking advantage Best-in-Class have is that because they are better focused on bringing operational metrics and information to the executive level, they are in a good position to compare performance across a portfolio of plants. The Best-in-Class are 56% more likely to be able to do this than Industry Average companies and almost twice as likely as Laggards. This capability gives them the power to identify which plants are doing things right and by comparison bring the expertise needed to improve the Laggard plants within their operations.

Technology

The process industries are by necessity more highly automated than discrete manufacturing. It is important to measure temperatures, pressures, reaction rates in chemical processing, and external conditions affecting equipment in the field such as corrosion, equipment vibration or other factors which might compromise operations. As Table 5 shows, Best-in-Class companies tend to use DCS, HMI / SCADA, and data historians to control operations at the plant level. Although use of Programmable Logic Controllers (PLC) was high, there was no distinction for Best-in-Class.

Of the systems within manufacturing, Asset Performance Management (APM) and Enterprise Manufacturing Intelligence (EMI) prove to be the most important factor in continuing to improve operations. Within APM maintenance activities can be better coordinated to improve uptime availability as well as overall analytics for the continued health and optimum performance of a company's assets. EMI is becoming a new way for the Best-in-Class to turn collected data into actionable intelligence. Upcoming Aberdeen reports will focus on these two technologies for an in depth understanding of how they can improve operational performance.

Fast Facts

- √ Best-in-Class manufacturers are over 70% as likely as others to use Enterprise Manufacturing Intelligence (EMI)
- √ Best-in-Class manufacturers are 45% more likely to use Asset Performance Management (APM) than Industry Average manufacturers
- √ Best-in-Class manufacturers are more likely than others to integrate control, manufacturing and other business systems to ERP - from 34% for Quality Management Systems (QMS) to over five-times for Product Lifecycle Management (PLM)

Table 5: Technology Categories

	Best-in-Class	Industry Average	Laggard
Control Systems	HMI / SCADA		
	80%	**62%**	**61%**
	Programmable Logic Controllers (PLC)		
	84%	**88%**	**79%**
	Distributed Control Systems (DCS)		
	70%	**58%**	**48%**
	Data historians		
	82%	**64%**	**68%**
Manufacturing Operations	Asset Performance Management (APM)		
	42%	**29%**	**22%**
	Enterprise Manufacturing Intelligence (EMI)		
	24%	**13%**	**14%**
Business Systems	Enterprise Resource Planning (ERP)		
	67%	**64%**	**62%**
	Supply Chain Management (SCM)		
	57%	**49%**	**40%**
	Product Lifecycle Management (PLM)		
	41%	**26%**	**11%**

Technology Acronyms

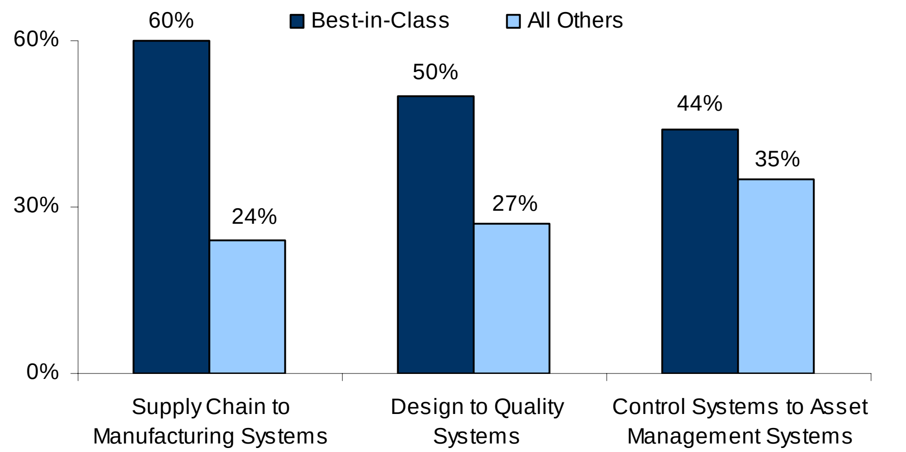
- √ **HMI/SCADA:** Human Machine Interface / Supervisory Control and Data Acquisition
- √ **DCS:** Distributed Control Systems
- √ **PLC:** Programmable Logic Controller
- √ **MES:** Manufacturing Execution Systems
- √ **APM:** Asset Performance Management
- √ **EMI:** Enterprise Manufacturing Intelligence
- √ **ERP:** Enterprise Resource Planning
- √ **PLM:** Product Lifecycle Management
- √ **SCM:** Supply Chain Management
- √ **QMS:** Quality Management Systems

We observe ERP adoption amongst our survey respondents to be lower than other industries. Aberdeen's ERP research over the past two years has seen adoption of ERP across all industries at approximately 85%. In the process industries, it is very important to have strong supply networks to ensure that continuous operations are not interrupted. Design systems such as PLM prove to be the single strongest differentiator for Best-in-Class performance. Best-in-Class process manufacturers are 58% more likely than Industry Average to have used a design system and nearly three-times more likely than Laggards. Using a design system gives companies the ability to drive product specifications from a single source, eliminating confusion over intended manufacturing targets.

Real-Time Interoperability

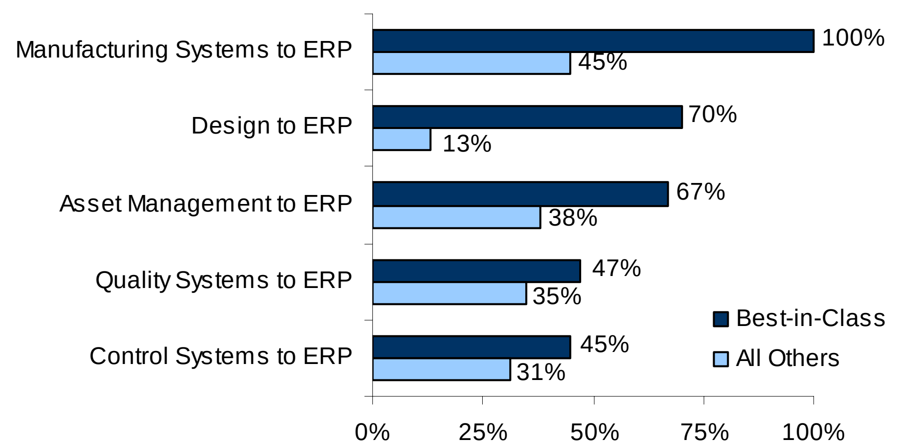
As Figure 4 and Figure 5 show, interoperability between all systems is needed to truly enable the Best-in-Class. Figure 4 shows the importance of connecting the supply chain with manufacturing systems and linking design with quality, connecting the intended product to actual product produced in operations. Data from control systems prove important to help gauge asset health and efficiency when these two systems can be linked together. The most striking of which is the connection of multiple systems to ERP, and most notably ERP to both PLM and manufacturing systems.

Figure 4: Real-Time Interoperability Between Systems



Source: Aberdeen Group, September 2008

Figure 5: Real-Time Interoperability with ERP



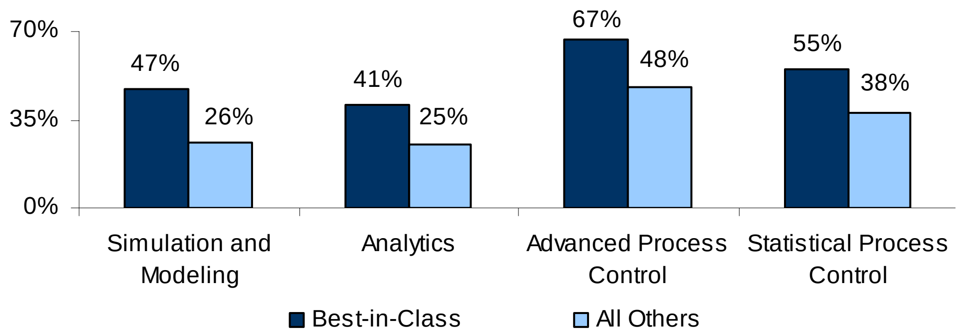
Source: Aberdeen Group, September 2008

Technology Enablers

There are several distinct areas of functionality which can help improve the likelihood of a company performing at Best-in-Class levels. Different technology enablers can apply to continuous process operations and batch process operations, whereas some are universal for each.

For common technologies which can be applied in both continuous and batch operations, Figure 6 shows that the Best-in-Class are 81% more likely than others to use simulation and modeling of process characteristics and system dynamics to determine the best path to optimum performance of localized unit operations. Simulation and modeling should also be used in conjunction with diagnostics when the process behavior is not responding within the expected operating parameters. The Best-in-Class use analytics 64% more so than others to characterize and interpret behavior of operations so that they can improve them. We also find that Best-in-Class are more likely to have instituted Statistical Process Control (SPC) and advanced process control techniques more than other companies. SPC is used especially in batch operations to monitor and control the physical property values and characteristics of the material produced, but can also be used as a quality measure to ensure that samples measured throughout a product stream stay on target to the intended design specification.

Figure 6: Technology Enablers

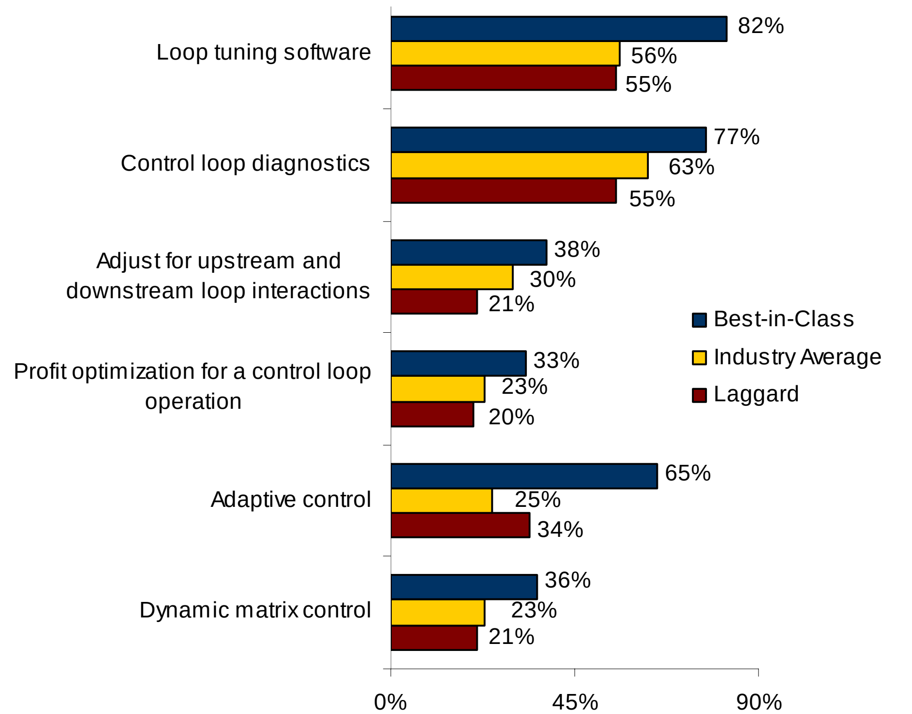


Source: Aberdeen Group, September 2008

We looked more closely to study the interaction of simulation and modeling with analytics and advanced process control to see that there were many individual factors contributing to improved performance in both continuous operations and batch process operations. In continuous control operations with specific technology enablers shown in Figure 7, the Best-in-Class were more likely to analyze and then improve critical unit operations both with the degree of control and with respect to profitability. These critical operations should first be diagnosed for efficient behavior, and then the appropriate control loops should be tuned better to tighten control limits, and adjustments made for the nature of how one unit operation affects a related upstream or downstream unit operation.

The Best-in-Class are beginning to look at these critical operations through the lens of profit objectives to make sure they translate the best opportunities for optimization. This underscores a concrete manner in which to make corporate objectives visible to operations and have operational improvements impact the bottom line, aiding in corporate performance objectives.

Figure 7: Continuous Process Control

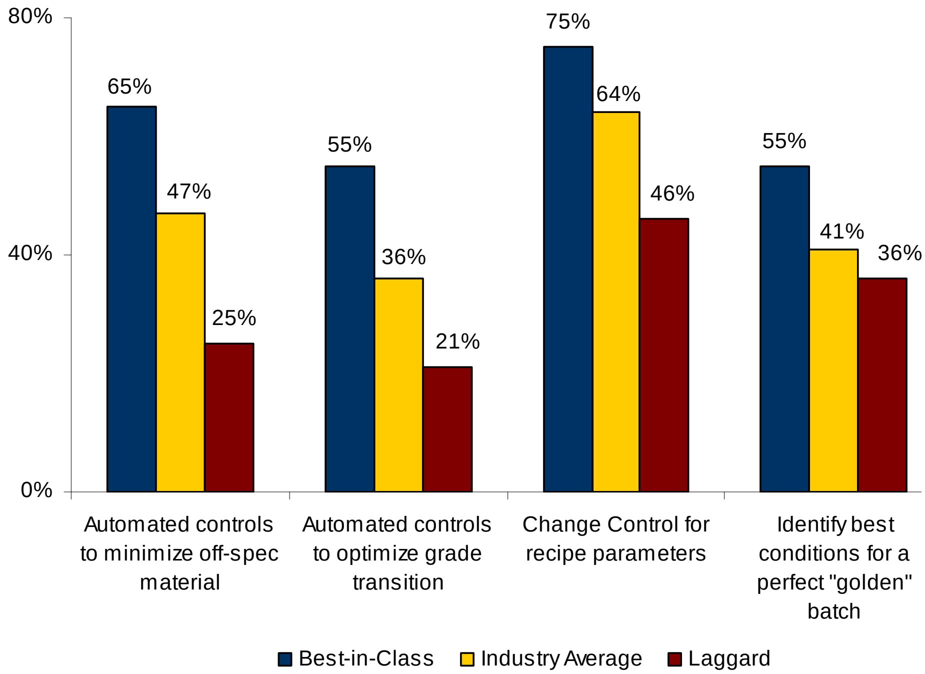


Source: Aberdeen Group, September 2008

Advanced control techniques which the Best-in-Class use to improve performance are adaptive control and dynamic matrix control. With adaptive control, the control system learns about the physical process it is controlling as it runs and 'adapts' its control action to it over time, connecting the model of the actual process with its control. This technique takes into account changing ambient conditions as well as feedstock variances. With dynamic matrix control, a complete mathematical model of the process is determined and updated as the physical process runs. When conditions vary, updated models can be made and stored to take each change into account and re-used as needed.

In batch processing, Figure 8 reveals that the Best-in-Class effectively use advanced techniques to improve performance for each batch run. These include automated control algorithms specifically targeted to reduce the amount of off-spec materials in a given batch run as well as optimize grade transition from batch to batch.

Figure 8: Batch Process Control



Source: Aberdeen Group, September 2008

The other two differentiators we find for Best-in-Class center around managing the change control of recipe parameters and to identify the best process conditions and recipe parameters over time to produce the perfect or "golden batch." The Best-in-Class are more apt to have a master recipe in place, typically in the design system and then track variations to the recipe based on actual batches to learn about the production. Change control is maintained for expected processing conditions, and maintained to prove traceability to understand how an unexpected process variation may have affected the actual batch results. The ultimate result is that Best-in-Class use techniques such as this to hone in on the elusive "golden batch."

Case Study — Evonik Degussa

Evonik Degussa, a subsidiary of Evonik Industries is Germany's 3rd largest chemical producer focusing on specialty chemicals. Evonik Degussa has over 100 production sites in 30 countries around the world with sales of over €10 Billion. "We are beginning to institute a unique view of continuous improvement here at Evonik Degussa which we call Advanced Process Operations" said Kai Dadhe, a project manager at Evonik Degussa.

continued

Case Study — Evonik Degussa

"We are bringing people who are closest to production into the process to improve decision making within operations and within our supply chain. The core of our vision is to create reliable process operations by having all personnel from the plant manager, project mangers, DCS and process engineers, day foremen and line operators have mutual goals and interests within operations."

Evonik Degussa started on this path over 10 years ago when, as Degussa, it began to standardize on one platform for production data management. "In our business, plant throughput is our primary concern, though we do keep a close watch on energy consumption. With our data historian we have the data process engineers need to simulate what if situations to identify bottlenecks in critical operations so that we can increase throughput. Operators can use trending data to detect potential problems like catalyst deactivation in a reactor which would drive down line production rates. We are moving towards predictive maintenance to detect problems like this to get back running to peak performance more quickly."

Aberdeen Insights — Technology

Simulation and modeling are an important part of gaining proper visibility into process operations. Modeling the manufacturing process is the first step in gaining visibility into the nature of the unit operations of the process. Archived data collected by data historians are used to understand process characteristics, temperatures, pressures, and learn how a process will respond to external process upsets. The Best-in-Class are 28% more likely to use historians to aggregate data collected from real-time control systems such as PLCs, HMI / SCADA, and DCS.

The next step, simulating a process response to develop what-if scenarios for process upsets or changes in process conditions can be powerful. Best-in-Class companies are 81% more likely than others to use simulation and modeling to understand the system they need to control.

Using modeling and simulation information, loop tuning software can then be use to tighten control limits around control set points to reduce process instability and open the door to cost savings. The Best-in-Class are 45% more likely than all others to use loop tuning to improve operational efficiency.

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Chapter Three: Required Actions

Whether a company is trying to move its performance in operational Excellence from Laggard to Industry Average, or Industry Average to Best-in-Class, the following actions will help spur the necessary performance improvements:

Laggard Steps to Success

- Standardize the measurement of KPIs across the enterprise to put all processes, lines and plants on equal footing, making sure that energy consumption and costs are used as a KPI. Best-in-Class companies are 35% more likely than Laggards to incorporate this capability.
- Use Distributed Control Systems (DCS) and HMI / SCADA to bring system-wide control to the plant floor and leverage that data by using data historians to uncover trends.
- Use control loop diagnostics to improve continuous operations; for batch operations use automated controls to minimize off-spec material and optimize grade transition. Best-in-Class manufacturers are 1.5 times more likely than Laggards to integrate automated control technologies.

Industry Average Steps to Success

- Use cross-functional continuous improvement teams to improve operational and corporate performance. The Best-in-Class are 45% more likely to use these teams to improve corporate performance. Foster an environment that is prepared to act when there are corporate directives made so that the company can execute on strategic actions.
- Use energy consumption in manufacturing operations as a KPI for decision making.
- Use loop tuning software and adaptive control to tighten tolerances and provide superior control.

Best-in-Class Steps to Success

- Continue to institute cross functional teams to improve corporate performance and identify and standardize the appropriate KPIs to link plant performance with corporate performance.
- Follow through on strategic action to reduce energy consumption by using energy costs as a KPI. Aberdeen observed only a marginal difference between Best-in-Class (48%) and Industry Average (46%), leaving significant room for top performers to surge ahead.

Fast Facts

√ The Best-in-Class are 83% more likely than all others to take a strategic action to reduce energy consumption and 23% more likely to measure energy consumption than all others

√ The Best-in-Class are 46% more likely than Industry average to use loop tuning software to squeeze efficiency out of operations

√ The Best-in-Class are more than one and a half times as likely as Laggards to use automated controls to minimize off-spec material and optimize grade transition

√ The Best-in-Class are more than 70% as likely as others to use Enterprise Manufacturing Intelligence (EMI)

√ Best-in-Class manufacturers are 45% more likely to use Asset Performance Management (APM) than Industry Average manufacturers

"The continuous improvement drive within our manufacturing plant is based on solid manufacturing principles. The attitude on the shop floor is that the 'status quo' is never good enough."

~ Arnoud DeJonge, Manufacturing Manger, Lubrizol

- Use APM and EMI technologies to drive localized performance for improving asset utilization, return on assets, and connecting manufacturing metrics to the appropriate decision makers in the organization.

Aberdeen Insights — Summary

There are three important considerations to ensure operational excellence in the process industries. First, improve operational efficiency at the localized unit level by optimizing continuous controls and batch process controls on the plant floor. This requires visibility into equipment performance and loop interactions by modeling and simulation and the use of advanced control techniques to make complex systems controllable.

Second, provide visibility within operations so that optimal decisions can be made in the process control of operations and in minimizing adverse events to operations.

Third link plant systems together so that the entire enterprise has visibility into the entire range of operations from design, to manufacturing to supply chain and enterprise. Once each department has a better understanding of how their actions affect other departments in providing superior performance, they may then act in one direction to achieve corporate and executive goals for improving operations.

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Appendix A: Research Methodology

Between August and September 2008, Aberdeen examined the use, the experiences, and the intentions of 200 enterprises in the process industries regarding how they achieve operational excellence.

Aberdeen supplemented this online survey effort with interviews with select survey respondents, gathering additional information on strategies, experiences, and performance results.

Responding enterprises included the following:

- *Job title / function:* The research sample included respondents with the following job titles: Manager (38%); Staff (16%), Director (15%), Senior Management (CxO, President, Vice President) (14%), Consultant (12%), and other (6%)
- *Manufacturing Mode:* Continuous process (38%); batch process (23%); continuous and batch process (22%); continuous and discrete process (5%); batch and discrete process (12%)
- *Industry:* The research sample included respondents exclusively from the process industries representing the following segments: chemicals (20%), oil and gas (15%), pharmaceutical and biotechnology (14%), metals, mining and minerals (13%), food and beverage (12%), paper, lumber and timber (5%), other energy (4%)
- *Geography:* Half of the respondents (50%) were from North America. Remaining respondents were from the Asia-Pacific region (26%) Europe, Middle East and Africa (21%), South America (3%).
- *Company size:* Twenty-seven percent (27%) of respondents were from large enterprises (annual revenues above US $1 billion); 46% were from midsize enterprises (annual revenues between $50 million and $1 billion); and 27% of respondents were from small businesses (annual revenues of $50 million or less).
- *Headcount:* Forty-five percent (45%) of respondents were from large enterprises (headcount greater than 1,000 employees); 34% were from midsize enterprises (headcount between 100 and 999 employees); and 21% of respondents were from small businesses (headcount between 1 and 99 employees).

Solution providers recognized as sponsors were solicited after the fact and had no substantive influence on the direction of this report. Their sponsorship has made it possible for Aberdeen Group to make these findings available to readers at no charge.

Study Focus

Responding manufacturing executives completed an online survey that included questions designed to determine the following:

√ The pressures faced in running efficient operations

√ The strategic actions taken to address these pressures

√ Top technology enablers used to improve operational performance for both continuous operations and batch operations

√ The benefits that have been derived from technology adoption and integration

The study aimed to identify emerging best practices for process manufacturing operations and to provide a framework by which readers could assess their own capabilities.

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Table 6: The PACE Framework Key

Overview
Aberdeen applies a methodology to benchmark research that evaluates the business pressures, actions, capabilities, and enablers (PACE) that indicate corporate behavior in specific business processes. These terms are defined as follows: **Pressures —** external forces that impact an organization's market position, competitiveness, or business operations (e.g., economic, political and regulatory, technology, changing customer preferences, competitive) **Actions —** the strategic approaches that an organization takes in response to industry pressures (e.g., align the corporate business model to leverage industry opportunities, such as product / service strategy, target markets, financial strategy, go-to-market, and sales strategy) **Capabilities —** the business process competencies required to execute corporate strategy (e.g., skilled people, brand, market positioning, viable products / services, ecosystem partners, financing) **Enablers —** the key functionality of technology solutions required to support the organization's enabling business practices (e.g., development platform, applications, network connectivity, user interface, training and support, partner interfaces, data cleansing, and management)

Source: Aberdeen Group, September 2008

Table 7: The Competitive Framework Key

Overview	
The Aberdeen Competitive Framework defines enterprises as falling into one of the following three levels of practices and performance: **Best-in-Class (20%) —** Practices that are the best currently being employed and are significantly superior to the Industry Average, and result in the top industry performance. **Industry Average (50%) —** Practices that represent the average or norm, and result in average industry performance. **Laggards (30%) —** Practices that are significantly behind the average of the industry, and result in below average performance.	In the following categories: **Process —** What is the scope of process standardization? What is the efficiency and effectiveness of this process? **Organization —** How is your company currently organized to manage and optimize this particular process? **Knowledge —** What visibility do you have into key data and intelligence required to manage this process? **Technology —** What level of automation have you used to support this process? How is this automation integrated and aligned? **Performance —** What do you measure? How frequently? What's your actual performance?

Source: Aberdeen Group, September 2008

Table 8: The Relationship Between PACE and the Competitive Framework

PACE and the Competitive Framework – How They Interact
Aberdeen research indicates that companies that identify the most influential pressures and take the most transformational and effective actions are most likely to achieve superior performance. The level of competitive performance that a company achieves is strongly determined by the PACE choices that they make and how well they execute those decisions.

Source: Aberdeen Group, September 2008

Appendix B: Related Aberdeen Research

Related Aberdeen research that forms a companion or reference to this report include:

- *ERP Plus in Process Industries;* February 2008
- *Global Manufacturing Operations Management*; August 2008
- *Enterprise Asset Management: Maximizing Return on Assets and Emerging Trends;* June 2008
- *2008 ERP in Manufacturing*; June 2008
- *Event Driven Manufacturing Intelligence: Closed Loop Performance Management*; May 2008
- *Risk Mitigation in Manufacturing Operations;* March 2008
- *Compliance and Traceability in Manufacturing*; December 2007
- *Will 2008 Finally be the Year of Plant-to-Enterprise Integration?;* June 2008

Information on these and any other Aberdeen publications can be found at www.Aberdeen.com.

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