Paper 21A

# Operational Excellence: Best Practices in Manufacturing


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# Best Practices in Manufacturing

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## Abstract

This paper considers the role of new and emerging technologies in helping companies to achieve operational excellence. Among those key technologies are the following:

- Integration infrastructure for bringing together diverse data in manufacturing environments
- Improved visibility (web-based views of real-time information)
- Event management for intelligent alerting and automated responses to important business events
- Performance scorecarding and analytics (for making performance-vs-target results visible and providing the analysis environment to understand and improve performance)
- Look-ahead analytics for projecting future performance and improving future profitability (not only from learning but also from past performance).

These technologies are available today and can be implemented by process industry companies as they strive to establish and maintain operational excellence in manufacturing.

## Introduction

For more than twenty years, manufacturers have focused on improving the quality of their processes as a way to achieve operational excellence. Advancements in technology over the past two decades have played a key role in driving the growing number of quality improvement initiatives in manufacturing worldwide, and have underpinned the more recent Six Sigma projects undertaken in the United States.

Today, however, process manufacturers are recognizing that operational excellence relies not only on traditional technology, but also on the effective combination of emerging technologies and the role of the "human factor." Over-emphasis of one aspect to the detriment of the other will limit an organization from achieving its true potential.

A suite of software applications has been developed in order to fulfill both the technical and human requirements of achieving operational excellence. This emerging technology is available today and can be implemented to provide process industry companies with capabilities that improve visibility, manage events, and provide performance scorecarding and analytics for improving and understanding performance.

## Background and Historical Context

In discussing the current technologies designed to help process manufacturers achieve operational excellence, it is important to understand the breakthroughs and the legacies that have created today's operating environment.

## Technology and PC-Based Tools

The first application of technology to specific areas within the process industries occurred in the 1970s, when Distributed Control Systems (DCS) provided operators with improved visibility of a particular process and an unprecedented easy-to-use environment. In the continuous process industries, advanced control technology, such as Dynamic Matrix Control (DMC), successfully enabled process manufacturers to achieve improvements in productivity and yield by pushing processes closer to operating constraints. Later, the advent of process historians offered operators and selected operations staff a standard tool for investigating performance issues and understanding process performance.

Augmenting these technologies over the years has been the emergence of PC-based tools for a variety of functions, including data analysis. Microsoft Excel, for example, is widely deployed in many plants, although all too often it is deployed in "information silos" that offer very little sharing of information and lead to localized decision making. Further technologies that address plant scheduling, planning, and execution have also emerged. With all these systems have come masses of data…so much so, in fact, that manufacturers are heard to say that they are "drowning in data." What they really mean, however, is that they need to distill *information* from the abundance of *data*—and that often involves correlating data from many different systems.

As underlying systems have increasingly become commodities, and as operating environments have become populated with disparate systems, it is clear that integration of the different technologies is an important issue if key business processes are to be automated. This requirement has become even more acute as manufacturers strive for more agile decision-making, based on an accurate understanding of the current state of process operations.

## The Impact of ERP Systems

In the early 1990s, the advent of enterprise resource planning (ERP) systems provided a comprehensive, integrated source of information for the entire organization, thereby allowing changes to propagate easily across a business. ERP systems have indeed achieved benefits in operational excellence, but they have also incurred large investment costs—costs so large, in fact, that companies are today reluctant to repeat the experience. The ERP systems have also established some important standards which customers expect suppliers in the manufacturing space to emulate.

## Integration Technologies and Standards

To solve to the complexities of the integration of different business systems, information technology (IT) departments have sometimes selected enterprise application integration (EAI) technologies. EAI suppliers such as IBM, webMethods and TIBCO have developed powerful "integration stacks" specifically designed to make systems integration easier and more reliable. While these general integration technologies do not necessarily take advantage of some of the particular characteristics of the process industries, they have brought some potential order to the technology environment for process manufacturers. Order is very much required—but lack of order and lack of standards characterize the current environment.

## The Human Factor

As technologies evolved over the past two decades, they did so against a backdrop of mandated cost and manpower reductions. Exacerbating this problem is the fact that many experienced operations personnel are about to retire. This situation, combined with staffs that have been consistently reduced for many years, creates a critical knowledge management challenge.

## Operational Excellence in Manufacturing

Operational excellence may be achieved by a series of steps, as discussed below.

### Step 1: Visibility and Empowerment

Process manufacturers must provide users across the organization with meaningful, real-time visibility across systems and operational silos to better contribute to organizational goals. In many cases, this requirement has meant leveraging new applications and technologies, such as web-based technology. Web-based technology brings new possibilities to operations; for example,

- It enables all Operations personnel within a plant to see one "version of the truth," thereby helping to overcome an organization built on silos. It encourages collaborative decision making and optimization of operations on a broader basis.
- It can also support this "version of the truth" vertically, and not simply horizontally, within an organization. Supervisors, managers, and operators can all be provided with appropriate operational views to help them to make better decisions.

ARC Advisory Group has described this new generation of web-based visibility tools as "Performance Personalization Tools" (PPTs) because they employ web-based technology—underpinned by a data model—allowing data to be stored, retrieved and navigated in context. The net effect is to convert masses of data into information, which can be intuitively accessed, to greatly facilitate decision-making.

### Step 2: Business Response and Agility

Process industry manufacturers must make high quality and rapid decisions. **Figure 1** depicts the "latency period," defined as the delta between the impact of time to react to a business event on the value of the action taken. Agility of response is important at all levels of operations, from the plant to the business. Intelligent alarm management and escalation are key to reducing the latency period and thereby increasing the value of rapid, accurate decisions to the business. Operators will often acknowledge alerts as a matter of course; however, situations can occur in which a particular combination of alerts from the plant, or a composite alert (combining alerts from the DCS with those from a reliability system, for example) signifies an impending larger problem which may have a major impact on plant reliability. It is imperative to be able to flexibly configure systems to handle such hybrid scenarios.

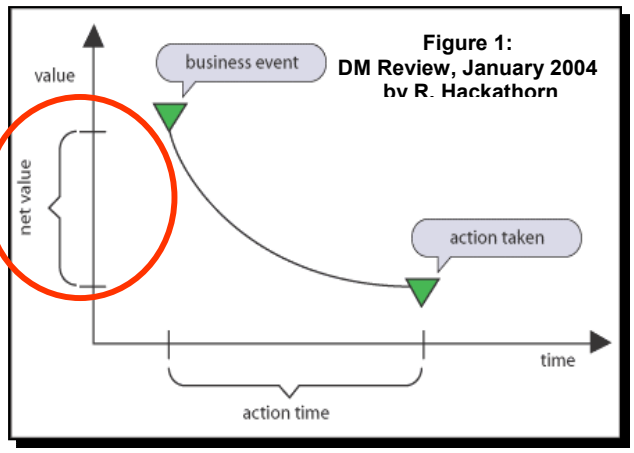


**Figure 1:**
**DM Review, January 2004**
**by R. Hackathorn**

Escalation capabilities are also important. If a particular alert is not getting the attention it deserves after an appropriate time (or number of occurrences), for example, it should be escalated to a higher level in the supervisory hierarchy so that it is addressed. From a business perspective, agility at a higher level allows companies to manage important events in the supply chain, such as significantly increased demand from a particular customer. When these business events can be coupled with a specific scenario analysis, companies can anticipate the best course of action by projecting likely future performance.

Key aspects of response agility in the process industries include collecting process knowledge, embedding process knowledge, automating responses in particular scenarios, and enabling all appropriate event sources.

Comprehensive operational excellence systems will also have the capability to automate certain aspects of business response, for example, by passing information from one system to another automatically or triggering a sequence of response actions.

## Step 3: Integration and Standards

A typical process operations environment consists of many systems, each of which contains important data. Often, however, these rarely-integrated systems are connected with a variety of point-to-point interfaces, or may even be comprised on standalone spreadsheets for a small set of users.

The biggest challenge for point-to-point integration is the need to adapt to change. A change in an application can affect a number of interfaces: the ripple effect can be large and expensive. A new, more flexible solution that copes as the business and information requirements change is fundamental in enabling operational excellence. Any new approach must also cope with the practical realities of integration in modern environments: namely environments which are distributed and where networks and applications occasionally fail.

The roll out of SAP across many companies places requirements on data integration with the plant floor. Information about production orders is required in the plants and information about actual production is required in SAP. These information requirements increase in complexity when other systems, such as supply chain management, are introduced. Given these growing requirements, operational excellence can be achieved only through the combination of bi-directional business process execution as well as visualization.

## Step 4: Business and Operational Alignment with Scorecards and Dashboards

Most Operations personnel working in a large plant have little idea of the official corporate strategy; nor do they know how they can best maximize their contribution to that strategy. Similarly, visibility of operational performance between the corporate and business levels is often very poor. A scorecarding system (perhaps based on a balanced scorecard approach) can be very effective in making performance visible, thereby forcing an emphasis on visibility of performance targets and actual performance and encouraging an environment of increased accountability.

Many companies have undertaken the non-trivial task of defining KPIs which are important to them (some have created executive dashboards that typically provide visualization of business information). Those that have are in a good position to adopt scorecarding technology, particularly if these have been defined across multiple plants within a business unit. For those that have not taken the adoption challenge, the task is more significant. The important interplay of human and technology factors is very evident in this situation. To overcome these challenges, companies should work with a vendor who has both the domain expertise as well as the technology to apply to this challenge.

At any rate, the scorecarding system should be web-based to ensure maximum performance visibility and use. It should support hierarchically-defined key performance indicators (KPIs) so that users can “drill-down” into areas of poor performance to understand the contributing factor(s) causing performance targets to be missed. An advanced scorecarding system supports not just targets and actuals, but also potential performance targets. These are maximum potential performance levels, which might be computed via on-line models for example.

## Achieving Operational Excellence in Manufacturing

A suite of software applications, Aspen Operations Manager, has been developed in order to fulfill both the technical and human requirements of achieving operational excellence. This suite is available today and can be implemented to provide process industry companies with capabilities that fulfill the demands of the steps outlined above.

### Visibility and Empowerment: Role Based Visualization

The Role Based Visualization application incorporates a variety of tools to address the following tasks:

- Building web-based graphics. Some of these authoring tools are themselves web-based, and therefore enable user-configurable environments. The tools include libraries of standard "drag and drop" process graphics elements to create web pages.
- Converting DCS graphics (e.g., Honeywell TDC 3000) to a web implementation, encapsulating the graphic in the web
- Organizing data storage, retrieval and navigation, thereby effectively converting the data into information
- Offering a portal environment that allows different graphic elements to be composed and screens to be tailored to the varying needs of operational personnel.

**Figures 2** and **3** represent Role Based Visualization screens.

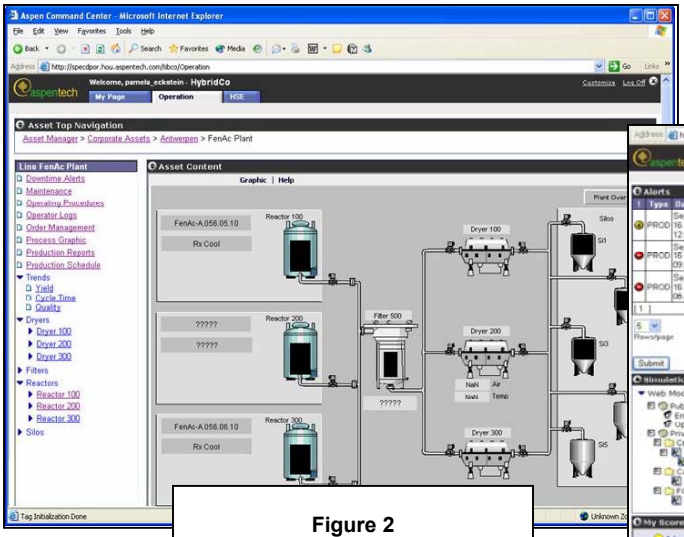


**Figure 2**
**Context-sensitive content**

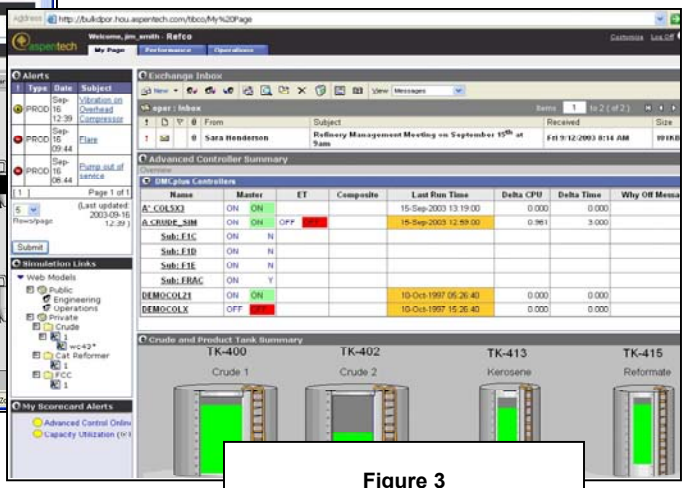


**Figure 3**
**Hybrid systems environment**

### Business Response and Agility: Event Management

To comprehensively address the needs of the process industries, the Event Management application incorporates a number of sub-systems, including the following:

- Portal-packs to deliver web content into a portal environment.
- A scalable Rules Engine, configurable with wizards for most users or with a full development environment for power users.

- Ability to template specific solutions.
- Integration with a broad variety of standard components and fully compliant with Aspen Operations Manager - Integration Infrastructure.

The Event Management application is often used in conjunction with other business and plant systems. **Figure 4**, for example, depicts how Event Management can complement a compliance management system. The application provides suggestions for the likely cause for specific limit violations, as well as advice on what steps should be taken to correct the violation. Event Management may also be used to trigger workflows involving manual and automated steps.

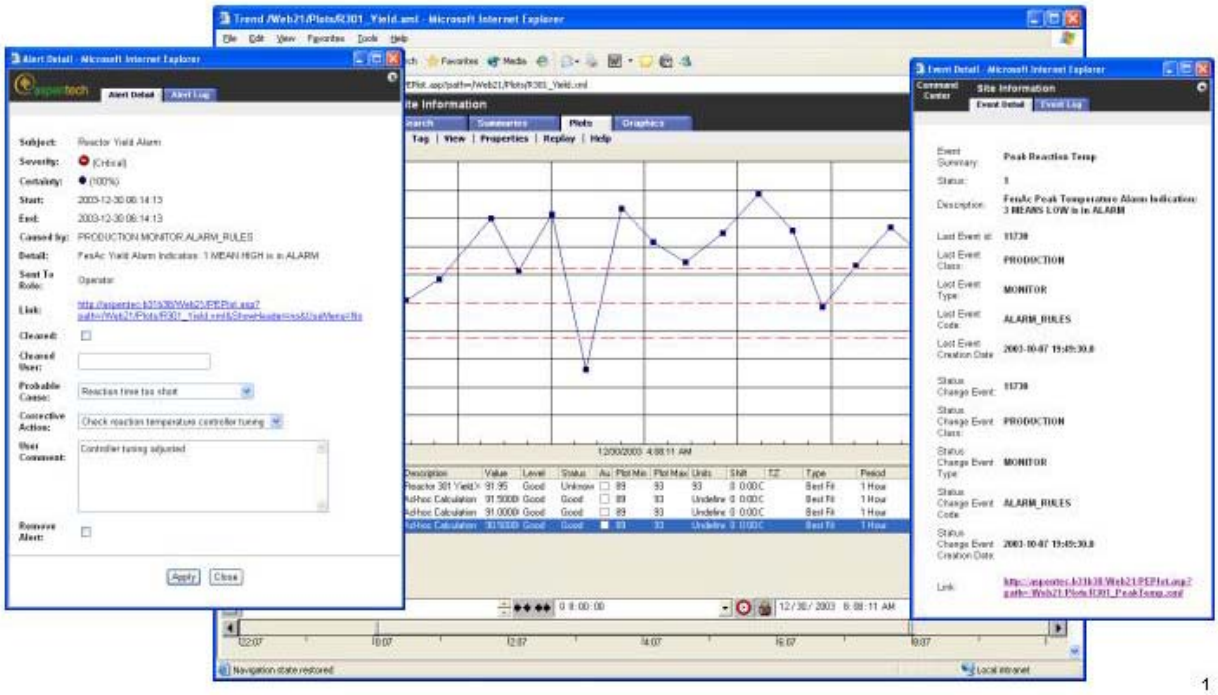

**Figure 4: Event alert drill-down and embedded knowledge**

## Integration and Standards: Integration Infrastructure

The Integration Infrastructure embeds a robust EAI architecture from TIBCO and augments it with a data model and content and connectivity for the process industry, aligned with the ISA S95 standard. Standard messages for plans, schedules, production balances, and process values have been defined, as well as components for the Master Data Manager module. These components—which include units of measure, material codes, properties, prices, equipments, and hierarchy—allow a central point of definition and synchronization with other Master Data systems, and also provide a means of propagating configuration information to a number of applications.

### Business and Operational Alignment: Performance Scorecarding

The Performance Scorecarding application is a powerful application that stores data in a structured, dimensioned form which enables rapid "slice and dice" analysis and enables conditions to be defined for variables. These conditions can then be linked to traffic lights to graphically flag significant deviations. An example might be in a polymer process where a transition time alert is generated within a business. Using the Performance Scorecarding applications, users can drill-down to establish that the problem is occurring at a particular production facility for a particular transition. Other key features of the Performance Scorecarding application include the following:

- Powerful reporting (including HTML reports)
- Ability to link to a variety of relational data-sources
- Ability to support drill down
- Ability to support 'drill-through' (connections to sources of data for display of more granular data)
- Compatibility with Microsoft Excel and AspenTech's Integration Infrastructure
- Pre-configured data structures for the process industry

**Figure 5** shows an example of a typical Performance Scorecarding environment and the ability to drill down in a particular area to display key results graphically.

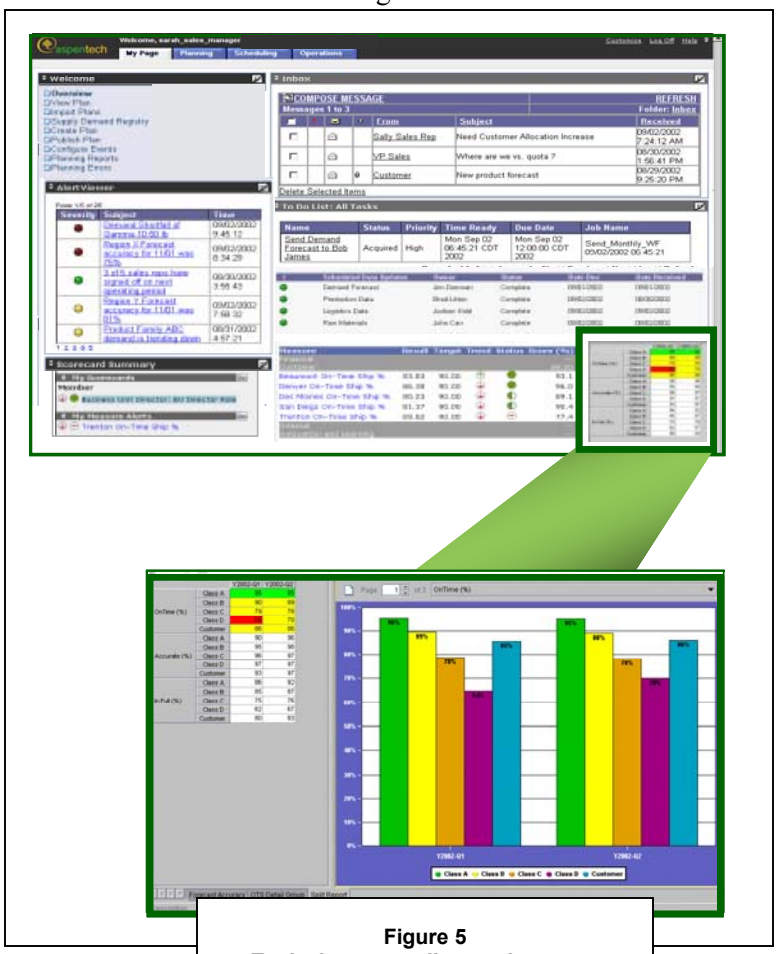

**Figure 5**
**Typical scorecarding environment**

## Conclusion

For process manufacturers today, the new technology that will help achieve operational excellence is entering the market now. With increasing pressure from shareholders, customers and even employees to ensure the business performs to the stated goals, these technologies can help achieve a level of collaboration and excellence not seen in the past. In many cases, the infrastructure is in place. Even with cost pressures these technologies can help organizations achieve the operational excellence they need, with their existing resources (infrastructure and talent) as long as they act now.