Event Driven Manufacturing

A White Paper by:
Zoneworx Incorporated

H. Philip White
CTO and Co-Founder

January 2000
The Power of Events

"Enterprises with fast reaction times have a competitive advantage. They sell more product, deliver better customer service, and capitalize on new business opportunities sooner than their competitors."

- Gartner Group

In today’s rapidly changing world all companies must become more agile to survive. This paper describes a novel approach that can help. Realtime event management brings businesses unprecedented ROI by extending the functionality of their current Information Technology (IT) investments. By working on top of existing manufacturing systems, realtime event management extends the life of these systems while improving the visibility of critical data.

To be attractive, the realtime event management system must install very quickly and require no alterations to source databases and plant floor systems, thus minimizing impact and speeding the implementation. Also, training costs must be low by utilizing communication devices already familiar to existing staff.

Most important, realtime event management aligns IT with business objectives. By implementing a system for identifying and tracking critical business events, IT adds value to these systems with great benefit to the whole enterprise. Businesses can now focus on moving forward, rather than combing through stacks of static, historical reports. Operations become much more responsive and customer satisfaction and loyalty improve.

The Internet Drives Change

“The OEMs hope to improve rolling forecasts and require Tier 1 suppliers to electronically integrate to their Tier 2 suppliers to wring the costs from the overall supply chain.”

- Bill Swanton, AMR Research

As the Internet and e-business become ubiquitous, companies unwilling to adapt will be left behind. The changes are numerous, but some of the more important ones are:

Product Life Cycle  Speed of change has become a competitive weapon. Being able to determine customer needs and spin a product to meet those needs faster than the competition is a major competitive advantage. This effect has shortened the useful life of many products and relegated those that have not changed to lowly commodity status.

Zero Inventory  Having low finished goods inventory has always been a goal of manufacturers, but it becomes absolutely imperative today. Shorter product life cycles, sales channels that no longer stock product, combined with end customers who want Just in Time (JIT) delivery make this a necessity for profitability.

Build to Promise  Not only is it unacceptable to have inventory any more, but you also have to deliver the product to the customers when they want it. Determining an accurate delivery and keeping to it is a competitive advantage. Customers who can’t get what they want, when they want it, will go somewhere else.

Mass Customization  Customers also want flexibility. If the standard color is red, they will want it green. If the standard bolt pattern is a square, they’ll want a circle. Customers want to configure a product that meets their requirements, and they will go somewhere else if they don’t get it.
Because of these factors, manufacturers are responding in many ways:

**Demand-based Production**

Most existing manufacturers have facilities that were designed for a Build-to-Forecast way of doing business. Moving to a Build-to-Promise model requires change. Some companies are utilizing Flow-based production techniques that minimize Work-in-Process (WIP) inventory and enable efficient Build-to-Promise manufacturing, but this process typically requires a major facility redesign.

**Activity-based Costing/Pricing**

Mass Customization requires that manufacturers have an efficient method of determining the exact price of the customer-configured product from the planned activities that produce it, and an exact cost based on the production steps actually performed. Traditional Enterprise Resource Planning (ERP) packages typically do not have these capabilities, requiring manufacturers to resort to inaccurate estimation techniques.

**Supply Chain Integration**

All of this is driving manufacturers to focus on specific areas of production. No longer do we see facilities like the Ford River Rouge Plant—a model of vertical integration. Today, specialization and outsourcing is the way. All companies are pushing out areas of production to specialized suppliers. Yet overall product quality control must be maintained. These networks of multiple companies are acting as a large virtual manufacturing facility with its own operational procedures. This means that every manufacturer can become part of an extended supply chain and be subject to the requirements of its virtual manufacturing facility.

Examples of the effects of these trends are numerous:

**Automotive**

The automotive manufacturers have had a huge supply chain for decades. Today they work closely with their Tier 1 suppliers early in the design process to provide key components for their product. In many ways the auto manufacturers are becoming Marketing, Design, and Final Assembly with all other work outsourced. The subassemblies that were once developed in house are even being spun out as separate companies and left to compete on their own (e.g., General Motors’ spin off of Delphi Automotive).

Although they outsource, the auto manufacturers still want to control quality, costs, and delivery standards. Build-to-Promise is becoming a requirement, since the cost of holding inventory is unacceptable. Also, they are demanding the tracking of more and more production level information: for example, serial numbers on key components of subassemblies and records that can track the production history (genealogy) of a part in case of a failure.

Many of these requirements are currently only on the Tier 1 suppliers, but this is changing. The desire to limit recall exposure and catch problems earlier in production is driving these requirements further into the supply chain, and this will cause smaller manufacturers to modernize facilities and processes just to cope.

**Electronics**

Every major electronics manufacturer today does almost no manufacturing. Cisco for example outsources all manufacturing to companies like Slectron and Flextronics. Even companies that do manufacturing—Dell, for instance—still leverage a highly outsourced model and perform final assembly only of components based on actual customer-configured orders.

This environment is characterized by extremely short product life cycles, fast delivery, and Build-to-Promise manufacturing. Products change so quickly that any inventory is a liability. The supply chain is integrated so tightly that, in the case of Dell, disk drives arrive hourly in quantities based on customer orders.
These trends will affect all manufacturers regardless of size or industry. Any company that supplies to another larger company, builds subcomponents, or supplies material on an as-needed basis will be affected in the next few years. The suppliers that will win in this new environment must be agile and will have the following characteristics:

**Meeting Customer Production Needs**

On the discrete manufacturing side of the market, this means, for example, the ability for a supplier to provide JIT delivery of four custom models of alternator, based on the daily demand for 10 models of vehicle at 2ppm failure rates.

On the process side of the market this means the ability for a chemical supplier to provide JIT delivery and empty container collection of Chemical X in two custom refillable container types, based on daily demand for 35 different end products at 99.9997% purity.

Meeting these needs will be the baseline for future manufacturers. They won’t even be able to play the game without this capability.

**Responsive to Customer Changes**

Once the door for Mass Customization is opened, mass in-process order changes will follow.

A customer orders a computer with a 10 Gigabyte hard drive and 128 Megabytes of RAM. Then, the next day a new company promotion, an article, or talk with a friend prompts the customer to change the order to a 30 Gigabyte hard drive and 256 Megabytes of RAM.

In-process order changes will have their greatest effect on producers with long production and delivery times, as there is more exposure to an in-process change. Handling this effectively will be a differentiator for companies. This will be not a small undertaking.

**Meeting Customer Data Needs**

Final assembly manufacturers want more and more data about the history of the production of the subassemblies they incorporate. This can range from a serial number on the part that can be looked up in a database to determine what day it was produced and by what machine to Read/Write Radio Frequency Identification (W/R RFID) tags that contain a detailed production and test history physically attached to the subassembly.

Tracking, logging, and archiving the critical quality characteristics on each step of production is becoming as key as the part itself.

Having flexibility to meet customer needs in this area will be a major differentiator for companies and will require IT infrastructure.

The winners in this new Internet-based, e-business environment will be the agile manufacturers that embrace these market changes and use them as a differentiator to their customers. The ones that don’t will be left behind.

**Manufacturers Are Not Prepared**

“Wherever build-to-order can approximate the delivery times of build-to-stock, it is taking away market share decreases in dramatic chunks.”

- Geoffrey Moore, Chairman, The Chasm Group

Most manufacturers are not prepared for the changes coming, mostly because the needs are relatively new and have been driven by the growth of the World Wide Web. Because of this, current manufacturing systems have not been designed to cope with these issues.

**ERP Systems**

Most existing Enterprise Resource Planning (ERP) systems have been built with a sales forecasting model. These systems are unprepared for the dynamic environment that the future will bring. Add to this that these systems are extremely expensive and company invasive, typically requiring over $1M and many months of integration for a mid-sized manufacturer.
Because of this, companies that have migrated over to an ERP are still looking for a return on their investment, and companies that haven’t are concerned about doing it. They are struggling with the balance of running their business more efficiently and the perceived and actual cost of an ERP. This is one of the reasons that many ERP vendors are now looking at offering their product more as a subscribed service to customers instead of the traditional purchased product model.

**MES Systems**

Most existing Manufacturing Execution Systems (MES) have been built with a Build-to-Forecast/Stock model. They are based on calculated models of production with little or no actual feedback from the production systems they model (e.g., Setup/Change Over Times, What is Up/Down). They create production schedules and release material based on these models with no knowledge of the actual daily capacity of the facility and with the only recourse of rescheduling Over/Under runs the next day.

These systems are not inexpensive, typically requiring over $100K and many weeks of integration for a mid-sized manufacturer. Also, they typically provide many features that are not useful for a given facility. This adds complexity to the overall system since there are many features available that are not being used by a given installation.

These systems are in place and manufacturers are not going to rip them out. Rather, what they need are ways to leverage their current infrastructure investment and add vertically integrated functionality according to their needs. These thin vertical slices can address the areas of greatest pain and be added incrementally.

To achieve this, manufacturer do not want to purchase some large monolithic solution up front that locks them in for life, but an open framework that is adaptable to changing needs. They want to start with attacking the quick ROI items, the ones obvious to everyone, and build upon these successes incrementally with a continuous improvement mentality, becoming more competitive and profitable every passing year.

**Variation and Non-Conformance**

*“IT strategies that integrate business processes, streamline supply chains, and build e-commerce platforms don’t account for the fact that customer service is constrained by reliable production performance.”*

- Roddy Martin, AMR Research

Generally, e-business issues amplify the problems of variability and non-conformance in production systems. Sometimes variability and non-conformance are perceived only from the narrow viewpoint *Does the end product meet spec?*, but it is much more important to view them from the overall customer value standpoint. *Does the product meet spec?* is one aspect of this, but so are the following:

- Are customer on-time delivery targets meeting spec?
- Is capacity utilization meeting spec?
- Is equipment up time meeting spec?
- Is machine setup time meeting spec?
- Is incoming material quality meeting spec?
- Is material delivery meeting spec?
- And many, many more.

It is not only important to know these items and track the variation in company performance over time, but it is also important to know when the company fails to conform to the given specification and to coordinate a response as soon as possible. Even in the best of systems problems occur, and if they go unnoticed the company runs the risk of disappointing a customer or potentially affecting multiple customer orders.
Non-conformance and variation must be detected as soon as they happen so that corrective action can take place to remedy the situation. Examples include:

**Material Variability**  
All facilities face the problems related to material not meeting specifications. In this age of JIT delivery, a problem on a minor assembly could affect an entire plant’s production. Again, the faster this is noticed the better, so that a remedy can be applied. The more time a company has to react to a situation the higher the chance of a successful outcome.

**Change of Order**  
Today, in many facilities a change of an order can have devastating effects. Not only can it drastically affect the delivery of a particular order to a customer, but it may affect other orders in the plant as well. A mechanism must inform all the affected parties that a change has occurred, so that an assessment can be made and actions taken to remedy the situation before it gets out of hand.

The results of this may vary from handling the change and still delivering on time to the product needing major rework and immediately providing the customer with a new delivery date. In either case it is better to know when the change happened instead of waiting until the effects are felt.

**Line Problems**  
Even the best run facilities have problems, and the most rigorous preventative maintenance programs do not prevent 100% of unplanned downtime. The implications of this go well beyond the individual piece of equipment. It may be necessary to inform up-stream and down-stream production if the equipment is down longer than $X$ time. Also, suppliers may have to be notified to reduce deliveries if $Y$ time has been exceeded.

It is important that the actual condition of the facility be visible to a wide audience, potentially, all the way up to sales, who might be promising an impossible delivery.

Every system and every manufacturing facility can handle some variation and still run smoothly and efficiently, but all operations have their limits. Detecting when these limits have been reached and calling attention to them allows the effects to be quickly contained. The call for attention may not be limited within the plant’s four walls. In an integrated supply chain scenario, which is becoming common, this call may be routed to suppliers, and the remedy may be an action on their part.

All of these issues are cross-functional in nature: something that Production does affects Sales; something happening at a Supplier affects Production, and so on. Effective containment is key, and the longer the delays between the incident, its detection, and corrective action, the more devastating the result.

What companies need is a system that can monitor variation in real-time, and compare current performance against various criteria. These criteria can be production specifications, but also can be historical information (e.g., today’s run vs. last week’s, or last month’s). The system also needs to be able to send a call to action when non-conformance has been detected. The system must be flexible to meet the diverse, and ever changing, needs of a given company.

**True Manufacturing Integration in the Past has been Painful**

"Focusing on the value creation process in isolation from suppliers and customers is not sufficient."

- Introduction to Supply Chain Management, Prentice Hall, 1999

Most existing manufacturing systems have taken a very horizontal approach to problem solving, focusing only on the set of problems in a specific layer.

- **SCM** Supply Chain Management systems focus on issues of an integrated supply chain.
- **ERP** Enterprise Resource Planning systems focus on issues with company back office operations.
MES  Manufacturing Execution Systems focus on issues with plant floor operations.

HMI  Human Machine Interface systems focus on issues with operator interface to equipment.

PLC  Programmable Logic Controllers focus on issues with computer-based control of equipment.

Today, the value is not in the horizontal integration but in the vertical integration of these systems to solve business problems. Unfortunately, getting the layers to communicate has been expensive and painful, especially the higher you go in the stack. Standards are limited and many interfacing methods are highly proprietary.

In spite of these problems many companies have made the attempt. The results have varied but some common threads have emerged:

- Most projects have been large scale (Requiring a year or more to complete)
- Most projects have been expensive ($100K or more)
- Nearly all successful projects were based on solving a pressing business need (typically around key performance indicators)
- Most successful projects had a fast ROI (6–18 months)
- Most unsuccessful projects got bogged down in system complexity because of unclear or changing requirements

What companies need is to reap these rewards without the up front pain and expense. Companies no longer want to expend huge amounts of effort and money with only the promise of a return in the distant future. They want to cut through the layers of existing manufacturing systems and solve the real integration problems they face everyday. They want systems that work with their existing infrastructure, are flexible enough to meet their needs, and are affordable enough for even small facilities.

**Integration Based on Real-Time Event Management**

“Although there are technologies that provide system-specific event notification, these systems are stove-pipe solutions. People want to be notified about multiple business conditions from multiple systems.”

- Matt Cain, Vice President, Meta Group

Companies need an integration strategy based on real-time event management. Simply put, this strategy constantly monitors enterprise and production systems looking for an event. This event is expressed to the system as a rule that needs to be followed. If an event is detected, a corresponding action is triggered. This action can take a wide variety of forms from e-mail to a supplier, a command to a control system, or a complicated sequence of notification/acknowledgement pairs with enforced time limits and escalation procedures.

A true real-time event management system has the following attributes:

**Uses Existing Infrastructure**  All companies have some form of existing information technology and plant floor infrastructure that they don’t want to replace, and most companies are looking for ways to augment it and use it as a competitive advantage. A real-time event management system leverages this investment by tying into existing plant floor and enterprise systems as the bridge between the two worlds.

**Easy to Deploy**  All companies have problems that would be easy to fix if the right people knew about them as they happened. A real-time event management system allows companies to start with key performance indicators and grow from there. There’s no need to install a massive system just to get a tiny benefit; rather, start small and grow.
### Flexible Event Detection
Events must be detected from a variety of inputs and systems. In addition to running SQL queries to identify events reflected in relational databases, a system must detect events generated by procedures and triggers stored in databases and by plant floor equipment, as well as support common data formats and messaging protocols. Only through such a solution can meaningful actions be generated from many diverse systems.

### Rich Action Capabilities
Actions need to take a variety of forms. Some actions require immediacy; thus sending a notification via pager, cell phone, or issuing a command to a plant floor device is required in addition to a simultaneous Web page, e-mail, or fax-based report.

### Centrally Managed
Event detection must be created and managed centrally. Having event detection resident in various systems means that they cannot be managed easily, nor can they provide a comprehensive view of how they are managing the enterprise. Business managers must be able to specify and implement the business rules for event detection quickly, monitor their effectiveness, and alter them based on business conditions.

### Grow as Needs Grow
A real-time event management system is a great first step in any long term enterprise integration plan. It can be used as the Marines landing first in a problem area and holding the ground until reinforcements arrive. Once a problem area is addressed, the real-time event management system can solve the problem or collect data to design an ideal solution.

Real-time event management can bridge the gaps between applications or corporations in a much simpler, faster, and more cost-effective manner than existing systems, such as ERP, MES, or other enterprise integration platforms. Realtime event management produces quick returns because its non-invasive technology requires no enhancement or maintenance programming of existing systems. Event or exception conditions to be monitored are defined using SQL statements which can incorporate pre-defined database triggers or stored procedures, efficiently leveraging an organization's existing query structures. Last, actions are directed to devices that employees, suppliers, and customers already use on a daily basis—pagers, cell phones, e-mail, faxes, web browsers, or even plant floor systems. Information flows directly and immediately to employees, suppliers, or customers, wherever they are and whenever something important happens that they need to respond to.

### Real-Time Event Management Systems Will Enable Agile Manufacturing for the Masses

"Manufacturers cannot solve all manufacturing problems simultaneously with ever-decreasing resources, so they must find business problems with the highest priority."

- Roddy Martin, AMR Research

The Internet has changed many things, and now manufacturing companies around the globe are faced with the need to become more agile. Every year these trends affect smaller and smaller companies, most of which are unprepared and cannot afford the expensive solutions of larger firms. Real-time event management can help by allowing companies to deploy solutions based on vertical thin slices of functionality focused on a pressing business need: for example,

<table>
<thead>
<tr>
<th>Process Control Tolerances</th>
<th>If quality control standards and tolerances are not being met, notify QA, Maintenance, or Engineering.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Conformance</td>
<td>Notify Purchasing and Engineering if a materials delivery fails incoming inspection.</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>Initiate replenishment cycle immediately when material levels reach a planned level (e-kanban).</td>
</tr>
</tbody>
</table>
Material Movement
Notify Operations if materials required for a manufacturing operation do not arrive at a work cell before safety stock is broached.

Delivery Monitoring
Notify Receiving or Operations if scheduled JIT inventory delivery is more than X minutes late.

Equipment/Vehicle Maintenance
Notify Operations if scheduled preventative maintenance lock-out does not occur.

Product Obsolescence
Notify Sales of possible obsolescence situation when individual products have been held in inventory past a time threshold.

Work Order Management
Notify Operations to re-allocate resources or re-route jobs to meet production time schedules if the duration of an open work order slips.

Planning Forecast Review
Notify Operations if forecast received is X% off of expected.

Measuring key indicators and comparing them against fixed specifications or historical data can detect variations and non-conformance in real-time, giving a company the maximum time to react and contain the problem before it affects anything else. It is nearly impossible to solve a problem you don’t know about. Real-time event management makes these problems visible immediately and to those who can do something about it.

Contact Zoneworx
To learn more about how Zoneworx can help make your company become more agile and e-business ready please contact:

Zoneworx Incorporated
40925 County Center Drive
Suite 200
Temecula CA, 92591

P: 909-296-1226
F: 909-296-1227
E: Sales@zoneworx.com
W: www.zoneworx.com