



SAP INSIGHT



THE CASE FOR MANUFACTURING INTELLIGENCE



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THE CASE FOR MANUFACTURING INTELLIGENCE

by Naveen Agarwal



CEO NOTES

Many CEOs understand the value of truly adaptive manufacturing operations - integrating manufacturing systems with those of suppliers, the organization, and eventually, customers - to cost-effectively meet and exceed customer demands.

But that dream has not become reality for most companies. Large numbers of manufacturing operations must cope with diverse IT systems, global competition, stringent manufacturing conditions, thin operating margins, and increasing regulatory requirements. At the same time, CEOs recognize that velocity is critical - to decrease time to market even while improving quality and more effectively meeting demand. Their ability to achieve these goals is hampered by one major thing: lack of hard manufacturing intelligence.

Adaptive manufacturing is the ability of a factory to profitably replenish a supply network while dynamically responding to unplanned events. To be an adaptive manufacturer, a company must have achieved two core capabilities: manufacturing excellence and manufacturing synchronization, as defined below:

- **Manufacturing excellence** is the ability of a factory to reliably produce to targets while delivering best-in-class, year-over-year cost and quality improvements.

- **Manufacturing synchronization** is the electronic linking of enterprise business processes and master data with plant operational processes.

In this SAP Insight, we will focus on manufacturing excellence. The prerequisite for manufacturing excellence is manufacturing intelligence - data access, metrics, alerts, and analytics. Access to manufacturing intelligence provides the operation with greater quality, agility, productivity improvement, asset optimization, and information accessibility. The key manufacturing intelligence applications area as follows:

- Real-time performance management (dashboards, scorecards, metrics)
- Continuous improvement initiatives (Six Sigma, lean manufacturing, TPM, right-first-time)

This SAP Insight explores the problem manufacturers face, the SAP Solution designed to help them and the various ways that solution has helped companies increase their level of manufacturing intelligence and become more adaptive.



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THE PROBLEM: A DISCONNECT

Most manufacturing companies suffer from a real disconnect between their enterprise resource planning (ERP) systems and manufacturing operations. While IT systems contain the information needed to solve problems but existing systems are not integrated enough to surface the information.

The system environment, at the lowest level, typically consists of shop floor automation and control systems (SFACs) that collect data from the PLCs and sensors connected to machinery on the factory or plant floor. SFACs usually connect to historical and supervisory control and data acquisition systems, known as SCADA, which are used as repositories to store this voluminous data on a real-time basis and drive feedback control at the machine level. At the next highest level are manufacturing-execution systems that track all customer orders, schedules, labor, resources, and inventors across the production line by shift.

A typical manufacturing plant will have between 10 and 50 SFACs; a multisite manufacturing company will often have between 40 and 700 SFACs across the enterprise. Yet a recent survey found that less than 1% of respondents indicated that manufacturing data is automatically integrated with ERP.

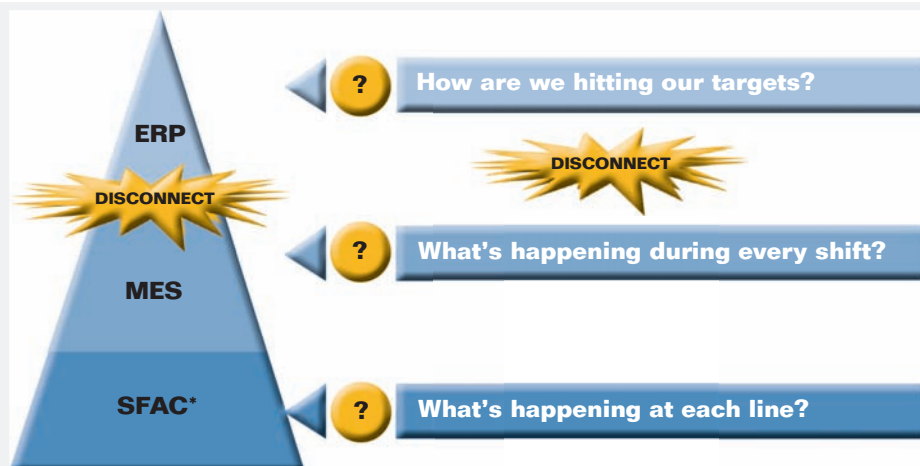
At the same time, manufacturing intelligence is growing in importance because it can ease common problems such as:

- **Plant managers missing their budgets**, the result of their inability to measure and control actual production costs against targets.
- **Production personnel in a constant state of putting out fires**, because they cannot see manufacturing exceptions and respond when they happen.
- **Wide variations in manufacturing performance across shifts**, lines, and plants because too much time is wasted looking for needed data across multiple systems.

These very real problems symbolize a gap between the business and the real-time plant floor. This disconnect leads to a lack of visibility into manufacturing exceptions and performance deviations, which adversely affect responsiveness and in turn, debilitate performance.

Figure 1

Where the Disconnect Originates

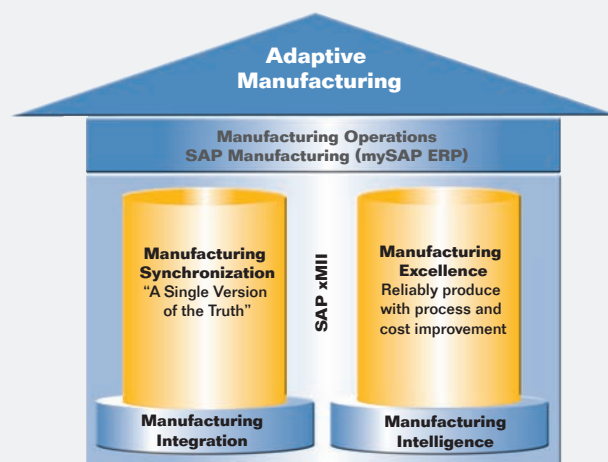


THE SOLUTION: SAP® XApp™ MANUFACTURING INTEGRATION AND INTELLIGENCE

The SAP® xApp™ Manufacturing Integration and Intelligence (SAP xMII) composite application provides a unified approach to delivering manufacturing intelligence. Some of the world's top companies have begun to work toward adaptive manufacturing with the help of this application. SAP xMII provides manufacturing intelligence with a real-time analytics engine that aggregates and delivers unified visualization of events, alerts, key performance indicators (KPIs), and decision support to production personnel through role-based dashboards. SAP xMII can serve as a single, standards-compliant connection between ERP and other software, such as manufacturing-execution systems, sales force automation applications, and legacy systems - thus driving the interoperability of plant-to-enterprise business processes.

Figure 2

Adaptive Manufacturing



MANUFACTURING INTELLIGENCE: SOLVING THE QUALITY PUZZLE

Quality control has long created a puzzle for many manufacturers part because improving quality requires process stability and capability. Companies that have solved the quality puzzle, in fact, perform analysis using real-time manufacturing process trends and history. This historical data enables them to better understand how the variations in the process affect the variations in quality. These companies avoid process difficulties with real-time information about the process, allowing them to maintain their statistical quality control (SQC) limits within a tighter band. The processes throughout their plants show a greater degree of consistency across all shifts at all plant locations.

SAP xMII can help other companies achieve greater quality content by helping:

- Reduce "out of spec" held product;
- Reduce scrap and waste;
- Improve yield (reduced product giveaway); and,
- Increase customer satisfaction and sales due to improved consistency; in the food industry, for example, in flavor, texture, portion size.

REDUCED SCRAP AND WASTE

If certain product specifications fall outside official control limit, there is no cost-effective means to rework the product. This is often the case once a product has been packaged and is ready for shipment.

A dry-baked-goods plant, for instance, was experiencing difficulty in controlling moisture content in its finished product. If moisture content is too high, the product becomes soggy after 24 hours in the package. If it is too low, the product becomes brittle and turns to dust during the distribution process. Off-spec material must be scrapped. Control of moisture content is challenging, and fluctuations occur periodically due to variation in hold times and other shift-timing variables. The inability to reduce scrap and waste costs the company \$122,400 per month, with an annual cost of \$1.47 million.

With SAP xMII, however, analysis of historic production cycles reveals the critical process parameters that provide earlier indication of high moisture content. By using SQC methods and real-time information to monitor these variables, SAP



REDUCE "OUT OF SPEC" AND "HELD" PRODUCT

If product specifications fall outside control limits in a manufacturing process, the product stream or batch is often placed in a "hold" status while the severity of the deviation is evaluated and corrective action is taken. Early detection helps recover or rework the defective material. However, there are costs associated with the hold time and rework.

One brewery was experiencing periodic filter breakthroughs in its filtration room, which produced a stream of beer with a high turbidity. This "off spec" quality deficiency was detected during routine sampling in the holding tank before going to filter. The filter cartridge was replaced, but 400 barrels of beer had to be stored and refiltered. In addition, a different product was redirected into the line to continue production while the off-spec product was being reworked. The cost to the brewery for a single instance was \$92,150 for an annual cost of \$368,600 if the problem were to occur four times a year.

Instead, with SAP xMII, filter-room parameters including differential pressures, temperatures, and turbidities are displaced in real time for the operators. Early signs of filter breakdown are detected by exception, and operators can predict filter charges based on filter condition rather than time in service. Filter cartridges are replaced when necessary, immediately, without interrupting production, resulting in cost savings of \$1,150 per occurrence with annual savings of \$4,600. The company in turn enjoys a revenue increase of \$91,000 per occurrence for an annual revenue increase of \$364,000.

CASE STUDY

xMII alerts production operators to these indicators, enabling them to make adjustments before moisture content drifts out of specification. Over a period of time, the number of bad batches is reduced.

With this capability, the plant will save \$1.29 million annually. And because the plant is operating at full capacity, seven more product batches are sold each month, with annual revenue increases of \$2.52 million.

REDUCED OVERRUN AND UNDERRUN OF PRODUCTION ORDER

The ability to match actual production to the schedule can be difficult, especially if the schedule often changes in the middle of the shift. At the same time, it is important to match production to the schedule because it leads to more efficient inventory control, lower working capital requirements, and cost reductions.

In another situation, a consumer packaged goods manufacturer was having trouble matching actual production to the schedule. The operators, lacking real-time production data, would estimate

production based on sums of machine counts. As a result, over- and underruns were common.

Estimating also posed problems for the different support groups responsible for ordering and staging the production materials, resulting in a mismatch of production material. Leftover materials were either scrapped or sent back to their storage areas to make room for the next run; handling them twice increased costs. Special-order products were frequently scrapped. Underruns resulted in lost sales, costing the company \$3.29 million annually, while overruns, which required additional movement and storage, cost \$706,000 annually.

With SAP xMII, operators can simultaneously view scheduling information and production order fulfillment status from the company's ERP system, and real-time production data from the plant floor systems. This same information is also available to support staff in the warehouse and across the enterprise. The ability to correctly match actual production to schedule reduces the average mismatch to 50 cases for the 10,000-case run. Annually, the company saved \$2.7 million preventing underruns, and \$509,000 preventing overruns.



CASE STUDY

IMPROVED MANUFACTURING YIELD

The variation in process parameters is not always enough to produce off-spec product, but it can increase material cost, larger-than-normal portion size, or product giveaway. Improved process stability can reduce this variation and increase the yield of the manufacturing process.

One example is a packaged goods manufacturer that had difficulty controlling the amount of a high-cost ingredient in the product. The solution to a variation in viscosity was to periodically add more than the needed amount to be certain to meet the minimum spec. The nominal was set near the upper control limit to make certain the low fluctuation did not fall below the minimum specification. However, fluctuation in the piece weight of the finished product regularly exceeded the upper control limit, resulting in product giveaway for an annual cost \$575,000.

Historical analysis of the process using SAP xMII indicated that the condition of the batch between the mixing and the extrusion phase (time, temperature, agitation) were primary contributors to viscosity. Production operators made improvements in the consistency of the conditions under which batches are held before extrusion. Using this real-time information, production operators monitoring batch conditions are alerted when a prepared batch requires a change in temperature or agitation to keep its viscosity within the desired control limits. With this system, the company expects to save \$476,000 annually.

INTELLIGENCE: APPROACHING THE SIX SIGMA IDEAL

Providing real-time information multiplies organizational effectiveness. When knowledge workers are faced with a process to improve, they typically spend 80% of their time obtaining the information they need, and 20% analyzing it and making decisions that will improve it. With SAP xMII, the current and historic data from multiple sources, systems, and locations is available instantly in real time, in its original resolution, with a few clicks of a mouse. Powerful client tools allow knowledge workers to compare, analyze, and manipulate the data quickly in a way that makes sense to them. The result is a drastic improvement in productivity, with roughly 10% of time spent gathering data, and 90% spent analyzing it.

This can be illustrated by a process engineer at a Fortune 500 company, who is charged with the responsibility for finding ways to reduce costs by \$2 million annually. With SAP xMII, he and his group easily achieve more than twice that level, effectively doubling their effectiveness without adding a single headcount.



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INTELLIGENCE: OPTIMIZING ASSETS

In every manufacturing plant, a cycle of steady-state operation must be balanced with the proper equipment maintenance. If the production cycle is stretched too long before maintenance, equipment inefficiencies can increase operating costs and reduce yields. Moreover, these inefficiencies can increase the risk of run to failure, which can result in unplanned downtime and extensive maintenance costs. On the other hand, preventive maintenance performed more frequently than needed can result in lost production time and increase maintenance costs accordingly.

To the extent that limiting factors of these cycles can be understood and their cost calculated, the process cycle can be optimized. With the real-time information provided by SAP xMII, plants can perform maintenance based on the actual condition of the equipment. SAP xMII provides the tools to collect the information, perform the advanced calculations, and help engineers optimize these production cycles.



CASE STUDY

A food processing plant provides a case in point. The plant requires heating and cooling, and crystallization occurs within the tubes of the heat exchangers. With continued operation, the thickness of the deposits increases and heat exchanger efficiency is reduced, resulting in higher energy costs and lower process yields. In addition, heating and cooling cycles take longer, reducing overall equipment effectiveness. The need for efficient operation must be balanced against meeting the production schedule, along with the downtime and labor costs required for cleaning the heat exchanger.

The plant was recently having difficulty meeting its production schedule. Weekly heat exchanger cleanings were postponed to avoid lost production time, but yields were suffering. The company estimates the total costs of the inefficiency at \$440,000 per year.

By implementing SAP xMII, however, engineers can measure and examine the interaction of complex variables in real time. The engineers use SAP xMII to calculate the optimum point to take the heat exchanger out of service for cleaning. The heat exchanger efficiency calculation is an array based on differential pressures, temperatures, flows, and energy losses. The energy evaluation is drawn from the cost of coal, boiler efficiencies, and steam usage. Combined with the increase in cycle time, the energy costs are compared against the known costs and estimated downtime for cleaning the heat exchanger. The resulting calculation determines the optimum time to take the heat exchanger out of service for cleaning. SAP xMII allows operators to monitor the condition in real time, and alert maintenance personnel in advance for planning the exchanger's cleaning. With SAP xMII, the company has cut its yield losses to 3% from 7% and achieved annual savings totaling \$252,000. In fact, the improved yield from the clean exchanger more than offsets the production losses from the cleaning downtime.

INTELLIGENCE: INFORMATION ACCESSIBILITY

SAP xMII can make information available anywhere in the world. Teams of engineers can better analyze and resolve problems and/or determine the root causes of an outage, even from a remote location. Corporate central engineering or staff can access plant data from remote offices.

Consider the example in which the Shanghai plant of a Global 1000 manufacturer suffered from an equipment failure that idled two of its lines. The automation engineer, located at corporate headquarters in London, and the plant process engineers, away from the plant at a conference in Sydney, could not do much to help - and likewise the process engineers in Frankfurt. While some plant information was relayed to London via e-mail and fax, the automation and process engineers could not manage troubleshooting without more detailed real-time information. It took a full eight hours to contact the engineers in Sydney, and another 12 hours for them to travel back to Shanghai. Once at the plant, the engineers successfully solved the problem, and the plant was up and running again in four hours. But because of the lack of information, about \$440,000 was lost in sales.

With SAP xMII, employees in each remote location could have viewed the same detailed historic data leading to the failure along with the real-time data during troubleshooting. The plant could benefit from expert assistance in real time - without incurring expensive travel costs.

In this case, the automation engineer immediately accessed the process trends, and directed the troubleshooting effort from London. While the plant contacted the process engineers in Sydney, the engineers in Frankfurt accessed the data in SAP xMII. The engineers narrowed down the problem to one of their possible causes. As soon as they reached the engineers in Sydney, they reviewed the data in SAP xMII, discussed the troubleshooting effort with the other engineers, and quickly solved the problem. The plant is up and running again in nine hours, rather than the 24 it would have required previously. And the exercise does not demand a special trip to Shanghai from Sydney. The plant saved 15 hours of downtime, and \$264,000 in lost sales.



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CONCLUSION

In the quest for manufacturing adaptability, the right manufacturing intelligence is paramount. Manufacturing intelligence provides the near-time visibility into customer orders across multiple plants - from scheduling to dispatching. It allows the manufacturer to proactively detect machine, material, labor, and quality issues before customers do. And it helps the manufacturer evaluate real-time KPIs and actual production costs and variances against targets. In short, manufacturing intelligence supports manufacturing integration, and together they provide the foundation for manufacturing adaptability.

SAP xMII helps provide this intelligence by electronically synchronizing ERP and master data with real-time manufacturing processes and systems, to deliver “a single version of the truth” across the enterprise.

The results are impressive. Synchronized manufacturing provides:

- Higher Customer Satisfaction
- Reduced Costs and Errors
- Rapid Time-to-value
- Lower TCO

Figure 4

**Maximize Value from your
Manufacturing Operations
with SAP xMII
Manufacturing Integration
and Intelligence as Levers...**



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