Curing Enterprise Rigidity in Manufacturing Companies

The Value of Enterprise Control

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1. The Need for Enterprise Agility

If you find that market uncertainties make it difficult to optimize operations of your manufacturing business, then an agile solution that gives you better control of your enterprise resources may be what you need.

Manufacturing companies often struggle to optimize their business due to the rigidity of their internal systems and operating procedures. Rigidity is often designed into manufacturing organizations in order to create predictability. In a dynamically changing world like today’s, organizations need to be both predictable and agile. Manufacturing companies must be able to produce repeatable quality at low cost while adapting to changing market conditions. The constant struggle between the needs for repeatability and agility is one of the biggest challenges for modern corporations.

Before we introduce the concept of enterprise control, we would like to shed some light on why it is important to handle uncertainty and to have better control over enterprise-wide operations.

If you take a look at the state of typical manufacturing companies in early 2011, there are a number of common elements that describe their situation:

• Production output is approaching pre-recession levels, but many companies still have excess manufacturing capacity.
• Most companies are experiencing good growth, but they are concerned if it will last.
• Corporate earnings are booming due to tight cost control and streamlined operations.

The questions on the executives’ minds are: “Will this last?” and “How do I take advantage of the current growth without setting the company up for new failure in the event of a ‘double dip’?”

You might ask, “What are the reasons that these executives are questioning the future?” Here are some examples of concerns that we have seen from manufacturing companies:

• The cost of raw materials is increasing and may continue to go up. An example is the recent rise in wheat prices that have cut into the bottom line of food manufacturers.[1]
• Intermediate goods costs are going up. Economic development in rapidly growing nations that have supplied low-cost ingredients is a cause of concern. The relative economic strength of countries like China may eventually lead to a strengthening of their currency, which will cause an increase in the cost of intermediate and finished goods produced in these countries.[2]
• Consumers are becoming more demanding, requiring more value and more choices for less cost.[3]
• Political instability in countries and regions that have been reliable suppliers of low-cost raw materials, such as oil, and labor-intensive manufactured products, may cause temporary or long-term disruptions in the supply chain. Recent developments in the Middle East and Northern Africa show that educated and well-informed populations are revolting against their leaders in the quest for food, stability, wealth and democracy.[4]
• Large trade deficits and surpluses are changing the global economic power balance. Countries that are consuming more than they are producing will increase their dependency on the foreign countries that have financed their consumption.[5]
• Government deficits are a source of concern with regards to future taxation levels and the level of government services that can be provided. Government and trade deficits may eventually change the currency evaluations for the implicated countries.

In order to compete successfully, corporations must be agile enough to change when the economic conditions change, while being prepared to accelerate their growth when the market is taking off.
This white paper shows how manufacturing companies can align operations with the corporate strategy to optimize business performance and maximize the economic output over time. Process control and production control are often seen as technical tools that have little direct influence on the financial performance of a corporation. This white paper explains how business performance can be improved with enterprise control that spans from the process level to the financial reports.

2. Symptoms of Enterprise Rigidity

Creating the agility needed to meet the challenges listed above may seem like a daunting task. Most manufacturing companies have an element of rigidity that makes it hard for them to change fast enough to handle unforeseen obstacles.

Some of the symptoms of enterprise rigidity are:

- Organizational culture that is resistant to change, often due to lack of visibility into corporate goals and lack of empowerment to take action.
- Business systems with processes that are outdated, dictated by the enterprise resource planning (ERP) system supplier and set in stone.
- Business systems that have grown in complexity to the level where they are hard to maintain and no longer add value.
- High costs due to non-value-added processes that have been implemented in the enterprise with the intent of providing better business control.
- Large inventory levels that expose the corporation to risk in the event of changes in customer buying behavior.
- Production facilities with long change-over times, forcing large batches to be produced to meet expected demand.
- Lengthy times to introduce new products and ramp up production to a level where it creates self-sustaining value.

This rigidity not only reduces the corporation’s ability to be profitable, but it also exposes the company to tremendous risk which may lead to the failure of the entire business. The current competitive environment is forcing companies to operate with lower margins and fewer resources which makes operations very sensitive to unforeseen changes.

3. The Traditional Approach to Enterprise Control

The traditional approach to enterprise resource control is to implement ERP systems with the focus on financial information. This approach is facing the following challenges:

1. Financial measures are lagging indicators
   - They are generated after-the-fact and often are only communicated at an aggregated level to a select group of employees.
   - They are seldom presented in the context of the day-to-day job that needs to be done.
   - They are not available to the people who can make a difference. You may think that only C-level people in a company have the power to make decisions with big financial impact, but the reality is that “the operator on the plant floor has the biggest check book, and he does not have to ask for permission to make a mistake.”

2. ERP systems are designed for planning, not for control
   - A plan does not equal reality. A famous quote is “If you want to make God laugh, tell him your plans.” Many organizations are trying to create plans that go beyond their controllable time horizon.
   - When reality changes, plans become unrealistic. The perception that the plan is real sometimes delays necessary changes in the organization.

3. Few people have access and visibility into the system
   - Performance targets are created but poorly communicated, enforced and updated.
   - The result is that people do not understand how their day-to-day job is related to the corporate goals.
4. Controlling Enterprise Resources

Enterprise resource control may seem like an unachievable goal. This is why Invensys has defined enterprise control as a journey toward the ability to optimize operations and maximize the financial return on the operating assets.

Invensys has expanded from a process control company to an enterprise control company, and we are inviting you to join us on the same journey. One way to understand how enterprise control has evolved is to look at the analogy with other control systems that exist in Invensys’ portfolio.

Measurement, Instrumentation and Automated Data Collection

One of Lord Kelvin’s famous quotes is: “If you cannot measure it, you cannot improve it”. This statement is as true today as it was more than 100 years ago. At the enterprise level of a corporation, performance is measured in financial terms; at the process level, performance is measured in pressure, flow, temperature, level, etc. Invensys is in the unique position that we can offer solutions that provide real-time accounting measures that link the information from the enterprise level to the production unit level, with integrated closed-loop feedback.

Manufacturing process performance is the foundation for enterprise performance. Most manufacturing companies have a majority of the value creation at the process level. Inaccurate measurement and data collection at the process level will have a ripple effect throughout the corporation and cause ineffective enterprise control.

A basic element of control theory is that you need to sample your measurements at least twice as fast as the highest frequency change that you want to control in your process. This may sound very theoretical, but imagine that you are driving a car with your eyes closed, and that you would only open your eyes for one second every 10 seconds. This may work okay if you are on a road that is completely straight and with no other cars present. Now imagine that you are doing the same thing in a busy city with intersections, pedestrians and curves in the road. The result would be catastrophic as you have no understanding of what happened while your eyes were closed. The same is true for process control. Enterprise financial systems are typically updated monthly; some companies may be very aggressive and look at the financial information daily, but imagine how difficult it would be to run a business if the only visibility to the operation was an annual snapshot of the balance sheet. At the process level, business critical information may change in the range of hours to seconds; controlling your enterprise with information that is at best updated daily is like driving with your eyes closed on a busy road with curves. Measurement and data collection at the process level must be done quickly and accurately.

Automation is often referred to as a mechanism for reducing the cost of the human workforce, but this is not its most important contribution. History has shown that automation’s biggest value is accuracy, quality and repeatability of information and processes. Most modern products cannot be produced without automation. Process data changes very frequently; hence, the amount of information to be collected goes beyond what is humanly possible to manually collect. Manually collected measurements are prone to reading and recording errors. Measurements must be done automatically in order to meet the requirements for sampling rate and accuracy.

The first function in enterprise control is to ensure that accurate, timely and automated measurements can be made. The measurements must be done at all levels of the enterprise starting at the process level and propagating up to the financial level. Invensys offers a wide range of measurement and instrumentation solutions that provide data with a necessary accuracy and automated sampling rate to ensure that the right data is available to control the enterprise.

Process Control

A basic requirement for any control system to function is that actions must be taken before an unacceptable error occurs. Process control systems are designed to take accurate and timely actions for all predictable events. This is the area of control that Invensys is most famous for. Invensys has more than 100 years of history in the process control space and has been a significant contributor to how modern control systems work.
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In traditional process control systems, a process is controlled either through:

- Logic control where a set of logical expressions are used to determine how to operate a machine or a process. This type of logic is typically done in a programmable logic controller (PLC) using ladder logic, structured text programming or other types of Boolean logic.
- On-off control where negative feedback control is used to turn on or off a process to achieve the desired process output. This type of control is often used for temperature control.
- Regulatory control where negative feedback is used to manipulate the process to a desired state. This is most often done using PID (proportional-integral-derivative) control loops and implemented using function block diagrams.
- Batch or sequential control wherein a time-based series of specific actions are executed over a set time period.
- Hybrid control which is some combination of the above.

The analogy between a process control system and business operations is very strong. The corporation is guided by a "business operating system" which typically is implemented through documented processes and quality management systems. Any abnormal business outcome or behavior is flagged as a business deviation. Similarly, the control of plant floor processes is done using a process control system. When a process deviation occurs, an alarm is raised which indicates that human intervention is required. The process control system is equivalent to the business operating system, and the alarm is equivalent to the business deviation.

Invensys offers automated process control ranging from single-loop controllers, through programmable automation controllers (PACs) to distributed control systems (DCSs).

Production Unit and Production Line Control
Invensys entered the production control space through the introduction of distributed control systems, supervisory control systems, and batch execution systems. Production unit control is at the very heart of an enterprise control system. The production unit is the smallest element that can be identified to produce real economic output. Production unit control is focused on the ability of a single unit or line to produce the intermediate or finished goods that have been requested.

Unit and line control is focused on:

- Equipment state, often represented through the OMAC (Organization for Machine Automation and Control) model.
- Batch process control, often represented using the ISA-88 model.
- Procedural control, which can be represented using the ISA-106 model.

Production unit control is often implemented using sequential flow diagrams that show how the unit/line can transition between the possible production states. Production unit performance is often measured as economic output per production unit and as overall equipment effectiveness (OEE).

Plant Control
Invensys is a leading supplier of solutions for manufacturing execution (MES) which is the key element of a plant control system. Plant control is focused on operating the plant to fulfill production orders as requested by the manufacturing resource planning system (aka MRP II). Plant control is focused on:

- Finite capacity scheduling to optimize the production schedule based on criteria such as cost, on-time delivery, risk and inventory size.
- Production dispatching to instruct production units/lines about what to produce.
- Manufacturing operations to manage the totality of plant floor resources such as machines (units/lines), work in progress, inventory and personnel.

Well-run plant control systems optimize the operations of the plant with regards to strategic goals and economic output.
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Multi-Plant Control
In a multi-plant control system, the real-time information about the current and planned plant status is used to determine which plant should be requested to produce specific finished goods. The nature of a multi-plant control system varies both in form and complexity based on the type of products that the plants are producing:

- In some industries, the sum of the plants can be controlled in a fleet management system, as occurs with power generation plants that feed electrical power to the same grid.
- In other industries where production tasks cannot be moved as easily as in the power generation industry, the multi-plant control system is primarily focused on detecting, generating and distributing best practices for plant and process modeling, measurement and optimization. This type of modeling often includes generation of manual and automated workflow processes. These best practices can be used for continual improvement processes and for comparing plant-to-plant performance.

Multi-plant control requires solutions for creation, distribution and management of corporate standards for systems and processes.

Production Asset Management and Maintenance
The production units are significant financial assets that must be managed and maintained to produce the optimal economic output. In extreme situations, assets can be optimized to maximize either availability or utilization, although neither of these extremes will produce the optimum economic output.

Invensys asset management solutions provide maintenance management, spares and inventory management and spare part procurement capability. When coupled with condition-based monitoring, Invensys is uniquely positioned to offer customers real-time answers to help reduce costs while continuing to maximize asset reliability and performance. The overall asset management solution helps customers realize an optimum return from all their assets—people, processes and equipment—thereby enabling true asset excellence.

People Enablement, Operations and Workflow Control
Most operations at the enterprise level are done with human interaction. Enterprise control systems extend the automated control from the process level to the enterprise level by implementing business process workflows.

Invensys is offering workflow functionality that allows business processes to be integrated from the plant floor to the board room. Workflow tools can capture best practices, optimize these practices to make them lean and execute them to provide consistent operational excellence. The practices can be continually improved and evolve to meet constantly increasing requirements for operational efficiency. Well-documented processes significantly reduce the risk of losing business knowledge due to staff attrition and retirement.

Contextualization Services
Contextualization is a critical element of an enterprise control solution. On the financial level, contextualization is used to identify the impact of a financial measurement where information such as revenue, cost, profit, assets, liabilities and debts, is put in context of time, business unit, customers and product lines. Similarly, production and process information is put in context of plant floor events. Examples of contextualization include equipment, team, product, production order, batch and time.

A temperature measurement makes no sense to a shareholder of a corporation, but it may be critical to the economic value creation of a production line. Enterprise control enables process data to be put in context of production data, turning a process level measurement into valuable enterprise level information.

Contextualization can either happen through standardized rules and naming conventions and manually configured relationships, or through a semantic engine that identifies the behavioral relationships and exposes them to the user when appropriate.
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Intelligence and Analysis Services
Intelligence and analysis services allow for correlation of information in similar context. An example is to be able to show a comparison of the information of the currently produced batch, overlaid with the optimal golden-batch. This enables process improvements to be made in real time.

Deviation management can also be implemented using analysis services. Automated control systems generate alarms which is the process control system’s way to create a business process deviation report. Analysis services are able to analyze vast numbers of alarms and correlate them to process performance and economic output.

Analysis services can aggregate data so that it becomes relevant for higher-level business understanding. Aggregated data can be used to compare enterprise actuals against enterprise plans.

Visualization Services
Humans are a critical part of enterprise control. Invensys is a leading supplier of human machine interfaces (HMIs) that allow operators to see information about a process’ behavior and performance that would otherwise not be visible. Visualization systems for other parts of the enterprise control system are equally important. Information needs to be transparently presented to and from all parts of the enterprise, and it needs to be presented in context to all relevant users.

Information can be presented with a number of different technologies that each provide a different advantage:

- Large TV displays present information to a group of people in a single location.
- Operator HMIs represent information about a relevant process to one or more operators.
- Desktop software and web browsers present content to stationary users throughout the corporation.
- Phones, PDAs, and tablets provide personalized information that is available wherever you go.

Visualization services together with contextualization services provide the situational awareness that allow humans to see patterns, issues and opportunities that are hard to detect programmatically. Visualization services enable solutions to be built that are embedded in day-to-day operations.

Control and Optimization Services
Control and optimization services provide value at all levels from the plant floor to the enterprise. Control and optimization are similar in many ways, but they have some very distinct differences. The primary difference is that optimization services focus on identifying the optimum state of a process based on a set of criteria, whereas control systems are responsible for driving the process towards a defined state. An example of optimization is the process of planning a route and driving a car in order to minimize the driving time. The control system would focus on following the laws of the road and driving the car safely, whereas the optimization system would focus on minimizing the driving time.

Real-time and predictive process simulation enables future process outcomes to be understood. This type of prediction can be used to take corrective actions before an undesired outcome is produced. Simulation can also be used for process and plant design, operator training and process improvements such as “what-if” scenarios.

The control of continuous processes can be optimized using advanced process control (APC). Continuous processes are distinctly different from discrete and batch processes, as data from the process is auto-correlated, which means that there is a statistical correlation between two samples that are taken close together in time. APC commonly uses a model of the physical system to determine what the process’ behavior should be and then optimize the control parameters. This type of system is known as model-based predictive control. APC is used to reduce the variance of continuous processes so that the process can be run closer to its specification limit.
The control of discrete and batch processes can be optimized using statistical process control (SPC). The data from discrete processes does not have any auto-correlation, unless the process is out of control. SPC can be used to determine the predictability of the process as well as determining unexpected changes in the process’ behavior. SPC is used to reduce the variance of discrete and batch processes so that the process can be run closer to its specification limit.

Optimization at the enterprise level enables companies to optimize the use and performance of all the resources they have at their disposal. Enterprise optimization can benefit from the process optimization tools that are used on the plant floor.

Enterprise Control
Enterprise control takes the control capability beyond managing plants, and extends it to controlling all the resources in the enterprise. An enterprise control system is focused on optimizing the operation of a business and is typically measured along the following four perspectives (as defined by Kaplan and Norton\(^6\)):

- Financial perspective: Indicators of business performance that deal with the P&L, cash flow and balance sheet including ratios that measure the overall ability to return value on an investment.
- Customer perspective: Indicators that measure customer engagement and satisfaction. Net Promoter Score is one of several ways to measure the performance of the customer perspective.
- Business process perspective: The enterprise’s ability to effectively execute their business processes in order to achieve the strategic goals and optimize the financial output.
- Learning and growth perspective: The enterprise’s ability to gain new knowledge and improve its business processes.

Enterprise control requires a very strong link between strategic and financial business objectives, and must include elements for real-time finance and procedures for continuous optimization.

5. The Benefits of Enterprise Control

Invensys has experienced the business benefits that our customers are gaining through the projects that we have delivered. Some of these benefits are:

- Improved product quality through reduced process variation.
- Better ability to innovate by enabling manufacturing to ramp up new products faster.
- Reduced cost through reduced waste and higher productivity.
- Better ability to serve your customers with the right product at the right time through improved agility.

These and other benefits enable an enterprise to optimize business performance in alignment with its corporate strategy and to maximize return on operating assets.
6. Building a Control Solution that Fits Your Enterprise

No two corporations are the same; hence, no two enterprise control solutions can ever be completely identical, but they are often assembled from similar parts. Invensys has identified the need to create repeatable solutions that can be adapted to each company’s requirements. Industry Solution Blueprints provide templates and starting points for how to select, implement, sustain, and enhance enterprise control solutions. For more information about how Invensys can help you turn your Enterprise Rigidity into Enterprise Agility, please visit iom.invensys.com.

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