Challenges and trends in discrete manufacturing

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Over 50 years ago, the 100,000 workers at Ford's Rouge automobile factory turned out 1200 cars per day. Nowadays, Ford's plant on that same site still produces 800 cars each day – but with just 3000 workers.

Similar stories abound in the manufacturing industries; technology revolution and evolution; a shift from vertical integration, better business and production practices and improved industrial relations – all have changed manufacturing beyond recognition.

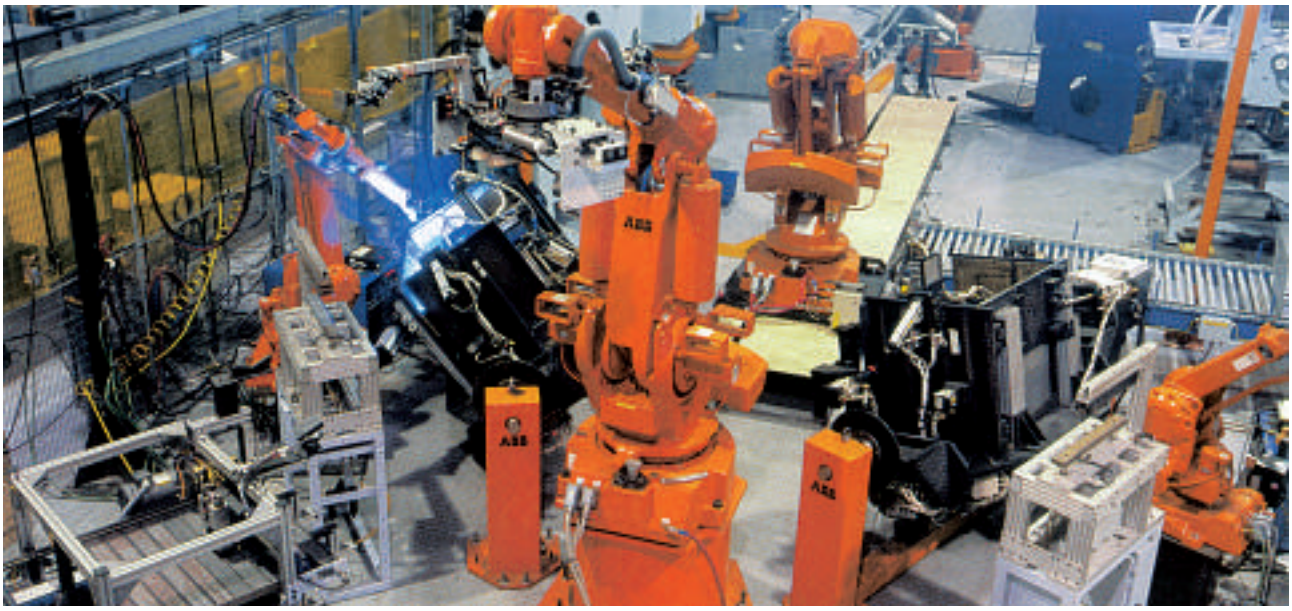
So what are the current challenges and trends in manufacturing? Certainly, the relentless advance of technology will continue, as will user pressure for more customized design or improved environmental friendliness. Some trends are already with us and more, as yet indiscernible, will come. But one major, fundamental shift now resounding throughout industry is the way in which information involving *every single aspect* of the manufacturing process is being integrated into one seamless system.

To remain with the automobile manufacturing example, consider the information transfer frenzy unleashed, directly or indirectly, when a new car is ordered; dozens, if not hundreds, of systems become involved: order processing, sub-assembly and component suppliers, shipping companies, logistics, overall production line control, controllers for robots, paint shops, welders, car delivery logistics and so on. The list is seemingly endless; it is little wonder new cars take months to deliver.

This situation is now changing very quickly. Increased competition in the manufacturing world is forcing companies to continually adapt their production practices in order to stay ahead of the pack. The quest for further improvements to operational and manufacturing excellence is increasingly focusing on enhancing the productivity of existing production assets. Typical solutions, such as Lean Manufacturing, aim to raise machine utilization, shorten lead times and lower inventories. More advanced approaches seek to successfully link shop floor operations to their front-end systems, such as ERPs (Enterprise Resource Planning) and SCM (Supply Chain Management) applications. But even these approaches do not successfully provide a holistic solution in which all relevant internal and external information, from the topmost business system all the way down to the shop floor, can be shared, in real time.

A holistic approach

In the past few years, most large manufacturers have heavily invested in eBusiness IT infrastructure to improve



business operations, and it is just this infrastructure we must look to to increase the productivity of manufacturing operations. There are three fundamental elements of this IT infrastructure that a modern manufacturer must have in place if it is to be ranked 'world class':

■ *Business systems that integrate the manufacturer with its suppliers and that integrate all the relevant processes from the order front-end to the shop floor.* Two vital factors here are transparency and automation of the whole chain. The shop floor and key suppliers should know order details and capacity requirements in real time. In practice, this would mean that when an order is placed, all relevant parties receive, at the same time, the information they need (article specification, quantity required, date of the delivery, etc) to start work on the order 1. This enables capacity to be very closely matched to requirements. Information transparency to suppliers is one of the most efficient ways to reduce

1 All parties involved in a world-class operation must have access to all relevant information in order to optimize the supplier-to-customer chain (3). This requires integration of business systems (1) and the production information and product manufacturing technologies (2).

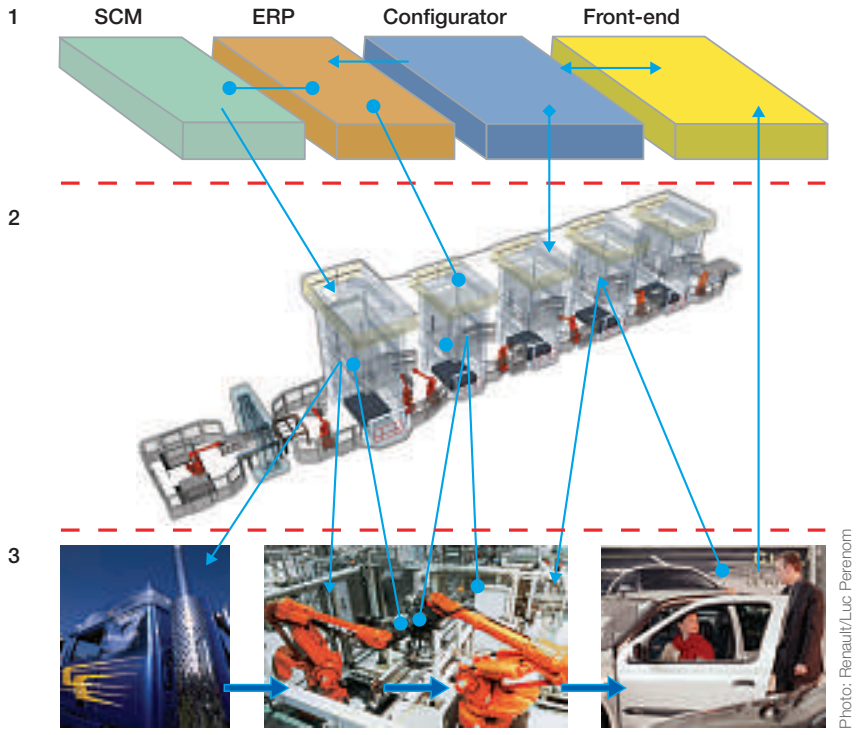
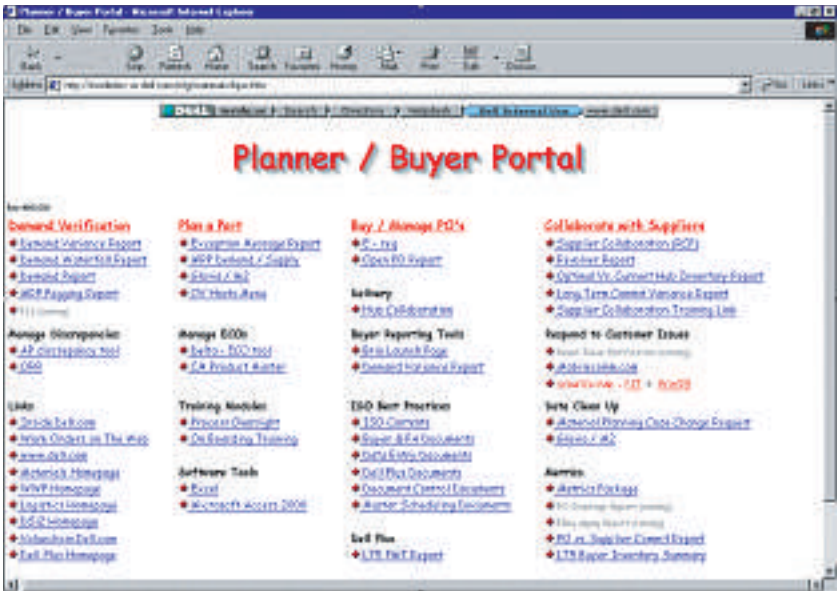


Photo: Renault/Luc Perenom

2 Dell's planner/buyer portal



inventories and improve on-time delivery by suppliers. Inventories are replaced by information, and the shop floor and supplier can report on available capacity, delivery dates, delivery problems, etc.

■ *Optimized information and material flow on the shop floor:* Often the best result comes from applying traditional best practices of Lean Manufacturing or JIT (Just In Time) combined with advanced production control methods (eg, CONWIP, Constant Work In Progress), tailored to the specific requirements of the factory in question. The key here is to have a simple and robust production control system which makes information and components available to all parties involved in the production process, despite the continuous and fast-moving flow of raw materials, parts and components.

■ *Product manufacturing technologies:* A good knowledge of the equipment, product design which is linked to manufacturing, rigorous functional maintenance and quality programs, and an adequate level of automation all ensure high productivity.

A good example of a company that has taken this holistic approach to manufacturing, and which considers operational excellence to be its key competitive factor, is *Dell Computer Corporation.* Dell has introduced many practices that are considered industrial benchmarks in discrete manufacturing.

A theory developed by William Lovejoy [1], states that information, capacity/capability and inventory are substitutes for each other. Building on this idea, Dell developed 'ValueChain', a pipeline for real-time information exchange with suppliers. ValueChain enables a common global procurement process within Dell and suppliers. In this, global supply planning generates a constrained optimal supply plan 2 and a demand fulfillment philosophy successfully aligns material pull with customers' orders. Virtual integration and information sharing allows Dell to improve its productivity by eliminating raw material warehouses and finished product stockrooms

The challenge for manufacturing

The main challenge in manufacturing in the next few years will be to integrate business systems more closely with the manufacturing information flow (production control) and shop floor equipment. When ERP took off in the mid-1990s, it was hoped that it would provide this integration. However, this hope proved to be unfounded. Often, ERP packages were developed with business functionalities in mind (ie, accounting, marketing) and were therefore not suitable for production control and scheduling.

Often, the shop floor control principle used by ERP is 'push'-based (order placement initiates the production process) when 'pull'-based would be more appropriate. In pull-based manufacturing, orders are placed to enable the product to be taken to final assembly, or to the next production bottleneck, at which point the required components are 'pulled' from other manufacturing steps. Either way, the manufacturing-related information (ie, order status, machine status, work in progress) in the ERP rarely reflects shop floor reality. This is directly linked to scheduling problems.

Today, schemes that seamlessly unite all the information relevant to a manufac-

turing process, from suppliers through ERP systems down to the shop floor, are not common. This is a major technological challenge that the manufacturing industries have to solve before they can progress to the next highest level of productivity. Companies that *can* meet this challenge will be the winners of tomorrow. ABB, with its Industrial IT platform (see box), is in a unique position to close this gap for the manufacturing industries.

The power of Industrial^{IT}

In the 1980s, Computer Integrated Manufacturing (CIM) was *the* buzzword. However, despite worldwide efforts to create standards and technologies, the CIM vision did not take off, principally because the technology and architecture necessary to cope with numerous different machines and applications were missing.

ABB's Industrial IT architecture [2], with its key technology AIP (Aspect Integrator Platform), now makes this CIM vision possible. The Industrial IT that ABB has provided for the process and utility industries is also being applied to discrete manufacturing. As the annual expenditure on manufacturing software will be around 70 BUSD by 2004, there is no lack of market opportunity.

As mentioned, discrete manufacturing still lacks a viable architecture to connect various machines, controllers and manufacturing and business applications. Moreover, the modern factory now has a

Industrial IT – a quick tour

ABB's Industrial IT is an information architecture for seamlessly linking multiple applications and systems in real time. Just as the Microsoft environment makes life simple in the PC world, so Industrial IT makes things easy in the industrial world by delivering advanced, pre-engineered products which are equally ready-to-use and which are *reusable* across many tasks. These products will be easier to configure, install and move around within the business enterprise, and they will provide their owners with *real-time* information.

The Industrial IT concept defines the collection of information required to support each plant component as an 'Object'. This contains all the characteristics, or 'Aspects', of the device, such as design drawings, control diagrams, maintenance information, location, quality information and configuration information. But an Aspect is not *just* the real-time information connected with a particular Object; it also defines a set of software functions that create, access and manipulate this information.

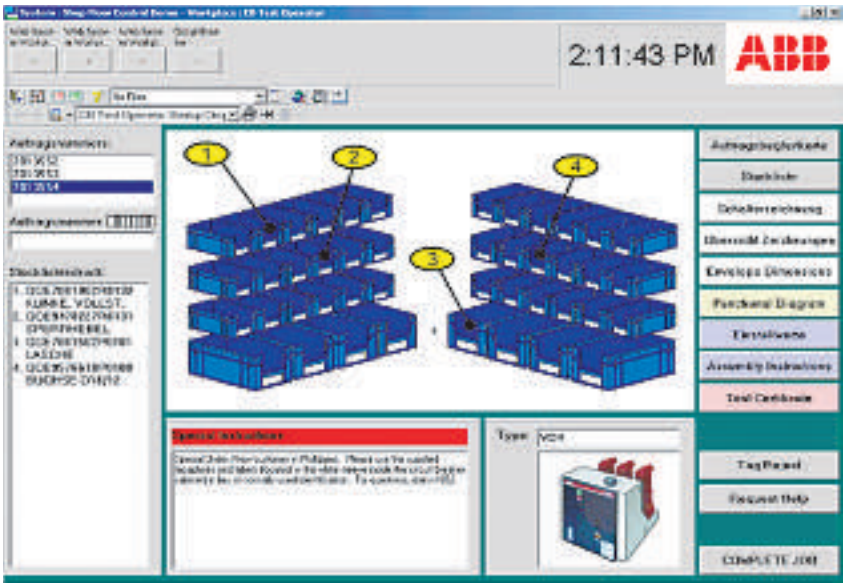
The individual Aspects are enabled by software systems known as Aspect Systems, each of which stores, manages and presents information in its own optimal way. When an Aspect System is installed, it registers all interfaces that it supports with an 'Aspect Directory'. When an Aspect System wants to perform an operation that involves actions from other Aspect Systems, it 'asks' the Aspect Directory for references to these. This is how a change to one component in the factory would be broadcast to all the other system components that need to know.

Navigation through these structures is provided by the ABB Plant Explorer, which resembles Windows Explorer. However, it does not organize information merely into files and folders, but into an actual plant hierarchy, allowing you to create, delete, copy and move Objects and Aspects at the click of a mouse.

Integration of all these 'enabled' products by means of their associated Objects and Aspects is the job of the Industrial IT Aspect Integrator Platform. The AIP is one of the key elements in the entire Industrial IT architecture.

All new ABB products, whether software, hardware or services, will be 'Industrial IT Enabled' indicating that the product has the ability to be combined with other Industrial IT products in this 'Plug and Produce' manner.

3 Example of an IIT application on the assembly shop floor



larger number of isolated business systems, applications and automated machinery than ever before. Everyday operations can involve dozens of these, which makes the IT infrastructure highly complex and a costly asset. Efficient use of this infrastructure is one of the most important competitive factors for discrete manufacturing today. Its role will be even more important in the future when the advantages of eBusiness are fully exploited. What is needed, then, is a common platform to link all applications and machines.

This is where ABB's Industrial IT, and AIP, come in. AIP electronically integrates all relevant data into one single system.

One single system

The challenge for ABB is to create innovative, simple and practical applications to be used by operators and managers to get access to the relevant, real-time information that they need to run their everyday operations. As a simple example we can use the interface for an operator in an assembly process 3. In this case, the operator receives the order of products to be assembled (top right), the list of components to be assembled (lower right) and the linkages to other relevant applications and assembly instructions, which include information to complete the order. This increases production capacity by an estimated 10% and improves product quality.

ABB's Industrial IT and Aspect Integrator Platform are already in place, and ABB is fully involved in developing solutions which will power the manufacturing industries of tomorrow. Three major strategic activities under way are:

- Integration of business/manufacturing information systems across three geographically distant factories.
- Development of Advanced Supply Chain Management and Execution Applications.
- Integration of multiple lower level manufacturing/quality information systems in a factory.

As with CIM in the 1980s, the vision is clear. Today, ABB's Industrial IT provides the technology platform for the solutions and tools to make this issue, which is so critical to world-class manufacturing, a reality.

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[2] The ABCs of Industrial IT. ABB Review 1/2002, 6–13.