Enterprise solutions for discrete manufacturing

How ABB improves its manufacturing processes with Industrial^{IT}

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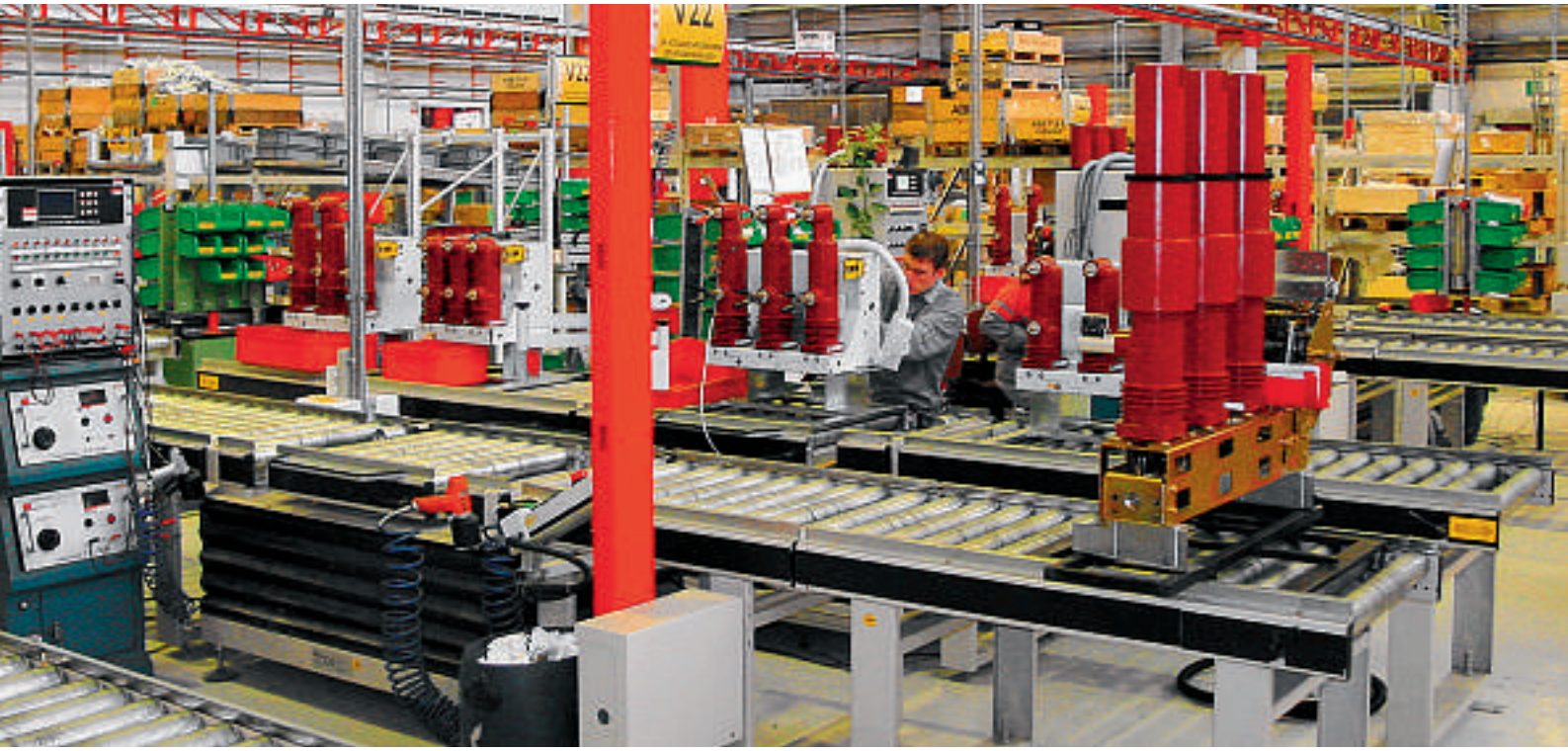


Manufacturing, especially the manufacture of high-quality, long-service products, is not simply about producing at the lowest cost in the shortest possible time. Although these are clearly key factors in sustainable, profitable business, there are others like flexibility of delivery and enhanced service capabilities that today play an almost equally important role.

An optimal manufacturing process that includes tracking and auditing of all material and equipment parts, from purchase through to delivery, is vitally important for our customers' business success. State-of-the-art technology from ABB makes it possible.

As a leading supplier of equipment to the utility market, the Power Technologies division of ABB is committed to being at the cutting edge of manufacturing. The products that leave its factories, for example switchgear, transformers and cables, all have a service life of many decades and exhibit important quality characteristics they are expected to retain over this long lifespan.

The division, with nearly 150 factories, covers the whole spectrum of manufacturing, from continuous flow to job shop 1. In one class of factory – the 'operator-paced line flow' type – ABB recently began to implement a revolutionary production and quality control support environment. Based on the company's Industrial^{IT} architecture and integrated into its business environment, it provides a *connectivity solution* that stretches from shop-floor processes to top-floor strategies.

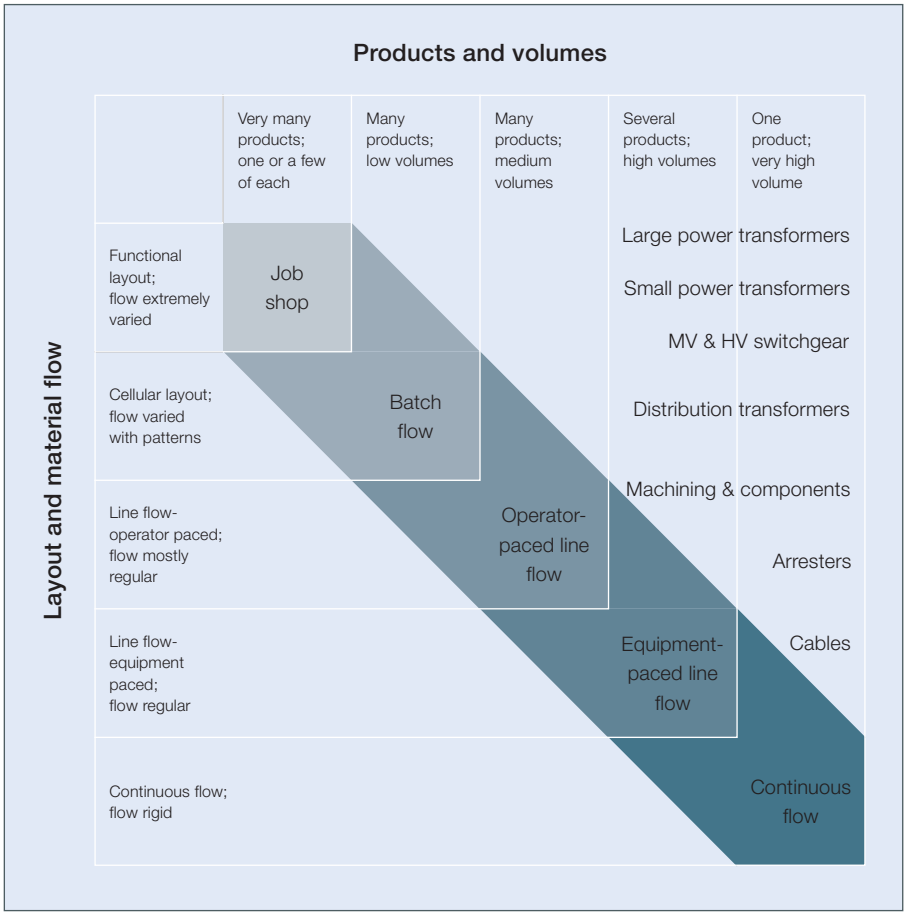
Typically, these factories have several production lines performing partial assembly of sub-units and at the same time assembling different, customized products. Within the process the sub-units are normally standardized and completed in accordance with a production forecast. Production orders are automatically generated by the order-handling system as a function of the buffer level and the production forecast evaluation. Customers' switchgear orders are planned individually by the production department, which provides the input for the weekly assembly plan. To improve the flexibility of the manufacturing process, connectivity solutions provide the basis for near real-time monitoring of manufacturing processes and a high-availability infrastructure for implementing support functions.

The requirements that the new connectivity solutions have to satisfy were determined after intensive analysis of the plant managers' concerns. These focused on their efforts to improve an already solid position in customer satisfaction with delivery and maintenance, and at the same time ensure maximum production effectiveness. The functions considered of importance in setting up the requirements for automated support in, for example, ABB's MV products manufacturing plants, were:

- *Tracking of customer orders:* Automate order management and reduce the need for manual reporting.
- *Production control:* Track activity in individual shop floor workplaces to improve productivity results.
- *Planning modifications:* Reduce reliance on visual inspection of shop floor activities prior to planning changes by informing the planning team of the real-time status on the shop floor.
- *Quality analysis:* On-line monitoring of all stations in the manufacturing process to reduce waste, identify and correct process issues, trace problems in supplier batches, and reduce reliance on manufacturing dockets.
- *Test-bed result consolidation:* Include the results of sub-assembly tests in one unique report.
- *Periodic inspection of tools:* Track the inspection requirements of special tools, with notification of deviations from the inspection schedule.

Connectivity solutions allow near-real-time monitoring of manufacturing processes and provide an infrastructure for implementing support functions.

1 A whole host of manufacturing processes are involved in producing ABB power technology equipment.



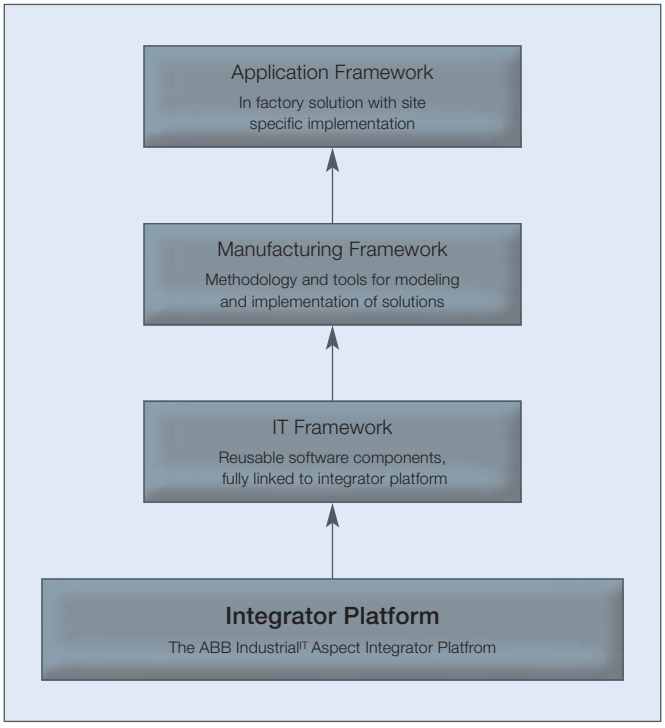
- *Machine algorithms:* Provide support for back-up, updating and verification of loaded machine algorithms for automated lines and test facilities.
- *Machine maintenance:* Track machine maintenance history and provide up-to-date maintenance documentation on-line.
- *Data and documentation:* Minimize non-value-added activities by reducing paper-based data and documentation for transfer, collection and filing, and
  at the same time enhance reliability through targeted single-source storage.
- *Integration with ERP:* Ensure that the back-office ERP and the actual shop floor activities are consistent in near real-time.

The ABB Connectivity Solution has been developed to provide an integrated production and quality control support system to cope with a factory's multiple needs: process flexibility and optimization; quality and audit trail requirements; plus interaction between fully automated, semi-automated and operator-driven process segments.

The philosophy behind its design and implementation is that each plant receives a system built to uniquely support its processes. At the same time, the delivered technology must ensure:

- The right amount of standardization for ease of use and easy maintenance across a large number of factories, for a range of products based on significantly different manufacturing processes.
- Easy deployment, with the flexibility required to redefine the configuration as the manufacturing process is upgraded or changed, while maintaining the integrity and thus reusability of the software.

2 A four-tier framework provides ease of deployment, flexibility and the right level of standardization.



The basic concept behind the solution is that of a four-tier framework, with each tier building on the functionality of the tier below it and supporting the tier above 2. The foundation of this framework is the ABB Industrial^{IT} Aspect Integrator Platform (AIP).

Tier 1: Integrator platform

The AIP platform was chosen specifically as the foundation of the total connectivity solution framework because it was designed to provide flexible integration of any number of elements. It pays particular attention to the special needs of connecting databases, documentation repositories, transaction processing systems (typically found on the 'top-floor' and in supply-chain management), and real-time control systems (a common feature of automated manufacturing). It typically includes event-handling capabilities that are essential if the system is to fulfill requirements such as those listed above.

As a general tool, it also lends itself to the implementation of data-driven system configurations. This is a huge advantage as it ensures that the operational system can be quickly updated via data engineering in the case of process changes. No special software engineering is required.

Tier 2: IT framework

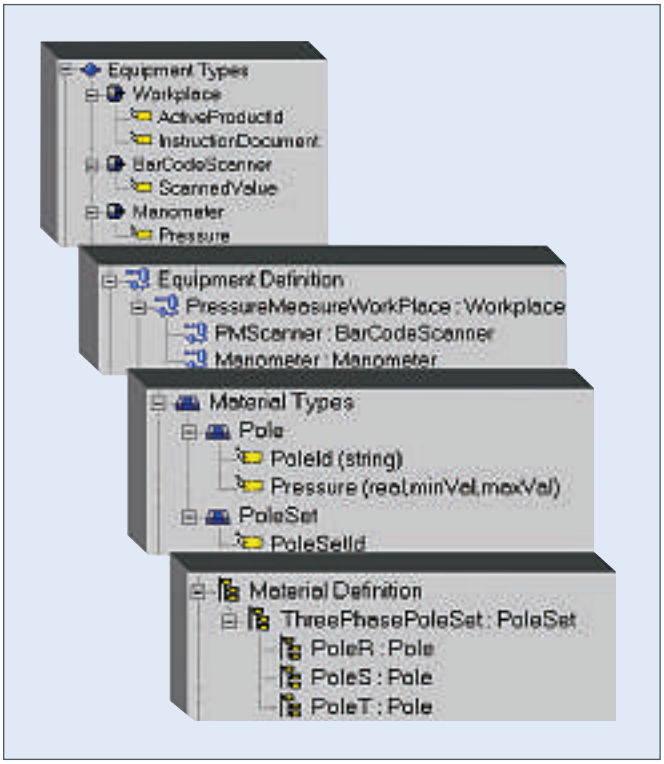
The IT framework supports the application configuration in the manufacturing environment. It includes the connectivity links for interfacing with the typical business system components already in use and supports a library of connectors for interfacing with many shop floor automation technologies. Implementa-

tion of an OPC[1] access server ensures not only that communication between operator workplaces and the manufacturing process is kept very flexible, but also that any technology supporting TCP/IP network programming can be used to add more clients. The specific functions related to how the connectivity is to be implemented are also defined within this tier.

Tier 3: Manufacturing framework

The manufacturing framework provides the essential components for mapping the individual elements on the factory floor, as well as the manufacturing process definition for the particular factory. As such, it includes a general 'manufacturing model' and the tools used to transfer the specific factory requirements to the model. Flexibility is guaranteed by a formalized collection of constraints and rules for building the database within the domain of interest, and a comprehensive description of the elements according to the ISA-S95 standard. This standard, which ABB actively supports, provides definitions of all the different types of device/equipment, materials, personnel and production segments, etc, found in a manufacturing environment. This tier also provides the tools for creating reports and setting up an in-depth analysis of the data collected during manufacturing.

3 The tools in the manufacturing framework allow each factory to build an exact model of the equipment, materials and workplaces.

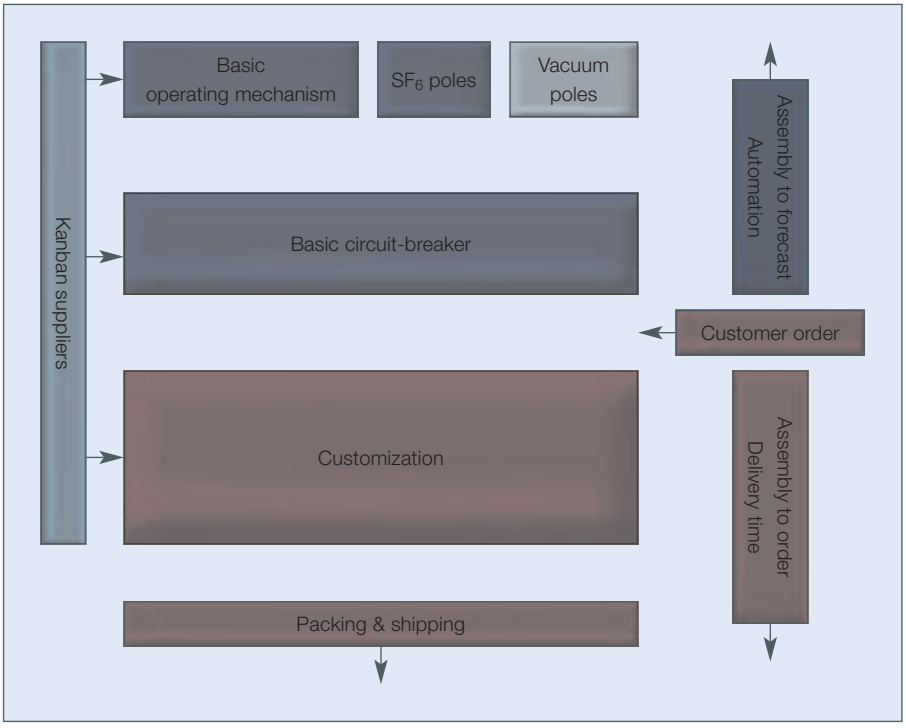


Tier 4: Application framework

The application framework provides the basis for implementing a particular solution in a particular factory. It is created by entering the specific factory data in the generic manufacturing framework and process steps 3 in a consistent manner. Support is provided by the easy-to-use manufacturing framework toolbox. A thorough analysis of the shop floor processes 4 is extremely important at this stage. Experience has shown that a joint workshop between the factory process planners and ABB Connectivity Solution consultants prior to starting data entry is ideal for familiarizing the factory staff with the tools and the mapping of their factory process into the data model. The data input follows a straightforward set of rules:

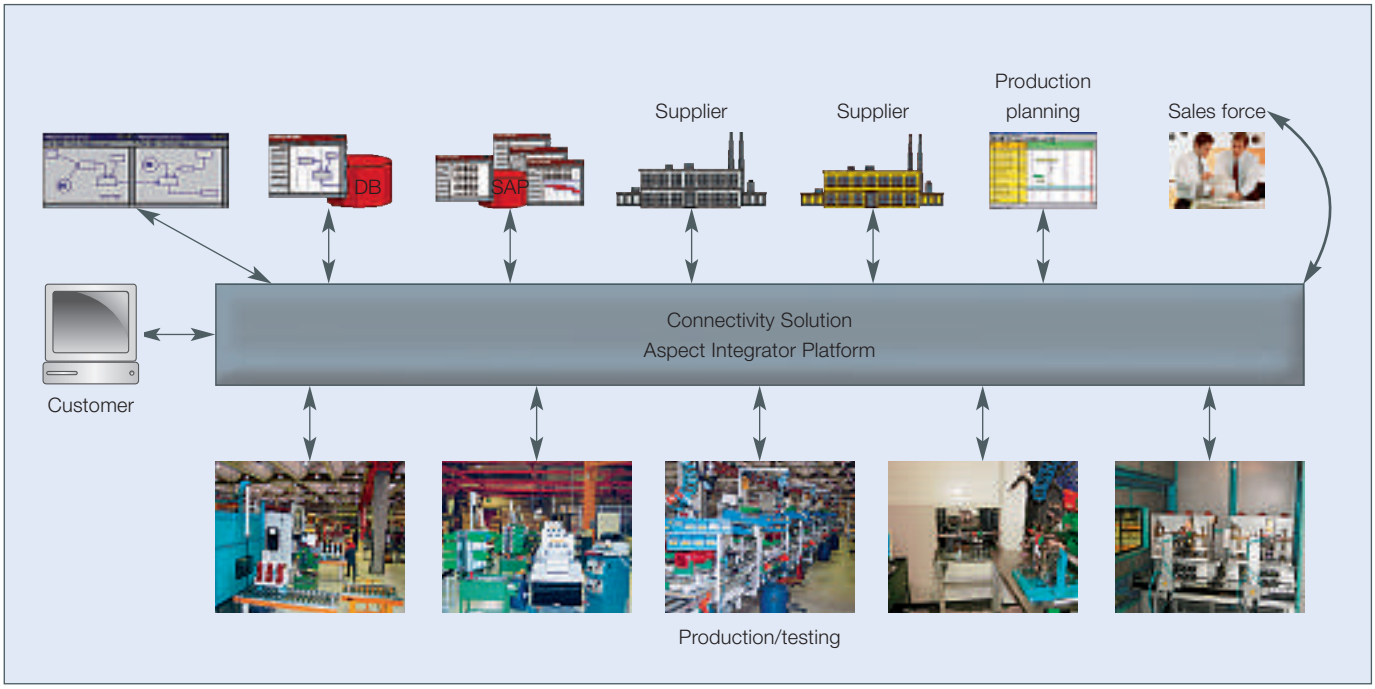
- Define the resources (equipment, materials, personnel) used in the production process.
- Define the production steps, the resources for each step, and the action taken at each step.
- Define the events that trigger a transition or an action.

4 Overview of materials, equipment and process definitions for an MV circuit-breaker factory which need to be mapped into the manufacturing framework to create the factory application framework.



[1] Open Process Control (originally OLE Process Control) – open standards specifying interfaces in the process control domain.

5	Interacting through the Connectivity Solution, the shop floor workplaces are directly linked to the company IS and ERP environment, to the quality control office and production manager's office, and to third-party companies (eg, suppliers), as necessary.



The factory team maps the manufacturing process 'one-to-one' into the model following these simple rules, and uses the appropriate tools to generate the workplace screen layouts and specific report layouts. Once familiar with this procedure, users can move rapidly forward with data entry. Checks carried out every 2 to 3 weeks with support from a solution consultant ensure that the optimum description is generated.

System rollout takes place in three phases:
First, the new hardware and software package based on the factory-specific application framework is installed, the connections to the local systems and shop floor automation equipment are made, and all basic function tests to verify the system are performed 5.
Second, the office staff are trained in the use of the new system. The elimination of paper means that users have to adapt to a completely new daily work routine.
Third, the shop floor staff are trained. It has to be remembered here that, even today, many of the personnel on the shop floor have had little experience of computer systems. This training is therefore key to a project's success, and must be completed before the system is taken into operation.

The ABB Connectivity Solution supports the optimization of manufacturing, handling of customer deliveries and service.

Normal running of the factory is not disturbed by any of these three rollout phases.

Reconfiguration made easy

The ABB Connectivity Solution provides manufacturers with a very flexible, easy-to-use system that supports optimization of the manufacturing process, improves handling of customer deliveries and enhances service capabilities. Not only does the solution generate a considerable, and recurring, efficiency improvement, but, being data driven, it can also be easily reconfigured by the local staff. This is a major advantage whenever there are staffing or material changes, when shop-floor machinery is upgraded, and especially when completely new product lines are being introduced.

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