SIMATIC IT for the Discrete Industry

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SIMATIC IT Architecture

SIMATIC IT Custom Graphical User Interface
Executive Overview

SIMATIC IT is a scalable, standards-based manufacturing execution and intelligence solution. It contains configurable standard functionality for R&D and production environments and can be easily adapted to clients’ specific requirements for new and existing applications. Standard functionality includes interoperability with both business systems and control systems. These elements lower the total cost of ownership for implementation and roll out of captured best practices in manufacturing.

SIMATIC IT contains libraries of preconfigured use cases commonly encountered in the industry. These are constantly upgraded and extended. Use cases for many of the discrete and process industry verticals are available. Siemens developed a value framework that maps these functionalities against industry business processes and strategic or tactical value, enabling a value-oriented application design to maximize ROI. The functionalities range from production, through quality and maintenance to inventory operations.

Siemens uses a homogeneous and sound technical approach to build and integrate the broad range of product components. The product takes advantage of the latest Microsoft applications and operation system functions.

Consistent with Siemens’s MES philosophy, SIMATIC IT comes with a palette of services, such as global account management, and industry sector experts, plus training, implementation, maintenance, and support. Implementation resources are available from over 100 certified partners worldwide, assisted and complemented by Siemens.

Available data indicate that the benefits of manufacturing execution systems (MES), such as SIMATIC IT, can reach from 2-3 percent of turnover for pure manufacturing operations up to 4-6 percent when integrated with business and supply chain optimization systems. An MES replacing a legacy system and designed for both functionality and ROI can also provide quick payback even when counting only the incremental benefits, particularly when organizational and business process changes support system changes. These benefits come both from cost reductions, such as reduced cost of raw materials, energy and business process efficiency, as well as from increased production value, either from increased production amounts, or increased
average sales prices and brand value. These benefits are typically achieved through streamlined business and manufacturing processes, reduced errors and process variability, improved reliability and availability, improved quality, reduced cost of quality and compliance, reduced inventory and work-in-progress, improved real-time visibility enabling agility, and improved performance management.

In the near future, integrating manufacturing systems with R&D, production, and product lifecycle management (PLM) systems will become increasingly important for next-generation systems, and will create new integration-related benefits. Siemens’ existing integration capabilities, combined with strategic acquisitions in the PLM and process engineering domains, place the company at the leading edge of business process efficiency.

**SIMATIC IT**

**The Construction Of An Integrated Solution Portfolio...**

SIMATIC IT is a “third generation” MES, or operations management solution for both discrete and process manufacturing industries. SIMATIC IT has its roots in Genova, Italy, in ORSI Automazione, led by Giorgio Cuttica. His strong vision continues to give direction to the Siemens MES division since ORSI was acquired in 2001. In the same period, Siemens acquired Compex in Belgium. This brought the SIMATIC IT Unilab LIMS and SIMATIC IT Interspec Specification Management solutions to the Siemens portfolio. Finally, in 2003, Siemens acquired the US company, IndX, with the XHQ Manufacturing intelligence solution. The three manufacturing solutions ended up in Automation Systems (AS) organization, part of the Industry Automation division (IA). This is sig-
significant, since IA and AS are product-focused, and the products acquired have benefited from an important long-term commitment and effort by Siemens, guided by a long-term strategy. Over time, Siemens consolidated the products into the SIMATIC IT portfolio, while continuing to support the original products. Early in 2009, Siemens acquired Elan Software from France, further strengthening the company’s MES capability, particularly in the pharmaceutical and biotech industries.

... And A Client Interaction Model

With the acquisition of UGS, a 7 B$ US PLM software company active in the discrete industry, Siemens IA demonstrated an important commitment to the software business to complement its hardware business. Siemens PLM Software facilitated the adoption of new business processes, consistent with Siemens’ vision of a "whole product," which includes the product itself, IT account management, support by industry sector experts, training, implementation, maintenance and support. For both its software businesses, PLM Software and MES, Siemens complemented the traditional regional partner and sales model with global, direct software or “IT” account management, industry expertise and implementation services. This gave both clients and Siemens the opportunity to manage the relationship at a global level, and plan, implement, and optimize MES as an enterprise solution, while retaining local sales support.
These changes required a great deal of leadership by both the acquiring and the acquired parties. The style is one of well-thought-out steps. It is one element of a regularly updated, long-term strategy, guided by principles of transparency and efficiency on one hand, and client value on the other.

**Technology**

**Principles and Philosophy**
SIMATIC IT is designed and built upon a few basic principles:

- The use of Microsoft Windows and the ISA-95 standard
- A graphical, object-orientated framework with components and a modeling environment combined with libraries of best practices
- A comprehensive set of integration capabilities
- Organized into Production, Intelligence, and R&D suites

SIMATIC IT uses an architecture based on components and libraries integrated with a single platform. This allows seamless mixing and matching of components and libraries from the different suites.

**SIMATIC IT Production Suite**
The ISA-95 standard generically defines the functions of manufacturing and the information exchanged between the production and enterprise levels. Every manufacturing process can be modeled according to the scheme, but each is different. Operating procedures and business processes differ, along with materials, products, equipment, and many other details. While the processes automated by business systems can be standardized to a high degree, manufacturing processes tend to be very different, resisting standardized solutions. In addition, manufacturing processes change regularly due to optimization requirements, economic conditions, new product introduction, equipment maintenance, etc. Finally, not every client requires their manufacturing process to be automated to the same degree.

SIMATIC IT provides a wide palette of application building capabilities. These include a highly flexible modeling environment that can adapt to virtually every type of production to maximize ROI (Production Modeler), plus both often-used basic functionalities (Components) and pre-configured processes (Libraries) to minimize effort and payback time.
As defined in the ISA-95 standard, “Operations Management” includes a broad scope of plant functions in the areas of production, quality, maintenance, and inventory management. The standard has proven to be an aid in designing MES functionalities and in standardizing integration of enterprise-wide MES with other enterprise applications. SIMATIC IT functionalities, data models, and information exchange capabilities are ISA 95-compliant.

Microsoft Windows, the most widely used computer operating system, is rapidly gaining acceptance in real-time manufacturing applications. Windows offers an increasing number of professional computing capabilities that enterprise solutions, such as SIMATIC IT, can exploit. These include the ability to deal with clusters and managing maintenance (see below).

**Unrestricted Modeling Capability For Full Flexibility**

The Production Modeler (PM) framework is the central piece upon which other functionalities rely. It is a graphical, object-oriented development environment. It can be used to model any ISA-95 equipment resource or a full plant\(^1\). Each object has associated methods or functions, events, attributes and rules. Attributes are static information on the object; methods describe operations. Using generic model building blocks (e.g., an equipment model), rules (a production rule) and data objects (an order or material data structure), a plant model can be created.

Each time a generic model or data object is used, it becomes a particular instance, inheriting the properties of the parent object. For example, a model of a pump can be instantiated to represent the different pumps in a plant of the same type. A particular instance can be distinguished by individual characteristics, such as its name, capacity, location, or age, but behaves according to the same rules. The benefits of object orientation are evident: the parent model is created and maintained once and for all its instances. The reuse of a generic, partially configured model of a piece of process equipment only requires the entry or modification of its specific parameters, such as size, location, or power consumption, upon instantiation in a plant model.

Objects can also represent other operations, such as electronic or IT operations, manual operations, or other activities that are not directly related to the physical production processes. The combination of a set of rules and equipment models can describe the (physical) production process. In fact, any physical or electronic process workflow can be represented, whether automated or manual. The use of rules allows conditional branching of the

\(^{1}\) Other resource types are handled by SIMATIC IT Components, see below.
model under different conditions, or to react to real-time events. Graphical representation and manipulation make the rules easy to use.

The developer can use the same environment to build and to execute any type of model during model development or maintenance. This environment is specific to the needs of MES application engineers, providing access to all model details and with rights to create and delete models.

Other users in the plant, such as operators and supervisors, require very different, dedicated interfaces, with graphics or tables, focused on their activities and with access authorization appropriate to their responsibilities. These dedicated, web-based interfaces can be added using the client application builder (see table “Service Components”).

<table>
<thead>
<tr>
<th>Functional Component</th>
<th>Main functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Definition Management</td>
<td>Description of how to make the product (equipment, materials, conditions, operations, information required)</td>
</tr>
<tr>
<td>Product Order Manager</td>
<td>Import order schedule, create a production order for a defined product, execute and monitor production, create production report</td>
</tr>
<tr>
<td>Material Manager</td>
<td>Defining material characteristics, tracking and tracing of material in the plant, creates detailed genealogy</td>
</tr>
<tr>
<td>Personnel Manager</td>
<td>Defining individuals and groups, qualifications and skills, synchronize with ERP, define work schedules, record worked hours, check presence during production</td>
</tr>
<tr>
<td>Shift Calendar Manager</td>
<td>Managing plant calendar, shifts and exceptions</td>
</tr>
</tbody>
</table>

**Components: Efficiency From Standard Functionality**

Frequently used functions do not have to be modeled by the user: they are provided in standard product components, such as Product Definition Manager, Material Manager, Production Order Manager, Personnel Manager and Shift Calendar Manager. The framework has the capability to integrate third party or existing applications, in order to behave as one of the native product components. This can be conveniently done using .NET, while COM interfaces continue to be supported.
### Other components are the data historian, the client application builder, and data integration service for ERP interoperability. Report Manager, OEE and SPC are optional components.

<table>
<thead>
<tr>
<th>Service Components</th>
<th>Main functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Historian</td>
<td>Displays real-time plant data; archive of historical plant data. KPI calculation, data analysis and reporting of continuous and batch production information. Native interfaces to Siemens control products and OPC. Standard reports are provided by the component Report Manager.</td>
</tr>
<tr>
<td>Client Application Builder</td>
<td>Creation of custom and secure graphical user interfaces in a web browser; aggregation and transformation of data from different sources before visualization; use of rules. Standard portal or full customization using role-based security.</td>
</tr>
<tr>
<td>Data Integration Service</td>
<td>Reliable XML message exchange with other applications including B2MML implementation, SAP, MQ Series and generic connectors such as Web Service, .NET and COM. Acts as plant level message bus, including message buffering.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Components</th>
<th>Main functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report Manager</td>
<td>Ad-hoc, event or time-based reports, client/server or web-based, that does not require SQL knowledge across components, libraries and applications. Includes a library of predefined reports for Data Historian, Production Manager, Unilab and Interspec. Uses Business Objects™ technology.</td>
</tr>
<tr>
<td>OEE</td>
<td>Measurement, reporting and analysis of capacity utilization and reliability KPI’s such as Overall Equipment Efficiency. Flexibility to adapt existing and define new KPI’s. Uses Data Historian and Report Manager.</td>
</tr>
</tbody>
</table>
Libraries Provide Further Efficiency Gains

Efficient application engineering uses a modular approach that creates quality- and productivity-related benefits through standardization and reuse of model sections. SIMATIC IT Libraries enable this by allowing the user to save and reuse model sections configured to various degrees, together with workflow, user interfaces, and reports.

Partners, integrators, or application engineering departments that often configure applications of the same type, for example for similar processes, can build sets of ready-to-use modules that incorporate their know-how. Object-orientated libraries allow these organizations to standardize their models, such that trained personnel can use the libraries and easily interpret the models created. The efficiency gained in application engineering and maintenance, and accumulated know-how, can provide an important competitive advantage. Other associated benefits are reduced project risk, improved estimation of project effort, increased ROI or reduced solution payback time.

While these benefits are real, they require a long-term commitment in maintenance and warranty. Since not all integrators or users have sufficient recurring business to make this commitment, the added value can be elusive. Realizing this, Siemens now provides libraries that are supported, maintained, and continuously improved and extended (see also: Industry and Client Strategies, next section).

Library elements can be used by a plant model or another library element from the same or another library. This means libraries can be constructed upon other libraries. Siemens Process and Discrete Libraries reuse functions from standard components and are built upon by the industry-specific libraries and provide a set of use cases encountered in most industries. Examples
include maintenance and ERP integration, loading and unloading, warehouse management, genealogy, quality management, etc. The industry

libraries represent use cases for specific industrial sectors in discrete industry (such as automotive manufacturing), process industries (such as chemicals), and for the hybrid industries (such as food and beverage and pharmaceuticals). All the use cases provided correspond to user’s needs, providing high added value, without the need for analysis, design, and engineering. The diagram above illustrates how libraries reduce the application engineering effort.

**SIMATIC IT Intelligence Suite**

While the standalone SIMATIC IT XHQ product is still available and supported to provide users with KPI’s and on-line dashboards, its successor and extension, SIMATIC IT Intelligence Suite, is fully integrated within the SIMATIC IT environment. Anyone in manufacturing needs context-specific information for their activities. Intelligence Suite has the capability to configure web-based dashboards displaying real-time and historic trends of KPI’s. These can be composed of pure production information or combined with data from other sources, such as ERP. Dashboards for decision support in different industry sectors can be tailored to fit the needs of the different user profiles or customized, pre-packaged library screens.
SIMATIC IT Industry Libraries (defect management)

SIMATIC IT Intelligence Suite (KPI visualization)
A real strength of Intelligence Suite, is the capability to deliver good response times, while providing decision-support information to a thousand or more users collected from multiple sources around the world. What makes this even more impressive, is the fact that Siemens has increased the reporting time horizon from just three to six months to long-term historical trends through integration with the Data Historian. Data is extracted from the different manufacturing and business systems and stored, along with their relationships, in the Manufacturing Intelligence Data Store. KPI’s and trend plots are aggregated from this database according to the users’ specifications, and cached in the Data Warehouse to provide the excellent response times.

The 2009 release of Intelligence Suite will include the functionality described. A new version of XHQ will include Visual Composer to make it easy to configure web interfaces. This development also applied to of Client Application Builder (see above).

Industry and Domain Expertise

Industry, Product and Client Strategies
As previously mentioned, Siemens’ new global client interaction model also includes support from industry experts. These support clients and prospects in their respective industry verticals and niches, and consult on global implementation strategies. These industry managers have also industry expert counterparts in service delivery. In total, approximately 85 experts for all industry sectors and on all major continents are available to support global clients. In the discrete industries, support is provided for automotive, aerospace, mechatronics, for example white goods, and electronics.

With substantial experience with client applications, the Industry Managers are in an excellent position to devise industry-specific strategies. Before being productized, industry libraries are developed and proven in real applications to help protect clients’ investments. For each use case, the added value is identified and stored in the Value Framework for reference and comparison. The Value Framework helps clients map the potential value delivered from library cases against business processes. Currently, this value is qualitative in nature, but is intended to contain benchmark values when more experience is gained. Siemens offers a full ROI analysis at an early phase of an implementation project. The company’s experience is that the base product, plus the libraries and implementation services, keep the application cost competitive, while yielding good return on investment.
Discrete Industry Competencies, Functionalities, and Benefits

A plant’s process dictates the feasibility, order, and timing, in which the ISA-95 functions from the product components and libraries need to be executed. This makes Production Modeler an essential component, since it mimics the plant’s individual processes, procedures, and rules and invokes the functions from the product components or libraries when required. For large-scale implementations, a template plant model can be stored in a project library and rolled out with small modifications to different, but similar plants, thus significantly reducing cost of ownership.

An MES for automotive manufacturing must execute very complex processes in terms of automation, manual operations, and product variance, and do so at high speed. Key benefits are real-time visibility on inventory and work-in-progress for support of Lean Manufacturing and real-time quality management. Siemens has extensive experience in MES for power train manufacturing. The company is developing libraries for other automotive operations by working closely with selected clients to transform project experience into standard libraries. Gradually, these will be released as maintained, warranted products that will help shorten the time to value and improve payback. Continental, Daimler, Federal Mogul, Fiat, and Iveco are some of the successful client companies with which Siemens is working.

Aerospace and heavy equipment manufacturing have much in common with automotive. However, since product does not typically move through the factory, a different type of MES is required. Furthermore, since PLM software is commonly used aerospace, the capability to integrate PLM and MES yields significant value.

A characteristic of mechatronics plants is a very high degree of automation, to the degree that a line manager can supervise production with the MES providing all work instructions to automated operations. One example is Whirlpool Europe, where tight integration with the ERP and real-time inventory and production performance reporting support Lean Manufacturing.

In electronics manufacturing, the solution integrates seamlessly with new product introduction software from the Unicam MES modules inherited from Siemens PLM Software. Key benefits are assembly line optimization, real-time electronic circuit testing and defect management, in addition to the production scheduling and management capabilities of Production Suite. Over time, the Unicam products will be fully integrated with SIMATIC IT.
Siemens Electronics Werk Amberg uses the company’s own SIMATIC IT to produce PLCs.

In the near future, discrete MES applications will start to benefit from the integration with the Product Lifecycle Management solutions from Siemens PLM Software. This will help speed up new product introductions and facilitate product improvements by automating the update of MES data and models. Already today, SIMATIC IT users benefit from seamless integration with both business systems as well as automation.

Operational performance requirements in global discrete industries drive the need for collaborative decision-making and real-time visibility across plants located on different continents. Individual sites must have visibility by monitoring real-time and historical KPI’s to compete in their local environment. The SIMATIC IT Intelligence Suite provides these capabilities in the context of local or global manufacturing or supply chain operations in an easy-to-understand dashboard format.

This real-time, in-context decision-support information, which maps closely to ARC’s Real-Time Performance Management concept, not only enables plant personnel to make better decisions, it also often enables them to anticipate problems in advance.

**Delivery**

In the large majority of cases, Siemens partners sell, implement, and support SIMATIC IT applications. Partners are certified in their domains of competence and presence in the world regions (see Technical Partner Support). The new client interaction model opens the possibility for Siemens and partners to share the work, and, where advantageous for the client, for Siemens to take a leading role in managing a client relationship globally.
Siemens delivery services provide:

- Use case consulting
- Justification support
- Implementation consulting

Use case consulting includes needs and requirements analysis, prototyping, and making basic design specifications. Justification support helps determining the ROI and the strategic value of the application. Implementation consulting includes detailed application and system design, implementation (including turn-key projects), customization and optimization, and specialized assistance and training (see also Value Added Services).

Siemens uses its own project implementation methodology. The company has PMI-certified personnel and its methodologies comply with ISO 9000 quality standards. For each project, KPI’s for project value and implementation efficiency can be mutually agreed upon for optimal project management.

**Value Added Services**

Siemens’ Value Added Services organization provides maintenance, support,
and training to partners and end-users and is located in the MES competence center next to product development and delivery services.

**Maintenance**

SIMATIC IT Maintenance Services provide a package of professional services offering a variety of different support options (see graph on p. 22). Technical Support Services (TSS) deliver hotline support via telephone or website. The bronze, silver, and gold schemes provide increasing service time coverage and decreasing response times. In a closer collaboration with the client, Siemens provides remote support. Agent-based Diagnosis Service transmits real-time performance indicators of the client’s hardware and SIMATIC IT installation to the MES competence center to enable potential problems to be detected before they happen. The service is highly secure, works through firewalls, and transmits selected parameters indicative of system and application performance (while effectively compartmentalizing product or production information). Automatic delivery of new software and library versions, called Software Update Service, is also part of the base package. Alternately, a client can choose to extend support for an older version beyond the standard life cycle.

In the near future, the Software Management Service and Tool will be able to implement patches and upgrades from remote locations and in an automated manner, without having to shut down the production systems. This option
uses a combination of new SIMATIC IT and Microsoft System Center Configuration Manager technology.

Beyond the standard software, clients can choose to take support for the application and developed libraries, and if required, to have shadow system at Siemens’s support site. They can also schedule support on a regular basis.

In summary, Siemens provides both classical reactive support, customized for specific users, and preventive and predictive support, which can reduce unwanted and unplanned production stops. In particular, Agent-based diagnostics and the future Software Management Service are powerful options increasing productive uptime of SIMATIC IT applications and contributing to plant availability and reliability.

**Technical Partner Support**

Since Siemens partners sell, implement and support most applications; strong partner support remains strategic for the company. To help guarantee success for all parties, Siemens has two levels of partner certification: Solution Partner and Solution Partner Specialist. Certification includes product and sales training on one or more suites for a minimum number of partner resources per certified region. Solution Partner Specialists have additional pre-sales and project implementation training and are certified to be competent in specific, named industry sectors or “niches.”
Siemens provides pre-sales, bidding, and product and implementation support to all partners. Bidding support reviews the technical feasibility and economic viability of project proposals, a quality and reliability check of advantage to all parties. Partners can provide all technical support or share it with Siemens, according to all parties’ preference, and at the same cost for the end-user. A certificate needs to be obtained each year.

Training
The SIMATIC IT training portfolio consists of:

- A general introduction to MES and SIMATIC IT
- Basic and advanced SIMATIC IT Product training
- SIMATIC IT Training Academy
- SIMATIC IT Expert Workshops

Product training includes introductory level training for each of the SIMATIC IT Suites, and advanced training for specific components (see figure). The training is provided by professional trainers in regional training centers or at the customer’s site. For experts, standard modules in advanced topics
and tailored trainings are given by senior consultants. The program is open to customers and partners. SIMATIC IT Training Academy is only available to Siemens Solutions partners and specialists, as a part of their certification (see above).

**Conclusion**

When properly designed and implemented in conjunction with appropriate organizational and business process changes, MES applications can help improve manufacturing and business performance to a significant degree. This is accomplished in part through business and manufacturing process streamlining, reduced errors and process variability, improved reliability and availability, improved quality, reduced cost of quality and compliance, reduced inventory and work-in-progress, improved real-time visibility enabling agility, and improved performance management.

With its SIMATIC IT offering, Siemens has clearly aimed at raising the bar when it comes to delivering MES benefits. SIMATIC IT technology and libraries have a potential for high ROI and low cost of ownership. Siemens Value Framework allows applications to be designed for added value. The Siemens project management and partner program keep projects on track.

However, the client’s role is also essential. The client needs to take responsibility for evaluating and improving their own operations processes before attempting to automate them via MES. The client’s management is responsible for sponsoring MES projects, informing and consulting with personnel, and providing appropriate training. While improving processes, employees should be given some respite from their normal duties to provide them with adequate time to deal effectively with the changes. Middle management should support the initiative and be prepared to coach the users in how the new technology can be used in their daily activities to improve performance and why this is important. Client-internal support should be provided, including management of changes and improvements inevitably required in a constantly changing manufacturing environment. Ideally, the initiative should be closely monitored for added value throughout its lifecycle.

With these success factors in mind, an MES initiative is very likely to deliver sustainable added value.
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