

White Paper

Automation in the Digital Enterprise

To stay competitive, manufacturers must weave a digital thread through their operations to drive quantum gains in time to market, flexibility and efficiency. At Siemens, an important part of that thread is called Totally Integrated Automation.

Manufacturers with rigid production models and siloed organizations often suffer the consequences of information islands across their operations, from procurement to production to customer service and support. Even keeping several operational databases synchronized can cause problems. Latencies, errors, quality issues and lack of flexibility are typical symptoms, as are the costs of opportunities lost to more agile competitors.

This can be especially true in complex, knowledge-intensive industries such as aerospace, automotive, biotechnology and others due to the vast amounts of highly coordinated information such manufacturing requires. And that's

not to mention the information flows across the dynamic and much larger ecosystems of suppliers, partners and customers.

What's needed is a digital thread of real-time, continuously updated information that runs end-to-end through all manufacturing operations. And it must be available to all critical stakeholders, so they can have consistent visibility anytime, anywhere to operational data to make faster, better informed decisions. This way, everyone involved can be more aware, responsive and decisive at strategic levels. At the same time, they can ensure that automation is properly engineered to handle the day-to-day

production tasks to continually optimize and improve production, while reducing time to market.

Today, more and more companies in industries worldwide are realizing the great potential of the data-driven Digital Enterprise, sometimes called Smart Manufacturing or Industry 4.0.

Whatever its name, benefits include reduced time to market, enhanced flexibility, increased efficiency and continuous process optimization and integration. Together they can help deliver sustained, game-changing competitive advantages well into the future.

In pioneering the digital thread concept more than a decade ago, Siemens has helped sophisticated manufacturers in highly complex, global industries gain these advantages with its proven Totally Integrated Automation (TIA) portfolio. What follows is a look into what TIA is and how it can facilitate manufacturers seeking to better automate the Digital Enterprise in their operations.

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Weaving the Digital Thread through Manufacturing Operations with TIA

Siemens isn't the only company talking about the role of the digital thread in modern manufacturing, but starting over a decade ago, it has led the realization of that concept in practical, effective applications of the TIA portfolio and TIA Portal with customers worldwide.

Early on, Siemens realized that any manufacturer on the road to enacting a Digital Enterprise must include automation in its plans. After all, to be truly effective, digitalization has to start on the manufacturing floor with field level devices communicating up to control and operator levels, then to the higher management and enterprise levels in accordance with ISA-95 as shown in Figure 1.

All components in the Siemens TIA portfolio are designed, engineered and built on an open system architecture that spans the entire production process. It also enables their interoperability across all these automation levels.

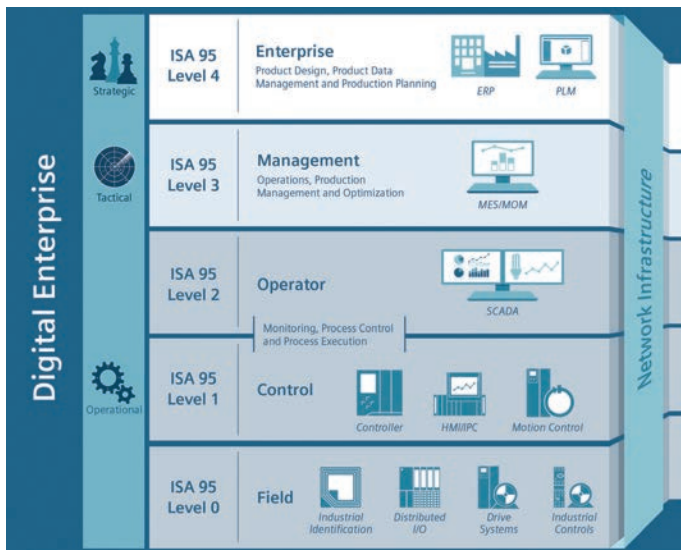


Figure 1. Digitalization must start on the shop floor and facilitate data-sharing and operational visibility upwards from the field to control, operator and management levels.

The TIA System Architecture is built on open standards and is supported by a comprehensive portfolio of TIA software and hardware. This also facilitates critical interoperability with legacy and third-party components and systems.

The basis for the Siemens TIA open architecture are the following shared foundational characteristics:

- Consistent data management
- Global standards and guidelines
- Uniform hardware and software interfaces

These common traits have been proven to reduce engineering time, helping to lower costs, accelerate time to market and deliver greater flexibility in responding to mass customization requirements and new market opportunities.

With the TIA System Architecture as part of the Digital Enterprise, manufacturers can gain the following core capabilities in a single, cost-effective platform to span all of their production processes:

- **Integrated Engineering.** Standardized data interfaces across the entire TIA portfolio provide consistent data management, which reduces or eliminates transcoding and other costly performance burdens and complexities. It also helps simplify and integrate engineering workflows. Parallel processes can be conducted with data that's always up-to-date.
- **Industrial Data Management.** By turning the growing volumes of plant data from a wide range of sources into actionable information, management gains valuable operating visibility to improve decision-making, reduce downtime via efficient diagnostics and optimize utilization of capital assets, materials and labor. This can boost plant availability, productivity, quality and flexibility.
- **Industrial Communication.** Without fast, reliable and secure communications across components and systems, the Digital Enterprise would remain a vision instead of the practical operating model it is today. Siemens TIA communications devices use international, manufacturer-independent standards, such as IEC 61850. They offer fast, easy installation and configuration, enabling flexible network architectures.
- **Industrial Security.** Cyber threats are growing in frequency and sophistication, so manufacturers must protect their personnel, assets, processes and reputations from harm. Siemens TIA components have security built-in, not added-on. This supports the Siemens recommended defense-in-depth security model, which includes plant and network security safeguards.
- **Safety Integrated.** Plant safety isn't a cost of doing business; it's an investment in the business. Research shows safer manufacturing is more productive and profitable with higher quality and yields. Safety integrated features are based on the latest international standards and integrated into all TIA components, so manufacturers can reduce or eliminate the cost, operation and maintenance of separate safety systems.

In effect, the Siemens TIA approach removes all horizontal and vertical boundaries in shop-floor automation and beyond, which substantially reduces engineering effort and cost. This boosts flexibility, reliability and safety across all automation tasks.

Central to the Siemens TIA portfolio for automating the Digital Enterprise is its SIMATIC brand of sophisticated controllers, distributed I/O, WinCC HMI software, industrial PCs and other related components – all programmable via the TIA Portal.

The SIMATIC S7-1500 advanced controller, for example, is the latest innovation in the TIA portfolio's wide range of PLCs for just about every application. Flexible in its scalability, this advanced controller raises the bar on automation with extremely fast response times, safety integration, security integration, easy commissioning and integrated system diagnostics for the full range of medium and high-end applications.

The TIA Portal offers a fully integrated engineering framework that supports the planning, programming and optimization of all machine and process tasks and sequences. It's based on a consistent, standardized operating concept, enabling users to quickly and easily program and integrate the operation of all Siemens controllers, distributed I/O, HMI, power supply and distribution, drives, network components, motion control and motor management.

With shared data storage, known as the smart library concept, users can tap existing libraries of proven code to program universal hardware and software functions efficiently. At the same time, they can develop and store libraries of their own proprietary code to use as needed.

Enabling the Digital Twin – Both in Products and Production

Today's Digital Enterprise will have the tools needed to generate a so-called digital twin, not only of products, but also of their production. A digital twin for a product describes an exact, virtual copy of that product, modeled in high-performance software systems. It lets engineers visualize and test an almost limitless set of variables and "what-if" scenarios in design and materials to ensure the best combination of both – before fabricating a test model. This reduces time, cost and risk substantially, while accelerating time to market by weeks, if not months. CAD/CAE programs can provide the tools needed to build digital twins of products.

Creating a digital twin for a product's manufacturing is even more profound. Complex machines, production cells and entire production lines can be designed, tested, commissioned and even maintenance analyzed before committing to the time, cost and effort of building their physical analogs. This way, industrial engineers can validate designs and test configurations of, for example, machine control systems much earlier in the engineering process. The digital twin for the production line is also valuable for training personnel on using the production line...in a safe environment.

Production digital twins can dramatically reduce the risk of errors and failures in critical phases of a machine's lifecycle, such as during actual commissioning. It also can significantly shorten commissioning time. If the machine information is available on an integrated data platform, later modifications can be tested and modified in exactly the same way, accelerating the introduction of innovative features and modifications for making new products. What's more, digital twins for production can be used to optimize other operational parameters, from energy consumption to cleaning and maintenance cycles.

As illustrated in Figure 2, Totally Integrated Automation – supported by the Siemens PLM Software Suite in conjunction with PLM and MES/MOM – can help manufacturers develop digital twins to model all levels of their production environments: Vertically, from the field level all the way up to manufacturing management levels; and horizontally, across engineering, production and service.

The Siemens PLM Software Suite offers highly integrated and sophisticated tools for intelligent data management and simulating a digital twin's full product lifecycle in the context of engineering, production and service phases. As its name implies, it is a robust collaboration platform that can provide the full data backbone to the Siemens Product Lifecycle Management (PLM) suite, one of the world's most comprehensive portfolios of simulation and data management software applications.

With the TIA Portal, automation code can be generated for the complete automation of the factory, by enabling engineers to pull functional blocks and ladder logic from libraries of proven code and quickly assemble and test it before committing to production.

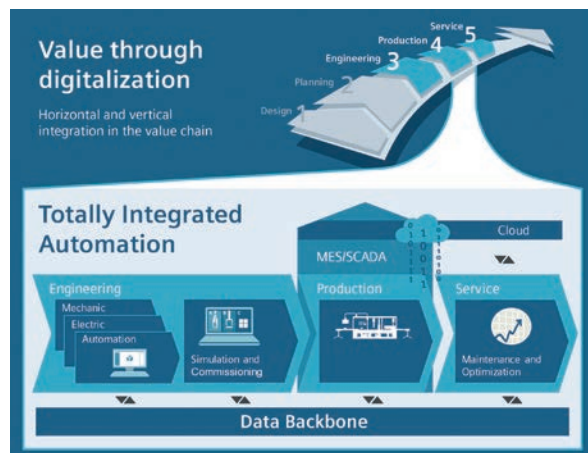


Figure 2. From virtual to real: Totally Integrated Automation (TIA) spans engineering, production and service in the value chain. It provides the tools to model the three steps shown as a digital twin to optimize them before committing to their physical forms, thereby saving time, cost and risk.

Siemens Totally Integrated Automation (TIA) Portfolio

Product Families At a Glance

- **SIMATIC:** Covers a wide range of Siemens controllers, I/O, HMI devices and software, RFID and industrial PCs.
- **SCALANCE:** Describes Siemens communication devices, including industrials Ethernet switches and routers, wireless access points, security devices, and more.
- **SIMOTION:** Refers to Siemens motion control systems and components.
- **SINAMICS:** Includes Siemens general purpose and servo drives, motors, and other drive-related products.
- **SINUMERIK:** Describes Siemens line of computer-numerical control (CNC) systems and related components and software.

Advanced simulation tools for the automation system simulates the entire automation system for functional testing of user blocks and provides test functions that can be carried out in exactly the same manner as with a real controller.

These tools can also simulate commissioning of the automation system, so any issues can be identified and resolved before physical commissioning. This virtual commissioning can save a lot of project time and cost.

Complementing these capabilities is Tecnomatix plant and process simulation software, which helps engineers model a digital twin for production and determine the best ways to optimize manufacturing and utilization of capital assets.

Once production's digital twin is realized in a physical production system, vertical integration of the shop floor's automation fabric with higher level systems can happen. Manufacturing Operations Management (MOM) links PLM, ERP and automation domain to provide a real-time industry software layer – a key Siemens differentiator.

What's Automation's ROI in the Digital Enterprise?

While each customer situations differ, metrics are emerging that support the game-changing potential of automating the digital enterprise.

- **Reductions** in automation engineering time using the Siemens TIA Portal.
- **Reductions** in I/O cabinet space using Siemens TIA components.
- **Faster** time to market using Siemens PLM software and automation tools.
- **Improvements** in on-time and complete shipments (OTCS).
- **Improvements** in successful new product introductions (SNPI).

In effect, the Siemens MOM enables plant operators to standardize and optimize manufacturing processes, minimize lead-times, optimize asset utilization and reduce global time-to-market. This can boost production visibility and improve response times, increasing overall enterprise agility.

For example, the PLM domain can mirror the plant model, while also holding bills of materials and processes (i.e., recipes). The ERP domain holds order and supply chain data, in addition to as-built information. The automation domain provides for collecting and monitoring data, from the shop floor to the top floor manufacturing execution system (MES).

Siemens highly secure, cloud-based complement called MindSphere enables data-driven services for monitoring performance, energy and resource consumption. It also serves as a channel for alerts to faults and needs for preventive maintenance. When faults do occur, MindSphere can facilitate remote diagnostics and faster recovery times, minimizing production disruptions.

The Modernization Journey: Tomorrow's Business Imperative

Ultimately, to stay competitive and economically viable, every manufacturing enterprise will need to create a digital twin of its entire value-added process in order to better respond to

often volatile market changes and emerging customer opportunities. Doing so will be a huge step toward manufacturing's modernization. This entails creating a Digital Enterprise and realizing its many benefits of improved time to market, flexibility and efficiency, all with greater visibility for management, suppliers and even customers.

How Automation Helps Siemens Improve SIMATIC Production

Here are some numbers from Siemens fully automated plant in Amberg, Germany, which mass-customizes SIMATIC products for domestic and international customer applications:

Speed: 1,000,000 SIMATIC components produced monthly – about 1 per second.

Configurability: 1,300 different product models produced for 60,000 different customers.

Flexibility: New order lead times reduced to just 24 hours, even down to lot sizes of just one unit.

Efficiency: Machine utilization increased to 95% – a 9x improvement.

Quality: Defects reduced from 600 per million parts to just 11.5 – 99.99885%, nearly "7-9s" quality.

But each manufacturer's modernization journey will inevitably be different, depending on their capital, expertise and organizational will to move forward. That's why Siemens takes a consultative approach to first learn and understand how these factors are at play within a customer's business and organizational model. We then examine every step of their processes and their respective interactions and dependencies. Not until we have gained a 360° view of their entire operation do we make recommendations on how to proceed.

Today, customers can already invest in proven, future-proof solutions for a step-by-step transition of their manufacturing automation to support their own versions of Digital Enterprise and corresponding timetables. They are tailoring PLM, MES/ MOM, automation, industrial communications, industrial security and services solutions to their own requirements.

By digitalizing the processes of all equipment vertically and horizontally, they can build a continuous, centrally managed data model to improve overall efficiency, productivity and utilization of their capital investment. In turn, this can help boost their enterprise profitability, customer satisfaction and a sustained competitive advantage. And while these benefits can provide clear business advantages today, they will be critical business imperatives tomorrow.

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