

# ARC WHITE PAPER

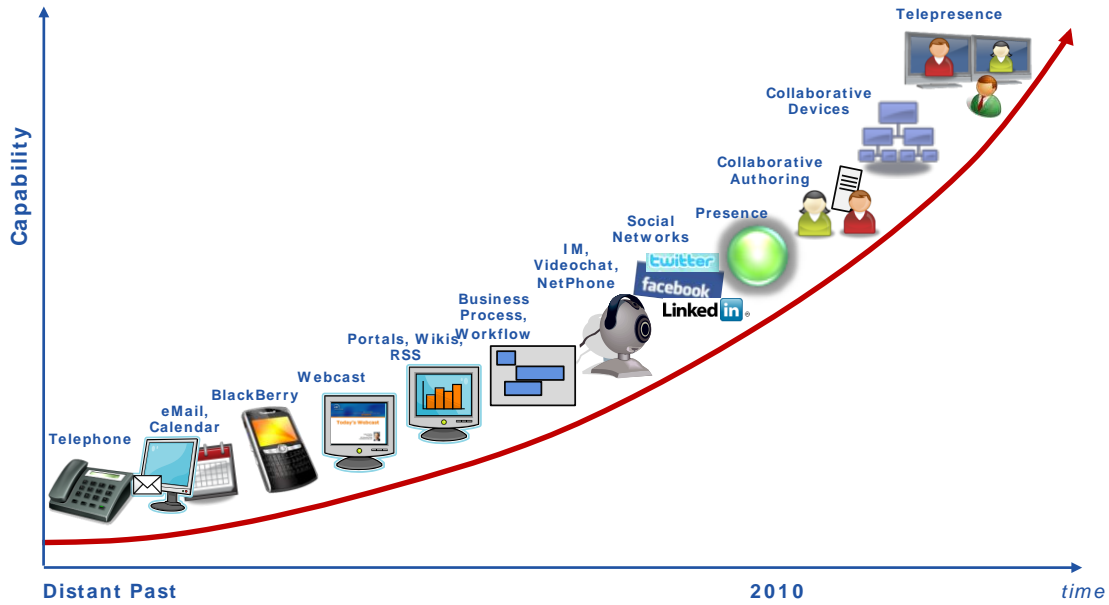
By ARC Advisory Group

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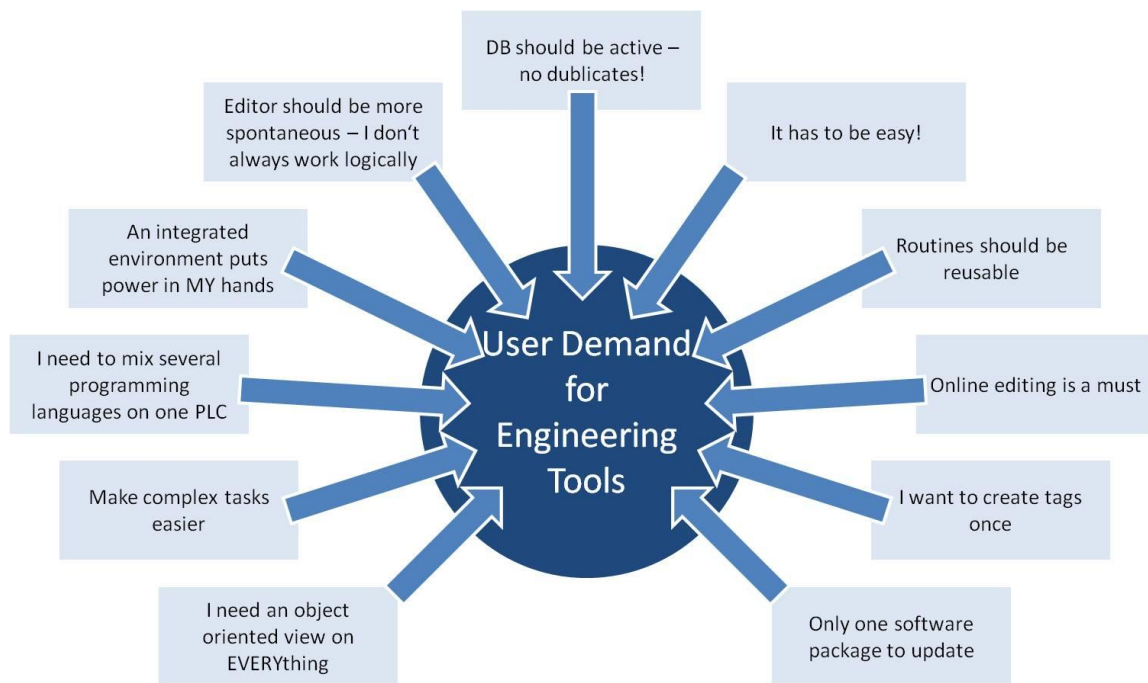
## Modern Engineering Tools Drive Productivity in Manufacturing

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## Collaborative Technologies are Influencing the Development of Industrial Engineering Tools



## Users Demand an Integrated Environment with Intuitive Interfaces (User Comments from ARC Interviews)

## Executive Overview

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The forces of globalization have fundamentally changed the way manufacturing companies do business today. Automation users are exposed to more technical and economic challenges than ever before. From machine builders to system integrators to process plant operators, companies are faced with cutting development and engineer costs while improving execution and mastering new technologies.

In today's technologically mature markets, the highest gains can be achieved with software.

Industrial software is playing a key role in helping automation users to meet the new challenges of globalization.

Meeting these new challenges means investing in and mastering new technologies. While IT and automation hardware still make up a sizeable part of capital costs, their portion is diminishing in favor of software. Thanks to many developments in just the last

decade, industrial software has become the key to keeping up with the challenges of globalization. Production management software helps companies to effectively plan, optimize, execute, and document manufacturing processes to meet the demands of information-hungry customers and authorities. Product lifecycle management (PLM) solutions digitalize the phases of a product's lifecycle, from design through manufacturing to support. PLM software also helps manufacturers to lay out, simulate and optimize complete production plants before construction even begins. At the automation level, disparate functions like PLC programming, operator panel design, and device configuration are being merged into single, comprehensive engineering frameworks, helping plant engineers and maintenance personnel to design, build, commission and maintain manufacturing assets more efficiently and effectively than ever before.

Siemens AG, a leading supplier of industrial solutions, has released a completely new engineering framework - the Totally Integrated Automation Portal (TIA Portal) - to help customers realize new efficiencies in automation engineering. In the long-term, the company plans to bring all significant software-based tools from its Industrial Automation and Drive Technologies divisions into this single engineering environment.

## Business Drivers for Manufacturers

In the last decade, the manufacturing industries have been driven by market forces that have fundamentally changed the way companies do business. No force has had a greater impact than globalization. Today's manufacturers face new challenges posed by a faster-paced, more globalized world. Thanks to globalization, customers have access to more suppliers, so their expectations are higher and their loyalty more fleeting. To keep inventory costs down, they often place orders more frequently, but order smaller lots and expect a faster turnaround. In addition, they want more visibility into producers' supply chains, demanding more real-time information about orders, and expect components to be traceable.

Successful manufacturers today address markets around the globe and tailor their products to the needs and whims of local tastes. But the clear synergies available to global manufacturers are accompanied by the increased complexities of managing product

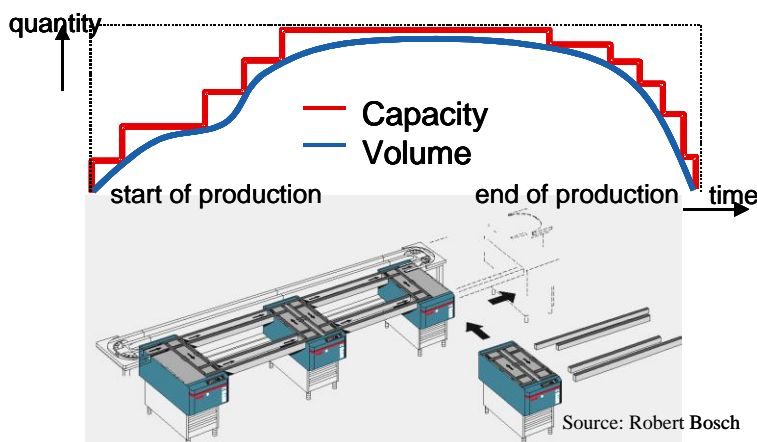
portfolios, including keeping track of the ever-increasing number of product variations, maintaining the consistency of product configurations, and allowing for local modifications.

These new challenges are forcing manufacturers to deal with information as they have never done before. Products that once left factories anonymously are now shipped surrounded by a cloud of information that follows them down the supply chain and accompanies them

throughout their lifecycle. Managing this metadata means collecting, evaluating and storing vast quantities of information – tasks that are driving the integration of production equipment with enterprise systems. Together with other information-driven areas such as process simulation, product data management, these challenges are collectively creating the Digital Plant.

### Machine Builders: Key Players in the Digital Plant

Machine builders are playing a decisive role in this development as well. In addition to addressing the information requirements placed on automation



**Flexible Manufacturing Means Reconfiguring Lines to Adapt to Changing Production Capacity Demand.**

architectures, makers of industrial machinery are helping manufacturers cope with the need to respond to real-time demand changes by developing flexible machine concepts with modular designs. Flexible manufacturing is the art of quickly reconfiguring production equipment to respond to changing market demand. Unlike classic machines that are designed to produce a single product, a flexible machine can run a variety of products of different sizes and shapes and switch between products with a minimum changeover time.

Another aspect of flexible manufacturing takes advantage of modular machine design. Production or packaging lines are made up of intelligent machine modules that can be reconfigured physically to adapt to fluctuations in production capacity. Throughput can be increased, for example, by adding parallel lanes to free up bottlenecks.

### **Information: The Common Thread**

In industries such as food & beverage, pharmaceutical and consumer packaged goods, manufacturers seek a competitive advantage through “lifestyle packaging” - the use of elaborate styles and shapes of product packaging as part of a marketing strategy, often tailored to specific customer segments. Lifestyle packaging results in a much greater variety of packaging styles, and this in turn puts pressure on machine builders to accommodate greater flexibility in packaging line capabilities. This means that the operational range of packaging machines must be increased by adding changeover flexibility to accommodate a wide range of package sizes, shapes, and end-of-line packaging.

In general, all current trends and drivers in manufacturing boil down to a single challenge of managing information from manufacturing processes. This challenge is gradually being met as companies focus on the integration of IT technologies and practices into their production systems.

## **Evolution and Vision of Engineering Tools**

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Engineering tools have undergone a long evolution ever since bulky hardware terminals were used to configure the first programmable logic controllers in the late 1960s. “Tools” used to mean actual tools like screwdrivers for adjusting potentiometers or voltmeters to check signals from

sensors or field devices. Today, the term refers almost exclusively to software-based applications for design, programming, configuration, set-up, and troubleshooting.

Industry technology has traditionally lagged behind commercial technology, held back by proprietary standards or requirements for hardware ruggedness. While the use of commercially available personal computers helped to lower hardware costs in the 1980s, it wasn't until the advent of

Microsoft's Windows operating systems that engineering tools for industrial applications began taking advantage of existing, available IT standards.

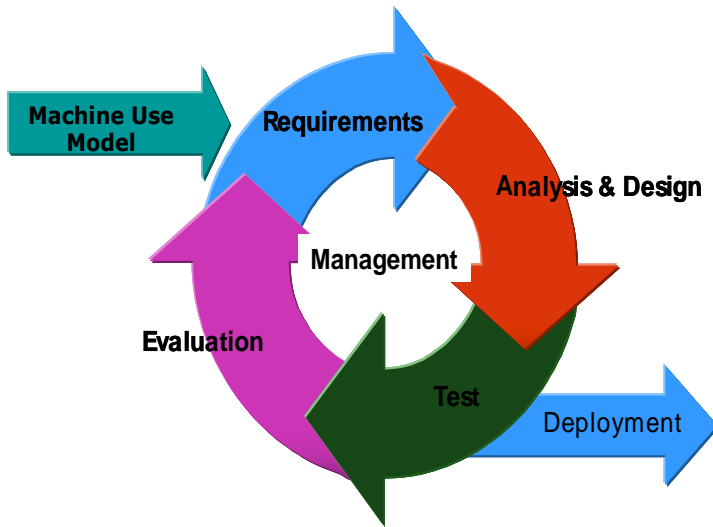
The "modern" era of Windows-based engineering tools enabled automation suppliers to focus more on features than on underlying architecture. While programming and configuration tools benefitted from better graphics and standardized interfaces, they still remained single-point solutions for PLC and motion control programming, machine vision set-up, or panel configuration. At the same time, the commercial world advanced in leaps and bounds as

multiple business functions consolidated into "office productivity suites". These suites employed standard user interfaces and allowed the first practical sharing of objects between applications, creating true efficiencies.

Now, with some time delay to the commercial world, industrial software is moving to the application suite model, driven by the need to improve productivity and shorten engineering cycles.

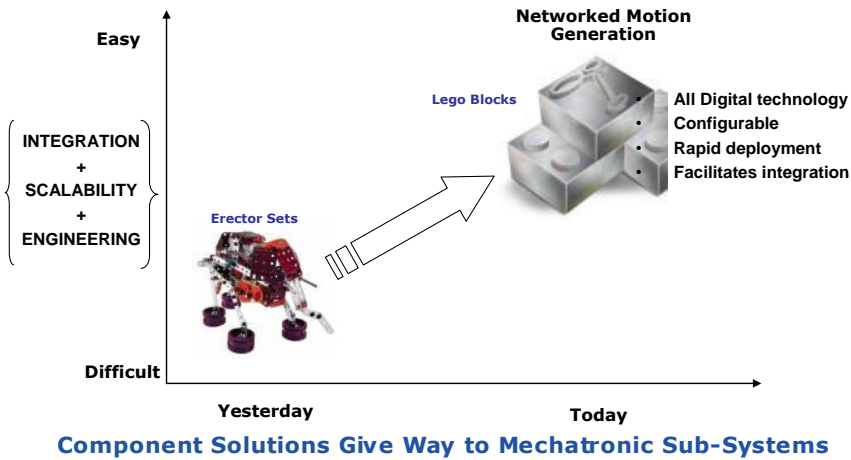
### Driving Business Value through Software Management

Increasingly, more machine builders are becoming custom design houses, capable of providing line and machine configurations built to a customer's specification. To achieve this, they take advantage of modularity in the design of both mechanical and electrical subsystems. However, in software design, many machine builders continue to use monolithic concepts, controlling widely dispersed machine functions from a single, centralized program structure. Some are simply not aware that modular software can lower development costs and shorten commissioning time.



**Automation Software Development Profits From Off-the-Shelf Technologies and a Common Environment**

Modular design approaches to programming go hand in hand with mechatronics because each takes an object-oriented view of machine sub-systems. The modular approach allows machine builders to divide their machine designs into functional units, and then program and configure each unit as if were a standalone system. The mechatronic view differs only in that it breaks down subsystems into electrical, mechanical and software components.



The goal is to build up a library of software objects that are pre-validated so that ensuing designs can be assembled like Lego blocks rather than starting each time from scratch. Many engineering tools now have libraries for user-created objects, but not all allow the user to manage them efficiently and track changes as objects are developed.

For machine builders, the challenge is to manage a collaborative design effort between electrical, mechanical, and software engineering teams. While the costs of automation control platforms and hardware continue to decline, the hidden cost of software development is escalating rapidly, thereby negating many of these cost reductions. In effect, software development is rapidly garnering a greater percentage of the overall engineering effort, so efficiency gains won in engineering productivity are amplified.

### Evolution, not Revolution

Software development tools for enterprise applications have become more sophisticated in the last two decades, driven by the need to increase productivity and lower development costs. Tools for industrial applications, on the other hand, have evolved more slowly, due in part to the smaller demand from manufacturing industries, and the conservative view of many market participants. Lifecycles of manufacturing assets are long because of their high capital and total lifecycle costs, so users typically take a dim view of any developments that might introduce new risks.

Despite this conservative view, an unstoppable evolutionary change is driving the development of engineering tools. Recent engineering graduates

entering the industry are coming equipped with knowledge and experience of modern software development methods that would make current industry veterans blush. The project engineers of tomorrow understand object-oriented programming and are used to integrating sophisticated control algorithms with dynamic data base access. Ladder logic may offer a path to legacy applications, but the simple fact is that today's engineering graduates don't want to program like their fathers did.

<b>Automation Software</b>	
CNC Configuration	CNC, intelligent drives, and spindle drives require configuration parameters specific to the machine geometry, mechanical component selection, motor types, and sensor.
PLC Programming	Machine tool subsystems such as tool changers, automated material handling and M code functions use PLC programming tools to integrate with the CNC system.
Operator Panel Design	Customizing the operator panel using modern tools and languages that facilitates the use of the machine tool.
Third-Party Applications	CAM software, enterprise integration, and data logging tools require integration by the machine builder.

**A Typical Automation Application Suite for Machine Tool Builders**

Current engineering tools tend to focus on solving specific tasks at hand, such as configuring screens for operator panels, programming the movements of servo axes, or devising interlocks in PLC code. This sharp focus results from the traditional division of these tasks. While technology has integrated many of these functions at a higher level, supporting software often employs unique user interfaces optimized for specific tasks, but doesn't integrate them well in a common environment.

These task-oriented tools rarely take into account what automation engineers are confronted with on a daily basis: the need to coordinate between multiple, complex control and monitoring systems in disparate environments. Existing tools require their own specific approach to work with and don't allow flexibility across discipline boundaries. In the past, this was less of a problem, but the complexity of modern systems means that engineers and maintenance personnel have to learn and master more tools.

Another deficit with current engineering tools is the lack of support for simultaneous teamwork on large projects. Large systems are commissioned by teams of engineers working in parallel, but many engineering tools still don't allow multiple users to work on the same object at the same time.



## Requirements for Modern Engineering Tools

For industrial applications, the top requirement for engineering tools is that they contribute to productivity through increased usability. Only by incorporating these modern developments into industrial applications can engineering tools help end users, machine builders, and systems integrators to mitigate the new business challenges posed by globalization.

The industrial world should not view contemporary office suites as a benchmark for application integration. Instead, the bar should be set higher to demand seamless integration of data, visualization, and programming code among a variety of disparate automation devices.

The evolution of software development environments has shown that, contrary to popular perception, ease of use can actually increase as complexity grows. On the surface, this may seem like no easy task since system complexity has increased over time as devices have become smarter. The key is to use technology to hide complexity without reducing functionality, similar to the way that cloud computing keeps complexity hidden in the background, making technology accessible to users with few skills.

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In the enterprise world, knowledge workers are accustomed to juggling multiple applications as they combine text, graphics and numerical data to create everything from monthly sales reports to advertising copy. While PC operating systems have helped create a common look and feel for these apps, commercial “office” suites still don’t offer a truly single environment to integrate disparate media. Instead, individual applications merely accept each other’s data formats to allow the copying and pasting of objects. For this reason, the industrial world should not view contemporary office suites as a benchmark for application integration, but rather should set the bar higher to demand seamless integration of data, visualization, and programming code among a variety of disparate automation devices. The solution is to break down barriers between applications by integrating them in a single engineering environment – an *engineering framework*. The establishment of a common framework that allows for easy integration of specific engineering tasks is a key part of the vision for modern engineering tools.

### Framework is the Word

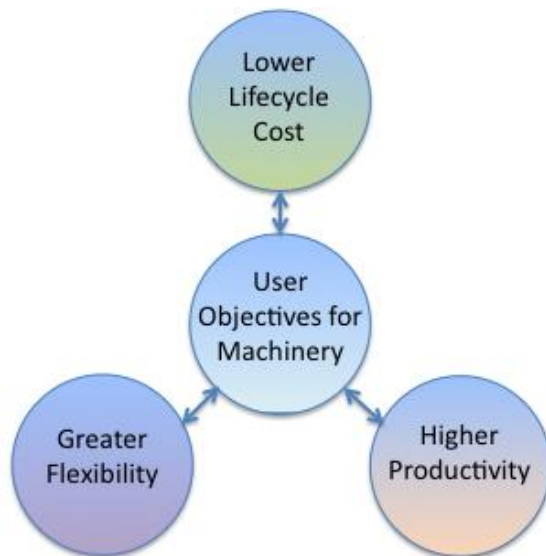
An engineering framework for automation tasks must have the ultimate goal of increasing productivity by allowing more efficient use and re-use of common elements. In addition, the tasks within a framework must be intuitive, allowing the user to work productively and efficiently. Finally, the

framework must support efficiencies in the future, such as libraries of reusable objects created by users as well as objects that can be purchased from future automation “app stores”.

One important difference between a framework and a suite of applications is that a framework provides a single, common environment for all applications that enables seamless sharing of common elements among them. Unlike an office suite, a framework mimics the final system by describing and configuring the various real-world communications paths between devices. This is more complex than simply supporting dynamic links, for example, to allow values to be updated between a spreadsheet and a text document.

### Frameworks Should Be Intuitive

Today’s engineers expect software to be intuitive – just like the other software that they use in their daily lives. They have less time for training and want to devote more time to solving problems. Consequently, the evolution of software must make applications easier to use with little or no training necessary, and industrial software can no longer be the exception. At no time in modern history have engineers been less willing to study onerous user manuals!



**Reusable Objectives Increase Productivity and Lower Engineering Costs**

Within a framework, each application is bound to have a different program structure, so creating a common look and feel among all applications is the most important part of making software intuitive. An attractive, modern design can also contribute to overall intuitiveness. Another important aspect is the use of built-in intelligence -- making objects, tools, or data that are related to the current task appear automatically via pop-up menus or palettes rather than making the user search for these items. This gives

the user the feeling that the software is anticipating each move and is helping the user in the background by shortening the steps to complete certain tasks – for example, to create a new tag on the fly. Reducing the number of mouse clicks required to complete simple tasks makes software feel more intuitive and user-friendly.

In addition to intuitiveness, the “fun” factor cannot be overlooked. Positive experiences result from intelligent features such as tasks that are completed

automatically, or suggested solutions based on context or previous user behavior. Software usability studies show that the overall quality of the user experience contributes significantly to productivity that can be enhanced with positive experiences. Again, the more the programmer feels comfortable in the environment and can concentrate on the task at hand, the more efficient and productive the work.

### **Frameworks Should Be Efficient**

One of the most difficult problems of working with automation systems has traditionally been the management of controller data. While PLCs store data in non-volatile memory, these devices typically offer only simple data structures - mostly linear lists of bit, byte and word data. As visualization software gradually replaced dedicated displays, the database was moved to operator panels or industrial PCs where data could be manipulated in a freer, more PC-like environment. "Tags", or virtual data that point to fixed PLC addresses, were created to allow users to process data in a wide variety of data formats, or group dissimilar data types together in logical object-oriented structures.

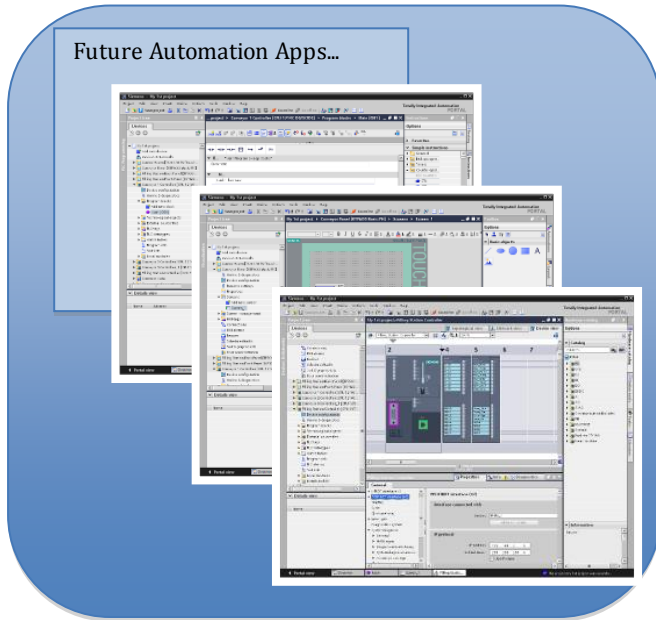
The challenge for modern engineering tools is to unite all system data in a single common database that is accessible by all devices.

In the past, the data management problem was caused by the fact that data "lived" at no single location, but rather was dispersed among several devices in an automation system, including PLCs, motion controllers, operator panels, IPCs, and even some smart field devices. Creating a new data point in one system necessitated the creation of corresponding tags in the other systems if this information was to be shared. One of the greatest challenges for modern engineering tools is to unite all system data in a single common database that is accessible by all devices. Such a feature has the potential to dramatically increase the efficiency with which automation systems are engineered and deployed.

Another important feature for efficiency gains is the reusability of program objects. In general, machine builders today are incorporating more complex algorithms into PLC code, taking advantage of higher processor performance and integrated high-level languages that allow code to run on the controller rather than on an external industrial PC. Not only does this simplify the integration process, it also allows machine builders to protect their intellectual property by encoding these algorithms into "black boxes" that cannot be reverse-engineered.

### Frameworks Should Be All-Encompassing

An engineering framework is not an application itself, but simply an environment in which other applications run and interact with each other. For this reason, end users make more of a commitment when deciding on a framework versus individual applications because they are putting a higher amount of trust in future support and compatibility with future applications that may be added. For this reason, the supplier's long-term commitment to integrating future software solutions into the framework is an important consideration.



**Modern Engineering Frameworks Let the User Focus on the Task at Hand By Hiding Complex Technologies in the Background**

Frameworks should also be “open” in the sense that they allow users to customize them or automate certain routine functions. An example of this is a machine builder that creates a routine to automatically put together blocks of PLC code from a library of program modules. Each new configuration is based on the customer's wishes for specific features. The machine builder would create this routine with a minimum of effort using an application programming interface (API) that provides the necessary access to the framework's inner workings.

Finally, an engineering framework should justify and protect a user's investment by being scalable across current and future applications. Manufacturing industries are often divided into “process” and “discrete” – a result of the historical segmentation of industries by controller type. However, the reality is that most industries are made up of elements of each. For this reason, a framework should provide blanket coverage across all applications, from PLC to DCS programming, from motion control to field device parameterizing, from wireless network setup to fieldbus configuration, and from operator panel design to safety programming.

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## TIA Portal Integrates Engineering Tools

Siemens AG, one of the world's leading industrial companies, subscribes to the philosophy of “Totally Integrated Automation” (TIA). This concept

ensures users that automation equipment from the company's vast portfolio of hardware and software will be compatible and therefore easy to integrate, helping customers lower their engineering costs. Now, Siemens is extending the concept of total integration to its automation software.

The first step of Siemens' initiative is the release of the "TIA Portal", an engineering framework that integrates multiple automation application in a single environment. TIA Portal is a new, intuitive development environment that integrates existing engineering tools with which automation users are already familiar. The first release of TIA Portal brings together the familiar STEP 7 tool for programming and configuring SIMATIC controllers. Integrated into this environment is WinCC, the configuration tool for setting up Siemens' extensive family of operator panels. Finally, drives can set-up and parameterized in the same framework with StartDrive, a configuration tool for SINAMIC AC drives.

### **Common Tags**

The most obvious advantage of using TIA Portal is the universal accessibility of data tags. Tags created in any tool for any device are automatically and immediately accessible to other devices. If, for example, a user creates a new tag in the PLC to measure a temperature, that tag is automatically created in the operator panel at the same time. This saves valuable engineering time compared to conventional methods that require the tag to be created in each device. Should the user wish to modify that tag's properties, he or she can change parameters from whichever tool is currently being used just by changing the view. In any case, the data is universally accessible.

For handling large amounts of data, the Portal makes it easy to create large data blocks and supports incremental naming of tags. Tag properties can be copied or changed easily for multiple objects simultaneously, and newly created data can be "dropped" directly into the configurations of other controllers or panels. The Portal ensures that the proper HMI variable, tag name, or IO field is created in the target object and creates a connection between the devices if one doesn't already exist.

### **Topology Overview**

Another valuable feature is the integrated device and network portal that allows hardware and networks to be configured from a single topology view. Interconnections between devices are defined by drawing a line between them. Specific network parameters can be set immediately, or this

task can be delayed until later. In any case, tags immediately understand the logical connections between devices, so the user can continue to work without being “punished” for not completing the network setup. Later, commissioning personnel can troubleshoot the network connections online using diagnostic tools from within this same view.

Many current engineering tools support libraries for storing user-defined function blocks or complete programs. The TIA Portal goes beyond this by allowing users to archive all program components, including program blocks, variable definitions, HMI imagines, module configurations, and complete system topologies. These components can be stored either in a local library or across project boundaries in global libraries. In addition, pre-engineered objects are available for specific devices or functions, saving the user time and effort that would otherwise be required to set these up.

Finally, the TIA Portal integrates safety functions directly within the framework, so that both safety and non-safety components can be configured within the same environment and with the same familiar tools.

## Last Word

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Facing new challenges through globalization, automation users are investing in new technologies and skills to maintain competitiveness and conquer new markets. In today’s technologically mature markets, the highest gains can be achieved with software. In the next decade, software-based tools such as product lifecycle management software and engineering frameworks will help users make gains in productivity and efficiency that will rival the benefits realized by the application of manufacturing execution software in the previous decade.

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**Acronym Reference:** For a complete list of industry acronyms, refer to our web page at [www.arcweb.com/Research/IndustryTerms/](http://www.arcweb.com/Research/IndustryTerms/)

<b>API</b> Application Program Interface	<b>HMI</b> Human Machine Interface
<b>B2B</b> Business-to-Business	<b>IOP</b> Interoperability
<b>BPM</b> Business Process Management	<b>IT</b> Information Technology
<b>CAGR</b> Compound Annual Growth Rate	<b>MIS</b> Management Information System
<b>CAS</b> Collaborative Automation System	<b>OpX</b> Operational Excellence
<b>CMM</b> Collaborative Management Model	<b>PAS</b> Process Automation System
<b>CPG</b> Consumer Packaged Goods	<b>PLC</b> Programmable Logic Controller
<b>CPM</b> Collaborative Production Management	<b>PLM</b> Product Lifecycle Management
<b>CRM</b> Customer Relationship Management	<b>RFID</b> Radio Frequency Identification
<b>DCS</b> Distributed Control System	<b>ROA</b> Return on Assets
<b>EAM</b> Enterprise Asset Management	<b>RPM</b> Real-time Performance Management
<b>ERP</b> Enterprise Resource Planning	<b>SCM</b> Supply Chain Management
	<b>WMS</b> Warehouse Management System

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