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Project Execution: The Future Is Now

From ultimate flexibility in the field to streamlined integration of packaged units, ABB sets new standard in automation engineering

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Project Execution: The Future Is Now

From ultimate flexibility in the field to streamlined integration of packaged units and electrical equipment, ABB sets new standard in the execution of automation projects

FOR decades now, ABB has been on the leading edge of efforts to streamline the design and delivery of digital automation systems—and to minimize associated project risk. To learn more about how ABB's latest technologies, software tools and project execution methodology are helping the process industries to improve capital project delivery, Keith Larson, publisher of *Control*, sat down with Brandon Spencer, vice president and business unit manager for oil, gas and chemicals in North America, for the big picture view.

LARSON: What's behind the current industry-wide emphasis on improving capital project delivery?

SPENCER: The process industries' newest production assets have never been larger or more complicated. But with increased scale and complexity has come a growing inability to predictably deliver capital projects on schedule and within budget. Key contributors to this growing risk are late design changes that tend to cascade throughout a project, causing delays and budget overruns.

LARSON: We've heard that from the readers of *Control*, too. In a recent poll, 70% of respondents indicated that late changes often affect overall project budget and schedule. Further, the majority indicated that these effects are "significant" or "major." What is it about automation in particular that tends to put it on the critical path of project completion?

SPENCER: The engineering of instrumentation and automation systems necessarily depends on the design decisions made by other engineering disciplines. And traditional automation systems lack the flexbility to roll with any late changes that come their way.

For example, despite the longstanding availability of fully digital fieldbuses for instrument communication, many process end users still specify analog electronic loops. And while analog loops remain a familiar and trusted technology, they require an extensive hardware infrastructure of input/output (I/O) systems in order to bridge the gap between analog field instruments and digital automation systems.

Traditionally, these I/O subsystems and even the enclosures for them have been custom, highly engineered systems designed

to accommodate a specific mix of I/O types based on anticipated process requirements. Schedule delays and cost overruns happen when, say, a new measurement point is added late in the design cycle and there isn't a spare I/O channel of the appropriate type available. With the old way of doing I/O, this kicked off a whole series of expensive and time-consuming rework.

LARSON: ABB has put forth Select I/O, which can be configured in the field on a single-channel basis, as a key part of the solution to this problem. How does Select I/O help reduce project risk?

SPENCER: Select I/O effectively allows each I/O channel to remain flexible and "undeclared" until very late in the project, often until just before commissioning. All that's needed from a project planning perspective is an approximate I/O count. This effectively decouples I/O hardware engineering from software design, which lowers development costs and shortens delivery schedule. Further, physical marshalling cabinets and terminal blocks are eliminated in favor of "digital" marshalling in the course of system commissioning.

LARSON: What other steps has ABB taken to reduce project risk and streamline delivery?

SPENCER: ABB uses a combination of digital technologies to speed the development, testing and validation of automation applications. Development teams have the option of using these tools locally or collaborating across the cloud. Standardized logic templates mean that developers seldom start from scratch but can adapt proven strategies to their processes' unique requirements. Also, process simulation and hardware emulation tools allow full software testing in a virtual environment that mimics how the real system will behave.

Finally, automated data management tools effectively allow I/O points within process skids and intelligent electrical devices to be digitally marshalled into the 800xA architecture as well. This means that all of the data points that make up a project—whether resident in a control system I/O module or within a connected electrical substation—are integrated, visible and manageable from the start. ∞

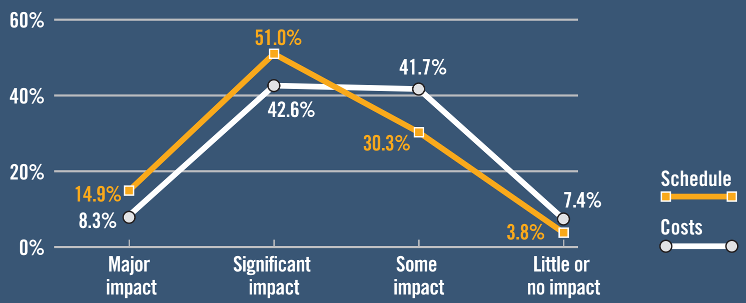
The Problem with Projects

Serial engineering workflows and dated automation infrastructure practices contribute to poor project flexibility as well as cost, schedule risk

CAPITAL project execution is under the microscope. Ever larger and more complex projects—especially in the energy sector—are proving increasingly difficult to manage. According to a 2014 Ernst & Young study, 64% of oil & gas "mega" projects faced cost overruns and 73% reported scheduling delays. The financial risks posed by this inability to deliver projects as planned has only intensified over the past several years in the oil & gas sector, as lower energy prices have raised visibility. Indeed, more than one multinational energy stock has taken a hit on news of cost overruns or start-up difficulties associated with new, multi-billion dollar production assets.

And while the largest and most complex projects attract the most attention, respondents to a recent study across *Control*'s broader process industry readership indicate that execution predictability remains a stubborn problem on projects big and small. The median survey respondent indicated that 25% of projects are delayed by 15% of original schedule, and that 20% of projects run over budget by an average of 15%. On the high end, however, a full 25% of respondents indicated that the typical project was delayed by more than 50% of original schedule and/or cost more than 50% of the original budget. (For more on survey methodology and respondent demographics, see sidebar on p9.)

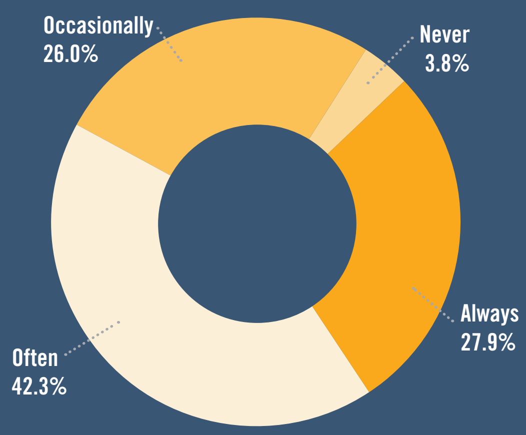
FIGURE 1. LATE CHANGES IMPACTING SCHEDULE & COSTS



The majority of *Control* survey respondents say that late changes have a significant or major impact on project execution schedules and costs. (See sidebar, p9, for more on the survey methodology and respondent demographics.)

FIGURE 2. AUTOMATION ENGINEERING REMAINS ON CRITICAL PATH

More than 70% of *Control* survey respondents indicate that control system design and development remains on the critical path of project completion.



Automation on the critical path

While any number of unexpected developments can throw a project off track, automation is uniquely positioned to either absorb project risks—or to amplify them. This is because the design of process automation systems necessarily depends on the design of the processes they will control.

Traditionally, this serial dependency has been handled by a process "design freeze," at which point all the essential control and automation requirements are fixed (in theory) and automation development can proceed in parallel with detailed process design. At this point, the automation team engineers the controllers, the enclosures, the marshalling panels, and the particular combination of input/output (I/O) modules and other hardware system components they think they will need based on pre-freeze engineering work.

But today's projects are increasingly complex, and they may involve dozens or hundreds of equipment manufacturers, skid builders and other process technology suppliers. This adds up to incomplete information and new automation requirements that continue to trickle in long after the design-freeze milestone. These

THE CURRENT STATE OF PROJECT EXECUTION PRACTICES

In January 2017, *Control* conducted an email survey on the current state of project execution practices across its global audience of process automation professionals. The organizations represented by the 211 survey respondents reported involvement with nearly 5,000 total projects in a typical year. The average respondent cited organizational involvement in 24.5 projects in a typical year, although the median involvement was 6.0.

The largest process industry segment represented was oil & gas at 33%, followed by engineering & integration services at 22% and chemicals at 18%. Other segments included: power generation at 5.6%, pharmaceuticals at 5.1%, food & beverage at 4.6% and metals & mining at 2.6%. "Other" industrial verticals totaled 9.2%.

Geographically, 61% of respondents hailed from the Americas, with 22% from Europe/Middle East/Africa and 17% from Asia-Pacific regions.

The median survey respondent indicated that 25% of projects are delayed by 15% of original schedule, and that 20% of projects run over budget by 15%. On the high end, however, a full quarter of respondents indicated that the typical project was delayed by more than 50% of original plan and/or cost more than 50% of original budget.

Responses to other survey questions appear in figures throughout this special supplement.

changes cascade through the project, resulting in expensive and time-consuming rework. And that adds up to cost overruns, delayed project delivery—or both.

Inflexible project practices

A big part of this inability to be more flexible—to respond to change and deal with incomplete information—derives from long-standing project practices based on outdated technology and workflows. A chief offender is the hard-wired analog instrument that, despite the availability of digital alternatives, persists in common use because of simplicity of operation, widespread familiarity and habit.

Analog instrumentation, in turn, has long relied on traditional, non-configurable multi-channel I/O modules that might include 8, 16 or 32 fixed input/output channels. While one module may accommodate a limited mix of common signal types, they're fixed at the factory early in the project cycle, and can't be changed after shipment. This requires the project automation team to know with a high degree of accuracy the exact mix of I/O channels that will be required for any given application—or face rework and delay.

Making matters worse, each control strategy or application program to be developed must be mapped to a specific controller (or redundant pair of controllers), and all of the I/O modules within the scope of that application connected to that particular controller. All of the associated field instruments must be marshalled to the correct type of I/O channel that is connected, in turn, to the correct controller.

Marshalling as work-around

Indeed, the decades-old practice of physical signal marshalling was created to help deal with all these interdependencies. Onsite, analog signal pairs from the field are landed on hundreds or thousands of pairs of terminal blocks in extensive marshalling cabinets. These custom-built marshalling cabinets also provide a platform for ancillary I/O functions needed for certain loops, such as intrinsic safety, isolation and circuit protection.

Marshalling, then, allows instruments themselves to be commissioned—and basic loop integrity verified—at the same time that the I/O modules, controllers, other hardware and system software undergo factory acceptance testing (FAT) back at the automation supplier's staging facility. Once tested and shipped to the project site, each I/O module channel is wired, pair by meticulous pair, to the appropriate terminations in the marshalling cabinets. So it is that the two worlds of analog instrumentation and digital control come together. Finally.

Amid mounting pressure to reduce project risk, automation leaders at several large energy companies, including ExxonMobil and ConocoPhillips, challenged the automation supplier community to help keep automation off the critical path to project completion. The vision was that with new technology and new ways of thinking, the automation engineering community could dramatically streamline engineering workflows while increasing the ability of their designs to gracefully absorb even late changes. The remaining articles in this special supplement tell the story of how ABB has done just that. ∞

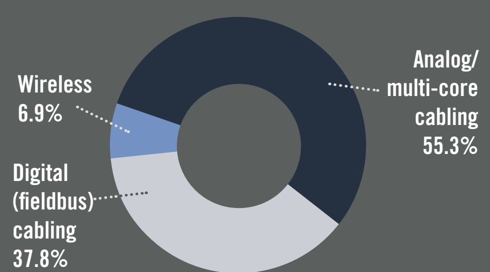
Maximize I/O Flexibility

Moving automation engineering off the critical project path starts with accommodating even late changes in instrumentation requirements

ALL industrial processes are analog in nature. As such, one of the foundational requirements of process automation is the translation of analog process variables into the bits and bytes that today's digital controllers can understand. A controller's digital decisions, in turn, must at some point be translated back into analog action such as a change in valve position or an adjustment in motor speed.

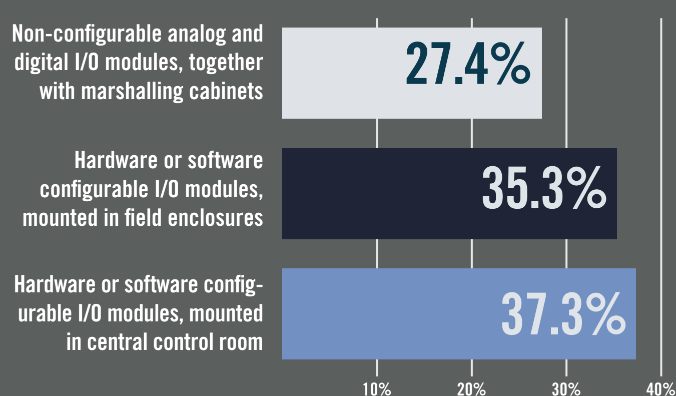
Not so long ago, this input/output (or simply I/O) function was the exclusive province of fixed-functionality, multi-channel I/O modules that bridged the divide between the digital process automation system and each of the hundreds or thousands of analog field devices in a typical process plant. As discussed earlier in this volume (see "The Problem with Projects," p6), the wire pair from each field device had to be physically marshalled to a specific type of I/O channel, which in turn had to be connected to the controller responsible for that particular variable. These serial design interdependencies made for inflexible I/O subsystems that

FIGURE 1. ANALOG TRANSMITTERS PERSIST IN USE



Despite the inherent advantages of digitally networked field instrumentation, a survey of *Control* readers indicates that more than half of new project I/O relies on analog signal transmission. (See sidebar, p9, for more on the survey methodology and respondent demographics.)

FIGURE 2. CONFIGURABLE I/O MAKING INROADS



could not gracefully accommodate change, resulting in redesign, rework and ultimately late projects that ran over budget as well.

Eliminate I/O where possible

Over the past several years, ABB together and other automation system suppliers have begun to chip away at these serial interdependencies. First, through the development of fieldbus and wireless instrument networks. These advances in digital communications technology increase system flexibility by effectively eliminating the need for traditional I/O hardware altogether. Any new measurement points or outputs added to a project must still be digitally mapped to the broader control system strategies, but that can be done relatively late in the project via software—an approach that's always less disruptive than reengineering, reordering and/or reinstalling multiple new hardware components.

The second means by which process plant designers have kept inflexible I/O designs from derailing project delivery is by leveraging modularized process units and other higher level subsystems such as intelligent electrical devices (IEDs) where possible and practical. These subsystems arrive at the project site not with a bundle of analog wires to physically marshal into the main automation system, but with a single (or redundant) Ethernet cable connection. The subtleties of lower-level field device connectivity are left to the subsystem supplier and the measurement and control parameters digitally mapped to broader strategies in the main control system. By some estimates, more than 50% of today's measurement and control points are wired not at the project site, but come already embedded within larger pieces of equipment and skids.

Configurability tames remaining I/O

Despite these innovative ways of eliminating traditional I/O engineering dependencies, old habits die hard. Indeed, a recent survey of *Control* readers indicates that analog instruments still account for some 55% of capital project I/O points, whereas 38% is connected via fieldbus and 7% by wireless (Figure 1). Clearly, the process industries still appreciate the simplicity and familiarity of analog instrumentation. So, a third innovation was needed to free project engineers from the rigid tyranny of fixed-functionality I/O modules: single-channel, flexible I/O such as ABB's Select I/O offering.

Available for process automation and safety applications, this extension to the System 800xA family of Flexible I/O Solutions allows for each I/O channel to be individually characterized using a plug-in hardware module. This approach streamlines project execution in a number of ways.

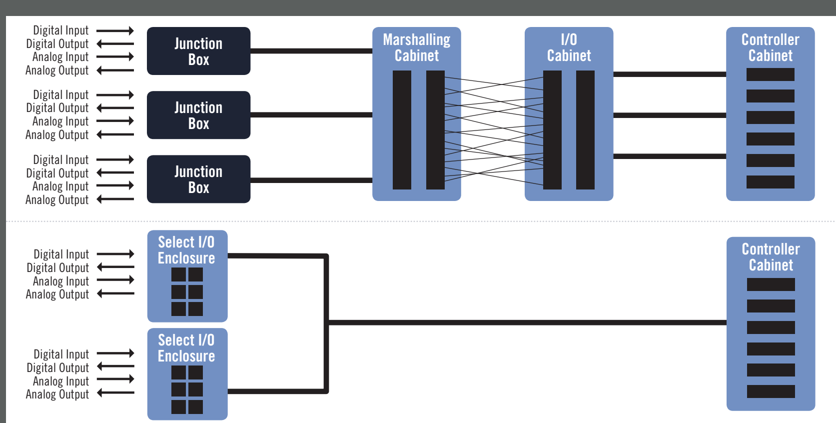
First, because the base hardware for every type of signal is the same, automation system designers need only know an approximate I/O count at the design-freeze milestone. Designers can then order standard—not custom—I/O module bases and enclosures, knowing that they have full flexibility to alter the mix of I/O types at any point in the project. Further, since control system hardware components are now standard issue, the factory acceptance test (FAT) of control system hardware is a thing of the past.

Second, because each channel can take on any signal type and be digitally marshalled to any controller, the need for physical marshalling—and all those cabinets and terminations, too—disappears completely (Figure 3). In addition to lowering costs and speeding execution, this has the added benefit of significantly reducing overall system footprint, which can be critically important in an application such as an off-shore oil rig where floor-space and even allowable weight are at a premium. Instrument installation techs save time, too, because they can simply land their wire pairs on the most convenient pair of I/O terminations and move on to the next.

In the end, single-channel, configurable I/O does much to sever the serial design dependencies that plague the execution of automation projects. Hardware and software aspects of automation system design can proceed in parallel, compressing schedules and reducing risk. But ABB goes a step further, delivering software tools and new execution workflows to ensure that these streamlined, parallel engineering processes meet up in a fully tested, fully functional automation solution. ∞

FIGURE 3. PHYSICAL MARSHALLING ELIMINATED

(LEFT) For those instruments that rely on analog/multi-core cabling, *Control* readers indicate more than 70% already take advantage of configurable I/O modules in their organizations' project work.



Before (above) and after (below). A key advantage of I/O modules that can be configured on a single-channel basis is the elimination of marshalling cabinets and all the physical space, expense and labor they represent.

ABB Intelligent

EXECUTION IN THE PAST

Traditional, controller-centric I/O solutions promote an inflexible project execution model. Automation engineering tasks are serially interdependent and change is disruptive—causing added expense and schedule delays

TODAY'S SOLUTION TECHNOLOGIES

- System 800xA Flexible I/O Solutions
- Select I/O & xStream Engineering
- Cloud Engineering
- Design Standardization
- Automated Data Management

SELECT I/O

is a single channel, late binding, Ethernet I/O solution that decouples project tasks and promotes standardization

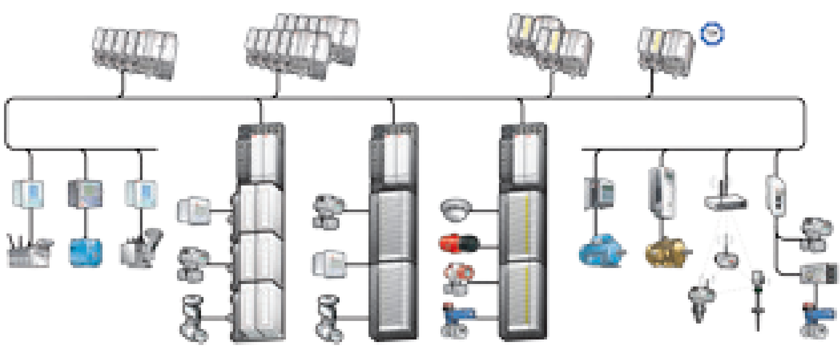
Projects

BENEFITS OF THE NEW APPROACH

- Serial dependencies severed
- Impact of late changes minimized
- Testing effort, system footprint reduced
- Automation off the critical path

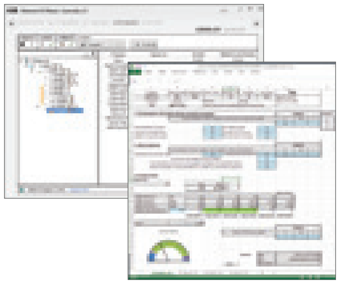
SYSTEM 800xA FLEXIBLE I/O SOLUTIONS

deliver the right I/O solution for specific project requirements, including Ethernet, fieldbus, hardwired, and wireless I/O



xSTREAM ENGINEERING

methodology embraces digital marshalling and late binding principles, creating a flexible, parallel workflow environment



Sever Design Dependencies

The decoupling of automation hardware and software engineering allows many formerly serial tasks to be done in parallel—while fully eliminating others

THE advent of input/output (I/O) hardware systems that are fully flexible on a single-channel basis has remarkably wide-ranging implications when it comes to project risk. With this latest advance, each analog I/O channel and module starts out essentially identical to the next; entire I/O cabinets—fully assembled with redundant power supplies and network connections—can be ordered with a single part number. Only late in the project execution cycle, often just before commissioning, does each channel take on its true identity, often through a plug-in signal conditioning module (SCM) as in the case of ABB's Select I/O offering.

When it comes to project execution, this persistent flexibility means that even analog, point-to-point signal loops behave much more like their I/O-independent digital counterparts. Put another way, fieldbus instrumentation, packaged skids and other digital devices already plug directly into plant control and instrument networks without the need for specialized conditioning.

Now, instrument installation techs can land their analog signal pairs on any convenient I/O channel without regard for signal conditioning specifics—much as they might when connecting a digital device to a digital network. Importantly, that specialized conditioning is added to the channel late in the project, and only then is the instrument digitally marshalled to the plant's full automation and information architecture and bound to the appropriate controller and applications.

The practice of custom I/O "engineering" is effectively eliminated, as are the remaining serial dependencies between automation hardware and software engineering. Control system hardware and software development tasks can proceed along parallel paths, dramatically compressing project delivery (Figure 1) while maintaining the flexibility to accommodate change and, in turn, reduce budget and schedule risk.

Processing in parallel

The common starting point for parallel application development and hardware tasks remains the list of necessary input and output points that emerges from a preliminary process design. In ABB's xStream Engineering methodology, for example, each of these points will have been given a unique "Signal" identifier, or field device tag. Functioning as both instrument Signal and application Signal, the consistent and coordinated use of these field device tags throughout hardware and software project execution processes contributes to the smooth and speedy start-up of a fully functioning system (see sidebar, p16).

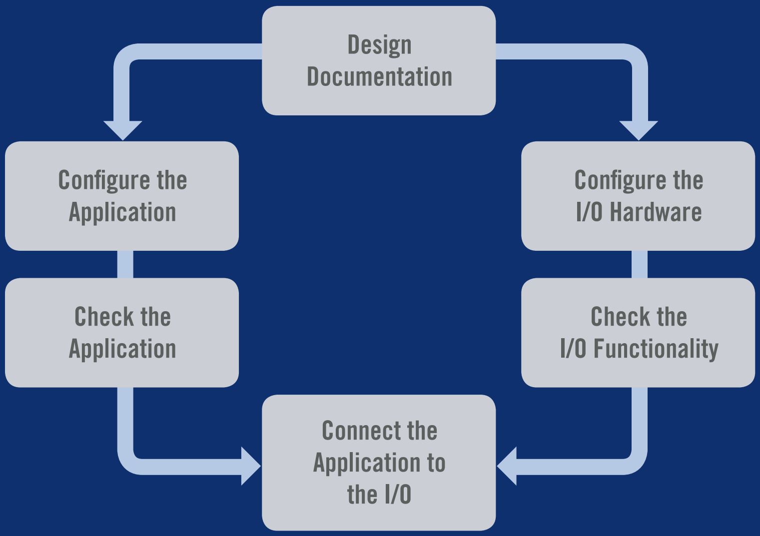
Engineers responsible for the hardware side of the control system equation can then order standard cabinets with the adequate number of generic I/O channels (plus spare capacity) based on the list of Signals. Because the project is based on pre-designed and tested I/O cabinets that require no custom engineering, there's no need

AN XSTREAM ENGINEERING EXAMPLE: CONFIGURE, CHECK, CONNECT

ABB's xStream Engineering methodology is so named for the enabling of project teams to perform multiple ("x") tasks simultaneously in parallel work "streams." Representative of this concept is the System 800xA's Ethernet I/O Wizard which can be used in the field to configure and functionally check Select I/O prior to—and independent of—delivery of the application.

To illustrate how this works, think of two simple work streams. One is the field work that can be done while the application work is being done in another location. In the field, the I/O cabinets can be delivered early in the project and later, just before commissioning occurs:

1. **Configure:** On a particular cluster of Select I/O, the Select I/O Module base is populated with the Signal Conditioning Modules (SCMs) that match each channel's I/O type. The technician then connects his mobile device (laptop or tablet with System 800xA configuration tools) to the Ethernet I/O Field Communications Interface (FCI). The Select I/O is automatically scanned, and that information combined with data from the I/O signal list as well as information contained in any HART devices that are present. A test configuration is automatically created based on the I/O type detected to help in doing functional loop checks. For example, if there's an analog input, or AI, SCM connected to a HART transmitter, then the Ethernet I/O Wizard will automatically detect this, configure the I/O structure and create a temporary AI control module, complete with faceplate and trend displays as well as device manager tools to aid the field engineer/technician in their testing efforts.
2. **Check:** With the I/O configured and a test configuration running, smart and non-smart field equipment can be functionally checked in the field even as application engineering continues along a separate path and in a different location. Using System 800xA's Extended Automation features such as Documentation Manager, field testing and verification documentation is created and stored.
3. **Connect:** Once functionality is checked, the established I/O structure can be imported into the master production system that contains the application code. Since they both have been configured using the same unique signal names, the software and hardware are digitally marshalled automatically—no mapping required. The full system—hardware and software—is now ready for final commissioning.



for a factory acceptance test (FAT) when the cabinets arrive. Instead, they can proceed to install the cabinets, wire the field devices to the I/O, configure each I/O channel with the appropriate plug-in signal conditioning module and field device tag, and finally check that each loop functions as expected.

Meanwhile, those responsible for the software side of the equation will have developed the necessary application logic, allocated the applications to specific controllers, and—in a virtual FAT—tested the software against emulated hardware and a simulated process to ensure that the code will perform as anticipated.

Finally, the tested application and hardware meet up on site. I/O points are digitally marshalled and bound to their designated controllers and applications, independent of physical I/O channel location. This ability to preserve automation system flexibility while performing hardware and software engineering tasks in parallel is a critical step toward moving automation off the critical path of the overall project schedule.

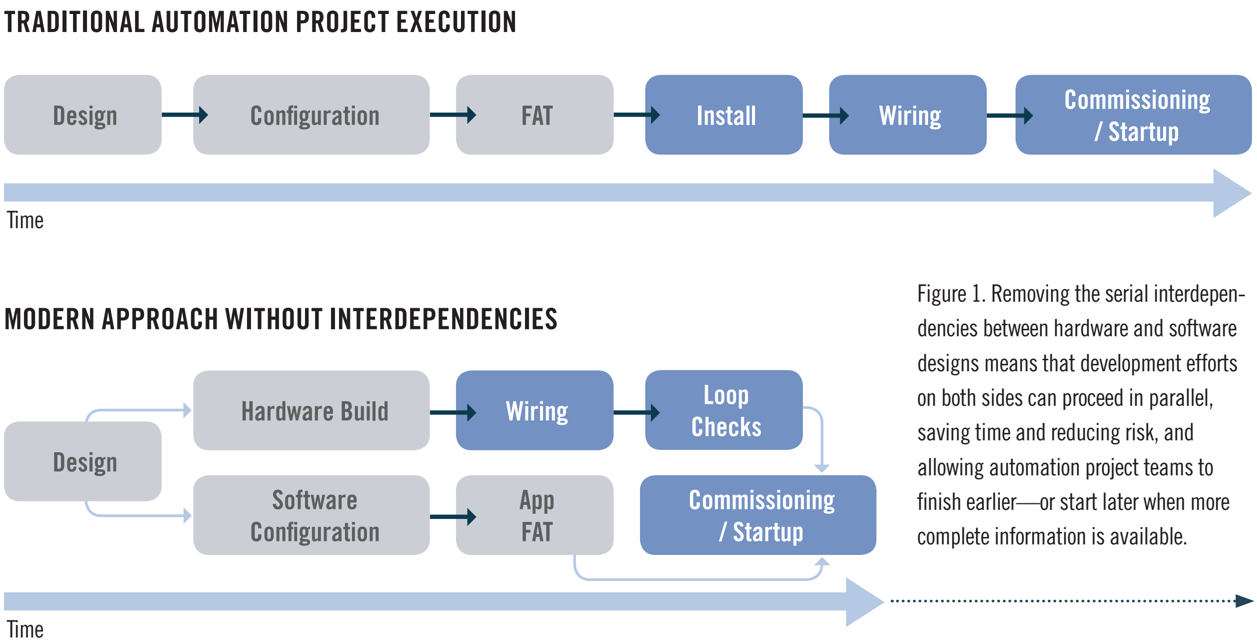


Figure 1. Removing the serial interdependencies between hardware and software designs means that development efforts on both sides can proceed in parallel, saving time and reducing risk, and allowing automation project teams to finish earlier—or start later when more complete information is available.

Indeed, while a recent survey of *Control* readers indicates that analog communications still accounts for some 55% of instrumentation connections in a typical project, more than two-thirds of those points today are digitally marshalled through configurable I/O modules (see related figures on p10).

The ability to perform tasks in parallel provides a step-change in project execution speed and flexibility. But ABB also has developed a cadre of computer-aided engineering (CAE) tools that further streamline and error-proof those remaining engineering tasks. And that's the subject of our next chapter in this series. ∞

Accelerate Engineering Workflows

Leverage standardization, computer-aided exchange tools and cloud-based environments to ramp up project execution efficiency

MOVING automation off the critical path of project execution requires agility as well as speed. As discussed earlier in this article series, the move to configurable single-channel input/output (I/O) systems and fully digital instrument communications has advanced both causes. First, by improving the ability of automation system designs to absorb and mitigate midstream changes in a project's functional requirements. Second, by eliminating hardware and software interdependencies and allowing more project execution tasks to advance in parallel rather than sequentially.

But there's another class of tools, technologies and best practices that can further reduce project execution risk by increasing the absolute speed, efficiency and first-time accuracy of automation engineering tasks. Broadly, they fall into three groups: standardization, computer-aided engineering exchange (CAEX) tools and cloud-based environments. Each has an outsized impact on a different phase of project execution: from design to implementation to test.

Standards, templates streamline design

ABB, for one, has long employed a philosophy of re-use and standardization in order to drive down project costs and delivery times. During the initial stages of a project, this includes standards and templates such as for developing functional and detailed design specifications.

These standards range from libraries of TÜV-certified oil & gas applications to templates designed to seamlessly integrate IEC 61850-compliant intelligent electrical devices (IEDs). Available to project teams through globally accessible repositories, these standards also help to enforce consistency across today's multinational organizations.

Consistent use of standards also breeds familiarity and reduces the need for training relative to custom, one-of-a-kind project designs. These benefits accrue not only during the execution of a project, but continue to add up through the operational phases of a production asset's lifecycle.

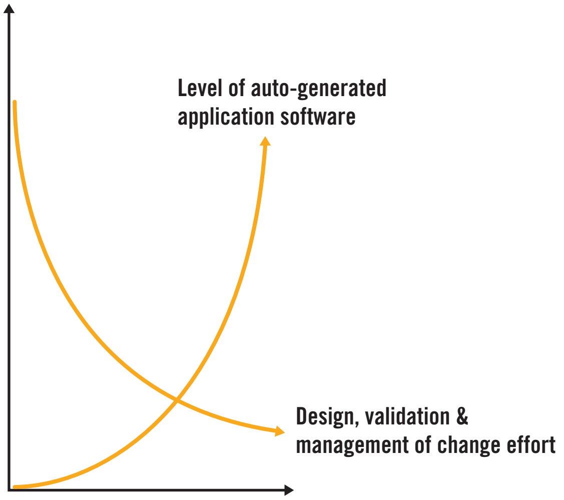


Figure 1. The computer-aided exchange of engineering data and the auto-generation of application software reduce time and effort during design. Testing goes faster, too, since fewer errors are introduced.

Fast, error-free implementation

When standards and templates are used consistently in the design of automation systems, project implementation largely consists of instantiating the appropriate standards and templates with project-specific data. CAEX tools help automate many of the labor intensive, manual tasks involved in this process. This helps to minimize human error, directly leading to lower costs and less time spent in functional testing (Figure 1).

CAEX tools from ABB, in particular, convert project-specific data from a variety of sources into a common data format. This data is then used to automatically generate a large proportion of project-specific application software and associated hardware documentation, such as bills of material and wiring diagrams. The tools also help manage changes and revisions, creating discrepancy reports between versions and facilitating roll-back to an earlier one if necessary.

System testing moves to the cloud

While a secure cloud-computing environment enables efficient collaboration among today's global design teams, it's during final sys-

tem test that the cloud truly shines in terms of project execution efficiency.

By moving to standardized I/O hardware and enclosures, we've already eliminated the need for a factory acceptance test (FAT) on control system hardware. Now, with a combination of virtualization, emulation and simulation technologies—all implemented in the cloud—engineers can perform a virtual FAT of the finished control system software, probing its performance against the project's functional specifications, without ever leaving their desks.

With ABB automation systems, this is made possible because their flagship System 800xA platform has for several years now supported virtualization in operational mode, meaning that control applications execute as virtual machines abstracted from hardware implementation specifics.

For testing purposes, this virtualized application is moved to the cloud and paired with emulation software that recreates the actions of the control system hardware as well as simulation software that recreates the dynamics of the process to be controlled. Communication with other third-party applications can also be simulated and tested in this way.

This virtual commissioning helps to identify any potential issues, resulting in smoother, faster production start-up. Testing application software in the cloud also allows control system hardware to be shipped to site much earlier.

Quality of inputs is job one

A final set of contributions to increased project execution efficiency actually comes before all others, and rests primarily with the asset owner/operator and its engineering partners.

First is provision of an upfront functional requirement specification that is clear, precise—and complete as possible. Second is engineering data that is consistent, correct and of high quality. Third is a willingness to accept standard designs and templates where practical—even if some compromise is necessary. Efficient project execution hinges on the quality of inputs as well as a flexible, modular and pragmatic approach to automation engineering. ∞

Intelligent Project Delivery: Only the Beginning

ABB project execution methodology pays further dividends through integration with electrical infrastructure, lays groundwork for Collaborative Operations

THE process industries' push to streamline the execution of capital projects is easy to grasp. Production assets have never been larger, more complex—or more expensive to build. Meanwhile, windows of opportunity open and close seemingly at a moment's notice. And with some capital projects qualifying as multi-billion dollar bets, asset-intensive industries around the world understandably crave both speed and predictability in project delivery.

As described in detail in the earlier stories in this series, ABB has led the charge to develop new technologies and best practices to reduce project risk by moving automation engineering off the critical path of project completion. These innovations range from automated software tools that seamlessly integrate digitally networked third-party skids to I/O solutions that preserve single-channel flexibility until just before system commissioning. Serial dependencies between automation hardware and software development have been severed, allowing these design tasks to be performed along concurrent, parallel paths. The need for physical marshalling of analog I/O signals has been effectively eliminated, along with its requisite panels, terminations and labor. Finally, increasingly modular, standardized software applications are now tested and validated against simulated processes and emulated hardware in virtual, cloud-based "factory" acceptance tests.

Intelligent infrastructure

While the future is indeed now when it comes to moving automation engineering off the critical path of project delivery, ABB sees such "Intelligent Engineering" as only one aspect of a lifecycle approach that also includes the integration of Intelligent

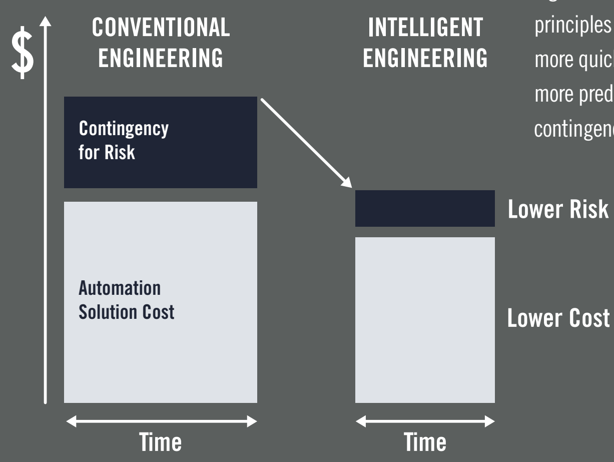


Figure 1. Intelligent engineering principles allow projects to be executed more quickly, less expensively and more predictably—allowing planned contingencies to be reduced as well.

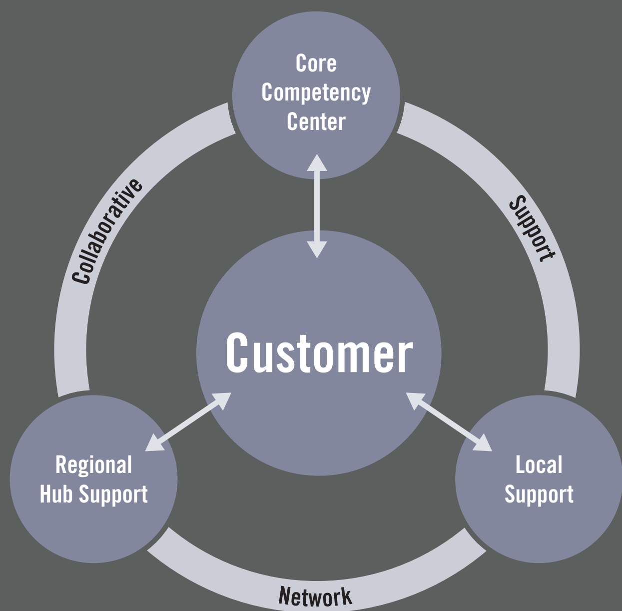


Figure 2. When the dust of project execution settles, the ABB Collaborative Support Network will help the company's customers optimize performance and reduce operational risk throughout the production asset's lifecycle.

Infrastructure during project delivery.

This infrastructure includes the full range of ABB capabilities—from electrical substations and switchgear to safety instrumented systems and process chromatographs—managed and delivered by ABB in the role of main automation, instrumentation and electrical contractor (MAC, MIC and MEC). The company also oversees interface management of the engineering suppliers in this context and takes responsibility for data transfer among participants to ensure the effective integration of all components and systems.

In ABB's calculus, such Intelligent Engineering and Intelligent Infrastructure add up to Intelligent Projects that take 50% less time to design, engineer, install and commission compared with traditional project execution methodologies. Further, the company estimates that the reduced risk and increased competitiveness inherent in this approach can cut capital and operating costs by 20-30%.

Collaborative Operations

But ABB's vision of world-class execution doesn't stop with project delivery. Rather, Intelligent Applications and Intelligent Services—which together constitute what the company calls a Collaborative Operations approach—take up where project execution leaves off.

The Intelligent Services aspect, in particular, is to take the form of the ABB Collaborative Support Network (Figure 2). This offering leverages secure connectivity and 24/7 remote monitoring to provide plant personel with the on-demand support of process and system experts. This network will consist of local and regional hubs complemented by global Core Competency Centers.

Project execution is indeed only the beginning of the asset lifecycle. And the foundation laid by a project partnership with ABB will pay ongoing dividends as attention shifts from managing project risks to exploiting new opportunities ahead. ∞

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