Reducing Automation Project Execution Timelines

by Irvine Wilson

Executive Summary

Successful implementation of an automation system requires careful orchestration of data, people, and equipment against a demanding project timeline. Scheduling, integration, and testing can consume a significant part of a project calendar. Unwelcome surprises or changes often occur late in the process, causing rework and significant delays. This paper outlines practical steps that can cut costs by simplifying and shortening the project process while improving the quality of the automation system that gets delivered.

998-2095-10-21-15AR0

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Introduction

A plant automation system functions as the brain and nervous system of a modern process plant. As such, with daily production revenues potentially in the millions, the sooner that the automation system goes online, the sooner it can positively impact the bottom line. Because it is critical to the long term safety and profitability of the plant, installation must proceed methodically in compliance with the highest standards of quality.

However, in the one or two years it may take to specify, design, engineer, build, test and commission a new automation system, any number of forces can emerge to push the project off track. For instance, civil and mechanical engineering design and construction work often takes precedence over the automation system, resulting in costly automation system delivery delays.

This paper discusses traditional barriers to effective automation system implementation. Emerging strategies for removing automation systems from the critical path of the process plant build are analyzed. Methods for shortening time to value and securing long term safe and optimal plant operations are also reviewed.

Barriers to success

Successful implementation of an automation system requires careful orchestration of data, people and equipment against a demanding schedule, usually amidst changing business priorities subject to influence by global economic and cultural issues. Within this context, the following are some of the barriers to successful project execution:

- Traditional requirement to configure the system on the same hardware on which it will run
- Traditional requirement to deploy dedicated I/O for each field device protocol utilized
- Need to reconcile data and information from numerous engineering tools and sources
- Over-specification and a requirement for specialized expertise that may be located elsewhere in the world
- Aggressive schedule for design finalization, resulting in multiple iterations of design changes and re-work
- Late discovery of process or packages design changes and errors that require re-engineering
- Lack of early synchronization between controls, safety and various other systems installation issues
- Need to test the system as an integrated assembly before shipment to site and after all field connections are in place
- Need to validate Automation Functional Specification against User Requirement Specification and to manage all the documents produced during the execution of the project
- More time spent in testing simple repetitive applications, resulting in less time to test complex applications

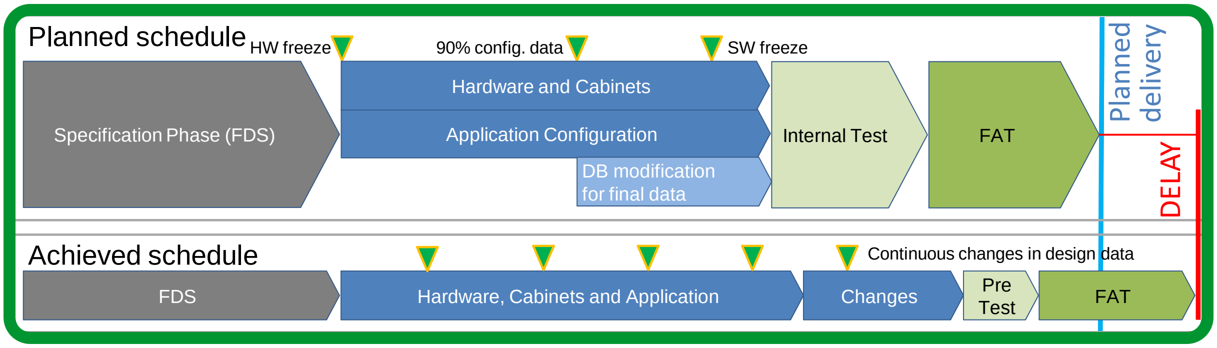
End user and EPC concerns

When end users and the engineering and construction contractor (EPC) are beginning a new venture, they tend to be most concerned with how they can:

- Reduce design risk by accepting late changes and by re-using knowledge and experiences
- Reduce schedule by using project data earlier and by minimizing full integrated Factory Acceptance Tests (FAT)
- Reduce the burden of generating and maintaining project documentation

- Reduce time to beneficial operations by using state of the art simulation to ensure that:
    - Process design, control schemes, and start-up procedures are fully and dynamically tested
    - Engineers, operators and field technicians are fully trained in start-up and plant operations

Figure 1
Typical project scheduling (plan vs. actual)



Ensuring Proficient Execution

In order to address these challenges, Subject Matter Experts at Schneider Electric have been analyzing, over several years, the execution of several large automation projects. The purpose of this research was to identify issues and to devise solutions that can significantly reduce system configuration and documentation efforts.

This paper documents and summarizes the findings and actions that have resulted from this in-depth analysis. The information gathered is organized into the six following areas:

- Scheduling
- Hardware and software design integration
- Emulation of systems to drive low cost collaboration
- Testing
- Enablers and tools
- Intergraph SmartPlant Instrumentation (SPI) Data Exchange

Five of the six areas are described in detail below.

Scheduling

Issue: The main factor that impacts schedule is availability and maturity of design data. Process data tends to come in late and, more often than not, the data is incomplete if not wrong. The quality of that data is critical because it feeds control algorithms that will have a direct impact on the alarm, emergency management and long-term performance of the plant.

Resolution / recommendation: What is needed is a tool that leverages 'early' but incomplete data. It is enough to agree on one instance for each typical device module and control loop to permit automated tools to start building the system configuration and the operator interface required for testing. The build phase can be run as many times as required because the process is automated. This phase is where rules, embedding past experiences and knowledge, enter into play. Rules allow for validation of the process and drive the EPC or the end user to focus on critical areas to complete the automation. This means the project will not suffer from delays introduced by EPCs that are reluctant to provide incomplete data, or from automation vendors that are waiting to get 'good enough' data. Process data, available within databases, can be automatically extracted and formatted to start developing the hardware cabinets, system architecture, I/O allocation, configuration and operators interface.

Hardware and software design integration

Issue: Hardware and software designs are often implemented in a manner characterized by two dependent serial development paths. These interdependencies lead to increased complexity and unpredictable delays.

Resolution / recommendation: Tools are needed that allow for separate hardware and software design. Thus, a parallel work path can be implemented instead of dependent serial paths during project execution. The tool needs to be flexible in order to accommodate disparate signal levels and also should have the ability to be configured remotely via software. Such a tool would also use rules to define how to allocate and segregate I/O signals so that automatic I/O allocation could be possible. This will then allow for last minute changes to be accommodated, documented and ready for testing.

Emulation of systems to drive collaboration

Issue: Projects span over a number of months, if not years, and involve a large number of people across geographies that possess expertise in different disciplines. Tight communications is a requirement for success. Such a work environment necessitates a comprehensive approach to collaboration that is cost effective.

Resolution / recommendation: A collaborative environment with a common repository and versioning capabilities results in less required travel, while still allowing a number of people to work together without the need to either meet face-to-face or see the physical system in person.

To support such a collaborative process, tools need to leverage an IT driven virtualization environment so that the hardware and software components of the automation systems can be emulated, and have the ability to mimic the same performance of a real system. This allows automation hardware to be delivered on a just-in-time basis. Utilizing such a tool, the disparate teams can test and validate different process solutions. Such an emulated, virtualized system can be used many times during the plant's life. Future facility expansions, operator training, or process optimization can be tested in advance on a copy of the virtual system. The rules utilized to build the automation system can be run to secure new functionalities and consistency with the existing application.

Time, Cost, Quality

To ensure that time, cost, and quality constraints are removed from the project, Schneider Electric experts work on:

- Late maturity of data
- Ensuring Hardware is independent from Software
- Collaboration between geographically separated teams
- Enabling Virtual Testing
- Moving project data automatically to avoid delays and human errors

Testing

Issue: The Factory Acceptance Test (FAT) which occurs towards the end of the project is critical to project success. Unfortunately, the time allocated to execute the FAT is often compromised as a result of delays that occurred earlier in the project. Therefore, stakeholders are at risk regarding overall quality because potential performance threats and unforeseen automation behaviors are only partially accounted for.

Resolution / recommendation: Tools are needed that allow for virtual testing, where users can witness the testing of plant units in real time, wherever they may be. With such a tool, devices, loops, and operator interface can be tested at the earliest stages of project execution. Adoption of standardized common behaviours, based on past experiences, greatly reduces the risk of unanticipated occurrences. Pre-built and pre-tested cabinets with automatic I/O allocation avoid the traditional FAT approach or, at a minimum, allow the FAT to be performed offline as soon as cabinets are ready for shipment. Most documents are automatically generated and ready to be shared and verified at the earliest stage. Third party packages and serial interfaces to sub-systems are tested at sub-vendor premises utilizing prototype Distributed Control System (DCS) kits. Software, network load, CPU load, dynamics graphics, historian, alarms and events, Sequences of Events (SOE), controls and logic, safety logic, complex loops and sequences can all be tested leveraging advanced tools.

End users can be granted access to the tools at the beginning of the project. They can test controls and configurations at their convenience and focus on specific controls during FAT testing. If more screens and workstations are required to accelerate testing, this can be easily accommodated. Furthermore, engineers (e.g. process engineers) can simulate and test various operating scenarios which could have been difficult to perform during a conventional FAT. Such flexibility and thoroughness in testing helps to improve the quality of software delivered and reduces risk. The tested software can be completely exported and easily imported to the target controllers and workstations at the site.

Intergraph SmartPlant Instrumentation

Schneider Electric experts leverage information from the "Intools Instrument Index" for auto generation of control and safety modules.

- Auto generation of tieback simulation testing platform
- Auto design of system architecture
- Auto generation of system cabinet details
- Auto generation of dynamic symbols on process displays

Intergraph® SmartPlant® Instrumentation Data Exchange

Issue: Automation engineers need good quality, reliable project data delivered on time to respect their commitments. Spreadsheets, Microsoft Access or bespoke solutions provides partial solutions and are difficult to be applied when numerous contributors or disperse team are involved in the project design.

Resolution / recommendation:
The Intergraph SmartPlant Instrumentation (SPI) is one of the available control and instrument design databases suitable for global automation projects. Software suites like SPI are required to secure a single source of instrumentation design data, to enforce consistency and to provide efficient handover to the automation and operational teams.

Tools are required to interface with design databases. The scope is to eliminate manual errors and reduce drastically the time required to utilize process data. A versioning mechanism will facilitate tracks of changes. A single repository will result in an automation system easy to be maintained and improved during the plant life cycle.

Enablers and tools

The result of the recommendations made by the Schneider Electric subject matter experts is today referred to as the Flexible, Lean Execution (FLEX) program. The FLEX program is both a tool and a philosophy. FLEX is a framework that bridges user process specification to automation design specification and testing.

"FLEX is both a tool and a philosophy. It is a virtualized environment and a workflow based on a number of tools and libraries encapsulating past experiences."

The FLEX program focuses on providing stakeholders with the following benefits:

- Encapsulates past knowledge, as well as best practices and standards into well formalized rules
- Mitigates the impact of data maturing late on project execution
- Ensures that automation is off the project critical path
- Facilitates smooth expansion of facilities and ensures that operations spread across the world are built up with consistent criteria

The goal of FLEX is to accelerate project delivery. FLEX is comprised of several 'Intelligent Engineering' components: Libraries and Rules, an 'Engineering Workbench' engine, a 'SmartPlant Integration' import/export tool, and 'Cloud Engineering'.

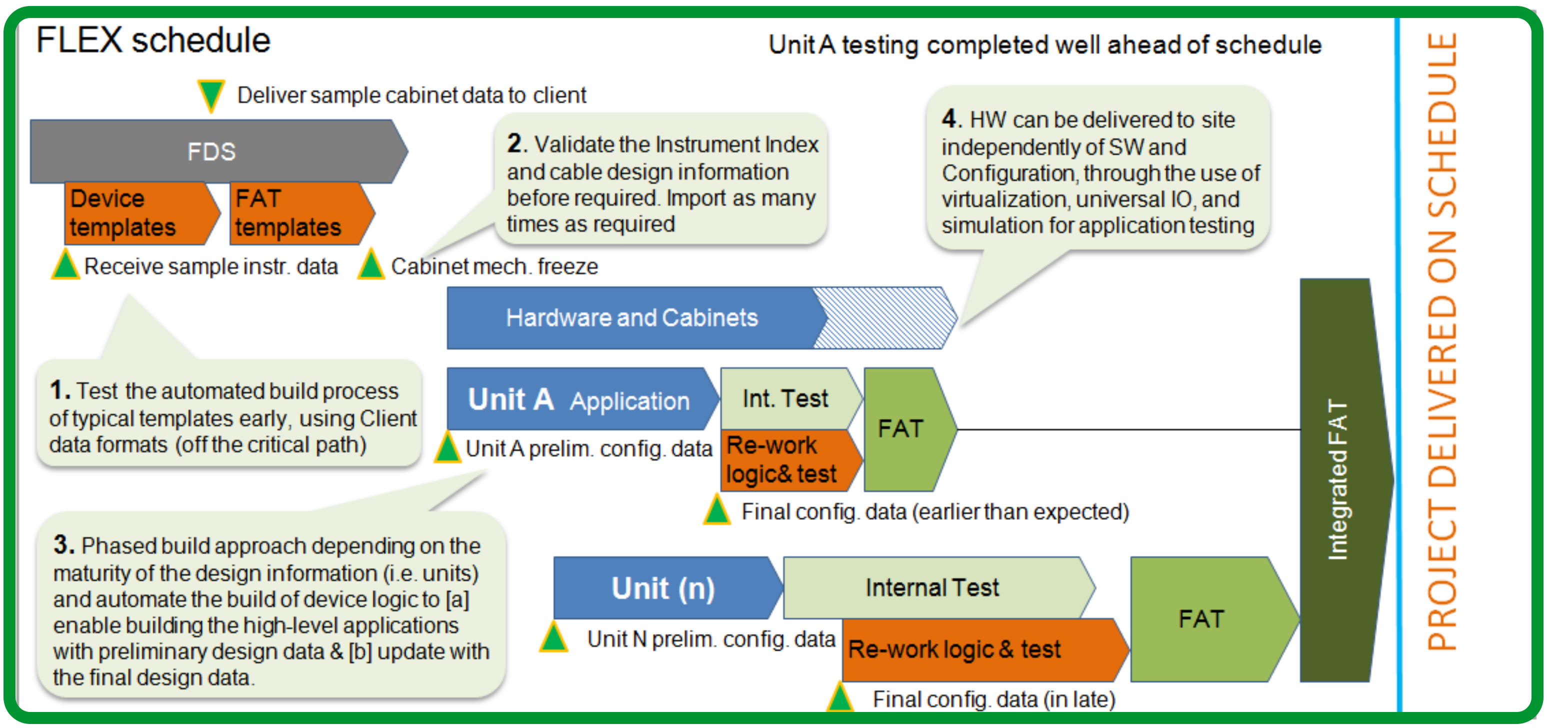
Templates, Libraries and Rules, and Engineering Workbench are the FLEX components that assure the project will be executed according to the planned schedule. FLEX adapts to the maturing of data thereby reducing change requests and validates data at earlier project stages to help increase process confidence.

Cloud Engineering is the FLEX component that allows for virtual testing. Cloud Engineering promotes a transparent collaborative work environment involving end users, engineering offices, and subject matter experts (each at different offices). This approach fosters teamwork, facilitates a quicker turnaround of fixes (punch list) and faster availability of specialist support that may be required during testing.

Cloud Engineering supports hardware and software emulation for Foxboro Evo and Triconex systems, and can provide the same performance as the actual hardware components.

Schneider Electric has invested in and developed SmartPlant Integration tools and processes in order to address the challenges of designing and building automation systems. An automated interface is the key asset permitting the effective and efficient deployment of the “use data as they mature” FLEX strategy. FLEX utilizes these data to generate a number of documents required by the project. Because the extraction of data is automated, no human error is likely to occur and the use of available, albeit incomplete, information is possible. Applying rules to the data allows the process to validate itself, leaving engineering and construction contractors (EPCs) to focus on critical parts of the automation. The configuration from ‘early’ units can be easily and consistently applied onto subsequent units.

Figure 2
How a FLEX schedule improves project execution



FLEX also offers another powerful functionality, which is SPI Return. Early collaboration with the SPI administration team enables the definition of the interface touch points with the SPI database to be clearly identified, enabling consistent information transfer from Engineering Workbench to SPI. Data is returned for import into the SPI database so that Instrument Loop Drawings (ILDs) can be produced. These include the marshalling wiring, the I/O card channel assignment and the function block on which a field signal is landed. The data returned ensures that the SPI Project Database is aligned with all changes that occurred during the testing phases.

FLEX adopts two ‘Intelligent Marshalling’ technologies: Control and Safety Universal IO and a new generation of Pre-Configured Cabinets. Plans are to expand the current components to embrace Simulation (Tie-Back, Mid-Fidelity), Operator Training Simulator (OTS), Cause and Effect Editor and Electrification (Smart MCC, LV&MV).

Intelligent Marshalling provides Hardware and Software separation. FLEX Universal IO is recommended when cabinet footprint or energy consumption need to be optimized. In case Standard IO can be considered, Engineering Workbench uses IO Allocation and Segregation rules to generate automatically detailed design documents to build marshalling and systems cabinet and automation wiring drawings.

Conclusion

The transition to accelerated automation project execution requires both a new philosophy and tools that leverage current, available technologies. Successful automation project execution is dependent upon three fundamental rules: respect the schedule, control the costs and deliver the expected quality and plant performance.

In order to enable a change in project execution, the following steps should be considered:

1. Identify subject matter experts, advisors or operators to generate a set of rules encapsulating past experiences. Define a template library.
2. Leverage virtualization technologies in order to enable the creation of emulated process automation environments
3. Apply rules to templates using an automated engine to generate detailed design documentation and configuration as soon as project data are made available
4. Run the automated workflow as many times as required until all process data are consolidated and the process design converges

The approach described in this paper, if properly executed, can provide significant benefits including early detection of process incongruence, error-free documentation and reports, consistent and repeatable control and safety configurations, knowledge reuse, and ultimately, safe, maintainable, easy to improve plant automation.

About the author

Irvine Wilson is the Senior Director of Schneider Electric’s Global Engineering Management team. He has spent many years in the Global Delivery Organization involved in major global projects and in R+D on software development. His focus is on ensuring that engineering efficiencies, best practices and standardization are adopted worldwide within the Schneider Electric’s Process Automation Engineering teams.

Contact us

To learn how FLEX can minimize the impact of change and shorten the time to production on your project, visit: www.real-time-answers.com/project-execution/