A Quantitative Comparison of Digitized Industrial Automation Systems

by Kaishi Zhang

Executive summary

This paper presents a quantitative performance comparison of four leading industrial automation vendor systems. Three use cases are illustrated that present data gathered from actual field research. Results show the strongest efficiency and productivity gains from the Schneider Electric EcoStruxure Automation Expert system. This suggests that a move away from traditional, heavily engineered and proprietary systems to user experience-driven systems can generate engineering and operational efficiency gains by a factor of 3 to 4X.

Introduction

Changing the way industrial automation systems are engineered, operated, and maintained is critical to bringing new sources of tangible business value to plant owners and the EPCs, OEMs, and systems integrators who support them. Traditional design and implementation approaches suffer from gross inefficiencies due to overly engineered, tailored, and closed designs, or very narrowly defined “engineered once/deployed once” methodologies. These challenges have only been masked with an array of band-aid tools instead of genuine solutions. As a result, many industrial automation engineering projects are saddled with human error, scheduling delays, and cost overruns.

Rigid applications require highly skilled engineers with specific experience in a particular proprietary system to perform the configuration and integration work. Due to this outdated engineering approach, plant stakeholders are unable to recognize major shifts, to make the necessary adjustments, and to realize additional total cost of ownership (TCO) benefits.

The solution lies in an open engineering philosophy and strategy that centers around user experience. By placing the user at the center of the engineering universe, plants attain the operational phase in a shorter time period, with lower costs and fewer risks.

User experience is measured through simplicity of engineering, deployment, plug and play connectivity, the smooth coupling or decoupling of hardware and software, and a seamless and easy upgrade path. When properly executed, the result is lower TCO.

Efficiency of the engineering and operation system plays a critical role in every stage of a plant lifecycle. A well-designed engineering system reduces CapEx, lowers OpEx, sparks innovation in greenfield environments, optimizes brownfield performance, allows for seamless upgrades, and even helps shorten turnarounds. Efficiency starts from the way plant assets are engineered to the way the plant is operated and maintained.

New system architecture

The desire to designate user experience as the highest priority when planning and executing industrial automation engineering design and deployment projects is nothing new. However, existing traditional systems and tools severely constrain the degree to which such as approach can be successfully executed.

In order to overcome these barriers, Schneider Electric has designed a new system called EcoStruxure Automation Expert that transforms the task of automation engineering in several important ways. It is based on IEC 61499 standard for modeling of distributed information and control system. These fundamental architectural changes are summed up in **Figure 1** below.

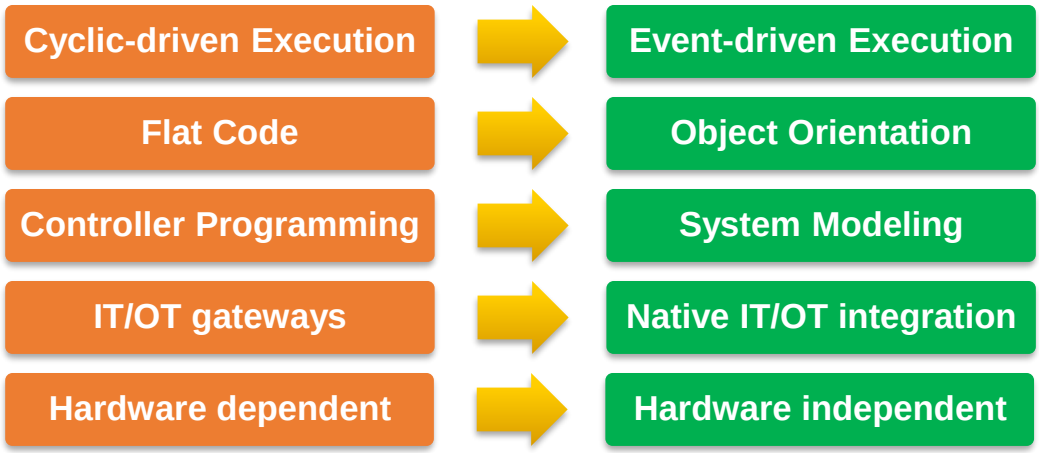

Figure 1

New architecture focuses on speed, agility, flexibility and efficiency

The new EcoStruxure Automation Expert approach places emphasis on simplifying the user experience of all stakeholders, be they engineers, plant operators, systems integrators, or machine builders (see **Appendix A** for a detailed breakdown of system user group-specific benefits).

The use cases illustrated below demonstrate tangible and quantifiable gains from both a CapEx and OpEx perspective. The goal of the system is to help industrial organizations to lower project-related TCO.

Deploying such a system reduces TCO in several important ways:

- **Driving to 100% Engineering Efficiency**: all low- or no-value-added tasks are automated, eliminating duplication of efforts from one tool to another,
- **Ready for 100% Operational Effectiveness**: everything you need is at your fingertips to maximize asset uptime, minimize asset downtime, and to optimize workforce efficiency,
- **Now 100% Future Proof**: continuously keep your operations up to date with a wrap and reuse approach for current systems while allowing full application portability for future migrations.

When working within such an environment, the support and maintenance process also allows for remote management, which eliminates the need for highly skilled experts to be dispatched to end user sites for troubleshooting. Instead, from the OEM perspective, those experts are now better utilized for high-value process optimization and development.

Summary of case study comparisons

To conduct an unbiased field research, external contractors with significant automation project experience with specific vendors were hired for engineering comparison. Our case study involved the testing and evaluation of four leading marketplace vendor engineering automation systems. These included Schneider Electric EcoStruxure Automation Expert, and three other automation vendor offers in the market. Several scenarios were analyzed including application development engineering hours, time taken to perform diagnostics, and the time taken to implement control device changeovers.

The comparison exercise highlighted several striking differences in the way these various system technologies operate (see **Figures 2, 3 and 4**).

1. New project creation scenario:

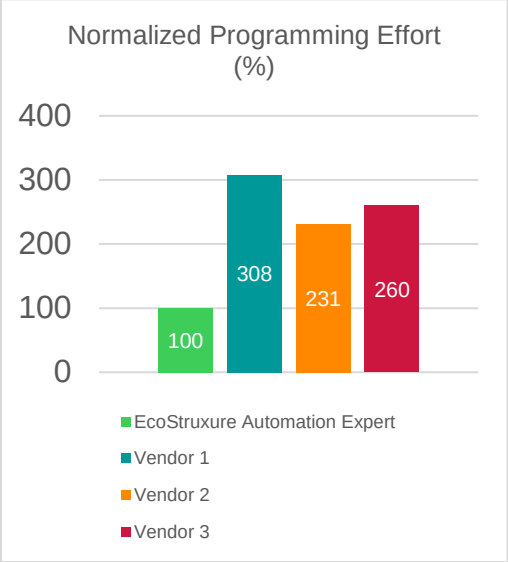

Figure 2

Application development time comparison

When analyzing the typical CapEx lifecycle as it pertains to a small-sized project, engineering a new program takes an average of 2,400 minutes with typical automation tools in the market. These engineering tasks include application creation, the importing of relevant libraries, logic creation, device creation and configuration, HMI development, and successful project deployment.

EcoStruxure Automation Expert saved 68% in application engineering hours when compared to vendor 1. It took only one third of the time to perform the same tasks when using the EcoStruxure Automation Expert system.

2.Troubleshooting and system diagnostics scenario:

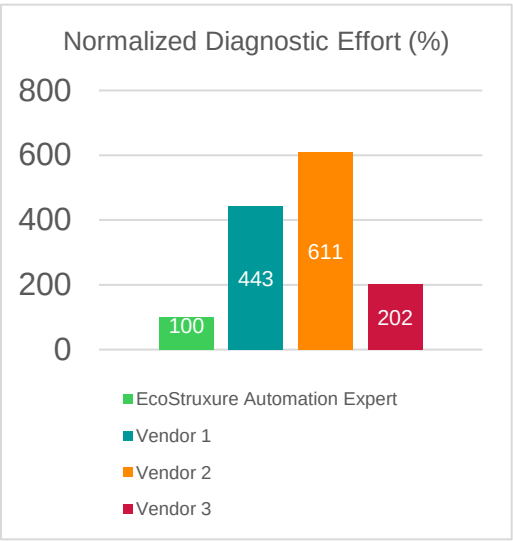

Figure 3

Diagnostic analysis time comparison

In this scenario, the amount of effort required to perform proper system diagnostics was analyzed. The work involved creation of the maintenance canvas, debugging of issues, and the various steps involved in the troubleshooting process.

When compared to similar work performed across all four of the systems, the EcoStruxure Automation Expert demonstrated a reduction of 50% to 80% in the time it took to perform these tasks.

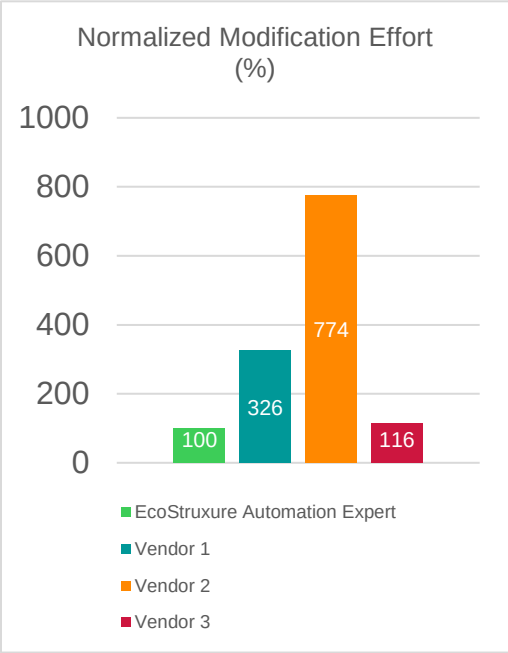

Figure 4

System change implementation time comparison

3.System agility scenario:

When working within the context of modern engineering systems, system agility can significantly impact both CapEx and OpEx. In this case, the agility of the various systems was tested through hands-on demonstrations of the labor involved in changing the controller from one unit to another and by assigning a new controller to an asset. Often a cumbersome task when using traditional systems, EcoStruxure Automation Expert enabled execution of these tasks at a rate that was 70% to 80% faster when compared to the other vendor systems.

For example, the calculation for vendor 1 application was based on changing three motors for a conveying belt originally managed by a large CPU which was then changed to be managed by one motor controller with a small CPU.

TCO case study

In the following case study analysis, we examine how the introduction of the EcoStruxure Automation Expert system drives a major reduction in TCO across both the CapEx and OpEx phases in industrial automation projects.

Assumptions

In describing this case study, the scenario assumes projects deployed within an average mid-sized plant (see **Table 1** listed below for case study assumptions). For a typical mid-sized industrial plant, the total investment could be around 25M to 30M €. Automation system is about 500K to 1M €, of which 80% is accounted for engineering, including activities like design, programming, testing, etc.

Table 1

Assumptions surrounding typical industrial plant project investments

Plant	Large Project	Mid-Size Project
Average Plant Size	100 – 120 M €	25 – 30 M €
Automation	5 – 7 M €	500 K – 1 M €
Engineering	**4 – 6 M €**	**400 K – 800K €**

An average mid-sized project within such a plant typically requires 9 months of engineering work. About 20% of that time is spent programming, which is equivalent to 1.8 months. Engineering costs can range from 400k € (see low-end of the range from the **Table 1**) for an average mid-sized project to nearly 6M € for a large-sized project. Daily production of such an organization is estimated to be 500k € in revenue.

Example 1: Impact of engineering phase on CapEx

In a typical industrial facility, the lifecycle costs, on average, consist of 40% CapEx and 60% OpEx. Automation engineering represents the lion's share of the expense at 80 to 90 percent and those costs break down into the following categories:

- Design
- Programming
- Commissioning
- Testing

"EcoStruxure Automation Expert shortened engineering by 1.2 months, resulting in a cost saving of nearly 40K € for a typical system integrator."

Hardware is less than 20% of the cost and can even be as low as 10% of expense if only core automation hardware (i.e., without accounting for cabinet, cables) is considered.

The deployment of a system such as EcoStruxure Automation Expert benefits such an environment in the following ways:

- The typical programming time of 1.8 months is reduced to 0.6 months, which means that the project is delivered in 7.8 months instead of 9 months.
- The shorter engineering time results in a cost saving of nearly 40K € for a typical system integrator with an hourly rate of 200 €.
- Hypothetically, assuming engineering of the automation system is on the critical path of entire project schedule, the shorter delivery time allows for earlier production, which equates to a gain of 18 Million € in additional revenues.

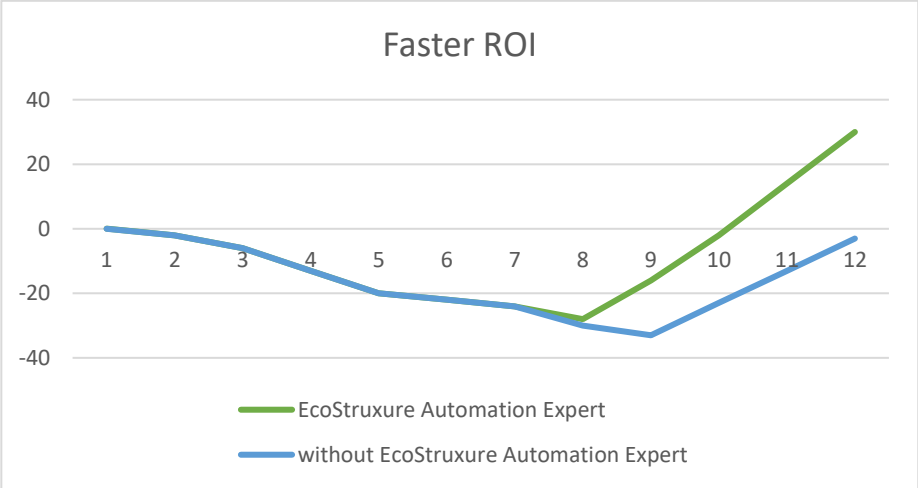

Figure 5

Illustration of revenue gains driven by shorter overall project implementation.

Example 2: Impact of troubleshooting improvement on OpEx

When a plant experiences an unanticipated shutdown, rapid recovery back to an operational state is critical. When evaluating the ability of a plant to troubleshoot and to migrate plant systems back on-line, the following assumptions were made:

- The estimated plant turnaround time for the plant is 3 hours
- Production costs per unit of work (in this case described as a "packet") in this plant is estimated at 10 €.
- Plant machines produce 100 packets per minute

- Over a period of 16 hours, the plant generates 960,000 € in revenue value, which equates to 60,000 € per hour.
- An average downtime for this plant is 3 hours per month, which equates to 180k € in lost revenue per month.

When applied within the context of such a scenario, EcoStruxure Automation Expert provides benefit in the following ways:

"EcoStruxure Automation Expert helped reduce annual production revenue losses by 1.7M €."

- **Recovery time is reduced by 80%,** which means that the plant is back online 5 times faster than if using any other solution currently on the market. Those gains can be realized because recovery time is 0.6 hours instead of 3 hours. These time reductions equate to losses of 36k € per month instead of 180k € per month. On an annual basis **that cost avoidance amounts to 1.7M €.**

- **Operator production is up 80%** because a simple user interface reduces the amount of effort required to operate and maintain the system. Since the interface embraces the event-driven paradigm of the IEC61499 standard, only a short learning curve is required for new employees coming in. This helps plant management avoid the risk of losing experience through workforce turnover.

Example 3: Impact of system agility on OpEx

A third area where traditional engineering automation systems are challenged is in the area of asset modification. Modifying an asset is easier and faster using EcoStruxure Automation Expert. In our testing, traditional systems easily exceeded the average 3-hour window during regular plant recovery exercise.

Mirroring the same assumptions that were presented in the above Example 2, modifying any asset to run on a different controller using EcoStruxure Automation Expert reduced unit revenue loss by 70% to 80% when compared to the other vendor systems. Instead of losing 180k €, the losses would be reduced to 54k € per shutdown of a single unit.

Conclusion

With quantitative comparison conducted in this exercise, **key values** brought by EcoStruxure Automation Expert V20.2 are:

- **Asset centric and object-oriented design** – helps process engineer to design the production process and avoid tedious and error-prone automation by automatically generating the foundation of the application.
- **Heterogenous system diagnosis** – helps a maintenance engineer fix a problem in a heterogenous environment to minimize the downtime and avoid waste of time for root cause analysis by providing a single and consistent diagnostic service for the entire multi-vendor system with contextual information.
- **System agility empowered by hardware independence** – helps define tailored architectures and control system strategies and enables faster modifications of the system to answer ever-changing business needs by providing a hardware agnostic application design. In addition, hardware independence offers greater flexibility for plant modernization and significantly reduces the dependency on hardware obsolescence, which reduces TCO and improves ROI.

For those organizations ready to undertake the journey to high-efficiency engineering automation project execution, several short-term and long-term steps can be taken:

- **Within the next month** – Identify initial areas within the enterprise where engineering costs are high and where project delivery times are extended. Begin to seek out vendors who offer systems that are easy to adopt and that allow for phased transition to process optimization.
- **Within the next 6 months** – Secure funding for those projects that represent low risk and high return. During this time, begin to assemble a team of interested internal stakeholders.
- **Within the next year** – Implement your first new engineering automation system pilot. Track expenses and quantify benefits during the pilot and test period. Leverage vendors to fill in knowledge gaps where required.

There are many plants operating today – and even under construction today – using inefficient engineering automation systems that fail to optimize engineering and operational processes. New, disruptive digitized systems like EcoStruxure Automation Expert are now available at an affordable cost to address these issues.

About the authors

Kaishi Zhang is a Customer Co-creation Director of the Next Generation Automation Incubator with Schneider Electric, and holds 10+ years of experience in Industrial Control and Software. He is responsible for the overall marketing definition and customer advisory board of the next generation automation system. He graduated with a master's degree in electrical engineering from the University of Minnesota, Twin Cities.

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Appendix A: System benefits by user profile

End User – A plant manager in industrial organization

Challenge	Opportunity	Benefits
Maximize operational efficiency	Minimize unplanned system downtime with holistic system management to ensure peak season product delivery; Less dependency on external technical support	4 times faster to troubleshoot and identify root cause of failure with out-of-box system diagnosis
Increase flexibility	Flexible system/line to ensure agility: easy to modify the system on the fly due to demand change or maintenance schedule	3 times faster in software engineering for standard production strategies;
Ease workforce recruiting and knowledge retention issues	Leverage plant operation resources to manage automation systems rather than depend on dedicated automation engineers	It is much easier to find IT resources than automation resources
Maximize innovation	Be the FIRST distribution center to adopt Schneider's next generation automation system	Showcase an Industry 4.0 ready system with optimized TCO

System Integrator – An engineering department head in large company

Challenge	Opportunity	Benefits
Reduce cost and risk Reduce project duration	System modeling rather than programming; Wrap and reuse legacy installed base by providing a System-of-Systems approach; Auto-generate peer-to-peer communication across controllers	3 times faster to create automation application; Diagnose heterogeneous system faults 4 times faster
Ease workforce recruiting and knowledge retention issues	Use IT engineers for automation projects	It is much easier to find IT resources than automation resources
IP protection in automation domain	Decoupled software application from hardware platform	Zero effort to migrate application to new hardware platform

Machine Builder – A business owner with local footprint

Challenge	Opportunity	Benefits
Reduce cost and risk Reduce time-to-market	System modeling rather than programming; Common interface to connect with other machines; Standardize and reuse designs	3 times faster to create automation application; Diagnose heterogeneous system faults 4 times faster
Ease workforce recruiting and knowledge retention issues	Use IT engineers for automation projects	It is much easier to find IT resources than automation resources
Increase flexibility	"Smart machines"; Quick response to machine variants, shorter lifecycles	Develop multi-controller machines three times faster
IP protection in automation domain	Totally decoupled software application from hardware platform	Zero effort to migrate application to new hardware platform