Executive Summary
Predictability in today’s capital-intensive markets is a challenge. Project cost overruns are one of the areas that are out of control and contributing to this dynamic. CAPEX planning, returns on invested capital and cash flow are all impacted negatively by these inefficiencies. Tweaking the project execution process can result in incremental improvement, but does not really move the needle. A true paradigm shift in the way projects are implemented is required to get the type of capital efficiency that industrial businesses need to be successful in this highly competitive, tight-margin environment.

Lean execution already entails removing waste on projects – including redundant tasks and rework. A new approach to automation project execution takes a further step by removing the traditional dependencies that used to force project flows to be sequential in nature. This drastically improves the overall project schedule – keeping automation systems off the critical path. This new methodology relies on separating physical from functional design, allowing parallel workflows, using standardized designs, and enabling engineering to be done from anywhere in the world.

With the recent development of a suite of key technologies and proven domain expertise, Honeywell Process Solutions is transforming project execution in the process industries with “Lean Execution of Automation Projects (LEAP).” This methodology could result in 30% capital savings and optimized scheduling by 25% for large automation projects. Honeywell’s LEAP approach can also have a significant impact on overall project implementation, potentially taking millions of dollars off the total cost of a large capital project while improving project schedule, cost and risk.

Honeywell utilizes three innovative technologies, Universal I/O, Virtualization and Cloud Engineering, to enable this new project execution methodology. These solutions enable important project benefits such as late binding of automation systems to physical hardware and equipment, flexible hardware procurement, improved agility and flexibility, and enhanced design options.
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Introduction

Predictability in today’s capital-intensive markets is a challenge. While capital spend is up 400%, revenues are only up 2%. Project cost overruns across all industrial markets are one of the areas that are out of control and contributing to this dynamic. In fact, one of the largest companies in the world recently stated their project execution nightmares as:

- Project cost overruns,
- Missed schedules,
- Missed production dates,
- All causing unacceptable and unpredictable RISK.

Honeywell has conducted extensive Voice of the Customer (VOC) analysis on this topic and has found that these same issues and dynamics are experienced by companies of all sizes, all over the world. CAPEX planning, returns on invested capital and cash flow are all impacted negatively by these inefficiencies. Significant work has been done to improve project efficiencies through the use of integrated database tools and workflow, but this has not really addressed some of the fundamental issues. Fine-tuning the project execution process can result in incremental changes, but does not really move the needle. In fact, processes used to implement plant automation and safety system projects have not changed much in the last 40 years.

When it comes to large Greenfield projects in the industrial world, modular construction techniques are driving the need for early hardware shipments and reduced time to integrate components. In addition, global sourcing, geographically distributed plant design and engineering, and remote locations of construction sites make the project lifecycle increasingly dynamic by nature. Globally delivered projects require coordination across multiple offices and locations. Mega-projects often involve multiple engineering procurement and construction (EPC) companies around the globe with different project scope. Resource constraints may involve executing multiple projects or sites at the same time. Resource development in emerging geographies also means more projects in locations with the fewest resources.

After decades of executing automation projects in the traditional way, it is time for new thinking. Why is it necessary to order physical systems at the beginning of the project? Why must groups of people travel across the globe to remote locations? Why force hardware freezes prematurely? And why should design be coupled to hardware? Now, more than ever, a paradigm shift in project execution methodologies is needed to increase capital efficiency and ensure predictability in cost and schedule on automation projects worldwide.

Traditional Project Implementation

Conventional project engineering processes progress through a series of activities that continuously build upon each other to move the design from abstract ideas to validated engineering designs. Through the progression of these activities, decisions are made which enable subsequent activities to move forward based on the final design (See Fig. 1).
In the process industries, the plant automation system is a collaboratively engineered system in that its design typically is not known at the time of procurement; instead, the supplier develops the system from multiple requirement inputs derived from various engineering activities.

Due to the sequential nature of the traditional engineering approach for automation systems, there is only one path to project completion. Tasks are executed in fixed sequence to meet install dates, and outputs from one task are required for the following task. This single path means that any delay or issue arising in one of the activities will directly affect the delivery of the subsequent tasks (See Fig. 2).

![Figure 2. Traditional automation project workflow](image)

The ultimate efficiency for this model is to execute each one of these tasks in the timeliest manner, and only execute it once. In a real world situation, this becomes a very challenging endeavor. Projects are often required to be finished on tighter and tighter schedules, and changes in a project’s scope or definition often occur in its later stages. These late changes may mean that a design will need to be changed, the build and/or configuration modified, and potentially, the testing of the component repeated.

**Evolving Project Strategies**

During new construction, particularly on “mega-projects,” it is crucial to minimize risk, increase flexibility, shorten schedules and, most importantly, keep automation systems off the critical path. This requires the elimination of non-value-added processes, which can be considered “waste.” Typical examples include repetitive tasks, rework and redundant tasks.

The demands placed on automation system suppliers to accommodate evolving project execution models have required reassessment of traditional delivery models. A paradigm shift in project implementation strategies means the workflow on projects can now be very different. New approaches to project execution can optimize processes and eliminate non-value-added activities that were once highly problematic. These techniques are intended to drive effectiveness—not efficiency—since to efficiently do what is not required is not effective.

**Changes in Delivery Models**

In contrast to the traditional automation project workflow described above, configuration of the automation system software to meet the functional requirements best favors a more iterative approach. With this technique, the system is built up as functional units. The units themselves have no dependence upon the hardware design state or the completion of other non-related units.

Separation of the physical and functional aspects of the control system into independent hardware and software design activities enables both of these tasks to be performed in parallel. This breaking of the dependence of the software configuration from the hardware delivery also allows configuration activities to occur out of the traditional order of tasks.

In addition, configuration activities can be started much earlier in the project schedule, as they are not reliant on the physical system being designed. This independence leads to the creation of two separate execution paths, which can be managed to meet the project’s deliverables with greater flexibility than the traditional model (See Fig. 3).
Transformation of Workflow
Changes in project implementation strategies now support the traditional (i.e., define, design, manufacture and install) workflow for the physical hardware components and an independent workflow (i.e., define, configure, test) for the functional software. In the case of functional development, there is no penalty for breaking the workflow into modular functional packages. For example, a utilities process unit could be functionally completed prior to starting another production unit that may have a less complete definition. This enables the project team to be far more agile in supporting the fragmented data inputs that result from parallel upstream design activities.

In the evolution of process automation, the functionality of control systems has moved steadily away from dependency on hardware to software configuration. The functionality can be applied to multi-purpose hardware supporting a greater variety of functionality with fewer, more versatile standardized components. In this sense, the software configuration supports control system functionality while the hardware supports physical requirements, such as input and output (I/O) connections that are truly universal and can be changed remotely.

Advent of New Technology
Thanks to abstraction technologies offered by Honeywell Process Solutions, including Universal I/O (UIO), Virtualization and Cloud Engineering (Virtual Engineering Platform), industrial firms can transform the way in which plant automation projects are executed. These technologies are specifically designed to decouple physical design from functional design. They support key project benefits such as: late binding of system configuration data, flexible hardware procurement, improved agility and flexibility, and enhanced design options. Honeywell’s solution – Lean Execution of Automation Projects (LEAP) - can have a significant impact on large capital mega-project implementation, taking millions of dollars off the total installed cost of large control system projects.

With the latest technology developments, it is now possible to achieve full abstraction of the control system infrastructure. Supervisory Control Level 2 nodes are abstracted via virtualization, while Control Level 1 and I/O can be fully simulated in a server environment and abstracted by the Universal I/O. This overall abstraction from the server to the I/O is fostering the new LEAP approach, which brings greater versatility to the traditional model of an engineered automation system.

Universal I/O
In the process of physical design for control systems, the objective is to start the design task as late as possible. Removing configuration activities from the critical path is one step towards that goal. Another step is to reduce the time taken for design by simplification of the design process itself.
The development of Universal Channel Technology has completely liberated field I/O, as well as control cabinets, from channel-type dependency. This more standardized, multifunctional solution permits late additions and modifications to I/O schedules with no more than a soft configuration change—potentially saving weeks of schedule delay when making late-stage design changes.

**Late binding:** Through the use of Universal I/O, late data binding can occur well into the construction phase of a project without the huge impact late instrumentation design changes would typically bring to conventional designs. Users no longer require different modules for each I/O type, and are able to reconfigure any I/O channel without having to go into the field to make physical changes. Additionally, functional design can be separated from the physical design. This allows for parallel work operations (i.e., functional and physical design can happen independently and concurrently). In situations where there is limited physical access to the control system during commissioning or offshore operations, the ability to make changes from a remotely connected engineering station can prove invaluable.

**Flexible hardware procurement:** Since Universal Channel Technology has ushered in a more standardized design approach based on the use of a single, Universal I/O module, standard cabinet designs can be manufactured later in the project schedule. Plus, fewer spares will need to be available as part of a project.

**Improved agility and flexibility:** With the Universal I/O solution, project teams can start work sooner — they just require a total I/O count and do not need to worry about the I/O mix. Universal I/O modules reduce equipment requirements and footprint, and can be quickly configured for multiple channel types, ensuring utmost flexibility in system design. This concept enables multiple remote locations to be controlled out of a single centralized unit, with each channel of I/O individually software-configured either as analog input (AI), analog output (AO), digital input (DI) or digital output (DO).

**Enhanced design options:** Universal Channel Technology makes it possible to utilize remote cabinet designs, with corresponding savings in equipment space, power, cooling and weight requirements. It eliminates wasted I/O space and enables reductions in both installation and operational costs since users are no longer concerned about having sufficient modules for AI, AO, DI or DO configuration. The I/O connection can easily be configured, and reconfigured, at any point.

The application of standardized Universal Cabinet designs to control system projects also allows for efficiency improvements in many areas in the design process and I/O assignment. In addition to these improvements, Universal Cabinets bring cost reductions and schedule gains in other parts of the project.

With Universal Cabinets, any field signal can be connected to any I/O channel. The control system can be sized purely on the estimated total I/O count for the overall process or process units. Taking these benefits into the design process, there is no longer a requirement to custom-design each cabinet based on the specific I/O mix for that location. A Universal Cabinet containing nothing but Universal I/O can be designed once and installed in any location for the project (See Fig. 4).

**Figure 4.** Universal Channel Technology allows I/O cabinets to be standardized, because any field signal can be connected to any I/O channel.
For instance, a typical mid-sized process unit might require 10 I/O cabinets, with each cabinet containing around 500 input and output signals. To build these cabinets using conventional I/O, it is assumed each cabinet will need to have the appropriate mix of I/O arranged internally, as well as custom power and heat calculations. The cabinet layouts will have to be sent to a designer to produce internal arrangement drawings for internal and client approvals. After manufacture, the cabinets will be inspected and validated against the custom arrangements. Specific custom factory inspection and test records will need to be produced, with all of the cabinets assembled together and powered-up and tested as part of the customer’s acceptance test.

If the project had chosen Universal Cabinets, many of the aforementioned design activities could have been eliminated. Since all of the cabinets would be the same, there is no longer a need to produce custom layouts and drawings. Plus, no additional approvals would be necessary, since the quantity of the cabinets would be decided at the definition stage of the project. Manufacture and test requirements would also have been met by standard factory processes. Optionally, the end user could have chosen to witness the testing, with the cabinets then shipped directly to the site without the need for further power-on and staging.

If at a later point in the project the definition changed and more I/O was needed, this requirement could be easily and quickly accommodated by spare capacity within the cabinets. Or, additional standard cabinets could be manufactured with minimal lead-time and shipped directly to the site without impacting other project activities.

**Virtualization**

Plant managers seek to reduce the amount of computer hardware in their facilities and their total cost of ownership (TCO), but they must do it without compromising existing safety, reliability and production. Simply put, virtualization abstracts operating systems and applications from the underlying physical infrastructure by representing the hardware as virtual devices. Virtualization allows a single server to simultaneously run multiple operating systems and applications. It does this while insulating these virtual machines (VMs) from the underlying hardware and also from each other.

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**Figure 5.** With virtualization, it is now possible to achieve full abstraction of the control system infrastructure.
Virtualization is now proving to be an important productivity and efficiency tool for all types of industrial operations. Targeted virtualization solutions simplify and decrease requirements for plant hardware, while enabling greater reliability and availability of process control systems.

**Late binding:** Virtualization makes a significant contribution to design independence on automation projects. Traditional methods of deploying process control systems have involved a tight coupling between control functions and the instruments connected to the process. By employing virtualization solutions, development of supervisory layer VMs can occur independently of the physical virtual infrastructure design. Virtual machines can be installed on the final physical virtual infrastructure late in the project cycle, and development of these machines can occur at the same time as the physical virtual infrastructure design. All of Honeywell’s simulators can also run as VMs, enabling implementation of changes to occur independently of hardware installation on site.

**Flexible hardware procurement:** When projects are provisioned with virtual machines rather than physical servers, virtual infrastructure purchases can be deferred until later in the project. The actual hardware is not procured until after final testing so that users can buy the most current technology, thereby avoiding a costly hardware refresh during project execution. Given that hardware is shared rather than dedicated, an estimated number of host servers can be used to meet the needs of a system without having to identify the exact server and operator station requirements. Virtualization allows for a single, standardized workstation and server design that can accommodate a wide variety of topologies in a similar manner to Universal Cabinet designs.

**Improved agility and flexibility:** Plants also achieve greater agility and flexibility with virtualization technology. Virtualization allows project engineers to add new virtual machines without requiring new hardware (within limits). As such, they can start work sooner without worrying about a precise VM count. Even when hardware has been purchased, if additional nodes are required, they can be handled on the existing hardware assuming sufficient capacity. And using virtualized templates, new nodes can be spun up effortlessly without having to do full installs.

**Enhanced design options:** Virtualization, coupled with the deployment of blade server technology, allows for a standardized, yet modular supervisory design that can handle a wide range of system design scenarios on new construction projects. Additionally, the technology can reduce the physical footprint of hardware components in the plant server room, with corresponding savings in space, power, cooling and weight. Facility savings are both direct (consumed by the hardware) and indirect (ancillary service reductions). Running these virtualization solutions on blade hardware then provides the ultimate synergy of resource utilization provided by virtualization with the hardware density provided by blade technology.

Additionally, virtualized servers with a thin client operator interface are the best option for many applications commonly found in the plant control room. Like the server room, footprint can be optimized in terms of equipment space, cooling and noise. This is achieved through the thin client’s compact form and lower power usage. Additionally, thin clients have the flexibility to be geographically separated from the facility, using reliable redundant network connectivity.

**Cloud Engineering**

Today, more and more engineering and industrial companies manage their projects across multiple locations. A lot of project teams aren’t defined by geographical proximity anymore. Instead, engineering professionals work as a “human cloud” that is made possible thanks to the rapid development of new cloud computing technologies. For companies that have global development and manufacturing operations, the ability to share data without being limited by time or place helps their various locations collaborate more closely. It also allows engineers to concentrate on their work rather than how, when, and where their jobs are executed.

**Late binding:** Cloud engineering solutions enable automation work around the world to be engineered in the cloud in a manner totally decoupled from the physical infrastructure. The VMs or databases can then be bound late in the project cycle with the physical hardware.

**Flexible hardware procurement:** One basic advantage of the cloud engineering approach is the freedom to use the automation supplier’s infrastructure during the project engineering process — not the customer’s. This allows the project to procure the project servers as late as possible in the schedule, ensuring that the technology delivered with the system uses the latest hardware available.

**Improved ability and flexibility:** With a virtual engineering platform, subject matter experts (SMEs) have fewer physical constraints and can start work on the project without waiting for servers or other components. As all of the control functions have been virtualized, remote testing is possible. This can be done through allowing more iterative remote inspection during the detail design phase of a project, reducing the need to test these areas during a factory acceptance test (FAT) or, alternatively, a traditional FAT could be conducted where large portions are
performed remotely. Either way, large reductions in travel expenses are achieved on the order of 50-70% for testing. Once the virtual FAT has been completed, the virtual machines are moved from virtual staging resources to the final servers for the site acceptance test (SAT). As the machines have been virtualized, nothing needs to be reloaded or reinstalled when they are transitioned to the final hardware (See Fig. 6).

![Virtualization Diagram](image)

**Figure 6.** Virtualized engineering environments in the cloud allow engineers to work together on projects from locations around the world.

**Enhanced design options:** Cloud engineering can deliver the functionality required by industrial firms that want to transform the way in which they operate to achieve a competitive advantage. Companies are running applications in the cloud to lower costs, deploy more quickly, and simplify infrastructure management. The ability to detect and react quickly to issues reduces waste and elapsed time, which reduces costs and improves time to market.

The combination of virtual engineering with full virtual target system deployment yields the highest possible benefits in terms of engineering design efficiency, quick deployment, late change management, flexible hardware procurement, and footprint for automation projects.

**Advantages for Industrial Projects**

When applying optimized project workflows enabled by Honeywell’s innovative control system technologies, a number of tasks that previously occurred in a system-staging environment can now be pushed out to the construction phase to enable earlier on-site delivery of hardware. With Universal I/O, users can now order fully standard Universal Cabinets from the factory in whatever quantities required, and execute a project without assigning I/O to a channel until commissioning. With virtualization and product simulators, control strategies can be developed and tested prior to the final design, and users can develop those strategies in the cloud and allow the project engineer never to leave home.

Applied together, these technologies enable a new project execution methodology that revolutionizes project execution. By separating physical from functional design, this methodology allows parallel workflows, applies standardized designs, and enables engineering to be done from anywhere in the world. Overall, a reduction in main automation contractor (MAC) costs could result in 30% capital savings and optimizing scheduling by 25%.

For an integrated main automation contractor project of approximately $50 million with 40,000 I/O, this methodology could potentially deliver the following benefits:
• 66% reduction in defect opportunities and marshalling labor due to elimination of multiple terminations per loop
• 90% reduction in marshalling cabinets from 120 to less than 10 due to moving the I/O to the field
• 50% reduction in servers and network cabinets through server consolidation
• 60% reduction in remote instrument enclosures (RIEs)/local equipment rooms (LERs)/field auxiliary rooms (FARs) from 7 to 3 due to decreased footprint of automation equipment
• Shipment of control system I/O hardware up to 6 months earlier to optimize field construction schedules due to standardized cabinet designs
• 50% reduction in travel expenses through virtualized engineering development and virtual acceptance testing
• Finally, reduction in total MAC costs of about $16 million (30%) through the reductions stated above

Additionally, a large capital project could realize 4 to 5 times that amount in total savings when the impacts of LEAP are applied across an entire project. The savings would come from reduced capital costs, improved operational readiness and early production, installation and commissioning, engineering time, document control and review, schedule optimization, travel time, and the typical delays and change orders incurred on most projects due to late design changes. Cutting back on rework, buildings needed and footprint can have far-reaching benefits across the project. For example, the reduction in design engineering documentation and drawings alone through elimination of marshalling designs and rework could dramatically affect the engineering hours on a major project. Reduced footprint of equipment through standardization not only saves space, but reduces the number of buildings/enclosures dramatically – and the associated shipping and logistics, cooling and power requirements that support them.

In general, this methodology can offer a variety of benefits to different project stakeholders:

**Benefits to an Engineering Procurement Construction (EPC) Contractor:**
- Reduce Construction Costs
- Reduce Risk from Late Changes
- Enables Effective Deployment of Resources
- Project delivery is more flexible

**Benefits to the End User Company:**
- Automation costs are predictable
- Project schedule risk is reduced
- CAPEX is more efficient
- Earlier production dates

**Conclusion**

The benefits of optimized project implementation strategies coupled with the latest automation technology advancements, can be realized at both ends of the project schedule and represent a true paradigm shift. This approach may be applicable individually to a single project, or applied broadly to gain the maximum project flexibility.

LEAP utilizes three innovative technologies - Universal I/O, Virtualization and Cloud Engineering - to enable parallel workflows, standardized designs, and more efficient remote engineering. The resulting optimization in scheduling, equipment footprint, labor and engineering time can be significant.

Across an entire construction project, the cost benefits can be multiplied 4 to 5 times, allowing both EPCs and end users to realize dramatic improvement in project execution. This new project implementation approach is essential to ensuring control systems pose the least risk to project schedule, cost and risk and allow for safe, efficient and reliable plant startup and operation.
For More Information
Learn more about New Solutions for Optimizing Delivery of Automation Projects, visit our website www.honeywellprocess.com or contact your Honeywell account manager.

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