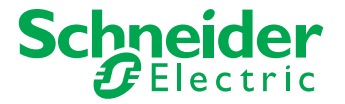


Life Is On



The future of automation is now

by Donald C. Clark and Martin A. Turk

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Introduction

Regulatory control systems — from pneumatic single loop controllers to modern distributed control systems (DCSs) — have proven to be very successful in managing the basics of plant operations, regardless of the nature of the processes involved. Over time, technological advancements have enabled dramatic improvements to be made in the functionality that process automation systems provide, enabling them to performing increasingly complex tasks. However, until recently, the primary purpose of these systems has been to control process variables, such as temperatures, pressures, levels, and flows, with the goal of achieving stable and safe plant operations.

In response to the myriad internal and external pressures that affect the performance and competitiveness of process plants today, automation systems are undergoing significant enhancements and expansions of their functionality. The emphasis in the past was on improving process efficiency while in the future it will be on improving business performance. And you have to have the former before you can hope to get the latter.

To understand the current state of process automation we start by examining the history of automation technology in the context of the business drivers over the past half century that are responsible for the evolution — and, in some cases, revolution — of this technology. We then look at advances in measurement systems and the new classes of variables (e.g., indicators of financial performance) that are being brought into process automation systems to address the current business drivers and competitive pressures affecting process plants.

These advances — coupled with the effect of changes in the speed of information access and sharing — demand that a new perspective on operations be adopted. This, in turn, is driving further evolution of automation system capabilities and an increasing reliance on value-added applications to both improve and provide real-time feedback about the economic performance of process plants. Taken together, this nexus of business drivers and technological advancements has resulted in a new class of automation technology (i.e., an enterprise control system) which provides the foundation for production operations management whose purpose is to effectively close the business control loop. This will greatly facilitate collaboration for improved decision-making and enable companies to manage their processes as a business, just as they manage their business as a process.

Brief history of automation technology

Over the course of the last 60+ years the primary focus of companies in the hydrocarbon processing industry (HPI) has changed in response to competitive pressures. In the middle of the last century these companies made significant investments in product chemistry and R&D activities to create molecules with commercial appeal. The industry was focused on “what to make.” In the latter decades the emphasis shifted to one of “how to make it.” Process efficiency and cost management became strategic initiatives. Today, global competition and economic uncertainty have made it an imperative for companies in the HPI to devote their energies to maximizing profits by optimizing their operations. This shifting focus is illustrated in Figure 1 below.

Simply put, this evolution of business drivers has shifted company strategies from those focused on improving process efficiency to those focused on improving business performance. These evolving strategies have had profound effects on organizations and the technologies they need to achieve and maintain competitiveness. Let’s take a brief look at the resulting changes in automation technology.

In the 1950s, prior to the advent of the “digital age” in process automation, control systems were designed to hold process conditions at their target values — in the face of measured and unmeasured disturbances — using straightforward, single loop, feedback process industry drivers control strategies. This approach produced satisfactory results as long as concerted efforts were made to keep the control loops correctly tuned. Such regulatory control systems remain a key component of all process automation architectures.

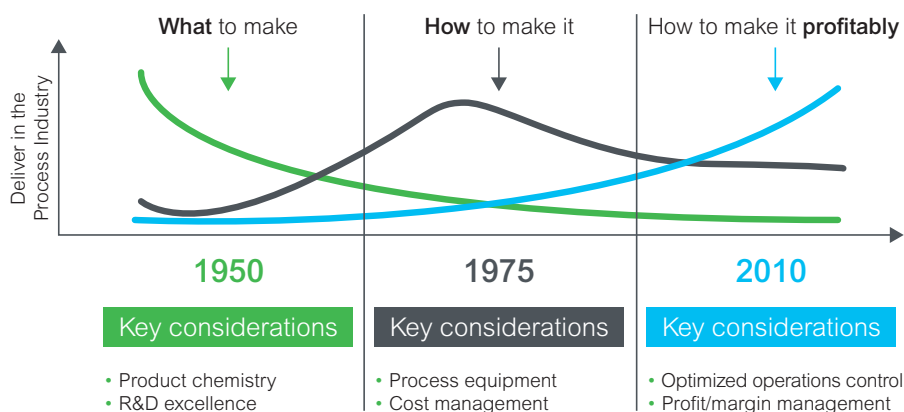


Figure 1
Evolution of process industries drivers

As process technologies became more complex in response to competitive pressures to improve product quality and yields while reducing operating costs, greater demands were placed on process control systems to be able to manage these processes at the higher levels of performance required to meet their operating objectives. As a result, significant advancements were made in the mathematics of process control (e.g., decoupling control, relative gain array, and dynamic matrix control) and in the systems used to execute these “advanced” control strategies.

It was in the 1960s that the first digital computers were used for implementing advanced regulatory and supervisory process control strategies. Within a couple of decades, as the power of process control computers increased and the first DCSs were introduced, control theory had produced a working version of dynamic matrix control to better handle the interactions of multiple manipulated and controlled variables in complex processes, particularly those used in petroleum refining. This technology remains the preferred mathematical construct for implementing multivariable predictive control in refineries and petrochemical plants.

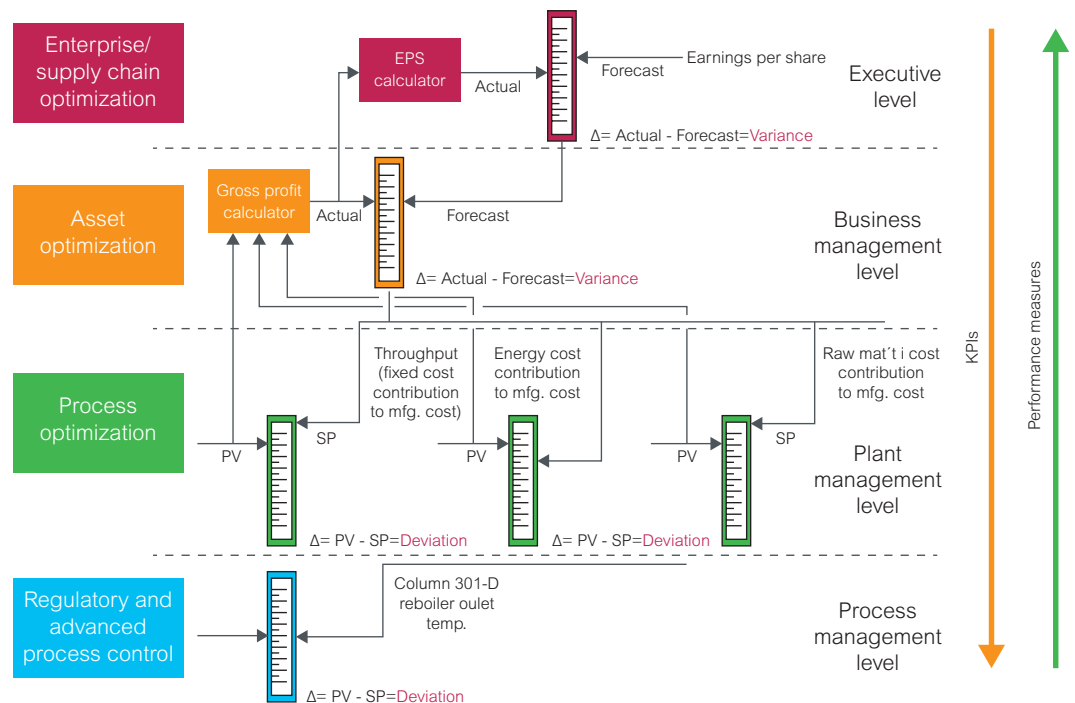
These advancements in automation technology have produced significant improvements in the control of complex processes. However, the use of this technology has been to improve process efficiency, primarily aimed at reducing operating costs. While the number of process measurements accessed by the control systems has increased over the years, by and large, the types of measurements have not changed much. Key measurements that have been absent from the operators purview are those that indicate the economic impact of each of their actions (e.g., changing controller setpoints or making manual adjustments to manipulated variables). They have not been provided with cost and/or profit control loops that are not only connected to state variable measurements, but also to stream property measurements. However, this situation is changing.

Today’s world-class plants are very large in size to capitalize on economies of scale and reduce unit costs. These plants now have the ability to measure and report in near real time on the economic performance of the facility. This has transformed automation systems into ones that close the business control loop (a graphical depiction of the business control loop is given in Figure 2). As a result, there is more emphasis on availability and reliability of the plant, and the entirety of the IT platforms to maximize utilization. Plants are being operated with longer run times between shutdown, faster changeovers, accelerated startups, and smaller operating crews. All of these factors have increased dependence on advanced control, optimization, and dynamic simulation. Properly managed, such plants are great sources of value. However, there is also the potential for large negative financial impact when failures occur.

Automation of the business control loop enables both plant-level and corporate-level personnel to manage the “process as a business” by providing them with a view of the process in the context of business variables, assuming such measurements are available.

It has been shown in actual practice that giving trained and empowered plant operators real-time information about the economic impact of their decisions (i.e., Dynamic Performance Measures, or DPMs) allows them to improve process profitability without any changes to their process control systems. Sasol Infrachem implemented a relatively inexpensive DPM system in several of its steam plants and realized a benefit of millions of dollars per year, which paid for the project in a couple of weeks! As a result of this outstanding success the company has continued to invest in DPM systems in other process facilities with equally compelling benefits.

Figure 2
The business control loop



The changing nature of process measurements

Effective execution of the business control loop increases reliance on a rich set of applications that are designed to streamline and automate the “business of the business” (refer to Figure 3). With time, the content of the information in these applications also increases. With this increase in the richness and capability of the needed applications, there has been a proportional increase in both total I/O count in a plant and in the I/O ratio. In the early days, typical I/O ratios were about 1-2:1, with I/O counts on the order of 4,000. Today, the ratios are 7-9:1, with the counts often exceeding 75,000. Why? Because the applications demand an ever-increasing amount of input information to deliver the functionality demanded of them.

Furthermore, to improve visibility into the business performance of the plant, it is necessary to have better measurements of the properties of the process streams that provide the value uplift for which the plant was designed. Online process measurement technology is advancing at a rapid pace such that robust, relatively inexpensive stream property measurement sensors will soon become commonplace in petroleum refineries and petrochemical plants. These measurements will facilitate the ability of operations personnel to make decisions based on profitability, not expediency.

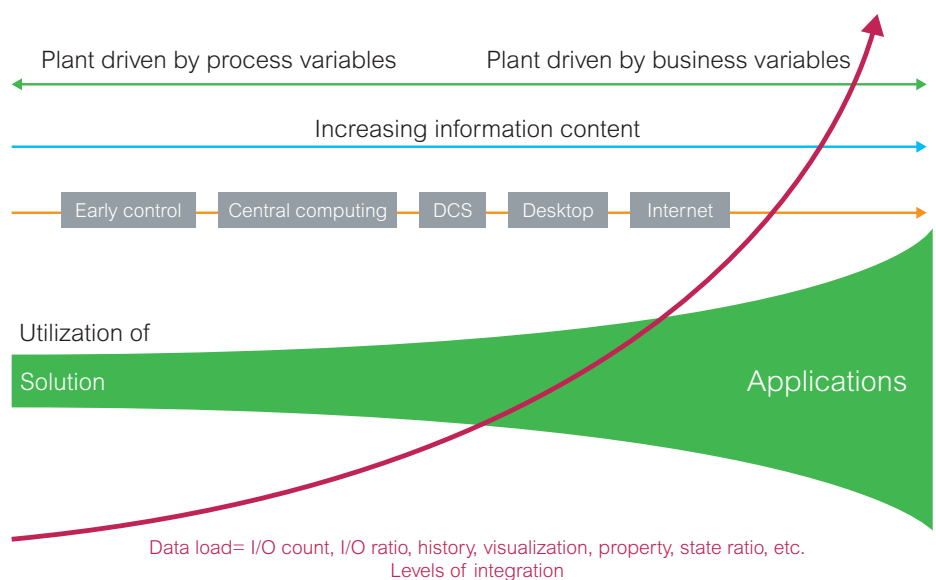


Figure 3
Growing reliance on applications drives increasing data load

A new perspective on operations

One of the key driving forces responsible for the changing nature of automation systems — going beyond control of processes to control of business performance — is the dramatic reduction in the time constant of information flow across the globe. It wasn't too many years ago that it took days for information to travel from one part of the world to the other. This relatively long time constant of information flow (τ_{IF}) enabled petroleum refiners and petrochemical producers sufficient time to respond to events that affected them since the time constant of the refinery or petrochemical plant's decision-making process (τ_{DP}) was shorter than τ_{IF} . Telex and facsimile transmission reduced the τ_{IF} somewhat, but plants were still able to respond in a timely manner.

As little as 20 years ago no one in the HPI spoke about the need for agility to achieve and sustain competitiveness. But, as the saying goes, “times have changed.” Today, information flow across the globe is, for all intents and purposes, instantaneous, such that τ_{IF} is approaching zero. The same cannot be said for τ_{DP} . While automation technology has enabled τ_{DP} to shrink, it is still large compared to τ_{IF} . It is not surprising that many HPI facilities have either changed hands or shuttered due to their lack of competitiveness and profitability. The challenge remains to continue to cost effectively apply automation technology, information management tools, and modern decision-making paradigms in ways that further reduce the value of τ_{DP} .

Your choice — A patchwork of applications or an enterprise control system

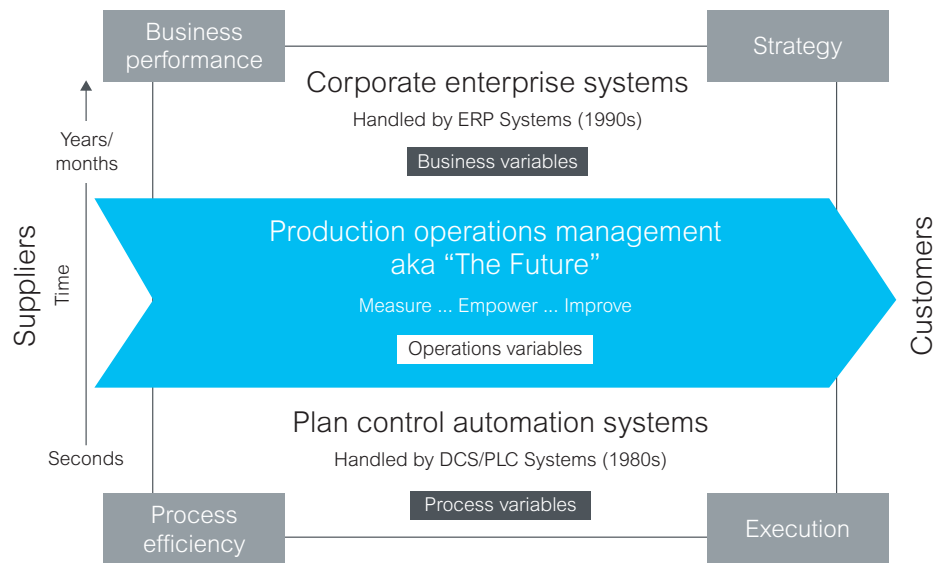
One of the primary causes of a high τ_{DP} is the fact that many of today’s HPI facilities and businesses are managed using a patchwork of loosely coupled applications. While these myriad applications — some of which are mission critical — may be connected to plant information and/or corporate business networks, Microsoft Excel® remains the preferred mechanism for sharing information among these applications. This is not only time consuming and manpower intensive, but lacks the robustness and cost effectiveness demanded of high-performance companies.

The good news is that the industry is at the nexus of a technology revolution that has finally enabled realization of the vision of an integrated enterprise control system, what we referred to several decades ago as CIM, Computer Integrated Manufacturing. This revolution includes:

- Service-oriented architectures
- Cloud computing
- Solid-state high-speed memory devices
- Parallel computing
- Virtualization
- A wealth of off-the-shelf hardware platforms and software applications
- Definition and wide-spread acceptance of industry standards (e.g., S95) that allow for greater interoperability and lower costs
- Wireless communications
- Cybersecurity

Due to these technologies it is now possible to tightly couple business performance/strategy with process efficiency/execution via a Production Operations Management — Enterprise Control — System (Figure 4). This “system of systems” is based on the modular integration of applications that are custom tailored to industry needs. Empowered individuals at all levels of the organization now have the capability at their fingertips to measure business performance in near real time and then use this information to make decisions and take actions quickly and correctly in order to correct for deviations from plan or reinforce positive behavior. The net result is a significant decrease in τ_{DP} , which makes an organization more responsive to market forces and, therefore, better able to compete in the global HPI.

Figure 4
Production operations management system



Other benefits of an enterprise control system are cross-disciplinary collaboration enabled by new visualization techniques and new tools to convert vast amounts of data into information. Agility is enhanced by being able to make use of remote expertise (i.e., bringing the problem to the expert) and decentralized, but coordinated plant operations.

The future is now

Real time is the new frontier of sustainable value creation. An enterprise control system extends the control loop concept into the business of operations. It enables understanding of:

- The What — business variances right now, i.e., the right information, to the right people, at the right time, in the right context
- The Why — root cause connections to variances

And it provides the ability to:

- Control/automate the routine
- Look forward/set the most profitable pathway

This new way of doing business allows companies in the HPI to identify future profitability opportunities and have a small enough τ_{DP} to take advantage of them. The result is faster time to profits.

Benefit sources include:

- Cross-platform integration
- Real-time schedule feed forward from operations, not just to operations
- Built-in robustness and fault tolerance
- Smarter asset management maintenance strategies — device level and up
- Dynamic simulation, online optimization for process and business — to run online “what if” scenarios
- Inventory reductions
- Ability to quickly and correctly identify the “point-of-no-return” on operating costs
- Running a virtual “single plant” across many actual sites/locations
- Quality improvement (waste ↓, yield ↑)
- Enhanced cybersecurity
- Agile real-time business finance visibility of asset utilization

In summary, automation moves into asset optimization; it spans all elements of operations; it becomes the vehicle to run your process as a business. The future of automation is now and it is indeed bright!

If you enjoyed reading this paper, we invite you to view the accompanying webcast:

“How to achieve new levels of plant performance with your DCS”
presented by Don Clark

Planning to migrate your DCS?
Visit the DCS Migration Resource Center

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