DCS or PLC?

Seven Questions to Help You Select the Best Solution

Distributed Control Systems (DCS) or Programmable Logic Controllers (PLC)
For manufacturers in the process industries, the procedure for selecting the best automation technology is not as easy as it once was. In the past it was fairly easy to determine whether a PLC or a DCS was right for your application, because their strengths and weaknesses were well understood. In recent years this has become more difficult, thanks primarily to the advancement of the microprocessor, which has allowed the technologies to merge. With the trend toward flexible manufacturing in industry, many of the applications in the process industries now share the *requirements* traditionally thought to be exclusive to either DCS or PLC. These hybrid applications typically require a process control system that can deliver *both* PLC and DCS capabilities. Thus understanding the merging of PLC and DCS functionality is important for selecting the best system for your company.

In this white paper, we will shift away from some of the classic stereotypes of DCS and PLC , such as those shown in Table 1 on page 9, in order to explore seven key criteria, which will help your company select the system that best meets your goals. We will also demonstrate why having a clear picture of the

White Paper

process AUTOMATION

The convergence of PLC and DCS technologies has created a situation where it is more challenging than ever for process manufacturers to select the best technology for their application. A successful evaluation should start by developing a clear picture of the *requirements* of your application and the *needs* of your engineering, maintenance, and operations personnel. To help clearly define these requirements and needs for your company, this paper outlines the seven key questions that will lead you to making the right choice.

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requirements of your application and the *needs* of your engineering, maintenance, and operations personnel is paramount to finding the right automation technology for your company. Finally, we will provide you with a simple check list (Table 4) to help you determine what type of system works best for your application.

Benefits of Selecting the "Right" Automation Technology
In this era of global competition, manufacturers in the process industries are being driven to achieve operational excellence to secure their place ahead of their competition now and in the future. Selection of new automation technologies impacts this goal. Consequently, the selection process is more important to a company's staying power than ever before. In fact, the importance of the selection of technology far outweighs the cost of the automation investment itself.

Selecting the right technology and the right supplier can help your company:

- respond quickly to changing market conditions in a way that creates a sustainable competitive advantage
- minimize Total Cost of Ownership (TCO) over the life of your plant
- create a system which is easily maintainable/ upgradeable for the long-term
- achieve its future goals and vision

Let's Get Technical Stereotypes Out of the Way!
Selecting an automation system based on a review of available products is the typical course of action for someone in the market for a new automation system. The problem with this approach is that your perception of which systems "make the cut" is often based on old stereotypes or influenced by the claims of the first salesperson in the door. Let's look at the components of a DCS or PLC based system to see how different (or similar) they really are.

At first glance, the pictured system architectures look very similar. Both systems share the following components:

- Field devices
- Input/output modules
- Controllers
- Human machine interface (HMI)
- Engineering
- Supervisory control
- Business integration

As you look at the following system architectures, you should note that the technologies used in each system are in fact, very similar; the difference becomes more apparent when you consider the nature and requirements of the application.

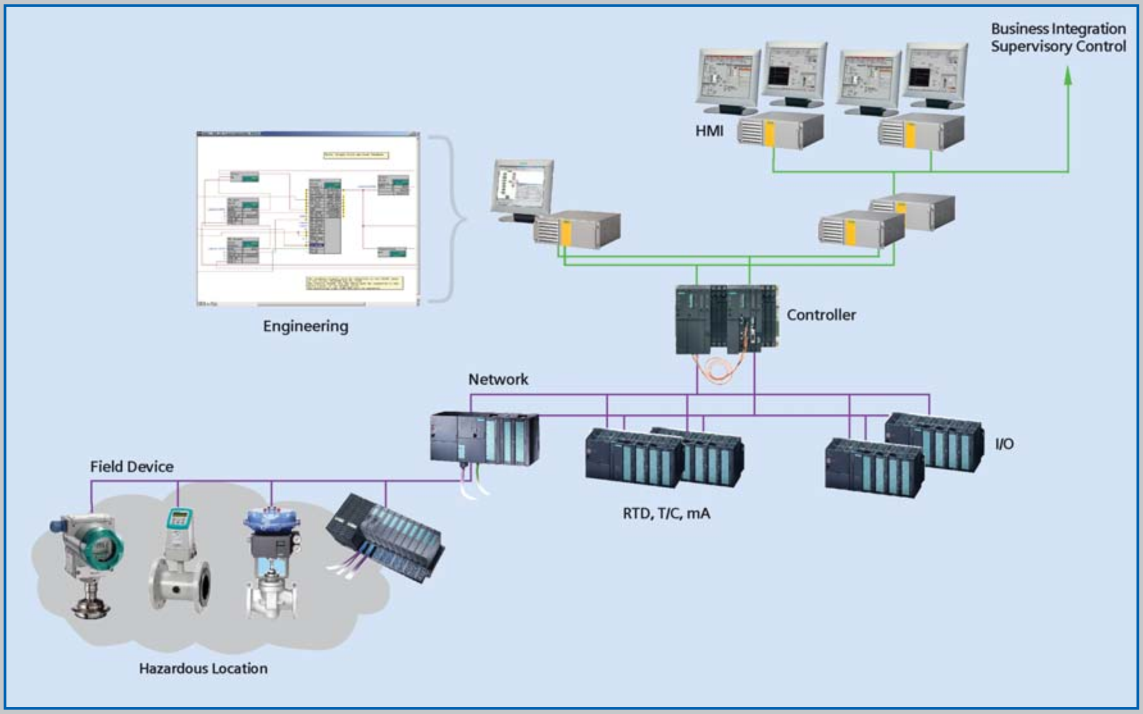

Figure 1 Typical DCS System Architecture

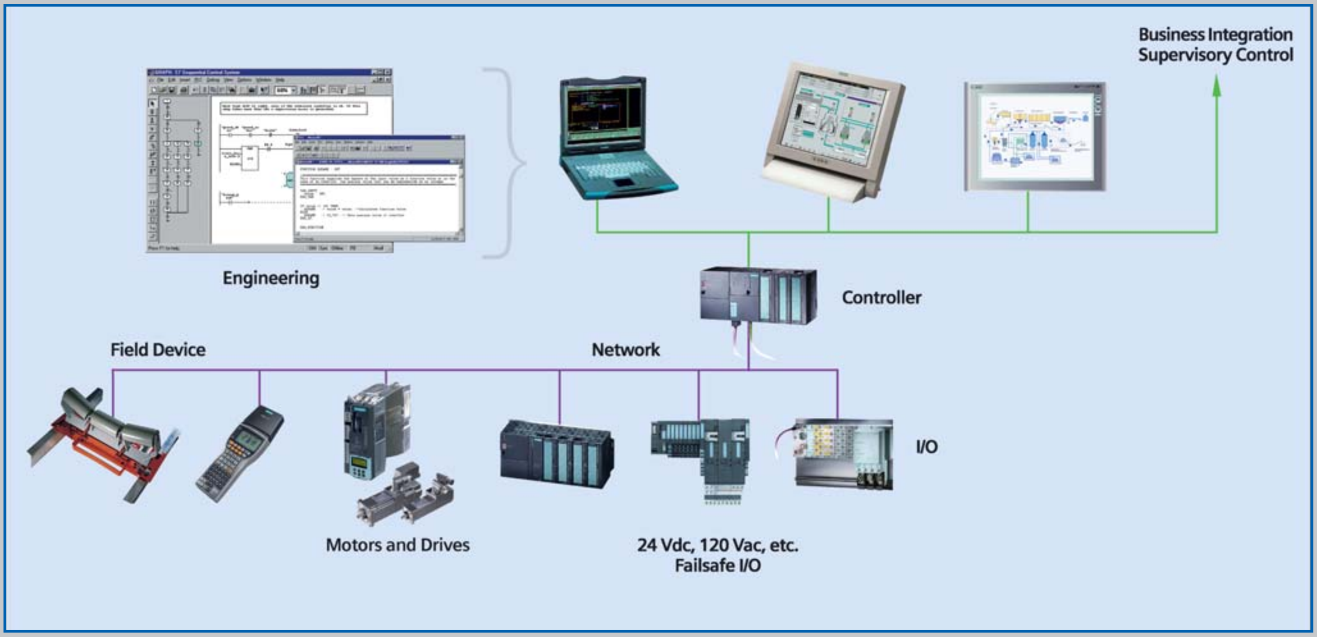

Figure 2 Typical PLC-based System Architecture

For example, in the DCS architecture diagram, redundancy is often employed for I/O, controllers, networks, and HMI servers. Since redundancy adds cost and sometimes complexity, DCS users must carefully evaluate their need for redundancy in order to achieve their required system availability and to prevent unplanned downtime.

The PLC architecture illustrates one of its most common applications, the control of discrete field devices such as motors and drives. To effectively control motors and drives requires that the controller be able to execute at high speeds (typically a 10–20 msec scan rate), and that the electrical technician responsible for maintaining it be able to read and troubleshoot the configuration in a language that he is familiar with (relay ladder logic).

From a technology point of view, one can see that PLC and DCS are not that different, which has paved the way for them to merge. Therefore, we must look beyond technology to the application expertise and domain knowledge that is built in to these systems by the supplier, so that we can better understand the "sweetspots" where each is best applied.

The Seven Questions to Ask Yourself Before Choosing a System

Now we will get to the core of this paper – the seven questions you should ask yourself before choosing a system.

Please realize that we will be using broad generalizations in the following analysis, and that every individual application will have exceptions to these "rules;" however, the logic is still sound. Since the authors work "on different sides of the PLC/DCS fence" for a supplier that has delivered both DCS and PLC solutions to the market for over 25 years, we feel that we are in a unique position to deliver both sides of the story.

The seven questions are designed to make you think about your company's operating philosophy and application *requirements*, taking into account the point of view of all the major stakeholders in your plant (engineering, operations, maintenance, etc.).

1. What are you manufacturing, and how?
2. What is the value of the product being manufactured and the cost of downtime?
3. What do you view as the "heart" of the system?
4. What does the operator need to be successful?
5. What system performance is required?
6. What degree of customization is required?
7. What are your engineering expectations?

Note that a consolidated list of questions and possible responses are presented at the back of this paper in Table 4 (tearoff page). One simple method for gauging whether you should be using a PLC or DCS is to go through this survey form, checking all of the responses that apply. If all of your responses are in one column, then your application clearly calls for this one type of system. If you have multiple selections from both the PLC and DCS columns, then maybe you have a “hybrid” application which requires a process control system capable of delivering both PLC and DCS functionality.

1. What are you manufacturing and how?

This may seem like a very basic question, but it is fundamental to determining the requirements of the application and, therefore, the best fit automation system. The way a product is manufactured, the performance needed, along with any physical limitations of the process, all influence the system selection.

Typical factory automation applications, for which the PLC was originally designed, involve the manufacturing and/or assembly of specific items – "things." These applications may employ one or more machines and a fair amount of material movement from machine to machine. A typical characteristic of this type of process is that the operator can usually monitor the "things" visually as they progress through the manufacturing line. The process is, by nature, very logic control intensive, often with high-speed requirements (throughput = profits). This type of process is often controlled by a PLC and Human Machine Interface (HMI) combination.

Process automation applications typically involve the transformation of raw materials through the reaction of component chemicals or the introduction of physical changes to produce a new, different product – "stuff." These applications may be composed of one or more process unit operations piped together. One key characteristic is that the operator can't see the product. It is usually held within a vessel and may be hazardous in nature. There is usually a large amount of simple to complex analog control (i.e., PID or loop control), although the response time is not that fast (100ms or greater). This type of process is often controlled by a DCS, although the analog control capability of a PLC may be more than adequate. A determining factor in the selection process is often how large in scope the control application is (i.e., plantwide versus single unit and number of I/O points).

There may also be sequential (or batch) control needs. A PLC can be used effectively for "simple" batch applications, while a DCS is typically better suited for "complex" batch manufacturing facilities that require a high level of flexibility and recipe management. Again, the *requirements* of the batch application determine whether it is "simple" or "complex:"

- Number of products manufactured: Single product *or* Multiple products
- Recipe parameters: Constant *or* Variable
- Procedures: Single procedure *or* Multiple (different) procedures
- Equipment utilization and arbitration: Fixed/none *or* Flexible/often
- Frequency of changes to formulas and recipes: Never *or* Often

Select all responses that apply to your application.

PLC	DCS
❑ Manufacturing or assembly of specific items (aka "Things")	❑ Involves the combination and/or transformation of raw materials (aka "Stuff")
❑ Product is visible as it moves through the process	❑ Often impossible to visually see the product as it moves through the process
❑ High-speed logic control (such as motors)	❑ Regulatory/Analog (loop) control
❑ Simple Batch control	❑ Complex Batch Control

2. What is the value of the product being manufactured and the cost of downtime?

If the value of each independent product being manufactured is relatively low, and/or downtime results in lost production, but with little additional cost or damage to the process, the PLC is the likely choice. If the value of a batch is high, either in raw material cost or market value, and downtime not only results in lost production but potentially dangerous and damaging conditions, the selection should be DCS. A plant that has a $10 million batch of a cancer drug in production that relies on strict and continuous temperature control, for example, has a lot at stake in the event of a glitch. In some chemical applications, maintaining the process at steady state is critical, because if the system goes down, the product could solidify in the pipes. If the cat cracker in a refinery goes down it could be days before it can be brought back on line so that production can resume. This means lots of lost revenue for the refinery. The DCS system, which typically includes optional redundancy, is probably worth the additional upfront investment for these applications.

In contrast, the bottling operation of a brewery that only needs to run 10 hours a day to meet production schedules, and which can be shutdown for system maintenance, troubleshooting, or upgrades with very little impact on the bottom line, is a classic PLC application.

In process applications running 24/7/365, downtime is one of the gremlins you try to avoid at all cost. And money is not the only deciding factor. Dangerous downtime is clearly another deciding factor in the system selection process. For example, a refinery has flares that are continuously burning off gas. The system controlling those flares simply can't fail, because if the gas isn't burning, it's collecting and pooling, causing an extremely dangerous situation. The more volatile the application, the more it may require a solution with lots of redundancy to ensure that the system is available when needed.

Select all responses that apply to your application.

PLC			DCS
PLC	❑ Value of the individual component being manufactured is relatively low	❑ The value of a "batch" can be very high (either in raw material cost or market value)	DCS
	❑ Downtime mainly results in lost production	❑ Downtime not only results in lost production, but can result in dangerous conditions	
	❑ Downtime does not typically damage the process equipment	❑ Downtime can result in process equipment damage (product hardens, etc.)	
	❑ Return to steady state production after an outage is short and relatively straightforward	❑ Return to steady state production after an unplanned outage can be long, expensive, and difficult	

3. What do you view as the "heart" of the system?

Typically the heart of a factory automation control system is the controller (PLC), which contains all of the logic to move the product in through the assembly line. The HMI is often an on-machine panel or a PC-based station that provides the operator with supplemental or exception data. Increasingly, operational information resulting from data analysis is also a requirement for factory automation applications – driving demand for a more sophisticated HMI.

In process automation, where the environment can be volatile and dangerous, and where operators can't see the actual product, the HMI is considered by most to be the heart of the system. In this scenario, the HMI is a central control room console that provides the only complete "window" into the process, enabling the operator to monitor and control the processes which are occurring inside pipes and vessels located throughout the plant.

Select the responses that best fit your application.

PLC	❑ Typically, the heart of the system is the controller	❑ Typically, the heart of the system is the HMI	DCS

4. What does the operator need to be successful?

In a PLC environment, the operator's primary role is to handle exceptions. Status information and exception alarming help keep the operator aware of what is happening in the process, which in many cases can run "lights out."

The DCS plant requires an operator to make decisions and continuously interact with the process to keep it running. In fact, leveraging the operator's process knowledge is often critical to operational excellence and keeping the process running optimally. Operators particularly earn their keep during product grade changes and when adjusting the process to address changes in the production environment (such as a different feedstock). The operator will change setpoints, open/close valves, or make a manual addition to move a batch to the next stage of production. Within the HMI, faceplates and analog trends provide a critical view into what is really happening in the production process, while the alarm management system focuses the operator's attention on areas where he must intervene to keep the process running within its target performance envelope. In the event of an HMI failure, the plant could be forced to shutdown in order to keep people and equipment safe.

It all boils down to the vital need to have an operator "in the loop" versus "out of the loop." The DCS operator is the ultimate system stakeholder, whose upfront buy-in for the HMI design is essential for overall project success.

Select the responses that best fit your application.

PLC			DCS
PLC	❑ The operator's primary role is to handle exceptions	❑ The operator's interaction is typically required to keep the process in its target performance range	DCS
	❑ Status information (On/Off, Run/Stop) is critical information for the operator	❑ Faceplates and analog trends are critical to "see" what is happening to the process	
	❑ Exception-based alarming is key information for the operator	❑ Alarm management is key to safe operation of the process and for responding effectively during plant upset conditions	
	❑ Manufacturing might be able to run "lights-out"	❑ Failure of the HMI could force the shutdown of the process	

5. What system performance is required?

The speed of logic execution is a key differentiator. The PLC has been designed to meet the demands of high-speed applications that require scan rates of 10 milliseconds or less, including operations involving motion control, high-speed interlocking, or control of motors and drives. Fast scan rates are necessary to be able to effectively control these devices.

The DCS doesn't have to be that quick – most of the time. The regulatory control loops normally scan in the 100 to 500 millisecond range. In some cases, it could be detrimental to have control logic execute any faster – possibly causing excessive wear on final control elements such as valves, resulting in premature maintenance and process issues.

The extra cost for redundancy, an insurance policy of sorts, may be well worth it in the case of the typical DCS system, where high availability is mission critical. However, it is often not cost-justified to make a PLC system fully redundant.

Taking the PLC system offline to make configuration and engineering changes may have less impact, since the platform is not running continuously or because the process can be restarted easily. In contrast, configuration changes and tweaks to the DCS system are done online, while the process is running virtually non-stop. Many process applications may only shut down once or twice a year for scheduled maintenance, while others, such as a blast furnace, are planned to stay on-line continuously for 5-7 years.

The issue of analog control is important, but confusing. DCS was originally designed for delivering analog control, but to say the DCS has a lock on the analog control market reiterates the problem with traditional thinking. Increasingly, the PLC is capable of delivering simple to complex PID control, but the DCS is clearly the choice for applications with a large amount of advanced analog control, including cascade loops, model predictive control, ratio, and feedforward loops.

These are advanced process control solutions that are driven as much or more by a vendor's domain knowledge and experience as the different platform capabilities. It's that heritage and expertise, which comes from meeting customer needs for decades, that differentiates the systems, not the technology. If a company can't explain to you how their feedforward loop works, for example, they probably don't offer true "DCS" control.

Select the responses that best fit your application.

PLC			DCS
PLC	❑ Fast logic scan (approx. 10ms) is required to perform motor or motion control	❑ Control loops require deterministic scan execution at a speed of 100 to 500 ms	DCS
	❑ Redundancy may not be cost justified	❑ System redundancy is often required	
	❑ System can be taken offline to make configuration changes	❑ Online configuration changes often required	
	❑ Analog Control: Simple PID only	❑ Analog Control: Simple to advanced PID control up to Advanced Process Control	
	❑ Diagnostics to tell you when something is broken	❑ Asset Management alerts you to what might break before it does	

6. What degree of customization is required?

The expectation and desire to be able to create a customized application varies greatly between DCS and PLC users.

Because the PLC was originally designed to be a jack of all trades, it's understood that the development of customized routines and functions is required to meet the unique needs of an application.

A systems integrator may be applying a PLC toward a palletizing machine today and pointing it toward a laser cutting lathe tomorrow. The PLC delivers a "toolkit" of functions and elemental building blocks that can be custom-developed and chained together to address the requirements of an application. Provisions are available to enable the integration of functions and products into a seamless architecture. Additionally, powerful programming languages are typically available to facilitate the creation of custom code from scratch.

Pre-engineered "solutions," consisting of standards, templates, and extensive libraries, are what DCS application engineers expect "out-of-the-box" when working with a new system. The highest priority of a DCS is to deliver reliability and availability, which often results in a design which trades unlimited functionality for repeatability and dependability. The significant tradeoff with the DCS is its inability to accept many custom modifications without creating compatibility issues. The system is expected to function as a complete solution, which drives the use of standard functions already "baked in" to the platform.

Select the responses that best fit your application.

PLC	DCS
❑ High level programming languages are available for creating custom logic	❑ Custom logic created from existing function blocks
❑ Customized routines usually required	❑ Many algorithms (i.e. PID) are complex and do not vary among applications
❑ Standard libraries considered nice features	❑ Standard application libraries are expected (function blocks and faceplates)
❑ Provisions must be available to integrate functions/ products into an integrated architecture	❑ Entire system is expected to function as a complete solution

7. What are your engineering expectations?

Factory automation engineers want customizable control platforms, which offer the individual components that can be quickly programmed together to accomplish the task at hand. Often integrators and engineers open the PLC "toolkit," roll up their sleeves, and start programming. The tools provided by a PLC are typically optimized to support a "bottom-up" approach to engineering, which works well for smaller applications.

DCS engineers, on the other hand, are typically most effective using a "top-down" approach for engineering, which forces them to put significant effort into the upfront design. This focus on upfront design is a key to minimizing costs, compressing the project schedule, and creating an application that can be maintained by plant personnel over the long term. Since DCS applications are typically larger and plantwide in scope, the ability to propagate libraries and templates throughout the application is very important to minimize rework and promote the use of standards.

Think about it this way – The PLC is controlling a machine, while the DCS is controlling the plant.

For example, a pencil manufacturer is producing an incredible amount of pencils at an extremely rapid speed using a PLC. By programming in machine code, engineers might be able to squeeze another 10 milliseconds out of the machine, which is now capable of punching out even more pencils and profits.

The PLC engineer demands that kind of flexibility and open architecture.

The process engineers controlling entire plants with a DCS require more intuitive programming platforms, which utilize pre-defined and pre-tested functions to save time and drive repeatability.

Having the right tool for the job is also critical. Ladder logic is the ideal and preferred configuration language for many discrete control applications, such as high-speed interlocking or the control of motors and drives. Function block diagram, on the other hand, is preferred for continuous control and for implementation of alarming schemes.

Select the responses that best fit your application.

PLC		DCS
❑ Program/configure individual components, integrate later (bottom-up)	❑ Up-front design of complete system before implementation begins (top-down)	
❑ Desire customizable platforms to build upon	❑ Looking for significant "out-of-the-box" functionality	
❑ System designed to be flexible	❑ System designed to make it "easy" to engineer process applications	
❑ Solution is generic in nature, to be applied on a wide variety of applications	❑ Use of pre-defined, pre-tested functions saves time	
❑ Use ladder logic to configure application	❑ Use function block diagram to configuration application	

Do you have a Hybrid Application?
Now that we have reviewed the key criteria for selection of a PLC or DCS, you may be thinking that your application requires capabilities from *both* a PLC and a DCS. If this is TRUE, then you may need a process control system for hybrid applications, as shown below.

What is a "hybrid?"

- "The marriage of the discrete functions, which PLCs handled so simply and economically, with the sophisticated analog continuous control capabilities of the DCSs"
- "Defined based on the industries in which the systems work and serve, like pharmaceutical, fine chemicals, food and beverage, and others"
- "The architectural marriage of the PLC simplicity and cost with the sophisticated operator displays, alarm management, and easy but sophisticated configuration capabilities of the DCS"

** Reference – Intech, Sept 2007, "Hybrid Control Identity Crisis: Whats in a Name?"*

Table 2 Definitions of Hybrid

How to Select a Process Control System for a Hybrid Application
This paper has described the key attributes and differentiators between classic PLC and DCS systems. This same information can be used to define the key *requirements* for a process control system that would be ideally suited for hybrid applications, such as those in the pharmaceutical, fine chemicals, and food & beverage industries.

- Controller – Can execute fast scan logic (10- 20 msec), such as that required for motor control, and slow scan logic (100 - 500 msec), such as required for analog control, simultaneously in a single controller
- Engineering Configuration Languages – Provides ladder logic, function block diagram, and a powerful programming language for creation of custom logic from scratch
- Flexible Modular Redundancy – Offers the option of tailoring the level of system redundancy to deliver the required system availability by balancing up-front cost versus the cost of unplanned downtime
- Modular Batch from Simple to Complex – Provides modular batch capability to cost-effectively address the continuum of simple to complex batch applications
- Alarm Management – Offers power alarm management tools to help operators respond effectively to plant upset conditions
- System Diagnostics and Asset Management – Provides both a rich set of built-in system diagnostics, as well as asset management of all critical assets in the plant (transmitters, valve positioners, motors, drives, MCCs, heat exchangers, etc.)
- Scalable Platform – Hardware, software, and licensing supports smooth and economical scaleup from small all-in-one systems (10's of I/O) up to large client/server systems (10,000's of I/O)

Table 3 Key Requirements of a Process Control System for Use in Hybrid Applications

How to Select a Control System Supplier for Hybrid Applications
The majority of today's well-known automation suppliers offer one technology or the other (DCS or PLC), as shown in Figure 3 on page 9. This is an important thing to realize when one is doing an evaluation for a hybrid application.

To make their offerings attractive to the hybrid industries, many suppliers are touting their capabilities to provide both PLC and DCS functionality in their system. As we have seen, the technology difference between PLC and DCS is quickly disappearing, leaving only the experience and domain expertise of the supplier as a key differentiator. However, gaps in domain expertise are not closed overnight; significant knowledge has been accumulated by suppliers over the last 30 years, so beware of suppliers who are just now claiming DCS or PLC capabilities in their portfolio. For hybrid applications, users who want to ensure that their requirements can be addressed should consider selecting a supplier who has a long and proven track record for delivering both PLC solutions and a “full-blown” DCS.

Conclusion

Many of the stereotypes of yesterday are being replaced, thanks to the convergence of PLC and DCS. This convergence has opened up a new set of options for hybrid applications and for those process plants that traditionally used PLCs to control their electrical infrastructure (such as motors, drives, and Motor Control Centers (MCCs), while utilizing DCS for regulatory control. Remember, it's not about the technology. Most importantly, it is about the *requirements* of your application and what supplier has the best solution, heritage, experience, and breadth of knowledge to meet your *needs,* today and tomorrow.

Whatever you choose, we hope that you can feel like you have made a wiser and better informed decision based on the information in this paper. You may find that a traditional PLC or DCS no longer meets your requirements. If you have a hybrid application, then you may need a process control system which combines the best of the PLC and DCS, and a supplier who can provide a full offering of both discrete and process capabilities, all based on a common platform.

Bob Nelson, PLC Marketing Manager, and Todd Stauffer, DCS Marketing Manager, for Siemens Energy & Automation, have over 40 years’ combined experience in the automation and control industry.

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Characteristic	PLC	DCS
Market Introduction	1960s	1975
Replacement of . . .	Electromechanical Relays	Pneumatic & Single-Loop Controllers
Products Manufactured . . .	“Things”	“Stuff”
Classic Application	Automotive	Refining
Type of Control	Discrete	Regulatory
Redundancy	“Warm” Backup	“Hot” Backup
Engineering Mindset	"Programming"	"Configuration"
Operator Interaction	Exception Basis	Man in the Loop
Operator Interface	Simple Graphics	Sophisticated Graphics
Size/Footprint	Compact	Large
Up-front cost	$$	$$$$
System	"Open"	"Closed" (Proprietary)

Table 1 Classic Stereotypes of PLC vs. DCS

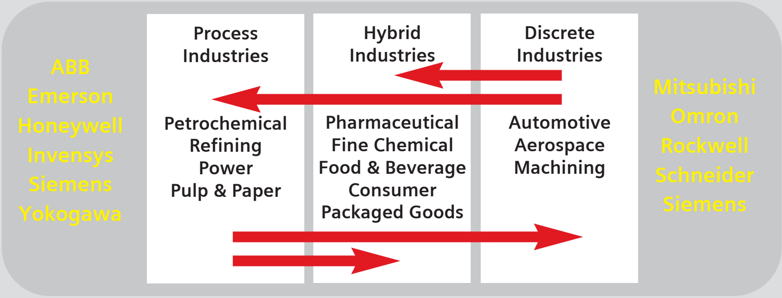

Figure 3 Hybrid Industries and Migration of Functions by Supplier Systems

Notes

Table 4 The Seven Questions to Ask Yourself Before Choosing a System

Project Name: ______________________________

Select all responses that apply to your application.

1. What are you manufacturing and how?

❑ Manufacturing or assembly of specific items (aka, "Things") ❑ Can see the product moving through the process ❑ High-speed logic control (such as motors) ❑ Simple Batch control	**OR**	❑ Involves the combination and/or transformation of raw materials (aka "Stuff") ❑ Cannot see the product moving through the process ❑ Regulatory/Analog (loop) control ❑ Complex Batch control

2. What is the value of the product being manufactured and the cost of downtime?

❑ Value of the individual component being manufactured is relatively low ❑ Downtime mainly results in lost production ❑ Downtime does not typically damage the process equipment	**OR**	❑ The value of a "batch" can be very high (either in raw material cost or market value) ❑ Downtime not only results in lost production, it can result in dangerous conditions ❑ Downtime can result in process equipment damage (product hardens, etc.)

3. What do you view as the "heart" of the system?

❑ Typically, this is the controller	**OR**	❑ Typically, this is the HMI

4. What does the operator need to be successful?

❑ The operator's primary role is to handle exceptions ❑ Status information (On/Off, Run/Stop) is critical information for the operator ❑ Exception-based alarming is key information for the operator ❑ Manufacturing might be able to run "lights-out"	**OR**	❑ The operator's interaction is typically required to keep the process in its target performance range ❑ Faceplates and analog trends are critical to "see" what is happening to the process ❑ Alarm management is key to safe operation of the process and for responding effectively during plant upset conditions ❑ Failure of the HMI could force the shutdown of the process

5. What system performance is required?

❑ Fast logic scan (approx.10ms) is required to perform motor or motion control ❑ Redundancy is not normally cost justified ❑ System can be taken offline to make configuration changes ❑ Analog Control: Simple PID only ❑ Diagnostics to tell you when something is broken	**OR**	❑ Control loops require deterministic scan execution at a speed of 100 to 500 ms. ❑ System redundancy is often required ❑ Online configuration changes often required ❑ Analog Control: Simple to advanced PID control up to Advanced Process Control ❑ Asset Management alerts you to what might break before it does

6. What degree of customization is required?

❑ High level programming languages are available for creating custom logic ❑ Customized routines usually required ❑ Standard libraries considered nice features ❑ Provisions must be available to integrate functions/ products into an integrated architecture	**OR**	❑ Custom logic created from existing function blocks ❑ Many algorithms (i.e., PID) are very complex and don't vary application to application ❑ Standard application libraries are expected (function blocks and faceplates) ❑ The entire system is expected to function as a complete solution

7. What are your engineering expectations?

❑ Program/configure individual components → integrate later ("bottom-up") ❑ Desire customizable platforms to build upon ❑ System designed to be flexible ❑ Solution is generic in nature, to be applied on a wide variety of applications ❑ Use Ladder Logic to configure application	**OR**	❑ Upfront design of complete system before implementation begins ("top-down") ❑ Looking for significant "out-of-the-box" functionality ❑ System designed to make it "easy" to engineer process applications ❑ Use of pre-defined, pre-tested functions saves time ❑ Use Function Block Diagram to configure application

PLC TOTAL ____________ **DCS TOTAL ____________**

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