# DCS GAP IDENTIFICATION

**Part 1-** Avoid the Pitfalls of DCS Migration with Front-End Loading

# Introduction

Your control system is the nervous system of your plant. It communicates every decision to the control units in the field. It's the reason operators know the state of the plant and the process. Like the body's nervous system, a plant's control system is complex, particularly if it has grown over the years and has changed significantly from its original design.

In this second of four white papers, we'll show you how to minimize the risk factors in upgrading your control system to meet the requirements of the new century.

Many plants in North America and elsewhere were built in the past century. For example, the ExxonMobil plant in Joliet, Illinois, is currently the youngest oil refinery in the United States — and it was built in the early 1980s. You may work in a plant that is well past its original life expectancy, but you have somehow kept it working all these years.

Some process plants have done partial DCS upgrades, but others — maybe even yours — are still operating with large parts of the original control system still in operation. You may have patched it, upgraded it and coddled it along, but it may be well past its prime.

Worse yet, your control system wasn't designed for the plant you have today — it was created specifically for the plant that was built long ago. Think of all the changes that have been made in that time, all the improvements in quality, throughput and enterprise integration you've made — or would like to make — if only the control system would let you.

Do you have the ability to make rapid changes in product or product mix? Do you have adequate physical security? Sufficient cyber security for the control system? How well does your safety instrumented system work with the basic process control system? Is your control room an operator-friendly workplace? Do you have enough I/O to add new sensors and controllers for the future?

How does the DCS' HMI handle alarm management issues? Do you have a history of near-miss accidents because the alarm management system doesn't work well in crisis situations?

Do you have the ability to add an historian and an advanced process control package to your existing DCS without much blood, sweat, tears and cursing?

Do you have adequate spare parts on hand for your control system? Are spare parts even available anymore? For how much longer will the OEM support your DCS and how much is that going to cost you?

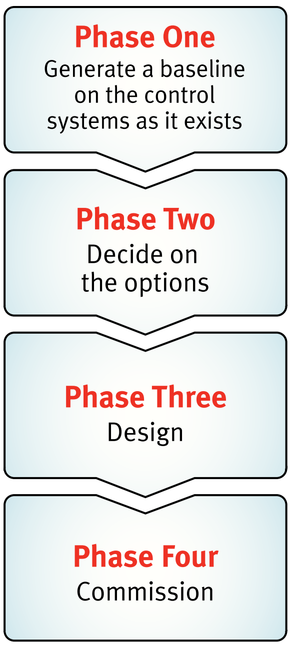
If you are faced with these issues, you know you need to do a major upgrade on your control system. You also know it's a monumental decision — one an engineering team makes only once or twice in their entire careers. A major mistake on a DCS upgrade is surely a career-limiting move.

The easy option is to rely on whichever OEM supplied the original control system, or did the most recent upgrade. It's the easiest option — but is it the right one? To determine the best choice for your plant, you will need to do some serious pre-planning.

End-users do pre-planning because they know that front-end loading the engineering requirements and design phase saves remarkable amounts of time, effort and money — and it can prevent catastrophic mistakes. This reduces the possibility of expensive — and possibly career-ending — change orders and cost overruns.

So, how do you do the pre-planning required for a DCS upgrade?

## Front-end loading




Most end-users divide the front-end loading (FEL) portion of the upgrade project into three or four basic phases:

Phase one: Generate a baseline for the current control system.

Phase two: Determine your options.

Phase three: Design.

Phase four: Commission.

In this white paper, we will concentrate on phases one and two.

Depending on the plant's engineering capabilities, the first and second phases may be done by the plant or by corporate engineering. However, with the lack of process control resources in the process industries, many of these phases can be done by third parties, including A&E firms, system integrators or control system manufacturers. As the design and migration plans are developed, the cost estimates get more precise.

## Phase one: Generating a baseline

During the first phase, you will determine a baseline for your system. To work with an OEM, A&E firm or a system integrator, you will need to have basic, current information about your control system. You must know how the control system functions, how it was originally designed to function and how you want it to function in the future. If you don't have this information, a third party can help you dig it up and develop it into usable data. End-users, however, would be wise to examine the perspectives, biases and experience of various third parties and choose one that will understand and incorporate their specific needs and goals, rather than deliver a canned, off-the-shelf analysis and plan. Look for objectivity, as well as a partner who will help you think creatively and develop migration plans that meet your specific needs and goals. Be wary of too many unexamined assumptions. If they already "know" the solution before doing their investigation and listening to you, keep looking for a better partner.

During this phase, you will also need to assemble the team that will guide the project to completion. It’s always best to have the same group of engineers, operators and managers run an upgrade project from the start all the way to an operating, upgraded system.

Once you have the design and upgrade management team in place, their first task is to assemble the existing documentation, especially P&IDs, PFDs and loop sheets. That’s often much harder than it seems. Think of all the control rooms you’ve been in where the most critical information is pasted to the console with sticky notes. The documentation task begins by bringing together the original operating manuals and drawings — what were considered “as-builts” on the day the plant opened. Be sure to add to any documented changes that have been made in the years since the plant was started up — there are always many.

*“The original documentation became obsolete the day the plant opened.”*

“As-built” drawings and manuals are seldom as comprehensive as the name suggests. The original documentation became obsolete the day the plant opened, and until fairly recently, there have been only rudimentary methods to track changes. Maintenance records are one of your best resources to determine the gaps between the as-builts and reality. That way, you can see all the changes in field devices or I/O, or in the DCS itself.

The most important, and also the most costly and time-consuming, part of phase one is to walk the plant. In doing this, you will find the discrepancies between what you think you have and what you actually have. You cannot safely skip this step.

The next step in phase one is to integrate all the documentation and new discoveries, creating a new set of as-builts that accurately reflect the current condition of the plant.

Be sure to include the changes in the software and control programming — the intellectual property you have layered over the basic process control system and the safety instrumented system over the life of the plant.

In many — if not all — cases, the intellectual property in your control system is worth much more than the cost of the system itself. Several refineries and chemical plants found this to be true in the aftermath of Hurricane Katrina. Not only were the field devices and controllers ruined, but the control room hardware and the software resident on the hard drives were also destroyed. In at least one case, even the backups were destroyed, because the storage location was flooded along with the control system.

You need to be sure that the intellectual property, the software and configuration, as well as any incidental programming are well documented. Make sure that the operators are running the plant the way the documentation directs — and the way that they say they are. Sometimes — and this may go on for years with nobody noticing — operators develop ways of accomplishing a task that are quite different from the way the operating manuals say the task should be accomplished.

If you do not have operators on your upgrade team, now is the time to recruit them — either as full members or as advisors. The operators may know more about how the plant actually runs than anyone, including the engineers. You are courting a failed upgrade if you do not involve the operations staff, as well as the maintenance staff, in the planning process as early as you can.

You have now put together an upgraded documentation package, with clearly understood intellectual property and input from operations, and you are ready to move ahead.

Your next task is a very high-level look at what features and functionality the control system should have at the end of the upgrade cycle.

Ignoring the control system, do a complete analysis of the process and the control system requirements as if you were creating a greenfield plant. Include any field devices that would be additionally required, as well as the necessary I/O. Look at ways to use the control system to generate energy savings, if there are any (and there usually are). Finally, describe the way the control system should interface with the rest of the plant and the enterprise, including both physical and cyber security requirements.

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The degree to which you follow the requirements of this phase is often an indicator of your probable success at the end of the project. Many end-users skimp on phase one because they think they can get the engineer-constructor or system integrator to do it for them. Sometimes this works. Often it does not. Remember that, once this documentation is developed, tools are available to make future baseline upgrades a predictable and relatively easy task.

Deliverables at the end of phase one includes: a current documentation package, a clear high level concept of future operation and functionality, and an approximate high-level cost estimate for the project. This estimate is usually about +/-50%, and is intended to give upper management an “is it bigger than a breadbox?” idea of the cost and scope of the project.

## Phase two: Determining options

Phase two is often done by a third party, but can also be done by the end-user if the end-user has enough qualified manpower with enough time to commit to the project.

If you are going to have phase two done by a third party, you will need to select both the type of third party and, of course, the third party themselves.

There are three basic kinds of third parties capable of doing phase two FEL analysis. The first is a DCS manufacturer (OEM). This could be the OEM whose DCS you will be upgrading from, or a newly favored DCS vendor who has perhaps been selected by the company as an enterprise-wide provider. The second type is a traditional architecture and engineering consulting firm (A&E) that can provide process engineering development, design and project supervision. The third type of third party is a system integrator, who has experience working on all different types of technology platforms and can provide unbiased analysis based on this experience. Of course, each of these third-party firms has strengths and weaknesses, and some may even be a combination of more than one type. You will need to identify and rank them according to which type of third party can do the best work and deliver the best value for your specific situation.

The discipline of control system integration has grown largely because of the need of end-user companies to have a contractor who will assume full system responsibility for the entire control system, instrumentation and final control elements. Control system integrators design and implement automation and control systems for utilities and industries, including the process industries. They offer the ability to be a neutral third party that can operate on behalf of the end-user and select best-of-breed solutions and implement those solutions with full system responsibility.

Beginning in 1994, the Control System Integrators Association (CSIA) has developed the Best Practices and Benchmarks document and a complete certification system for control system integrators. This has permitted the discipline of control system integraration to be clearly defined, and permitted the growth of integration companies and their capabilities to include front-end design and front-end loading, procurement, assembly, implementation and service for control system projects of any size, worldwide. CSIA certification is a globally respected and recognized achievement that proves that a control system integrator has met the requirements, in both business and engineering, of the CSIA Best Practices and Benchmarks in its most current revision.

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Once you have completed the investigation process, you can then select the third-party firm that will do the work for phase two, under the direction of your design and upgrade management team.

In phase two, you — and possibly your third-party engineering consultant — take the data, documentation and learning from phase one and look at the gaps between the existing up-to-date documentation and as-builts, and the features and functionality you want to have in your future, upgraded DCS.

In this gap analysis, see how many of the requirements defined in the list you developed in phase one can still be satisfied with the existing control system without any changes at all. You will likely find that virtually none of them can be. Pay close attention to the requirements around functional safety, network connectivity with the enterprise and functional security. In many cases, an older DCS simply can’t do what a more modern system can do.

Next, note how many of the new requirements could be satisfied by a minor expansion or upgrade of the current system. If you have recently upgraded your DCS platform — perhaps by replacing the consoles and computers, and re-using the existing I/O — some of the new requirements you have identified may be able to be met by re-configuring, modifying or upgrading the existing DCS.

See how many of the requirements you developed in phase one can only be satisfied by a new control system designed specifically for these requirements. If you have an older system that has been coddled along — if you can only find spare parts on eBay — you will probably find that your existing system simply cannot be modified to meet the new requirements you’ve identified. This is often particularly true of the networking and security and safety issues.

Now, project out 20 years (the average life expectancy of a control system), and see how many of the projected requirements can be filled by either an upgrade to the current system or a new control system. The more clearly and carefully you do this projection, the more likely it is that the control system you are going to design and install will be able to last a 20-year period without major modification (other than PC upgrades).

After you have a clear picture of the detailed requirements for your control system, both now and in 20 years, you can start to take a look at the technologies available and the vendors who offer them.

The best way to proceed is to carefully and objectively investigate and document the capabilities of each system you are interested in against a detailed requirement list and set of specifications. Some OEMs may offer a DCS that meets most of your objectives. Others may not. Some vendors may offer a best-of-breed partial solution that can be combined with partial solutions and integrated into an operating whole. This is often the case. Few vendors offer one of everything, and even fewer offer the best of each type of device, system or software.

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One of the reasons the discipline of control system integration has achieved the prominence it has is the ability of a qualified (CSIA certified) control system integrator to seamlessly integrate a variety of best-of-breed products and controls to produce a customized system with the best available technology that will last as long as the plant does.

Now you and your third-party firm, if you are using one, are ready to decide if you need a simple upgrade or a more significant upgrade — or even a rip-and-replace of your DCS.

The deliverables for phase two should include the evaluation of the best available technologies for your situation. That evaluation should include the comparison matrix you produced to evaluate each vendor against the identified project requirements.

This is the time to determine the kind of upgrade you propose to move forward with. Based on the information you have gathered, you will need to decide on a minor or major upgrade to your existing system, or a completely new system.

In all likelihood, you will have found that you have a need to innovate — to design and implement a control system that is different from the one you currently have. This means that a typical “rip and replace” strategy, where you remove your old control system and install the newest version of the same system, or the successor system, simply won’t work. You will most likely find that your needs have changed so much that it is time to look at a “zero base design” instead of a rip-and-replace upgrade. Innovation does not cost more — and its payback is usually rapid.

You should also put together a very high-level preliminary system design that you can show to management and give them an idea of what the system you’re proposing to design might look like, and how it should work.

Your evaluation should account for the economics of an upgrade for your plant, and determine if the profitability, throughput and quality control of the plant will be significantly improved by doing this upgrade project. You will be asked to justify the project cost based on these indices. Of course, nobody does a control system upgrade just because the new technologies are cool. Plant upgrades are only done when they will produce increased capacity, lower cost, improved reliability and deliver better quality.

You will also need to deliver an evaluation of strategies for operations and maintenance going forward, based on the upgrade path, technology and vendor you have selected. You will be asked to justify the project cost based on any noted or perceived differentials in cost for maintenance and operations of each vendor's system, and you will need to show both a reduction in cost of maintenance and operations and a possible savings in reduced labor cost as well.

A risk assessment should be part of the design and upgrade management team report. This risk assessment should include every type of risk, from environmental to health and safety, and from plant security to technical risks. Remember to include an analysis of the risk you face if you do nothing at all. This is critical and often overlooked. As your control system gets older, the risk of unplanned downtime increases in nonlinear fashion. Unplanned downtime can always create a significant safety hazard, and even an accident. Try to quantify the cost and potential for failure of a major unplanned downtime related to the failure of the control system, if no upgrade is performed.

A detailed definition of the project scope, cost and schedule should be your final deliverable. This should be on the order of +/-25% accurate, so this is what the project approval will be based on.

This phase of the project will allow you to go to management. If you've done your job correctly, you'll get the go ahead to move forward with your DCS upgrade.This has been the first in a series of five white papers designed to help you discover the most appropriate way to modernize your control system. The next white paper in the series will take you through the strategic planning process we've outlined, and give you a glimpse of what other manufacturing companies have done, and are doing.

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