Plan your applications first, then buy your distributed control system

Hans Eder, President, ACT, Brussels, Belgium

This third in a series of articles by Hans Eder of ACT looks at the benefits derived from carefully assessing all possible future operational requirements—particularly those that might call for Advance Process Control—before selecting a DCS. As obvious a step as this might seem, Mr. Eder says that few make the effort.

Control engineers typically use the same procedures when selecting and sizing new control systems. First, they determine the number of existing controllers (which is generally equal to the number of basic loops in the plant) as well as the number of indicators, displays, and so on currently being used. Next, they estimate the anticipated system growth rate over the targeted lifetime of the DCS. From this data, they determine the final requirements for the new system or systems.

Although the above data can yield a fairly accurate assessment of system size and capacity requirements in terms of basic controls, indicators, and so on, it doesn't leave room for special control and monitoring applications that go beyond the operation's current scope. As a result, this approach leads to problems when a need develops that can't be addressed simply by adding a few single controllers or a couple of cascades. At this point, it suddenly becomes painfully obvious that the original system selection and specification did not take into account the possible future requirement for a more sophisticated solution to accommodate this type of change in scope. Once it's been established that the existing system can't be easily modified to tackle the expanded scope, there's nothing left to do but phone the consultants!

No power, no cure

The sad truth is, technical consultants generally are only called in to help at a plant when there is a problem. The fact is, these experts could do so much more for the company if they were called in both early in the project, and on a regular basis to help uncover new opportunities for improvement, optimize existing controllers, and provide a host of additional benefits But this is something that we'll get into later on in this series. For now, suffice it to say that when a consultant is finally called in, it's typically after plant personnel have already expended a great deal of effort on the problem, and failed to come up with a good answer. Thus, the pressure is on to develop a solution and to implement it quickly.

When the expert takes a closer look at the situation, it often turns out that the cure cannot be achieved using simple PID control. Then, the real trouble starts! I've personally been involved in many cases in which the answer to the plant's new requirements would have been a relatively simple advanced control application—a control scheme that could have been developed and implemented quite fast. But once the detailed design and implementation specifics had been developed, it became clear that the existing DCS either did not have the needed capacity, or was lacking vital features to accommodate any advanced control functions, let alone a complete application.

Of course, once this becomes apparent, frustration builds for both the customer and consultant. The customer faces the embarrassment of having put in a lot of time and effort, plus money for outside help, while still being saddled with the original problem. At the same time, the consultant can't prove that he or she has developed the right strategy to satisfy the company's new requirements and enable it to move forward. Thus, he/she is not to be able to deliver a success story, which is so vital to a consultant's business.

What went wrong?

In school and, even more so, in seminars on troubleshooting techniques, we learned to always take one step and make one change at a time. By doing this we can always see exactly what any particular step or action has or hasn't achieved.

This is precisely the philosophy that's usually applied when a new system is chosen. In most cases, if we recommend that a customer identify all potential future advanced controls before setting up the selection criteria for a new DCS, the customer will reject this proposal—believing strongly that this method would "mix up" too many things. The fear is that new controls and new control approaches, all on top of the new

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DCS, might confuse the issue. The customer invariably wants to adhere to the "one step at a time" approach. As a result, he or she returns to the typical selection procedures outlined in the beginning of this article—estimating the needed system capacity on the basis of the existing loops plus some percentage of spare capacity for future expansions.

The problem is, the nominal capacity of the system by no means gives the full picture of available "horsepower." A system that could easily accommodate a 50% increase in basic PID loops may run into performance problems with just a few "exotic" calculations. The software code for the basic, standard controllers provided in systems, like the PID or the ratio controller, usually is highly optimized to produce the absolute minimum load on the system. Other controllers or algorithms may not be designed so efficiently—since the vendors expect them to be used only in rare cases. Consequently, when the more frequent use of these controllers is called for, they can slow down the system dramatically.

At the same time, key features may not be available in these controllers in the form needed, or may be totally missing. Examples of these features include:

1. Routines or algorithm's to describe the process dynamics. For any simple modeling or simulation of the process dynamics—whether it is to be used for a disturbance compensation scheme (a feedforward), a Smith Predictor, or for a model based controller—we need to have a feature (often called a deadtime table or a deadtime algorithm) that allows us to simulate or model the deadtime of a process. We will also need another feature to describe the transient process behavior. Typically, this is done using a so-called lead/lag algorithm that allows us to combine retarding effects, time constant effects as well as the anticipating effects, the effect of a lead time.

Without these two features, even simple feedforwards aren't possible. When substitutes for these algorithms have to be developed by the users, they often are much less efficient and require many more system resources than algorithms that are supplied with the system.

2. Programming capabilities. Another key requirement that should not be missing in any system is the availability of a suitable programming language. The demands in such a language can vary, depending upon the expected applications, and can range from simple computations to ladder logic handling to, in some cases, provisions for delicate calculations that require double precision for accuracy reasons.

3. Software switches. These switches should always be available in the system to enable the user to trigger one or more actions or programs whenever their status is changed. These switches are very important in that they can help to combine and execute otherwise cumbersome actions with one click or by pressing one button. This is particularly important for starting up or safely shutting down more complex control schemes to avoid mistakes by the operators, which may keep the application from functioning, or from reaching the best suitable fall-back state.

4. Status indicators. Indicators that provide information regarding the status of the controllers (for example, the operating mode, availability of a valid input signal, initialization of the input processing or the control execution, windup situations, hitting a limit or clamp, or being in alarm state or not) shouldn't just exist in the system, but rather be readily available to the user (for example, in the programming language) to allow him or her to safely detect certain situations and take the proper actions.

5. Extended plotting and trending. Often, advanced controls require plotting and trending capabilities that go well beyond that offered in some systems. Case in point: it is not sufficient to simply plot the measurement, the setpoint and the output over time; we need to observe the behavior of several other internal parameters, the outcome of intermediate calculations, and, of course, the status of switches and indicators.

To digress for one moment, I find it very disconcerting that there are quite a few so-called "modern" or "state-of the art" DCS systems around that lack most or all of the above features. Worse still, I recently came across a system that did not even have wind-up protection as a standard feature for its PID—making this system a true anachronism. After all, roughly four decades have past since the introduction of Advanced Process Control in the industry! Going one step further, I'm not aware of a single DCS on the market today that comes with what I would call a full technology set—ranging from different PID versions over standard feedforward and constraint control blocks or meta-tags to simple model-free optimization to model-based predictive control. Not one! And if there's a vendor out there reading this article that can point one out to me, I'd love to learn about it.

How can we make sure we'll get the right system?

But let's get back to the main problem at hand—the missing system features and horsepower. The cure is very simple and

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not at all costly. To be sure that all the features needed over the life time of the DCS are properly addressed, we simply need to conduct an investigation, a so-called Incentive Study, well before the new system is specified.

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The first goal of such a study is to look for untapped opportunities to further improve plant operations as well as for measures needed to cope with anticipated changes in operations, product specifications, or regulations. The focus of these improvement opportunities can be to increase total throughput or product yield, improve product quality, or to reduce energy, utility consumption, or emissions.

The second goal is to describe every single control application that is needed in order to make the so-identified operations improvements or adaptations possible. The end result is a document that is typically called an Applications Design Basis Memorandum, or DBM. This document describes, in short form, every modification to an existing application, and every new application as identified in the previous step. It tells the objective of every application, its inputs, outputs, and the technology to be applied, lists any needed extra measurements and analyzers, and gives at least an indication of the development time, complexity, and the estimated credits involved.

The effort needed for such an incentive study varies widely with the size and complexity of the investigated process or plant. But, in general, it is not as big as is sometimes thought, and often only takes a few weeks.

With such a sound data base available, it is now very easy to develop a complete Master Plan that enables us to steer all future work on the project, and to properly plan the installation of new or different measurements, analyzers, etc. as well as the purchase of additional technology, special training of the staff, and so on.

This knowledge of future challenges, along with an indepth understanding of the capabilities required to meet them, enables us to select the most suitable DCS and size it properly so that we will be able to cope with all of our present and upcoming system needs. In addition, carrying out an incentive study always results in a wealth of extra information, typically on operating targets, limits or procedures that may be not only out of date, but may actually suggest some totally wrong actions. In other words, with the study we get additional opportunities to immediately improve plant operations—which can help the entire effort pay for itself in a very, very short time. And lastly, our newly acquired knowledge can help us avoid a host of problems and frustrations that we might otherwise experience with the system in the future.

About the author

Hans H. Eder is the founder and president of ACT, an Austria-based company delivering technical and management consulting, training courses, seminars and other special services, plus software products for operations optimization and automation, mostly to large international companies. A former advanced control engineer, APC manager and CIM Advisor with EXXON/ESSO, and CIM advisor with Exxon, he is a recognized expert in the economics of control. Mr. Eder has more than 25 years of experience in model-based predictive control.

Some of his many accomplishments include the design of an award-winning Windows tool called TOPAS for training and optimization, the development of a model-based predictive controller called AMC that fits into every DCS, and the development of a model-based batch reactor control scheme (feedback & feed forward) in a single day.

Mr. Eder received his masters degree in mechanical engineering from T.U. Vienna. He can be contacted at: ACT, Brussels office, Madeliefjeslaan 13, B 3080 Tervuren, Belgium (++32)-2-767-0895; hans.eder@act-control.com; http://www.act-control.com.