Maximize profits and minimize problems from APC

Advanced Process Control (APC) is now much more widely used than some 10 or 15 years ago. Yet, in comparison with its potential, the overall utilization is still very meager. Key reasons are the still existing widespread lack of knowledge about its benefits, the lack op suitable technology and tools right in the DCS and also some occasional problems with APC applications that are reported. Since the power and effect of any negative example is just enormous, let us see what the most common problems are and how they can be avoided.

Let us begin with the question: What do we expect from APC, what is its purpose? The main mission of APC is to deliver significant, measurable improvements to operations and thus profits in a most cost and time effective way. The success of the individual application is therefore determined by

- its achievements, i.e. the performance improvement realized,
- its utilization, the “service factor” and
- the time and cost needed for development.

On the longer term, to ensure that APC is an ongoing activity, there is one more key factor to be addressed, namely the appreciation of management of the value of APC and the support for these activities. Let us look now in more detail what is necessary to satisfy these success factors. We will do this separately for every phase of the application development.

1. Planning

Selecting the right problem or improvement opportunity that shall be addressed is not always trivial. First of, the application must satisfy a real need. Any application that delivers good results but is not considered as truly necessary can do serious damage to our long term plans. We might be tempted to look for an opportunity to apply a favored technology, but should avoid this: The prime motivation must be a “profit pull” and not a “technology push”. And we should resist the thought that it can fully compensate design flaws - as is sometimes tried: APC just helps us to make best use of the equipment (of course by doing this it makes these flaws very visible).

Next of course all prerequisite controls must be already in place and properly functioning. A common threat here is that quality of the existing controls is poorer than expected and the effort for bringing them to the needed performance is often grossly underestimated – and typically also accounted for as APC development time, which results in some unjust debits.

A truly key consideration concerns the scope of the application. Of course we want make maximum impact which typically calls for a larger scope. The difficulty lies here to balance this objective against the resulting complexity and size of the application, which will not only drastically increase the development effort: We also need to consider the process control maturity of the plant - a fact that is unfortunately often overlooked. This decision is especially critical for the very first APC application in a plant: On one side we must produce a significant change yet on the other hand the solution must not be
a) too difficult for those who develop and will later support it as they do not have experience yet
b) too complicated in order not the overwhelm the operators.

Especially the second point is a very common cause of problems and many that have developed technical marvels and present them officially in a conference have to admit more privately over a cup of coffee later that the service factor - the fraction of the time the application is in use relative to the time it should be used - leaves a lot to be desired.

The point simply is: When operators had in the past only to deal with single PI loops and the odd cascade here and there, a large-scale multivariable scheme is overwhelming them. They cannot understand its moves, see several variables change now at the same time while they typically make

one move at a time. The confidence in the technology is not there yet and so, if in doubt, they just shut the application down.

I had this painful experience myself with my first multivariable control scheme for a fluid cat cracker back in 1978. Especially in a plant where every shift had a totally different way to operate it, operators would not believe in the results of the application and would only use it after I had demonstrated that all single pairings between all controlled variables and all manipulated variables were functioning properly – one by one! Certainly, it would have been much easier to start with a simple 2x2 scheme, maybe a dual quality control of a splitter tower, and then come with the large scheme – and most likely not taken longer.

And there is another aspect: We have also seen quite a few cases where only basic loops exists and a huge multivariable scheme is kind of hovering over them. Process control works in an hierarchical way. The middle layer - all the many small scale Advanced Controls - is in many plants not addressed at all. Yet these applications can bring significant money – with comparably very little effort. Besides, developing them builds up experience for technical staff and confidence for operations and management. And working on that layer not only brings sound benefits fast, it establishes a better basis for the large scale controls and optimizations: Just think about the different dynamics and thus control frequency requirements.

2. Design

Has the decision been made concerning the control objectives then we need to define how to reach them. The two main consideration here concern the strategy and the selection of the formulation.

The strategy must be adequate and the approach sound. That is obvious. However, one aspect that is sometimes overlooked is simply the human resistance to drastic changes: It may well be that a different strategy might be better suited but one might settle for one that is closer to the current operating practice in order not to work against the habits of the operators. This could result in a slight performance penalty yet often brings an disproportional gain in the application utilization.

The human factor has to be always kept in mind: It is the operators who have ultimately the decision over the use of an application. APC engineers can certainly intervene and explain and maybe even force its use - while being present at the plant, which, however, is just around 40 hours per week compared to 168 hours for the operators. The bottom line: Every application has to deliver “on-line performance” – that is two words: Performance and on-line use, i.e. service factor.

Also here the complexity issue pops up again - since over-complexity is in my experience the most frequent cause of failure. In the course of the development engineers feel often compelled to include more and more influencing variables – just to make sure that nothing is missed. The result is often an unmanageable monster – especially for the less experienced.

For model based controls, one of the key decisions is whether to use a black box model or a process description based on first principles. While the latter one will deliver certainly the more “correct” model, it will be a multiple in size and complexity compared to a black box model. The most euphoric attempt I have ever seen was the development of a Real Time Optimization (RTO) scheme of an entire chemicals plant - based on first principles! It became quickly clear that more than 500 000 equations had to be written and solving them would take the fastest computer around 4 hours. After such time too many things have changed in the plant, simply rendering the solution obsolete. Einstein once said: “All models should be as simple as possible – but no simpler” and disregarding such advice sure enough brings its penalties.

Along the same lines: Given the choice between a smaller application that runs right in the DCS and a larger, somewhat more powerful one on a dedicated outboard-processor (with a true real-time operating system – of course!) I certainly would go for the first option simply to avoid all the extra interfaces etc. that are known to reduce the overall service factor.

3. Implementation

Also on the more detailed level the right decisions must be made in order to ensure success. Selection of the proper technology is of course another key factor and again, the best choice is the most simple and robust one that can handle the job. And, of course, the process and the needed performance determine the choice not any personal pet technology.

Standardization is another point: Functionality can be provided by standard modules or individual developments. Although the latter one may be tailored better for the task, it is preferential to use standard modules as much as possible as they are tested, optimized for performance, known and documented - all factors that will reduce development and testing time now and minimize time for troubleshooting and adaptation, for by familiarization by other APC engineers later and all together boost the service factor.

Sound information about the process is another must. In most cases that means plant tests. From the view of operations, tests are disturbances and thus not welcome. All necessary information must be therefore obtained with the minimum number of tests. That demands solid planning and a lot of process knowledge upfront in order to make the right moves and to immediately pinpoint any abnormalities and deviations from the test plan in order to be able demand a second chance. And we also need the right tools to turn the resulting data into true information.

4. Start up and operation

When it comes to the final stage we are sometimes confronted with a suggestion that sounds reasonable but can be absolutely detrimental, namely: to operate the application first in a so-called “advisory mode”. This is especially the case when operations are not fully convinced about a new strategy or technology. In this case the new setpoints are not sent down automatically to the lower level controllers, but offered first to the operators for inspection. They can then confirm or reject the whole solution, sometimes even decide to use only part of it or alter values.

This is lethal: A solutions for a multivariable problem must be implemented either in full or discarded. Any partial implementation is simply wrong because it will not be possible any more to observe all targets and constraints. The consequence is that the performance of such a “manually improved” application is poor, in the worst case so poor that any further work is stopped.

Finally, and with this we are closing the loop, we have to provide credible undisputable proof of our achievement – which of course implies that we have established a sound base case beforehand. We need to make our success known to the right people and functions as this will greatly ease our to future efforts to get agreement for plant tests, for financial and manpower resources. Information is the key and therefore when I was APC manager in an oil refinery we used three different types of documentation:

- Technical documentation - giving all technical details necessary for maintenance and adaptation and a source of valuable information for future work and experience exchange between sites
- Operator documentation - telling the purpose, prerequisites and every feature operators have to know to safely start up, operate and shut down the application
- Management documentation – informing key decision makers about the rational, realized benefits and eventual impact on other parts of the plant.

Doing this meant certainly extra effort but we benefited very much - in terms of high application service factors, lots of valuable feedback from operations plus outstanding recognition and support by management.

Conclusion

APC is still looked at skeptically by many managers and even technical professionals. Besides, it is an extra activity, it is not an unavoidable, fundamental requirement. Therefore, every APC application must deliver a sound success story else the long term aspects of the whole activity are dull. The listed facts and factors should help in getting more benefits, more success and thus also more professional fulfillment from APC.

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