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Solomon Associates' advanced process control survey

Measuring advanced process control (APC) benefits is as important as it is difficult. We justify APC projects on estimations that the unit operation would improve. To the extent that these preproject numbers are based on a fairly deep process engineering analysis of the history of operation, they are believable. After commissioning an application we perform another process engineering exercise, a post-project audit, showing that indeed this application, with the right tuning parameters and operating targets, is making money.

But what about long-term monitoring? Can we show that an application makes money day in and day out? That unit stability is maintained, inferential models are reliable, manipulated variables are not unnecessarily clamped and control variable targets are correct? Theoretically, we could monitor by performing daily process engineering analyses, but that would not be very practical, and we must find a simpler way that would still be believable.

In the recent discourse about the declining APC business, some claim that APC has failed because we failed to measure application performance. As a result, we did not know how to drive the APC applications. Skeptical management withheld funding and the situation snow-balled, nearly decimating the whole industry.

I have asked my friend and colleague, Greg Martin, to be interviewed about his experience in APC monitoring. Greg is certainly experienced enough to seriously answer this question. He spent decades as a control engineer at Union Carbide, Shell, Setpoint, Profimatics and Pavilion Technologies. Since 2003, he has been an independent consultant focusing on process modeling, multivariable predictive controllers (MVPC) and real-time optimization (RTO).

In addition to Greg's knowledge of the industry, having fought in the trenches for a number of decades, Greg is APC practice senior associate for Solomon Associates (SA), who have in the past investigated APC profitability and are now in the process of conducting another survey about the benefits of APC to operating companies. I have asked him questions about Solomon's methodology in assessing the value of APC and how he thought APC should be monitored day-to-day in the unit.

Zak: *Are you comfortable with the reliability of your prior SA APC Survey (1994)? I remember thinking at the time that each of the engineers filling out your questionnaires possibly had his or her own approach and sometimes misconceptions, and no one verified that the information was correct?*

Greg: The 1994 SA APC Survey was based on an inventory of control functions. Typical functions were itemized from the literature and APC practice, and lists of functions for different refining processes were generated. Then a "value" in terms of percent improvement was assigned to each function, more complex functions generally getting higher assigned values.

The survey clients were asked to fill in an inventory of these functions, checking off which they had in their refinery processes. The survey procedure then made an accounting of these results in terms of value, and various benefit calculations (e.g., by process or unit) were made. These results were used to create benchmarks to compare one survey participant with another. Ultimately, a ranking was made across the population of survey clients. The documentation back to a survey client included the population and where it ranked relative to the others.

A hallmark of all SA surveys is the extensive effort to validate the survey input to ensure the data will support comparative analysis. However, since no process data were gathered, the 1994 analysis was not based on an analysis of process performance, but on the inventory of installed applications. No survey is perfect, but the 1994 APC Survey was satisfactory as a management tool, and clients were comfortable with the method. Of course, if someone intentionally cheated on the questionnaire they would not receive correct answers for their refinery. Generally we "trust but verify." If a client were found to be cheating, we would bring this to the attention of the client, and it might not be invited back for future studies. This time the SA team would like to incorporate a more general metric to compare performance, in terms that are commonly used in an APC benefits study. The inventory of applications would be maintained, but not used for benchmarking.

Zak: *What is different about the current SA APC Survey?*

Greg: The current SA APC Survey benchmarking will measure performance in terms of reduced variability. While the exact method is proprietary to SA, I can say that it is rigorous and is based on notions that are common to APC practice experts.

Without revealing details, the main new ingredient allows a variability metric to be calculated based on process time-series data and process information. Senior consultants in the SA organization and top people in selected client organizations have reviewed the new method and find it to be rigorous and innovative.

The metric has mathematical properties suited to this problem in that it is independent of the scale of the refinery operation, is dimensionless and has the proper algebra so that it can be combined or decomposed without loss of mathematical rigor.

If you will, this tool would keep the person who fills out our questionnaire honest. The variability and questionnaire answers would have to be in line, or else we would try to investigate the discrepancies.

Zak: *Does every refinery have the same disturbances, and would you be able to compare refinery-to-refinery variability?*

Greg: Yes, I believe the dimensionless variability could be compared. Our current survey includes variability analysis for the refining processes in two operating regimes: normal operations and crude switch. These analyses are based on time-series data provided by the client. There is also a specialized variability analysis for gasoline and distillate blending.

Benchmarking is based on comparisons of the variability metrics for each area (normal operation, crude switch, gasoline blending and distillate blending), and the clients are ranked versus the population based on the variability metrics.

The results back to the client are the variability metric distributions broken down, for example, by unit, with quartile ranges shown, and their variability for that unit indicated on the plot. SA uses, as a minimum, an average of the top three performers in a group to represent the "best practice" achievable.

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Zak: *Would there be any attempt to estimate dollar benefits?*

Greg: The metrics are also used to estimate the variabilities that a client would have if instead of its present automation system it had an automation system that performed with the "best practices" of APC. This calculation results in variabilities that can be compared with measured variabilities from the data, and then converted into benefits using a standard procedure: the same-limit rule.[1]

The same-limit rule says that you typically operate 95% of the time below the operating limit and 5% above it. If variability is reduced, you could tighten the operation, pushing against that same limit, and you make money because the average operation would now be much closer to that limit. You should know the value of such tightening and readily estimate the dollar benefit. For example, consider a unit with a naphtha cutpoint limit of 420°F, where—due to poor control—the average cutpoint is 400°F, violating the 420°F limit 5% of the time. The reduced variability would permit the refiner to achieve an average cutpoint of 410°F, while still violating the limit 5% of the time. That 10°F improvement in cutpoint has a known economic value.

The refiner will get benefits estimates for its applications only, not for any other SA client. Benefits estimates are in terms of throughput, conversion, selectivity, yield, product split, energy recovery, fuel consumption and greenhouse gases. Standard economic values, differential values, fuel costs and emission penalties are used to convert these benefits estimates into units of the local currency (e.g., $/year).

Zak: *It occurs to me that the survey methodology could be applied periodically to a client's operating data for daily monitoring. Is that correct?*

Greg: Absolutely! The methodology is data-driven, which means it can be reapplied whenever you get a new set of data. That could be done daily. Solomon is considering offering the metric to clients as the latest in a series of Solomon metrics. We are conducting the study now for the refining industry, and plan to pick a set of additional industries for study in 2007. We would actually appreciate hearing from your readers on their interest levels for the study within other industry segments.

Zak: *What do you think about the performance monitoring tools now on the market?*

Greg: It is difficult to comment about someone else's product. My general impression is that the performance monitoring products in use are sophisticated, and a knowledgeable vendor engineer can obtain valuable information from them—not so much about benefits, but about whether or not the controller is working correctly. You could say that these are maintenance tools. To monitor financial performance one needs to compute, historize and trend certain performance indicators. It is not enough to monitor the behavior of control variables and manipulated variables. **HP**

LITERATURE CITED

[1] Martin, G., "Understand control function benefits estimates," *Hydrocarbon Processing,* October, 2004, pp. 43–46.

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