Originally appeared in HYDROCARBON PROCESSING® November 2006, pg 19-20. Posted with permission.

Y. ZAK FRIEDMAN, CONTRIBUTING EDITOR

Zak@petrocontrol.com

Jim Ford's views on advanced process control

C. F. Picou Associates, Inc. (CFPA), an affiliate of Maverick Technologies, was founded in 1974 by Dr. Courtney Picou. Originally aiming to provide process engineering consulting to the refining industry, the company quickly moved into advanced process control (APC), executed many projects worldwide in the 1980s and 1990s, and has remained a small, but well-regarded, APC provider with good experienced engineers. With that in mind, I have asked Dr. Jim Ford, the president of CFPA, to air his opinion of the APC industry. Jim has spent most of his career with CFPA, starting as an APC engineer and going through the ranks to eventually become the CFPA president.

Zak: *What differentiates you as an APC company?*
Jim: First and foremost, we are process engineers who specialize in process control, and we do not view APC as mathematicians. We take time to understand the unit operation before formulating a control solution, and the control tool is secondary.

While much of the industry is sold on one and only one tool, namely multivariable predictive control (MVPC), we apply a range of solutions and prefer a "hierarchical" systems approach. We break a big problem down into smaller problems, solving the smaller ones at the advanced regulatory control (ARC) level in the control hierarchy, working up to more complex solutions to achieve higher-level control objectives. We apply MVPCs typically on top of lower-level ARCs.

Where called for, we do not shy away from stand-alone ARC as an effective tool for many applications. Since most of the APC service industry abandoned ARC, this leaves us with the advantage of being proficient at both.

Zak: *OK, I understand the desire to reduce complexity, but is that enough to differentiate you from competitors?*
Jim: Our approach to APC is also different because we emphasize front-end project work. We apply a methodology of project development based on process analysis that would typically include P&ID review, data analysis and interviews with operations. We identify the operating goals, objectives, limitations, operating problems, major disturbances and finally the benefits that are to be gained by mitigating the effects of the problems and disturbances. Only then do we formulate control improvements. The solution formulation is based on the hierarchical systems approach discussed earlier. The worst mistake that can be made is to initiate an APC project having already decided on the solution (MVPC, of course), which is the way that it's now being done almost universally.

Zak: *Why are you so adamant about MVPC? Isn't it just a control tool that you can configure to suit almost any design objectives?*
Jim: You're right, and I'm not anti-MVPC. On the other hand, I can haul a load of dirt in my new convertible, but a used pickup truck would be a better choice. That's the key point—often MVPC is sold as the "only" tool, whether it's the best one or not. The best tool is the one that achieves the control objectives at the lowest long-term cost (installation and maintenance). If the objective is to control inventories (vessel levels) by adjusting inter-unit flows during charge rate changes, do you really need an MVPC controller? We were in a refinery last week where that is exactly what one MVPC controller was doing.

Zak: *Do you have an idea as to why the industry has moved away from ARC solutions?*
Jim: This shift is consistent with a recent trend in large corporations, led by IT departments, to "standardize" technology solutions and then to "translate" standard solutions from one problem to the next. The argument is: ease of implementation, low maintenance cost, reduced training, flexibility of movement across the whole organization, etc. Thus, the automation group in a refinery is told to standardize on Company A's data historian, Company B's DCS, Company C's MVPC package and use this exclusively for all APC. Obviously, such an approach ignores the nature of real control problems in refineries and chemical plants and relegates control engineers to pointers and clickers.

Zak: *Can you give an example of the misapplication of MVPC?*
Jim: If you use MVPC where a PID controller with feedforward could work just as well, it is a misapplication, for example, using a multivariable controller to control a fired heater outlet temperature by adjusting the fuel. Even in the case where you have multiple control variables and a single manipulated variable, a set of PID controllers with a selector would likely work better than the multivariable controller. Another widely misapplied MVPC application is the one I mentioned earlier—for inventory control. PID with feedforward is a simpler and better performing solution.

Zak: *If you think the industry is on the wrong track, what would you recommend as imperatives for a successful project?*
Jim: Here are my own guidelines:

- Execute a detailed APC definition and justification study first. Companies like ours can do this at reasonable cost. The study will provide a basis for investment and control technology decisions.
- Use qualified personnel on the project. Don't send an engineer to a two-week APC course and then expect a successful result. If you have to outsource, use an APC company that specializes in process engineering, not in mathematics.
- Design the APC to solve the operating problem and apply appropriate control technology.
- Utilize the principle of "hierarchy"—simpler solutions to solve lower-level problems, with ascending, higher-level solutions achieving more complex control objectives.

Continued

If MVPC is contemplated, ask the following questions:

• Is the control problem to be solved truly multivariable? Should several *MV*s be adjusted to control one *CV*?

• Are there significant dead-times and lags, such that the model-based, predictive power of MVPC might provide superior control performance?

• Are there significant interactions between many *MV*s and many *CV*s, or are there just isolated "islands" of interactions where each island represents a fairly simple control problem?

• How big does the controller really have to be? Could the problem be effectively solved with a number of small controllers?

Zak: *As is well known, you may commission an application quite successfully but it still would not make money because no one tries to move the unit toward real constraints. What should be the structure of APC management that would best capture the APC benefits?*

Jim: In the ideal case, a process engineer or unit supervisor who is responsible for day-to-day process unit productivity and is in the operations "chain of command" should make sure that appropriate targets are entered. This person would not necessarily have control training, but should understand the controller structure and the cause and effect of changing targets.

A less ideal situation is when responsibility for setting targets falls on the APC engineer. While the APC engineer may know what needs to be done, he or she is not in the plant operation chain of command and the engineer's ideas could be ignored.

I would not recommend giving target setting responsibility to the board operator. Not that the operator is not capable of understanding the controls, but operators work shifts, go on special assignments, take vacations and there is no continuity in monitoring of the application.

Whatever you do, operation supervisors must be involved in determining APC targets, or else they might give orders, overriding what the APC is trying to accomplish.

Zak: *Can you give examples of successful and unsuccessful advanced control projects where the end-user made the difference?*

Jim: We implemented APC on a crude tower, vacuum tower and two delayed cokers that was successful, partly because that refinery had the ideal situation of APC ownership stated earlier. The same can be said for a polycarbonate plant where the unit process engineer oversaw the APC operation.

We have done recent projects in three refineries, working almost exclusively with either console operators or APC engineers. I would not say that the projects were unsuccessful, but they would have captured more benefits if process supervisors were directly involved on a day-to-day basis.

Zak: *In the past 20 years, have the man-hours required to execute a successful advanced control project increased, decreased or stayed the same? What factors have contributed to the change or lack thereof?*

Jim: On the one hand, the number of man-hours has decreased because of superior productivity tools. It takes less time to accomplish configuration, programming and documentation. On the other hand, because of technology improvements, the solutions are becoming more sophisticated and complex, which tends to increase process analysis and commissioning time. Maintenance requirements are somewhat higher than 20 years ago and I attribute this to more frequent changes to process units. Overall the level of effort required has remained about flat.

Zak: *What is your opinion about unit closed-loop optimization?*

Jim: I question whether RETRO (the term you coined for real-time rigorous optimization) receives the proper front-end engineering analysis for definition and justification, with the result that it is often misapplied. How often does a true local profit maximum exist which is not at constraint corners that could have been determined independently by process engineering analysis? An optimizer has value only if it tells us something we don't already know. And, beyond these considerations, the fundamental problem shared by all RETROs is the one that Dr. Picou stated to one of his clients several years ago: the optimizer will never optimize the plant—it will, at best, only optimize the model!

Zak: *Do you think that APC is going out of style?*

Jim: No. Not a single client has told us APC is no longer wanted. APC might collapse if a Solomon study says it is a waste of money, just as MVPC flourished because a Solomon study in 1994 said that everybody else is doing it, so why aren't you? If vendors are struggling and operating companies are questioning the value of their investments, I would say that APC is being re-evaluated, not that it is on its way out.

While the refining market for new APC applications is saturated, because most major units already have APC, we have been getting a lot of inquiries about assisting with "re-commissioning" existing applications. There are a lot of "under-performing" APC applications out there, and people at the sites do want to repair them.

The situation is different in the chemical industry, where smaller economies of scale have made it more difficult to show large ROIs for justifying major MVPC projects. However, most DCS systems used in chemical plants will support a good deal of DCS-resident ARC, and we have the ability to implement the ARC without asking our customers to purchase additional hardware and software. They like that!

Zak: *Thank you for this interesting talk. Similar things have been said before, but the degree of agreement among experienced APC engineers amazes me; yet, we seem powerless to remedy this situation.*

Jim: Thank you as well. And things will improve. Well-designed APC can pay off handsomely, and operating companies are beginning to realize that a long-term commitment is required to maintain high service factors. Where we have been hired to assist with ongoing maintenance, APC service factors have increased dramatically. Such improvements breed new APC projects and renewed faith in APC. **HP**

Y. Zak Friedman is a principal consultant in advanced process control and online optimization with Petrocontrol. He specializes in the use of first-principles models for inferential process control and has developed a number of distillation and reactor models. Dr. Friedman's experience spans over 30 years in the hydrocarbon industry, working with Exxon Research and Engineering, KBC Advanced Technology and since 1992 with Petrocontrol. He holds a BS degree from the Israel Institute of Technology (Technion) and a PhD from Purdue University.

Jim Ford has extensive project experience in the design and implementation of DCS-resident advanced supervisory control (ASC), model-predictive, multi-variable control (MPC), and inferred properties as applied to refineries (crude, FCCU, hydrocracker, coker, reformer, oxygenates, POX) and petrochemical processes (olefins, styrene, aromatics, engineering plastics, specialty chemicals). He received a BS degree in chemical engineering from Georgia Tech in 1968, a PhD degree in chemical engineering from Tulane University in 1972, and an MBA degree from Syracuse University in 1976. Dr. Ford is President of C. F. Picou Associates, a small APC consulting company located in Baton Rouge and an affiliate of Maverick Technologies.