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Box, Hunter, and Hunter in their classic text "Statistics for Experimenters", state that analysis of happenstance data is somewhere between useless and downright misleading. That's bad news if you want to get any information from your plant database - most of the data in these databases are usually nothing but happenstance data.

What's wrong with this data? Basically, it's not from planned experiments. Box et al. describe 4 different land mines that await anyone who goes datamining without first doing open-loop planned experiments.

One of the most pernicious hazards you should know about is the effect that feedback has on data. To learn more about how feedback (hopelessly) skews your data, see the section "Feedback - Friend or Foe?" in this newsletter.

Spotlight

Controller Performance Assessment

Now Available on Windows 95/NT

It's not easy to determine how well your controllers are doing their job; PV variance alone is inadequate since this value is a result of the size of the (usually unknown) disturbance as well as the quality of control. A better measure is the Harris Controller Performance Index - this metric indicates controller performance independent of the size of the plant disturbances.

Control Arts software for calculating this and several other metrics is now available for Windows 95/NT. Now you can analyze a single tag, or a list of tags, quickly and easily to see which of your (hundreds of) controllers need attention.

You can even schedule reports that will automatically print out the Controller Metrics from the last shift. Along with your cup of Java, it's just the thing to start your day.

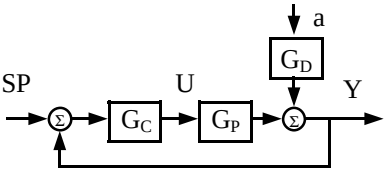
Feedback - Friend or Foe?

As control engineers, you understand the positive role that feedback has in stabilizing and controlling a plant. However, suppose you want to build a controller or inferential model. Can you use normal operating data to build these models? It might seem as if the inputs move around enough, but under feedback, they only move because the output is moving (see figure below). So what would a model tell you about the process - the effect that the inputs have on the outputs (through the process), or the effect that the outputs have on the inputs (through the controller)?

In fact, it represents a combination of both the process and the controller transfer functions together - and there's no way to separate the two. Since a controller is an approximation to the inverse of the process, the two generally cancel each other, and you end up with no information.

You're likely building a model for one of two reasons - either for an advanced controller or for an inferential model. Since there are some differences to these applications, let's consider each in turn:

Model Based Controllers



Is the relation between U and Y represented by G_P or G_C or both?

Unless you've got a self-tuning controller, the standard practice is to take the DCS controllers off during a plant test. That of course guarantees that there's no feedback effects in the data, right? Guess again. There are many feedback paths in a plant. Like an automated controller, operators are always adjusting the plant to keep it between the ditches (that's their job after all). Letting the operators adjust outputs/setpoints during a test is a quick way to introduce lots of feedback into your plant data.

So how do you know if your "open-loop" test contains confounding feedback? Look for the following:

1. Does the step response suspiciously return to the origin, or close to it? If your response looks like a closed loop response to a disturbance, you better consider retesting.
2. Were the operators concerned about the value during the test? Product compositions and levels usually fall into this category.
3. Was there cross-correlation at lag 0 (i.e., Did the output immediately change when the input changed)? Remember that

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Feedback - Friend or Foe? (continued)

this is impossible for digital systems unless there's feedback (in which case the *input* changes immediately with a change of *output*).

4. Did the mass balance close? As feedback has a large effect on the process gains, a quick check of the mass balance will indicate gain accuracy.

Feedback will in general severely compromise the quality of your models, but you can take steps to recognize the problem and reduce its effects. The Control Arts Controller Model Identification software automatically identifies feedback indicators in your plant test data. In addition, low-order transfer function models are less sensitive to feedback effects than high order step weight models. Finally, if you *have* to leave a controller on during testing, there are special plant tests and identification techniques that can identify models under closed loop conditions. Use Control Arts expert Plant Consulting to help you through this stage.

Neural Nets

First, there's *no way* any software can generate an accurate inferential model from happenstance plant data. Feedback effects usually result in the model having zero gain or even the wrong sign of the gains. A salesman might spin a good story about using happenstance data instead of doing proper plant tests, but remember that garbage-in means garbage-out.

There's worse news - feedback may also corrupt your model even if you've used good data to build it. If you go on to use your inferential model in a feedback control scheme, then you're essentially changing the process. And since your neural net model was built using open-loop data, it will immediately give biased results and poor control.

You might *suspect* your models are degrading, but determining model fidelity is difficult, especially if the models are updated on-line. For this situation, check out the Control Arts Model Fidelity Assessment package - it was designed to provide an easy and accurate indication of model performance.

New Product - Multivariable Controller

You're probably already familiar with the wide range of Control Arts control and analysis tools. To fulfill our objective of being a full-service solution provider we have added a multivariable controller.

What are some advantages of the Control Arts Multivariable controller? Here's a list of some of the custom capabilities of this controller:

- **Design-time sensitivity tests.** You don't want to install a controller that's sensitive to model error, even if the controller checks for this. Control Arts controller design lets you check for this common problem before you unleash your controller on the plant.

- **Continuos performance monitoring.** Does your controller achieve better performance, and maintain good performance as the process changes? Control Arts has multivariable performance measures that indicate the true performance of the controller.

- **On-line diagnostics.** Ever try maintaining a multivariable controller? With everything moving and everything connected, it's always a challenge to determine where the problem is. Now we've made that easier, with sophisticated statistical tests that assist you in isolating the problem - and you need to know the source of the problem before you can do anything about it.

- **Dynamic constrained optimization.** Controllers often make the most money by pushing a plant to its constraints. But if it does that, better make sure your controller can handle *dynamic* input constraints. After all, input constraints exist in your plant - any dynamic controller that ignores them does so with huge risk.

- **Fast and efficient run-time performance.** Think you need a VAX? Not if you've written the controller properly. Besides, that expensive upgrade to R500 also gave you some powerful processing boards - why not make use of them? We do.

Couple this product with a state-of-the-art model identification package and a wide range of application specific controllers (12 in all!), and you've got a complete, integrated, robust package that's suitable for a total plant solution. Most importantly, now you've got a maintainable system - one that will keep on providing the best possible return on your control investment.

Control Arts Information

Control Arts Inc.

Contact:
Dr. Alan Hugo
AlanHugo@ControlArtsInc.com

Address:
616 Bobbie Drive
Danville, CA 9452

Phone: (925) 838-2062
Fax: (925) 838-1866

Now on the World Wide Web:
www.ControlArtsInc.com

Send comments to: webmistress @ControlArtsInc.com

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