

## OPERATIONS & ENGINEERING SKILLS

# Advanced Tuning Tackles the Nonlinear World

IN A NONLINEAR WORLD, THE CHALLENGE OF ADVANCED LOOP TUNING IS TO KEEP CONTINUOUS AND BATCH PROCESSES, as well as discrete operations, functioning cleanly and productively without unplanned downtime.

Matching process simulation with advanced loop tuning gives end-users a tool to find the most satisfactory and productive set of operating conditions. “[But] you can’t force tuning. It’s not static. It’s important to be able to be able to identify how the process changes,” explains Terry Blevins, principal technologist with controls vendor Emerson Process Management’s Delta V research and development group, in Austin, Texas.

Using simulated response for tuning selection, the end-user chooses different tunings and then sees simulated closed-loop responses, Blevins says. That simulation allows operators to see, in seconds, the impact of changes that might take hours, if not longer, to manifest in some processes, explains Greg McMillan, principal consultant with the same group in which Blevins works.

For example, a distillation column may take a shift or a day to reach steady state after operating parameters change, McMillan explains. Batch processes may take longer: “eight hours—or, in the case of a bioreactor, 22 days from the beginning of a batch to its end,” he remarks. With simulation, though, what would take 20 days may take only a few minutes to test and observe, McMillan notes.

### SIMULATE TO TEST

Simulation also allows operators to test system robustness, to see how much change is possible without causing problems, Blevins comments. Dynamic simulation also allows end-users to test different types of equipment and control systems, adds McMillan, co-host with Blevins of Modeling and Control, a blog that focuses on process simulation and control. Benefits may include reduction of capital for equipment and operating costs, McMillan predicts.

Overcoming smaller, down-sized staffs is another benefit manufacturers may realize with dynamic simulation. “Engineers now just don’t have the time on a batch process to spend two months to determine the best tuning,” Blevins observes. “By having dynamic simulations, they can explore different strategies in days, rather than months.” That

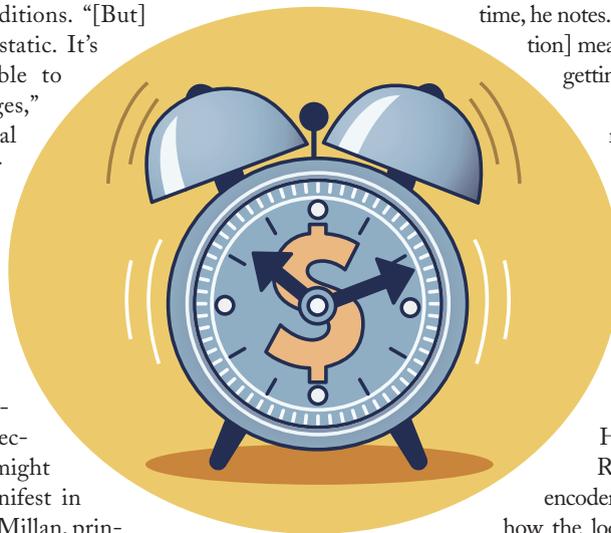
means someone may be very productive in a relatively short time, he notes. “Oftentimes, [using dynamic simulation] means the difference between something getting done or never getting done.”

Getting things done—and done right—with direct drive and other types of motors used in machine-tool operations provides the ability to get more accurate parts and higher repeatability of operations. But end-users should be aware of two critical issues with tuning, cautions Peter Rochford, principal applications engineer with automation vendor Bosch Rexroth Corp., in Hoffman Estates, Ill.

Rochford’s first tip is to be aware of encoder selections, because they can affect how the loop’s gain is achieved, He splits gain into velocity-loop and position-loop gain. The former affects how smoothly the motor runs, which affects smoothness of the machined surface. “Position-loop gain affects how fast you can accelerate the axes. Typically, that affects accuracy of the machined part,” he explains. When tuning the motors, tune the velocity loop first, Rochford advises. “It has to be faster than the position loop.” He suggests three to five times faster.

Users must also be aware of the resonant frequency of the motor, Rochford adds. If it’s too low, that causes oscillation in the velocity loop, he says. “You [also] want to be careful not to excite the natural resonance, because it will make tuning difficult.”

Whatever the type of operation, though, unless the factory floor is dark, operations typically are anything but linear. Managing that nonlinearity requires a strategy. And as Blevins says, “An integral part of tuning to evaluate that strategy is to put together a correct strategy, and then have the right parameters.”



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