Applications, Definitions, Transitions

As we know and like to proclaim, control is a pervasive technology. Whether it's aircraft or spacecraft, refineries or paper mills, homes or buildings, biomedical devices or systems biology, cars or trucks, our concepts and methods are broadly useful to industry and society. Control is a crucial component of these and other engineered systems, their performance, safety, and other qualities dependent on the appropriate implementation of our expertise. We also know that successful applications of advanced control are not generic applications. Technical details of problems—delays, nonlinearities, multivariable couplings, and measurement difficulties—must be understood and factored into control design.

But there is another aspect of application specificity that is not so widely appreciated in the controls research community—at least, if the ignorance I exhibited through much of my career is anything to go by! I refer here to the variations in industry structures, product life cycles, business models, even cultural norms that complicate the transition of research to practice.

Consider the functional roles involved in taking an algorithm to product. The algorithm developer will likely be a control engineer with a product that may be in, say, Matlab. This Matlab implementation must be converted, by a software developer, to code that meets industry and company standards for quality (and in some cases certification). The next step in the value chain may be the control system supplier, whose job it is to integrate the software in the control system. In many cases, the control system supplier will source to another company, the manufacturer, or system integrator. And the chain doesn't stop there…the manufacturer may sell the product to an operator, who may cause an end user to ultimately experience the benefit of that algorithm. So it is that as a passenger flying from Tokyo to Amsterdam (one hop on the way from the annual conference of the Japanese Society for Instrumentation and Control Engineers, SICE, to the European Control Conference—the IEEE Control Systems Society (CSS) is a cosponsor of both) I can type this column without fear of a coffee spill on my laptop!

This may all seem generic, but variations across different industries in which functions are performed by organizations significantly influence how research developments ultimately become products. For example, for flight controls, manufacturers of commercial aircraft are more likely than manufacturers of regional jets to rely on in-house groups rather than on control system suppliers. In either case, a research development in flight control must be adopted early in the chain if it is to have an impact on practice. In contrast, in process control, it is possible for the end user, for example, plant owner or operator, to implement a new algorithm directly.

For a slightly more in-depth comparison across two industries, let me rely on a presentation by a fellow CSS volunteer and Honeywell Fellow Greg Stewart at the American Control Conference this year. Greg has had considerable experience in control applications in two very different areas, paper machines and turbocharged automotive engines. Some points based on his presentation:

» There are about 20 million turbocharged engines sold globally

Alexander Fradkov (General chair for the 2009 IEEE Multiconference on Systems and Control, MSC), Carlos Canudas de Witt (program chair, 2009 IEEE Conference on Control Applications, CCA), and Tariq Samad (CSS president) at the MSC banquet in St. Petersburg, Russia. MSC 2009 was the first CSS conference in Russia and included CCA and the IEEE International Symposium on Intelligent Control (with Hua Wang as Program chair). The banquet was held in the Peter and Paul Fortress, built in the early 18th century.

Digital Object Identifier 10.1109/MCS.2009.934589

each year, all with embedded controls…versus only a few paper machines. The engine controllers are mostly copies of several designs, but the opportunities for new control products in the automotive engine space are, in principle, greater.

- On the other hand, the huge installed base of turbo engines isn't readily accessible for control upgrades and tuning whereas the approximately 10,000 paper machines worldwide are a significant market for advanced control services.
- The process involved in automotive control design (in general) is considerably more involved and prolonged than for paper machine controls. Getting new control technology into production is that much harder.
- The cost and complexity of the automotive control design process, though, also means that the process itself is a potential area of innovation for advanced control.

These few bullets hint at the complexity of the issues involved in either application area. With the assistance of experts in other control domains, Greg is planning on expanding his comparative analysis; the full story should make for compelling reading for those of us interested in the interplay of business needs and technology development.

* * *

In the last issue of *IEEE Control Systems Magazine*, I posed the question of defining controls to a nontechnical person (and offered "Control is the intelligence behind how things work!"). A related discussion has been underway on our LinkedIn group, where I posted a similar question. Here's a selection of the pithier responses:

- Control engineering = mind engineering (Ricardo Sanz to his eight-year-old son)
- Control is making a system (anything) behave (Giampiero Campa)
- Control uses measurements to increase performance (Richard Braatz)
- [Control is about] the effects of feedback in complex systems (Richard Murray)
- Control theory studies how to make systems behave in certain ways by supplying proper "inputs" to them (Shreyas Sundaram)
- Control systems are interfaces that make something behave like something else (John Bay)
- [Control is] the science of making machines obey (Mark Wilcutts)
- [Control is] the hidden technology: widely used, very successful, seldom talked about, except when disaster strikes (Leonid Freidovich, citing Karl Åström).

There's more on the LinkedIn board, including several longer postings that space doesn't permit including here.

Speaking of the IEEE CSS LinkedIn group, it's now 500+ strong and serving as a forum for wide-ranging discussions. If you haven't joined, you can sign up at http://www.linkedin.com/e/gis/1514847.

My thanks again to Richard Murray, who proposed and formed the group.

* * *

As I look back over a year's worth of my columns, themes of outreach, application impact, and practical relevance have recurred. I have had the privilege of being the first CSS President from industry in over a decade (Mike Masten from Texas Instruments was the last such, in 1996), and these themes reflect the affiliation. The soapbox that *IEEE Control Systems Magazine* has furnished to broadcast my perspective on our field and community has been one of the key benefits of the presidency!

I have also covered new initiatives in CSS: Web site enhancements, new workshops, promotion of our successes…and matters of definition. The CSS Executive Committee and other Society volunteers have been busy throughout the year in these and other activities. Working with these colleagues and friends has truly been a delight.

As I complete my term, other ExCom members are completing theirs. Elena Valcher is finishing two years as vice president of Conference Activities after a similar stint in the VP Member Activities role—where she made such an impact that many of us still rely on her for guidance on membership matters! Eyad Abed has served beyond the call of duty as VP of Financial Activities—extending the usual two-year VP term with another year at our request. David Castañón, my immediate predecessor and past president this year, completes many years of service to the Society. I would also like to acknowledge the unofficial service of another former president, Ted Djaferis, who has provided advice on various issues to me throughout this year.

Despite these ExCom departures, the Society will be in excellent hands next year, under the leadership of our new president, Roberto Tempo. For the rest of the 2010 Executive Committee, please see Roberto's interview in this issue or my column in the October issue.

This has truly been a memorable year for me. The sense of privilege I felt at being appointed CSS president has, over the course of the year, been reinforced with first-hand observations: the dedication of our volunteer base, the collegiality and good will within our community, the intellectual standard we maintain in our activities, the enthusiasm on the part of so many of you to take our field to the next level. CSS is an outstanding organization because of the caliber of its members and volunteers, and I thank you for the opportunity to serve.

I will continue to be on the CSS Executive Committee in 2010, as past president, and you can continue to reach me at tariq.samad@honeywell.com.

Tariq Samad