The Good Oil on Control or the Raw Prawn

> ## We should seek to inform the technical community about the power and limitations of our methods and viewpoints.

I have been independently approached by a surprising number of concerned IEEE and IEEE Control Systems Society (CSS) Fellows with calls to arms for control to do a better job of promoting its existence and importance to the community and to address our communications more effectively. In Australian parlance, the public needs *the good oil* on control, and that requires action from us, all of us, to tell the story and do so persuasively and persistently.

Hot on the heels of the multipronged rallying cry, *The New York Times* of February 3, 2019 presented a control story of its own (the only recent one I can remember) dealing with the crash of Lion Air Flight 610 in October 2018. A central suspect in the crash investigation was the maneuvering characteristic augmentation system, a new feedback control system designed to prevent aircraft stall. The *Times* story was factual and well investigated, revealing that the control system was not the prime culprit. That jersey likely went to a malfunctioning sensor and problems with maintenance and pilot training. But it does add an undesirable coda to Karl Åström's bravura epithet for control, "the hidden technology…until something goes wrong."

The Aussie antonym for giving the good oil is *coming the raw prawn,* which might just as well apply to doing and saying nothing versus spreading untruths. A brief reading of the IEEE Code of Ethics makes it quite apparent that, in joining the CSS, what we all agreed to do is definitely not to come the raw prawn with individuals and the Society. But

first, more aspects are needed to help to delineate and scope out the extent of the problem and the level of alarm.

A parliament (surely the appropriate collective noun: vice wisdom, sleuth, sloth, gaggle, or murder) of CSS past presidents, including Panos Antsaklis, Christos Cassandras, and Tariq Samad, and the current editor-in-chief of *IEEE Transactions on Automatic Control*, Alessandro Astolfi, approached me at the IEEE Conference on Decision and Control (CDC) in Miami, Florida. They were greatly concerned about improving the control community's public engagement and were vexed that other fields are adopting the subject area's domain and vocabulary.

Control is falling behind in its publicity outside of its field, and this gap is being filled with cognate but tangential subjects, without the deep focus on feedback and decision making under uncertainty that the associated rigorous theory supports. The four cognoscenti propose developing a new formal sustained effort within the CSS to target the public. We are working to formulate a cogent and achievable approach, which will take some time to crystalize and consume resources but is sorely needed. CSS Board of Governors member Okyay Kaynak approached me separately about the quality of communications and how

it might improve with some CSS guidance and, dare I say, feedback.

"Machine learning is eating our lunch!" my good friend and long-time control-adept Robert Kosut remarked at the 2018 International Federation of Automatic Control (IFAC) Symposium on System Identification (SysId) in Stockholm, Sweden. Two of the six plenary addresses at that event concentrated on the connections between machine learning and system identification. The one by Michael Jordan from the University of California, Berkeley, sought to leverage from statistics and real-world modeling from data—system identification—to reinforce and guide the development of tools that are appropriate for formulating informed and purpose-oriented machine learning from real-world experimental data. The second, from Csaba Szepesvári from the University of Alberta and Google Deep Mind, went in the other direction by encouraging system-identification researchers to join the computer-focused algorithm designers from reinforcement learning.

Also at SysId 2018, and again after sessions at CDC, Victor Solo from the University of New South Wales (who possesses higher degrees in both time-series analysis and electrical engineering) lamented with me about the relatively perfunctory focus of artificial intelligence

and machine learning on central real-world questions of experiment design and data quality. The concern is, in small part, about being miffed at not being consulted but mostly signifies a disappointment in failing to recognize that these issues have been studied at least since R.A. Fisher following F.Y. Edgeworth almost 100 years ago. Both are difficult to answer and critical to performance in practice. Professional ethics demand we intervene where we see missteps taken, but it also stings to not be recognized for our domain expertise. Vic prefers the sobriquet *artificial savant* to artificial intelligence, to capture the narrowness of the reasoning tasks performed. Our desire is to speak out to aid progress.

A recent experience with a U.S.-based mining company provides a salient example. A management-consulting firm was engaged after it offered a big data solution to improve mining operations by self-guided analysis of historical data. This occurred without the due diligence that is typically applied to such exploratory ventures and largely without drawing on local domain expertise. The quantitative analysis of technical risk and a comparative assessment of alternatives was forgone in exchange for vice presidential risk, one presumes on the strength of the hype. The control engineers at the company felt that their cautious, measured, theory-based approach had been trumped along with their technical expertise in modeling and control.

This problem is by no means new. It has been with us for a very long time and has been a constant of CSS and IFAC operations almost ab initio. Part of the recent change and alarm has been amplified by the popular expectations of technology and its commercialization through the adoption of terms like *smart* or *intelligent* into product titles, which are moving outside the walled gardens of computers and into contact with the real world. While control is an enabler of many technologies, it rarely is the basis of a product line, except maybe in chemical engineering. So is this all that has changed? Not really. There has been unprecedented growth in areas such as data science. Again, on January 24, 2019, *The New York Times* noted the surge in undergraduate university students who seek to enroll in computer science, operating under the belief that this is the best path to wealth and status. Historically, the various branches of engineering have seen ebbs and flows in attraction, based on the perceptions of the candidate students. This time around, it really does feel different, with the presence of the software houses topping the lists of market capitalization. The *Times* describes it as a "stampede." This clearly creates problems for computer science departments, not just in retaining their best faculty. However, it also engenders a mismatch between algorithm expectation and practice. This becomes more evident in the pushing back of timelines for the release of autonomous vehicles, for example. More knowledge of the problems might temper expectations and, more importantly, focus talented minds to study the core issues.

While we might be fired up to launch *Antifa for Artificial Intelligence* (Vic's exhortation) to set people on the one true control path, in reality, we should seek to inform the technical community about the power and limitations of our methods and viewpoints. If this seems like a responsibility, then so much the better. When formulating a response, a core consideration is defining the intended audience of any putative publicity effort. Experience across the advanced engineering sectors of energy, transport, aerospace, semiconductor, and other manufacturing (as well as with broadly based and process engineering companies) all indicate strong demand for (and appreciation of) controls talent and specialists. Would they need more convincing? Would it be wise to target the public, in general, the hoi-polloi? With what aim or intended outcome? Do we wish to become pointy-headed objects of distant admiration—rocket scientists, brain surgeons, nuclear physicists—or is the aim more mundane and business focused? Is the competition for young minds more important or that for senior management? Would a full-frontal assault on machine learning pay dividends? Tough questions.

Control systems (and the CSS and IFAC) have a history of seeking informative outreach. Some years ago, CSS published *Control Systems: Meet the Challenge and Put Control in Your Future*, a brochure directed at informing lay but technical readers. The very successful "The Impact of Control Technology" from Tariq Samad and Anuradha Annaswamy curates success stories from and challenges for control in two editions and is a worthy adjunct to marketing control to engineers. Richard Murray and his team produced the thought-provoking and forward-looking *Future Directions in Control in an Information-Rich World.* CSS holds a video-clip contest biennially. Pedro Albertos' and Iven Mareels' *Feedback and Control for Everyone* is another noteworthy book that aims to inform nonexperts. But more and more persistence is needed, respecting the changes in the nature of communications and the receptiveness of audiences.

I would welcome hearing your thoughts and ideas as we strategize.

Bob Bitmead