

## What Does “Control” Have to Offer?

I would like to start my series of president's messages by offering some personal reflections on what the IEEE Control Systems Society (CSS) can offer. To consider this question, I first want to take a diversion into what control is. Some time ago, as a junior faculty member, a colleague recommended I read the book *What Is This Thing Called Science* by A.F. Chalmers. It is a book on the philosophy of science that examines and critiques, in a form that I found quite accessible and entertaining, various views on the way in which science has developed and what it actually is. I won't claim to be able to match Chalmers' abilities, but I thought it would be interesting to examine a parallel theme and share some views on what control is.

Typical definitions of control, in a technical context, are along the lines of modification of dynamic behavior, frequently using processing of sensed measurements to generate actions that alter the behavior. However, in a broader context, “control” has a variety of connotations, not all of which are positive. One incident that highlighted this to me occurred during the Asian Control Conference held in Melbourne, Australia, in 2004. It turned out that prior to this conference, the then prime minister of Australia had made some controversial remarks about the possibility, under quite specific circumstances, of preemptive military actions in Asia. And so when some members of the public saw Asian Control Conference, they were a little incensed that we might be continuing a theme of

viewing ourselves as local leaders and needing to impose our “control” (in a political or military sense) on Asia. Thankfully, we were able to explain that it was definitely not a conference on the control of Asia, it was an Asian conference on feedback control.

The paradigm, of measurement, processing, and actuation—or perhaps the more modern variant “sense, think, act”—I believe has had, and will continue to have, a profound effect on our modern industrial society. I realize that I am mostly preaching to the choir here, so I will refrain from repeating examples, but I would claim that the vast majority of modern technologies rely, to at least some extent and in many cases to a large extent, on control. However, it could also be described as an “ethereal” kind of technology—since despite its widespread use, it is mostly invisible. Another way of describing this is that

control is a key quiet achiever of modern technological advances, and when it does become visible it is usually because it has failed in some way.

Ruth (my better half) and I recently had the pleasure during a short holiday in September to experience an example of a modern technology that clearly depends on feedback control. On two occasions we took a ride on a Segway. Ruth and I greatly enjoyed this experience, found it very simple to learn, and (mostly) very robust. Yes, on some quite rough terrain, on one or two occasions we got a wheel caught on a rock, and the Segway was not able to maintain balance with one wheel effectively jammed. Since we were stationary at the time, it did not cause us any harm, and only mild embarrassment. However, that scenario is a rather extreme test of robustness for the control system, and in all other circumstances, I felt it performed very well. The device



Ruth and Rick Middleton on a Segway holiday.

clearly intrigues the public in general as people stop and stare and marvel at how it works. As control engineers, we understand the “magic” here. It is a clever mechanism, which although open-loop unstable, with the correct sensors, actuators and computer control, does a few of the things that what we expect feedback control to do, namely, stabilize an unstable system and provide smooth tracking with disturbance rejection.

To me, this illustrates that there is both an art and a science in good control. The “art” lies in marrying an appropriate mechanism, with the necessary sensors and actuators, in a design that permits good control. There is also quite an art in selecting an appropriate model framework, with neither too little nor too much detail, and formulating the control objectives in suitable ways. Control theory, the “science,” then provides an excellent array of tools to allow control

synthesis, analysis, simulation, and design. Both the art and the science of control I believe are crucial components of control applications.

Based on this, I would like to discuss some key aspects of what I believe our community can offer to society in general. In addressing this question, there are numerous success stories and applications of control that have had a substantial impact on society, and I am grateful to former CSS President Tariq Samad and others for pursuing many examples. Also, I think the science of control, control theory, offers an academic pursuit that is of value in itself, as is any advancement in knowledge. Beyond this, however, I think our field potentially offers insights into feedback, sensing, estimation, dynamics, adaptation, robustness, stability, and regulation that would be difficult to obtain elsewhere. These concepts are important in a wide range of fields but in many cases are only poorly or empir-

ically understood. Within CSS, in many ways, we can give sharper meanings to and analysis of these concepts and have insights into their interactions.

However, it is not necessarily true that others are beating a path to our door. In part this may be a language barrier—the language of mathematics that we make extensive use of is not always widely understood. It seems to me that if we are to make use of insights from feedback control, then we need to engage with a broad range of disciplines and applications where these factors may be crucial.

In closing therefore, I would like to encourage members of our community to continue the many important theoretical advances, and in addition to reach out to other engineering and scientific disciplines, as well as applications, to realize the potential contributions of the CSS.

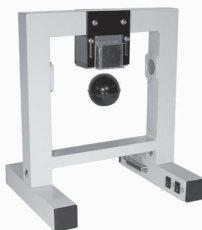
**Rick Middleton**



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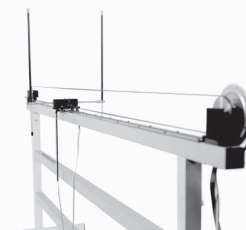
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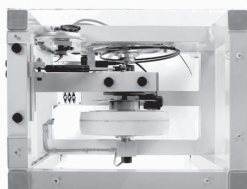
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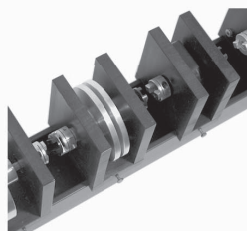
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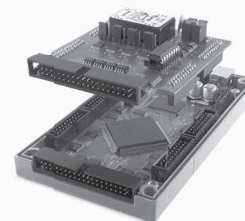
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