

In this issue of *IEEE Control Systems Magazine (CSM)*, we speak with 2014 IEEE Control Systems Society President Jay A. Farrell, whose interview includes a discussion on his priorities for the upcoming year. He received B.S. degrees in physics and electrical engineering from Iowa State University and M.S. and Ph.D. degrees in electrical engineering from the University of Notre Dame. He is a professor and chair of the Department of Electrical Engineering at the University of California, Riverside. He has coauthored over 200 technical publications, authored the book *Aided Navigation: GPS with High Rate Sensors* (McGraw-Hill, 2008), and coauthored the books *The Global Positioning System and Inertial Navigation* (McGraw-Hill, 1998) and *Adaptive Approximation Based Control: Unifying Neural, Fuzzy and Traditional Adaptive Approximation Approaches* (Wiley, 2006). His major current research interests are in advanced navigation, control, and planning methods for autonomous vehicles and tracking with distributed camera systems.

We also speak with six other IEEE Fellows in the control systems field.

Vincent Blondel is professor of applied mathematics at the Louvain School of Engineering at the Université catholique de Louvain (Louvain-la-Neuve, Belgium) and dean of engineering at the École Polytechnique de Louvain. He received an engineering degree, a degree in philosophy, and a Ph.D. in applied

mathematics from the Université catholique de Louvain and an M.Sc. in pure mathematics from Imperial College London, United Kingdom. He has also completed a master's thesis at the Institut National Polytechnique de Grenoble (France). He is a research affiliate at the Massachusetts Institute of Technology (MIT), where he was visiting professor and Fulbright fellow in 2005–2006 and 2010–2011. His major current research interests lie in several areas of mathematical control theory, theoretical computer science, and network science.

Eduardo F. Camacho received his doctorate in electrical engineering from the University of Seville, where he is now a full professor in the Department of System Engineering and Automatic Control. His service includes being chair of the International Federation of Automatic Control (IFAC) Publication Committee (2002–2005), the IEEE/CSS International Affairs Committee (2003–2006), and the IFAC Policy Committee (2005–2011); an editor of *Control Engineering Practice*, *European Journal of Control*, and *Optimal Control Applications and Methods*; and president of the European Union Control Association (2005–2007). His research interests include model predictive control and solar energy systems. He has coauthored six books and over 300 journal and conference papers. He is a Fellow of IFAC.

Tongwen Chen is a professor of electrical and computer engineering at the University of Alberta, Edmonton, Canada.

JAY A. FARRELL

Q. Congratulations on your new role in the IEEE Control Systems Society (CSS). You have been extremely active in CSS over the years. Which of the numerous roles have you found the most rewarding thus far?

Jay: Thank you. I greatly appreciate the honor and responsibility of serving as CSS president.

This will be my 28th year as a Member of IEEE. My first Conference on Decision and Control (CDC) was in Austin in 1988. In the intervening years, I have attended 22 of 26 and have been on the operating committees of six CDCs.

By far, the most rewarding CSS service thus far has been organizing the 51st IEEE CDC. The role of general chair called on many prior relationships and tested many skills that I had developed during all my prior IEEE service. In such endeavors, I

have been fortunate to be advised by and to collaborate with hard-working people who appreciate good humor along with good food and drink to celebrate completion.

It is these relationships that make the service worthwhile.

Q. How did your educational background bring you to the systems and control field?

Jay: As an undergraduate student at Iowa State, I was intrigued by an early edition of an applied Kalman filtering

He received the B.Eng. degree in automation and instrumentation from Tsinghua University (Beijing) in 1984 and the M.A.Sc. and Ph.D. degrees in electrical engineering from the University of Toronto in 1988 and 1991, respectively. He has served on the program committees of many conferences, including the 32nd Chinese Control Conference, the International Conference on Control and Fault-Tolerant Systems, and the IEEE Conference on Decision and Control in 2013. He has coauthored one book and a number of journal papers.

Mustafa Khammash is professor of control theory and systems biology in the Department of Biosystems Science and Engineering at the Swiss Federal Institute of Technology (ETH Zürich). He received his B.S. degree from Texas A&M University in 1986 and his Ph.D. from Rice University in 1990, both in electrical engineering. He was formerly a professor in the Department of Electrical Engineering at Iowa State University and then a professor in the Department of Mechanical Engineering at the University of California, Santa Barbara, where he served as vice chair of the Department of Mechanical Engineering from 2003 to 2006 and the director of the Center for Control, Dynamical Systems, and Computation from 2005 to 2011. He has coauthored more than 150 journal and proceedings papers and is a Fellow of IFAC.

Bozenna Pasik-Duncan is a professor of mathematics and a courtesy professor of electrical engineering and computer science at the University of Kansas. She received her master's degree in mathematics from the University of Warsaw in 1970

and her Ph.D. and D.Sc. (Habilitation) degrees from the Warsaw School of Economics in Poland in 1978 and 1986, respectively. Before moving to the University of Kansas in 1984, she was a faculty member in the Department of Mathematics at Warsaw School of Economics, vice president of the Warsaw Chapter of the Polish Mathematical Society, and director of the Applied Mathematics Center of the Polish Mathematical Society. She is a member of the IEEE-USA Communication Committee, chair of the IFAC Harold Chestnut Control Engineering Textbook Prize Selection Committee, chair of the Outreach Program at the University of Kansas, and faculty advisor to the Association for Women in Mathematics Student Chapter at the University of Kansas. Her main research interests are in control of stochastic systems. She is a Fellow of IFAC.

Gang Tao is a professor in the Department of Electrical and Computer Engineering at the University of Virginia. He received his B.S. in electrical engineering from the University of Science and Technology of China in 1982 and his M.S. in electrical engineering and applied mathematics and his Ph.D. in electrical engineering from the University of Southern California from 1984 to 1989. He was a visiting assistant professor at Washington State University from 1989 to 1991 and an assistant research engineer at the University of California, Santa Barbara, from 1991 to 1992. Since August 1992, he has been with the Department of Electrical and Computer Engineering at the University of Virginia. His main research interests are in adaptive control. He has coauthored four books and coedited two books.

book by R.G. Brown [1], who was a professor at Iowa State. As a senior interested in graduate school, I told Prof. Brown of my interest in nonlinear dynamical systems and my constraint of having a potential future spouse working in Michigan. He optimized the solution by directing me to Tony Michel at Notre Dame in Indiana. Tony emphasized rigorous mathematics, careful writing, and a very strong work ethic.

Prior to my junior year, I had an internship at Tellabs, working on phase-locked loops for telecommunications circuits. James Melsa, who was CSS president in 1988, also filled various executive roles at Tellabs, and was chair of the Department of

Electrical Engineering at the University of Notre Dame. In these varied roles, he brought Charlie Rohrs to have joint positions at Tellabs and Notre Dame.



Jay Farrell.

In addition to being a great personality, Charlie is one of the unique people who have a very strong mathematical background, with a keen interest in transitioning theory to practice, while thoroughly understanding the results and limitations, so that he could push both the theory and practice to achieve those limits. Interactions with Charlie and my work at Draper Lab initiated my interest in application-driven research.

Finally, at frequent meetings and meals with Panos Antsaklis and

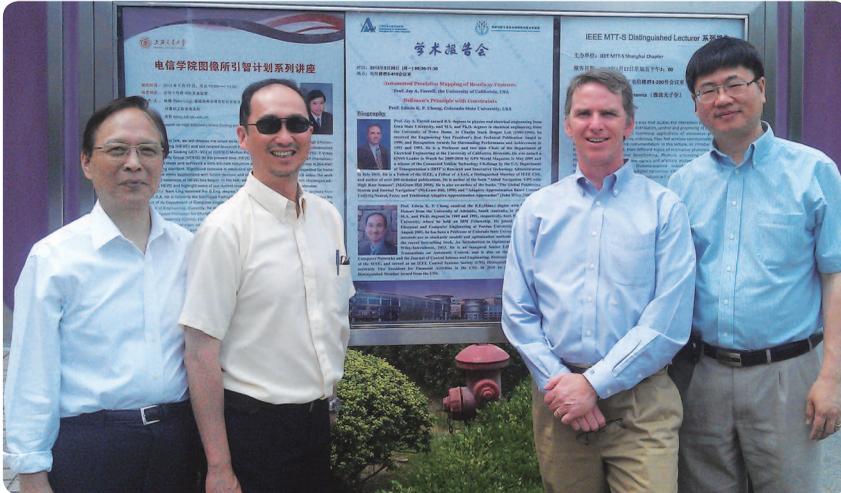
Kevin Passino, the conversation focused on life, classes, research, and service, always flavored with a large dose of humor.

The mix of rigorous theory, practical applications, and an appreciation of service were all strongly emphasized in the Notre Dame environment and have stayed with me throughout my career.

Q. What are your current research interests?

Jay: My present research interests are focused on estimation and optimization in the context of dynamic systems.

Since 1994, when I joined the University of California, Riverside (UCR), a main topic has been precise and reliable vehicle state estimation. With the advent of autonomous cars, or cars augmented with control for either convenience or enhanced



Xiren Cao, Edwin Chong, Jay Farrell, and Zongli Lin at Shanghai Jiao Tong University in May 2013.

safety, vehicle state estimation with position accuracy at the *where-in-lane* level (decimeter accuracy) has been of interest. Also of interest is precise automated mapping of roadway-relevant features (signs, lights, curbs, and lane markings). Our systems have been demonstrated in the automated control of buses and cars, in graphical user interfaces for highway maintenance vehicles, and in automated mapping demonstrations

for the U.S. Department of Transportation. Our current research is focused on real-time smoothing algorithms to enhance the integrity of the estimated state vector.

A second major research focus considers distributed camera networks. The overall objective is for the cameras to collaborate to track all targets in the area to a specified accuracy at all times, while collaboratively obtaining high-resolution images, at

times of opportunity, that will enable increased performance on higher level scene-understanding tasks such as face and activity recognition. The main three problem areas are feature-to-target association; target state estimation; and optimal selection of pan, tilt, and zoom settings. Each of these must be accomplished across a network using distribute computation and information.

Q. What do you see as some of the priorities for ensuring the future success and impact of control-related technology?

Jay: Dynamic systems, estimation, and feedback control have never been more relevant, and I have no worries about the future success and impact of our field. This confidence is based on the rapidly declining cost and increasing capabilities of sensor and computational technologies, combined with the fact that our world is composed of dynamic systems that do not naturally perform in the manner that we wish they would; therefore, estimation and control are required.

A major challenge to our field is to maintain a balance between practice and theory. The ubiquity of inexpensive high-performance sensors and computers allows many people from diverse fields to implement and demonstrate novel and exciting working systems with embedded (hidden) controllers; however, implementation without analysis can be a risky proposition, especially as controllers become commonplace in safety-of-life systems. One of the strengths of our community is that it contains the full spectrum of skills; from those who can derive, organize, and clearly explain a theorem and proof concerned with, for example, fundamental performance limits; to those capable of translating the theorem into practical algorithmic tools; to those ready to use those tools to achieve enhanced system performance. The appreciation of this range of skills is demonstrated by the diversity of



Jinrong (Jenna) Cheng and Jay Farrell in front of an autonomously driven bus using California PATH and UCR navigation systems.

the Society's publication and conference venues.

With these ideas in mind, the Society leadership is always interested in enhancing the value of and contributions to CSS membership for those in industry. Any new ideas would be greatly appreciated.

Q. How do you see your role as president of the Society, and what are your priorities for the next year?

Jay: The state of our Society is very good. Membership, technical activities, publications, conferences, and finances all have positive trends. The credit for these trends belongs to a long history of thoughtful leadership within our Society. Given the strong state of the CSS, my goals are to enhance the value of Society membership and to facilitate Society service.

As an organization of volunteers, with each volunteer serving over a short time span, the CSS has a very limited institutional memory. I have been involved with IEEE and CSS in various roles for about 25 years and have seen several recurring themes. Without repositories of knowledge, including the humans who preceded me in my various roles, the service would have been much more difficult.

An objective of my term is to work with the CSS volunteers to define practical and self-sustaining mechanisms to pass down knowledge and best practices from one generation of volunteers to the next. If successful, the learning curve for each new role will be decreased for future CSS volunteers. The effective transition of knowledge between generations of leaders is critical to effective service and management.

Q. The young members in our field—especially students—are the future of CSS. How can we expand their participation and role in CSS?



Theresa and Jay Farrell on New Year's Eve.

Jay: Young members are the future of our Society, both in the CSS and the larger society in which we live and work. In both, youth participation is critical. Participation is enhanced by a better understanding of the role of service and its benefits.

With 2014 being the 60th anniversary of the CSS, I went back to the December 2004 issue of *IEEE Control Systems Magazine*. That issue celebrated the 50th anniversary of the CSS with various articles related to our history. Particularly relevant to this question are the comments of past CSS presidents [1].

Many of the pioneers who laid the theoretical foundations of our field

were also the leaders of the CSS. Some of their remembrances of their time and efforts while leading the CSS include "the esprit-de-corps of that amazing group of colleagues that I had the honor to be associated with" (Micheal Athans), and "close contact and concentrated interaction with giants and leaders, having diverse talents, styles and viewpoints" (Elliot Axelband). Almost unanimous in their assessment of the impact of CSS

service on their careers are the following factors: becoming friends with a diverse set of experts and leaders in our field, learning to work and manage effectively in the context of a volunteer organization, and learning to motivate and appreciate the skills and contributions of others. A quote from Jack Rugh motivates the value of CSS service, "my involvement with the CSS ..., confirms that a great deal can be enjoyably accomplished by a small volunteer group of dedicated, like-minded individuals."

I encourage young members interested in enjoyably working with their colleagues to contribute to the organization of their technical

Profile of Jay A. Farrell

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- *IEEE Control Systems Society experience highlights:* general chair, 51st IEEE Conference on Decision and Control, 2012; general vice-chair, Joint European Control Conference and 50th IEEE Conference on Decision and Control, 2011; Board of Governors, 2003–2006, 2012–2014; vice president, Technical Activities 2007–2008; vice president, Financial Affairs 2005–2006.
- *Notable awards:* Charles Stark Draper Recognition Award, 1991, 1993; IEEE Fellow, 2008; IEEE Control Systems Society Distinguished Member Award, 2009; a GNSS Leader to Watch for 2009–2010 by *GPS World Magazine*; AAAS Fellow, 2011; U.S. Department of Transportation, Research and Innovative Technology Administration, Connected Vehicle Technology Challenge, 2011.

community by volunteering in some capacity.

Q. What are some of your interests and activities outside of your professional career? Please also tell us about your family.

Jay: Racquetball is currently my only competitive sport. Against students, it is a great form of exercise, while getting to know them informally outside the lab. Sailing, biking, skiing, and hiking are my more social exercise-related activities. My sailing is currently limited to the southern California coast, but given time and opportunity I aspire to sail the Turkish and Dalmatian coasts. I also enjoy playing cards and watching both (American) college football and soccer,

especially with colleagues from around the world.

My wife, Theresa, and I met as undergraduates in 1985. We were married in 1988 while she was working at United Technologies in Dearborn and I was a graduate student at Notre Dame. Theresa is a major gifts officer at the University of Redlands. We celebrated our 25th anniversary in May 2013. In the same month, our daughter Sarah graduated magna cum laude from Harvard, majoring in chemistry with a minor in economics. She is currently working at UBS in New York. Our son Daniel is a junior at Saint Mary's College of California majoring in mathematics. Theresa, Sarah, and Daniel have been able to attend sev-

eral CSS conferences. Please introduce yourself to them the next time that they can attend.

Q. Thank you for your comments. We wish you success as 2014 CSS president, and we look forward to reading your editorials in the magazine.

Jay: You are welcome. Thank you to the members of the IEEE CSS for trusting me with the leadership of our Society.

REFERENCES

- [1] R. G. Brown, *Introduction to Random Signal Analysis and Kalman Filtering*. New York: Wiley, 1983.
- [2] C. B. Schrader, "Preserving the promise of our past presidents: Precedence, progression, and persistence," *IEEE Control Syst. Mag.*, vol. 24, no. 6, pp. 37-55, Dec. 2004.

VINCENT BLONDEL

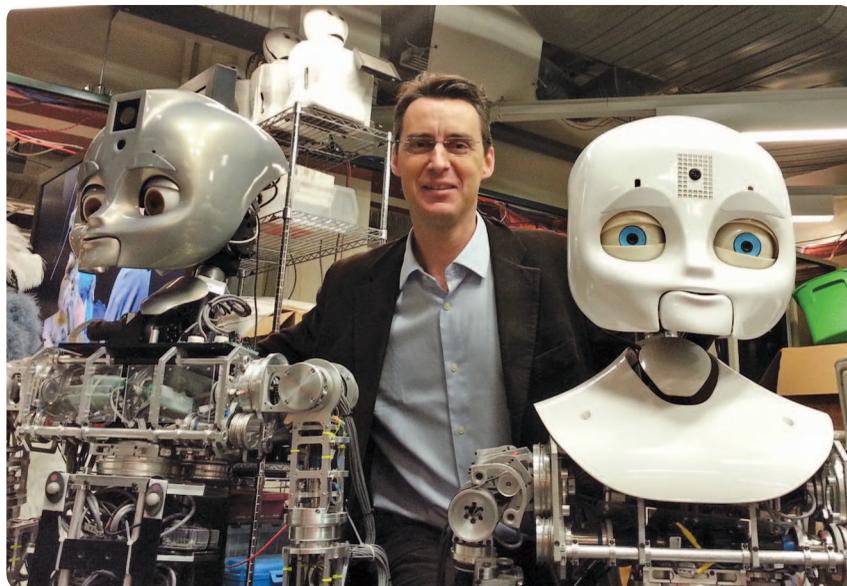
Q. How did your education and early career lead to your interest in the control field?

Vincent: For many years I felt that my initial choice to study engineering rather than mathematics had been a mistake. As a student, I read a lot on mathematics and on the history of mathematics. I was fascinated by works such as "A Mathematician's Apology" by Cambridge number theorist G.H. Hardy. Hardy would write things such as: "The mathematician's patterns, like the painter's or the poet's must be beautiful; the ideas like the colors or the words, must fit together in a harmonious way. Beauty is the first test: there is no permanent place in the world for ugly mathematics." I would read this and feel thrilled!

After my engineering studies, I went on for a master of science in mathematics at Imperial College in London and then completed a Ph.D. in control. For my Ph.D., I was first given papers to read in H-infinity control. This was the fancy topic at the time.

I found these papers difficult to read and far from my attraction to pure mathematics. I then came across the very nice book *Control System Synthesis* by M. Vidyasagar. I could only understand its contents up to Chapter 6, but that chapter contained the description of a clearly stated problem: simultaneous stabilization of linear systems. This was a problem that was easy

to state ("under what conditions are three linear systems stabilizable by the same controller?"), the problem had already been open for some time (it is actually still open), and the problem was mathematically clear. This was the perfect combination for my pure mathematics aspirations at that time, and I decided to make this the subject of my Ph.D. thesis.



Vincent Blondel in good company at the Media Lab at MIT.