

Profile: Mark W. Spong

Education: B.A. magna cum laude, Hiram College, Hiram, Ohio; M.S. New Mexico State University; M.S. and D.Sc. Washington University, St. Louis.

Current Position: Professor and Head, Department of General Engineering and Research Professor in the Coordinated Science Laboratory, University of Illinois at Urbana-Champaign

Institutions where you have taught or conducted research: Lehigh University; Cornell University; the University of Illinois; National Polytechnic Institute of Mexico; Laboratoire d'Automatique de Grenoble, France; Lund Institute of Technology; Katholieke Universiteit, Leuven, Belgium; Supelec, Gif-sur-Yvette, France; The Universite de Technologie de Compiegne, France; National University of Singapore; and the Technical University of Munich.

Work you are most proud of: I was fortunate to get into robot control when it was a relatively young field and thus I was able to produce some results early on that both contributed to the maturation of the field and also proved useful beyond robotics. For example, my 1987 paper co-authored with M. Vidyasagar, "Robust Linear Compensator Design for Nonlinear Robot Control," was the first paper on so-called L1-optimal control, before it was called L1-optimal control, and helped motivate the development of that methodology. Interestingly enough, we proved semiglobal asymptotic stability in that paper but didn't call it that since the term "semiglobal" was not coined until 1989. My most cited paper is "Adaptive Motion Control of Rigid Robots: A Tutorial," co-authored with Romeo Ortega, which coined the term "passivity based control." I am also proud of my contributions to the control of joint elasticity in robots using feedback linearization and singular perturbation methods and the work in teleoperation of my first PhD student Bob Anderson, which solved the longstanding problem of time delay induced instability in force reflecting teleoperators.

Notable Awards: The John R. Ragazzini Award and O. Hugo Schuck Award from AACC; the Senior Scientist Research Award from the Alexander von Humboldt Foundation; IEEE Fellow and the CSS Distinguished Member Award; IEEE Third Millennium Medal. My male ego also requires that I mention making the All Northeast Ohio High School Basketball team in 1971.

Course you especially enjoy teaching: Robot Dynamics and Control at Illinois for which I developed the course, textbook, and lab.

Recent books read: *A Beautiful Mind* by Silvia Nassar; *My Losing Season* by Pat Conroy; *The Power of Babel: A Natural History of Language* by John McWhorter

Last vacation: Mexico City

Interests: travel, sports, languages, fine wine, classical music

CSM: Congratulations on your election as the next CSS president.

MS: Thank you very much. It is a tremendous honor for me to have the opportunity to serve the Control Systems Society as President. My entire professional career has been spent as a CSS member, and I cherish the many personal and professional relationships that have resulted from my activities in the Society. The fact that my CSS colleagues have entrusted me with this job is very gratifying.

CSM: Before we delve into some of your plans for the coming year, I'd like to ask you about your background, in particular, I was wondering if there was some singular event in your life that made you seriously think about systems and control as a potential career field.

MS: My undergraduate and beginning graduate training was in math and physics. My interest in dynamical systems started when I read Hirsh and Smale's book, *Differential Equations, Dynamical Systems, and Linear Algebra*. My interest in control started when I participated in a weekly mathematics seminar in graduate school at New Mexico State University during the semester when the topic was control theory. My contribution to the seminar was to present to the group a proof of the Pontryagin Maximum Principle. I read the book of Lee and Markus, *Foundations of Optimal Control Theory*, and realized that control theory contained beautiful and quite deep mathematics. So, I guess one could say it was my interest in mathematics that led me to choose a career in control. Although mathematics motivated me to enter the field, my subsequent interests were in applications of control especially to robotics. I now enjoy control theory much more when I see practical applications.

CSM: Please describe your involvement with the CSS over the years.

MS: I've been more or less involved in the Society in some capacity since 1982. Like most of us, I began my involvement in the Society by reviewing papers and serving on conference program committees. Later I served as an Associate Editor for all of the CSS publications, the Control Systems Magazine, Transactions on Automatic Control, and Transactions on Control Systems Technology. I served for three years as Editor-in-Chief of the Transactions on Control Systems Technology followed by two years as Vice President for Publication Activities. During my tenure as VP for Publication Activities we produced the CSS Digital Archive, which I think is a valuable resource for members and nonmembers alike. I was also on the Board of Governors for many years and served as the General Chair of the Conference on Control Applications in Mexico City in 2001.

CSM: In this 50th anniversary year, there is a lot of talk about the future of our field. What advice would you give to an undergraduate who is thinking about control as an employment specialization or graduate school major?

MS: I'm very positive about the future of our field. First of all, engineering problems are become increasingly more complex and large scale. As a result, employers are seeking engineering graduates who not only have technical skills but who also have a broad multidisciplinary perspective that enables them to work in teams on systems integration problems. I think a background in systems and control provides excellent training for such jobs. Second, control is ubiquitous. Inside the modern automobile, airplane, ship, train, factory, refinery, indeed inside almost any modern engineered system, is an interconnected network of microprocessors, sensors, and actuators controlling dozens of processes and variables. Of course, I realize that I am preaching to the choir here. As we know, control is the hidden enabling technology underlying many high tech applications. We are now seeing control principles

applied in new areas such as Internet congestion control, wireless communications, and biomedical applications. And, while I believe that no amount of technology can secure us from the threat of terrorism (this goal requires political as well as technical solutions), it is clear that control technology is greatly needed in applications, such as securing supervisory control and data acquisition (SCADA) systems from hackers, employing sensors to detect biological or radiological hazards, and of course in military surveillance and weapons systems. The bottom line is that I believe control engineers will be increasingly in demand, and I would not hesitate to advise a student to choose control as a field of study.

CSM: How is the CSS doing? What do you view as our strengths and weaknesses, and what can each of us do to improve the Society?

MS: Perhaps a short answer to this question is that our strength lies in our membership and our weakness lies in the fact that our membership base is shrinking. I will expand on this below but before doing that let me say that overall the Society is healthy. As President-elect I have had the opportunity to attend two IEEE level meetings and will attend a third before the end of the year. I have seen that the CSS has a high reputation within the IEEE and is a role model as a well-organized, well-run Society. Our volunteers continue to devote considerable time and energy to keeping the Society healthy. As you know, during the past few years the IEEE has gone through some financial difficulties, which have had a negative impact on all of the Societies including the CSS. While some difficulties remain, I think most of the worst is over and we have some cause for optimism. These financial issues have been addressed in several Presidents' messages and I'm sure I will have more to report in my messages next year so I will defer further discussion about that. I prefer to talk here about our membership. Our membership continues to decline several percent per year and has gone from over ten thousand members to under eight thousand in the last four or so years. Most of the Societies within the IEEE are experiencing similar declines in membership. There are undoubtedly several reasons for this decline but the conventional wisdom is that the wide availability of our journals and conference proceedings electronically, through IEEEExplore and other means, reduces the incentive of people to join the Society. This observation is certainly true if the primary reason for joining the Society is to be able to subscribe to our journals. But perhaps an even more important reason to be a CSS member is the opportunity for networking and personal growth that membership can provide. Certainly, as a university professor, I've always been able to walk over to the library and read the CSS publications. The real reason to belong to a professional society is to have personal interaction with others in your profession, to exchange ideas, to mentor and be mentored. As a Society we need to do a better job not only of providing increased opportunities for such networking but also of advertising to members, especially to the younger members, the importance of personal interaction to one's professional growth. Several of the CSS activities, such as the Workshops for High School students, student travel support, and the Distinguished Lecturer Program, help in this regard but we need to do better.

CSM: Your name is well known to the community as one of the developers of the Pendubot. Do you have any thoughts about the future of control education?

MS: Well, I've been teaching control courses for twenty-five years and, while we have made great advances in the hands-on laboratory experiences we give our students, I think that the changes to the textbook and lecture material have not been as significant. For the most part we still teach the same tools (root locus, Routh-Hurwitz) and simply supplement them with Matlab routines to aid in the computation. Perhaps it is time to think of bringing into the undergraduate classroom more of the computational advances that researchers have brought to bear on control research problems. I'm thinking of convex optimization and LMI's, randomized algorithms,

neural networks, and the like that take advantage of the tremendous advances in computational power. Or perhaps a first course in control ought to be a course in mechatronics that focuses more on control technology and less on theory. Analysis tools could then be covered in a second course. I'm not advocating that we abandon fundamentals. I'm merely thinking out loud that perhaps fundamental analysis and design tools are better learned after one has had exposure to their applications. Of course, I have the luxury of teaching in a department that has two required controls courses in the undergraduate curriculum. Most engineering programs these days do not require a course in control, which is unfortunate.

CSM: Let's return to CSS issues. How do you see your role as President-Elect of the Society and what are your priorities for the coming year?

MS: The President represents the Society in the IEEE as a member of TAB and presides over the Executive Committee and Board of Governors. But equally important is that the President can serve as an ambassador of the Society to the world at large. I see my role therefore as two-fold. Within IEEE and the CSS we are challenged to maintain our high standards and serve our members in the face of reduced reserves and changing business models. We can do that by continuing to improve our journals and conferences and by finding creative ways to maintain our member base. One of my priorities will be to address the decline in membership. The goal is not necessary to maximize the number of members but rather to make sure that we provide the right mix of benefits both to serve our members and to adapt to rapid changes resulting from globalization, technology advances, and other forces. Another priority will be to find ways to increase the visibility of the field, both to educate the general public and to attract the best students to the profession.

CSM: Thank you for your comments, and all of us in CSS wish you the best of success for 2005!