FEATURE

Fifty Years in Control

The story of the IEEE Control Systems Society

By Daniel Y. Abramovitch and Gene F. Franklin

The IEEE Control Systems Society (CSS) was established in 1954 and thus celebrates its 50th anniversary this year. As part of that celebration, we have compiled an overview of the history of this group.

How does one write the history of a professional society that is now 50 years old? To be honest, this is a difficult task that rests on the memories of those who were there since the Society's inception, articles that have already been written, and personal knowledge. In writing this article we recruited commentary from all of the current and former editors-in-chief of the IEEE CSS publications as well as the current and former Society presidents. Taking the comments and insights of those who responded, we have tried to knit their memories into a picture of how the Society began and create a mosaic of where it is now. Our task was made considerably easier by the use of the IEEE CSS archive DVD, which is a truly remarkable trove of documentation. Mostly, though, the story is based on the memories of the people who created and contribute to the Society.

Early Background

Toward the end of the 19th century, in response to the interests of the rapidly growing number of electrical engineers and inventors developing the telegraph, the telephone, incandescent and arc lights, and electric motors, the American Institute of Electrical Engineers (AIEE) was formed. The group was formed in October 1884 and published the first issue of *Transactions of the AIEE* in that year. Interestingly, one of the first papers published was on the Edison effect, a precursor to electronics. For many years, AIEE activity centered on problems affecting the electric utilities industry, including the generation and distribution of electrical power. The important topic of instruments for measuring electrical quantities was added later. In 1945, the AIEE established a Technical Committee on Industrial Control, which became the Committee on Feedback Control in 1950. The Institute published a magazine of general interest called *Electrical Engineering* and reserved *Transactions of the AIEE* for more technical and specialized papers. It was general practice for technical papers to be submitted for presentation at either the winter or summer meeting of the Institute. Discussions at the meetings were then recorded so that later a paper, plus its discussion, would be published in the transactions. This policy caused a substantial delay between submission of a paper and its publication. During this time, the ASME and the ISA also published papers on control in their transactions and held annual meetings that included papers on control.

In May 1912, the Institute of Radio Engineers (IRE) was formed as an international society focusing on wireless communication, an area not pertinent to the interests of the AIEE. Until the Second World War, the IRE was vigorous

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but substantially smaller than the AIEE. However, the development of electronic technologies to support the conduct of World War II from 1939 to 1945 led to important advances in science and technology, including many contributions to electronics that caused increased interest and membership in the IRE. Developments in control were especially motivated by problems in servomechanism design for the control of antennas used to track aircraft with radar [1]–[4]. Many of these developments took place at the Radiation Laboratory (Rad Lab) at the Massachusetts Institute of Technology (MIT), created specifically to study the problems of radar. Much of the work at the Rad Lab was led by physicists because the education of most electrical engineers did not include the necessary math or physics called for by these problems. It was said by some, and perhaps only partially in jest, that in the standard American EE curriculum of the time, $2\pi f$ was taken as a constant equal to 377; that is, f was always 60 Hz.

The melding for the first time of servomechanism design with electronic feedback amplifier design is described in *Theory of Servomechanisms* by James, Nichols, and Phillips published by McGraw Hill in 1948 as Volume 25 of the Radiation Laboratory Series. This work had a profound influence on the control profession. Although electrical machines had long been of interest to the AIEE, the *control* of machines using electronic devices was new territory. The IRE increasingly responded to the wide range of interests in electronics, from audio to microwaves, by establishing Technical Groups that were given substantial autonomy to respond to the varied interests of their members. The groups managed their own publications and did not require that papers be first presented at a national meeting, a policy that was attractive to engineers working in control. Still, as of 1953, there was no group in the IRE with specific interests in control.

The Professional Group on Automatic Control (PGAC) Forms

In 1950, Prof. George Newton of MIT submitted a paper titled "Statistical Filter Theory for Feedback Systems Subject to Saturation" to *Proceedings of the IRE*. The paper was rejected with comments to the effect that the subject matter was not suitable for the IRE publication. This event seems to have been a major stimulus for discussions on the possibility of establishing an IRE Technical Group on control. Meetings were held with the leadership of the IRE, and in the July 1951 issue of *Proceedings of the IRE,* the following announcement appeared:

> Chairman Brainerd announced the formation of a new IRE Technical Committee on Servo-Systems. The Scope of the Committee will include: Recommend standard definitions of terms within the field and encourage formation of a Professional Group in the field. [5]

It is interesting to note that every one of the members of the Committee, all of them from the Northeast, first had to join the IRE before they could be appointed. As a result of the recommendations of this committee, arrangements were made to include members from all parts of the country, and the first official meeting of the 17-member Administrative Committee for the new Professional Group on Automatic Control (PGAC) of the IRE was held at MIT on 19 October 1954. The 13 members present elected Robert Wilcox of the Raytheon Company as chair and Jack Lozier of Bell Labs as vice-chair [5]. A plenary session on control had already been scheduled for the IRE National Meeting of March 1955, and a committee of the new PGAC chaired by Lozier was put in charge of its organization. The committee arranged for a panel discussion led by Prof. Gordon Brown of MIT. Areas of concern to the committee were soliciting papers for the transactions and attracting new members to the group. In the interests of membership, several local chapters of the PGAC were established in major cities where there was activity in control.

At the October 1954 meeting, the PGAC also planned for the publication of technical papers and appointed George Axelby to be editor of *Transactions of the PGAC*. In his farewell editorial for *IEEE Transactions on Automatic Control* (*TAC)* in 1968, Axelby described the selection process this way:

> There were no volunteers to assume the editor's task, but it was decided to draft the person with the most experience in obtaining papers for a publication, and this turned out to be the member of an AIEE Subcommittee in charge of the Abstracts and Proceedings of the Second Feedback Control Systems Conference which was held in Atlantic City in April of that year [1954]. Only 13 papers were involved, but apparently the experience of having processed that many papers was sufficient qualification to become an editor at that time. [6]

Axelby oversaw publication of the first issue of *Transactions of the PGAC* in April 1956 with seven papers and continued service as editor (what would today be called editor-in-chief) with great distinction until 1968. At the 1987 IEEE Conference on Decision and Control (CDC), in partial recognition of his many years of service, the Society established the "George S. Axelby Outstanding Paper Award" for authors of papers published in *TAC* [7].

The AIEE and IRE Become the IEEE, and the CSS Is Created

During the immediate post-war period there were many who felt that the profession would be better served by having only one society for electrical engineers. For example, in 1950 the IRE and the AIEE authorized Joint

Student Branches at universities to represent both societies. In 1957 the membership of the IRE exceeded that of the AIEE for the first time, and the movement to merge led to active discussions among the officers of the two EE societies. The cooperation between the control groups of the AIEE and the IRE on joint conferences and other matters is reported to have made an important contribution to these discussions. The matter was put to a member vote, and, based on the outcome of that vote, the IRE and AIEE were merged on 1 January 1963 to form the IEEE. As part of the merger, the Feedback Control Committee of the AIEE and the PGAC of the IRE were merged to form the Professional Technical Group on Automatic Control (PTGAC) [8]. Years later, in 1971, that group became a full-fledged IEEE Society named the Control Systems Society (CSS) of the IEEE [9]. Recurring issues that have faced the governing boards and presidents of the Society over the years include:

1) how best to attract new members and retain existing members
2) how to establish publications and conferences that will best meet the needs of the entire controls community
3) how to effectively set fees for services so the Society remains financially solvent
4) how best to respond to the perceived gap between control theory and control practice.

These issues will arise throughout the discussion below, and we will return to them in a later section.

Perhaps no single effort has been as central to the IEEE Control Systems Society as *IEEE Transactions on Automatic Control*.

The Beginnings of IFAC and AACC

While the IRE and the AIEE were giving birth to the CSS, international events were occurring that had a major influence on the field. The first International Conference on Automatic Control was held in Heidelberg, Germany, in September 1956. At that meeting, an informal group, which included AIEE member Harold Chestnut of GE and Rufus Oldenberger of the ASME, resolved to form an International Federation of Automatic Control (IFAC). In the United States, in response to this activity, representatives from the IRE, AIEE, ASME, ISA, and AIChE met in September 1957 in Atlantic City to form the American Automatic Control Council (AACC) as the USA National Member Organization of the proposed IFAC. The Council was supported by dues levied on each of the member societies. The AACC drafted a constitution for IFAC, which was presented to an international gathering in Dusseldorf, Germany, in April 1957. A final draft constitution of IFAC based on the AACC effort was written and later presented at the first organizational meeting of IFAC in Paris in September 1957. At that meeting, the constitution was adopted, Harold Chestnut of the United States was elected president, and the invitation to hold the first Congress of IFAC in Moscow was accepted. Accordingly, the first International Congress on Automatic Control sponsored by IFAC was held in Moscow from 27 June to 2 July 1960 and was well attended by the world community of control engineers [10], [11]. A history of many of the IFAC Congresses is given in [12].

In the growing spirit of cooperation in control, on 4–6 November 1959 a National Automatic Control Conference was held in Dallas, Texas. The conference was organized by the PGAC of the IRE and included members of ASME, AIEE, and ISA. Many of the papers presented at the conference were published in a special issue of *Transactions of the PGAC* in December 1959, although for copyright reasons only abstracts were published of papers that were to be presented at the 1960 IFAC Congress. Included in the latter category was a paper by R.E. (Rudy) Kalman on the general theory of control in which the concepts of controllability and observability and the outline of the design method later known as LQG were introduced [13]. Also in this issue were two papers by Kalman and J.E. (Jack) Bertram on the second method of Lyapunov [14], [15]. Of these papers, George Axelby noted:

> It is interesting to note that [Kalman] and Jack Bertram submitted two papers using state-space notation at the 1959 PGAC Conference held in Dallas. This was quite a mystery to most of the attendees, and I asked Kalman if he would submit it to the PGAC transactions, but he said that he could not because it was to presented at the 1960 IFAC Congress. [16]

The societies comprising the AACC agreed to sponsor only one annual conference dedicated to control, to be called the Joint Automatic Control Conference (JACC). The first JACC, sponsored by ASME, was held at MIT on 7–9 September 1960. At MIT, it was agreed by the members of AACC that the JACC would have sponsorship in turn by the different member societies: the ASME in 1960, the ISA in 1961, the AIEE in 1963, and the PGAC of the IRE in 1964. The meeting was to be held during the summer, and the location was to rotate from East to Midwest to West to East. In

order to minimize expenses for student and international attendees, many of the early JACC meetings were held at universities where attendees could stay in dormitories. Papers accepted for the conference were to be of archival quality scheduled to be published in a society transactions. The plan for rotating sponsorship caused a number of organizational and scheduling difficulties and considerable frustration for members during years when their society had no say in the conference arrangements. Eventually, in response to these problems, all responsibility for the JACC was transferred to the AACC in 1982 and the conference was renamed the American Control Conference (ACC).

The Society has made continual efforts to become more inclusive, particularly to women and minorities.

The IFAC Congress is still held every three years. The president of IFAC is chosen from the national organization of the next host country. A large and important international gathering, IFAC Congress's locations span the world, with Sydney (1999) and Barcelona (2002) being the most recent locations. The next Congress will be held in Prague in the Czech Republic in 2005. As Steve Kahne noted:

> From the beginning, IFAC was a truly international society. There has never been more than one United States representative around the table at the IFAC Council (IFAC's "Board of Governors"); only three of the 17 presidents of IFAC during its first 50 years have been from the United States; the United States is but one of the 50 National Members of IFAC; something like 10% of the IFAC conferences have been in the United States; and IFAC's headquarters have never been in the United States. This means that American traditions and styles have played only a modest role in the operation of the Federation. About 16% of the IFAC officials have been from the United States so, to be sure, United States contributors have played a disproportionate role in IFAC leadership. Although I do not have the definitive data, I would estimate that maybe about the same percentage of all IFAC authors during the past 50 years have been from the United States. The result has been that IFAC has always reflected a truly international perspective in our field. [17]

Although named the American Control Conference, the ACC now stands as one of the premier international conferences in automatic control. The ACC is held every year in the United States, excluding those years when the AACC is the host organization and the United States is the host country for the IFAC. The ACC still cycles between the eastern, central, and western states. Depending upon its location, the ACC is most often held in early June, although it can be pushed to the week before or after the 4 July weekend (American Independence Day) for locations amenable to such events. Examples of this timing include the 2004 ACC in Boston, the 1994 ACC in Baltimore, and the upcoming 2007 ACC in New York.

Whether the ACC is considered a theoretical or applied conference often depends mostly on the member society of the attendee. Still, the ACC is one conference that has made a concerted effort in the past few years to include an industrial track. Since the late 1990s, much of this track has been occupied by tutorial sessions, including the 2001 ACC's full three-day track of nine tutorial sessions organized by L.K. Mestha of Xerox Research on topics ranging from disk drive control to software, and the 2004 ACC's full three-day track of ten tutorial sessions organized by Daniel Abramovitch of Agilent Labs on topics ranging from nano- and microsystems, to model-based control of semiconductor processing, to supply chain management.

The Conference on Decision and Control

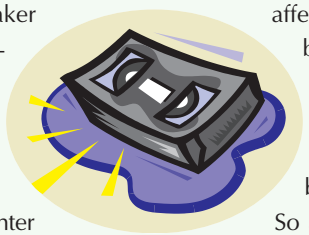
In 1961, in response to intense interest on adaptive and learning systems among the membership, the CSS established an annual Symposium on Adaptive Processes (SAP). The SAP was set up to be a symposium rather than a conference to avoid conflict with the JACC agreement. The distinction was that, while papers presented at the JACC were to be carefully reviewed and deemed suitable for publication in a society transactions, papers accepted for the SAP were expected to include speculative and preliminary results. In 1970, the CSS augmented the SAP meeting to include the Symposium on Decision and Control Systems. Special efforts were made to attract papers to the new Symposium on the "fringes" of control in such areas as economic systems, urban and social systems, biomedical systems, and societalecological systems [9]. The first meeting of the new joint symposia named the Conference on Decision and Control including the SAP was held in December of 1970 at the University of Texas in Austin, and the second was at the Hotel Americana in Miami Beach, Florida, in December of 1971. Separate program chairs were appointed for the SAP and for the Decision and Control Symposium. In 1986, the explicit sessions comprising the SAP were dropped and the winter meeting of the CSS became simply the Conference on Decision and Control (CDC).

Memorable CDC Moments

Unlike the ACC and IFAC, the CDC is entirely under the management of the CSS, which might explain why the CDC inflames more passion at sessions than the more practical ACC and the Conference on Controls Applications (CCA). On the other hand, perhaps it is the warm weather. Whatever the reason, it seems that some of the most memorable control conference events have occurred at the CDC.

At the 1987 CDC in Los Angeles, a spirited debate broke out at a large plenary session about the legitimacy of having sessions dealing with control issues in the so-called Strategic Defense Initiative. The banquet featured an appearance by John Doyle as a vagabond. The costume was quite effective, except for the MIT labeled toboggan hat.

Perhaps the greatest Friday afternoon session of all time was co-chaired at the 1990 CDC in Honolulu, Hawaii, by Rick Johnson and Bob Bitmead. Deciding to make the most of the venue, they had a blender in the front of the room. As each speaker came up, they offered a fresh Blue Hawaii (blended tropical drink), maintaining quality control by frequently sampling the data themselves. The best paper of session award was decided by Rick, serving as a human applause meter.



The first Bode Prize lecture was given by Gunter Stein at the 1989 CDC in Tampa, Florida [18]. The talk was viewed with such renown that the IEEE sold videos of the talk for several years. Eventually, the IEEE lost track of these tapes, which were thought lost until a casual mention of the "lost tape" by Danny Abramovitch to Dennis Bernstein in 2002 brought an immediate response that a copy at the University of Michigan was viewed on a regular basis by Dennis's classes. Copies eventually made their way back to the CSS History Committee. Through a great deal of encouragement from then *CSM* Editor-in-Chief Tariq Samad, a paper based on this talk was preserved in *CSM* [19].

At the 1998 CDC, again in Tampa, an amusing and raucous fuzzy-versus-conventional-control debate occurred between two old friends, Lotfi Zadeh and Mike Athans [20].

At the 1982 CDC in Orlando, Florida, a famous talk on some failings of model reference adaptive control in the presence of unmodeled dynamics was given by a graduate student named Charlie Rohrs [21]. The talk probably would have gone fine had the student's adviser, Mike Athans, not told Karl Åström ahead of time that next on the list to be dismantled was the self-tuning regulator. At later CDCs it was reported that, in one of the meeting rooms, someone had written, "I was at a wrestling match, and an adaptive control session broke out." In retrospect, Rohrs had brought to light an important issue that affected how adaptive control systems would be subsequently analyzed [22].

At the 1989 CDC in Tampa, Florida, General Chair Len Shaw told one of the more memorable jokes about control to the banquet crowd:

So a mathematician says to an engineer, "You engineers don't really understand optimal control. You don't really know the difference between H_∞ and L_2." The engineer replies, "I do so. I am going to die at aitch-infinity and I'll see you in 'el, too ." [23]

For the most part, the CDC has followed a policy of meeting in warm weather locations. Since 1970, only the 1991 CDC in Brighton, England, and the 1996 CDC in Kobe, Japan, have strayed from this pattern. Rumor has it that this warm weather tradition was originated to lure researchers out of cold weather locations in December.

Today, the CDC is a well-attended conference of international renown. For the most part, the venues are in the United States or nearby, although there have been some notable exceptions, including Athens in 1986, Brighton in 1991, Kobe in 1997, Sydney in 2002, and The Bahamas in 2004. By the same token, two CDCs have been held in Hawaii (1989 and 2003), with the official reason being stated as to make it more convenient for the Society's members from the Pacific Rim. The CDC retains its title as the main theoretical conference for the Society.

The Conference on Control Applications

As the CDC, and, to a lesser extent, the ACC, came to be dominated by papers on control theory, a movement developed to better respond to members' interest in control applications. Daniel Repperger, one of the driving forces behind the formation of the Conference on Control Applications (CCA), recalls:

Dr. Bernard Friedland developed a CAB (Conference Activity Board) position paper to describe a

The Editors of *IEEE Transactions on Automatic Control*

Throughout its history, *IEEE Transactions on Automatic Control* has had ten editors-in-chief:

- George S. Axelby was the founding editor serving from May 1956 to November 1968.
- John B. Lewis took over in December 1968.
- Jose B. Cruz took over in January 1971.
- Jerry Mendel took over in June 1973.
- Stephen Kahne took over in January 1975.
- Michael Sain took over in January 1979.
- Abe Haddad took over in June 1983.
- N. Harris McClamroch took over in January 1989.
- John Baillieul took over in July 1992.
- Christos Cassandras has served from July 1998 to the present.

number of ways the Society could better meet the needs of regional conferences, specialty conferences, and other groups that may be small in size. To solidify the differences expressed at the December 1988 CSS Board of Governors (BoG) meeting, Dr. Charles J. Herget formed a committee to investigate the issues regarding this type of conference.

One objective that seemed consistent in Friedland's position paper and the preliminary Herget committee report was the need to draw out the 70% of the membership who did not attend the major technical meetings held by the CSS. Many of these members worked in industry or were outside of the United States. At the June 1989 BoG meeting, Daniel W. Repperger and Pradeep Misra presented a proposal to hold an applications conference in Dayton. The venue (Dayton, Ohio) was selected primarily because of the Wright Patterson Air Force Base and the opportunity to emphasize aerospace applications—the central theme of the first conference. The initial goal was that each conference would focus on a set of applications relevant to the venue selected. The June 1989 BoG meeting had an intense and heated discussion on the need for such conferences and questioned whether such conferences would really meet the needs of the under-served 70%. An issue was the concern that the quality of papers received at such a conference might not be up to the Society's standards. The conference was not approved at the June 1989 BoG meeting.

However, in December 1989, Dr. Herget presented to the BoG an extensive report that responded to many of the issues discussed previously and developed a unified structure for such a conference. With the approval of this report, the BoG finally established the Conference on Control Applications (CCA).

At the first CCA held in September 1992, in Dayton, Ohio, D.W. Repperger served as the General Chair, and Pradeep Misra of Wright State University and Stephen Yurkovich of Ohio State University served as technical cochairs. The technical cochairs maintained the high level of standards for the papers and brought valuable experience on how to run the conference from a technical perspective. The CCA has turned out to be a success as noted at the tenth such event (Mexico City) on 5–7 September 2001 when it was observed that this conference had been held in Europe, Canada, and Latin America and was scheduled for Asia in the ensuing years. [24]

IEEE Transactions on Automatic Control

Perhaps no single effort has been as central to the Control Systems Society as *IEEE Transactions on Automatic Control*. *TAC* has had a consistent mission throughout its history: to be the premier archival journal for control theory [25], [26]. This effort led to some twists and turns along the way, including the alternately famous and infamous Information Dissemination Committee (IDC), which will be described below. Perhaps because of this early and continued emphasis, no aspect of the Society's history seems to have more documentation, both written accounts and facts burned into the memories of the participants. This section will be a summary of those memories [25], [27]–[29].

Throughout its history, *TAC* has had ten editors-in-chief (although early on the position was simply called editor). The journal began as *IRE Transactions on Automatic Control* in 1956, with typewritten pages. John Baillieul recalls the origins:

> In the early days, it was really a product of the dedication and energy of George Axelby. In looking back at the early issues, I get the feeling that despite the apparent intellectual excitement that pervaded the field, it was difficult to fill up the pages of the *Transactions*. Conference records (the IRE National Convention, WESCON) comprised the largest share of the content. This content diminished greatly over the years, and beginning with my term as EIC, conference submissions were never considered for publication in the *Transactions* since there was an independent Conference Editorial Board.

> There have been a number of changes in the way the editorial activities have been carried out over the years. For several years after the *Transactions'* inaugural issue in 1956, papers were selected by the editor (George S. Axelby) with the help of a Paper Study and Procurement Committee. This somewhat informal system was changed in 1965 when the Information Dissemination Committee was formed. [27]

As mentioned above, the PGAC established a transactions from the start, and the AIEE also published papers on control in *Transactions of the AIEE*. The merger of the IRE and AIEE included their publishing activities, and, after a number of name changes, the publication became known as *IEEE Transactions on Automatic Control (TAC)*. From the start *TAC* followed the tradition of the IRE in giving the editor latitude in selecting papers without requiring prior presentation at a conference. *TAC* became the principal journal for electrical engineers in control and with time became one of the premier journals in the world for papers on the theory of control. Selection of papers was made by the editor with the advice of chairs of technical committees and a body of reviewers. With the merger of AIEE and IRE, it was necessary to consider the organization of the publication of technical papers, which had been handled differently by the two parent organizations. While the AIEE had no journal corresponding to *TAC*, there was some resistance from the AIEE about simply continuing to organize *TAC* in the manner created by the IRE [28], [30].

At the time, there seemed to be several undercurrents behind this conflict. As described by Louis Kazda in 1986 [29], the IRE had taken a more theoretical route in control than the AIEE in the 1950s. Also, during the 1950s the IRE had grown more quickly than the AIEE and included stronger influence from academic circles. In the meantime, the AIEE, dominated by members from industry, had grown more slowly. Thus, at the merger, there seemed to be some hesitancy from the AIEE members to yield to the IRE structure for *TAC*. Second, Louis Kazda and other AIEE members were reluctant to entrust too much power in the editor [31], wanting to retain a structure similar to the AIEE tradition of having papers discussed before their publication.

Thus, in 1963, Lou Kazda proposed establishing the IDC as a solution to the problem. This committee would be responsible for the review of papers, the scheduling of sessions on control at conferences, and the publication of *TAC*. The IDC would be chaired by the vice chair of the Administration Committee, and members would include the editor of *TAC*, the editor of the newsletter, and chairs of the various technical committees. This idea was implemented in 1964 and the IDC was mentioned in a brief note by George Axelby in October 1964 [32]. The January 1965 *TAC* was the first issue published under the guidance of the IDC [33].

Although some regarded the IDC oversight as a potential challenge to the role and skills of George Axelby as editor, he had the foresight to see the benefit of this structure:

> Actually, when Lou Kazda told me in a rather threatening way that the paper reviewing and selection process would have to change, and that my authority would be greatly diminished, I believe that he thought I would object strenuously, perhaps even threaten to resign, which he may have hoped, but I believe my reply was simply "OK." However, in reality, I thought that it was a great idea: my workload would be greatly diminished, the review and selection process would be in more qualified hands than mine. Consequently, I remained as editor of the *IEEE Transactions.* [34]

The IDC became a central feature of *TAC* and, by extension, of the Society itself, for many years. The IDC was perhaps a unique entity among all IEEE journals, in that every paper published by *TAC* had to gain unanimous approval of the IDC members. Papers were submitted to the editor of *TAC*, distributed to the appropriate technical chairs to arrange reviews, and then the final choices were made by the IDC [29]. The review process itself was fairly rigid [35]. Three types of reviewers were sought for each paper:

- A new Ph.D. who would check every equation of the paper to make sure it was correct.
- Someone doing work in a similar area. This person would be able to review the value of the paper to that particular area.
- A mature generalist. This person could put the paper in the context as far as interest to the entire field.

By seeking at least one of each of these types of reviewers for each paper, the IDC hoped to completely understand the importance and value of every paper.

At first the IDC held quarterly meetings at the New York headquarters of the IEEE to make the final selection of accepted papers. Every paper to be published was to be discussed in these meetings. Mike Athans, an influential member of the committee and the Society in the early years, recalls the operation of the committee:

> The IDC was essentially comprised of associate editors with a specific area of expertise and with a maximum tenure of two years. However, a unique aspect of the IDC was that they would meet every three months (in pleasant surroundings) and discuss each and every paper, including the three written reviews obtained for each paper, and recommend its fate to the EIC. The IDC decisions were:
>
> 1) accept, as is (which almost never happened)
> 2) rewrite and resubmit as a regular paper (common)

3) rewrite and resubmit as a short paper (very common)
4) rewrite and resubmit as a correspondence item (very very common)
5) reject (very common).

It was not uncommon for a paper to be reviewed on the spot by the IDC members. I firmly believe that the extraordinarily high standards for publishing in *TAC* trace their roots to the IDC process (often likened to the Holy Inquisition by frustrated authors). When an IDC member had his paper under review, he would leave the room with the certain knowledge that his paper would be scrutinized to the nth degree! To the best of my knowledge, no other IEEE Group or Society had formal meetings of their associate editors like the IDC did.

One may wonder why the Technical Committee chairs were willing to put up with such a formal and financially costly review process. In my case, a position shared by many other IDCers, it was due to the fact that our field was experiencing a very rapid growth with the introduction of optimal control, Kalman filtering, Lyapunov stability theory, and emerging software. The IDC meeting discussions provided very valuable knowledge (and intelligence on who is doing what) to the academics who knew in detail what was the state-of-the-art of the entire field a full year before publication. [28]

As time went on, the IDC meetings were moved to correspond with conferences, primarily the ACC, the CDC, and the IEEE ITERCON or ELECTRO [36], [37]. By the early 1980s, the meetings were held only twice a year, at the ACC and CDC [38]. The chair of the IDC was a vice president of the CSS, and this position was seen in part as a stepping stone toward the eventual presidency of the Society. In fact, Len Silverman of USC was the only vice president of the Society (and chair of the IDC) to not take the presidency of the CSS, quite possibly because he had just become dean of engineering at the University of Southern California (USC).

Eventually, the increasing number of submissions and the decrease in travel budgets ended the practicality of the IDC. By 1981, then CSS President Stephen Kahne proposed eliminating the IDC and returning to a more traditional associate editor structure [38]. Not only had the workload on the members of the IDC become crushing [36], but the IDC itself had become increasingly controversial over the years, resulting in repeated commentary and editorials in *TAC* and elsewhere. There were issues about who could and could not attend IDC meetings [37], [39], and the IDC was viewed as being overly conservative by many authors [36]. Finally, the CSS was a unified entity, and any misgivings of the original constituent groups were by then long forgotten.

It is not surprising that, with all publication decisions requiring the consensus of the entire IDC, *Transactions on Automatic Control* had high rejection rates. Influential members of the community wanted to see the system changed, and the IDC was formally abolished at the end of 1983. It had come under criticism by a number of people, including some senior members of the Society, for being "overly conservative." The IDC was replaced by the Technical Activities Board (TAB) which in turn was replaced by the Transactions Editorial Board (TEB). The TEB's operation was considerably streamlined, with publication decisions made by associate editors in consultation with the EIC and usually an associate editor at large. Meetings of the TEB were reduced to a day or less, occurring only twice a year—at ACC and CDC—and only "problem" papers were discussed. [27]

From the start of both the JACC (later to be ACC) and the CDC, papers submitted by members of the CSS for presentation were also reviewed through the IDC and later the TEB. As the conferences grew in stature and popularity, the burden of reviewing a huge number of papers became increasingly problematic for the Technical Committee Chairs, and was seen as interfering with their primary task of maintaining the high standards of *TAC*. Finally, in 1992 under the leadership of Editor-in-Chief Harris McClamroch, a Conference Editorial Board was established to handle the papers for the conferences, and the editors of *TAC* were released to go about their primary job [27], [28].

The next big change was brought about in 1992 by EIC N. Harris McClamroch who, together with colleagues on the CSS Executive Committee at the time, created the Conference Editorial Board to take over from the TEB the responsibility for ACC and CDC paper reviews. With this change, the annual number of regular papers handled by the TEB was reduced from about 1,200 to a little over 300. This change was huge!! It drastically reduced the rate of burnout of associate editors. [27]

It is hard to overstate the importance of the IDC to *TAC* and by extension to the CSS itself. The rigorous standards set by the IDC pervaded the Society. Perhaps because of these standards, *TAC* published nothing that could not be rigorously proved, thus pushing away application papers. This was a problem seen by the IDC itself, as recalled by Steve Kahne:

In the earliest issues of *TAC* we can find substantial applications contributions but the emphasis quickly moved to a theoretical bias. There were many discussions at the quarterly meetings of the

> Information Dissemination Committee (IDC), the paper selection meetings of the editorial staff, lamenting the fact that the journal was not attracting applications papers. The usual excuses were reviewed—potential authors of applications papers would not be rewarded by their employers for publishing "trade secrets," or universities not doing real applications work that lead to publishable papers, or toy problems being submitted as if they were applications papers, etc. It is not an exaggeration to say that this discussion took place over at least 30 years of the life of the journal. [17]

The IDC went so far as to instruct *TAC* readers on what constituted a good applications paper. In it, the IDC wanted *TAC* to be the "natural medium for all significant control applications. Not only do we provide the proper critical reviews of how control theory is applied, but we also serve as a unifying factor, or meeting grounds, among the various applications fields.'' The essay went on to list three types of controls applications and seven components of a good applications paper [40]. Even in this attempt to encourage more applications, the rigor of the IDC came through, and so, despite this recruitment, *TAC* became a publication largely concerned with control theory. This development is somewhat ironic given that the origins of the IDC lay with the concerns of the members of the AIEE, a society that had a less theoretical bent than the IRE. Still, the technical rigor remains with *TAC* to this day. As *TAC* squeezed out application papers, it also spurred the formation of both *IEEE Control Systems Magazine (CSM)* and *IEEE Transactions on Control Systems Technology (TCST)*. Furthermore, the conservatism of the CSS led directly to the formation of the IEEE Systems, Man, and Cybernetics Society [41].

Despite the crushing workload, most former members of the IDC look back on it fondly [28], [36]. Perhaps this is because every member of the IDC knew of every important development in control theory being discussed in the CSS—usually a year before its publication. Former members are also proud of the rigor and order that was brought to the field during a period of rapid expansion. Still, while few say it in a way that can be quoted, there is a feeling among many CSS members that the IDC concentrated too much decision-making power over what was and was not good material into too few hands.

As to the question of whether the IDC was positive or negative for the *Transactions*, George Axelby recalls:

> From my point of view, it was very positive. It was a pleasure to listen to the Technical Committee chairs discuss the papers under review and the reviews they had obtained. This was especially true if a proof of a theorem was doubtful or incorrect. The rest of the knowledgeable attendees would join the discussion which might become rather serious or even humorous, but was always lively. If an important change had to be made, the Committee Chair would contact the author and explain what had to be done to make the paper acceptable. After the change was made, the paper would be reviewed again. I certainly could not have done this as well, and the result was a better published paper. If the paper was found to be acceptable with only minor changes, then I would contact the author with directions for the corrections and preparations for publication.
>
> The meetings of the IDC were always held in a friendly atmosphere, and after the meetings, most of us would go to dinner at a restaurant recommended by the *New York Times*. However, when Nick Nichols became chair of the IDC, the ritual changed. Nick was very fond of pigs knuckles prepared in a German restaurant. Therefore a group of us would join him at Luchow's German restaurant in lower Manhattan—although not every one had pig knuckles. Afterward, some of us walked all the way back to our hotels in central Manhattan. I remember walking back with John Zaborsky and Harold Kushner and others, having pleasant conversation, but we had to hold John back at the cross street intersections because he thought that pedestrians should have the right of way even if the traffic light was red against him! Anyway we had many pleasant experiences in and out of the IDC meetings, and I believe that the IDC meetings were a benefit to the reputation of the *Transactions* although, unfortunately, the content became less oriented toward application papers. However, this trend started years before the IDC was created. [34]

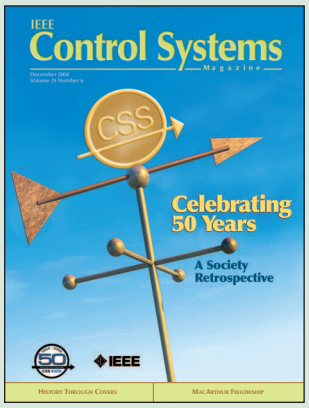
IEEE Control Systems Magazine Is Established

Although *TAC* developed into a premiere journal for papers on the theory of control, by the late 1970s there was strong support for a publication that would have a broader appeal to the membership, especially those in industry. This point of view was firmly supported by President Steve Kahne, and in 1981 it was decided to establish a magazine to be of interest to the general membership of the Society.

The founding editor of *CSM*, Mo Jamshidi, recalls the origins:

> In late 1970s the Control Systems Society (CSS) had recognized a need to reach out to the control engineers who are practicing in the industry. The Society had a "newsletter," edited by Prof. David L. Elliott of Washington University in St. Louis. The then president of CSS, Steven Kahne, approached me to see if I was interested in establishing a new IEEE magazine to

The Editors of *IEEE Control Systems Magazine*



Throughout its history, *IEEE Control Systems Magazine* has had five editors-in-chief:

- Mo Jamshidi was the founding editor and served from December 1981 to December 1984.
- Herb Rauch took over in January 1985.
- Steve Yurkovich took over in January 1993.
- Tariq Samad took over in January 1999.
- Dennis Bernstein took over in August 2003.

reach out to the practicing members of the Society as well as readers/members who are applying control theory to a real-time situation, be it in a laboratory or factory floor. I accepted the challenge, and, by December 1980 at the CDC, we put out a brochure announcing the publication. I was chosen as the "editor," and in those days, we did not use editor-in-chief. As of 1985 when I stepped down, we had put out 16 issues. [42]

The magazine was run with an editor-in-chief position, a group of technical associate editors (AEs), and a manager at the main IEEE office, as well as an associate editor for advertisements. Throughout its history, *CSM* has had five editors-in-chief. Although new AE positions have been added since then, the basic organizational structure set up then remains largely in place today [42].

Under the guidance of Mo Jamshidi, the magazine grew from a newsletter to a full magazine published four times a year with 32 pages per issue. In the early days, one of the main challenges for the magazine was getting the attention of the general Society members [42]. The magazine tried, then as now, to "have a balance between control applications, industrial control, control education, and surveys" [42].

Mo recalls that early on there was difficulty in selling the magazine to the CSS members. There was a need for practice-oriented papers but not enough authors to provide a "healthy backlog" of technical papers with broad appeal. In those days the main topics in *CSM* were aerospace applications, automation (robotics), history, and education [42].

CSM was one of the earliest IEEE magazines to introduce the concept of a special issue, focusing on a specific topic. The first special issue of *CSM* was the last issue put together by Mo Jamshidi. Later on, Herb Rauch of Lockheed Palo Alto Research Laboratories introduced the idea of a special section, where a portion of the magazine was devoted to a specific topic [42]. The year 1984 corresponded to the Centennial of the IEEE, which each Society celebrated in its own way. The CSS decided to do a special issue on the history of control. The November 1984 issue featured articles by Toshiyuki Kitamori, Nobuhide Suda, Etsujiro Shimemura, Masami Masubuchi, Hidenori Kimura, Yutaka Yoshitani [43], Stuart Bennett [44], Winfried Oppelt [45], Isaac Horowitz [46], Seymour Herwald [68], and an article by Richard E. Bellman and E. Stanley Lee that was a combination of a history of dynamic programming and—being completed after the former's death—a memorial for Richard Bellman [47]. This set of authors spanned the United States, United Kingdom, Germany, and Japan. Besides Mo Jamshidi, the co-guest editors for that historical issue were the late Nate Nichols (of Nichols chart fame), George Axelby (founding editor of IEEE CSS *TAC*), and Ole Franksen (Technical University of Denmark), whom Mo knew from the past as a control engineering historian [42].

Herb Rauch took over from Mo in January 1985. Herb recalls that before taking the position of editor-in-chief,

> . . . Society officers told me that the four major goals for my tenure would be (more or less in this order)
> a) Do not spend more money than was approved.
> b) Try to get any papers at all submitted to the Magazine.
> c) Publish papers interesting to the practicing engineer in industry.
> d) Do not publish "so what" papers.

When Herb took over, almost every Society officer and most of the people involved with CSS publications were from academia. Herb's industrial perspective would over time tilt the magazine more toward the practicing engineer and the student [48], a focus that it still enjoys today.

During his tenure, Herb sought to increase the size of the magazine. Being limited by page costs to 128 pages for 1985, he front loaded the February issue with 48 pages, using the Keynote Speech from the 1984 ACC by Robert A. Frosch as the keynote article of the issue [49]. Furthermore, he recruited practical engineering articles from Bill Powers [50] (Ford Motor Company Research Lab) and Austin Spang [51] (General Electric Corporate Research and Development) to accompany the keynote article. Articles by Donald Fraser [52] (Charles Stark Draper Laboratory) and Allen Stubberud [53] (Chief Scientist of the United States Air Force) rounded out a very practically oriented issue. To keep under the cost limit for the year, the November 1985 issue would be limited to 16 pages [48].

In a close vote, the Society voted to increase the 1986 page count to 192 pages, allowing six issues to be published that year. In the years that followed, the Society officers would increase the page count of the magazine steadily

every year. In fact, for three years, there was a special seventh issue in January of the next year to accommodate the backlog of accepted papers from the previous year.

The February 1985 issue set a pattern that Herb followed during his tenure as editor-in-chief, which was to use conference papers as the primary source for contributions. In particular, Herb reviewed each day's volume of the ACC proceedings and generated a dozen potential articles for solicitation. From these he would get approximately nine replies and six published articles. In a typical year, Herb recruited about 50 articles, of which roughly two-thirds were accepted, while about one-third of the 50 or so contributed articles were published [48].

Another innovation was the joint issue with other Societies:

> We hit the jackpot when Bill Perkins suggested a joint issue with the IEEE Industrial Applications Society. Papers would be solicited from their annual meeting, and the resulting special issue would go to members of both Societies. That arrangement was followed by similar arrangements with the IEEE Robotics and Automation Society and the IEEE Systems, Man, and Cybernetics Society. These three Societies did not have a magazine.
>
> Each of the three arrangements resulted in a separate annual special issue. *IEEE Control Systems Magazine* had about 11,000 subscribers. When the special issue went to another Society, there would be about 10,000 additional subscribers.
>
> I would get the appropriate proceedings by mail and very carefully slant my solicitation toward special topics that should be of interest to readers in both Societies. That is how the magazine got a special issue on "Image Understanding" from System, Man and Cybernetics and another Special Issue on "Control Applications from Japan" from Industrial Applications. [48]

During Herb's tenure, the magazine achieved its goal of publishing articles interesting to the practicing engineer in industry, for which he gives full credit to his associate editors. The goal of avoiding "so what" papers often took some delicacy, but with issues like the February 1992 special issue on Robotics and Automation, which featured seven articles, three technical notes, and 14 Society news items, it is obvious that Herb's goals had been achieved. *CSM* had moved from its infancy to one of the most vital instruments of the Society. It is no small wonder that Herb would show up at conferences in those years sporting his trademark black leather vest, an armful of the latest *CSM* issues, and a big smile.

During its history, *CSM* has grown in size and caliber. What started as an extension of a Society newsletter has grown steadily into a highly polished format with full color in most of the articles. This evolution was gradual as each editor-in-chief put their mark on the magazine. Between June and August 1992, as Herb Rauch was wrapping up his tenure, the magazine went from three to two columns [54]. Steve Yurkovich recalls trips between the editorial offices in New York and his office in Columbus, Ohio, to prepare for another format change in early 1993. The look of the articles was adjusted, but more importantly a different look was established for "columns" versus "departments" versus "features."

Steve recalls advice given to him by Herb before he took over as the editor-in-chief of *CSM*:

> The magazine EIC is an extremely important position in the IEEE CSS, primarily because the potential for broad readership and appeal of the magazine (if things are done right!) allow the EIC to emboss his/her mark not only on the publication itself, but also on the trends and philosophies of the field in general (albeit in a small way). I always took this advice seriously and regarded the EIC position as one with a large amount of responsibility toward the field. [55]

During Steve's tenure, the "From the Editor" column was greatly expanded. Technical articles were grouped together with no advertising in between. Steve insisted that the table of contents be the first thing the reader saw when opening the magazine. The changes must have been appreciated, as the Society for Technical Communication gave the "Excellence Award in the Magazines category of the 1995–1996 International Technical Publications Competition" to *CSM* on 18 April 1996. The award recognized Steve Yurkovich (as EIC) and Gregory Ross and Janet Dudar (IEEE staff).

When Tariq Samad took over, he continued to modify the look of the magazine. Sacrificing the color bar on the cover for an improved overall cover look, he pushed for the magazine to be more of a "read it now" publication [56]. Modifications to the font, an increase in the use of graphics and color, and more careful copy editing were all aimed at giving the articles a more uniform, polished feel. Authors of that time period may recall having to turn all their Latex articles into Microsoft Word documents (using a variety of dubious translators). Also, the use of authors' photos, often of inconsistent quality, was eliminated. Tariq also introduced several new columns including "Feedforward," "Student Guides," and "Lecture Notes" [57]. Finally, a "Lighter Side" column was added as a regular feature, a practice that has continued into Dennis Bernstein's tenure. Tariq also undertook some changes to the editorial board:

> To better reflect the changing demographics of our Society, I wanted the magazine's editorial board to have more industrial and government representation, more non-United States members, and more women. We were modestly successful in all these respects, although several of my nonacademic AEs didn't last in one or the other job—some left the board, others went to academia! [56]

Dennis Bernstein, who assumed the EIC position in August 2003, has taken his own tack, especially in trying to increase the educational content of the magazine [58]. Along with a return to the use of Latex, Dennis' editorial changes involved the elimination of footnotes, the requirement of informative figure captions, the inclusion of a story stop (a mark delineating the end of the story), and the creation of a new set of guidelines to unify and upgrade the writing style. The "Lighter Side" column now has a professional artist, and there are new columns, including "People in Control," which features control practitioners, and "Applications of Control," which covers industrial applications. Dennis also expanded the editorial board to broaden the coverage of *CSM*. Currently, in addition to a complement of AEs, the editorial board includes an associate editor for education, an associate editor for history, and three corresponding editors, whose task is to solicit contributions from industry worldwide for the "Applications of Control" column. Dennis' editorials are aimed at broadening the scope of *CSM* by relating control technology to both technological and social concerns. His December 2003 editorial titled "Control Engineering Month," published on the occasion of the 100th anniversary of controlled flight, was awarded the Silver Medal for Editorials in the 2004 SNAP (Society for National Association Publications) Excel Awards competition [57].

During its history, *CSM* has seen its themes change from mainly aerospace, industrial, and automotive control systems in the early 1980s to the more diverse topics that control engineers find themselves working in these days, such as the use of the Web for both control systems and control education, issues in control over wireless networks, applications of control to biological systems and health problems, issues with modern robotic systems, and control education for the new century [58]. Along the way, each editor-in-chief has put his own distinct stamp on what has become the heartbeat of the Society. Some trends have been pervasive. For example, all five editors spoke of the difficulty of getting enough industrial content. In fact, the articles generally were submitted by academics about 80% of the time, with practicing controls engineers making up most of the other 20% aside from a some small fraction from government labs.

CSM is unique among the CSS publications in that it accepts advertising, features regular columns and Society news, and seeks out historical and tutorial articles. As such, *CSM* has a broad readership throughout the Society and often contains the pulse of the Society. As Tariq puts it:

> It's probably been part of every EIC's vision for the *Magazine* that it should appeal to all members of the CSS. Theory-inclined researchers, industrial practitioners, educators, decision makers in industry and government, students anticipating a career in control systems . . . our membership is a diverse lot, and material of considerable interest to one subset may well go unread by another. The *Magazine* therefore has to package a considerable variety of material. And let's not forget that it is also the official organ of the Society and thus is responsible for archiving such scintillating stuff as the minutes of the Board of Governors meetings! This range of content, which distinguishes it from the *Transactions* of our Society, makes being at its helm more interesting (in my opinion, anyway) from the latter, and at the same time creates special challenges. [56]

IEEE Transactions on Control Systems Technology Is Created

Despite the success of *TAC* as the premier journal for control theory and the success of *CSM* as a general interest magazine of application, tutorial, survey, and history articles, there was a perceived void for archival articles on industrial applications and applied theory. "It was felt that a new journal focusing on industrial applications would be more relevant to industrial members of CSS" [59].

Bruce Krogh, founding editor of *TCST* recalls the origins:

> The concept for *TCST* was put forth in a brief paper that I distributed to the IEEE CSS BoG in 1991 entitled "Who's in Control?" This paper suggested that the *TAC* did not represent well the breadth of research in the control community, and proposed *TCST* as a new outlet for papers focusing on innovations in the design and implementation of real systems. Although there is some overlap in the types of papers that would be accepted for publication in *TCST* and *CSM*, *TCST* is an archival journal, whereas *CSM* publishes articles related to the interests and activities of the CSS membership beyond just technical papers. [63]

When he read Bruce's paper, then CSS President Alan Laub jumped on the idea.

> Yes, I consider *TCST* "my baby." Actually, the real work was done by Bruce. He submitted the proposal to the CSS officially in 1991 during my tenure as president. I thought the proposal was absolutely brilliant and exactly what the Society needed. Naturally, there were some conservative types around (especially on the fiscal side), but since we were rather flush with funds in those days, I managed to convince everyone on the Exec Comm that this was the way to go. It definitely required a bit of careful administrative "push." With the benefit of 20–20 hindsight, I think we made a great decision because I think *TCST* has really helped identify the CSS with myriad control applications. [60]

The approval for *TCST* came during Abe Haddad's term in 1992:

> I was president when the creation of *TCST* was approved. The driving force came from people like Alan Laub and Steve Kahne. Steve brought up the creation of the IFAC journal Control Engineering Practice and that we needed to do something similar. *TAC* was a great journal but it could not be changed to serve as both technology and theory (it did a wonderful job with theory but its attempts to cover technology were not very successful).
>
> At the IEEE TAB meetings there was opposition to the journal by the Industrial Electronics (IE) and Industry Applications (IA) Societies, who were afraid that our proposed *TCST* would compete with their journals. We prevailed by allowing them to suggest associate editors for the journal.
>
> Bruce Krogh was doing work that we felt fit the *TCST* concept, so he was picked to be first editor of the journal. [61]

Throughout its history, *TCST* has had four editors-in-chief. Focused on industrial applications and applied theory, *TCST* enforced a policy to exclude any papers that were purely theoretical or without significant application content [62]. Even so, most of the papers had academic origins, with some estimates of the origins being 80% academic, 10% industrial, and 10% government/military [63].

For the first three years, *TCST* was published four times per year (in March, June, September, and December). It then went to six times a year in 1996, alternating months with *CSM*. The number of pages has grown steadily, from 293 pages in 1993 to 974 pages in 2003 [63]. Also in 1996, *TCST* became a separate subscription from the Society membership. By July 2000, paper submissions were done electronically [62].

The range of applications presented in *TCST* has always been very broad—ranging from drug delivery systems and traffic control, to more standard topics such as automotive control and electric motor and drive control. In more recent years, papers on discrete-event systems and fuzzy control have shown up and

> ... the dominance of the military in control research has diminished. Advanced control technology is now being pursued for many civilian applications. There has also been a tremendous growth in the range of applications of controls, with exciting new areas emerging. Examples include communication networks, nanotechnology, and others. In addition, new problems and technologies are also emerging in more traditional areas such as robotics and automobiles. [62]

The Editors of *IEEE Transactions on Control Systems Technology*

Throughout its history, *IEEE Transactions on Control Systems Technology* has had four editors-in-chief:

- Bruce Krogh was the founding editor from January 1993 to December 1996, although his work started in 1992.
- Mark Spong served from January 1997 to December 1999.
- Sebastian Engell also served as co-editor during the period from 1993 to 2000.
- Marc Bodson served from January 2000 to December 2003.
- Frank Doyle is the current EIC. His term started in January 2004.

Early on, it was thought that getting a regular supply of good papers would be a major issue, but this proved to be unfounded [63]. However, getting AEs and authors from industry seems to have been a persistent challenge, since industrial researchers are rarely rewarded for and often not encouraged in such pursuits [59], [63]. Although the stated goal is to have a minimum of 50% AEs from industry and government, this level has been hard to attain [62]. In fact, Bruce Krogh recalls two of his industrial AEs becoming professors during his tenure [63].

As time went on, the limited number of pages in the journal resulted in a substantial backlog of papers, which was resolved at the beginning of Marc Bodson's tenure with a large increase in page count [59]. However, this change also resulted in a large increase in submissions (from 196 papers in 1999 to 283 papers in 2002). A new electronic submissions process was being phased in at the time [62].

Today, as in the beginning, *TCST* is an archival journal that focuses on meeting the needs of practicing engineers. Its struggles largely involve getting the participation of those same engineers for whom the journal is intended.

Automatica

In 1963, a new journal on control called *Automatica* was published by Pergamon, a publishing house specializing in scientific journals and owned by then British publishing mogul Robert Maxwell. The history of *Automatica* is related to the CSS for three distinct reasons. First, as the CSS is a member

of the AACC, which in turn is a member of IFAC, the official controls journal of IFAC is of interest to the members of the CSS. Second, since *Automatica* has become the official journal of IFAC and a competitor to the CSS *TAC*, its history is of interest here. Finally, *Automatica* was strongly influenced by CSS members, perhaps none more clearly than George Axelby, founding editor of *TAC* and the most distinguished editor of *Automatica*. George recalls the story this way:

> *Automatica* was not the official IFAC journal from the start. It was created by Robert Maxwell himself because he had become a member of Parliament, House of Commons, Labor Party, and he wanted to have a journal to show that he had an interest in automation and automatic control. In fact, he intended to gain international attention with the publication of the journal which he named *Automatica*. To help gain recognition, he appointed 35 internationally known members of an Honorary Editorial Advisory Board all well known in the control field. Harold Chestnut was chair of the Board. There were four executive editors: J.A. Aseltine, V. Broida, G.D.S. MacLellan, and H.M. Paynter. I was a member of the Board but was not an editor of the journal. Actually, like all the other honorary editors, I was never asked to do anything.
>
> The first issue of Maxwell's *Automatica* was published in Jan/Mar 1963 with a forward by Advisory Board Chairman H. Chestnut, and A. Tustin claiming that *Automatica* would become an international journal. The cover was printed in an orange-brown color with white and black lettering. The size of the journal was $7\frac{1}{2}$ by $9\frac{3}{4}$ inches, perhaps a European standard size, but not compatible with the size of other technical journals. It did not have a very attractive appearance in my opinion.
>
> Unfortunately, the journal did not enjoy the success that was expected. It was supposed to be published four times a year, but Vol. 4, No. 1 was published in May 1966, No. 2 in December 1966, No. 3 in August 1967, with 54, 41 (two papers), and 67 pages, respectively. Since Maxwell always sold subscriptions for Pergamon journals to libraries all over the world, the libraries must have been rather annoyed. However, the third IFAC Congress was held in London during the summer of 1966. Of course Maxwell knew that it was an international automatic control organization without a journal. Knowing that Hal Chestnut and John Coales, both presidents of IFAC, would have considerable influence in IFAC, he contacted them and proposed that his *Automatica* become the official IFAC journal. After two years of negotiation, an agreement was reached and there was an announcement in Vol. 4, Numbers 5/6, November 1968, that an agreement had been reached and that publication in the new format would commence in January 1969.
>
> Meanwhile, I was in London attending the Congress and intending to attend a luncheon for all the honorary editors being held by Maxwell. However, at the time the luncheon was to be held, I was delayed by extended activities at a technical session in which I participated, held in Westminster Abbey buildings. Because I was quite late I decided to have lunch elsewhere, but then changed my mind and went to the editors' luncheon which was being held in a large building beside the Thames River. I was served sitting beside some Russian friends I came to know at the Moscow Congress. They were planning to leave as soon as possible to tour London, and I agreed to go with them. As we were leaving, my name was called by Chestnut and Coales. They told me not to leave because Maxwell wanted to talk to me.
>
> We went back to a side room where Maxwell was waiting. It was the first time that I had ever met him. After the brief introduction, he asked me to become the first editor of the new IFAC journal *Automatica*! I thanked him for the invitation but stated that I could not accept because I was already an editor of the transactions and I was employed by a company, Westinghouse, which was involved in classified defense work. Thus, a position on an international journal would probably not be acceptable. I think that Maxwell, Coales, and Chestnut were all quite shocked at my response. They all were expecting me to respond with an eager, "Yes." It was hardly ever that anyone refused an offer from Robert Maxwell. As I left they asked me to think about it.
>
> After returning home, I forgot about the offer, but soon the invitation was sent to me in writing. I started to write a letter stating that my manager would not let me be an editor of an international journal, as I had stated in London. However, before sending the letter, I showed it to my manager. He showed it to higher management and they said that I should accept the offer, which I did to the Pergamon representative with conditions under which I would serve, such as: my design of the front cover, increased size of the journal, I would be the only editor responsible for all technical material published in the journal, I would select my own editorial staff, my expenses would be paid to attend IFAC meetings to obtain material for possible publication in the journal, and material being considered for publication by the present editors would be evaluated and published in the last issue of the original *Automatica* or rejected because I did not wish to consider them unless they were submitted to me as new papers. After several months of negotiations and dozens of letters, the

conditions were accepted, and I became the first editor of the new IFAC journal *Automatica*. This was announced in Vol. 4, Numbers 5/6, November 1968, the last issue of the original *Automatica*.

The Editorial Board decided to continue publication of the abstracts in the four official IFAC languages: English, French, German, and Russian, but the main texts would be published only in English. After about two years, it was found that publishing abstracts in anything but English was not practical, and this practice was discontinued. [30]

PaperPlaza

The past couple years have seen a dramatic improvement in the flexibility, accessibility, and usability of the conference paper logging system. This advance is due to the extraordinary work done by the team putting together PaperPlaza, the new, online paper submission and management system used increasingly by CSS affiliated conferences. For anyone who has been in a recent conference program committee meeting after a full day of creating sessions, when there are just a few session slots to fill and a handful of reasonable paper reviews (and one of the authors of this retrospective has), it is amazing how quickly Thomas Parisini and his crew can make the relevant information available.

Len Shaw, who was CSS President when PaperPlaza was first implemented, recalls its origins:

> The most significant "event" during my presidential year of 2002 was the development and implementation of PaperPlaza for the electronic management of conference papers—a development for which I can claim very little credit. (External advances in information technology had an impact on this event.) That development removed a "sword of Damocles" from nightmares suffered by Executive Committee members for several years. The software developed under the guidance of Jim and Yan Zhu for the first-generation system had allowed the Conference Editorial Board to make a huge improvement in the efficiency of paper evaluation. However, much of the software was incompletely documented and not scalable, and it used obsolescent platforms. It seemed that the wisdom of the system designers was essential to continued operation and not transferable to others.
>
> Despite being the main item on the agenda of the Long-Range Planning Committee for several years, finding a way to achieve modernization and a smooth transition to a new paper-handling system seemed to defy solution. As usual, the problem was solved as a result of the wisdom, dedication, and creativity of a few individuals. The Gordian knot was cut by Tamer Basar, who had agonized about the same problem when he was president two years earlier, and who appreciated the effectiveness of a similar system that Huibert Kwakernaak had developed for handling papers submitted to *Automatica*. Tamer had the idea that Huibert might be interested in the challenge of developing a system for the CEB, at a time when he was retiring from his faculty position and stepping down as editor-in-chief of *Automatica*. Roberto Tempo, who also had worked closely with Huibert, and who was the current CSS Conference VP, supported this idea and helped build Huibert's interest in the project. Pradeep Misra offered his information system skills and interpersonal skills to develop system specifications and transition implementation, as the link between Huibert and those who were operating the legacy system. All that I did was oversee the mechanics and hold lots of discussions to smooth the kind of personal sensitivities that are exposed in this kind of a changing of the guard. My selection of Thomas Parisini as "chair-elect" of the Conference Editorial Board probably was a key factor in the successful transition to the new system. [23]

Issues Through the Years

In all the material, editorial, and e-mails that one reads in assembling an article such as this, several consistent themes seem to appear year after year. This section will highlight some of those.

Theoretical rigor seems to have been a big thrust in the early days of the Society. It seems that the trends started at the 1960 IFAC and actions of the IDC largely ensured theoretical rigor in *TAC*, although some of the consequences resulted in the need for other journals, such as *CSM* and *TCST*, to accommodate more applied papers.

Furthermore, the adherence to theory in *TAC* and the CDC has often limited their appeal to practicing engineers. The Society has attempted to address this limitation through *CSM*, *TCST*, the CCA, and the addition of industrial and tutorial tracks at the ACC.

Industrial participation, or the lack thereof, also shows up in the level of industrial authorship in papers and participation on editorial boards. Virtually every editor-in-chief of *TAC*, *TCST*, and *CSM* has spoken about the difficulty in getting not only AEs from industry, but also procuring paper submissions from industry. In some situations, the most successful recruitments resulted in the AE becoming a professor before their term was up.

There seems to be no simple solution to increasing industrial participation. Although industrial participants receive credit for their publications, it is rarely part of their job description as it is for academics. Thus, George Axelby, Herb Rauch, and Tariq Samad are a rare breed: those who can be effective EICs and hold industrial jobs at the same time.

The ACC does an admirable job of trying to reach out to industrial participants with the industrial/tutorial track. Furthermore, the 2004 ACC featured a special session organized by Zhiqiang Gao and Russell Rhinehart on the theory versus practice divide [64]. More efforts in these directions are constantly being discussed at the ACC organizing meetings.

Still, it remains the case that 80% to 90% of papers presented at CSS conferences and published in CSS journals are of academic origin. Rather than being a recent trend, this situation seems to pervade editorials dating back to the early days of *TAC*. As George Axelby recalls:

> In the late 1950s, it became apparent to many control engineers that papers in automatic control publications were becoming more theoretical than applications oriented without giving any connection between the two fields: theory and application. They seemed to be becoming separate fields of interest, which they should not because control implies control of some physical process. This apparent separation became known as the GAP and it was a concern to many control engineers—especially in industry. Consequently, I wrote editorials about it. To my surprise, Rudy Kalman, of all people, congratulated me for writing an editorial about the GAP! However the subject generated enough interest that a two-day symposium on the GAP was held in Washington, DC, and Harold Chestnut wrote an editorial about it. However, in spite of the attention given to it, the GAP grew, especially after the 1960 IFAC Congress where the famous papers by Kalman, Bellman, and Pontryagin et. al., provided a basis for years of theoretical research especially in universities, and, of course, many more theoretical research papers from universities to be published. At the same time, it was difficult to obtain application papers from industries during the cold war because of proprietary claims and security limitations. Then, later because of the established reputation of the *Transactions* as a journal which catered to theoretical papers, fewer applications papers were submitted to the *Transactions*, and there was an opening for the excellent application publications that you mentioned. [34]

Attracting volunteers for offices is something that every Society has to do and the CSS is no exception. The health of the Society has been keyed to the efforts of these volunteers, as editors, Society officers, conference chairs, and authors. This article can only illustrate a small fraction of the work that has been done by these volunteers through the years.

The member base grew from 1,200 members in 1956 to about 4,000 by 1962. By the late 1980s and into the 1990s, the membership was well over 10,000, but recent years have seen a decrease to around 8,500 members in 2003. There have been several events that might have played a role in this decrease. Certainly, the tech crash of 2001 played a role, but Society membership was dropping even before then. The Society periodicals are available on-line at most large institutions, lowering the perceived benefits such as subscription discounts to many IEEE members. By the same token, many of the traditional industries that created a need for controls engineers have been contracting in the past decade.

While the AIEE started as an American organization, the IEEE representation these days is global. Thus, the CSS finds itself reaching out across the world to new chapters in remote locations. The Member Activities Board, which meets at every ACC and CDC, is heavily involved in this effort, providing financial support for conference attendance and support for sending distinguished lecturers to speak at chapters all over the world. In a related international activity, the CSS had a Human Rights Committee, headed by Jerry Mendel of USC, which aided disenfranchised controls engineers in the former Soviet Union, mostly Jewish engineers who lost their jobs upon requesting to emigrate. The discussions now include topics on how to use inexpensive telecommunications and data storage to bring some of the conference activities to remote members.

The Society has made continual efforts to become more inclusive, particularly for women and minorities. The Society has had two female presidents over the years, Jane Cullum and Cheryl Schrader, and there has been an ongoing and increasing effort to engage women in Society activities. A Women in Control group meets at every ACC and CDC to discuss issues specific to female controls researchers and practitioners.

The finances of the Society have had their ups and downs. Ambitious projects, such as the start of *CSM* and the publication of a 25-year index of *TAC* were undertaken during Stephen Kahne's term as president. Though wildly successful, the projects were also expensive and it was left to the term of Ted Davidson to reorganize the dues of the Society, separating *TAC* and *TCST* subscriptions from membership, to finally restore the bank accounts. By the same token, the subsequent 35-year index of *TAC* was also expensive but useful. During Len Shaw's presidency, the highly useful DVD archive of *TAC*, *CSM*, and *TCST* from 1956 to 2001 was published. Again, this archive has been highly useful to anyone who has gotten a copy—including the authors of this retrospective. However, the demand for the archive was overestimated—possibly due in part to the expansion of the IEEE's on-line XPLORE service—resulting in the CSS being saddled with additional copies offered at fire sale prices.

Where CSS Is Today

One may think of the Society in Dickensian terms: It is the best of times, it is the worst of times. Looking over recent

years, we have seen the traditional applications that funded research into control systems—such as aerospace, storage, and automotive—shrink their investments. Although control engineers participated in neither the Internet nor Telecom bubbles of the late 1990s, many were swept up in the wave of job losses that followed the crash of 2001. This loss is reflected in a shrinking membership base for the Society and for the IEEE, in reduced corporate and government sponsorship of university research, and in reduced travel funding for participation in conferences.

At the same time, the base of applications that go begging for work based on controls and system theory is more diverse now than ever before. The availability of inexpensive sensors, actuators, and computation have allowed feedback loops in washing machines and rice cookers, although it seems that the traditional controls community has ignored these applications, effectively ceding them to less traditional researchers such as those doing fuzzy control [65]. By the same token, the drop in hardware cost has allowed large systems that rely on information flow between many smaller feedback systems to emerge as reasonable problems. A recent series of NSF-sponsored symposia has pointed out both the issues and the promise of such problems [66] as areas that need control research, but at the same time do not lend themselves to closed-form solutions. Technologies such as the Internet and bioscience, which until recently had neither asked for nor gotten much attention from control researchers, are now fertile fields for our work. The rise of an information-rich world changes some of the fundamental assumptions on which many of our results were based [66], [67], while at the same time opening huge opportunities for adapting ourselves. As the ad hoc methods of analyzing these new applications are running out of steam, domain experts are turning to researchers in control and system theory to develop algorithms, theories, and models. The future belongs to those who are robust and can adapt. Such tasks should be easy for Society members, with or without the convergence proof.

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References

[1] D.A. Mindell, "Antiaircraft fire control and the development of integrated systems at Sperry, 1925–1940," *IEEE Contr. Syst. Mag.*, vol. 15, pp. 108–113, Apr. 1995.

[2] D.A. Mindell, "Engineers, psychologists, and administrators: Control systems research in wartime, 1940–45," *IEEE Contr. Syst. Mag.*, vol. 15, pp. 91–99, Aug. 1995.

[3] D.A. Mindell, "Automation's finest hour: Bell Labs and automatic control in World War II," *IEEE Contr. Syst. Mag.*, vol. 15, pp. 72–78, Dec. 1995.

[4] D.A. Mindell, *Between Human and Machine: Feedback, Control, and Computing Before Cybernetics*. Baltimore, MD: Johns Hopkins Univ. Press, 2002.

[5] J.E. Ward, "Predecessors of the IEEE Control Systems Society," *IEEE Contr. Syst. Mag.*, vol. 7, pp. 76–77, Feb. 1987.

[6] G.S. Axelby, "New guidance," *IEEE Trans Automat. Contr.* vol. 13, p. 461, Oct. 1968.

[7] "George Axelby Award," *IEEE Contr. Syst. Mag.*, vol. 8, pp. 97–98, Apr. 1988.

[8] S. Kahne, "Where is the beef?," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 3–8, May 1985.

[9] J. Zaborsky, "A report," *IEEE Trans. Automat. Contr.*, vol. 15, pp. 617–619, Oct. 1970.

[10] E.A. Feigenbaum, "Soviet cybernetics and computer sciences, 1960," *Commun. ACM*, vol. 4, pp. 566–579, Dec. 1961.

[11] B. Widrow, "Recollections of Norbert Wiener and the first IFAC World Congress," *IEEE Contr. Syst. Mag.*, vol. 21, pp. 65–70, June 2001.

[12] S. Kahne, "From IFAC: A history of the IFAC Congress," *IEEE Contr. Syst. Mag.*, vol. 16, pp. 10–12, 78–83, June 1996.

[13] R. Kalman, "On the general theory of control systems," *IRE Trans. Automat. Contr.,* vol. 4, pp. 110–110, Dec. 1959.

[14] R. Kalman and J. Bertram, "General approach to control theory based on the methods of Lyapunov," *IRE Trans. Automat. Contr.*, vol. 4, pp. 20–20, Dec. 1959.

[15] R. Kalman and J. Bertram, "Control system analysis and design via the second method of Lyapunov: (I) continuous-time systems (II) discrete time systems," *IRE Trans. Automat. Contr.*, vol. 4, pp. 112–112, Dec. 1959.

[16] G. Axelby, private communication, Mar. 2004.

[17] S. Kahne, private communication, Aug. 2004.

[18] G. Stein, "Respect the unstable," presented at the 1989 IEEE Conf. Decision and Control, Tampa, FL.

[19] G. Stein, "Respect the unstable," *IEEE Contr. Syst. Mag.*, vol. 23, pp. 12–25, Aug. 2003.

[20] D. Abramovitch and L. Bushnell, "Report on the 'Fuzzy versus Conventional Control Debate'," *IEEE Contr. Syst. Mag.*, vol. 19, pp. 88–91, June 1999.

[21] C.E. Rohrs, L. Valavani, M. Athans, and G. Stein, "Robustness of adaptive control algorithms in the presence of unmodeled dynamics," in *Proc. 21st IEEE Conf. Decision and Control*, Orlando, FL, 1982, pp. 3–11.

[22] C.E. Rohrs, L. Valavani, M. Athans, and G. Stein, "Robustness of continuous-time adaptive control algorithms in the presence of unmodeled dynamics," *IEEE Trans. Automat. Contr.*, vol. 30, pp. 881–889, Sept. 1985.

[23] L. Shaw, private communication, Apr. 2, 2004.

[24] D. Repperger, private communication, June 2, 2004.

[25] H. McClamroch, private communication, Mar. 13, 2004.

[26] A. Haddad, private communication, Mar. 13, 2004.

[27] J. Baillieul, private communication, Mar. 12, 2004.

[28] M. Athans, private communication, Apr. 24, 2004.

[29] L.F. Kazda, "The way it was," *IEEE Contr. Syst. Mag.*, vol. 6, pp. 15–16, Dec. 1986.

[30] G. Axelby, private communication, May 3, 2004.

[31] G. Axelby, private communication, May 18, 2004.

[32] G.S. Axelby, "Paper reviewing, selecting, and rejecting," *IEEE Trans. Automat. Contr.*, vol. 9, pp. 327–328, Oct. 1964.

[33] L.F. Kazda, "The information dissemination committee," *IEEE Trans. Automat. Contr.*, vol. 10, p. 1, Jan. 1965.

[34] G. Axelby, private communication, July 2004.

[35] S. Kahne, "Editorial: Reviews and reviewers," *IEEE Trans. Automat. Contr.*, vol. 21, p. 625, Apr. 1976.

[36] J. Baillieul. The Control Systems Society TAB [Online]. Available: www.ieeecss.org/TAB/history.html

[37] E.I. Axelband, "Editorial: The IDC," *IEEE Trans. Automat. Contr.*, vol. 20, p. 589, Oct. 1975.

[38] S. Kahne, "Where do we go from here?—A proposal for restructuring," *IEEE Contr. Syst. Mag.*, vol. 1, pp. 3–5, Mar. 1981.

[39] S. Kahne, "Comments on 'The IDC'," *IEEE Trans. Automat. Contr.*, vol. 21, p. 625, Aug. 1976.

[40] Information Dissemination Committee, "What constitutes a *good* applications paper," *IEEE Trans. Automat. Contr.*, vol. 18, pp. 569–570, Dec. 1973.

[41] S. Kahne, "Editorial: Our third decade," *IEEE Trans. Automat. Contr.*, vol. 21, p. 305, June 1976.

[42] M. Jamshidi, private communication, Feb. 18, 2004.

[43] T. Kitamori, N. Suda, E. Shimemura, M. Masubuchi, H. Kimura, and Y. Yoshitani, "Control engineering in Japan: Past and present," *IEEE Contr. Syst. Mag.*, vol. 4, pp. 4–10, Nov. 1984.

[44] S. Bennett, "Nicholas Minorsky and the automatic steering of ships," *IEEE Contr. Syst. Mag.*, vol. 4, pp. 10–15, Nov. 1984.

[45] W. Oppelt, "On the early growth of conceptual thinking in control system theory—The German role up to 1945," *IEEE Contr. Syst. Mag.*, vol. 4, pp. 16–22, Nov. 1984.

[46] I. Horowitz, "History of personal involvement in feedback control theory," *IEEE Contr. Syst. Mag.*, vol. 4, pp. 22–23, Nov. 1984.

[47] R.E. Bellman and E.S. Lee, "History and development of dynamic programming," *IEEE Contr. Syst. Mag.*, vol. 4, pp. 24–28, Nov. 1984.

[48] H. Rauch, private communication, Apr. 10, 2004.

[49] R.A. Frosch, "Getting it all under control," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 3–8, Feb. 1985.

[50] W.F. Powers, "Computer tools for modern control systems design," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 14–17, Feb. 1985.

[51] H.A. Spang, III, "Experience and future needs in computer-aided control design," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 18–21, Feb. 1985.

[52] D.C. Fraser, "Aircraft control systems—a projection to the year 2000," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 11–13, Feb. 1985.

[53] A.R. Stubberud, "A hard look at software," *IEEE Contr. Syst. Mag.*, vol. 5, pp. 9–10, Feb. 1985.

[54] S. Yurkovich, private communication, Apr. 29, 2004.

[55] S. Yurkovich, private communication, Apr. 28, 2004.

[56] T. Samad, private communication, Apr. 26, 2004.

[57] D. Bernstein, private communication, Aug. 19, 2004.

[58] D. Bernstein, private communication, May 13, 2004.

[59] M. Spong, private communication, Feb. 24, 2004.

[60] A. Laub, private communication, June 1, 2004.

[61] A. Haddad, private communication, June 1, 2004.

[62] M. Bodson, private communication, Feb. 29, 2004.

[63] B. Krogh, private communication, Feb. 23, 2004.

[64] Z. Gao and R.R. Rhinehart, "Theory vs. practice: The challenges from industry," in *Proc. 2004 American Control Conf.*, Boston, MA, 2004, pp. 1341–1349.

[65] D. Abramovitch, "Fuzzy control as a disruptive technology," *IEEE Contr. Syst. Mag.*, vol. 19, pp. 100–102, June 1999.

[66] R.M. Murray, Ed. (2003) Control in an information rich world: Report of the Panel on Future Directions in Control, Dynamics, and Systems. SIAM. Philadelphia, PA. [Online]. Available: www.cds.caltech.edu/murray/cdspanel/

[67] Y.C. Ho, "Optimization II—the rise of distributed intelligence," presented at the 2004 American Control Conf., Boston, MA, 2004.

[68] S.W. Herwald, "Recollections of the early development of servomechanisms and control sysems," *IEEE Control Syst. Mag.,* vol. 4, no. 4, pp. 29–32, Nov. 1984.

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