

Contributions to the Promotion of Mechanism and Machine Science by
the IFToMM Canadian Community (CCToMM)

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ABSTRACT

The Canadian Committee for the Theory of Machines and Mechanisms (CCToMM) has been a committee member of the International Federation for the Promotion of Mechanism and Machine Science (IFToMM) for almost 40 years. This article summarizes CCToMM's contributions to the promotion of mechanism and machine science both within Canada and internationally. Despite its mercurial beginnings, membership has grown to be stable, and has seen a steady growth in the past few years. CCToMM has organized its own successful technical symposium biennially since 2001, as well as a symposium within another forum. Prior to that, CCToMM sponsored annual theory of machines and mechanisms (TMM) symposia within other forums. Members of CCToMM regularly participate in IFToMM sponsored conferences. CCToMM also vigorously promotes student membership. An elected student representative sits on the Executive Council. CCToMM has thus fulfilled its mandate by being successful in promoting Canadian interest in, and the visibility of, mechanism and machine science.

INTRODUCTION

The Canadian Committee for the Theory of Machines and Mechanisms (CCToMM) was formally recognized as a national committee member of the International Federation for the Theory of Machines and Mechanisms (IFToMM) at the Third World Congress on the Theory of Machines and Mechanisms, held in Dubrovnik in 1971. Since then, the acronym IFToMM has evolved to mean International Federation for the Promotion of Mechanism and Machine Science. CCToMM, as a national committee member of IFToMM, shares the objectives of the latter, namely, the promotion of *research and development in the field of Machines and Mechan-*

isms by theoretical and experimental methods, along with their practical applications [1]. CCToMM was incorporated as a non profit organization in 1993 and is identified with the logo shown in Figure 1.

The field of interest to CCToMM is very broad, including various sub-fields of special interest to IFToMM, namely: Computer-Aided Design Methods; Dynamics of Machine Systems; Gears and Power Transmissions; Robots and Manipulators; Mechatronics; Micromechanisms; Control of Robots and Manipulators, to name a few.



Figure 1. CCToMM logo.

CCToMM produces an annual Newsletter, which is intended as a channel of communication between the Executive Council (EC) and CCToMM members, in addition to serving as a forum for all those interested in the field. The Newsletter is electronically distributed to members and is made available on the CCToMM website. The main advantage of a CCToMM membership is *networking*, which is enabled through access to information on technical issues and, most important, through access to other persons with the same technical interests. Moreover, CCToMM is actively involved in organizing a technical symposium called the CCToMM Symposium on Mechanisms, Machines, and Mechatronics (also referred to as the CCToMM M³ Symposium). Since 1999, the CCToMM M³ Symposium has been held every year.

HISTORY

Since its inception in 1971, CCToMM has grown to become an important part of the fabric of Canadian research in mechanisms and machine theory. CCToMM was founded by M.O.M. Osman, Professor of mechanical engineering at Concordia University in Montreal. The committee was fully formed and operating on time for the ASME DETC 1976, which took place in Montreal, basically under the auspices of Concordia's Department of Mechanical Engineering.

CCToMM was initiated with great enthusiasm, but the committee was unsuccessful in gathering a Canadian critical mass to sustain it. Moreover, they never stressed the need for membership dues to be paid so CCToMM could in turn pay its annual IFToMM subscription fee. Indeed, although affiliated to IFToMM by 1979, when the WC took place in Montreal, CCToMM failed to pay its regular dues to IFToMM. CCToMM was nearly expelled from IFToMM in 1987 due to arrears in membership fees. Rather than cause its demise, this state of affairs motivated the EC and membership to take quick action and in relatively short time finances were sorted out. CCToMM finished paying off its arrears in 1996 and has been an organisation in good standing since.

In the early 1990s membership in CCToMM quickly grew to the point where it reached steady state. For years, CCToMM had around 60 members but, due largely to active promotion, in the last few years this number has grown to 84, which represents an increase of 40%. Currently these 84 CCToMM members are from industry, academia and some provincial and federal government agencies. Although this may seem like a relatively small number, a deeper look into the Canadian university educational system may provide some insight.

Consider that in Canada there are about 30 universities offering a fully accredited undergraduate degree in mechanical engineering. In Canada, the practice of engineering is highly regulated by provincial associations. To ensure the highest education and ethical standards are followed while training engineers, all engineering programs in Canada are required to have their curricula reviewed on a regular basis by the Canadian Engineering Accreditation Board (CEAB) which is a branch of Engineers Canada. Through this review, CEAB accredit engineering programs that provide the academic requirements necessary for licensure as a professional engineer in Canada[2]. Graduates from accredited engineering programs can register as engineers in training (or EIT), and following an apprenticeship period (normally of no less than four years) in which valid engineering experience is acquired, they can become fully registered with the profes-

sional association within their jurisdiction. A registered professional engineer is a fully licensed engineer allowed to practice the engineering profession in the province(s) in which they are registered.

Approximately 25 of the universities with accredited mechanical engineering programs have graduate programs leading to Master's and Ph.D. degrees. This means research in mechanisms and machines in general in Canada has a small population to draw upon. Maintaining a steady population of over 80 active members is a strong indication of the viability of the Theory of Machines and Mechanisms (TMM) in Canada. In turn, this indicates that CCToMM has consistently fulfilled its mandate.

The vibrant Canadian Committee has proudly served the TMM community in both Canadian official languages. For example, presentations at CCToMM symposia are welcome in both the French and English languages. Moreover, the current EC is reflective of the cultural and linguistic diversity inherent to Canada. Indeed, it is also reflected in the succession of CCToMM Presidents:

- Professor M.O.M. Osman (1971-1992), Concordia University;
- Professor Jorge Angeles (1992-1996), McGill University;
- Professor Louis Cloutier (1996-1999), Université Laval;
- Dr. Jean-Claude Piedboeuf (1999-2003), Canadian Space Agency;
- Professor Ronald Podhorodeski (since 2003) University of Victoria.

CCToMM AND ITS RELATIONSHIP TO IFToMM

Canadian participation in IFToMM sponsored conferences has been quite strong in the past few years, particularly at the World Congress, Advances in Robot Kinematics (ARK), and RoManSy. For example, CCToMM members contributed 5%, or 23 full papers to the proceedings of the 12th World Congress in Besançon, France in 2007; and approximately 15% of papers in the proceedings of ARK 2008 in Batz-sur-Mer, France.

Many CCToMM members actively participate in IFToMM committees. Professor Jorge Angeles, a Past-President of CCToMM, was President of IFToMM from 1996-1999. He is presently a Member of the Technical Committee (TC) for Computational Kinematics. Moreover, Professor Angeles is one of nine IFToMM Honorary Members. Professor Leila Notash, who had previously served as CCToMM's Communications Officer, is presently Chair of the Permanent Commission for Communications, a

Member of the TC for Robotics, and an observer on the TC for Computational Kinematics. Professor John McPhee, also a former CCToMM Communications Officer, is Secretary of the TC for Multi-Body Dynamics. Professor József Kövecses is a Member of the TC for Nonlinear Oscillations. Professors Clément Gosselin and Marek Kujath are members of the TC for Computational Kinematics and of the Permanent Commission for Education, respectively, and are both members of the Permanent Commission for the History of Mechanism and Machine Science. Professor Gosselin additionally acts as an observer on the TCs for Gearing and for Linkages and Cams.

CCToMM SPONSORED EVENTS

The Canadian Society for Mechanical Engineering (CSME) has existed since 1972. Curiously, CCToMM is one year older. The mission statement for CSME is to foster excellence in the practice of mechanical engineering for the benefit of Canada and the world, and to serve and support its members [3]. Hence, it is natural to expect a strong connection between the two organizations.

Every two years since its inception, CSME sponsors a national forum to promote the communication and transfer of technology between mechanical engineering experts. At these forums, which are hosted by different universities across Canada, CCToMM has negotiated a symposium to be held as a parallel session during the forum. One of the difficulties of holding each symposium was that negotiations concerning profit/loss sharing, paper submission and review management had to be conducted every two years with the local organizing committee. At the CSME Board of Directors meeting in October 2009, a memorandum of understanding between CSME and CCToMM was mutually agreed to, ratified, and accepted by both parties for future symposia. All papers submitted to the Symposium are peer reviewed by at least two referees.

In addition to the symposia held within the CSME Forum, CCToMM began organizing its own biannual M³ (Mechanisms, Machines, and Mechatronics) symposia in alternating years (the odd-numbered years). In 1999 the first CCToMM M³ symposium was held as a stand-alone one-day event, but has grown into an event requiring two days. For years, the symposia have underscored the strong connection between CCToMM and the Canadian Space Agency (CSA) whose headquarters are in Saint-Hubert, Quebec. The first five symposia were hosted by CSA, while the last one in 2009 was hosted by the Laboratoire de Robotique at the Université Laval in Sainte-Foy, Quebec (this is the laboratory directed by Professor Clément

Gosselin). In addition to the technical presentations, invited speakers, generally from industry, present topics of general interest to the CCToMM community.

The stand-alone CCToMM M³ symposia attracts well over 60 attendees and are now typically held over two days with serial (*i.e.*, single track) presentations of typically 30 full-length papers. The proceedings are produced digitally and distributed to all attendees. More recently, the proceedings of the CCToMM M³ are placed in CCToMM's website free of charge for the entire community to access. In an effort to highlight the high quality of a number of the works presented in the symposia, the CCToMM EC has established the practice of publishing selected papers from the symposia in a special edition of the Transactions of the Canadian Society for Mechanical Engineering [4], an archival journal dedicated to the broad field of mechanical engineering published quarterly by the CSME. In these cases, selected papers are subjected to a second rigorous review process managed by an EC member of CCToMM acting as invited editor for the special issue of the Transactions of the CSME. Until recently, the Transactions of the CSME were only produced in paper. Fortunately, since early 2009 the transactions from 2006 (Volume 30) on are available electronically to subscribers through the Transactions of the CSME website.

TECHNICAL CONTRIBUTIONS

The most exceptional scientific impact on the international TMM community by members of CCToMM has undoubtedly been made by Professors Jorge Angeles and Clément Gosselin. They have each gained an enviable reputation internationally for their valuable contributions.

Professor Jorge Angeles is the founder and director of the Robot Mechanical Systems Laboratory within the Centre for Intelligent Machines at McGill University. His research interests focus on design theory and methodology, besides the theoretical and computational aspects of multibody mechanical systems for purposes of design and control. Research achievements conceived by Professor Angeles have led to a significant body of literature. Publications include five very famous and scientifically influential books on kinematics, synthesis and robotics. He has also authored or co-authored more than 180 refereed technical papers in research journals, nearly 300 full-length papers in refereed conference proceedings, as well as numerous chapters in books, invited papers, and edited books, in addition to several patents. Many of the students graduated under Professor Angeles' supervision have forged their own successful research careers and have also earned international renown. Perhaps the most well known

of these is Professor Clément Gosselin.

Professor Clément Gosselin has been a pioneer in many areas related to robotics, mechanism and machine design. More specifically, he has broken ground in areas related to parallel manipulator modelling, analysis, and design. He currently holds 7 patents, has nearly 150 journal publications and over 250 conference papers. He has co-authored 2 books and 4 book chapters, and, although it is hard to count the exact number of citations to his work, a quick assessment revealed well over 2000 of them. In fact, it is hard to find a paper on parallel manipulators that does not contain references to at least one of Prof. Gosselin's works. Amongst his most recent and visible contributions is the design, together with his graduate students, of the end effector (i.e., hand) to be installed on the Space Station Remote Manipulator System (i.e., on Dexter, the extension of the Canadarm2).

Still, there is much more to the strength of TMM in Canada. Independent research groups in universities, government agencies, and industry are spread across all ten provinces and three territories of Canada. Many of these groups have, and continue to yield scientifically influential work, and have produced many innovations in TMM. These groups continue to make important contributions in areas which include: parallel manipulator synthesis; actuation and kinematic redundancy; calibration of serial and parallel manipulators; geometrical methods for analysis and synthesis; parallel kinematic machines; and motion simulators, to name but a few.

CCToMM WEBSITE

In December 1998 the CCToMM website was created by Leila Notash, the Communications Officer for CCToMM at the time. The original domain was redirected to a university server. However, in 2003 the EC voted to obtain a unique Canadian domain name. Hence the URL:

www.cctomm.ca

The website is frequently updated and CCToMM membership has access to important news and information. For example, there is a list of the EC positions and occupants, as well as a comprehensive membership list including contact information. In addition, the CCToMM Newsletter is posted and archived along with proceedings from CCToMM M³ symposia starting from 2001. Recently the website has been enhanced to provide on-line membership applications, as well as on-line payment of annual membership dues.

STUDENT ACTIVITIES

At the 1996 CCToMM Annual General Meeting (AGM), Professor John Hayes, who is now the Communications Officer, was appointed to found the first Student Chapter of CCToMM. At the time he was a Ph.D. candidate at McGill University in Montreal. Since that time student membership has steadily grown and there has been at least one EC student representative to promote CCToMM student membership and activities for students studying in fields of interest. Now several Canadian universities have CCToMM student chapters.

Since the 2008 Annual General Meeting, CCToMM has allocated a budget to the student representatives towards the organisation of invited talks or seminars. Furthermore, CCToMM has considered the use of funds to create a prize, scholarship or bursary. In order to do this, the finances of CCToMM first need to guarantee the continuity of this prize. In 2009, the annual membership fee for regular members was raised from the historically low C\$30.00 to C\$50.00. Student membership dues remain at C\$10.00.

THE FUTURE

As mentioned previously, membership has grown and is now large enough to generate sufficient revenue to cover the organization's expenses and to start promoting student activities. Membership and activities are at present mostly concentrated in a small number of universities. One of the challenges for CCToMM is to increase membership to include both faculty and students from all universities across Canada.

The biannual CCToMM M³ Symposium has grown from a one-day to a two-day event. The vast majority of participants are from Canada. Efforts need to be made to increase international participation.

CONCLUSIONS

Since its founding in 1971, CCToMM has been nurtured into a strong presence for the promotion of mechanism and machine science in Canada. The activities of CCToMM have steadily grown, in particular over the last decade. Strong working relationships have been forged with industry and with CSA and other Canadian government organizations. Membership had been steady but recent initiatives have led to a significant increase of 40%. Moreover, the financial status of the organization is healthy.

The annual CCToMM M³ Symposium is consistently very successful and attracts most Canadian researchers involved in mechanism and machine science. Calls for papers to M³ that are posted on www.cctomm.ca

will hopefully attract the participation of more researchers from outside Canada in the future.

CCToMM has continued to fulfil its mandate by being consistently successful in increasing the visibility of mechanism and machine science in Canada. CCToMM vigorously promotes student participation at the symposia and within the committee itself. Of equal importance, its members make significant contributions to research at the international level as well as to the administration and operation of IFToMM.

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