IFToMM in MMS Developments

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Abstract The paper presents IFToMM and its activity as influential in Mechanism and Machine Science (MMS) and its future developments. IFToMM is the international federation of a worldwide community working in MMS with achievements in research, formation, practice and technological transfer. The role of IFToMM is discussed as influential not only in aggregating people with commonly shared activities but also in leading international collaboration for innovative trends in MMS.

Keywords Mechanism and machine science · IFToMM · Trends in MMS

1 Introduction

Two main facts can be highlighted in order to claim that MMS (Mechanism and Machine Science) is still necessary with a strong activity in formation, research, and practice, namely they are:

- Human beings operate and interact with their environments and using many systems with actions of mechanical nature so that mechanical systems will always be an essential part of systems that assist or substitute human beings in their actions and other tasks.
- There is a continuous need to update problems and solutions in Technology since Society continuously evolves with new and updated needs and requirements so that even mechanical systems are expected to be updated for new and/or updated functioning through a continuous evolution and update of knowledge, means, and operation for the successful applications of mechanical systems.

(IFToMM President 2016–2019)

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MMS can be understood as an evolution of TMM with a broader content and vision of a Science, including disciplines with synergy and integration purposes. The modernity of MMS has augmented TMM with new vision and means but also with many new disciplines, of which the most significant can be recognized in Robotics; Mechatronics; Computational Kinematics; Computer Graphics; Computer Simulation; CAD/CAM for TMM; Tribology; Multibody Dynamics, Medical Devices, Micro and Nano Machines, Energy Sustainable Systems, and Service Systems. In 2000 the evolution of the name from TMM to MMS brought also a change in the denomination of the IFToMM Federation from "IFToMM: the International Federation for TMM" to "IFToMM, the International Federation for the Promotion of MMS" [1].

Aggregation of people in communities is a need and motivation for the success of activity with common features and purposes. IFToMM as international federation of national/territory communities is the world aggregation of people working in MMS with a common vision that collaboration and activity share are helpful not only to achieve better results but to disseminate efficiently the achievements for a successful improvement of a peaceful society.

In this paper, a significant role of IFToMM is presented in MMS activities within technological achievements by using historical outlines and general considerations that are also based on the author's experience [2–5].

2 MMS and Its Future Developments

The meaning of MMS can be clarified by looking at IFToMM terminology with the terms [6]:

- Mechanism and Machine Science: Branch of science, which deals with the theory and practice of the geometry, motion, dynamics, and control of machines, mechanisms, and elements and systems thereof, together with their application in industry and other contexts, e.g. in Biomechanics and the environment. Related processes, such as the conversion and transfer of energy and information, also pertain to this field.
- Machine: mechanical system that performs a specific task, such as the forming of material, and the transference and transformation of motion and force.
- Mechanism: system of bodies designed to convert motions of, and forces on, one or several bodies into constrained motions of, and forces on, other bodies.

Today, a modern machine is understood as a combination of systems of different natures and this integration has led to the modern concept of Mechatronics, Fig. 1. Thus, most of the recent advances in machinery are sometimes considered to be in fields other than MMS. But Mechanism Design can still be recognized as a fundamental aspect for developing successful systems that operate in the mechanical world of human beings.

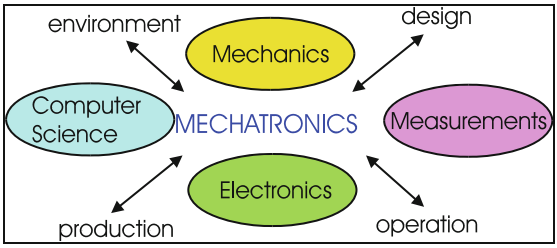


Fig. 1 A scheme for the mechatronic structure of modern (mechanical) systems

Future developments in MMS can be summarized with trends and challenges mainly in:

- 3D Kinematics
- Modeling and mathematization for MMS
- Multi-d.o.f. multibody systems
- Spatial mechanisms and manipulators
- Unconventional mechanisms
- Scaled mechanisms
- System design with multidisciplinary integration
- Bio-mechanical/mimetic systems
- Tribology issues
- Creative design
- Human-machine interactions for user/task-oriented systems
- Reconsideration and reformulation of theories and mechanism solutions.

Those topics and many others in MMS are also motivated by needs for formation and activity of professionals, who will be able to conceive and transmit innovation both into production, service frames and diary life.

Formation in MMS requires attention to modern methodologies that can efficiently use computer and software means, which are still evolving rapidly. Thus, there is a need to update also the teaching means that makes use of simulations and computer oriented formulation. In addition, mechatronic layout of modern mechanical systems suggests that mechanisms should be taught as integrated with other components like actuators and sensors since the beginning of the formation.

The mission of academy needs to be revitalized and better understood as a result of high expertise of teachers that can be reached also with intense research activity and links to the professional and industrial world. This requires more attention and vision not only from the academy but mainly from the society as a whole that through governing leaders should give more and more support to the formation system and research institutions.

Activity by professionals asks for novel applications and high performance machines since they are continually needed in evolving/updating systems and engineering tasks. In addition, there is a need to make understandable new methodologies to professionals for practical implementation both in their use and results.

In general, MMS activity will be directed for further developments by searching for:

- information and understanding of the functionality and impact of systems
- algorithms for design, operation, and evaluation of systems with user/task-oriented performance
- performance evaluation and economic merit of systems as constrained by environmental limits
- transfer of innovation
- human-machine interfaces and interactions.

Thus, mechanical aspects will have a significant role in modern systems mainly referring to:

– Human-machine interactions and user/task-oriented performance
– Mechanical tasks in motion operations
– Structure design for sizing dimensions.

Therefore, 'hot' topics of MMS can be considered:

- to analyze and to investigate operation and performance of modern (mechatronic) systems
- to analyze and to investigate the actions against the environment and within the mechatronic system.
- to focus on safety and comfort issues both for the system and for the human operators
- to consider the interactions mainly from mechanical viewpoints
- to size system actions according to task/user oriented requirements
- to consider complex motions such as spatial movement at high acceleration in novel environments
- to look at integrated systems via suitable modeling of components of other aspects than of a mechanical nature.

Trends in system composition can be summarized as in the examples in Table 1. In the future more than today, the presence of mechanical components will be reduced percentage-wise but nevertheless they will still be necessary and indeed be fundamental for the use and operation of systems.

An important area demanding new system designs can be recognized for service operations that can be understood in terms of set of actions and behaviors towards achieving a service task [2, 3]. Those service actions and tasks can be much more articulated and varied than traditional industrial applications.

Table 1 Examples of evolution of system composition

1960–2010	Mechanics (%)	Electronics/informatics (%)
Cars	90–50	10–50
Calculators	100–10	0–90
Cameras	100–10	0–90

A service task can be understood as the ultimate goal of the design and operation of a service machine, that can be conceived not only as a robot. A service task may be identified with well defined properties and by a large variety of situations. The multi-disciplinary for a service system is much wider than in any other engineering fields, since it includes technical aspects, human attitudes (of operators and/or users), human-machine interactions, and environment issues. Indeed, in developing and operating service robots, other than technical expertise, it is more and more necessary that competences from other fields of human life and environmental considerations be incorporated.

Referring to technical aspects, Fig. 2 summarizes the multi-disciplinary in terms of interactions with the environment and human beings, and in terms of a careful consideration of the environment. Those interactions should be understood not only in terms of engineering issues (mainly mechanical ones) but by looking at more general aspects, such as for example psychological attitudes and social impacts.

In particular, the main flow of technical design activity is indicated in the central streamline as referring to data identification in both technical and non-technical aspects, considerations of technical constraints/issues, analysis of service operation and goal, design activity and system programming, with final checks by operators and users. The core character on technical design activity is indicated by aspects and activities that are grouped in the two lateral blocks concerning with interactions with human beings and the environment, respectively. Each block will refer to aspects that even with non-technical concerns must be included in the machine development with proper models and problem formulation.

All the above considerations can be considered as attaining also to the process of building and transferring innovation, which will be understood not only as a technical advance but more widely as an enhancement of the quality of life in all its aspects with the help and support of technical means.

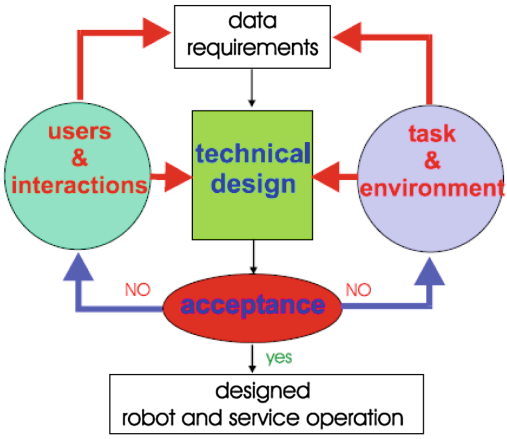


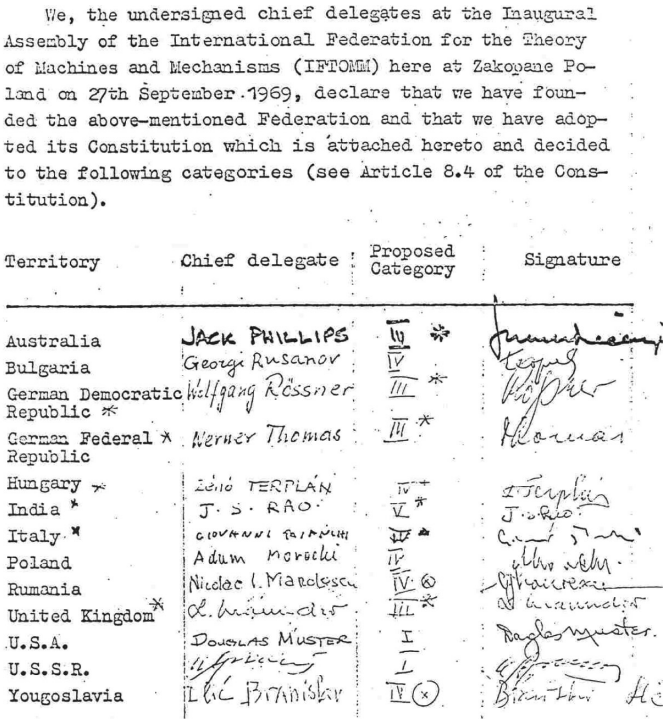
Fig. 2 A general flowchart with new peculiarities for designing and operating service systems

3 IFToMM and Its Role in MMS

The names of IFToMM and MMS are related to fields of Mechanical Engineering concerning with mechanisms in a broad sense.

The developments in TMM have stimulated cooperation around the world at various levels. One of the most relevant results has been the foundation of IFToMM in 1969, Fig. 3. IFToMM was founded as a Federation of territorial organizations but as based on the activity of individuals within a family frame with the aim to facilitate co-operation and exchange of opinions and research results in all the fields of TMM. Many individuals have contributed and still contribute to the success of IFToMM and related activity, (see IFToMM webpage: www.iftomm.org) under a coordination of IFToMM Presidents over time [5].

The foundation of IFToMM was the result of an intense activity for stimulating and promoting international collaboration, more than what had been done previously. The process started in the late 1950s', as documented by several letters that are stored in the IFToMM Archive at CISM in Udine, Italy. A first World Congress on TMM (Theory of Mechanisms and Machines) was held in 1965 in Varna,



We, the undersigned chief delegates at the Inaugural Assembly of the International Federation for the Theory of Machines and Mechanisms (IFTOMM) here at Zakopane Poland on 27th September 1969, declare that we have founded the above-mentioned Federation and that we have adopted its Constitution which is attached hereto and decided to the following categories (see Article 8.4 of the Constitution).

Territory	Chief delegate	Proposed Category	Signature
Australia	JACK PHILLIPS	III *	
Bulgaria	Georgi Rusanov	IV	
German Democratic Republic *	Wolfgang Rössner	III *	
German Federal Republic *	Werner Thomas	III *	
Hungary *	Zénó TERPLÁN	IV *	
India *	J. S. RAO	V *	
Italy *	GIOVANNI PAPPALARDO	IV *	
Poland	Adam Morecki	IV	
Rumania	Nicolae I. Manolescu	IV ⊗	
United Kingdom *	[illegible]	III *	
U.S.A.	Douglas Muster	I	
U.S.S.R.	[illegible]	I	
Yougoslavia	Ilić Branislav	IV (×)	

Fig. 3 The foundation act of IFToMM, the International Federation for the Theory of Machines and Mechanisms, in Zakopane (Poland) on 27 September 1969 (*courtesy* of IFToMM Archive)

Bulgaria during which the foundation of IFToMM was planned as later it was agreed during the Second World Congress on TMM in Zakopane, Poland. The Congress series was immediately recognized as the IFToMM World Congresses and in 2015 we have celebrated the 14th event with the participation of delegates from 47 Member Organizations and from more than 50 countries.

IFToMM activity has grown in many aspects, as for example concerning the number of member organizations (from the 13 founder members to the current 47 members), the size and scale of conference events (with many other conferences, even on specific topics, at national and international levels, in addition to the MMS World Congress), and the number and focus of technical committees working on specific discipline areas of MMS.

IFToMM was founded in 1969 and today a fourth generation of IFToMMists starts to be active. Knowing the History of IFToMM and how we arrived at today's modus operandi gives a greater awareness of community identity and significance [2, 3, 5].

The IFToMM community evolved from a family-like structure of few enthusiastic pioneers/visionaries and founders into a scientific worldwide community through the following generations:

- 1950's–'79 First generation: founding fathers and their friend colleagues up to the 4-th IFToMM World Congress in Newcastle-upon-Tyne in 1975 with prof. Leonard Maunder as Congress Chair.
- 1980–95 Second Generation: students and people educated by founding fathers and their friend colleagues; up to the 9-th World Congress in Milan in 1995 with prof. Alberto Rovetta as Congress Chair.
- 1996–2011 Third Generation: educated people in the frame of IFToMM and within IFToMM activity with 48 national organizations as IFToMM members, with Prof. Carlos Lopez-Cajùn. As General Chair for 2011 Congress.
- Today–Fourth Generation: educated people in local frames with international activities that are linked to IFToMM and within IFToMM activity through 47 organizations as IFToMM members.

IFToMM officers (who are the Chairs of IFToMM Member Organizations, the Chairs of TCs and PCs, and the members of the Executive Council) have contributed and still contribute as leaders for the mission of IFToMM, which is stated in the 1-st article of the Constitution as: 'The mission of IFToMM is the promotion of Mechanism and Machine Science'. A complete list of IFToMM officers over time is available in [7] and updates in the IFToMM webpage.

The structure of IFToMM is summarized in Fig. 4 with the IFToMM Bodies that are indicated in IFToMM constitution according to IFToMM mission to provide leadership for cooperation and development of modern results in the Mechanism and Machine Sciences by assisting and enhancing international collaboration.

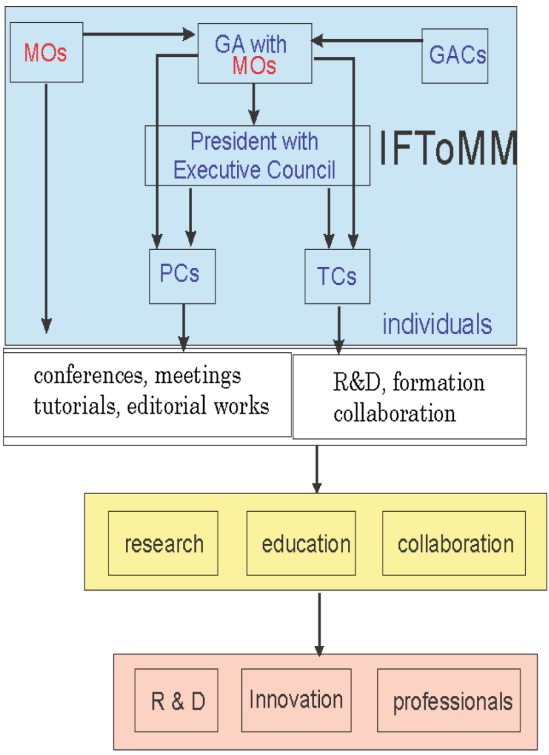


Fig. 4 A scheme for structure and activity of IFToMM

The bodies of IFToMM can be described synthetically as:

- General Assembly: it is the supreme body of the Federation and determines its policy. It is composed of the Chief Delegates of IFToMM Organization members (in 2016 they are 47) and members of the Executive Council.
- Executive Council: it manages the affairs of the Federation between the sessions of the General Assembly. It is elected every four years, meets annually and works also with telemeetings, and is composed of the President, Vice-President, Secretary-General, Treasurer, and six ordinary members.
- Permanent Commissions (PCs) and Technical Committees (TCs): Each PC and TC is composed of a Chairperson, appointed by the Executive Council, Deputy Chair, a Secretary and members, nominated by the Chairperson and appointed by the Executive Council. A Chairperson shall not serve for more than two terms consecutively. The general goals for the work of the PCs and TCs are aimed at promoting their fields of interest by attracting researchers and practitioners, including young individuals, in order:
  - to define new directions in research and development within their technical areas;
  - to establish contacts between researchers and engineers;

- to initiate and develop bases and procedures for modern problems;
- to promote the exchange of information;
- to organize national and international symposia, conferences, summer schools, and meetings.

In 2016 13 TCs are active in the fields of: Biomechanical Engineering, Computational Kinematics, Gearing and Transmissions, Linkages and Mechanical Controls, Micromachines, Multibody Dynamics, Reliability,, Robotics and Mechatronics, Rotordynamics, Sustainable Energy Systems, Transportation Machinery, Tribology, and Vibrations. Additional TCs are under consideration for hot topics with an IFToMM significant community. The PCs are on: Communications, Publications and Archiving, Education, History of MMS, and Standardization of Terminology.

Main aspects of the IFToMM activity are emphasized in Fig. 4 as related to Research, Formation, and Collaboration for final goals in R&D frames, Innovation, and Professionals Formation. Indeed, they are related to each other since a good teaching for a modern professionals formation needs to be well based on a successful research activity that today requires collaborations in teams even within international frames for shared approaches and results.

IFToMM activity can be summarized mainly in:

- conference events, in wide form and specific subjects not only as linked to TCs, at local and international frames, within series and in one shot events. A World Congress is organized every 4 years and the next one is 15th IFToMM World Congress that is scheduled in June 2019 in Kracow, Poland
- meetings and visit exchanges, including joint teaching
- project collaborations in research programs and in teaching plans
- organization of fields of interests for aggregation of an international community and planning actions as the above ones
- publications for dissemination purposes of research results and knowledge transfer. This is achieved at the moment through 5 affiliated journal and two book series specifically dedicated to MMS and IFToMM community. The journals are: Mechanism and Machine Theory (http://www.elsevier.com), Open-access Mechanical Sciences (http://www.mech-sci.net), Chinese Journal of Mechanical Engineering (http://www.cjmenet.com), Advances in Vibration Engineering (http://www.tvi-in.com/index.asp), Mechanics Based Design of Structures and Machines (http://www.tandf.co.uk/journals/titles/15397734.asp). The book series are published by Springer on MMS (http://www.springer.com/series/8779) and on History of MMS (http://www.springer.com/series/7481).

IFToMM significance can be summarized as being the unique world federation in MMS with the following motivations:

- Yesterday: To start and facilitate international collaboration between Eastern and Western countries

- Today: To help and enhance international collaboration and modern results on MMS
- Tomorrow: To leader cooperation and development in MMS Mechanism and Machine Science.

4 Conclusions

Not everything is new or recently developed in MMS, although innovation seems to be a priority today. But this does not mean that there is not interest for MMS, nor that there is no need to work on developing and enhancing knowledge and application of MMS. New challenges are determined for MMS in the new needs of Technology and Society both in term of developing new solutions and updating past solutions. An awareness of the historical background can give not only a conscious understanding of past efforts and solutions, including their paternity, but even more importantly it can help to find/develop ideas for new and updated problems to be solved. But the rapidly evolving needs of Technology and Society will require a continuous re-thinking and re-conceiving of methodologies and solutions in suitable updated applications. Thus, the main challenges for future success in MMS may be recognized in the community capability of being able to keep updating the field and therefore in being ready to solve new and updated problems with new ideas or by refreshing past solutions, as has been done successfully in the past. IFToMM is the international body that made MMS very successful and widespread in the second half o 20th century and it can have still an influential role in guiding/coordinating future development sin MMS. IFToMM is the frame that made MMS very successful in the second half of the 20-th century and it can have still an influential role in guiding/coordinating future developments.

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