

# The theory of machines and mechanisms



Proceedings of the  
7th World Congress

17-22 September 1987  
Sevilla, Spain

## Editors

**Emilio Bautista**  
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## Volume 1

### Invited lectures

**Kinematic analysis  
and synthesis of  
planar mechanisms**

**Kinematic analysis  
and synthesis of  
spatial mechanisms**

**Dynamics of machine  
elements and  
mechanisms**

**Tribology**

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# Foreword

The Seville Congress is the seventh in a series of international congresses on the Theory of Machines and Mechanisms. The first was held in Varna (Bulgaria) in 1965, the second in Zakopane (Poland) in 1969, the third in Kupari (Yugoslavia) in 1971, the fourth in Newcastle (UK) in 1975, the fifth in Montreal (Canada) in 1979, the sixth in New Delhi (India) in 1983.

During the Zakopane Congress, the International Federation for the Theory of Machines and Mechanisms was officially constituted. This Federation took as one of its responsibilities the organization of the successive congresses, changing the denomination from "International" to "World" Congresses. This denomination may have seemed rather ambitious at that time; it appears much less so today.

The booklet collecting the abstracts of the Zakopane Congress contains a total of 81 papers. The USSR was present with 19 papers; USA with 14 papers; Japan with 2; the UK with 1. All the other papers came from six European countries (Bulgaria, Czechoslovakia, the German Democratic Republic, the German Federal Republic, Poland, Romania). For the Seville Congress the number of accepted papers is 417, the countries of origin of the authors total 34, and all the continents are represented: Africa, North and South America, Asia, Australia, Europe. The Federation can certainly be pleased with this result and the term "world" can now be used without embarrassment.

The significance of the geographical and

numerical development of the congress is, however, determined by the significance of the papers presented. This cannot be measured by simple statistics.

General congresses of this kind do not intend to compete with the specialized symposia on restricted topics, which our Federation also organizes. The purpose of the Congress is to offer a general picture of the research done in the field of machines and mechanisms throughout the world, to promote this research by bringing together junior and senior scientists, and favour the interdisciplinary understanding and cooperation so important today in many projects.

If we read through the proceedings of all the IFTOMM congresses we have good reason to feel that our goals have been achieved. From congress to congress, in a diversified and lively series of papers, we can trace the development, through the exposition of its scientific foundation, of all modern mechanical engineering. The collection of the proceedings has itself become an important tool for reference and for the training of researchers.

Results like these are obtained through the contribution of many persons. Today our thanks go particularly to our Spanish colleagues, whose generous efforts have made this seventh congress possible.

Giovanni Bianchi  
President of IFTOMM

# Preface

For centuries Seville has been a melting-pot of cultures coming from all over the world. Open to every thought flow, this city played an important role in the development of the science, the technology and the mentality that allowed the discovery of the New World. Once again people from all over the world have met in Seville during the Seventh World Congress of the International Federation for the Theory of Machines and Mechanism (IFTOMM) on September 17-22, 1987 at Seville University, Spain.

The Congress Proceedings contain 417 papers contributed from 38 countries, and the Special Lectures presented by internationally renowned engineers. The technical sessions cover various fields of machines and mechanisms and in particular, Kinematic Analysis and Synthesis, Dynamics of Machines and Mechanisms, Gearing and Transmissions, Rotor-Dynamics, Vibrations and Noise in Machines, Biomechanisms, Tribology, Robots, Manipulators and Man-Machine Systems, Computer-Aided Design and Optimization, Industrial Applications for Special Machines and Mechanisms and Experimental and Teaching Methods.

Historically IFTOMM came into being on September 27, 1969, during the Second International Congress for the Theory of Machines and Mechanisms at Zakopane, Poland as a result of recommendations brought forward by an International Coordinating Committee. The Coordinating Committee was created at the suggestion of the Bulgarian delegation, participating in the First International Congress on Machines and Mechanisms held at Varna, Bulgaria in September 1965. The countries represented in the inaugural assembly at Zakopane included Australia, Bulgaria, Czechoslovakia, German Democratic Republic, German Federal Republic, Hungary, India, Italy, Netherlands, Norway, Poland, Romania, United States, Soviet Union and Yugoslavia. The Spanish National

Council for the Theory of Machines and Mechanisms was formally accepted as a regular Country member of IFTOMM in 1979 at Montreal, Canada during the Fifth Congress. The Sixth Congress was held in 1983 at New Delhi, India.

In the past, IFTOMM has played a major role in the unification of scientists working in the field of machines and mechanisms. Through its sponsorship of international meetings every four years, it has influenced new developments, it has enabled contacts between colleagues to be renewed, and in general, provided the incentive to develop new and productive friendship. It is sincerely hoped that the Seventh World Congress will continue to act as the catalyst for the advancement of new ideas and concepts in our field.

The Organizing Committee for the Seville Congress has been generously supported by many bodies. In particular, the Executive Council of IFTOMM and the Spanish Administration have contributed financial assistance. Seville University and the Engineers Association of Seville have contributed immensely to the success of this undertaking by providing the facilities and resources required in several aspects of the organizational activities, as well as a number of professional services essential to the organization of this Congress. To all these societies, institutions and individuals too numerous to single out, the Organizing Committee wishes to express its sincere thanks and appreciation.

The Spanish Council for the Theory of Machines and Mechanisms extend a warm welcome to all delegates and their guests and wish you all a pleasant and successful meeting.

On behalf of the Organizing Committee  
J. Nieto Nieto

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