Role of MMS and IFToMM in Technology Development
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The Role of MMS (Mechanism and Machine Science) and IFToMM in Greece

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Abstract- Based on the results of a postal ballot among the Chairs of the International Federation for the Theory of Machines and Mechanisms (IFToMM) members, the acceptation of the National Member Committee was admitted in 1999. After this new membership, IFToMM had 45 members all over the world. The late Professor A. Dimarogonas (1938-2000) motivated the establishment of a Greek Section of IFToMM since the 80s. The historical evolution of the Greek committee of the Greek Section of IFToMM and its influence on the structure of the courses of Machine Design, Synthesis of Mechanisms and the History of Technology in the Mechanical Engineering Department is presented here. The contribution of IFToMM to the development of Engineering Design and the Theory of Machines in Greece is presented here.

INTRODUCTION

On February 17, 1998 Professor Tatu Leinonen, the Secretary General of the International Federation for the Theory of Machines and Mechanisms (IFToMM) in a letter to the author reported the approval of the Federation for the candidacy of Greece for becoming a member. Based on the results of a postal ballot among the Chairs of IFToMM members, the acceptation of the National Member Committee was admitted in 1999. After this new membership, IFToMM had 45 members all over the world. [IFToMM 1999]. Since then, Greece belongs to the IFToMM and the author was appointed from the local National committee as the National Representative. The members of the first local National Committee were Prof. A.D. Dimarogonas, Prof. S.A. Paipetis, Prof. G. Massouros, Prof. P. Drakatos, Asistant Professors: S.D. Panteliou, N. Anifantis, C. Papadopoulos, A. Dentsoras, T. Chondros, Assoc. Professor N. Aspragathos (most of them Professors today), the professional Engineers: R. Xarchakou member of the Steering Committee of the Technical Chamber of Greece, T. Pafelias, formerly in GE, and A. Ekonomou technical director of the Greek Industrial Reconstruction Organization.

The motivation for the establishment of the IFToMM Greek committee was due to the late Professor A. Dimarogonas [Chondros 2001]. His contribution was decisive for the establishment of the Greek Section.

Andrew D. Dimarogonas (1938-2000) was widely recognized as a distinguished authority in various specialities of mechanical engineering. He made important contributions to the mechanical design and vibrations. His last appointment was as W. Palm Professor of Mechanical Design and the Director of the Manufacturing Program in the School of Engineering and Applied Science at Washington University, St. Louis, MO. His books on computer-aided machine design in 1988 and computer programs for mechanical engineers in 1993 won him international acclaim as a leading expert in the field of mechanical design. His books in 1976, 1992 and 1996 on Vibration Engineering [Dimarogonas 1976-2001] and in 1983 on Rotor Dynamics study the behaviour of cracked structural members and rotating machinery. In his books on design he introduces systematically computer-aided methods in design and integrates strength of materials with the kinematics and the dynamics of machines and mechanisms

Fig.1. Professor Andrew D. Dimarogonas (1938-2000)

Andrew D. Dimarogonas worked in Greek Industry and the Public Power Corporation (PPC) of Greece as a distribution network design engineer, 1962-1967, and was a lecturer at the National Technical University in Athens (NUT). By the C and IZ decrees of the military junta he was dismissed in 1967 from the PPC and the NUT together with many other democrats-faculty members or government employees- as dangerous to the "social establishment" of the dictatorship. He then decided to immigrate to the United States in 1967 and worked for the Turbine Department of the General Electric Company as design engineer and later was promoted to technical leader of dynamics and technical leader mechanical development of the Large Steam Turbine Division, Schenectady, New York, 1967-1974. He was a consultant in the manufacturing sector since then, dealing with such diverse products as balancing machinery, automotive fuel pumps, in-

telligent equipment design and non-destructive testing, industrial automation, engine rotor dynamics and the development of a 500-t railroad car. In parallel, he was a graduate student at the Rensselaer Polytechnic Institute (RPI) (1968-1970), was awarded a Ph.D. in Mechanical Engineering (ME) in 1970 and was appointed adjunct assistant professor of ME there (1970-1972).

In 1972, he was appointed Associate Professor of Mechanical Engineering at Lehigh University, Bethlehem, Pennsylvania. In 1974, the junta in Greece fell and he was reinstated to the NUT and PPC retroactively. He was then elected Chaired Professor of Machine Design at the University of Patras in Greece and, subsequently was elected by the faculty as Director, Design Division, Chairman ME, and Dean, School of Engineering at the UP (1974-1983). He also served as national trustee of the Greek Council of Peace, member of the governing board of the Technical Chamber of Greece and chairman of the Mechanical Engineering Accreditation Board.

During his career, a strong interest in history continually manifested itself in chapters of various books, technical papers, lectures, and a particularly notable two-volume *History of Engineering* (published in Greek) [Dimarogonas 1976]. In his book *Vibration for Engineers*, [Dimarogonas 1996] his historical sketches of great engineers and scientists include those of Pythagoras, Galileo, Newton, Euler, Gauss, Lagrange, Laplace, Hertz, Stodola, and Timoshenko.

As an engineer-historian, Professor Dimarogonas scrutinized many major scientific libraries in the United States and Europe for source material. He documented that the fundamental axioms of design were discovered during the middle of the last century in Europe and traced the origin of vibration theory to Archimedes and others of that period by unearthing obscure documents in continental libraries. He brought to light certain important historical developments in the field of dynamics and vibrations that were either glossed over or not fully understood. Andrew D. Dimarogonas received the 1999 ASME Engineer-Historian Award for his many works on integrating the history of mechanical engineering. His historical research often challenges current claims on innovation today [Dimarogonas 1990, 1992]

Greek academics members of IFToMM commissions are: Prof. Constantinos Mavroidis, Department of Mechanical, Industrial and Manufacturing Engineering, Northeastern University, also a member of the USA national committee, Prof. Evangelos Papadopoulos, Dept. of Mechanical Engineering, National Technical University of Athens, and T. G. Chondros, Department of Mechanical Engineering and Aeronautics, University of Patras, members of the IFToMM Permanent Commission for History of MMS (Mechanism and Machine Science). The author is the national repre-

sentative of the Transportation Machinery technical committee, serving also as IFToMM Greek Section national representative.

The historical evolution of the Greek committee of the Greek Section of IFToMM and its influence on the structure of the courses of Machine Design, Machines and Mechanisms Theory, Synthesis of Mechanisms, and the History of Technology will be presented here, through the evolution of the Mechanical Engineering and Aeronautics Department of the University of Patras.

ACHIEVEMENTS IN RESEARCH AND EDUCATION

Prof. Dimarogonas was the founder of the Design and Manufacturing Section of the Mechanical Engineering Department of the University of Patras. He taught a variety of courses to both the newly founded in 1972 Mechanical Engineering Department and the Civil Engineering Department. Courses taught include among others: Strength of Materials, Machine Design, Machine Elements, Numerical Methods for Engineers, Vibration for Engineers, Analysis and Synthesis of Mechanisms, Heat Transfer, and the History of Engineering. He decided to develop the Design Laboratory involving students attending his courses. Thus, third-grade students of the Mechanical Engineering Department in 1974-1975 designed and built models of machines and mechanisms under the supervision of Prof Dimarogonas that are still in operation as laboratory devices for teaching and demonstration purposes, as well as for research. Some other devices were built by post-graduate students in the frame of their PhD theses.

The Design Laboratory is equipped with a large number of mechanisms models and laboratory equipment including a full set of planar mechanisms, cams, gears, robotic arms, solar panels orientation mechanisms, automatic and pneumatic control devices. A lay-out of an automotive drive-train consisting of a 1970 1000 cc OPEL petrol engine with a 4-shift gearbox, a drive axle with a differential and brakes in operation. A Watt-governor provided stable engine revolution through a linkage connected with the throttle. Two opposing gearboxes with the primary and secondary axles connected in series were used to calculate friction losses under full load. A torque was introduced in the series connected axles of the gearboxes simulating full load. A 10 kW electric motor was used to drive the gearboxes while the power consumed was recorded and the temperature rise of the lubricating oil was measured. The principle of operation of the device was used in shipyards in Japan in the 70s for the evaluation of the efficiency of the propellers speed reducers.

A wear-friction machine incorporated two HANOMAG 2t trucks gearboxes connected in series for constant speed ratios in the rotating disk,

while the friction force for the specimens was achieved through a pair of compressed air actuators used in bus-automatic-doors mechanisms. Sophisticated devices were developed for the study of bearings wear and lubrication operating at different loading, and temperature and lubrication conditions.

A brake-power measuring device, incorporating a Mercedes 122 80kW diesel-engine with a 4-shift gearbox, and a rotating disk revolving into a sealed cylinder containing water, and restricted from revolution with a weight balance, was used for power and torque measurements. An apparatus for the evaluation of speed and oil characteristics on pressure distribution for a model of a Mitchell bearing used in ship propellers-axles applications was used extensively both for demonstration and research.

A 12t 322 Mercedes truck differential was used to support and drive the vertical axis of a heavy solar panel for automatic orientation. A Savonius-type wind-mill driving a 5kW electric generator was in operation for many years. Again, a light Opel-Blitz truck differential was used as a speed increaser.

Models of machines and mechanisms of historical importance were designed and constructed by students. Ancient machines models and mechanisms models are exhibited in the Design Laboratory. A digital library of graduate theses concerned with the design of mechanisms models also exist.

In the 80s professors A. Mayrommatis and S. Katsaitis were elected in the Chairs of Machine Theory and Machines and Mechanisms, and the teaching of Machine Theory and Machines and Mechanisms was separated from the Design and Manufacturing Chair. Professors A. Mavrommatis and S. Katsaitis were formerly professors in the USSR and the DDR respectively. They adopted teaching procedures and methods of analysis that were familiar among the academics of the USSR and the DDR. The courses related to the analysis and synthesis of machines and mechanisms, and the design of machines were based on analytical and graphical methods. Courses assignments for the analysis and the synthesis of mechanisms were a prerequisite for the students to pass the exams.

In 1990 professors A. Mayrommatis and S. Katsaitis retired and the author was elected as an Assistant Professor at the Department, and was appointed to the Laboratory of Machine Theory, and the teaching of the courses 24324 Kinematics of Machines and Mechanisms, and 244411 Dynamics of Machines and Mechanisms. A two-volume book *Kinematic and Dynamic Analysis of Machines and Mechanisms* (in greek) was published from the author in 1991. Apart from the analytical methods and graphical methods, numerical methods were incorporated for the analysis and simulation of planar mechanisms. A wealth of mechanisms configurations were

analyzed and simulated with the aid of a computer-aided algorithm written in Quick-Basic 7.0 that was developed by the author in 1992. Additional reading for the students includes many books available in the University Linbrary [Hartenberg-Denavit 1964, Dimarogonas 1976-2001, Shigley 1981 and 2004]. Textbooks from Mir Publishers, textbooks in Russian translated in English, gave the opportunity to the students of the Department in having access to important series of books in Design, Machine Theory and Kinematics, Strength of Materials and Vibration, Elasticity Theory, and Computational Methods in Engineering [Artobolevski 1975, Feodosyev 1973, Movnin 1975, Targ 1976, Shigley 1981, Chemilevski 1984, Dimarogonas 1996, 2001, Norton 1994, Muškis 1975, Bakhvalov 1977, Orlov P. 1976]. The series of Prof. Artobolevski books in mechanisms were of great help for students to design and prepare their homework assignments for the synthesis of mechanisms.

During the last 10 years, after a proposal by Prof I. Ardelean, from IFToMM Romania, there is an effort for establishing a network of academics involved in the subjects of IFToMM. In Greece a network of Professors from all over the country is established with the participation of the following academics: Professors Mrs S. Mitsi, K. Bouzakis, S. Natsiavas, A. Michaelides, K. Eustathiou, and J. Tsiafis from the Aristotelian University in Salonica, Mechanical Engineering Department; Professors N. Aravas and K. Papademetriou from Thessaly University in Volos, Mechanical Engineering Department; Professors K. Spentzas, E. Papadopoulos, D. Manolakos, C. Provatides, A. Michaelides, J. Antoniades and T. Kostopoulos from the National Technical University, Athens, Mechanical Engineering Department. In the frame of IFToMM and the various PCs, a correspondence among academics in Greece and abroad is facilitated. It appears that the influence of IFToMM may be useful in the development of the structure of the educational programs as well as for the better orientation of research activities among IFToMM members.

The structure of a series of courses related with the IFToMM activities will be presented here, mainly as a basis for discussion, and the beginning of a correspondence among academics of different Sections and Universities. Kinematics of Machines and Mechanisms, Dynamics of Machines and Mechanisms, Vehicle Dynamics, and the History of Technology tare aught today in the Mechanical Engineering and Aeronautics Department, in Patras, while similar courses exist in other Greek Institutions.

Course 24324 Kinematics of Machines and Mechanisms is taught at the third year. A short syllabus contains: Fundamental theories of kinematics, vector and matrix algebra, numerical methods for use in computational mechanics, computer programs for analyzing the response of simple and complex mechanical systems, cams, gears, gear trains, synthesis of me-

chanisms. Kinematic analysis, mobility and range of movement - Kutzbach and Grubler's criterion, number Synthesis, Grashof's criterion, displacement analysis of plane mechanisms– graphical and analytical methods, velocity and acceleration analysis, kinematic elements, fixed and variable speed kinematic pairs - closed loop linkages, the four-bar linkage, the slider-crank linkage, coordinate transformations, robot arms and manipulators, variable speed kinematic pairs - cams and followers, kinematics of gears, design of gear trains, simple, compound and epicyclic gear trains, sliding gear boxes and synchronous gear boxes dimensional synthesis of mechanism; motion, path and function generation. The students have to complete the design of a series of mechanisms. The software to be used can be found in the textbook *Computer Aided Design, A CAD Approach* by A.D. Dimarogonas [2001]. The students have the option of a choice of assignments among which: kinematics of a series of planar-mechanisms from Artobolevski [1975], a cam profile design, kinematics of gear trains, design of compound and epicyclic gear trains, kinematic design of a metal planner-shaper, kinematics and dynamics of a steam-powered road-roller, kinematics of a reflex-camera, the design of a 4-shift gearbox, and a light truck rear axle with 4:1 differential. For further reading the following books are proposed [Hartenberg and Denavit 1964, Artobolevski 1975, Movnin 1975, Targ 1976, Shigley 1981, Reshetov 1982, Chemilevski 1984, Norton 1994, Dimarogonas 1996, 2001, Muškis 1975, Bakhvalov 1977]. The students are visiting the Cornell *Kinematic Models Digital Library* [kmoddl.library.cornell.edu] to get mechanisms configurations and digitized historic books on kinematics, machines and mechanisms.

Course 24441 Dynamics of Machines and Mechanisms**,** taught at the fourth year. A short syllabus for this course follows: Basic concepts in dynamics, dynamics of rigid bodies, numerical methods for solving the differential equations of motion, computer program for planar dynamic analysis, balancing of rotating machinery and linkages, work and energy, power transmission, power flow analysis, force transmission, sources of forces in machines, general 3-dimensional dynamic behavior of mechanisms and machine elements, dynamics of internal combustion engines, power flow in gear trains, foundation of heavy machinery. The students have the option of a choice of assignments among which: design of a balancing machine, design of a 2L internal combustion petrol engine, calculation and analysis of machine forces, efficiency, the indicator diagram, dynamics of a combination heavy vehicle on a turn, safety and maintenance of heavy machinery in a paper-mill from vibration signatures, Additional reading proposed as [Timoshenko 1974, Reshetov 1982, Greenwood 1988, Norton 1994, Dimarogonas 1996, Ginsberg 1996, Williams 1996]

Course 24441 Vehicle Dynamics is taught at the fifth year of studies in the Department. The course will present students with the opportunity to learn the basic theoretical principles in Vehicle Dynamics and Design combined with a practical approach-using computer aided techniques for analysis and design. A short syllabus for this course follows: Basic concepts in vehicle dynamics, tires, drive train and gear boxes in ground vehicles, suspensions and steering mechanisms, fundamental approach to modeling, automotive design, acceleration and braking performance, road loads, energy balance, drive train, trucks and buses, accident reconstruction. Computer models and simulation of vehicle collisions and rollovers, failure analysis, finite element models (FEA). Emphasis is given to the application of codes and standards in automotive design and engineering, and the homologation process. The students have to select an assignment that may be a review of existing technology in the automotive sector, the design and calculation of a complete automotive system, energy and power calculations for the selection of drive-trains for different automotive configurations, accident reconstruction of real-world accidents, dynamic analysis of specific vehicles. For further reading the students have the choice among others of a series of textbooks available at the Laboratory and the University Library: [Artamonov 1976, Lukin 1989, Gillespie T.D. 1992, Ellis 1994, Milliken 1995, Böhm 1997, Newton 1997, Clennon 2004, Elvic 2004, Evans 2004, Brach 2005, Chondros 2007, Wong 2008]

Courses 114 and 124 *History of Technology I* and *History of Technology II* are integrated in the curriculum of the Mechanical Engineering and Aeronautics Department of the University of Patras to be taught during the first and second semester every year. The course belongs to the cultural and civilization core of courses offered by the Department. Students have the opportunity to select those courses among other courses, namely: The Language and Civilization, Language and Technology, Art and Technology, and other similar. As a mean 110 students out of 120 registered to the Department each academic year, have as a first choice the *History of Technology* courses.

The course was first introduced in 1974 in the newly founded (1972) Mechanical Engineering Department of the University of Patras by Professor Andrew Dimarogonas after his election as a Professor in the Department. The author was in the third year in the Department attending this course. Courses and students homework were integrated to identify important, not strictly technical, aspects of engineering and engineering design, such as the emergence of engineering societies, the engineering ethics, engineering aesthetics, the philosophers, artists and poets view of engineering. The history of engineering was also viewed for its cultural, economic and political impact on society. A textbook *History of Engineering* (2

Vols. in Greek) [Dimarogonas 1976] appeared after the handouts distributed by Prof. Dimarogonas during his first lectures in 1974. The history of engineering is broadly reviewed from the earliest record to modern times. The social, cultural, and economic effects of developments in engineering on contemporary events is examined.

The course goal is to introduce the student to the history of engineering and its cultural, economic and political impact on society. To identify important, not strictly technical, aspects of engineering and engineering design, such as the emergence of engineering societies, the engineering ethics, engineering aesthetics, the philosophers, artists and poets view of engineering. As an outline the following areas are highlighted: What is Engineering. Technology, invention and engineering. The primitive societies. The hand, the primitive tools. Production and the human society. The role of the domestication of animals and agriculture in the emergence of technology. Engineering as technology of scale. Early engineering. Mythology and the Bible. Irrigation and Potamic civilizations. Mesopotamia, Asia Minor, Egypt, India, China. The Great Empires. Pyramids and public works. The first engineers: Amenhot.ep and Gudea. Early sources on Engineering. Mythology and the Bible. The emergence of Reason. Natural Science. Ionian School of Natural philosophy. Thales and electromagnetism. Pythagoras and vibration. Democritus and atomic physics. Enqineering Science. Aristotle. Mechanical Engineering. The Pythagorean and the Alexandrian Engineers. Civil Engineering and Architecture. Roman Engineers. Chinese Enqineering. Arab Engineering and Design Methodology. Middle Ages. Time reckoninq and fluid power. Leonardo da Vinci. Alchemy, Chemistry. Renaissance. Galileo and Newton. Engineerinq Science. The Industrial Revolution, 1750-1830. The Age of Steam and Iron, 1830-1900. Modern Technology, 20th century. The engineering professions. The professional societies. Engineering ethics. French Engineering. The Ecole Polytechnique and Napoleon Bonaparte. Mechanics. German Engineering. Solid and Fluid mechanics. The engine. American Engineering. The ways in which technology, broadly defined, has contributed to the building of American society from colonial times to the present. The West Point. The large-scale project. The Automobile. Electronics and Computers. Aircraft and Spacecraft. Bioengineering.

The course introduces the student in the development of each of the major branches of engineering (e.g., CE, ChE, EE, ME, etc.) and its history. Each student is expected to research a particular engineering subject (e.g., James Watt, Leonardo da Vinci, the building of the pyramids, bridges, electric machines, plastics, the development of the digital computer) and write an essay or a paper tracing its history and its political, social, cul-

tural and economic impact on society. Alternatively, he/she will design and built a model of an engineering aspect of historical importance. A list of projects follows: Mythology and the Bible. The first engineers: Amenhotep and Gudea. The Pythagorean and the Alexandrian Engineers. Design and Reconstruction of Deus Ex Machina. The railroad. History of the Car. History of Aviation. Naval architecture from ancient times. The Rio - Andirio Bridge. The Wright Brothers and the airplane, the Apollo Project, the tunnel under the English Channel, the Challenger disaster, the case of the DC10 design, the Hyatt.-Regency Hotel failure in Kansas city, the Bhopal disaster. Suggested books for further reading [Vitruvius, M.P., 1rst Century AD. *De Architectura*, v. 7, Schroedinger 1954, Dowson 1979, Lancaster 1996, Ceccarelli 2000, Dimarogonas, 2001, Sih 2004, Chondros 2007-2010].

KINEMATICS - MACHINE DESIGN AND THE ROLE OF IFToMM

Kinematics and the design of machines and mechanisms have a distinct place in the history of engineering because they comprised a rational step-by-step logic to receive further a mathematical foundation (Chondros 2007 and 2010). In classical times concrete principles upon which design is developed as a science using mathematics and reason were established. The philosophical foundation of knowledge, aesthetics and ethics and their implications in engineering design are discussed in the works of Dimarogonas (Dimarogonas 1976, 1990, 1992, 1993, 1995, 1997, 2001).

Reuleaux [1872] suggested as the earliest machine the twirling stick for starting fire and discussed further other early machinery such as water mills. The lever and the wedge are technology heritage from the paleolithic era. The first known written record of the word *machine* appears in Homer (ca. 800 *BC*) and Herodotus (ca. 484-425 *BC*), to describe political manipulation [Dimarogonas 1997, 2001, Chondros 2004]. The word was not used with its modern meaning until Aeschylus ca 450 *BC* used it to describe the theatrical device used extensively in the ancient Greek theatre as a stage device to lift actors, chariots or flying horses in the air, as though flying, portraying the descent of gods from the sky and similar purposes. The *mechane* is also known with the Latin term *Deus Ex Machina*. *Mechanema* (mechanism), in turn, as used by Aristophanes (448-385 *BC*), means "an assemblage of machines." Crank and follower mechanisms were widely used in antiquity for many uses, including the foot operated sharpening wheel [Dimarogonas 1993].

Basic scientific principles discussed and explained by Archimedes in the 3rd century BC formed the instrument upon which engineering was established as a science distinct from crafts and unrelated empirical rules. Ctesibius, and his students Philo and Heron, and Pappus of Alexandria have

introduced analytical methods for the study and design of advanced machines and mechanisms, not always driven by practical needs. The nature of Mechanics and furthermore Mechanical Engineering was recognized as a science and an art, as well as the need for specialization and experimentation. Design methodologies appeared in gear sizing, screw threads, weight lifting, catapult engineering, pneumatic machines, and hydraulics. The idea that principles continue to work even with large changes in size was introduced followed by the proposition that mechanical power can be transferred from “toys” and laboratory work to practical applications. Then a rational, step-by-step logic was involved in solving mechanical problems and designing equipment [Papadopoulos 2007, Chondros 2007 and 2010].

The contribution of Leonardo Da Vinci, Galilei and Newton, the redefinition of classical physics and mechanics, the separation of the study of kinematics and the study of machinery in the 18th century, the early mechanization and the progress during the Industrial Revolution yielded the development of engineering design as a systematic process in modern era. The works of Willis, Chebyshev and Reuleaux constituted the basic scientific trends that later became the essence of the science today termed as the theory of mechanisms and machines, greatly contributed and enhanced engineering design [Chondros 2010].

Artobolevski in 1981 in a paper entitled *Some Problems in Mechanics and Machine Control* (Ishlinsky 1981) presented a brief history of the development of the theory of machines and mechanisms. He quotes the words of the outstanding physicist and creator of quantum mechanics, W. Heisenberg, writing: "To grasp the progress of science as a whole, it is useful to compare cotemporary problems of science with the problems of the preceding epoch and to investigate the specific changes that one or another important problem has undergone over decades and even centuries". However, in describing the history of machines, it is necessary to establish at least approximately the point of its origin as a science. This is particularly difficult and this process is confined with the machines and mechanisms which were designed in a systematic way and not arrived at empirically through a process of long evolution. This is a point that separates engineering science from technology and crafts. Considerable contribution to the development of engineering design and the science of machines is being made in different countries thanks to the International Federation for the Theory of Machines and Mechanisms (IFToMM) and the ASME Design Engineering Division.

CONCLUSIONS

The implication of analysis being an integral part of design in engineering has been ameliorated based on the development of mathematics and

mechanics. Design and building of machines have been aided by the theory of mechanisms. In the field of the theory of the structure and classification of mechanisms there have been established not only methods of structural analysis of mechanisms of arbitrary complexity but also methods of structural synthesis. Appreciable results have also been obtained in the dynamics of machines. Besides the traditional methods of dynamic analysis and synthesis of machines, fundamentally new approaches to the dynamics of machines are in evidence. Forecasting the future in any science is not easy, particularly in the present age of such rapid development in science and technology.

The history of technology can be approached not only as a chronology of machine development and a study of artifacts, but also as a study of economic and social development. Technology in history-that is, the relationship of technology to politics, economics, science, the arts, and the organization of production, and with the role it plays in the differentiation of individuals in society. In the frame of the courses in History of Engineering it is investigated how society shapes science and technology, and how in turn science and technology shape society and the environment.

The basic trend in the development of contemporary technology lays on the automation of all types of production with the aim of easing the physical labor of the working man, increasing labor productivity, improving the quality of goods, and ensuring mass production of consumer goods. As the complexity of machines and mechanisms built today increased, engineers heavily rely on science to predict the behavior of not-yet-built designs. The predictive ability for the behavior of new designs is now indispensable in engineering [Ishlinsky 1981, Papalambros 2008]. It is worthy to mention that many Engineering Departments have integrated the Machines and Mechanism theory in Machine Design courses.

Considerable contribution to the development of engineering design and the science of machines is being made in different countries thanks to the International Federation for the Theory of Machines and Mechanisms (IFToMM) and the ASME Design Engineering Division [Artobolevski, in Ishlinsky 1981, Dimarogonas 2001, McCarthy 2007, Papalambros 2008].

The development of the theory of mechanisms and machines requires the closest possible association of scientists and practical workers. Actual practice constantly confronts theory with new problems, and theory in turn finds in practical work a basis for its scientific research. A considerable contribution to the development of engineering design and the science of machines is being made in different countries thanks to the International Federation for the Theory of Machines and Mechanisms (IFToMM) and the ASME Design Engineering Division.

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