

Association for Machines and Mechanisms News Bulletin

Volume 7, No. 1

January 2015



Objectives and Activities

The main objective of AMM is to contribute to mechanical design at all levels starting from academic research to industrial initiatives, thereby enhancing the quality and reliability of indigenous machines. With this in view, AMM organises the International & National Conference on Machines and Mechanisms, iNaCoMM, and the workshops on Industrial Problems on Machines and Mechanisms, IPRoMM regularly.

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Message from the Editor-in-Chief

First, Wish You All A Very Happy and Warm New Year 2015 !!

Volume 7, No. 1, January 2015 issue of the Bulletin of the Association of Machines and Mechanisms (AMM) is being brought out as a New Year issue. However, the news of sad demise of Prof. Amalendu Mukherjee came as a shock to the academic and engineering community. We could gather some information about him to put that in the Obituary column in this issue. Prof. A.K. Samantaray of IIT Kharagpur and Prof. P.M. Pathak of IIT Roorkee kindly took pains to compile the information.

The message of Prof. Shankar Sehgal, the Zonal Vice President (North), is included in this issue. He took the responsibility to bring out this issue of the Bulletin.

This issue contains an invaluable article on "100th Birthday of Professor Crossley" written by Prof. J.S. Rao related to the history of this Association along with some rare photographs. Hope members would appreciate this contribution by Prof. Rao. He has also put a note to give him information, etc. related to another venture of him to compile a paper about Professor Belgaumkar.

A technical brief on "Flexible Materials: Possibility to Use in a Robot Finger" is also included in this issue highlighting some possibilities of easy gripping of components.

Dr. G. Sarvanakumar (Secretary AMM), Dr. C. Amarnath (President AMM) and other office bearers of AMM have taken due initiative to publish this issue. The Editor-in-Chief gratefully acknowledges sincere efforts of the office bearers and Editorial Board members for giving their peer review comments on articles submitted.

AMM members are requested to contribute articles and send same to the editorial team. Constructive suggestions, comments for improvement in the Bulletin of the AMM are most welcome.

Prof. Santanu Das
Editor-in-Chief

From the Desk of the Zonal Vice President

Wishing you a very Happy New Year 2015 !

While welcoming the New Year, it's time to take a look back at some of the major technological advances that have taken place across the world.

Although 3-D printing technology was developed earlier, but in 2014, this technology was used to print a number of new products like prosthetic devices and skull parts and even food. Next is, can we use 3-D printing technology to develop a robot-body that can walk, talk and work just like a human-body, the perfectly designed machine?

Augmented reality, the technology by which graphics, sounds, illusions of touch or smell can be augmented to the real world. Past year saw the application of this technology in retail stores (for virtual fitting rooms), automobiles windshields (for providing navigational and traffic information). Hoping to see more of augmented reality based machines and mechanisms in near future.

2014 witnessed the best use of science in capturing and processing signals from human brain. This time, the so-called scientific-mind-reading was used in precisely manoeuvring a plane in a simulator without touching any of the control buttons or pedals. This technology was also applied in developing prosthetic limbs which can be used for grasping solid objects. During the Football World Cup 2014 opening ceremony in Brazil, the first kick was hit by a paraplegic man wearing a mind-controlled exoskeleton. Further can we expect to develop more advanced and light weight artificial limbs such as artificial legs which may be used by a person for standing, walking, sitting on chair as well as on floor with crossed-legs or even for dancing? This definitely requires a sound knowledge and application of machines and mechanisms.

All such possibilities definitely require state-of-art machines and most importantly research oriented people from machines and mechanisms domain. Once again, Happy New Year to All.

Shankar Sehgal
Zonal Vice President (North)

About the Association of Machines and Mechanisms (AMM)

The AMM headquarter is currently located at the Department of Engineering Design, IIT Madras. A new set of office bearers have taken charge of the affairs of AMM. AMM invites both individual and corporate membership from Indian academia, research organizations and industry. Membership benefits and other information about AMM are available at www.ammindia.org. The body of Zonal Vice Presidents (ZVPs) is active over the past several years with representations from the four corners of the country. They are playing the role of nodal agencies so as to decentralise the AMM official activities and to organise workshops under the aegis of AMM to popularise the mechanism science in their respective regions. They also form the editorial team of this news bulletin. AMM invites contributory articles from its members and others working in the various fields of mechanisms science for this quarterly news bulletin. Interested people can contact the editorial team.

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**Past is experience, Present is experiment,
and Future is expectation. Use your
experience in your experiments to achieve
your expectations.**

--- Anonymous

About the International Federation for the Promotion of Mechanism and Machine Science (IFToMM)

How IFToMM can be reached

- Through your local Member Organization, to become active in IFToMM
- Through an IFToMM Technical Committee Chairperson, to participate in a specific activity
- Through the IFToMM Executive Council
- Through the IFToMM Secretary General:

Prof. Teresa Zielinska, Warsaw University of Technology, MEiL, ul. Nowowiejska 24, 00-665 Warsaw, Poland



IFToMM Presidents

From left to right: Giovanni Bianchi (1984-1987 and 1988-1991), Arcady Bessonov representing Ivan I. Artobolevsky (1969- 1971 and 1972-1975), Bernard Roth (1980-1983), Jorge Angeles (1996-1999), Kenneth J. Waldron (2000-2003 and 2004-2007), Leonard Maunder (1976-1979), Adam Morecki (1992-1995), Marco Ceccarelli (IFToMM Secretary General 2004-2007, President 2008-2011). Yoshiko Nakamura – current President

Main activities of IFToMM

- meetings, conferences, publications, direct collaboration
- 47 IFToMM Members of territory and national Organizations

- 13 Technical Committees:
 - 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
 - Vibrations
- 4 Permanent Commissions:
 - Communications, Publications and Archiving
 - Education
 - History of MMS
 - Standardization of Terminology

- 6 affiliated Journals and 2 book series:
 - Mechanism and Machine Theory*
<http://www.journals.elsevier.com/mechanism-and-machine-theory/>
 - Problems of Mechanics* <http://pam.edu.ge>
 - Open-access Mechanical Sciences*
<http://www.mech-sci.net>
 - Chinese Journal of Mechanical Engineering*
<http://www.cjmenet.com>
 - Journal of Vibration Engineering & Technologies*
<http://www.tvi-in.com/>
 - Mechanics Based Design of Structures and Machines*
<http://www.tandf.co.uk/journals/title/15397734.asp>
 - Book series on MMS
<http://www.springer.com/series/8779>
 - Book series on History of MMS
<http://www.springer.com/series/7481>
- A World Congress every 4 years



**International Federation for the
Promotion of
Mechanism and Machine Science**

Mission

To promote research and development in the field of Machines and Mechanisms by theoretical and experimental methods, along with their practical application

Vision

To provide leadership for cooperation and development of modern results in the Mechanism and Machine Sciences by assisting and enhancing international collaboration

IFToMM webpage:

<http://www.iftomm.org>

IFToMM, April 2014

Bodies of IFToMM

General Assembly

The General Assembly is the supreme body of the Federation and determines its policy. It is composed of the Chief Delegates of IFToMM Members and members of the Executive Council.

Executive Council

The Executive Council manages the affairs of the Federation between the sessions of the General Assembly. It is elected every four years, meets annually, and is composed of the President, Vice- President, Secretary-General, Treasurer, and six ordinary members.

Commissions and Committees

Each Permanent Commission and Technical Committee is composed of a Chairperson, appointed by the Executive Council, 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 Commissions and Committees 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;
- establish contacts between researchers and engineers;
- initiate and develop bases and procedures for modern problems;
- promote the exchange of information;
- organize national and international symposia,

conferences, summer schools, and meetings.

Member Organizations

ARMENIA AUSTRALIA
AUSTRIA AZERBAIJAN
BELARUS BRAZIL
BULGARIA CANADA
CHINA-BEIJING
CHINA-TAIPEI
CROATIA CZECH
REPUBLIC
DENMARK EGYPT
FINLAND FRANCE
GEORGIA GERMANY
GREECE HUNGARY
INDIA ISRAEL
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KAZAKHSTAN KOREA
LITHUANIA MACEDONIA
MEXICO
NETHERLANDS
PERU POLAND
PORTUGAL ROMANIA
RUSSIA SERBIA
SINGAPORE SLOVAKIA
SLOVENIA SPAIN
SWITZERLAND TUNISIA
TURKEY UKRAINE
UNITED KINGDOM USA
VIETNAM

*Welcome to Taipei,
China-Taipei, venue of
the 14th IFToMM World
Congress, 25-30 October,
2015,*

www.iftomm2015.tw

IFToMM supported Conferences (selection)

Int. Symposium on
History of Machines and
Mechanisms (HMM)
Workshop on
Computational
Kinematics (CK)
Rotordynamics
Conference
CISM-IFToMM
Symposium on Robot

Design, Dynamics, and
Control (ROMANSY)
Mechanical Transmission
Applications (MeTrApp)
Symposium on Robotics
& Mechatronics (ISRM)
European Conf on
Mechanism Science
(EUCOMES)
Asian Conference on
MMS (ASIAN MMS)
Summer Schools

Conferences under IFToMM patronage (selection)

Local conferences of the
IFToMM Members
Symposium on Theory
and Practice of Robot and
Manipulators (SYROM)
IFToMM-FeIbIM Int.
Symposium on Multibody
Systems and
Mechatronics (MUSME)

Joining IFToMM Member Organizations gives the following benefits:

international contacts for
potential developments of
joint projects;
reduced registration fees
for IFToMM
supported conferences;
participation and
contribution in IFToMM
activities and
publications;
flow of information on
IFToMM activities.

**You are kindly invited
to join IFToMM and its
activities.**

Obituary of Prof. Amalendu Mukherjee



Professor Amalendu Mukherjee was born in Rajasthan in the year 1947. His father was an English teacher and he was very much involved in literature, drama and other cultural activities. Prof. Mukherjee received B. Tech degree from Jodhpur University, Rajasthan, India in 1967 and Master and Ph.D degrees both from Indian Institute of Technology, Kharagpur, India in 1969 and 1976, respectively. His PhD work was on rotor dynamics which was carried out under the guidance of renowned expert Professor J.S. Rao. He received Alexander von Humboldt scholarship during 1980-81 at University of Clausthal-Zellerfeld, West Germany. He became a professor in 1985. He retired in June 2014 as professor in higher academic grade at Department of Mechanical Engineering, IIT, Kharagpur. His research activities were in the field of rotor-dynamics, robotics, stochastical mechanics, classical mechanics, random vibrations, advanced control systems, systems engineering and modeling and simulation of engineering systems.

Professor Mukherjee was head of Mechanical Engineering Department of IIT Kharagpur from 2004 to 2007. In 1999, he was declared a Fellow of Indian National Academy of Engineers (FNAE). He was elected as Member of Board of Governors of I.I.T Kharagpur by the SENATE in 1998. Professor Mukherjee had also worked as visiting professor at various international institutes/universities. He was chairman organizing committee of IPRoMM 2005 conference held at IIT Kharagpur. He had chaired and acted as IPC member of various conferences/symposia. He was given special felicitation for contribution to dynamics of machines by AMM during 12th NaCoMM 2005 at IIT Guwahati. He was an expert member of various national bodies for evaluation of various project proposals, selection of fellows of national bodies, faculty selection for various IITs, and so on. He was also a member of the accreditation committee set up by Ministry of Human Resource Development (MHRD) and All India Council of Technical Education (AICTE).

Professor Mukherjee was an expert in bond graph modeling. In 1983, he came across Bond graphs when invited by ASME to a review a work by D.C Karnopp. The strange symbols used in that article perplexed him and out of eagerness, he went to the library and found a book by Dean Karnopp. He said '*his life has never been the same thereafter*'. He saw the inner beauty of bond graph modeling and its unifying power. That was sort of liberation for him because at that point of time, he was doing multidisciplinary research and needed an appropriate tool to express his ideas properly. He worked extensively in that field and developed bond graph technique for modeling various kinds of dynamical systems.

He could mesmerize his audience like no one else. His classes and lectures were a treat to follow; he could mix tedious mathematical details with delightful humor and intelligent parallels with unparalleled ease and move about the subject like a magician navigating a magic world. His lectures were like living panorama: informative, rich, colorful, intelligible, expansive in both depth and breadth, and at the same time, engaging. The later, i.e., engaging the audience, is a skill that he mastered like no one else.

He was the first batch of faculty entrepreneurs from IIT Kharagpur. In 1994, he founded HighTech Consultants in partnership with other faculty members. Many other faculty entrepreneurship faded quickly because of lack of leadership and risk-taking ability. However, his company grew steadily and it has grown further in size in the last few years. The company now undertakes various consultancy works from industry and defence sector. He had been main architect for the creation of the bond graph software COntinuous System Modeller (COSMO) at I.I.T Kharagpur. Another powerful software, Symbols (SYstem Modelling through BOnd Graph Language and Simulation), was created under his supervision. Due to his efforts, bond graphs have found their way to large number of Indian industries and academic institutions. The families of software developed by him and his company are used worldwide in various academic institutes and industries including prestigious establishments like Naval Post Graduate School at Monterey, Ecole Centrale de Lille, TATA motors, University of Waterloo, Renault-Mahindra, University of Sheffield, various IITs and NITs, Defence Research and Development Organization, Indian Space Research Organization, etc.

Professor Mukherjee had guided about 15 PhD theses during his carrier. His students have gone on to achieve high positions in academics and industry: six of his ex-scholars are faculty members at various IITs and NITs, one is a faculty in a reputed US university, one is a top executive in General motors Co, another a top designer for TATA motors, and so on.

The deep knowledge that professor Mukherjee had was instrumental in success of various projects of national importance. He had been one of the pioneers in development of the second launch pad of Indian Space Research Organization, development of shock isolation systems for submarines, development of aircraft arrester systems, design of multi-stage aircraft turbine systems, and so on.

Professor Mukherjee had published about 75 papers in internationally reputed journals. He was not one who went for numbers. He did what his heart said; he was a free spirit not bounded by the narrow confines of targeted research. That attitude is evident from the path-breaking research he has conducted during his career. In the beginning of his academic career, he worked on rotor dynamics and lubrication. His research focused on various kinds of hydrodynamic lubricated bearings, and stability of rotor dynamic systems. Later on, he extended that to work on squeeze film dampers and visco-elastic lubricants (mostly during his stay in Germany). His initial works on bond graph modeling concerned analysis of repeated systems with fluid-structure interactions. Then he was inspired by the research of Prof. Neville Hogan of MIT and worked on overwhelming control and impedance control strategy for serial robots and implemented them in bond graph formalism. Most of his works during that period are published in various Transactions of the American Society of Mechanical Engineers (ASME). For a brief period of time, he worked on stochastic systems and proposed a means for derivation of moment closure equations from bond graph models.

In the summer of 2001, he was on visit to Lille in France as a visiting professor and was accompanied by his wife. His wife developed sudden illness and passed away there after a brief fight with cancer. This left a profound void in the life of Professor Mukherjee. He had ample time at hand to devote himself to studies. During this time, he just read and read. He also saw different world movies to spend his time. These changed his life permanently. He emerged stronger than ever after that debacle.

In the later part of his life, he became interested in classical mechanics and dynamics. He was particularly worried about the way non-conservative, non-potential and gyroscopic forces are included in extended Hamiltonian formulation. He found the usual De Alembert's principle to be an ad-hoc mechanism which offers little physical interpretation. He started from scratch and formulated a new approach called Umbra Lagrangian theory. Instead of virtual work, he proposed a virtual time model. All non-conservative and gyroscopic components are modeled in the virtual time (which is held fixed) and other parts are modeled in real time. The two-time scale models are represented in bond graph form with interactions (time-invariant

constraints) modeled by a so-called trans-temporal binding. After derivation of formal equations, a limit is taken so that virtual time is made equal to the real time. Later on, to include non-potential forces like circulatory and follower forces, Umbra-Hamiltonian approach was developed. These two approaches yield correct equations of motion for very complex systems. He also applied Noether's theorem, manifold calculus, gauge invariant transformations and prolongations to investigate the so-called Invariants of Motion in various interesting dynamical systems. His work has been later followed up by various other researchers. He is thus the father of Umbra-Lagrangian and Umbra-Hamiltonian theories. His research in this field has appeared in prestigious Journals like Nonlinear Dynamics and Transactions of the ASME. He was very proud when F.T. Brown wrote a section on his work in his book.

Professor Mukherjee had developed various pedagogic supports during his professional career. He has contributed extensively to develop various new experiments for the Machine Dynamics Laboratory of the Mechanical Engineering Department at IIT Kharagpur. He was also instrumental in setting up the Computer Aided Instructions (CAI) Laboratory where students learn various aspects of modeling, system simulation, soft-computing, and control systems engineering. He had developed a 38 hours Video Lecture Course entitled "Modeling and Simulation of Dynamic Systems". This lecture course is marketed by IIT Kharagpur and various leading universities and industries follow this course. Moreover, Professor Mukherjee has co-authored two books on bond graph modeling.

There are some interesting things related to Prof. Amalendu Mukherjee. He was a very good astrologer and he has published many works in astrological journals. People used to throng his home to pester him with request to predict their future, like promotion, matrimonial issues, etc. He happened to once accompany renowned Odissi dancer Sanjukta Panigrahi on Tabla in a Society for the Promotion of Indian Classical Music and Culture Amongst Youth (SPIC MACAY) program at IIT Kharagpur. His command over Sanskrit language was amazing and he could fluently recite and explain various stanzas of Hindu holy-book Gita with élan. Interestingly, he could do the same for writings by poets Mirza Ghalib, Meera Bai, Kabir, Mir Taqi Mir, Omar Khayyám and so many others. He could recite exact lyrics of various old Bollywood film songs.

He was not merely a Professor of Mechanical Engineering but a great orator, expert on western and oriental history, great philosophical mind, accomplished player of membranophone percussion instruments like Tabla, avid reader and traveler, Professor Mukherjee was a voracious reader. He had read books of various literatures from various cultures, watched movies from various cultures and spoke various languages. He had mastery over at least five Indian languages, English and German, and had basic knowledge of French and Arabic languages. He could read Arabic language and its derivative form called Urdu. Professor Mukherjee loved music, dance, quality cinema, paintings, literature, and especially, poetry. In short, he was an artist first who incidentally was also a scientist.

Prof. Amalendu Mukherjee is survived by a son Abhiro who works as a faculty member of NIST, Berhampur, Odisha.

Compiled by
Prof. A.K. Samantaray of IIT Kharagpur and
Prof. P.M. Pathak of IIT Roorkee

Excerpts of Messages from across the world (Compiled from group emails)

Geneviève DAUPHIN-TANGUY, Ecole Centrale de Lille, France (Seconded by Jeffrey L. Stein, University of Michigan):

We will never forget the discussions with Amalendu, on life, death, God, comparing Hindu and Christian religions, but also on Indian and French cultures. He was a great scientist, a "honnête homme" model of humanity as defined in France in the 17th century, with a very wide culture, a human contact full of kindness and sensitivity, and a true sense of humour.

José J. Granda, California State University, Sacramento:

This is a loss to the scientific community and a personal loss also as he was a wonderful friend. I had the opportunity to interact with him for many years as he integrated the International Program Committee of ICBGM since 1993. Those of us, who have chaired the conference over the years, learned firsthand his scientific contributions and knew of his charisma to help young authors and others to become researchers in Bond Graph Modeling and Simulation. He was an institution himself with so many abilities not only in the field but outside. I admired him not only as a Professor but personally as he visited me at home in Davis, California. He will be missed but his spirit and legacy will continue in years to come.

Wolfgang Borutzky, Technical University of Bonn, Germany:

I had the pleasure to meet with Prof. Mukherjee a number of times over two decades in France, in the USA and in India. I always appreciated his kindness, his esprit, his humor, and his clear understanding of all kinds of engineering problems. Apparently, he was also a gifted and charismatic teacher. Quite a number of young brilliant students worked with him and make major contributions to the research worldwide. I will always keep him in mind.

Donald Margolis, UC Davis, California:

This is very sad news about Amalendu. I have had some great interactions with him over the years. His contributions to the bond graph community and science community in general is significant and will never be forgotten. We had a most memorable visit when he came to UC Davis for a few days. We had some pretty intense discussions into the wee hours of the morning. I will always enjoy thinking about those meetings.

Belkacem Ould Bouamama, Université des Sciences et Technologies de Lille, France:

Our condolences to his family and bond graph community in India. We will remember his scientific expertise, broad smile and kindness.

Ranjan Mukherjee, Michigan State University:

Professor Amalendu Mukherjee was my teacher and mentor when I was an undergraduate student at IIT Kharagpur. I spent a lot of time with him in the last year of my undergraduate studies since he was my B.Tech thesis advisor. I frequently went to his home and we had discussions on a wide range of topics, from poetry to physics, to thermodynamics, and of course bond-graphs. His vast expanse of knowledge left an indelible impression in my mind and he certainly inspired me to pursue academics as a career. I am sure that he has had a positive impact on the life of many of his students and colleagues. His absence will be felt dearly.

Jorge Luis Baliño, Universidad Brasialia, Brazil:

I believe that the memory of the beloved remains in the work and primarily in the disciples and students that are inspired. I see that his life was fruitful.

Sergio Junco, Rosario National University, Argentina:

I saw in him not "just" an engineer, but as a scientist doing engineering in a way deeply rooted in classical science. Many years ago I heard for the first time about Umbra-Lagrangian time during one of his talks at an ICBGM conference. Recently I started research on Hamiltonian and Lagrangians as applied to control problems and came back to read the contributions by Amalendu. I was delighted.

P.M. Pathak, IIT Roorkee:

As his student, I had an opportunity to see him closely as a teacher and as a guardian. He was very much concerned about his students (both past and present). Even when he went on vacations, he used to think about the problems of his students. He used to say PhD is a training to do research and training should be rigorous. He used to call his office a concentration camp. He was very innovative. He emphasized on us to develop habit of reading. He had solutions of all the problems of his students, whether technical or personal.

Subir Saha, IIT Delhi:

I think it may not be wrong to say that he is the Father of Bond Graph in India. I remember how he remembered the food served at NaCoMM 2003 in IIT Delhi. After several years when I met him, he mentioned the good food at IIT Delhi. Hence, he knew how to appreciate food too without which our life engine will not run smoothly.

Vikas Rastogi, Delhi School of Engineering:

The great personality, who was the synonyms of dynamism and vibrancy during his whole carrier of academic and scholastic life. It is not only the irreparable loss to the dynamics and modelling community but a very personnel loss to me. He was undoubtedly the Father of Bond Graph Modeling in India. His adorable affection towards umbra-Lagrange's creation was a golden mark in his whole technical carrier of 44 years at IIT Kharagpur. For me, he was an Institution in himself with all great qualities, which are very rarely found in today's academic world.

Nilotpal Banerjee, NIT Durgapur:

I will remember him not only for his wit and wisdom but also as an expert in field of Sanskrit literature. He was a man with very good sense of humour too.

Sanjoy Ghoshal, ISM Dhanbad:

It is a loss of a great motivator, teacher and scientist. He will remain alive to all of us due to his scientific knowhow, unparalleled memory, interpersonal relationship, and of course bond graphs.

Anand Vaz, NIT Jalandhar:

Professor Mukherjee played an extremely significant role in pioneering and popularizing Bond Graph in India. He was an excellent teacher, fondly loved and remembered by his students, and colleagues. He had affectionately and passionately fostered a wonderful and friendly environment for learning and research at IIT, a 'gharana' by itself. He has also made tremendous contributions through initiating and facilitating the development of software for Bond Graph at Kharagpur. Professor Mukherjee will always be remembered, not only for Bond Graph in India, but also for his wit and humour, his proficiency on 'Galib', his 'Sher-O-Shayari', his knowledge and explanation on the 'Gita', his love for 'literature' on a variety of topics.

Tarun Bera, Thapar University, Patiala:

He was a genius in each and every field of Mechanical and control engineering. He is no more but his great work will remain with us forever.

Vijay Periasamy, Curtin University of Technology, Australia

I had the wonderful opportunity of working under him as a student. The things I most admired in him are his boundless enthusiasm for understanding science which reflected in his research and teaching endeavors; and his zest for all fine things in life (like literature, poetry, cinema,...). He will always be remembered through his work and also through the students and colleagues he inspired.

A.K. Samantaray, IIT Kharagpur

My ex-colleague Professor Mukherjee, was my teacher and continues to be my inspiration till now. He was also my closest friend. He had great mastery over mathematics and physics which allowed him to see engineering science from different perspectives. His work on extending Lagrangian and Hamiltonian mechanics is a masterpiece in itself. He was not the archetypal engineer. When there was an engineering problem, he understood it from the basics and gave solutions within minutes, which often turned out to be the right one. As far as diagnosis of machines goes, he was a doctor of machines who could feel their pulse and heartbeat just by touching and listening to them. I learnt more from Professor Mukherjee outside the class than inside. He had that uncanny ability to remember things that amazes me. He could recount particular scenes in particular movies with great details, recite old poems from so many poets across the world, refer to scientific books where a particular derivation/proof is given, give the precise date, place and sequence of events of particular historical events throughout the world, He was full of energy and never felt tired. He had great compassion for his students and colleagues. We will keep his memory alive by keeping the "Bond Graph Gharana" going stronger.

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100th Birthday of Professor Crossley

J.S. Rao

President Academics, Kumaraguru College of Technology, Coimbatore
Founder Member of IFToMM and Honorary Member IFToMM, Founder of AMM

This note is written in honor of Professor Dr. F. R. Erskine Crossley, Professor Emeritus, Architect and Founder Member of International Federation for Promotion of Theory of Mechanisms and Machines (IFToMM) and its first Vice President on his achieving 100 years of age on 21st July 2015 with glorious service to Kinematics and Kinetics Community of the world.

The scientists in the world have been always looking for a platform for academic exchanges. Theodore von Kármán, Professor in Aachen (Germany) proposed in 1922 the need for scientific congresses which were rare when the world was recovering from the ravages of World War I and some thirty people, all Europeans, met in Innsbruck to talk and listen. In a way International Union for Theoretical and Applied Mechanics (IUTAM) can be considered to have come into existence then. However, the formal constitution of IUTAM was adopted only on 26th of September 1946 just after the II World War. The formal date of foundation is generally attributed to be in 1948. One of those present in Innsbruck was Professor C.B. Biezeno of Delft. In his opening speech at the Tenth International Congress of Applied Mechanics, held in Stresa, Italy in 1960 Professor Biezeno recalled various incidents during the period 1922 to 1948. However much the scientific community desired a platform at high level for academic exchanges, the political situation was not conducive and did not promote such a body to be formed. In contrast, it is the wisdom of Professors Ivan Ivanovich Artobolevskii and F. R. Erskine Crossley who have foreseen the difficulties of cold war problems, planned well and came together to form the International Federation of Theory of Mechanisms and Machines (IFToMM) just in two years' time.

The fundamental subject in Mechanical Engineering is Theory of Mechanisms and Machines, popularly known as TMM in the East or Kinematics and Kinetics of Machinery or Dynamics of Machinery as known in the West. It was the desire of many mechanical engineers to have an International Union in this subject and bring scientists to a common platform for intense discussions. Cold War prevented a free movement of scientists between East and West.

In October 1967, Professor Artobolevskii organized a Mechanisms seminar at Sukhumi, Soviet Georgia and invited Professor Crossley, Professor Meyer zur Capellen of Aachen Professor George Sandor of Yale University and Professor den Hartog of M.I.T. Professor Crossley reciprocated with an invitation for ASME conference on Mechanisms to be held in October 1968. In this meeting Professor Artobolevskii proposed that a worldwide federation for the subject of TMM be formed which received enthusiastic response from the Western team of Professors. This resulted in the meeting at Varna, Bulgaria, held July 24, 1969, where delegates from other countries had been added. India was one of them.

Indian Part: Independent India set up a chain of Indian Institutes of Technology, the first one in Kharagpur in the industrial belt of Calcutta, Jamshedpur, Ranchi, Dhanbad, Durgapur ... Professor R.A. Kraus renowned Kinematician from Germany, was the first Director (acting) of Kharagpur Institute that started as Higher Technological Institute in 1951. He spearheaded the first Indian Institute of Technology department of Mechanical Engineering and established one of the finest Laboratories of Linkages replicating the laboratory at Technical

University, Braunschweig. The school of Kinematics set up here promoted Education, Research and Development in India; Professor B.M. Belgaumkar (my teacher) is the first Indian to head this department after Professor Kraus. I moved to Surrey to work with Professor William Carnegie in 1968. With these introductions I was noticed by IFToMM initiators and earned invitations to Varna and Zakopane in 1969.

In those days air travel was rare and while traveling by train I had the occasions to visit Professor Meyer Zur Capellen, Professor de Pater amongst others. When I reached Sofia in the evening by train, there was none to help me (I have not seen the mails that arrived in Surrey about the rearrangements). Upon showing my correspondence with Professor Konstantinov one young couple helped me to go to a Theater (I still have no idea and that remains a mystery) and connected me to an English speaking person from Professor Konstantinov office who then rushed me back to station for the train leaving for Varna. Next morning I found none at the station again – after some thinking I began to walk to find someone who can help me. I found a car by roadside and someone repairing it underneath. When he came out and seeing me he immediately realized and hugged me. Thus began a wonderful relation with Bulgaria. I have personally learnt a lot from IFToMM father figures in framing a constitution and contributed a little here and there.

Zakopane:



Prof. Crossley addressing the meeting; Prof. Maunder extreme left with Rao sitting opposite



Opening Session: Prof. Oderfeld- Polish Committee Chairman addressing, Extreme left is Prof. J.S. Rao, India and opposite to him Prof. Len Maunder of Newcastle, UK

It is a history that was made; IFToMM was founded as the International Federation for the Theory of Mechanisms and Machines in Zakopane, Poland on September 29, 1969 during the Second World Congress on TMM. It is a tribute that I can pay to Professor Belgaumkar (as it

is traditional in India's *Guru-Sishya Parampara*) who in anticipation of my possible contributions to IFToMM suggested my name as Indian Chief Delegate that led me signing the IFToMM constitution on this historic day. Under the vision of Professor Artobolevskii and Professor Crossley, the main architects of IFToMM the Federation grew to strength of 48 members and made several significant contributions over 45 years for the promotion of Mechanism and Machine Science in the World. It should be mentioned here the Polish committee headed by Professor Oderfeld and Professor Morecki made sure that the IFToMM formation went through smoothly.

Initially there are 13 Member Organizations; Members who attended the ceremony include Academician Ivan I. Artobolevskii (USSR), Prof. Erskine F.R. Crossley (USA), Prof. Michael S. Konstantinov (Bulgaria), Dr. Werner Thomas (GFR), Prof. B.M. Belgaumkar (India), Prof. Kenneth H. Hunt (Australia), Prof. J. Oderfeld (Poland), Prof. Jack Phillips (Australia), Prof. George Rusanov (Bulgaria), Prof. Wolfgang Rössner (GDR), Prof. Zènò Terplàn (Hungary), Prof. Jammi S. Rao (India), Prof. Giovanni Bianchi (Italy), Prof. Adam Morecki (Poland), Nicolae I. Manolescu (Rumania), Leonard Maunder (UK), Douglas Muster (USA), Ilic Branisky (Yugoslavia).



Delegates at the meeting- Prof. De Pater of Delft extreme right next to him Prof. Belgaumkar

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	IV *	<i>Jack Phillips</i>
Bulgaria	Georgi Rusanov	IV *	<i>Georgi Rusanov</i>
German Democratic Republic *	Wolfgang Rössner	III *	<i>Wolfgang Rössner</i>
German Federal *	Werner Thomas	III *	<i>Werner Thomas</i>
Hungary *	Zènò TERPLAN	IV *	<i>Zènò Terplan</i>
India *	J. S. RAO	V *	<i>J. S. Rao</i>
Italy *	Giovanni BIANCHI	IV *	<i>Giovanni Bianchi</i>
Poland	Adam Morecki	IV *	<i>Adam Morecki</i>
Rumania	Nicolae I. Manolescu	IV *	<i>Nicolae I. Manolescu</i>
United Kingdom *	L. Maunder	III *	<i>L. Maunder</i>
U.S.A.	DOUGLAS MUSTER	I	<i>Douglas Muster</i>
U.S.S.R.	Ivan I. Artobolevskii	I	<i>Ivan I. Artobolevskii</i>
Yugoslavia	Ilic BRANISKI	IV (x)	<i>Ilic Branisky</i>

IFToMM founding fathers' signatures at the Inaugural Ceremony

Professor Crossley and Kinematics and Dynamics of Machinery Teaching

Professor Crossley is known to be one of the best teachers of Dynamics and Controls and Nonlinearities. One can see his love of teaching this subject, an International conference for teachers in the subject of mechanisms was conducted by him in 1961 at Yale University, which was attended by eminent professors and researchers from western countries; Kurt Hain, Meyer zur Capellan and Walther Fritz Heinrich, Joseph Beggs, Ferdinand Freudenstein, Sigmund Rappaport, Artur Rothbart, Oene Bottema, Jaques Denavit, Kenneth Hunt amongst others. Professor Crossley himself presented a paper in this conference titled “Dynamic mechanisms and nonlinear control systems”. According to Georgia Tech Alumni Magazine of 1965 he began at Yale work on “Synthesis of Mechanisms” which was developed in Germany two decades earlier, using now analog computers. He lectured widely in his native country England, Manchester, Swansea, Salford, Sheffield and Cambridge followed by several schools in Germany and Italy. This is a golden era of kinematics with several significant contributions from Dudley, Erdman and Sandor, Faires, Green, Hall, Ham, Crane, and Rogers, Holowenko, Reuleaux and Rosenauer and Willis amongst others.

Professor Crossley is a pioneer in using digital computers for “Mechanism Structural Analysis and Type Synthesis” in mechanical design. He assembled a lively group of faculty and students, conducted weekly research seminars, that included students and faculty from other departments and even from other universities e.g., University of Florida. He led investigations of the effects on design of applying the criteria of three-dimensional kinematics to two-dimensional kinematics to reduce the needed accuracy in dimensions. In 1988 at his age of 73, he published recollections From Forty Years of Teaching Mechanisms in an article published in Journal of mechanisms, transmissions, and automation in design, providing an inspiration to the present generation on the rich past of teaching of design.

Association of Machines and Mechanisms

Because of our association from the beginning, IFToMM General Assembly at the 5th World Congress in Montreal in 1979 awarded the 6th World Congress to India to be held in 1983. This has set up an activity within India to form our national Association and bring awareness to the community regarding the 6th World Congress. I approached young and dynamic Professor C. Amarnath who readily volunteered to organize the 1st National Conference on Mechanisms and Machines in IIT Bombay. This was the (first) National Conference on Mechanisms and Machines, Bombay 2-3 December 1981 borne under Professor C. Amarnath’s leadership. On 3rd December 1981, we had a general meeting of the delegates where it was decided to form the National Association of Mechanisms and Machines (AMM) with Professor J. S. Rao as founder president, Professor S. Krishnamoorthy of VJTI as founder vice president and Professor C. Amarnath as the founder secretary. This conference and the founding committee paved the way to conducting a highly successful IFToMM World Congress in IIT Delhi. The AMM has been successfully conducting national conferences since then, the upcoming one and 17th conference in IIT Kanpur in June 2015.

We have been immensely benefited with the association and the parent body IFToMM. Several schools were established carrying out front line research on Mechanisms and Machines science, robotics, vibrations, rotor dynamics and condition monitoring, bearings, controls, lifing and optimization amongst others. We have contributed to many frontier areas; Complete Failure analysis of Narora Atomic Power Plant catastrophic failure of Nuclear Turbines, Real Time Condition Monitoring of Nuclear Plants and Expert Diagnostics, Kaveri Engine Designs, Cryogenic Pumps, Fusion reactors amongst others. We have participated in General World Congresses and associated World Congresses of Technical Committees such

as Rotor Dynamics, helped IFToMM Technical Committees and Permanent Commissions, Executive Council and other IFToMM activities. IFToMM recognized our contributions, sponsored our journals and recognized individual efforts. We are a frontline organization with IFToMM.



President Prof. Ken Waldron and then Secretary (later President) Prof. Marco Ceccarelli honoring Prof. J.S. Rao with IFToMM award 2004 for fundamental contributions as one of the founding fathers in developing IFToMM and MMS, and in promoting the PC History and IFToMM Distinguished Service award 2004 at the 11th World Congress, Tianjin, China

Closure

I express through this Newsletter, India Mechanisms and Machines Community's gratitude to the Living Legend Professor F R E Crossley for nurturing this worldwide activity and promoting the Science and Engineering in this field, particularly in India.

Reference

[1] J.S. Rao, Theory of Machines through the 20th century, Mechanism and Machine Theory, April 2015 (in press), <http://dx.doi.org/10.1016/j.mechmachtheory.2014.08.003>.

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NOTE

Few days ago Professor Ceccarelli requested me to write a paper on Professor Belgaumkar for HMM workshop in Mexico in 2015 and I began gathering information.

May I request our AMM members and others to kindly contact me for any details they have; even exact date of birth and passing out, his papers, works, his style of working, contributions, his family photographs, etc.

I will acknowledge them when I prepare this.

Prof. J.S. Rao

FLEXIBLE MATERIALS: POSSIBILITY TO USE IN A ROBOT FINGER

Manisha Kundu¹, Subarna Pal², Somojit bhuin³, Bipasa Hansda⁴ and Santanu Das⁵

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Grasping and holding different components are two main tasks done by a robot gripper. Using a flexible gripper, gripping a large weight of varying shapes may be possible with less force. In the present work, applicability of two flexible materials was explored experimentally. An indigenous gripping device was fabricated as shown in Fig.1 to find out gripping force required. Soft flexible materials, such as laminated ethylene vinyl acetate (EVA) foam (density: 24.887 kg/m³) and thermocole (polystyrene) (density: 29.279 kg/m³) were used as the gripping material. A low alloy steel flat (weight 0.1208 kg) with a tray hanging from it was friction gripped by the flexible gripper. Weights had been increased gradually until it got slipped from the finger of the gripper. Maximum weight it could carry was noted and the corresponding deflection of the spring was measured. It was found out that coefficients of friction of laminated EVA foam and thermocole against low alloy steel flat were 0.364 and 0.641 respectively.

Experiments were done in two stages. First, deflection of spring was kept constant at 3 mm. At this condition, grasping load remained constant. With each of the two finger materials, weights were varied, and maximum weight it could grip was found out. In the second stage, amount of weight was varied for each gripping material to grip, and related deflection was measured to evaluate grasping force needed.

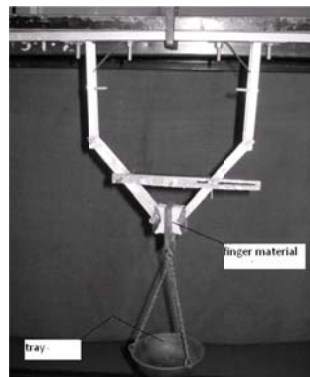


Fig. 1 The test set up

Coefficient of friction between thermocole and low alloy steel (weight 0.641 kg) was higher than the other materials tested. The two flexible finger materials were subjected to different loads, and corresponding deflections were noted to observe its load bearing capability. Gripping finger made of thermocole held more load with lower deflection than the other one. Laminated EVA foam material, on the other hand, gave higher load bearing capability than the other one with low deflection.

It was observed that spring force required to grip a weight was lesser than the weight gripped. Thermocole (polystyrene) might be used as a good finger material as it had high coefficient of friction against low alloy steel flat and needed less force and deflection to grip a load than laminated EVA foam tested.

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IFTOMM 2015 World Congress Oct. 25-30, 2015, Taipei, Taiwan <http://www.iftomm2015.tw>

Call for Paper

The 14th IFTOMM World Congress will be held in Taipei, Taiwan, on Oct. 25-30, 2015. IFTOMM World Congress is held every 4 years and is the largest congress on mechanism and machine science. It will provide opportunity for researchers, scholars and students with interests in the theory and practice of mechanisms and machines for new ideas, sharing experiences, and discussing future developments.

TOPICS OF THE CONGRESS

Papers are welcome on the general areas of the theory and practice of machines and mechanisms, but not limited, to the topics of the IFTOMM Technical Committees and Permanent Commissions, namely:

- Biomechanical engineering
- Computational kinematics
- Design methodology
- Dynamics of machinery
- Education
- Gearing and transmissions
- History of MMS
- Linkage and mechanical controls
- Mechatronics
- Micromechanisms
- Multibody dynamics
- Reliability of machines and mechanisms
- Robotics
- Rotor dynamics
- Standardization of terminology
- Sustainable energy systems
- Transportation machinery
- Tribology
- Vibration

ORGANIZING COMMITTEE

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(National Tsing Hua University)
Best Paper Award Chair: Hong Sen Yan
(National Cheng Kung University)
Secretary General: Tyng Liu
(National Taiwan University)

PRESENTATION AND PROCEEDINGS

The official language is English. Registered participants will receive one Digital Proceedings which will be Engineering Index (EI), DOI and ISBN numbered.

PAPER SUBMISSION

All papers must be submitted electronically and they will be reviewed. Authors are requested to submit a full length paper, 4 pages (minimum) to 10 pages (maximum). The abstracts are NOT acceptable. The format will follow the IFTOMM template that is available in the congress webpage. Best Paper awards will be given.

IMPORTANT DATES

Full version of the paper should be submitted through the Conference Web site.
On-line Submission System Open: 01 Sep. 2014
Full Paper submission: 15 Jan. 2015
Provisional decision: 15 Apr. 2015
Final version submission: 31 May 2015
Final decision: 15 Jul. 2015

REGISTRATION FEES

Early registration will be before 25 August 2015.

	Early Reg.	Regular Reg.
Delegate from IFTOMM MO:	US\$300	US\$600
Delegate from non-IFTOMM MO:	US\$350	US\$650
Student:	US\$150	US\$200
Accompanying Person:	US\$150	US\$200

IFTOMM Young Delegate Program will provide support to young researchers as ruled in IFTOMM webpage.

CONGRESS LOCATION

The island of Taiwan lies about 180 Km off the southeastern China. Taipei City, the capital of Taiwan is a city of fascinating contrasts – a mix of modern and traditional with a generous dash of energy and friendly smile.

It will be held in Taipei International Convention Center which situated in central Taipei, Xinyi District, near Taipei 101, with convenient transportation. For more information, please visit the Tourism Bureau site at: <http://www.taipeitravel.net/en/scene/>

ACCOMMODATION

A variety of hotels with special rate in different standards with the room rate ranging from US\$133 to US\$387 will be listed on the IFTOMM 2015 website.

TRAVEL INFORMATION

Taipei can be reached by flight from all around the world to Taiwan Taoyuan International Airport (TPE) and Taipei Song Shan Airport (TSA). TICC is located on Xinyi line of MRT.

Taiwan Taoyuan International Airport:
<http://www.taoyuan-airport.com/english/index.jsp>

Taipei Song Shan Airport:
<http://www.tsa.gov.tw/tsa/en/home.aspx>

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IFTOMM Web: www.iftomm.org / Conference Web: <http://www.iftomm2015.tw>

**2nd International and 17th National Conference
on
Machines and Mechanisms
(iNaCoMM-15)
December 16-19, 2015
organized by
Department of Mechanical Engineering**





IIT Kanpur
Under the aegis of



Association for Machines and Mechanisms

&



**IFTOMM
International Federation
for the Promotion of
Mechanism and Machine Science**

Introduction

The Department of Mechanical Engineering, IIT Kanpur, under the aegis of the Association for Machines and Mechanisms (AMM), and International Federation for the Promotion of Mechanism and Machine Science (IFTOMM) is hosting the 2nd International and 17th National Conference on Machines and Mechanisms (iNaCoMM 2015). The convention will be held on campus during December 16th - 19th, 2015.

Highlights of iNaCoMM-15

iNaCoMM 2015 is the 17th National and 2nd International in the series of biennial conferences on Machines and Mechanisms organized under the aegis of AMM and IFTOMM. The convention aims at bringing together researchers, industry experts and students, working on various aspects of design and analysis of machines and mechanisms, to deliberate via oral and poster presentations on recent, novel advances.

iNaCoMM 2015 will feature eminent researchers from India and overseas, as plenary speakers. The Conference is planned to commence with an introductory lecture on history and evolution of machines and mechanisms followed by a series of workshops on haptics, static balancing, precision mechanisms, and/or smart material-based mechanisms.

Each day thereafter will commence with a plenary talk by an eminent scientist followed by interesting morning and afternoon presentation/poster sessions on analysis and design of rigid body and compliant mechanisms, advances in biomedical devices, dynamics/control/vibration analysis of multi-body systems (special session) and machines, health monitoring, applications for rural environment and agriculture, mechatronic, micro- and nano- systems, and numerous other topics.

The day will culminate with another plenary lecture followed by soothing, recreational performances by our students from Music, Dance and Dramatics Clubs. Professional and Classical, music and dance nights are also planned.

Numerous industry representatives will also showcase recent technological advances in hardware and software.

Scope

The conference will cover following broad areas, but not limited to

- Agricultural and Industrial Applications
- Analysis and Synthesis of Mechanisms
- Compliant Mechanisms
- Design and Analysis of Biomedical Devices
- Dynamics and Control of Multi-body Systems
- Dynamics and Vibration Analysis in Machines
- Fault Diagnosis and Health Monitoring
- History of Machines and Mechanisms
- Mechanisms and Machines for Rural, Mechatronic Systems
- Micro-, Nano-Machines and Mechanisms
- Modeling and Simulation
- Robotics
- Theoretical and Computational Kinematics
- Tribology
- Vehicle Dynamics

Call for Papers

Authors are invited to submit a two-page extended abstract at the conference website www.inacomm2015.org

by **May 1st, 2015**. The official language is English. Acceptance of the abstracts will be communicated by **May, 15th, 2015**. Full paper submissions followed by the camera ready prints in the Conference template are expected by **November 15th, 2015**.

Important Dates

Submission of Abstract	May 1, 2015
Acceptance of Abstract	May 15, 2015
Submission of Full Paper	July 1, 2015
Notification of Decision & reviewer comments.	Oct. 1, 2015
Final submission of Camera-Ready Prints	Nov. 15, 2015
addressing of reviewer comments.	
Registration	Nov. 15, 2015

(one author must register for inclusion of paper in Conference Proceedings)

Registration Fees

Delegates from	India (INR)	Others (USD)
Full time research scholar	2000	200
Research Organizations	5000	300
Others (Academic Institutions)	7000	450
Concession (IFTOMM Members)	500	50

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On campus accommodation is available on payment basis at IIT Kanpur guest house/student hostels on first cum first served basis.

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For updates, please visit
www.inacomm15.org

About IIT Kanpur



IIT Kanpur is a mini-academic city, a self sustained, lush green campus spread across 1055 acres hosting about 14,000 inhabitants. The campus is well-equipped with infrastructure catering to our academic, culinary, residential and recreational requirements. It offers an innate picturesque ambience that is consistently energizing and calming.

IITK experiences all seasons – the scorching heat of the summer, the wet, humid afternoons of the rainy season, and the chilly and hazy nights of the winter. Our hallmark is the presence of peacocks on campus, often lurching on the green grounds or resting on high branches.

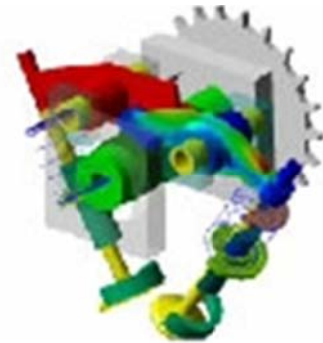
Tourism sites in and around Kanpur



India is an experience! A visit to IIT Kanpur comes with a unique advantage of exploring the rich and diverse heritage of Northern India. Kanpur is home to several historical sites, e.g., Bithoor, Ghatampur and Shivrajpur. Visits to the mystic ghats of Varanasi, ancient ruins of Kaushambi, architectural splendor of Khajuraho, clouds touching down in Nainital, moonlit Taj and the transcendent beauty of the Himalayas are bound to leave one enriched and craving for more.



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RecurDyn, based on multi-body dynamics, is the CAE software for multi-physics solutions. Starting with just multi-body dynamics in 2004, **RecurDyn** became the first Multi-Flexible Body Dynamics (MFBD) to integrate multi-body dynamics and non-linear finite element methods into its numerical integrator, which opened the new paradigm in the field of multi-physics CAE.

Today, **RecurDyn** continues to lead the multi-physics CAE field by creating interdisciplinary CAE software that integrates MFBD, Lubrication, Control, and Design Optimization, all in a single framework.

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