Association for Machines and Mechanisms News Bulletin

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Message from the Editor-in-Chief

Role of shaking forces and shaking moments in balancing of mechanical systems

How to perform the dynamic balancing of mechanical systems is an old problem in order to reduce the vibration of the frame on which the system is mounted due to the shaking forces and shaking moments. The purpose of balancing is also to make highly fluctuating driving torque/force needed to obtain nearly constant driving speed smooth. Related to the balancing of mechanisms, the shaking force and shaking moment are defined as the resultant of the inertia forces and moments of the moving links. When the dimensions of a mechanism and the input speed are given, the inertia forces depend only upon the mass distribution of the moving links. Balancing of shaking force and shaking moment in high speed mechanisms/machines reduces the forces transmitted to the frame. In effect, this reduces the noise and wear, improves the dynamic performance, and extends the fatigue life of the mechanisms.

The shaking force can be eliminated completely by attaching counterweights to the moving links. However, this increases overall mass and inertia of the mechanism. As a result, shaking moment, required driving torque/force, and reactions at the joints increase. To balance a mechanism completely, it is required to eliminate both the shaking force and the shaking moment. However, complete balancing of any one may result in an increased unbalance in the other one.

To improve the overall performance of a mechanism, it is required to trade-off between all the competing dynamic quantities, namely, the shaking force, shaking moment, driving torque/force, bearing reactions, etc. This means that the balancing problem should be treated as an optimization problem. In the optimization, an efficient dynamic algorithm is required to compute the dynamic quantities iteratively.

Note that the dynamic performance characteristics, i.e., the shaking force, shaking moment, input torque/force, etc., depend on the mass and inertia of each link, and its mass center location. Hence, the balancing can be achieved by redistributing the link masses optimally. A convenient way to represent the inertia properties of the links is to treat them as the dynamically equivalent system of point masses. Such dynamically equivalent system is referred as *equimomental system.* The concept of equimomental system of point masses, and its effective utilization in mechanism balancing have been studied extensively, particularly, for the planar mechanisms. In contrast, understanding of the balancing of spatial mechanisms is very limited. This may be due to their complexity in formulation of the balancing problem. The concept of equivalent systems of point masses will pave the way to simplify the balancing problem of many complex mechanisms which are spatial in nature.

Himanshu Chaudhary
Editor-in-Chief

Our 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 National Conference on Machines and Mechanisms, NaCoMM, and the workshops on Industrial Problems on Machines and Mechanisms, IPRoMM regularly.

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Rapier Drives

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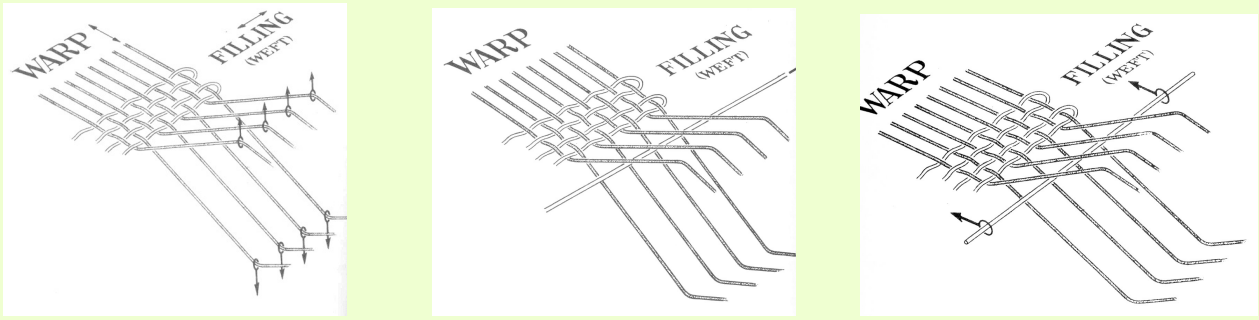
Dept. of Mech. Eng., IIT Bombay

The majority of production of Indian weaving industry comes from the decentralized sector. Most of the looms in this sector are of very old design. The primary reason is that they are available at a fraction of the cost of looms of better design. A secondary reason is that the "modern" looms have many electronic controls which the weavers in the decentralized sector are not able to maintain or repair. This has led to low productivity and low quality of fabrics produced in the decentralized sector. The weaving machinery manufacturers are not able to reduce the cost of the "modern" looms to a level at which they will become competitive with the "old" looms because the former require precision manufacturing techniques. A design which would allow the performance of the "old" looms to improve to some extent but does not require introduction of electronic components or the use of precision manufacturing techniques would be welcome by the Indian loom manufacturing industry. One probable design has been suggested in this article.



Shedding Picking Beating-up

Fig. 1: Primary motions of a loom [1]

In order to understand the rationale for this design, it is necessary to understand the primary motions of a loom. The three primary motions of a loom are shedding, picking and beating-up. These have been shown in Fig. 1. A loom cycle consists of these three motions in sequence. Out of these three motions, it is the second one - picking - which limits the speed of the loom. A shuttle loom of "old" design requires the weft to be inserted by encasing the weft package in a "shuttle" and propelling the shuttle from one side of the loom to the other, while allowing the weft to unwind (Fig. 2). This can work at a maximum speed of 200 cycles per minute.

An improvement over it is the rapier loom where the tip of the weft yarn is attached to a stick - the rapier - and the rapier is guided along a straight line - the required path of the yarn (Fig. 3). This can work at speeds of 650 cycles per minute. This has the additional advantage of lower noise compared to shuttle looms. However, the cost of an Indian rapier loom is about three times the cost of a shuttle loom. This is primarily because the drive to the rapier requires greater precision in manufacturing compared to the drive to a shuttle loom. One way of achieving a reasonable precision and reliability in driving and guiding a rapier with low cost manufacturing is to use a linkage mechanism with only revolute joints. The simplest possible solution would be to use the coupler curve of a four-bar mechanism to guide the rapier. This would require a four-bar coupler curve with the least deviation from a straight line over its entire path. Synthesis of such a mechanism will be discussed in our future article.

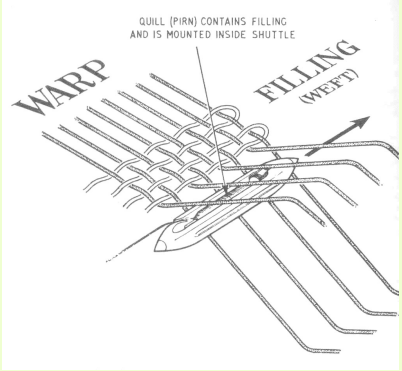
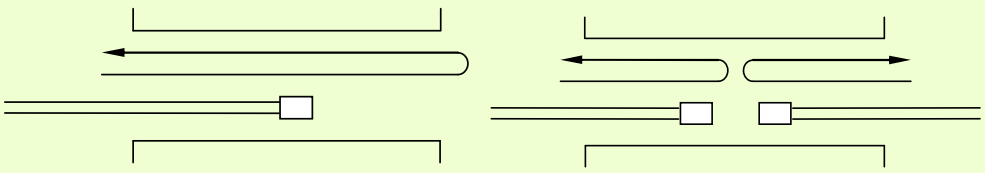


Fig. 2: Shuttle inserting weft [1]



(a) Single Rapier (b) Double Rapier

Fig. 3: Single and double rapiers

[1] Lord, P.R., and Mohamed, M. H., "Weaving: Conversion of Yarn to Fabric," Woodhead Publishing Ltd., 1992.

Forthcoming Events

NaCoMM 2011
15th National Conference on Machines and Mechanisms
Indian Institute of Technology Madras, Chennai, India
November 30 - December 02, 2011

Conference details and updates:
http://www.nacomm2011.org
Email:
nacomm2011@iitm.ac.in

Department of Engineering Design, IIT Madras under the aegis of ***Association for Machines and Mechanisms*** (AMM), and ***International Federation for the Promotion of Mechanism and Machine Science*** (IFToMM) is organising NaCoMM 2011.

The conference also includes a one-day workshop on the kinematics of mechanisms and robot manipulators, and a students' mechanism design contest. Selected papers would be published in the IFToMM's scientific journal, ***Mechanism and Machine Theory***.

TOPICS

- Analysis and Synthesis of Mechanisms
- Theoretical and Computational Kinematics
- Robotics, Mechatronic Systems
- Compliant Mechanisms
- Dynamics and Control of Multi-body Systems
- Dynamics and Vibration Analysis in Machines
- Micro-, Nano-Machines and Mechanisms

IMPORTANT DATES

Full paper submission: **Aug 15, 2011**
Acceptance notification: **Oct 15, 2011**
Camera ready paper: **Oct 30, 2011**
Registration: **Oct 30, 2011**

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REGISTRATION FEE*

Category of Delegates	Indian Citizens	Delegates from abroad
Full Time research scholars / students	Rs. 1500	US $150
Academia / Research Organisations	Rs. 4500	US $250
Others	Rs. 6500	US $400

*Delegates from IFToMM member organizations may claim a discount of US $50 while Life or Corporate members of AMM may claim a discount of Rs. 500 on the respective registration fee listed above.

Report on IFToMM World Congress in Guanajuato, Mexico

Subir Kumar Saha, Vice-President, AMM
Dept. of Mech. Eng., IIT Delhi

International Federation for the Promotion of Mechanism and Machine Science (IFToMM) organized the 13th world congress in Guanajuato, Mexico during June 19-23, 2011. The federation comprising of 48 member countries organizes this world congress once in every four years. India hosted this world congress in 1983 at IIT Delhi. The congress in Guanajuato accepted 307 papers for presentations. Except few, all papers were presented. Besides there were three keynote lectures given by Prof. Arturo Lara-Lopez from Mexico, Prof. Yuichi Okazaki from Japan, and Prof. Michael McCarthy from the USA on "Impact of Strategies for Cooperative Project of R&D," "Micromanufactories: A New Methodology for Sustainable Manufacturing," and "The Task Selection Problem in the Kinematic Synthesis of Linkages," respectively. The other presented papers were catergorized under the following topics: Robotics and Mechatronics, Computational Kinematics, Gearings, Linkages and Cams, Design Methodology, Biomechanics, Transportation Machinery, Micro Electromechanical Systems (MEMS), Rotor Dynamics, Dynamics of Machinery, Multibody Dynamics, History of Mechanism and Machine Science, Tribology, Education, Sustainable Energy Systems, Reliability of Machines and Mechanisms, Human-Machine Systems, Vibrations, Standardization of Terminology, Mechanical Transmissions and Non-linear Vibrations.

From India, there were 12 participants including two students and professors from different IITs, IISc, and Priyadarshini College of Engineering, Nagpur University. Prof. J. S. Rao, the Chief Science Officer of Altair Engineering (India), Bangalore was awarded the IFToMM Honorary membership for his contributions to the IFToMM directly and through the Association for Machines and Mechanisms (AMM), India, over last four decades during the congress banquet dinner on June 23, 2011. The next IFToMM congress will be held in Taipei, Taiwan in 2015 which was decided during the General Assembly on June 23, 2011.

Inauguration


Indian delegates

Mobility Equipment for Persons with Disability of Hand

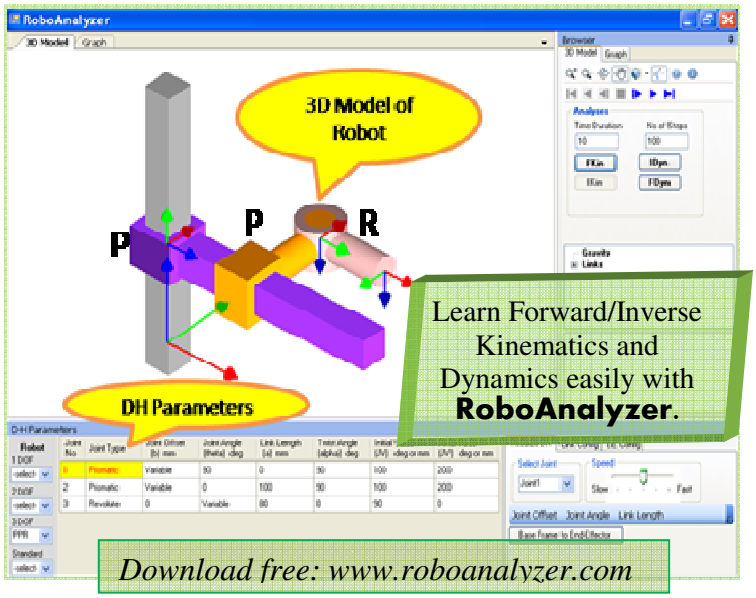
Dilip Sharma, Assoc. Prof. & Coordinator, IPR Cell
Dept. of Mech. Eng., Malaviya National Institute of Technology, Jaipur

This research relates to vehicles, and more particularly to mobility equipment adapted to be driven by a person who is unable to use his/her hands. It is thus observed that most of the conventional mobility equipments are largely not useful for persons having disability in their hands. Accordingly, there exists a need for a mobility equipment for a user who is unable to use his/her hands to drive the mobility equipment. There also exists a need for a mobility equipment that is simple, easy to use and is cost-effective in terms of production costs.

A tricycle for people with disabilities in both hands has been made, which is based on semi-recumbent design. This is shown in Fig. 1. The cycle provides a rapid and efficient means of mobility for hand disabled persons. The cycle is front wheel powered and rear wheel steered. Steering is done with the help of hip and waist movement on a revolving seat through links. The power to the cycle is given with the help of pedal assembly which is mounted ahead of the axle to which both the front wheels are mounted. Braking is done with the help of a lever operated by legs. They key feature of the design are as follows:

- **A semi-recumbent design,** which was chosen over conventional design because of low centre of gravity and greater comfort.
- **Steering** is accomplished using the hip and waist movement on a revolving chair and coupling this rotation to the rear wheel via a four-bar chain. The movement of rear wheel would steer the tricycle exactly in the opposite direction to that of a conventional front wheel steered bicycle.
- It is a compact system with the centre of mass located near the rider.
- A foot-operated lever is used to operate the brakes as one would not require pedaling while braking.

Fig. 1: Tricycle from side



Students' Mechanism Design Contest in NaCoMM 2011

Nirmal Hui, Asst. Prof.
Dept. of Mech. Eng., NIT Durgapur

Association for Machines and Mechanisms (AMM) started motivating the Indian students to take part in the process of creativity and innovations through the introduction of **Students' Mechanism Design Contest (SMDC)** in NaCoMM (National Conference on Machines and Mechanisms) conferences. The first such design competition was held at NIT Durgapur in NaCoMM-2009 (read about those mechanisms in Vol. 2, No. 2, April'10 issue of AMM News Bulletin available at www.ammindia.org). Salient benefits to the participants would be the following:

- Opportunity to demonstrate one's creativity to a host of students, teachers, and other participants.
- Exchange of ideas; possible new connections with mentors from other institutes.
- A great way to apply knowledge and/or common sense, vision and creativity to solve problems in real life.

Who can participate?

Participation is restricted to an individual/a group of students (up to three members), who should be registered as full-time student/research scholar/project staff in recognized institutes.

How to participate?

Participants are invited to submit proposals for design, construction and operation of mechanisms which are innovative and capable of solving challenging design problems.

1. The design problem may be chosen from a wide range of application domains - from agricultural and rural technology to automobile and aerospace engineering. A few typical examples (only representative) are given below:
    a. *Tree climbing mechanism.*
    b. *Walking mechanism (with two or more legs).*
    c. *Mars-rover type of small vehicle which can climb over significant obstacles.*
    d. *Staircase climbing mechanism.*
    e. *Foldable mechanisms, which can be deployed as useful structures, e.g., space-efficient beds, tables and other furniture, etc.*
    f. *An ergonomic device to help crush stones manually, for making road "aggregate" in rural application.*
    g. *An economical cable way system to transport materials (level and sloping grounds).*
    h. *Assistive devices for carrying heavy loads up staircases manually, e.g., LPG cylinders, water cans, etc.*
    i. *Ergonomic design for rod-bending machine to be used at construction sites.*
    j. *Assistive devices for easier vertical transport of materials at construction sites.*
    k. *A foot-operated substitute for the hand-pump.*

2. The mechanism could be manually powered or operated by a small motor or engine.
3. Operational safety of the operator, mechanism/machine and the power source is of utmost importance. Unsafe machines will not be allowed in the demonstration.
4. It is suggested that the mechanism be light and compact, and easy to transport, assemble and operate at the venue. Significant modifications/repairs cannot be done at the venue.
5. Machines using significant artificial intelligence (robots) are not allowed. However, some sort of remote control from an operator is allowed.
6. The prototype machine must be operated satisfactorily in front of the judges, and each machine will be given three chances at the most.

Procedure and deadlines

It will be a three stage competition. Stages with their technical details and planned dates are mentioned below.

1. Stage 1: Concept Development

(i) Participants must submit a 2-page proposal by **September 15, 2011**, outlining the design challenge and novelty/innovation of the proposed design. For detailed procedure of submission, participants are requested to follow the conference website: http://www.nacomm2011.org/studentcontest.html.
(ii) Decision on the proposals will be sent out by **September 30, 2011,** and participants with promising proposals would be asked to proceed towards developing a working prototype. In this regard preferences will be given to those which will have economic feasibility and possibility for commercialisation.

2. Stage 2: Model Development

(i) Shortlisted students will be asked to develop the model on their concept and submit a write-up explaining the working principle, hardware details, circuit diagram and at least some coloured photographs.
(ii) Participants have to submit details of the prototype by **October 20, 2011**, including photographs or video clips.
(iii) Reviews of the prototypes will be sent out by **November 10, 2011**, and successful participants would be asked to come for the final round, i.e., demonstration of the working prototypes during NaCoMM-2011 at IIT Madras.

3. Stage 3: Presentation

(i) Developers of the selected models will be invited to participate and demonstrate their developed model during NaCoMM 2011 (November 30 - December 02, 2011) before a panel of judges at IIT Madras.
(ii) At least one student of each team must register for the conference.
(iii) The winner would be decided based on the extent of innovation, difficulty of the design challenge, effectiveness of the proposed solution towards solving the actual problem, and quality in presentation, etc.
(iv) In any matter related to the contest, the decisions of the judges and/or the organisers would be final and binding.

Awards and Certificates

The winners will be awarded cash prizes and certificates. All participants would receive certificates of participation from the Association for Machines and Mechanisms (AMM), the parent body organising NaCoMM 2011.

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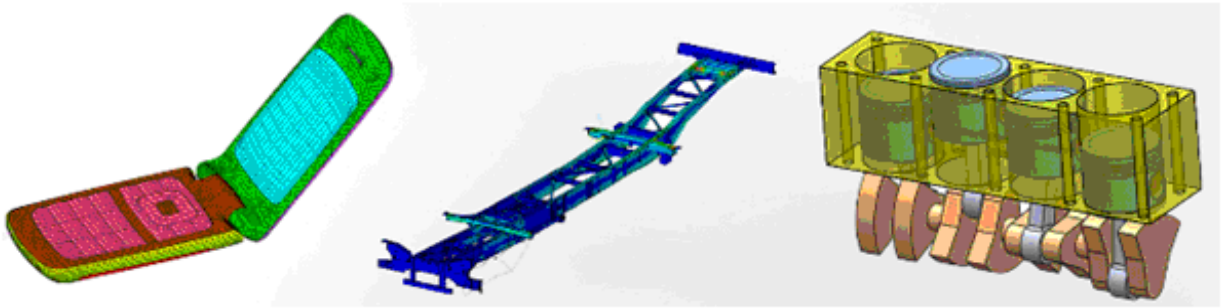

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