Association for Machines and Mechanisms News Bulletin

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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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Message from the Editor-in-Chief

Biomimicking: Recreating the Nature with Engineering

The term 'Biomimicking' comes from the terminology 'Biomimetics,' which is treated as the study of the structural and functional behaviour of different biological systems. During the 1950s an American Biophysicist Otto Schmitt incepted the term in his doctoral research and by the end of 1980s Canadian researcher Gavin S. P. Miller introduced the idea of using biomimicking technologies in the field of robotics and automation.

In present days, robotics research is largely concentrated on biomimicking the biological objects like worm, fish, snake, bat, butterfly, etc. In most of the cases, the mechanisms are modified and recreated from the available basic mechanisms like crank-shaft mechanism, slider-crank mechanism, screw-nut mechanism with applications of actuating elements like motors (D. C. and Servo), SMA (Shape Memory Alloy), IPMC (Ionic Polymer Metal Composite), and advanced sensory elements. The low cost computing elements like FPGA (Field Programmable Gate Array), microcontrollers are making the control algorithms easy with a wide scope of introducing artificial intelligence.

The researchers of Stanford University have designed and developed various biomimetic robots which include mimicking the walking phenomenon of cockroach using an alternating tripod gait in the six legs to provide smooth and faster walking on different terrain. The Brooklyn College scientists designed the underwater robot by mimicking the biological lobster (Robolobster). The application of smell sensor made the design autonomous in underwater environment for 5 hours. From the mid 1990, DARPA is researching on flying objects for surveillance operation and finally with the help of Georgia Tech they designed the artificial entomoptor using the mechanism of aerodynamic instruments. The biologically inspired cricket comes with a new mechanism 'Whegs' (wheels plus legs) from Case Western Reserve University. Scorpion robot from Fraunhofer Institute, Germany made the application of robotics in rescue operations taking the concept of parallel robot as the key mechanism. The CRIM Lab, Italy designed the artificial earthworm using SMA as the main material. The contraction and expansion of the SMA recreates the walking mechanism of a biological earthworm. In India, a multi-segmented earthworm is under development in BESU Shibpur, whereas a robotic fish was developed in CMERI, Durgapur. NETRA, an unmanned aerial system designed and developed by India's Defence Research & Development Organisation (DRDO), is considered as a commercially successful product. This device is very useful and effective as it needs very less training time and operator assistance. It has been used in the border areas and short missions for surveillance operation.

The above examples clearly show the bondage between biology and robotics by mimicking the biological nature of different objects. A deep investigation in this area will definitely make us able to solve many critical problems related to our daily life as well as in the field of medical sciences, rescue operations and defence related issues.

Subhasis Bhaumik, Editor- in- chief

Technical Article

Design Innovations in a Rapier

Anirban Guha and C. Amarnath
Department of Mechanical Engineering, IIT Bombay

A previous article in this News Bulletin (Vol. 3, No. 4, Oct. 2011 available from http://www.ammindia.org) had explained how three primary motions (actions) are required to weave a fabric in a textile loom. Inserting the weft across the width of a loom (Fig. 1) is one of these actions. A convenient way of performing this action is to use a rapier. This article will examine the different design innovations of a rapier.

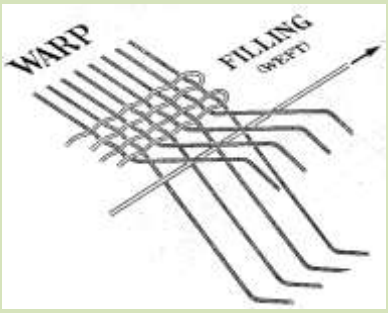


Figure 1: Schematic diagram of weft insertion [Lord and Mohamed, 1992]

The earliest use of a rapier can be found in the ruins of ancient Egypt (Fig. 2). Indeed, the concept of keeping the package of yarn permanently outside the loom, unwind the yarn from the package, and insert it in the loom by attaching it to the tip of a long stick (the rapier) seems to be one of the first ones to have been used by humans for large scale production of fabric.

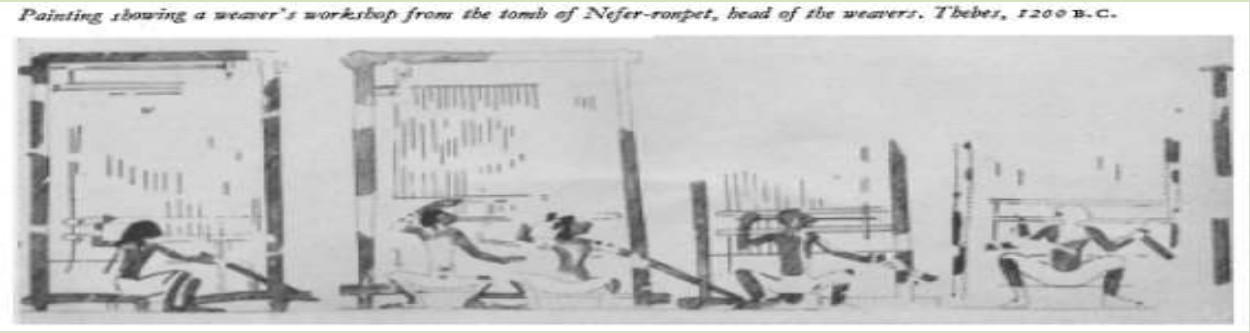
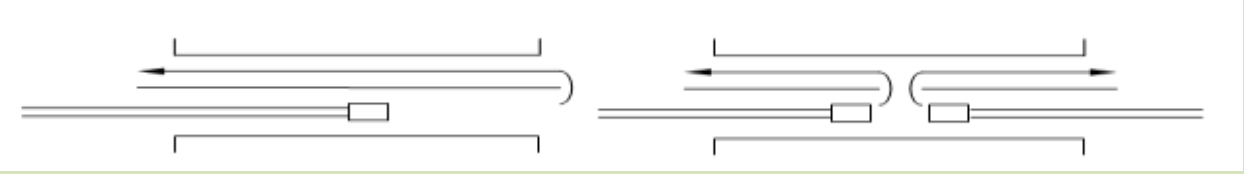


Figure 2: Weaving in ancient Egypt

The competing design was one of winding (wrapping) the weft yarn in a package and inserting the package in the loom. The yarn unwinds from the package as the package traverses the width of the loom. It is this design which was subjected to a major modification by John Kay in 1733 and provided one of the initial sparks for the industrial revolution in the form of the "fly shuttle." However, a major drawback of the shuttle method of weft insertion is that only a short length of yarn can be wound on the package. Thus, replenishment of this package needs to be done frequently, leading to loss of loom efficiency. This and other limitations of shuttle weaving have led to the rejuvenation of the rapier method of weft insertion.

The first method of rapier weaving in modern times consisted of a rigid rapier holding the weft yarn, traversing the width of the loom, releasing the yarn and withdrawing from the loom without the yarn (Fig. 3a). This required a space almost equal to the loom width being left unutilized in the factory to accommodate the rapier outside the loom. An attempt to save space and time led to insertion of two rapiers simultaneously from two sides of the loom (Fig. 3b). One rapier transferred the weft to the centre of the loom where it was taken up by the other rapier. This "double rapier" continues to be the most common form of rapiers till date.



(a) Single rapier (b) Double rapier

Figure 3: Single and double rapiers

Further attempts to save space have led to the rapier being made “flexible” (Fig. 4). This kind of rapier bends and wraps around a pulley outside the loom. The continuous flexing and unflexing (rolling and unrolling) of the rapier band (650 times per minute) exert high demand on the property of the material used. High performance polymers have been used but the technology is not easily available. The wrapping and unwrapping gives rise to longitudinal vibrations in the rapier. This has been analysed by Surov and Batalin (2000) with the aim of providing a mathematical basis for choosing proper design and material. Optimum designs for flexible rapier drives have also been discussed by Liu (1989) while Chen (1992) has worked on cam designs for the same.

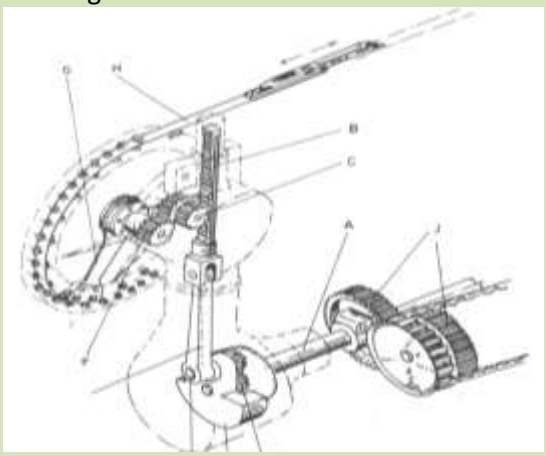


Figure 4: Flexible Rapier [Talukdar et al. 1998]

Another design innovation for saving space was the use of a single rigid rapier to insert weft yarns to two looms (Fig. 5). The two looms were placed side by side and the rapier was placed between them. Left movement of the rapier inserted weft in one loom and right movement inserted weft in the other. The two looms ran 180 degrees out of phase. The major drawback of this design was that a stoppage in one loom required the other one to be stopped too. This led to low overall efficiency.

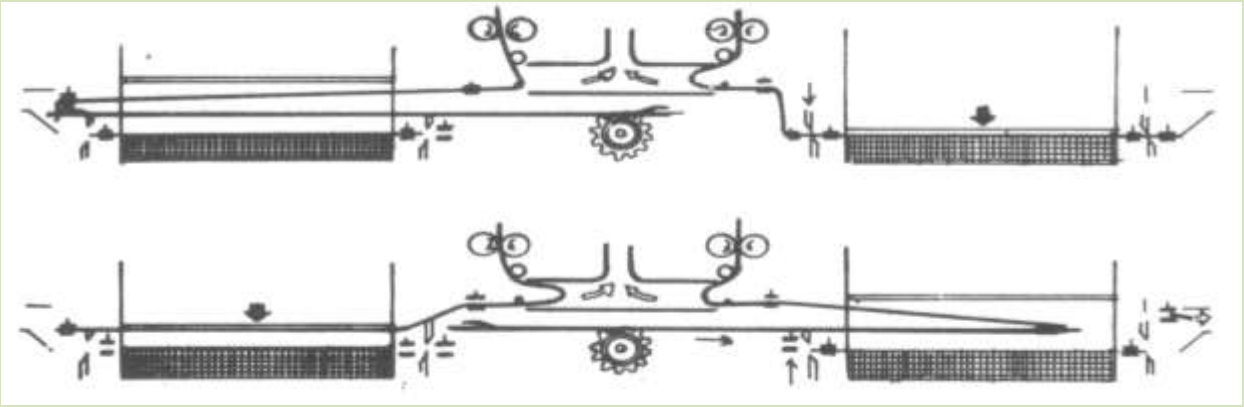


Figure 5: A rapier for two looms [Talukdar et al., 1998]

Catching the weft yarn, a soft and pliable material of variable diameter, is a task which is difficult to perform. Performing it with almost zero failure millions of times is even more difficult. One design innovation suggested was to make the gripper and rapier separate units. The gripper carefully gripped the yarn outside the loom. The rapier then carried the gripper to the other side of the loom (Fig. 6). Under this scheme, the gripper had greater time to adjust the mechanism for holding the yarn and was able to do so in a more reliable manner. Improvement in gripper technology gradually obviated the need for this design innovation.

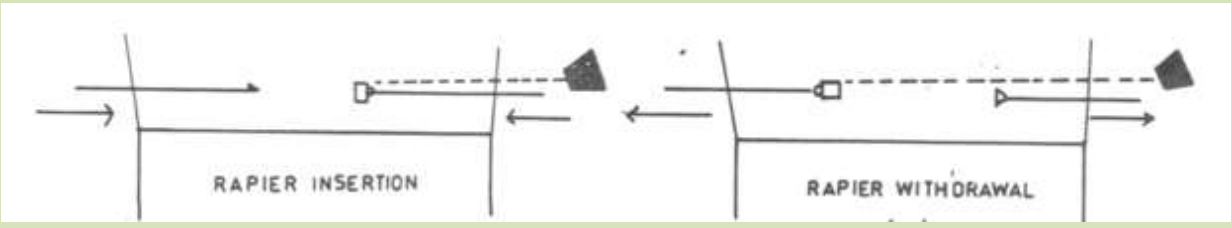


Figure 6: Gripper transfer [Talukdar et al., 1998]

The high noise and low quality of fabric produced in a shuttle loom has led to an increase in the number of rapier looms used in India. A number of loom manufacturers have started producing rapier looms. However, many of the crucial components continue to be imported.

All the design innovations described in this article addressed the overall mechanism of weft insertion. As mentioned earlier, the technology of gripping the yarn with a metallic gripper and releasing it about 650 times per minute remained one of the weakest points of the design. Indeed the technology of the rapier head (gripper) has seen a large number of design innovations over the last 50 years. Our next article will give a brief description of those innovations.

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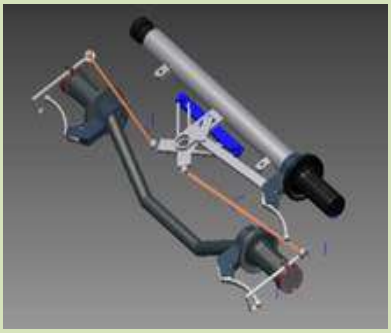
2011 India Inventor Student Design Competition

G. Saravana Kumar, Department of Engineering Design, IIT Madras

Autodesk® inventor student design competition was held in Indian Institute of Technology (IIT) Madras, Chennai on 16th Nov. 2011. The competition was organized by IIT Madras in association with Autodesk® and its academic partners (MSRIT, Bangalore; PSG College, Coimbatore; and IIT Gandhinagar), and industry sponsors, BOSCH & SAE India. The winners of the competition, in addition to receiving attractive cash prizes and certificates, are being offered internship program by Bosch India. Autodesk has also announced a 'Sustainability award' to the team that demonstrated the best environmentally friendly design. Over 368 teams from various engineering colleges across the country registered for the competition. The organizers received more than 60 designs for the competition. Student teams were given the theme to digitally design assistive and rehabilitation devices for people with any form of impairment.

Teams submitted their innovative and sustainable designs for evaluation by the academic advisory committee. The top 15 teams were shortlisted for evaluation by an eminent jury comprising of renowned industry and academic experts at the final competition held at IIT Madras. The top three prize winning entities are:

		
First Prize: "Wheel chair / stretcher," S. Jain, M.K. Verma, R. Kumar; Raj Kumar Goel Institute of Technology, Ghaziabad	Second Prize: "Driving for one handed," S Barathram, A. Vishwanath IIT Madras, Chennai	Third Prize: "Assistive wheelchair," S. Patil, P. Agarwal, S. Jawale IIT Madras, Chennai

Apart from these three, sustainability awards were also given and the team consisting of S. Patil, P. Agarwal and S. Jawale from IIT Madras won the first prize in this category. "*The objective of the competition was to sensitize young minds to India's design requirements and engage them in developing innovative solutions*" said Profs. M. Ramanathan and G. Saravana Kumar, Dept. of Engineering Design, IIT Madras.

Experiences in the ACMD 2012 Conference

Shivesh Kumar, Department of Mechanical Engineering, NITK Surathkal

Recently, I as a 4th year B. Tech student in NITK Surathkal had an opportunity to attend 6th Asian Conference on Multi-body Dynamics (ACMD) 2012--one of the prestigious conferences in the multi-body dynamics community---to present my paper entitled "Realistic Modelling and Dynamic Simulation of KUKA KR5 Robot using Recurdyn" with Prof. Subir Kumar Saha and Mr. Rajeevlochana C.G. who were my co-authors for this paper. It gives me immense pleasure to share my experiences of attending this conference through this page of the AMM News Bulletin.

The 6th ACMD 2012 was held in Suites Shanghai Hotel and was organized by Shanghai Jiao Tong University during 26th August to 30th August 2012. This conference is organized every 2 years and has been hosted by countries like Japan (thrice) and Korea (twice) earlier. The main purpose of this conference (ACMD) was to enhance cooperation and academic exchange among engineers in Asia and over the world in the fields of multi-body dynamics. This year, there were a total of 183 attendees and 137 technical sessions (including various technical paper presentations and keynote lectures). There were 86 attendees from China, 34 attendees from Korea, 33 attendees from Japan, and only 3 attendees from India. From the statistics, it is pretty clear that India has still a long way to go for making its presence felt in such events.

I was probably the only undergraduate student presenting a paper in this conference. Thanks to the guidance of Prof. Saha (my guide) and Mr. Rajeevlochana (my mentor) during my internship at Mechatronics Lab, IIT Delhi in 2011. Presenting my work in front of such an eminent international audience was a challenge as it was a matter of reputation of Indian Multi-body Dynamics community. My presentation went nice and I think I delivered it up to my professor's expectation. Apart from my presentation, I met a lot of people who are frontiers in this area. I think these types of conferences provide a great platform for students like me to interact with the best talents across the globe in any particular research area. I also got to know about the current cutting edge research happening in this field in different universities across the world while attending various technical sessions and keynote lectures. The conference also provided me a platform to interact with various professionals from different companies sponsoring this event. I met the company representatives of RecurDyn Inc., ECON Technologies, and Cybernet Systems Co. etc., and got to know their current projects and discovered the potential of associating with them in the future. Moreover, I had an opportunity to explore Shanghai – a city with great people and lovely skyline. Thus, attending such international events has a lot of advantages and I encourage students and academicians from various Indian technical universities like NITs and others to attend such conferences in future. Lastly, I would like to thank Mr. B Sridhar, Director, Function Bay Dynamics (India) Pvt. Ltd. and Function Bay Inc. Korea for providing the financial support to me and my mentor (Mr. Rajeevlochana) for attending this conference.

In order to popularize the area and make India's presence felt in such conferences, a Google group called 'multibody-dynamics-in-india@googlegroups.com' has been created. All interested in this area are requested to join the group for more fruitful interactions amongst the Indians working in the area of Multibody Dynamics.

Shivesh (myself), four Function Bay China representatives, Prof. Saha, Mr. Rajeevlochana C.G. (left to right)

AMM's Collaboration

DMG-Lib Project with Germany

Subir Kumar Saha, Department of Mechanical Engineering, IIT Delhi

With the initiatives taken by Prof. Amitabha Ghosh, AMM member and Ex-Director of IIT Kharagpur, AMM has finally agreed to join hands with RWTH Aachen University, Germany for the project "Contribution of Indian Scientific Institutions to DMG-Lib and think MOTION." In this connection, a meeting was held in the University of Aachen on June 02, 2012 in the presence of Prof. Ghosh and Prof. B. Corves, Head of the Department of Mechanism Theory and Dynamics of Machines (IGM) to discuss the modalities. Under the project, several universities from Germany and Italy are already collaborating to compile the information on Mechanisms and Machines and make them available through a website. It is anticipated that any user should be able to find any information in one place. For example, any old book with figures will have animations for the users to understand the working principle of those mechanisms with a click of a button.

From India, AMM will collaborate in compiling information from India. Key persons from IISc, Bangalore, leading IITs (i.e., IIT Kanpur, Kharagpur, Delhi, Madras, Bombay, Guwahati and Roorkee), NITs (e.g., NIT Jaipur, Durgapur and others), IIITs (e.g., IIIT Allahabad and others), Indian Institute of Space Technology in Tiruvenantapuram, reputed universities (e.g., Bengal Engineering and Science University in Shibpur and others), and research establishments (e.g., Central Mechanical Engineering Research Institute in Durgapur, and others) will help in this project. Prof. Asitava Ghosal of IISc, Bangalore has kindly agreed to coordinate the activity on behalf of AMM. For those who are interested to contribute towards this project, please contact Prof. Ghosal at asitava@mecheng.iisc.ernet.in.

CALL FOR PAPERS

ADVANCES IN ROBOTICS (AR-2013)

International Conference of Robotics Society of India

Pune, India

July 4th to July 6th, 2013 at R&DE (Engrs), DRDO

Patron: Dr. V. K. Saraswat, SA to RM and Secretary, Department of Defense Research and Development and DG, DRDO

Advisor: Dr. S. Guruprasad, Director, R&DE (Engrs)

Scope of the conference will include (representative and non-exhaustive):

1. Kinematics, dynamics, control, and simulation of robots and autonomous intelligent systems;
2. Design of robotic mechanisms;
3. Man-machine interface and integration;
4. Robotics-related computer hardware, software, and architectures;
5. Vision and other non-contact sensory systems;
6. Tactile and other contact sensory technology;
7. Active sensory processing and control;
8. Machine learning and artificial intelligence for robotics;
9. Medical and Assistive Robotics;
10. Bio-mimetic and Bio-inspired Robotics;
11. Swarm Robotics.

Last Date for Submission of Papers: 28.02.13

Additional information and instruction about paper submission will be available from http://www.rsindia.org/

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