Multibody Dynamics for Rural Applications (MuDRA)

--- Connecting Engineering Minds with Society ----

32nd

in the Series

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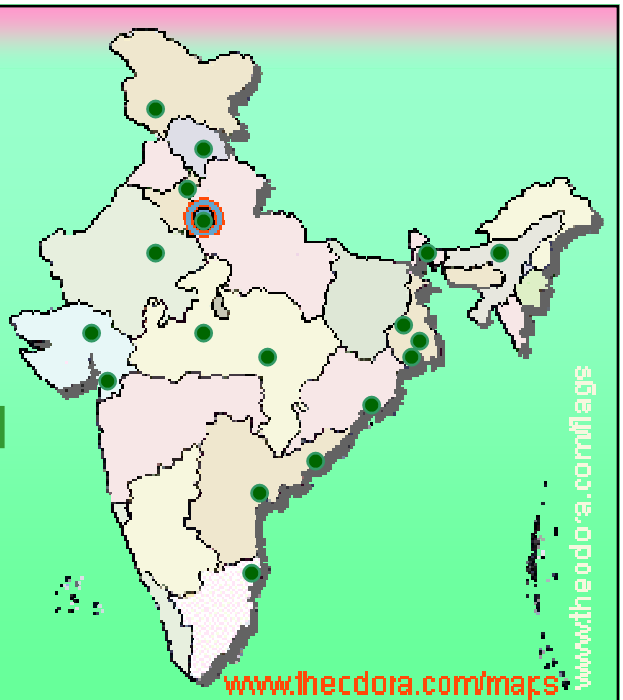
July 31, 2012@IIT Delhi, MEL731 Practical

Total: 31

India: 26

Poland: 1
Ethiopia: 1
USA: 1
Mexico: 2



Outline

- Origin of the concept
- Multibody Dynamics
  - Purpose and Definition
  - Modeling and Simulation
- MuDRA :
- Conclusions

Origin of the Concept

- Let's watch some videos
- What did we do with the above equipments?
- What's their future ???
- Other organizations:
  - MGIRI (C/O, IIT Delhi)
  - NIF (C/O, IIM Ahmedabad)
  - RuTaG (C/O, IIT Delhi, IIT Madras+)
  - ……
  - DripTech

As a Faculty

- Floated as B. Tech/M. Tech Projects
  - Not interested (True for many Faculty !)
- Apparent Reasons
  - What is the research content ?
  - Not fashionable
- Other Reasons
  - Difficult
  - Limited literature

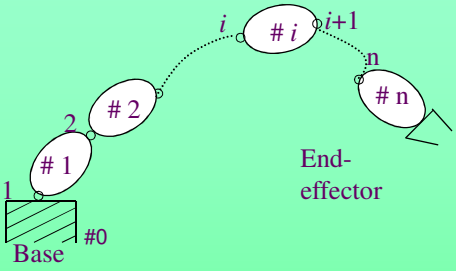
As a Researcher

- Areas of Research: Multibody Dynamics
  - Robotics
  - Mechatronics
  - Design

- Developed Mechanisms: Rural Applications
  - For carpet processing
  - For villages ADPM

Multibody Dynamics

A typical robot: SCORBOT-ER 9 (www.intelitek.com)

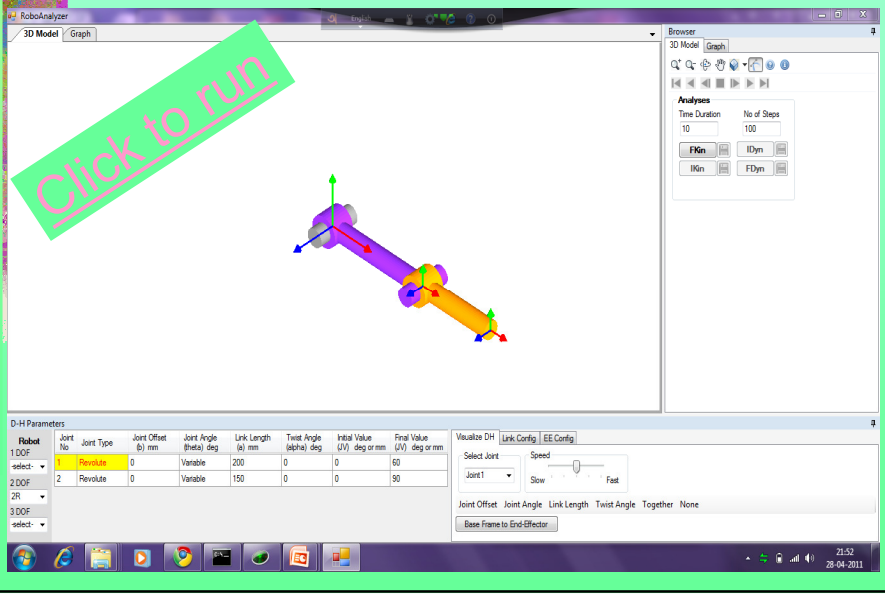


Numbering scheme for bodies and joints

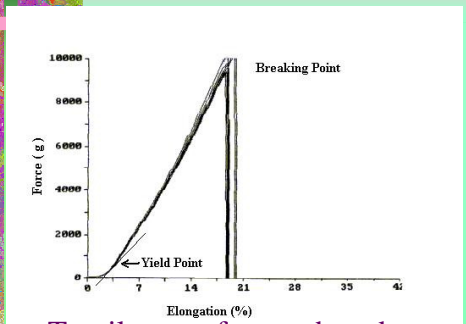
- **Issues: Mechanical design of links, Bearings, Fatigue analysis, Wear losses, Estimation of motor power**

RoboAnalyzer: IIT Delhi's Robot Software

(Download free: www.roboanalyzer.com)

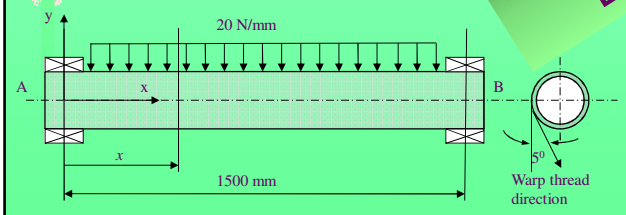


1. Loom Modelling

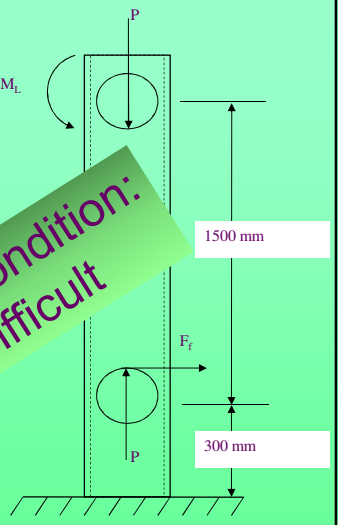


Tensile test of warp thread

End Condition: Difficult



Beam



Column

Optimization

For beams:

$$\text{Minimize, } W \equiv \rho \pi \ell \alpha t^2$$

$$\text{Subject to, } \sigma_{max} \le S_y;$$

$$\delta_{max} \le \delta_{all};$$

$$t \ge t_{min}$$

For columns:

$$\text{Minimize, } W \equiv 4 \rho L \beta t^2$$

$$\text{Subject to, } \sigma_{max} \le S_y;$$

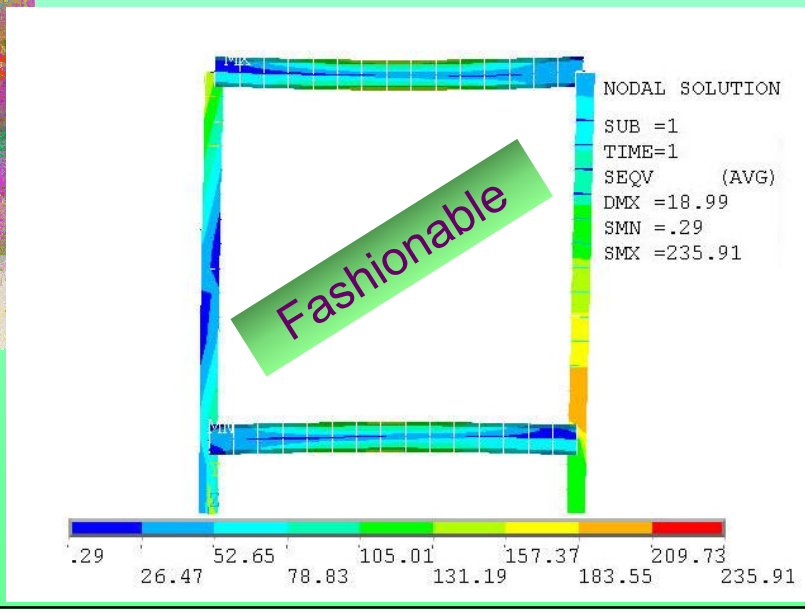
$$\sigma_{Buk} \le S_y;$$

$$t \ge t_{min}$$

Comparison

Components		Metallic loom	Optimized loom
Beam	Section	Hollow Circular	Hollow Circular
	Sy, MPa	360	150
	$\delta_{all,}$ mm	5	3
	d, mm	135	114
	t, mm	5	3.8
	W, Kg/m	16.2	10.6
Column	Section	Channel 200×75	Hollow Square
	S_y , MPa	240	240
	b, mm	-	76.9
	t, mm	-	1.4
	W, Kg/m	20.6	3.33

Finite Element Analysis (ANSYS)



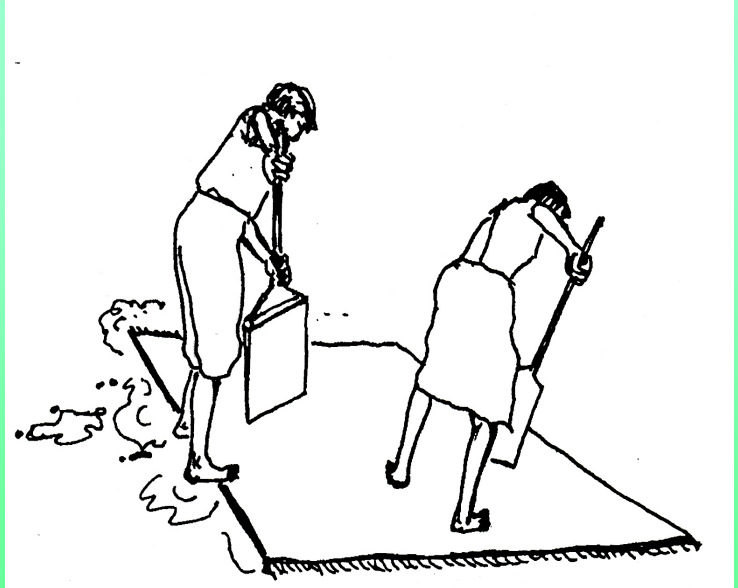
Savings

2005: Small, Rs. 19,500

Publications:
2005, 2006

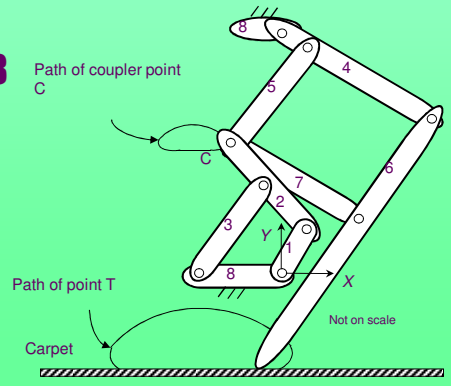
2005: Small, Rs. 15,000

2. Carpet Cleaning

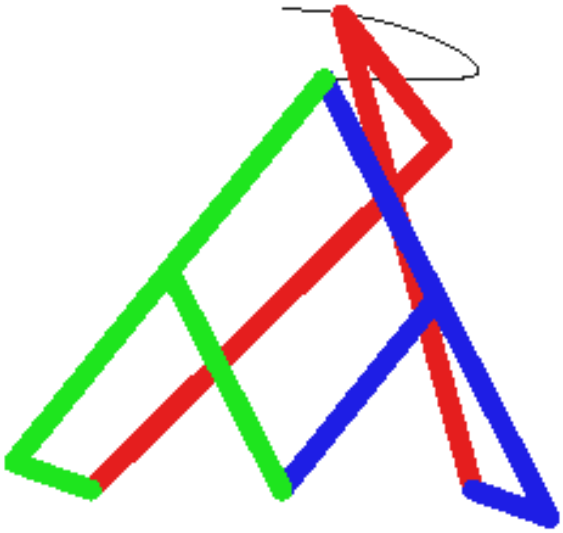


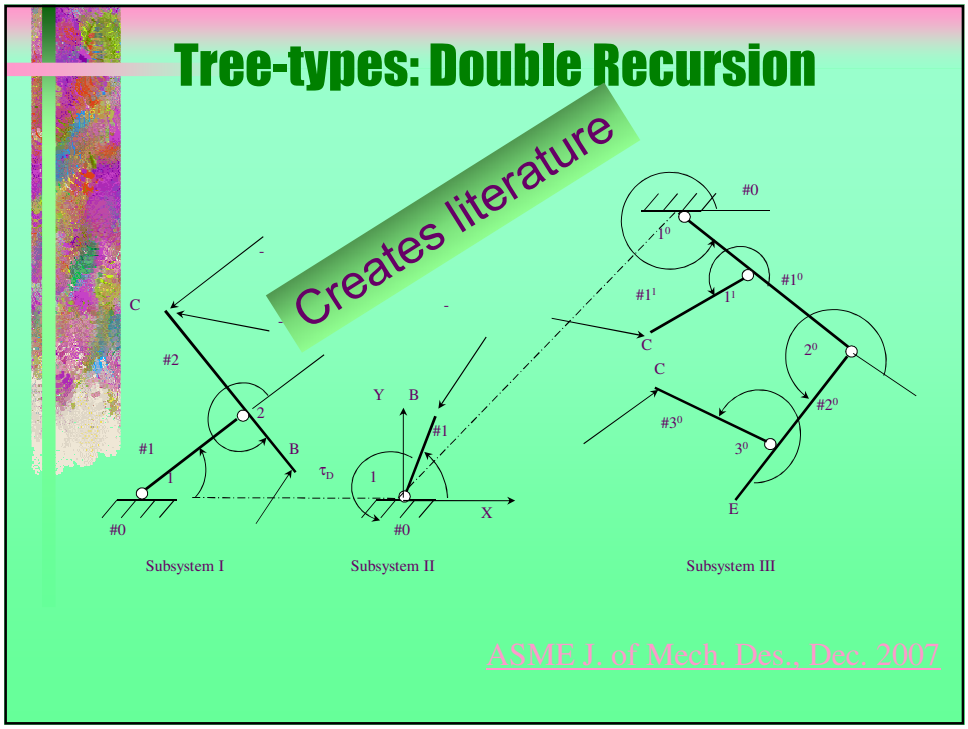
Carpet Scrapping Machine

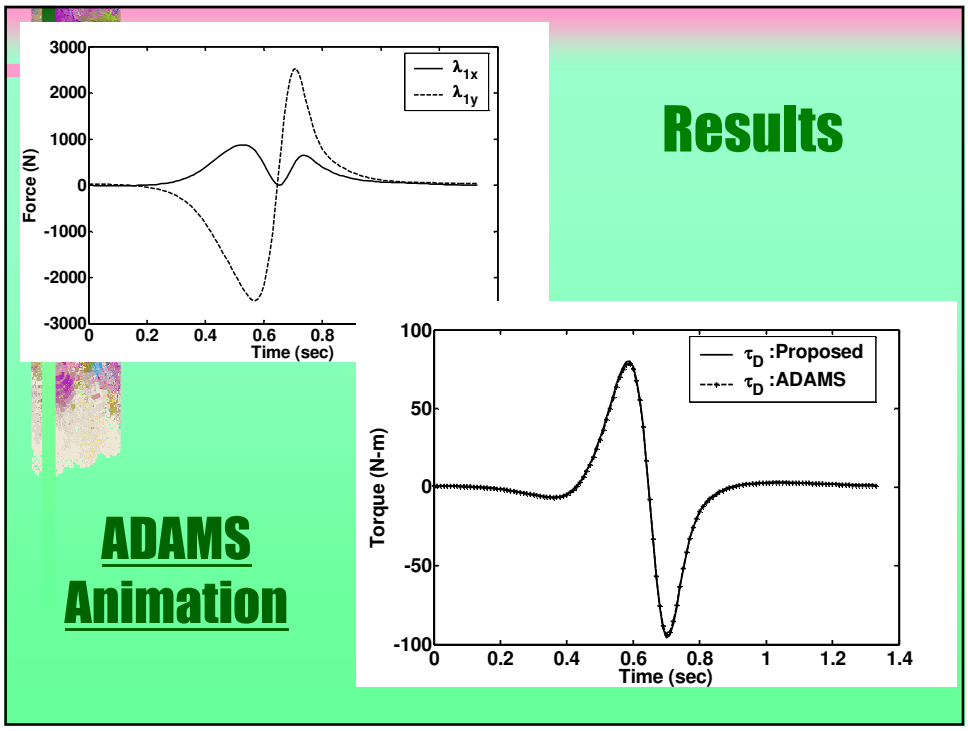
- Purpose: To reduce human effort
- Straight line generating machine
  - Chebyshev mechanism (in Working Model)
  - Cognate: 1-2-3-8
  - Pantograph: 4 to 8



Cognates of Chebyshev Mechanism




Tree-types: Double Recursion
Creates literature
C
#2
2
#1
B
1
#0
τ_D
Y
B
#1
1
X
#0
Subsystem I
Subsystem II
#0
1^0
#1^1
1^1
#1^0
C
C
2^0
#2^0
#3^0
3^0
E
Subsystem III
ASME J. of Mech. Des., Dec. 2007


Results
λ_{1x}
λ_{1y}
Force (N)
Time (sec)
τ_D :Proposed
τ_D :ADAMS
Torque (N-m)
Time (sec)
ADAMS Animation

Springer
the language of science

springer.com

Dynamics and Balancing of Multibody Systems
Series: Lecture Notes in Applied and Computational Mechanics , Vol. 37

Chaudhary, Himanshu, Saha, Subir Kumar
2009, XIV, 176 p. 59 illus., Hardcover
ISBN: 978-3-540-78178-3
Online version available

Preface

Saha's Book, €99

This book has evolved from the passionate desire of the authors in using the modern concepts of multibody dynamics for the design improvement of the machineries used in the rural sectors of India and The World. In this connection, the first author took up his doctoral research in 2003 whose findings have resulted in this book. It is expected that such developments

3. Sheep Shearing Machine

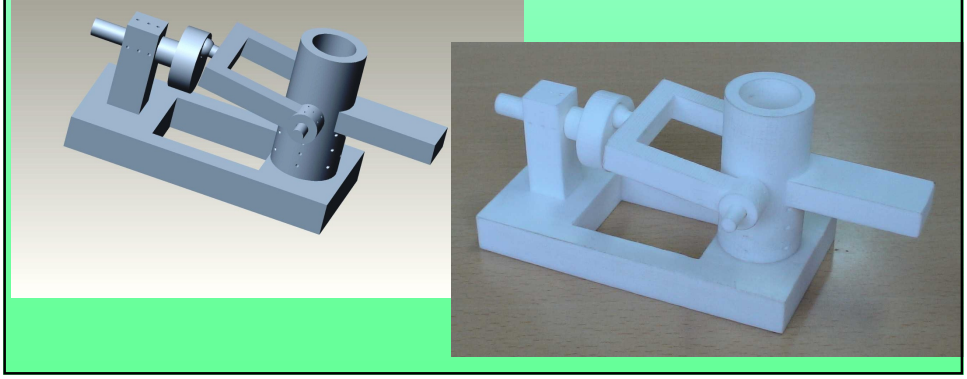
Applying MuDRA

- ADAMS Simulation using CATIA
- Analysis is ... d conference
- RecurDyn ...mation using ProE

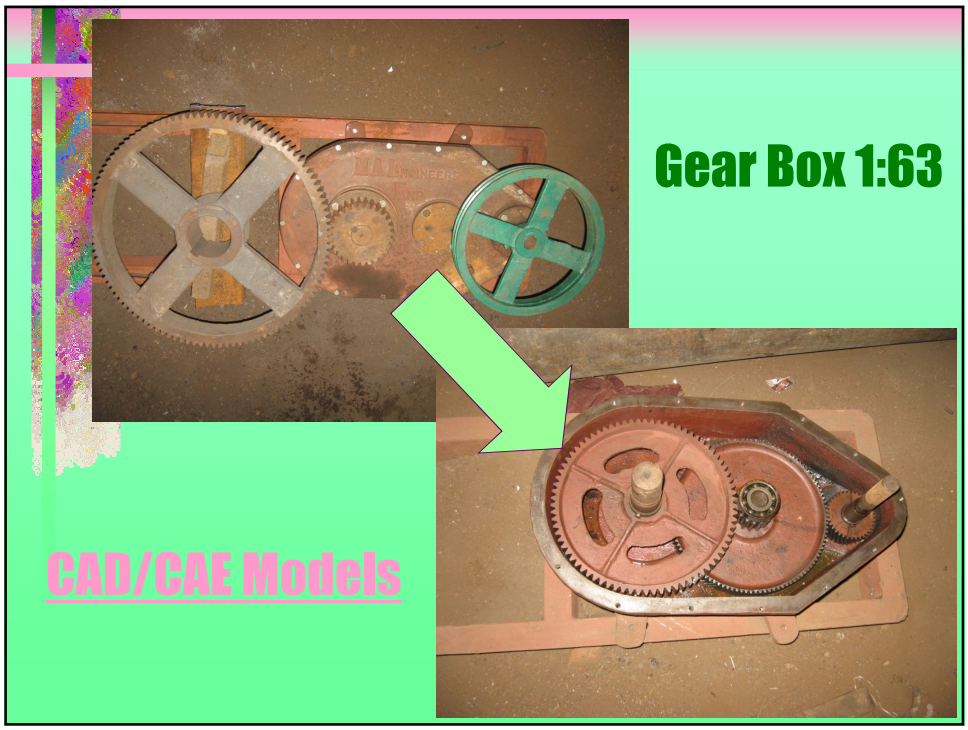
Reward for students

New Mechanism

- Synthesis reported to NaCoMM 2007
- Rapid Prototype (to visualize the motions)
- Modeling: RecurDyn



4. Animal Driven Prime Mover



MuDRA

- Multibody Dynamics for Rural Applications (MuDRA)
  - Pose rural mechanisms as research problems
  - Use of modern tools, e.g., Multibody Dyn.
  - Use of modern software, e.g., ADAMS/RecurDyn
  - Able to publish
- Benefits of MuDRA
  - Establishing a culture
  - Rural problems may get solved
  - Pride being one's own (Not follower)

Comment: Ms. Jyoti, Jan. 2012

... Main focus was on 'how you can apply your knowledge of M.Tech project in Tata Motors'... they said though you are good in robotics but we are not looking for the robotic expertise. .. i asked so what are you looking for?? they answered – PRODUCT DEVELOPMENT. As a reply i said "as you said i am good at robotics but that doesn't mean i don't know how to develop a product." They immediately asked me to justify this. i told i am working on some extra project under the same guide. ... These projects are mainly for the rural development. ...They asked me to draw the beam...Then they asked why that type of loading and boundary conditions... I answered and they said 'Good.' After this we discussed about the joining place etc.

Comment: Mr. Anil Kumar, May 2010

Sir, i got selected in Time Tooth Technoligies Ltd which is CAE based company sir the Loom project which i did was so much contributed to get the job and they are so much impressed with the way the work been carried out i.e. i told about the maintaining project dairy and weekly meetings moreover showing interest rural application with use of advanced technology.

Conclusions

- A philosophy of MuDRA is presented
  - To convert practical problems to research problems
  - Advanced tools/software are used for easy market recognition
  - Several publications/a book were possible
- Hope students/faculty will carry forward such new research area

Contact: saha@mech.iitd.ac.in

THANK YOU

For more information:

http://web.iitd.ac.in/~saha