Challenges & Opportunities of Leveraging Industry- Institutional Linkages for Endeavours of Higher Education

Prof. U. Chandrasekhar

Director - Centre for Research & Innovation, PMC Tech - Anna University &
Vice Chairman – NAFEMS India

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*"Universities are **powerful but vastly underutilised vehicles** for development, particularly with respect to science and technology in developing countries*

*If both universities and industries are encouraged to work together and actively; universities will be able to assume new roles that could **accelerate local and national development**"*

(Ref: UN Millennium Project Task Force, 2009)

Typology of University-Industry Interactions

High (Relationships)	Research partnerships	Inter-organizational arrangements for pursuing collaborative R&D, including research consortia and joint projects.
	Research services	Research-related activities commissioned to universities by industrial clients, including contract research, consulting, quality control, testing, certification, and prototype development.
	Shared infrastructure	Use of university labs and equipment by firms, business incubators, and technology parks located within universities.
Medium (Mobility)	Academic entrepreneurship	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own (spin-off companies).
	Human resource training and transfer	Training of industry employees, internship programs, postgraduate training in industry, secondments to industry of university faculty and research staff, adjunct faculty of industry participants.
Low (Transfer)	Commercialization of intellectual property	Transfer of university-generated IP (such as patents) to firms (e.g., via licensing).
	Scientific publications	Use of codified scientific knowledge within industry.
	Informal interaction	Formation of social relationships (e.g., conferences, meetings, social networks).

(Ref: Perkman and Walsh, 2007)

Difference in Priorities and Scope for Industry Linkages – Developed and Developing Economies

	Developed Economy	Developing Economies
Teaching University	• Private participation in graduate programs • Joint supervision of PhD students	• Curricula development to improve undergraduate and graduate studies • Student internships
Research University	• Research consortia and long term research partnerships to conduct frontier research	• Building absorptive capacity to adopt and diffuse already existing technologies • Focus on appropriate technologies to respond to local needs
Entrepreneurial University	• Spin-off companies, patent licensing • Entrepreneurship education	• Business incubation services • Entrepreneurship education

(Ref: Jose Guimon, 2013)

OUR OWN EXPERIENCE IN INDUSTRY – INSTITUTE INTERACTION

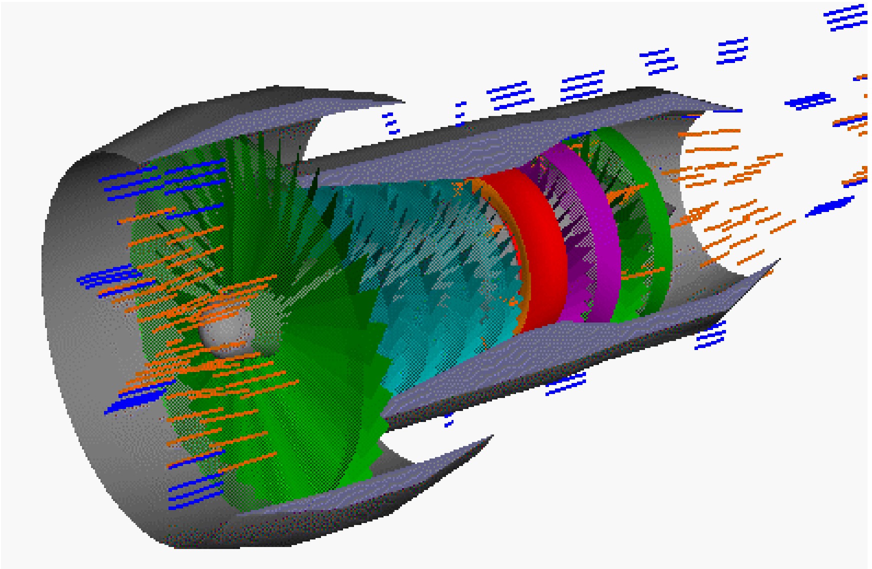
An Interaction for Refining the Curriculum in Engineering Analysis and Simulation

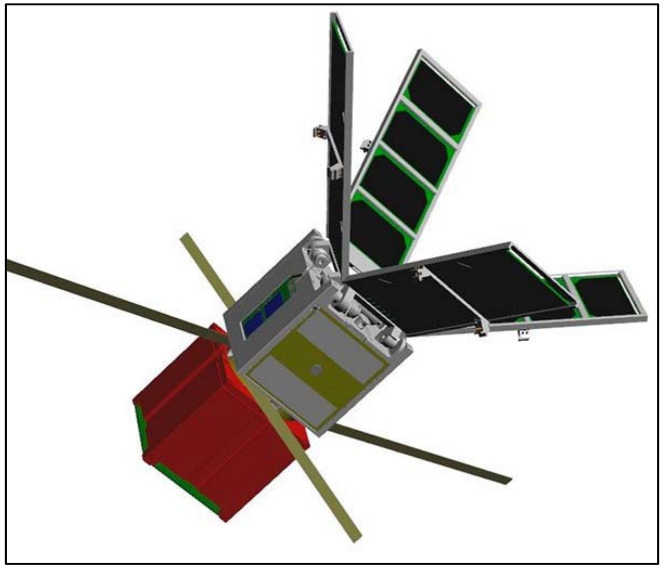
Period : 2014-2017

Targeted Outcomes

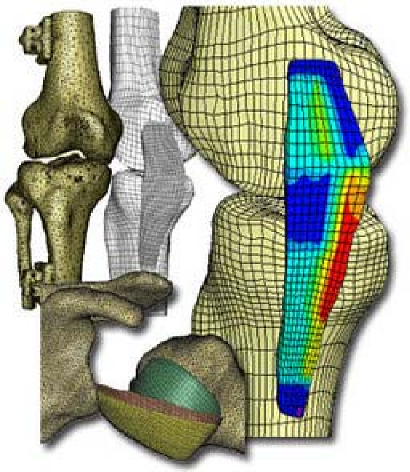
(i) *To redesign the pedagogy with industry collaboration* so that teaching-learning practices reflect their needs

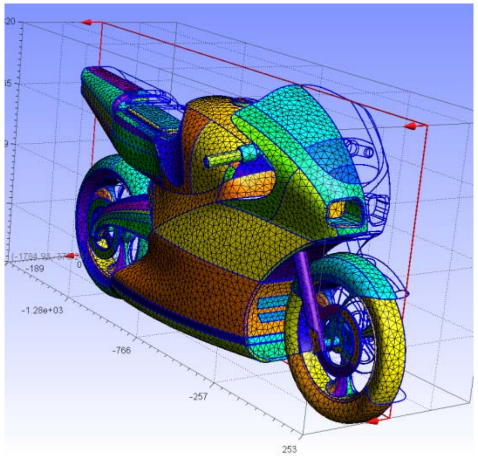
(ii) *Help the industries with "**engineers with better fitment with their captive project needs**"*





Aeronautical / Automotive / Biomedical / Civil / Electronic / Mechanical Systems



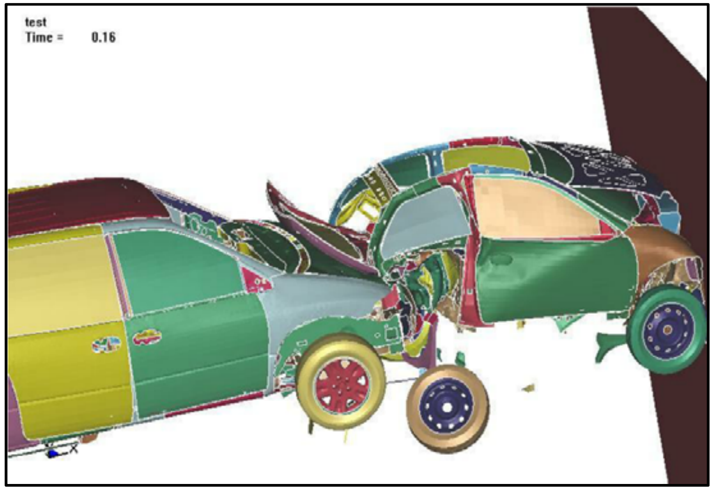


Engineers are involved in developing real-world solutions for national and global engineering modules and systems for a variety of user groups

Contemporary Real World Applications

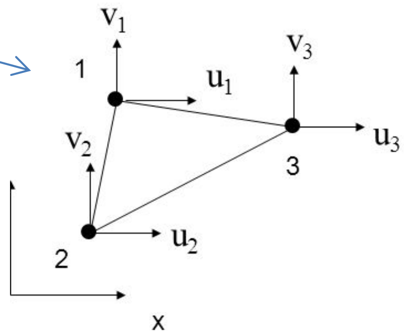
Industry Practices

- Radically different in 2018 compared to what it was in 1998
- Dynamic / Transient / Non-linear Phenomena / **Digital Twins** / Globally distributed work packages - Asia / Europe / USA
- Need for appreciation for physics – **Multiphysics**
- Agility to switch from one modelling protocol to other in quick time



FEM – Method of Teaching

Late 80's to mid 90's – Emphasis on mathematical treatment / Inversion of matrices / higher order equations / Non linearity concept was largely not captured & static analysis was the go to mode along with experimental mechanics



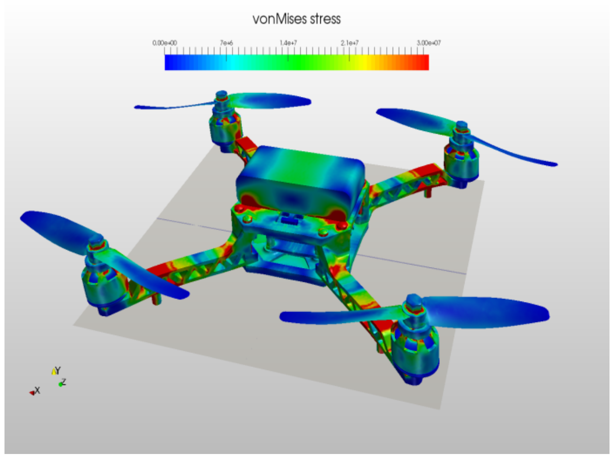
$$\begin{bmatrix} k_{11} & k_{12} & k_{13} & k_{14} & k_{15} & k_{16} \\ k_{21} & k_{22} & k_{23} & k_{24} & k_{25} & k_{26} \\ k_{31} & k_{32} & k_{33} & k_{34} & k_{35} & k_{36} \\ k_{41} & k_{42} & k_{43} & k_{44} & k_{45} & k_{46} \\ k_{51} & k_{52} & k_{53} & k_{54} & k_{55} & k_{56} \\ k_{61} & k_{62} & k_{63} & k_{64} & k_{65} & k_{66} \end{bmatrix} \begin{Bmatrix} u_1 \\ v_1 \\ u_2 \\ v_2 \\ u_3 \\ v_3 \end{Bmatrix} = \begin{Bmatrix} f_{1x} \\ f_{1y} \\ f_{2x} \\ f_{2y} \\ f_{3x} \\ f_{3y} \end{Bmatrix}$$

Mid 1990s to Early 2000 – FEM Solvers with limited ability / limited computational ability

Tools – ANSYS / NASTRAN / ABAQUS / Hypermesh

Early 2000 to 2018 – Versatile solvers / phenomenal improvements in computational power

FEM & CFD have moved from '***optional***; subject status to "***program core***" status in many institutions



Traditional Model (3 or 4 credits course)

Observations (2014 Workshop)

- Student use FEM / CFD methods as per defined procedure (routinely) with no effort on understanding physics
- Lack of a connect with design aspects
- Lab sessions and simplified problems – **avoid complexity**
- No emphasis on use of industry-quality standards for reports

- Industry has to invest great time and effort on **‘retraining’** or ‘extended orientation programs are needed for “on-boarding”

- We contacted more than 50 industries – Many said that “student preparation in engineering analysis is less than expected” and also said **“exposure to real-world problems must be incorporated in some way into curriculum”**

Took the help of professional bodies

the Institution of Engineers, NAFEMS and Aeronautical Society of India

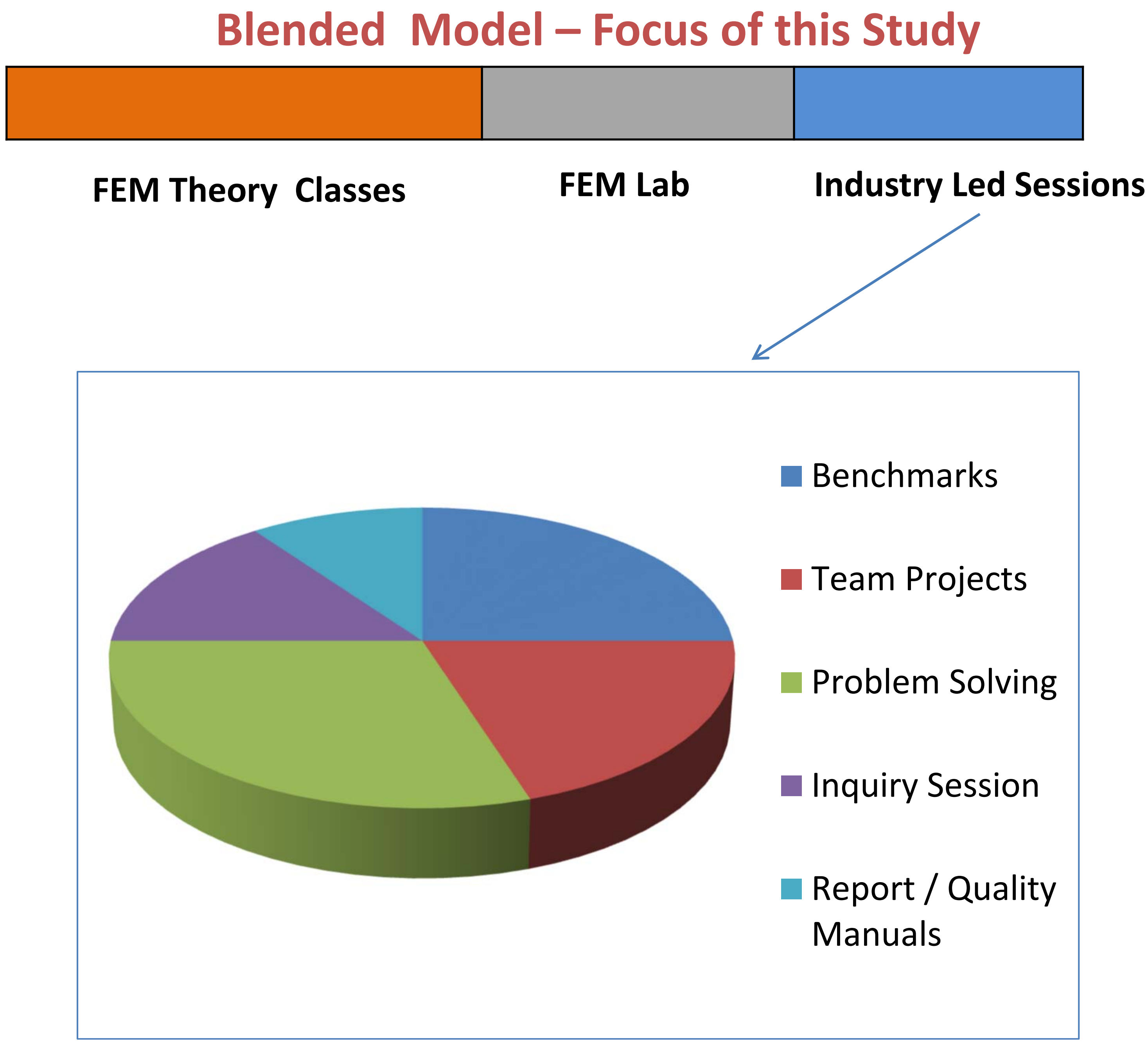
www.nafems.org

Carried out in close collaboration with **NAFEMS, an International Association dedicated to the cause of engineering modelling, analysis and simulation** (Similar to ASTM for Material Testing) – Many members from Industry and Academia

- **Aerospace**
- **Automotive**
- **Biomedical**
- **Electronics**
- **Defence**
- **Space Research**
- **Manufacturing**
- **Design Houses**
- **Academia**
- **52 industries + 3 professional bodies**

Industry Interaction Led to

1. **Repository of Project Ideas – About 75 real-world problems**
2. Readiness of industry EXPERTS to involve in **defining outcomes of Learning outcomes and developing the course contents**
3. **Inputs for Improvement of Employability**
4. **Preparing the students for global roles - **Team Dynamics / communication Aspects (Reporting of results)
5. In 2 cases, Industry helped the students to create a start-up in CAE domain


Blended Model – Focus of this Study
FEM Theory Classes
FEM Lab
Industry Led Sessions
Benchmarks
Team Projects
Problem Solving
Inquiry Session
Report / Quality Manuals

Overall Features of the Study

Comparative Studies – Traditional Model and Blended Learning Models

- 2 Year study (2015-2017)
- Control group of ~ 280 students each year
- **Enhanced association with engineering industries**

Development of a suitable teaching-learning model for improving the quality engineering modelling, analysis and simulation subjects (FEM)

OUTCOMES

- Problem Solving (beyond the normal)
- Learning Ability (new platforms)
- Efficiency (time taken)
- Alignment with Industry Expectations (adherence to standards)
- **Placements (spinoff benefits) or Jobs – Increased by almost 24%**

Led to a Project in INDO-UK
Higher Education Partnership Programme

ROYAL ACADEMY OF ENGINEERING

Newton-Bhabha Fund

Led to Globally Recognised Certification Program due to which Indian Engineers were able to get "onboarded" into Global Projects in USA / Europe

Series of interactions between **Industry Mentors – Mentee**

Started as Academic Exercise with industries (2014) → **Led to placements and R&D Projects (2017)** → **New Paradigm in Global Recognition & Mobility (2018)**

Industry Inputs for Starting a New Program

LARSEN & TOUBRO

WHEELS INDIA LIMITED

You Name it.. We Make it

DRDO

CVRDE

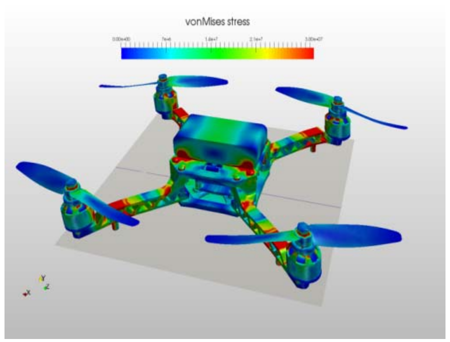
Volkswagen

Lucas TVS

ADDISON

Mahindra

New Masters Program on UAV (Drone)



How happy is the industry with university interaction ?

The satisfaction can be measured through “Objective” or “Subjective” ways

In India, recently a framework called National Institutional Ranking Framework was started by the Ministry On Human Resource Development
One of the points in that was “Industry Perception on University”

While preparing for this we developed a method
We circulate a questionnaire with questions - Subjective
Five Questions – Skills / Knowledge / Adaptability / Values / Team Role
Are you happy on overall with our systems and our students ?

A = X1 + X2 + X3 + X4 +……….+ Xn / n
X = +1, if industry is satisfied
X = -1, if industry is not satisfied
X = 0, no opinion
B = [No of industries contacted in this year / Number of Industries contacted last year]

Industry Perception Index = (A * B)

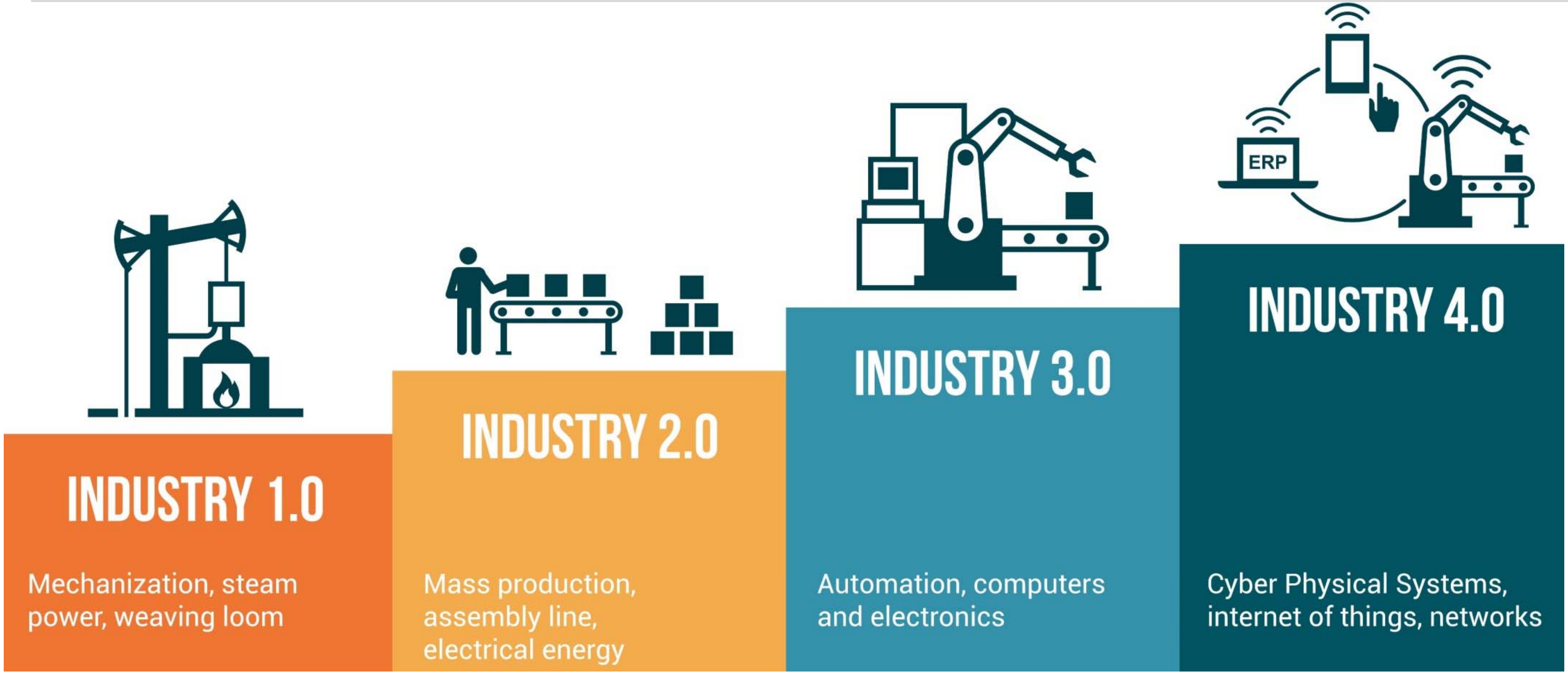
Industry 4.0

Universities across the world including South Asia and Southeast Asia are gearing up for introducing the relevant topics into their curricula

Cyber-Physical Things, IOT, Physical Internet – Digitisation and Data Transmission

- Learning from Contents
- Learning from Experience
- Learning from Feedback

Industry Interaction is not "**OPTIONAL**" – It is a **"MUST",** otherwise our programs could be out of sync with 21st Century needs



CDIO

World-wide CDIO Initiative

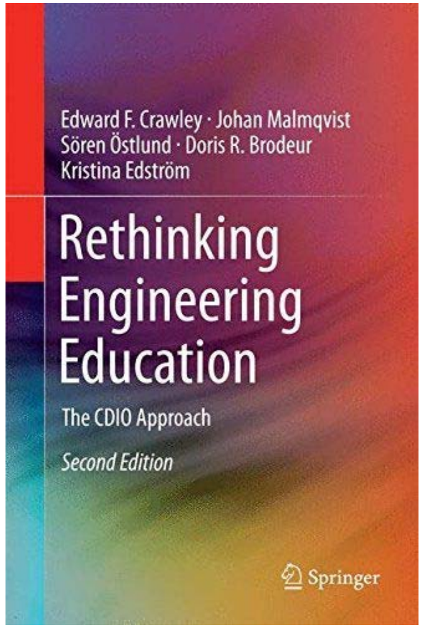
An education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating (CDIO) real-world systems and products.

Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment.

Established in 2000, CDIO has members from **Taiwan, Australia, Canada, Taiwan, Vietnam, South Korea China, Hong Kong, India, Ireland, Japan, Malaysia, New Zealand, Russia, Singapore, Thailand, Mongolia, Philippines and the United States**

12 CDIO Standards

- Context
- Learning Outcomes
- Integrated Curriculum
- Engineering Workspaces
- **Design- Implement Experiences**
- Active Learning
- **Enhancing Faculty Competence**
- Learning Assessment ……. so on



Washington Accord –
International accreditation agreement for professional engineering academic degrees between the bodies responsible for accreditation in its signatory countries

Established in 1989, the full signatories as of 2017 are **Australia, Canada, Taiwan, Pakistan, China, Hong Kong, India, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Sri Lanka, Turkey, the United Kingdom, Philippines and the USA**

Outcome Based Education (OBE) Approach - Starts with a clear picture of what is important for students to be able to do at the end of the program

Then we create a learning environment that supports the activities suitable for achieving the Intended Learning Outcomes (ILO)

- Disciplinary Knowledge / Skills
- Generic Skills
- Attitude and Values
- Leadership and Teamwork
- **Outlook / Global Mobility**
- **Orientation to future**

Rolls-Royce University Technology Centres
An increasingly global network

NORTH AMERICA

UTC at Purdue

Strategic Partnerships with Virginia Tech & the University of Virginia

Research programmes with Illinois, Georgia Tech, MIT and others

Research programmes at NRC in Canada

EUROPE

19 UTCs in the UK

UTCs in Sweden, Norway and Italy

4 UTCs in Germany, plus partnerships with DLR and the Fraunhofer Institutes

ASIA

UTC at Pusan in Korea

UTC at Nanyang in Singapore

Research Partnerships in Japan, Singapore, China

29 Rolls-Royce University Technology Centres worldwide

How can industry interactions lead to global careers for students ?

An interesting case study

FOXCONN Plant in Sri City, India

More than 11,000 people are employed here – Makes about 1 Million handsets or mobile phones per year

Started in 2014-15 – Produces mobile phones for Redmi Xiaomi / Micromax / Asus / Lava

Home » News » Three Taiwanese companies answer Make in India Call

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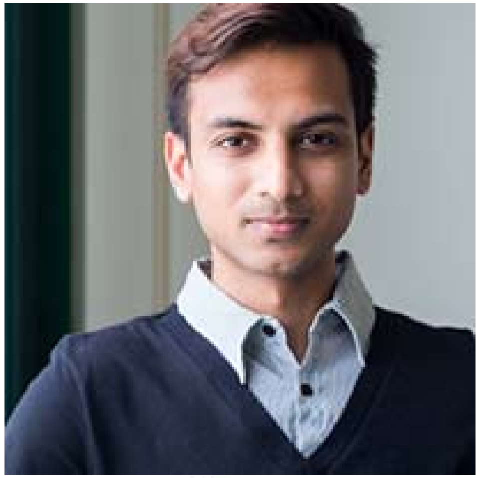
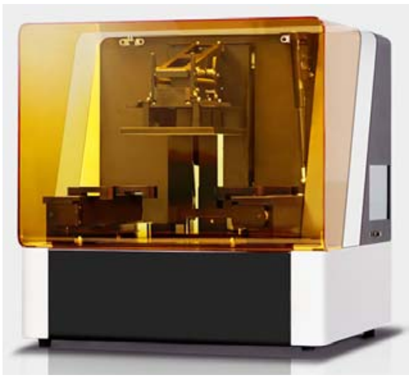
Taiwan – India Interaction

- **Started with conference call to the professors from NCKU / Tamkang / National Ilan**
- **Students for a short-trip (4 weeks to 6 weeks) - 2015**
- **Students for projects and internships to Taiwan – 2015&2016**
- **Masters Program in Taiwan**



ACKURETTA
TECHNOLOGIES



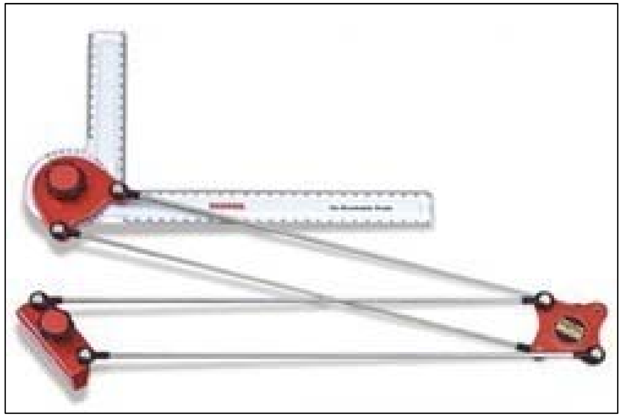
- **More than 1200 students from India institutions in Taiwan**
- **About 25 of them excellent jobs in Taiwan and about 10 are doing PhD**
    - NCKU
    - STUST
    - NTHU
    - Tamkang University etc.,

One Indian student started a company in 3D printing in Taipei

"Outcomes of the learning in terms of building skills and also preparing them global mobility are truly fulfilled)

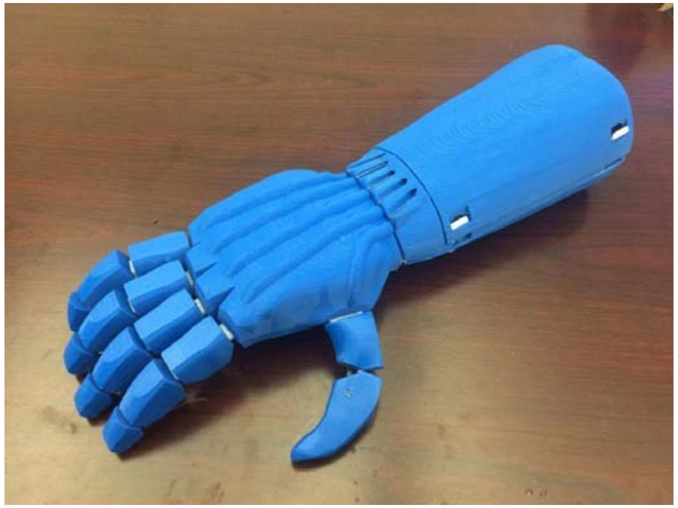
Engineering Drawing / Graphics

- Fundamental to all engineering activities
- **Initial Delivery** – Mini Drafter / Drawing Boards / Focus on 2D Sketching with Pencil
- **Next Mode** – Modelling Software (Autocad) – Computer aided design – Limited 3D modelling
- Current Stage – Students start off with 3D modelling – Several Options Google Sketchup, tinkercad, GrabCAD (freeware)
- Tens of thousands of CAD models on science / engineering / arts / technology are available for instantaneous downloads
- Students design reasonable complex assemblies like Formula Cars / Micro Satellites / Drones from early semesters



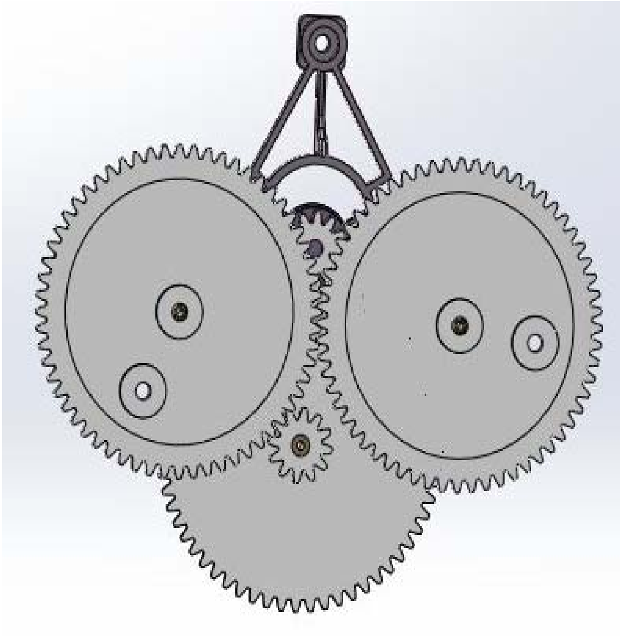
Engineering Drawing / Graphics

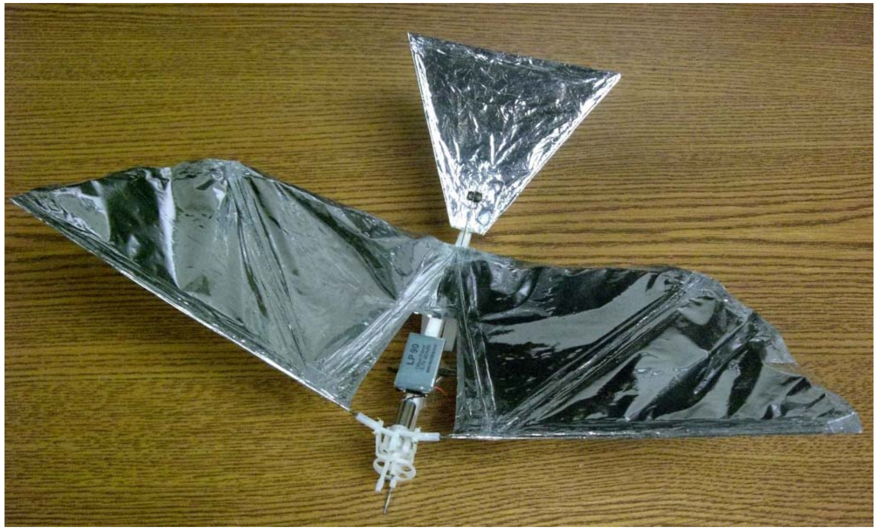
- **CS / IT / Electronics – Why should we learn engineering drawing, we know how to make 3D models ?**
- **Where shall we use in IT companies ?**
- Disconnect with drawing classes – handled by junior teachers – feeling of boredom / ennui
- Right in first semester – Drawing to Digital Fabrication
  - Start with 3D modelling – let them create products
  - Individual / Team
  - Integrate 3D printers / Scanners into classes
  - Exhibit the projects
  - Towards the end teach drawing fundamentals as necessary

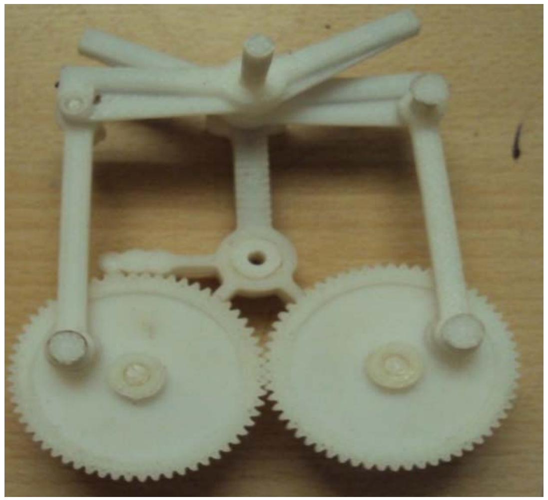


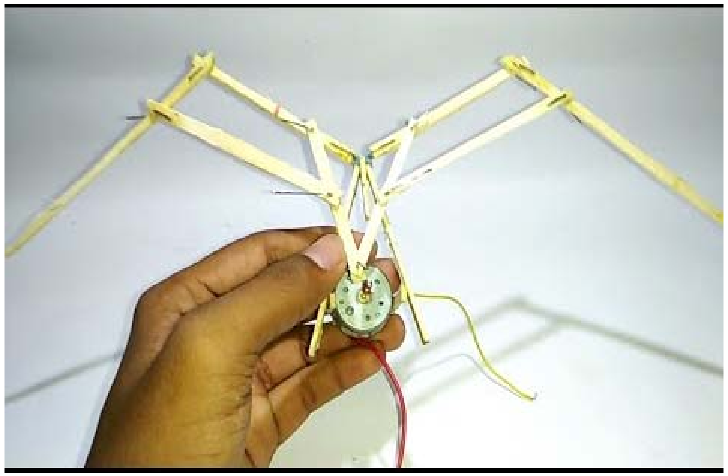
Projects by first year students

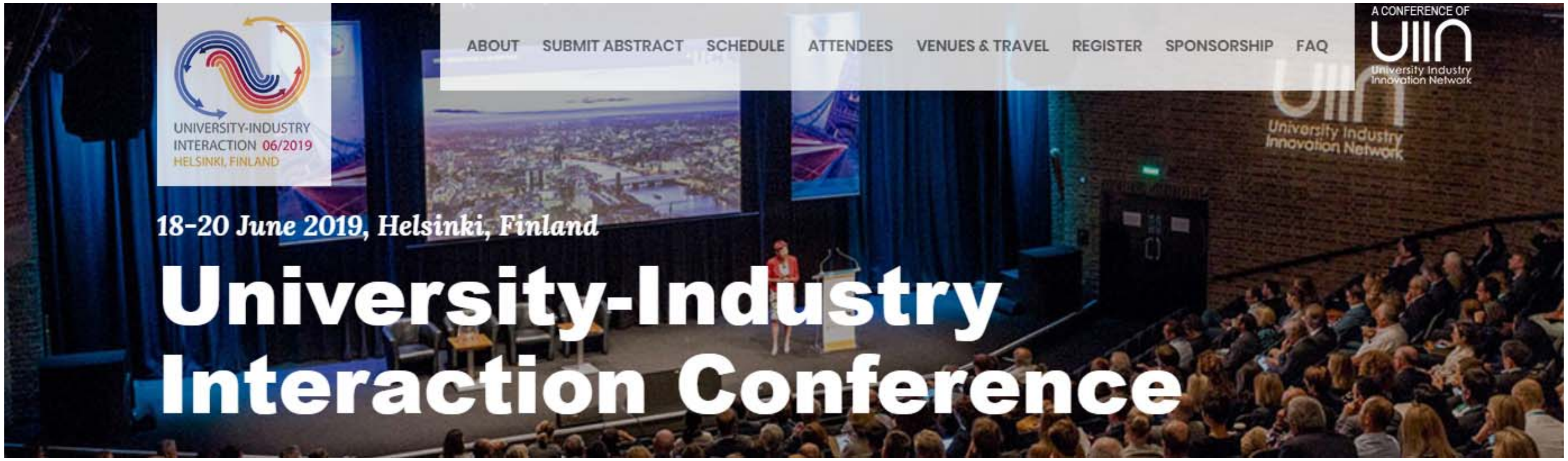
Series of projects by first year students
Collaboration with many small 3DP Companies











- Scope / Type – Vary for Developing Economies vis-à-vis Developed Economies
- Barriers Need to be Overcome – Cultural / Institutional / Systemic
- Synergies & Complementarities in Domains

In this VUCA World, it is Vital for Preparing the Students for 21st Century through Ensuring Intended Learning Outcomes


THANK YOU VERY MUCH
Let us all build a great future for 21st Century Students with active Industry Collaboration
Prof. U. Chandrasekhar
rofuc.edu@gmail.com