Research Collaboration Based Hub and Spoke Model for Higher Education

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Higher Education in Engineering

1. Under Graduate/Post Graduate Programs
2. Purpose: To produce high quality human resources by imparting knowledge and training to the students
3. What is expected from such human resources:
   - Industry ready
   - Innovation orientation
   - Global exposure
   - Interdisciplinary thinking

How to achieve this ???
Teaching/Learning through Collaborative Research

Collaboration
- Between Industry and Academia: Bridging the gap between industry and academia
- Amongst academic institutes/universities in the country: Reducing quality difference in the education at different tiers of institutes/universities
- Amongst academic institutes/universities in the world: learn from the best practices worldwide

Research
- Catalyst for collaboration

Teaching and Learning
- Implicit outcome
Our Research Collaboration based Hub and Spoke Model

- Maharashtra Institute of Technology, Aurangabad (MH),
- SGSITS Indore
- IET DAVE Indore
- from Cranfield university, Nottingham University
- M.I.T.S. Gwalior
- M.I.T Campus, Chennai- Lecture on SMA based optical fibre sensor
- Sri Sairam college of Engineering, Chennai
- And many other

- Tata
- Imaginarium
- Ace Micrometic Software Group
- Cyber infrastructure
- Janatics
- And Many other
Objective I: Development of a system that enables embedded intelligence in manufacturing equipment through effective data gathering, communication, analytics and decision making capabilities.


Objective III: Knowledge dissemination and identifying inputs for curriculum enhancement based on the output/learning from research collaboration.

Principal Investigator: Dr. Bhupesh K. Lad, Associate Professor, IIT Indore
Co-Principal Investigator: Dr. I. A. Palani, Associate Professor, IIT Indore
Collaborator from University of Cambridge: Dr. Ajith Kumar Parlikad, Prof. Bill O’Neill
Smart Machines

✓ Cyber twin approach
✓ Prognostics of machine tool components
✓ Failure and repair modeling
✓ Development of performance modeling
✓ Development of Shape Memory Based Alloy Structure for Machine tools

Smart Communication

✓ Social networks of machines

Smart Decision-making

✓ Integrated decision making in manufacturing industry
✓ Distributed decision making
GROUP ID: JOB_A_1459
BASIS: JOB TYPE [A]
LAST ACTIVITY: 11/02/2015 | 11:15:27
CURRENT TIME: 11/02/2015 | 11:16:39
MEMBER MACHINES: Machine 1
DEPARTMENTS: Maint. | Sched.

- Machine 1: Job Completed and Dispatched at 11/02/2015 | 11:15:20
- Machine 2: Job Received at 11/02/2015 | 11:15:25
- Machine 3: I have broken down. I need Maintenance.
  Activity Time: 11:16:10
  Component ID: MC3_CMP_23A.
- Machine 2: Job Completed at 11/02/2015 | 11:16:15
- Maint_D_34: Request Received from Machine 3. Expected time of Repair is 00:06:00 from CURRENT TIME [11:16:20]
Maintenance Dept. combines machine PM preferences to form enterprise PM schedule.

Scheduling Dept. sends job schedules to each machine.

Each machine evaluates its PM preferences.

Maintenance Dept.

Greedy Algorithm

Optimal Schedule

Smart Manufacturing | Dr. Bhupesh K Lad | bklad@iiti.ac.in
1) The Deposited SMA ring actuates by the heat generated due to friction.

2) It also absorbs the vibration caused in the tool holder during functioning.

3) These effects simultaneously reflects in increase in tool life.
MIG based additive manufacturing

Glove box with Argon Atmosphere

Molten Wire

Gushing Argon Gas

Welding Gun

Ni-Ti Sample

Trigger

Substrate

Ni-Ti Spool

Argon Gas
Success Stories

In a short span of time, the project has been very successful in achieving its objectives and creating the desired impact on society.
Success Stories

Technology Development

➢ A cyber twin based social network for a small section in a manufacturing industry is developed for distributed operations planning in collaboration with University of Cambridge.
➢ Various approaches for distributed and integrated operations planning are developed for industry.
➢ MTconnect based Cyber twin architecture is developed and demonstrated for machine tools.
➢ An pick and place robot and online monitoring of 3D printing machine was assembled for smart manufacturing laboratory
➢ Development of friendship matrix approach for digital twins for collaborative learning
➢ Laser assisted cold spray additive technique for developing shape memory alloy structures have been demonstrated for the first time by IIT Indore in collaboration with University of Cambridge.
➢ An In-house Metal Inert Gas (MIG) based additive manufacturing setup has been developed to fabricate tailor made structures of NiTi based shape memory alloys (SMA)…
Success Stories

Student exchanges and Internships

So far the project has offered research internship to **35 students from more than 15 institutes/universities** in India. Students are trained on various aspects of smart manufacturing. For example, 3 Undergraduates and 1 Post-Graduate interns have been trained on MIG based additive manufacturing technology. Many of these projects are directly done in collaboration with industry partners. Also few exchanges of students between IIT Indore and University of Cambridge have helped in strengthening partnership between the two institutes. Some of the students’ have shared their experience here under,

*Mr. Ajay Yadav,*
B.Tech Student, ATC, Indore

*I got the opportunity to work on cutting edge research problem under the mentorship of faculty members from IIT Indore and university of Cambridge. The project has added international research exposure to my profile and provided opportunity to interact and showcase my work to various experts from India and abroad.*

*Mr. Vaibhav Bedi,*
B.Tech Student, SJPML Institute of Engineering & Technology, Radaur

*The internship has provided me an opportunity to work on real word interdisciplinary research problem. The research environment and facilities at IIT Indore has motivated me to work hard to my highest potential. I also interact with faculty of University of Cambridge on my work. Apart from these, I presented my work at various industry forums and got positive feedbacks. This has helped me in building industrial contacts in my field of work. In summary, the internship has helped in me in overall development of my personality and will be very helpful in my future research career.*

*Mr. Shiva S,*
Research Scholar*
IIT Indore

*I visited Institute for Manufacturing (IfM), University of Cambridge and worked with the research group of Professor Bill O’Neil. It was a great experience to work in the state of the art laboratory for the research problem assigned to me. My visit to IfM gave me a wider opportunity in probing my research into new dimensions which sequentially incepts new ideas for the future scope of my research work. I am sure that the research connection build during my visit will be useful for my Post PhD research career.*
I visited the Institute for Manufacturing (IfM), University of Cambridge and worked with the Asset Management group headed by Dr. Ajith Parlikad under Newton-Bhabha programme (funded by RAE). My visit was a great experience for both intrinsic and extrinsic reasons, since it satisfied my desire to work with one of the top-ranked universities in the world and working alongside the subject-experts from over the globe, in their state of the arts laboratory, helped me gain new perspectives for my ongoing research work at IIT Indore. It was a good opportunity for me as I got to learn a lot of new, helpful things by working on latest software platforms and interacting with the leading industrial experts. My career will definitely benefit from the researchers I’ve interacted with, and the connections developed. I’m thankful to IIT Indore and my professor for providing such an opportunity.

Benefits to Students:
✓ Global exposure
✓ Industry exposure
✓ Improved leaning
✓ Improved career opportunity
Success Stories

➢ Best student project showcase award during national level event of manufacturing today summit-2016, at Pune.
➢ Best technology demonstration award for the student project during student research symposium at IIT Indore.
➢ Showcasing of a prototype at i2 Academia Pavilion during Indian Machine Tool Manufacturers' Association (IMTMA) ’s flagship event IMTEX 2017 on January 26 – February 1, 2017 at Bangalore.
➢ Best technology demonstration award during Industry Academia Conclave 2017 at IIT Indore.

Outreach, Expanding network, Confidence in students
Success Stories

➢ **Hamied-Cambridge visiting lecture grant of GBP 3200 awarded to Dr. Bhupesh K Lad.**

➢ **Received additional support of INR 5000000 (approximately GBP 50000) from the institute (IIT Indore) for smart manufacturing lab development.**

➢ **Submitted research proposals of worth INR 30000000 (approximately GBP 300000) to various India/UK funding agencies.**

Additional fund and Lab Development

- Newton Prize 2017, RAE, UK
- Cyber Physical System, DST, India
- Advanced Manufacturing Technology, DST, etc

Additional fund raised and laboratory development will help in making the outcome of the project sustainable.
Success Stories  Faculty Exchanges and Interactions

➢ Two faculty members from IIT Indore visited University of Cambridge and identified the possibilities for further research collaboration. Some joint proposals and ideas were discussed and finalized for onward submission to various funding agencies.

➢ Two faculty members from ACT, Indore spent 1-2 months time at IIT Indore and explored the possibility of strengthening research facilities at their institute.

➢ Interaction with faculty members of other institutes in India and UK

Increasing the research capability
Sharing the best teaching and learning/teaching practices
Identifying further opportunity for collaboration
Success Stories

Benefits to IIT Indore and University of Cambridge

- Student exchanges
- Joint supervision of student projects
- Technical outcomes
- Better understanding of issues faced by Indian Industries
- Knowledge and experience sharing in developing digital twins and in developing intelligent assets
- Sharing of techniques and methodologies for distributed decision-making
- Joint publication summarizing the results and lesson learnt
Success Stories

Benefits to Indian University Partner (Acropolis Technical Campus)

- Mentoring of 8 students for total of over 15 months by IIT Indore. Some of these students also got inputs from University of Cambridge
- Improved research capability and international linkages
- Joint publication
- Faculty mentorship
- A platform for students to present their work to industrial professionals and interact with industrial experts
A joint India-UK workshop on advanced manufacturing was organized by IIT Indore in the month of November 2016. Apart from University of Cambridge, faculty members from Cranfield university, Nottingham University and experts from various industries have participated in the same.

Principal investigator and Co-Principal investigator have presented the outcomes of the projects to various students, faculty members from various institutes in India.

This has motivated many students from these institutes to join the project as research interns.

The work was demonstrated by the students at various industry forums. Many industries have shown interest in research collaboration with smart manufacturing research group at IIT Indore.
The research outcomes are continuously being submitted to various journals and conferences. Few of them are already published and others, including joint publications with University of Cambridge, are at various stages of review. Details of the published papers are given below.


➢ Shaswat Sharma, Priya Chouhan , Lad, B. K. and Palani I A, “Investigation of Shape memory alloy based clamping devices for vibration damping and heat dissipation in machine tool operations”, International Conference on current research in Electronics, Computer Science, Information Technology and mechanical Engineering (ICECSITME-16) TECHNOARETE, Goa (Joint Publication with IIT Indore and Acropolis Technical Campus)


The following are our takeaway from the point of view of teaching in higher education:

- Research plays an important role in building successful and effective collaboration amongst Universities and Industries globally.
- Students are more excited to work on challenging research problems.
- Outreach is important.
- Better career opportunities for students can be created through such research-based learning/recaching.
- Dedicated 06 months research/industry based project in curriculum may be important.

Online learning Vs Research Based Learning
What Next??

What Academy Can Do?

- Identifying few key research areas
- Developing a consortium based on such Hun and Spoke Model to fund UG/PG students for research internships in these areas
- Such consortium will consist of interested Indian and UK university members, may be with certain joining fees or annual membership fees
- Any industry can join the group
- Each industry should contribute some specified amount of fund to take the access to the research output generated through such consortium and attract students of the participating universities
- Participating industry may float the project
- Student may apply to the consortium
- Matching (or Initial) grant from RAE, other UK and India funding agencies
Acknowledgement

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  (2) Micromatic Grinding Technologies Ltd, Ghaziabad,
  (3) Wabco India Private limited
  (3) Automation India Association, New Delhi
Thanks for your attention...!!!

Any Queries ??