

Exploring UK-India partnerships in distributed manufacturing

Inward mission to the UK: 16-19 June 2014

Delegate Reports

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UK Science & Innovation Network
Mumbai, India

Programme

16 June

One day workshop on distributed manufacturing: opportunities for growth (perspectives from the UK and India) *jointly organised by the Royal Academy of Engineering and Indian National Academy of Engineering*

17 June

- Roundtable meeting at the Royal Academy of Engineering
- Visit to Institute for Manufacturing, University of Cambridge

18 June

- Visit to Jaguar Land Rover innovation centre, Gaydon
- Visit to Manufacturing Technology Centre, Coventry

19 June

BIS Manufacturing Summit 2014, Liverpool

Table of Contents

[1] Dr. B. Ravi.....	4
[2] Dr. B. Gurumoorthy.....	6
[3] Dr. N. Ramesh Babu.....	8
[4] Dr. Sankha Deb.....	11

Dr. B. Ravi

Indian Institute of Technology Bombay, Mumbai

1) What are the current research challenges in distributed manufacturing?

Three challenges can be listed. One is finding the optimal ratio of global and local manufacturing (at the level of product, organization, or region) based on modelling of *true cost*. For example, while a distant country might offer a lower price, the true costs can be higher after considering uncertainties related to quality and logistics, environmental impact, loss of local jobs and other factors. Second is determining the optimal ratio of automated and manual production through (high) value engineering. For example, while car seats may be produced in an automated factory, the covers may be hand-crafted exclusively for each customer. Third is evolving alternate routes to meaningful employment for large populations without damaging the environment. For example, the rapidly growing Indian BPO industry can provide logistics planning and monitoring services for other countries. All three challenges are also connected at different levels; they need to be studied, modelled and experimented to find sector-specific optimal solution paths.

2) What are your expertise/capabilities in distributed manufacturing?

My past focus was building 3D software programs for casting development lifecycle engineering: mainly, part design for manufacturability, rapid tooling development, process simulation & optimization, and cost estimation. We have also developed a cloud-based simulation and education system benefitting 50,000 users worldwide. Our current work involves putting together a multi-disciplinary, multi-institution collaborative team, which will leverage Cax (CAD, CAE, CAM) technologies to develop innovative medical devices suitable and affordable to the targeted population. Future focus would be on evolving new models and networks for sustainable manufacturing, building on the ground and using the experience gained so far.

3) Broadly, what opportunities are there for UK-India collaboration? Can you name a few opportunity titles, which could take the form of potential research projects?

The world is yet to find the most effective solutions for challenges listed for the first question. The best minds in India and UK can work together, share their experience, evolve new approaches to sustainable manufacturing, and use their complementary strengths and industrial contacts to pilot and test the solutions. One potential project can involve analyzing the current supply chain of Jaguar Land Rover, modelling the true costs of castings, classifying them into groups to be produced in the UK, India and elsewhere, planning the appropriate manufacturing network, recommending the same to JLR, following up, verifying and improving the model, mapping & extending it to other scenarios of distributed manufacturing, and publishing the same.

4) Which organisations in the UK and India could be likely partners for joint projects in distributed manufacturing?

The following organizations for the above-mentioned project:

UK - Institutions: Cambridge University (IfM) and Warwick Mfg. Group

UK - Industry: Manufacturing Tech Centre Catapult and Jaguar Land Rover

India - Institutions: IIT Bombay, IIT Madras, IIT Kharagpur

India - Industry: Institute of Indian Foundrymen (Pune, Coimbatore, Kolkata)

5) What are some of the follow up actions you have planned?

In India: Build an informal network of thought leaders in sustainable manufacturing to discuss future scenarios and evolve policy documents.

In UK: Keep in touch with researchers at IfM (Prof. Mike Gregory's group); evolve a broad theme and overall plan for long-term collaborative projects in distributed sustainable manufacturing; establish a high level connection (MoU) between Cambridge University and IIT Bombay.

6) Any suggestions, requests, comments?

The high-profile UK-India distributed manufacturing activities, which were very well planned and executed, enabled building personal contacts between UK and Indian researchers, an important prerequisite for strong and long collaborations. It will be good to follow up with a similar visit by the UK team to India to work out the contours of one or two major projects that involve all three stakeholders: academia, industry and governments. This can be facilitated by the UK Science & Innovation Council, Royal Academy of Engineering, Indian National Academy of Engineering, and the Office of the Principal Scientific Advisor to the Government of India.

Dr. B. Gurumoorthy

Indian Institute of Science, Bengaluru

1) What are the current research challenges in distributed manufacturing?

- Product and Process models and Interoperability between them
- Managing large data
- Knowledge acquisition, integration and access
- Ontologies (related to Knowledge management and interoperability)
- Jigless assembly and tool less manufacturing
- Traceability of data on `as built parts' and process conditions
- Scale of manufacturing processes – design to scale

2) What are your expertise/capabilities in distributed manufacturing?

Product informatics, Process modelling, Ontologies and Interoperability

3) Broadly, what opportunities are there for UK-India collaboration? Can you name a few opportunity titles, which could take the form of potential research projects?

- Interoperability of product data (as opposed to shape data that is fairly well structured)
- Metrology assisted assembly
- Smart Products
(the above two are related in that the basic idea is that there is information available on the `as built parts' that is carried with the CAD model and this is processed along with a nominal plan to alter either process or assembly plan taking into account deviations accumulated till the present step)
- Integrating real time sensor data with knowledge
- Scale of manufacturing processes – design to scale

4) Which organisations in the UK and India could be likely partners for joint projects in distributed manufacturing?

Without ascribing projects to organizations I will just list the organizations below:

UK - Cambridge (IfM), Nottingham, Bath, Bristol, Birmingham, Sheffield
India – IITM, IITB, IITD, IITRoorkee, IISc, NIT Tiruchy, IIITM Jabalpur

5) As a result of this visit, what are the follow up actions you have planned?

We were in discussions with Cambridge for a project in product informatics. Now we plan to explore if we can also float a larger proposal on information modelling issues in distributed manufacturing once the discussions on the current proposal close.

We would also like to explore joint proposals for Indo-UK funds with one of the institutions listed above.

Another plan is to have two SME organizations on either side (India and UK) to work together to build a prototype of a medical device that is being designed in a joint project with a UK university. This could serve as a case study to understand issues in distributed prototyping at least.

We would also like to collaborate with the MTC to learn from their experience and translate appropriately in India.

6) Any suggestions, requests, comments?

It would be nice if one recommendation from this workshop could be to have the UKIERI (or the DST-ESPRC) to issue a call for joint proposals in the distributed manufacturing space.

Dr. N. Ramesh Babu

Indian Institute of Technology Madras, Chennai

1) What are the current research challenges in distributed manufacturing?

For the distributed manufacturing to become sustainable, economically competitive and closer to customers in meeting their requirements, some of the following challenges are to be addressed by the researchers all over the world.

1. Efficient use of resources like energy, materials, processes and technologies
2. Agile product design, manufacturing, assembly and service systems
3. Near net shape manufacturing with flexible advanced manufacturing methods and additive manufacturing
4. Development of advanced and smart materials and processing technologies
5. Remanufacturing systems for reuse and sustainable manufacturing
6. Intelligent manufacturing with sensors, machine learning and cognitive approaches
7. Strategies for quality assured production with advanced and additive methods of manufacturing
8. Surface engineering and coating technologies for repair and reuse of materials and products for sustainable manufacturing.

2) What are your expertise/capabilities in distributed manufacturing?

Over the last three decades, our group at Manufacturing Engineering Section, Department of Mechanical Engineering at Indian Institute of Technology, Madras has been engaged in research and developmental work in the areas of advanced manufacturing processes and methods, and application of automation principles in manufacturing. A brief outline of our R & D efforts in these areas is described below.

Manufacturing processes:

- Abrasive machining processes like precision grinding and abrasive water jet machining processes
- Activities include the development of strategies for design and manufacturing of precision grinding machine tools
- Strategies for efficient and effective processing of advanced materials including ceramics and composites by means of turning and milling processes
- Development of sensors and strategies for reliable peening of surfaces with high velocity water jets
- Development of multisensory approach for adaptive control of advanced machining processes like abrasive water jet cutting

- Development of diagnostic tools for evaluating the performance of precision grinding machine tools
- Laser materials processing of advanced materials like ceramics and composite materials

Sustainable Manufacturing:

- Development of new processes like laser dressing of grinding wheels
- Development of ice bonded abrasive polishing systems for polishing of advanced materials used in bio-medical applications

Manufacturing Automation:

- Tool path planning strategies for complex surface machining with multi-axe CNC machine tools
- Path planning strategies related to cooperative manipulation and coordinated manipulation of multiple robots
- Reverse engineering of PLC control programs for reconfigurable control system development

3) Broadly, what opportunities are there for UK-India collaboration? Can you name a few opportunity titles, which could take the form of potential research projects?

- Research collaboration in precision and ultra precision machining processes, including grinding and abrasive water jet machining processes and additive manufacturing with solid state processing methods.
- Research collaboration in sustainable manufacturing with a specific focus on energy efficient and environmentally conscious manufacturing methods.
- Agile and reconfigurable manufacturing with a specific interest in developing strategies for reverse engineering with cognitive and machine learning.

4) Which organisations in the UK and India could be likely partners for joint projects in distributed manufacturing?

Obviously, the agencies and organization promoting high value manufacturing research like EPSRC and ESRC will be approached for funding of joint research projects in the areas of advanced manufacturing, We would like to dialogue with the universities with whom we have established some linkages. These include: University of Cambridge, University of Manchester, University of Nottingham, Cranfield University, Warwick University, Liverpool John Moores University and Manufacturing Technology Centre (MTC).



5) As a result of this visit, what are the follow up actions you have planned?

I had the opportunity to meet several academicians at the UK-India workshop on Distributed Manufacturing organized by the Royal Academy of Engineering in London. I hope to interact with some of these academicians to nurture the cooperation in the field of manufacturing. I have invited Prof. Joseph Mark Howe, Professor of Sustainable Development, Director of Centre for Energy and Power Management, University of Central Lancashire, School of CEPS, Preston to IIT Madras during his visit to IISc, Bangalore in November 2014.

6) Any suggestions, requests, comments?

Perhaps, the UK Science & Innovation Network within the British High Commission can support the visit of a few eminent researchers to India when the Indian Academy of Engineering is planning to hold the next meeting in India. This will enable the UK researchers to interact with various researchers engaged in research in advanced manufacturing in India.



Dr. Sankha Deb

Indian Institute of Technology Kharagpur, Kharagpur

1) What are the current research challenges in distributed manufacturing?

In my opinion, some of the key research challenges in distributed manufacturing would be developing flexible, agile and reconfigurable manufacturing technologies and systems in quick response to the complexities brought about by the constant changes in an unpredictable business environment, development of standards for exchange of data and e-communication for interoperability between heterogeneous manufacturing systems exploiting the web based technologies, sustainability and taking into account environmental considerations, developing knowledge-based and analytical decision making tools for supporting real time decisions, high level of intelligence and adaptability of the system architecture to changes in business environment, and last but not the least, the need for integration of humans with the software and the machines by developing human machine interfaces.

2) What are your expertise/capabilities in distributed manufacturing?

In our research group at the Indian Institute of Technology Kharagpur, we have expertise in Computer Integrated Manufacturing, Flexible Automation and Robotics, Assembly Engineering, Intelligent Manufacturing Systems, applications of Artificial Intelligence (AI) and soft computing techniques and developing e-learning courseware and virtual laboratories. We have laboratory capabilities including Flexible Manufacturing Systems and Computer Integrated Manufacturing hardware and software to carry out advanced research in the above areas.

3) Broadly, what opportunities are there for UK-India collaboration? Can you name a few opportunity titles, which could take the form of potential research projects?

Following are some of the potential research projects that may be taken up for UK-India collaboration:

- Developing flexible, agile and reconfigurable manufacturing systems paradigms
- Developing a virtual environment for design and real time control of manufacturing systems
- Web technology based integration for distributed manufacturing
- Developing sustainable supply chain strategies
- Multi-Criteria Decision Making in Manufacturing Supply Chain Management



4) Which organisations in the UK and India could be likely partners for joint projects in distributed manufacturing?

The academic institutes, research organizations and industry could join hands together for proposing joint projects in various areas of distributed manufacturing mentioned in my response to question no. 3. The academic institutes in India may include the three Indian Institutes of Technology located at Kharagpur, Bombay and Madras, and the Indian Institute of Science (IISc) Bangalore. The UK institutes may include Institute for Manufacturing (IfM) Cambridge University, Warwick Manufacturing Group and Cranfield University. Industry partners may include automotive companies such as Mahindra and others like L&T in India and Jaguar Land Rover (JLR) in the UK. The research organizations may include DRDO, ISRO in India and Manufacturing Technology Centre (MTC) in UK.

5) As a result of this visit, what are the follow up actions you have planned?

I have planned to work on developing joint project proposals with the faculty members of Institute for Manufacturing (IfM), University of Cambridge in our mutual areas of research interests that would be of relevance to both UK and Indian industry.

6) Any suggestions, requests, comments?

The academies like Royal Academy of Engineering, Indian National Academy of Engineering and British High Commission can together play an important role by continuing to provide more funding opportunities in future to bring together the research and industry communities of both the countries and promote dialogue between them in order to identify common research goals for possible collaborations.