INSTITUTE FOR MANUFACTURING

people, projects and activities

2015

UNIVERSITY OF CAMBRIDGE

IfM MANAGEMENT TECHNOLOGY POLICY

Contents

Research

IfM research brings together expertise in management, technology and policy to address the full spectrum of manufacturing issues.

Inkjet Research Centre

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OVERVIEW

The Inkjet Research Centre (IRC) carries out research into the generic science which underlies this important technology. We have expertise in inkjet technology, fluid mechanics, visualisation, analysis and computation to study jet and drop creation, drop flight and drop-surface interaction.

KEY RESEARCH PROJECTS

Innovation in industrial inkjet technology: I4T

IRC is part of a consortium, led by the University of Cambridge and headed by Professor Ian Hutchings, awarded a multi-million pound EPSRC grant to investigate how inkjet print technology could revolutionise manufacturing processes.

The consortium members include two other Cambridge departments, the Universities of Durham and Leeds and a group of eight companies which include the major UK players in the inkjet sector.

The award, with additional funding from industry, supports a five-year programme of research to study the formulation, jetting and deposition of specialist printing fluids, and develop an overall process model. This work will improve the robustness of industrial inkjet printing and help companies develop new applications for the technology such as flat-panel displays, printed electronics, and photovoltaic cells for power generation.

Inkjet technology for 3D printing

The IRC is investigating the use of inkjet technology for the fabrication of 3D components, in particular via printing on to powder beds.

Impact acceleration

Three projects involving local companies have been funded by the EPSRC Impact Acceleration Scheme. These are projects in which researchers spend part of their time with a partner company and part at the University, in order to help transfer knowledge developed during our inkjet research and extend the work into relevant technology development.

Tiny Drops

This short project was a collaboration with Queen Mary University of London. It used the visualisation and analysis tools developed at the Inkjet Research Centre to study electrospray systems designed at QMUL. These are capable of creating drops with orders of magnitude less volume than conventional inkjet. The project was carried out with a view to using the technique for additive manufacturing.

PEOPLE

GKN Professor of Manufacturing Engineering: Ian Hutchings

Director of Inkjet Research Centre: Graham Martin

Researchers: Rafael Castrejon-Pita, Ching-Hsien Chen, Clare Conboy, Ronan Daly, Steve Hoath, Cristina Rodriguez-Rivero

Centre Administrator: Alice Cozens

Centre for Industrial Photonics

www.ifm.eng.cam.ac.uk/cip
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OVERVIEW

The Centre for Industrial Photonics (CIP) is engaged in a wide range of research and development topics that focus on advancing the state of laser and ion beam manufacturing technologies across length scales from nanometres to hundreds of metres.

Research activities go beyond the traditional application of lasers, such as localised delivery of optical energy, to perform materials processing operations such as cutting, welding and heat treatment.

CIP focuses on novel laser matter interactions through the application of ultrafast laser pulses, conditioned laser energy profiles that lead to designer materials, efficient laser-based production routes and in-process control methodologies.

KEY RESEARCH AREAS

Metal coatings: a Cambridge-developed production process that enables novel combinations of materials and metals to be deposited on a substrate for the production of 3D components. The process is in its final stages of commercial development and is being taken to market by a new University spin-out company, Laser Fusion Technologies Ltd.

Manufacturing processes: new programmes starting this year include the development of a low-cost laser 3D printer aimed at the schools market; a laser-based gasification technology for extracting energy products from fossil fuels: laser processing of carbon nanotubes and wires for improved electrical performance; high-speed, laser-based additive fabrication technology for metals; and a laser-forging process for shock hardening of metals.

WORKING WITH INDUSTRY

CIP's work is supported by national and international firms that compete in sectors including medical devices, packaging, photonics, communications technologies, oil and gas, energy generation, automotive and aerospace. CIP is well placed to deliver innovative solutions to industry as well as skilled postgraduates that can take new technologies into industry and increase the global competitiveness of the UK manufacturing base.

EPSRC initiatives: CIP is home to the Cambridge arm of the EPSRC Centre for Innovative Manufacturing in Ultra Precision, the EPSRC Centre for Innovative Manufacturing in Laser-based Production Processes, and the EPSRC Centre for Doctoral Training in Ultra Precision.

PEOPLE

Centre Head: Bill O'Neill
Researchers: Andrew Cockburn, Krste Pangovski, Martin Sparkes

Embedded Researcher: David Hopkinson

Research students: Matthew Bannister, Sam Brown, Tianqi Dong, Wenhe Feng, Jiho Han, Laurent Michaux, Francisco Orozco, Jon Parkins, Andy Payne, Nicky Soane, Jason Ten, Chris Wright, Karen Yu

MRes students: Dulce Garza, Diego Albarracin, Xin Chang, Alexandre Diaz, Daniel Gortat, Aaron Rai

Centre Administrators: Alice Cozens, Sophie Fuller

Technician: Michael Herring

RESEARCH

NanoManufacturing

www.ifm.eng.cam.ac.uk/nanomanufacturing
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OVERVIEW

This research centre focuses on the development of scalable technologies to structure nanoparticles such as carbon nanotubes, graphene, and metal oxides into well-defined superstructures. These may find application in sensors, electronics, catalysis, energy storage, water purification and smart materials.

BACKGROUND

Worldwide commercial interest in nanoparticles is reflected in an exponential increase in their production capacity. For instance, the current production capacity of carbon nanotubes (CNTs) now exceeds several thousand tons per years. These nanoparticles are used in diverse commercial products ranging from rechargeable batteries, automotive parts and sporting goods to boat hulls and water filters.

CURRENT CHALLENGES

Unprecedented mechanical and electrical properties are reported for individual nanoparticles. However, most engineering applications require the assembly of tens to millions of these nanoparticles into one device. Unfortunately, the figures of merit of such assembled materials typically drop by at least an order of magnitude in comparison to the constituent nanoparticles. We therefore need to expand our knowledge about manufacturing processes to enable more controlled nanoparticle organisation.

PEOPLE

Centre Head: Michaël De Volder
Researchers: Davor Copic, Chadramohan George, David Beesly, Shahab Ahmad
Research students: Sarah Jessl, M. Hadi Modarres, Jean de la Verpilliere

Fluids in Advanced Manufacturing

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OVERVIEW

Biological, polymeric and nanoscale materials are vital components when making new materials, sensors and biodiagnostic devices.

The FIAM team is creating fluid-based 'top-down' digital techniques and 'bottom-up' self-assembly approaches to integrate these functional materials at scale into regenerative medicine, drug delivery and diagnostic devices.

RESEARCH THEMES

1. Soft Matter Manufacturing Research

- Combining digital fabrication with self-organisation to make novel materials with tunable chemical, biological and mechanical properties for drug delivery and regenerative medicine.
- Self-assembled supramolecular polymer manufacturing for medical applications.

2. New Digital Manufacturing for Sensor Technologies

- Functional material printing and laser ablation for ultra-precise shaping and biosensor fabrication.
- Exploring fundamental manufacturing effects on advanced materials.

3. Manufacturing of Devices

- Direct-write microfluidic systems and sensors. Fabricated on paper and polymers for flexible, point-of-manufacture customisation.
- Point-of-care diagnostic device research.

4. Pathways to Manufacturing

Working with the Centre for Science Technology and Innovation Policy to advance understanding of scale-up risks for emerging technologies and novel manufacturing techniques.

PEOPLE

Head of Group: Ronan Daly
Research students: Yoanna Shams, Qingxin Zhang

Distributed Information & Automation Laboratory

www.ifm.eng.cam.ac.uk/dial
dial-enquiries@eng.cam.ac.uk

OVERVIEW

The Distributed Information and Automation Laboratory (DIAL) studies ways in which advanced information systems and automated identification technologies, such as radio-frequency identification (RFID), can be combined with advanced production and asset management systems to create and deploy smart products, flexible, reconfigurable manufacturing operations and innovative services.

KEY RESEARCH PROJECTS

Achieving Leveraged Advantage from Distributed Information (ALADDIN): a 3-year project funded by Boeing, developing techniques to automatically manage the integration of data across the enterprise, to extract maximum business intelligence.

Centre for Smart Infrastructure and Construction: Whole-life management of infrastructure assets supports through-life decision-making and information management for infrastructure assets, such as buildings and rail and sewage networks.

IT Architectures for Logistics Integration (ITALI) is developing new logistics IT architectures to enable more efficient and flexible logistics operations.

Disruption Tolerant Automated Lean Factories (DisTAL): a 3-year project funded by Boeing, to improve the resilience of manufacturing automation in the face of operational disruptions.

Hitachi Rail: developing an intelligent, adaptive, self-learning fault data management approach and fault-diagnosis tool for train systems.

Industrial uses of internet of things: an early initiator of the 'internet of things' concept, DIAL is examining its role in manufacturing.

TOOLS

DIAL has three tools designed to help companies overcome some key operational challenges:

Automation Assessment Tool: for companies considering automation, this is a quick and effective way of assessing the opportunities and the feasibility of implementation.

Industrial Resilience Audit: diagnoses why processes are experiencing disruption and helps identify short-term fixes and define longer-term plans to develop more flexible production processes.

Information Quality Assessment Tool: analyses the risks that poor information quality poses to companies and identifies the best way to mitigate the risk.

PEOPLE

Centre Head: Duncan McFarlane
Deputy Director, DIAL: Ajith Parlikad
Technical Officer, DIAL: Alan Thorne
Researchers: Phil Catton, Rachel Cuthbert, Amer Dheedan, Vaggelis Giannikas, Tariq Masood, Alena Puchkova, Raj Srinivasan, Jumyung Um, Pascal Wichmann, Philip Woodall
Research students: Joel Adams, Mudassar Ahmed, Torben Jess, Zhenglin Liang, Wenrong Lu, Nipat Rasmekomen, JiaQiang Wang
Centre Administrator: Petra Kasmanova
Technician: Simon Sennitt

Centre for Technology Management

www.ifm.eng.cam.ac.uk/ctm
ctm-enquiries@eng.cam.ac.uk

OVERVIEW

The Centre for Technology Management (CTM) is concerned with the effective integration of technological considerations into business decision-making. We support industrial managers and the wider technology management community by providing a focus for practical research, a forum for industry-academic discussion, a professional interface with industry and a range of industrially related services.

KEY PROJECTS

Digital fabrication: cross-disciplinary research to understand the emergence of additive manufacturing technologies, effective business models, and their impact on the UK economy.

Visualisation for strategy and innovation: improving understanding and practice for supporting strategic dialogue and communication.

Strategic technology management toolkits: how methods such as roadmapping, project selection, portfolio management, patent analytics and scenario planning can be integrated in a systematic and practical way.

Strategic intellectual property management: supporting decision making and technology transactions as part of the innovation process.

APPROACH

- Working closely with industry in a wide range of sectors including aerospace, automotive, utilities, pharmaceuticals, telecommunications, steel-making and fast moving consumer goods
- Disseminating our research findings to companies through reports, workshops and forums
- Developing technology managers through bespoke executive education
- Strategic Technology and Innovation Management Consortium – practice-oriented research and networking collaboration with industrial partners.

PEOPLE

Centre Head: David Probert
Academic staff: Tim Minshall, Frank Tietze
Researchers: Clare Farrukh, Simon Ford, Clive Kerr, Rick Mitchell, Letizia Mortara, Rob Phaal
Research students: Dayo Abinusawa, Joonmo Ahn, Bettina Blasini, Laurens Chaskel, Dominik Deradjat, Nitish Gupta, Yuta Hirose, Kyounglim Lee, Mohd Nazri Mahmud, Ahmed Mashhour, Elliott More, Hyunkyu Park, Sullivan Songhe Ye, Chung-Lin Tsai, David Weiss, Mark Wilson, Man Hang Yip, Bingqing Zhao
Research Assistant: Geraldine Guceri
Industrial practitioners: Nicky Athanassopoulou, Clemens Chaskel, Bill Colquhoun, Andrew Gill, Ricardo Gonzalez Nakazawa, Imoh Ilevbare, Steve Mann, Dominic Oughton, Jim Trueman, Michèle Routley, John Saiz

RESEARCH

Technology Enterprise Group

www.ifm.eng.cam.ac.uk/teg
tim.minshall@eng.cam.ac.uk

OVERVIEW

The Technology Enterprise Group (TEG) is focused on research and education relating to the origins, start-up and growth of technology-based ventures and their impact upon the economy.

RESEARCH THEMES

- Open innovation
- Investment and incubation for emerging technologies
- University-industry knowledge exchange

KEY PROJECTS

- Value creation and capture from additive manufacturing / 3D printing
- Open innovation strategies for SMEs in the UK and South Korea
- The role of corporate venture capital in supporting corporate ambidexterity
- The role of communication within an open innovation ecosystem
- How entrepreneurs learn from prior failure when setting up new ventures
- Investment and incubation for emerging technologies

ACTIVITIES

Bit by Bit: 3D Printing Interest Group

As part of the Bit by Bit research project on *Capturing Value from the Digital Fabrication 'Revolution'*, TEG is using social media to support the debate on the emergence of 3D printing.
www.dfab.info and twitter.com/dfab_info

Open Innovation Research Forum (OIRF)

OIRF is an international network of researchers looking at the challenges of implementing open innovation, supported by the Institute for Technology, Enterprise and Competitiveness (ITEC) at Doshisha University in Japan.
www.oirf.net and twitter.com/camoinet

Cambridge Technopole

TEG provides resources to support debate on the evolution of the Cambridge high tech business cluster.
www.cambridgetechnopole.org.uk and twitter.com/camtechpole

University enterprise activities

Activities supported by TEG include the University Enterprise Network, Cambridge University Entrepreneurs, and the i-Teams programme.
www.enterprisenetwork.group.cam.ac.uk

PEOPLE

Head of Group: Tim Minshall
Researchers: Simon Ford, Letizia Mortara
Research students: Dayo Abinusawa, Joonmo Ahn, Bettina Blasini, Dominik Deradjat, Sullivan Songhe Ye, David Weiss, Mark Wilson

Design Management Group

www.ifm.eng.cam.ac.uk/dmg
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OVERVIEW

It is widely accepted that the design of great products and services has a key part to play in a firm's success. The way in which the product development process is managed is critical to this success. The Design Management Group is interested in how design can be effectively managed to create sustainable, desirable, usable and producible new products and services. We are also active in understanding and promoting the importance of design at a national level.

RESEARCH THEMES

- Measuring the value of design
- Integrating design and technology
- Designing sustainable new products
- New approaches to managing product development
- Design trends and strategic design management

ACTIVITIES

Tools for managing new product development: in partnership with IfM Education and Consultancy Services, we are developing simple visual tools for the improvement of product development management, especially in small firms.

KEY PROJECTS INCLUDE:

A simple approach to design for manufacture: there are a range of methods for helping designers evaluate the producibility of new products. We have developed a simplified form of these for use in a workshop setting.

User involvement in New Product Development (NPD): exploring the ways in which firms involve users in new product development.

A toolkit for sustainable design: enabling designers and engineers to better understand the complexities of sustainable design.

Design management in the retail industry: exploring the tension between the role and contribution of design management in large retailers in the UK, US and EU.

Design in science: the role of design in the early stages of technology development, working with Cambridge scientific research projects.

FUTURE INTERESTS

- Design for additive manufacture: providing guidance and support for designers in adopting new production technologies.
- Design trends: understanding how designers capture, represent and use trends in the design of new products.

PEOPLE

Head of Group: James Moultrie
Research students: Krista Keraenen, Wei Liu, Clara Aranda-Jan, Jayné Franck, Yuuki Shigemoto, Katie Menzies, Bohao (Richard) Li

Centre for Strategy and Performance

www.ifm.eng.cam.ac.uk/csp
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OVERVIEW

The Centre for Strategy and Performance (CSP) combines academic objectivity with industrial know-how to help companies tackle their strategy and performance management. We aim to understand and improve the way strategic choices are made, plans are developed and implemented, and performance is measured and achieved.

RESEARCH THEMES

- Strategy modelling and visualisation
- Strategic decision making
- Competences, capability and resource analysis
- Performance measurement
- Innovation strategies and systems
- Start-up strategy

APPROACH

- Developing effective techniques for formulating strategy and designing performance measurement systems
- Working closely with industry so that our understanding of best practice is constantly updated
- Providing practical tools for industrial managers and consultants
- Interpreting and disseminate research findings

KEY PROJECTS INCLUDE:

Strategy in high growth SMEs: understanding the strategy processes in high growth SMEs.

Innovation capabilities, processes and ecosystems: Working with companies in the Middle East and North Africa (MENA region) to identify innovation capabilities and processes, and reach a deeper understanding of the nature of ecosystems in the region.

Business strategy process: developing a facilitated process that helps identify markets and competences, and create vision and action in small and medium manufacturers.

Capability and resource analysis: studying the way companies co-ordinate resources to improve capabilities and performance. Particular emphasis is placed on identifying synergistic capabilities within a supply chain.

Performance measurement systems: developing systems to evaluate and improve performance measurement in industrial companies.

PEOPLE

Centre Head: Ken Platts

Deputy Head: Mohamed (Mark) Khater

Research students: Carmina Buzuloiu, Tanya Edwards, Philipp Egger, Rich Morales, Tomasz Szejner, Claus Weidinger

Industrial practitioners: Nicky Athanassopoulou, John McManus, Dominic Oughton

Centre for International Manufacturing

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OVERVIEW

The Centre for International Manufacturing (CIM) focuses on strategic and operations management in close collaboration with industrial partners. The Centre provides expertise and support in the areas of international manufacturing and supply networks, particularly factory/plant management, operations network configuration and design and the development of capabilities.

APPROACH AND ACTIVITIES

- Researching new approaches to the understanding of industrial systems from a complex network perspective.
- Investigating disruptive supply networks that support novel business models.
- Developing a strong academic-industrial-institutional community where network design requires both industrial and policy perspectives.
- Hosting the annual Cambridge International Manufacturing Symposium bringing together industry, researchers and policymakers to discuss key themes.
- Working with multinational companies across a range of sectors on capturing value from their global operations networks.

RESEARCH THEMES

STRATEGIC NETWORK DESIGN

Designing a production footprint to reduce cost and increase responsiveness. Global production networks design projects aim to reduce cost, improve access to growing markets and vital resources, and improve agility and resilience in the face of changing market conditions.

Gaining competitive advantage across the end-to-end supply chain. Research addresses the key challenge associated with taking a more extended or even end-to-end supply chain perspective – the alignment of configuration and capability across both internal functions and external partners.

Developing a successful service supply network. A new set of approaches has been developed to help companies configure these complex multi-organisational networks of service partners.

Configuring global value networks. Structured approaches that support the needs of both the corporate strategist and the national policymaker to guide the mapping of complex industrial ecosystems, the configuration of new and disrupted global value networks, and the integration of these networks to enhance performance.

EMERGING THEMES

- Risk and resilience
- Sustainable supply networks
- Mergers and acquisitions
- Knowledge integration
- E-commerce-driven ‘last-mile’ logistics

PEOPLE

Centre Head: Jag Srai

Researchers: Tomás Harrington, Mukesh Kumar, Yongjiang Shi

Research students: Feifan Chang, Yuanjun Chen, Arsalan Ghani, Alexander Kouptsov, Xingkun Liang, Stanley Lim, Yang (Jonathan) Liu, Huey Yuen Ng, Mark Phillips, Xiangwei Shi, Guangbo (Norman) Zhang, Wenwen Zhao, Yinjie (Jessy) Zhou

Centre Administrator: Elizabeth Wickham

Industrial practitioners: Paul Christodoulou, Don Fleet, Andrew Gill, Eric Harris

Centre for Science, Technology & Innovation Policy

www.ifm.eng.cam.ac.uk/csti csti-enquiries@eng.cam.ac.uk

OVERVIEW

The Centre for Science, Technology and Innovation Policy (CSTI) is an applied policy research unit exploring what makes national innovation systems effective at translating new science and engineering ideas into novel technologies and emerging industries.

Research projects are designed to support the evidence needs of Science, Technology & Innovation (STI) policymakers, in particular those officials in public research agencies who are responsible for programme design, portfolio management and strategy development.

APPROACH

The CSTI research agenda is shaped in collaboration with policy and research agency partners.

CSTI's applied research activities are distinguished, in particular, by its efforts to:

- characterise more carefully the technologies, application systems and industrial structures involved in the journey from research to economic wealth
- ensure that research outputs are directly relevant to the evidence needs of those government agencies supporting the research and innovation base

RESEARCH THEMES

The public research base & the dynamics of innovation: exploring the evolving contribution of public research and higher education organisations to technological and industrial change, and growth.

Technological, manufacturing & industrial systems: characterising enabling technologies, production technologies, value chains to better understand the dynamics of S&T-based industrial change.

Science, technology & industrial emergence: developing innovation system functions-based approaches to analysing emerging technology dynamics; and practical foresight-related analyses for policy and public research strategy development.

Innovation system institutions - regulation & standards: exploring the evolving role of standardisation and regulatory activities on the emergence of new technologies and industries.

Economic value capture from industrial-innovation systems: analysing sources of national economic value capture from modern manufacturing systems, in particular during technological and industrial change.

PEOPLE

Centre Head: Eoin O'Sullivan

Researchers: Paul Beecher, Charles Featherston, Carlos López-Gómez, Tomas Ulrichsen

Research student: Jae-Yun (Jane) Ho

Affiliate: Laure Dodin

Interdisciplinary and collaborative programmes

The IfM's interdisciplinary research programmes are focused on particular industrial challenges and typically draw on the breadth of disciplinary expertise from engineering through management to economics and policy.

Cambridge Service Alliance

www.cambridgeservicealliance.org
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OVERVIEW

The Cambridge Service Alliance brings together industrial and academic partners to find innovative solutions to the challenges of designing and delivering high-performance complex services.

Complex service provision is becoming increasingly important as the business models of technology and manufacturing companies become more service- and less product-oriented.

Close to 60% of US manufacturing firms now offer services and solutions to supplement their products. In the public sector, governments are commissioning based on outcomes and delivery. Even traditional, product-oriented industries such as aerospace, defence and transportation are becoming increasingly service-based.

The services provided (and used) in these industries are examples of complex service systems, where organisations must manage several areas of complexity simultaneously

The Cambridge Service Alliance exists to help companies address these challenges. Working with our partners, we define and execute agreed programmes of research designed to push the boundaries of knowledge, as well as deliver practical benefits to Alliance members.

Cambridge Service Alliance partners: University of Cambridge, BAE Systems, Caterpillar, IBM, Pearson and Zoetis.

KEY RESEARCH AREAS FOR 2015

- business models – understanding value
- data and analytics
- making the shift to services

CAMBRIDGE SERVICE WEEK 2015

The annual Cambridge Service Week includes events for academics, practitioners and member organisations of the Alliance to address the evolving challenges facing service education, research, practice and policy. The theme for 2015 is 'Creating Customer Value Through Services'.

PEOPLE

Alliance Director: Professor Andy Neely

Professor of Industrial Information Engineering: Duncan McFarlane
Researchers: Ornella Benedettini, Tor Boe-Lillegraven, Marcus Eurich, Julia Jones, Ivanka Visnjic Kastalli, Chunshan Li, Veronica Martinez, Vieri Maestrini, Janet McColl-Kennedy, Alexis Nicolay, Ajith Parlikad, Florian Urmetzer, Chander Velu, Anna Viljakainen, Mohamed Zaki

Research students: Katharina Greve, Xia Han, Jingchen Hou, Jianyu Ji, Chara Makri, Claire Weiller, Zimeng Zhang

Support: Jacqueline Brown, Angela Walters

Industrial practitioners: Andrew Gill, Liz Salter

Business Model Innovation

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OVERVIEW

The research programme applies economic and management theories to innovation issues, with a particular focus on the reasons for, and consequences, of business model innovation. It also collaborates with a number of IfM research centres on business model innovation, covering technology, management and policy. Programme members also run courses on business model innovation based on the ongoing research.

KEY RESEARCH PROJECTS

Business model innovation in digital fabrication: examines the emergence of new business models in relation to digital fabrication technologies and the business model transition challenges faced by incumbent firms. This research is funded by EPSRC and ESRC grants and done collaboratively with the Centre for Technology Management and the Inkjet Research Centre.

Business model innovation and business ecosystems: studies firms moving from a relatively closed to a more collaborative innovation business model with an ecosystem of firms. It has three main strands:

- The type of governance systems firms need to be better at identifying and responding to intelligence gathered through working with ecosystem partners.
- Similarities and differences between manufacturing and service firms in their approaches to searching for new ideas in the market place.
- The transformation challenges of firms moving to a service-based business model with an ecosystem of firms (project within the Cambridge Service Alliance)

Business model innovation and entrepreneurship: examines how the degree of technology dependence of business models of start-up firms influences the survival of these firms. It also considers how the innovative nature of incumbent firms influences entrepreneurial spawning.

Business model innovation and economic development: examining the role of business models and technology for economic development, particularly for countries that have experienced some economic development and are looking to accelerate growth to catch up with more advanced economies. The research group is part of the Malaysia-UK Innovation Alliance and seeks to support the exchange of knowledge and intellectual property between Malaysia and the UK through the application of science, technology and innovation. A number of scholarships for PhD students to examine these issues have already been set up and further collaborations are planned.

PEOPLE

Head of programme: Chander Velu

Researchers: Nicky Athanassopoulou, Imoh Ilevbare, Veronica Martinez, Letizia Mortara, Doroteya Vladimirova, Mohamed Zaki

Research students: Alexander Koupstov Zurina Moktar, Mark Phillips

RESEARCH

Centre for Industrial Sustainability

www.ifm.eng.cam.ac.uk/cis
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OVERVIEW

To develop more sustainable societies, industries need to better understand how to respond to environmental, economic and social challenges and transform industrial behaviour. The Centre for Industrial Sustainability (CIS) works to develop knowledge and tools that accelerate the transition towards a sustainable industrial system.

RESEARCH THEMES

- Eco-efficient manufacturing: identifying waste and model factory resource flows
- Eco-factory technologies: resource-efficient manufacturing; eco-intelligent control systems
- Sustainable business innovation: re-thinking business models; mapping value to create new business models
- Industrial system transformation: mapping future industry, planning future industrial systems.

KEY PROJECTS AND OUTPUTS

The Centre has produced a number of tools to help manufacturers become more sustainable.

They include:

- Mapping value in business networks
- Finding uncaptured value across product lifecycles
- Transforming businesses to capture new value
- Manufacturing efficiency toolkit
- Energy saving activities for factory staff
- Circularity thinking toolkit
- Systems mapping and capability assessment

APPROACH

CIS works collaboratively with research centres across the IfM and with other universities and industrial partners. Within CIS is the EPSRC-funded Centre for Industrial Sustainability which has 60 staff across four universities and has helped over 200 companies innovate towards sustainability. The Centre provides knowledge and tools to help manufacturers profit from the opportunities of a sustainable future.

POLICY SUPPORT FOR DECISION-MAKERS

The Centre provides considerable support to governments, NGOs and policymakers. Recent examples are:

- UK All-party Parliamentary Manufacturing Group: Sustainable Manufacturing Commission
- UK Government: Foresight report on the future of manufacturing to 2050
- UNIDO: manufacturing policy for new economies
- Next Manufacturing Revolution: non-labour resource efficiency

PEOPLE

Centre Head: Professor Steve Evans
Commercial Director: Ian Bamford
Researchers: Claire Barlow, Nancy Bocken, Melanie Despeisse, Maria Holgado Granados, Dai Morgan, Doroteya Vladimirova

Research students: Jee-Yeon Choi, Lloyd Fernando, Zahit Ergun Gungor, Na Jiao, Sotirios Levakos, Yan Li, Lampros Litos, Pu Liu, Ioannis Mastoris, Sudhir Rama Murthy, Daniel Summerbell, Yuan Tao, Kirsten Van Fossen, Miying Yang

Marketing and Networking Coordinator: Dee Dee Frawley
Centre Administrator: Sharon Mey

Babbage Industrial Policy Network

www.ifm.eng.cam.ac.uk/brg

OVERVIEW

The Babbage Industrial Policy Network is an interdisciplinary forum bringing together experts from economics, engineering and operations management with a shared interest in manufacturing and industrial policy. The network and the Babbage Lecture Series are hosted by the Centre for Science, Technology & Innovation Policy.

BABBAGE NETWORK & FELLOWS

Researchers from the Centre of Science, Technology and Innovation Policy at IfM and from the Faculty of Economics in Cambridge working together with a broader community of Babbage Fellows to better understand modern manufacturing systems and to make industrial policy design and implementation more effective.

BABBAGE LECTURE SERIES

Recent seminars and lectures hosted by the Babbage Industrial Policy Network include:

Bringing production back into development
Ha-Joon Chang, University of Cambridge

Greater Boston's Industrial Ecosystem: A Manufactory of Sectors
Michael Best, Emeritus Professor, University of Massachusetts Lowell and former Co-director of the Centre for Industrial Competitiveness, USA

'Make in India': A New Paradigm for Manufacturing in India
Ranjan Mathai, Indian High Commissioner

Schumpeterian analysis of economic catch-up: knowledge, path-creation and the middle income trap
Professor Keun Lee, Director of the Center for Economic Catch-up and Seoul National University

The Entrepreneurial State and the Risk-Reward Relationship
Professor Mariana Mazzucato, University of Sussex

The Digital Future of Manufacturing, Policy and Technology Opportunities for American Innovation
Professor Thomas R. Kurfess, Georgia Institute of Technology

Innovation, Globalization and the Sustainability of the European Model(s)
Giovanni Dosi, Scuola Superiore Sant'Anna, Pisa

PEOPLE

Researchers: Antonio Andreoni, Ha-Joon Chang, Carlos López-Gómez, Mike Gregory, Eoin O'Sullivan, Bob Rowthorn

Manufacturing Industry Education Research Group

www.ifm.eng.cam.ac.uk/mierg

OVERVIEW

The Manufacturing Industry Education Group (MIERG) looks at educational issues related to manufacturing industry. It aims to research areas where new knowledge will benefit the learning and development of:

- **people** in becoming effective and excellent practitioners in manufacturing industry roles
- **manufacturing industry companies** in developing and sustaining the capabilities needed to compete in the global industrial ecosystem.

RESEARCH INTERESTS

- How can higher education support the initial professional development of graduates destined for manufacturing industry? What knowledge and skills are important?
- How do you develop graduate-level work related skills as part of higher education programmes?
- Understanding the changing knowledge and learning needs during the industrial emergence cycle.
- Competence assessment of registered engineers
- Technician skills for high value manufacturing
- What knowledge and skills are required to 'scale up'?
- What are the perceptions of engineers amongst school children?
- Inter-disciplinary projects in engineering education

KEY PROJECTS INCLUDE:

Perceptions of engineering: comparative study of different perceptions of engineering among schoolchildren in UK, Germany, Italy and Korea and investigation of the potential impact upon career pathways.

Development of professional capabilities for industry: examining how students develop these capabilities during an IfM MPhil programme. Work is currently focused on the short industrial placements that the students undertake; defining the activities that they need to do, the skills they need to develop and identifying the taught knowledge deployed.

Scale up of innovative technologies in the process industry: identifying the skills and knowledge needed for achieving successful scale up of innovative process technologies.

Initial development needs for technical graduates in small companies: (1) A survey of small companies, mainly in the technology sector, to investigate their needs for graduate training and their response to the different formats for part-time education. (2) An exploratory study of early career engineers in an early-stage company in an emerging industry to understand the relationships between their activities and the required capabilities.

PEOPLE

Programme co-ordinator: Judith Shawcross

Researchers: Claire Barlow, Ronan Daly, Tim Minshall, Tom Ridgman

Research students: Mohd Nazri Mahmud, Judith Shawcross, Hai Hua (Helen) Zhang

Education

Our programmes combine a comprehensive grounding in engineering, management and economic principles with practical application in industry.

Research degrees: PhDs and MPhils

www.ifm.eng.cam.ac.uk/phd
phd-enquiries@eng.cam.ac.uk

The Department of Engineering offers one-year MPhil and three-year PhD research degrees. Research topics within the IfM cover the full range of management, technology and policy issues addressed by our research centres and interdisciplinary programmes. Student research builds upon work in existing areas or develops along new avenues. We actively encourage applicants who have previous industrial or public sector experience.

CURRENT & RECENT PHD TOPICS

Roadmapping to understand and manage risks associated with sustainability
Manufacturing firms face challenges in evaluating sustainability issues – specifically resource scarcity – when devising business strategy. As many resources become ever more constrained in the future, firms will increasingly be forced to switch to more sustainable production methods. This research examines the potential for roadmapping as a strategy tool to help firms recognise future resource constraints.

High speed mask-less laser-controlled precision additive manufacture

Additive methods at both the nano and micron scale are used to develop advanced functional materials such as graphene and carbon nanotubes to manufacture next-generation functional devices. This project looks at depositing materials with lasers at high deposition rates and with high precision, with a view to developing a 'one-stop' laser manufacture platform.

Standards for emerging industries

This research explores the conditions that support innovation and successful transition of new scientific and technological research into emerging industries. The research specifically focuses on strategic frameworks and processes that can be used by policymakers and standards organisations to manage technical standards in a timely and anticipatory way.

Self-assembly for polymer microstructures
Liquid engineering can be used to build polymer microstructures containing functional materials. This research combines a self-assembly technique with a controllable digital patterning of liquid drops to liquid surfaces and then guiding their self-organisation into patterns.

'Through-life accountability' within complex service networks

This project aims to develop a methodology for mapping 'through-life accountability'. It is envisaged that this framework will help identify the sources of potential failure of product-service systems and, in turn, provide key insights for improving their safety.

Manufacturing excellent engineers

This project investigates how the experience gained by students via industry-based projects, visits and exercises contributes to their development as next-generation engineers and the resource requirements to deliver them.

APPLICATIONS

Admission to Cambridge research degrees is managed by the University's Board of Graduate Studies. Full details of how to apply can be found on its website:
www.admin.cam.ac.uk/offices/gradstud

Information specific to the Department of Engineering can be found at:
www.eng.cam.ac.uk/graduate/postgrad

Applicants are encouraged to discuss their proposed research topic with the IfM research centre concerned. Some funded studentships are available but early application is strongly advised.

MRes and PhD in Ultra Precision Engineering

www.CDT-UP.eng.cam.ac.uk

OVERVIEW

The MRes & PhD programme in Ultra Precision trains postgraduate students to be the precision engineers of the future. The programme is structured in two phases: a one-year taught MRes course at the University of Cambridge and Cranfield University followed by a three-year PhD research programme at Cranfield, Cambridge or another UK university.

MRes

During the MRes the students will learn advanced high precision techniques and processes, including: high energy laser micro/nano-processing; focused ion beam machining; reactive atom plasma processing; nanofabrication; graphene engineering; printed electronics; machine design; and advanced metrology systems.

The MRes is designed to give a balance between taught courses, lab sessions and research projects to allow students to develop a range of skills.

PhD

Upon successful completion of the MRes, the students progress to their PhD, choosing from a vast range of topics including: manufacturing engineering; laser processes; photonics; materials science; control systems; and machine design.

WORKING IN INDUSTRY

During their PhD many students will be offered the opportunity to work alongside industrial partners allowing them to gain valuable business experience whilst receiving an additional maintenance top-up, bringing their stipend up to a possible £20,000 pa tax free.

FUTURE CAREERS

Many industrial sectors require a high level of precision, such as aerospace, medical devices, automotive, energy, security and defence. Students completing the MRes and PhD will be central players in the ultra precision wealth creation economy.

- We welcome applicants from any field of science or engineering who have obtained a first or upper second class honours degree.
- Full EPSRC funding is available for UK students and EU students who have studied for three years full time in the UK.

PEOPLE

Course administrator: Sophie Fuller

MPhil in Industrial Systems, Manufacture and Management (ISMM)

www.ifm.eng.cam.ac.uk/ismm

ismm-enquiries@eng.cam.ac.uk

OVERVIEW

A one-year, taught MPhil programme that prepares graduates for fast-track careers in manufacturing and management.

It integrates the technical, operational and business skills needed by high calibre graduates to:

- provide industry with highly motivated and effective potential managers with experience in both practical industrial problem solving and rigorous academic research
- equips course members with the skills and experience they need to be immediately effective in industry, leading to accelerated promotion

COURSE PROGRAMME

ISMM consists of:

- 8 weeks of project work
- 16 weeks of taught modules
- 2-week overseas study tour either in mainland Europe or further afield
- 18-week dissertation project

Taught course
We teach manufacturing as a 'business'. It is taught by both academics and industrialists and involves lectures, exercises and case studies.

Company visits
Visits are arranged to a broad spectrum of companies demonstrating best practice in operations and management in technology-driven environments.

Industrial projects
Real problems tackled in teams of two or three, under normal commercial pressures, produces individuals with the self-reliance and confidence to rise to exceptional challenges.

Research project
Extended pieces of individual research, covering a range of topics chosen from technology, economics, management, services or policy areas.

Study tour
A two-week overseas tour providing an opportunity to experience industries and working environments outside the UK.

PEOPLE

Course Director: Simon Pattinson

Tutors: Gerry Frizelle, Vanessa McNiven, Tom Ridgman, David Schwarz, Yongjiang Shi, John Sullivan
Associate Tutors: Nicky Athanassopoulou, Derek Ford, Peter Hiscocks, Tim Minshall, John McManus, Bill O'Neill, Judith Shawcross
Support: Sally King, Sharon Nightingale

Manufacturing Engineering Tripos (MET)

www.ifm.eng.cam.ac.uk/met
met-enquiries@eng.cam.ac.uk

OVERVIEW

The Manufacturing Engineering Tripos (MET) is a two-year programme for 3rd and 4th-year undergraduate students who have successfully completed the first two years of a Cambridge engineering degree. It offers a thorough theoretical grounding combined with the chance to put ideas into practice in industry. The programme includes lectures, industrial visits, business skills development, company-based projects and a major project researching and designing a novel product.

MET IIA (3RD YEAR)

In their first year, MET students follow courses in:

- Materials into products
- Operation and control of production machines and systems
- Product design
- Operations management
- Industrial engineering
- Organisational behaviour
- Managing business and people
- Financial and management accounting
- Industrial economics, strategy and governance
- Contemporary issues in manufacturing

Company visits

A programme of industry visits to see theory put into practice.

Skills programme

A structured programme to develop specific business skills.

Design project

Students research the market for a product, prepare a design and manufacturing plan, and draw up a business plan for a company to produce the product.

MET IIB (4TH YEAR)

The second year of MET is very different from a standard undergraduate course. Intensive taught modules, normally lasting a week, are interspersed with two-week company-based projects. Module topics include: enterprise; globalisation and policy; Production technologies and materials; Manufacturing systems engineering, Sustainable manufacturing; Industrial systems, operations and services; Managing people; Technology and innovation management; and Strategy and marketing.

Industrial projects

Students undertake two-week projects in companies drawing on the material covered in the taught modules and working in pairs or larger groups on a real problem identified by the company concerned. For the final seven weeks of the course students undertake an individual industrial project.

Automation project

A hands-on group project in the IfM's automation lab, involving designing and building an automated manufacturing system.

International project

Throughout the year students work on an international research project that culminates in an overseas study tour.

PEOPLE

Course Directors: Tim Minshall, James Moultrie

Academic staff: Claire Barlow, Ronan Daly, Michaël De Volder, Mike Gregory, Ian Hutchings, Duncan McFarlane, Tim Minshall, James Moultrie, Bill O'Neill, Ajith Parlikad, Jim Platts, Ken Platts, David Probert, Alan Thorne, Frank Tietze, Chander Velu

Support: Shane Strawson (maternity cover), Mitha Madhu

Working with industry and government

IfM Education and Consultancy Services (IfM ECS)

IfM ECS works with companies of all sizes to create and capture value, and with national and regional governments to support and grow their industrial sectors. It does this by transferring the new ideas and approaches developed by researchers at the IfM through a programme of education and consultancy services.

Working with multinational companies

www.ifm.eng.cam.ac.uk/services/overview/large

IfM Education and Consultancy Services (IfM ECS) provides a range of consultancy services based on IfM research. Our industrial practitioners, all with many years of senior management experience, provide support for companies and public sector organisations. Their approach is very different to conventional consultancy – they work collaboratively to develop solutions and focus on transferring knowledge as well as delivering business results.

Working with industry both informs and funds future IfM research.

IfM ECS works with companies around the world to help them:

Develop their innovation and technology management strategies and capabilities
IfM ECS can help companies develop and put in place robust innovation and technology management strategies and systems. We use a range of research-based approaches and techniques adapted to each company's specific context and requirements.

Capture value from global networks
Researchers at the IfM's Centre for International Manufacturing have developed a set of structured approaches to help multinational companies redesign their global manufacturing value networks to achieve strategic and operational advantage.

Move to service-based business models
Introducing innovative, customer-focused service models – while effectively managing risk – into highly complex multinational manufacturing companies is a challenging task. IfM ECS supports this process using a range of approaches and techniques developed by researchers from the Cambridge Service Alliance.

RECENT PROJECTS INCLUDE:

Working with companies on technology and innovation management in a wide range of sectors including: oil and gas, automotive, aerospace, defence, chemicals, packaging for healthcare, food and beverages and household and personal care.

"Working with people from Cambridge University has undoubtedly brought a fresh and creative perspective to our product development approach. Often if you engage a large consultancy firm, you can risk engaging multiple consultants and receiving a not inconsiderable bill. Businesses sometimes need a lighter touch and a guiding hand in the right direction. IfM ECS is a real ambassador for such an approach and is a credit to the University."

Running the Open Innovation (OI) Forum for companies in the Food and FMCG sector, looking at hot topics and best practice in OI and addressing the 'Grand Challenges' facing the whole value chain. The Forum currently has 16 members including Mars, PepsiCo, Tesco and Unilever.

"Here is a real opportunity to create a breakthrough in consumer and community value as we further collaborate with our peers in the industry."

Working with multinational companies to configure their production, supply and service networks and to develop the capabilities they need to support these configurations. IfM ECS has now worked with more than 50 companies around the world on network redesign, most recently in white goods, toys, plastic pipes and aerospace.

"This project forms a major part of our corporate business strategy and will help to guide the optimisation of our footprint around the world."

Working with mid-sized companies

www.ifm.eng.cam.ac.uk/services/overview/mid-size

Mid-size companies are those that sit somewhere between large multinationals and SMEs. They are often very successful, longstanding businesses which play an important part in their national economies.

Our consultants work with mid-size businesses – and with business units of global companies – and understand both the challenges they face and the opportunities they have for growth. Our consultants have extensive experience at a senior level and a commitment to bringing research to bear on real industrial challenges and learning from the results.

We work with mid-size companies to:

- Identify and prioritise key business needs and opportunities
- Develop a successful business strategy
- Understand their markets
- Put their strategy into practice and regularly refresh it
- Turn their R&D into successful products, processes and services
- Develop their operations strategies and capabilities
- Improve individual factory performance
- Add a service dimension to their business
- Embed environmental sustainability into all aspects of the business.

RECENT PROJECT

IfM ECS worked with a mid-sized company based in the UK and India. The project looked at ways in which the company could improve its complex and labour-intensive production processes to bring its products to market more quickly and efficiently. This ongoing collaboration has used a number of IfM ECS methods. First, it defined and prioritised the issues that needed addressing and then redesigned some of its products and improved its subassembly processes. An online diagnostic tool was then used to collect large quantities of data from both within the company and from its suppliers and customers to understand the strengths and weaknesses in the company's technology system, to avoid bottlenecks, reallocate resources to ease constraints in key areas and make gains in capacity. The project also addressed issues relating to people and organisation such as developing management capabilities and looking outside the business for expertise in key areas.

Working with smaller manufacturers and industry sectors

www.ifm.eng.cam.ac.uk/services/overview/sme

IfM ECS works with small and medium-sized manufacturing companies throughout England and Wales to improve their business performance. We use a range of structured tools and processes developed by researchers at the IfM and delivered by our team of experienced practitioners, all of whom have many years' industrial experience at a senior level.

We understand that managers of smaller companies have to be very focused on the day-to-day challenge of keeping the firm on track. Our approach addresses the company's underlying issues quickly – without taking up too much management time.

How it works

The process typically has three phases:

- A one-day diagnostic to identify priority areas and create a plan which will develop capabilities and achieve real improvement.
- Four half-day business strategy development workshops to identify new market or product opportunities, to look at how the firm should compete and to develop a prioritised action plan to make sure the strategy is implemented.
- Half-day workshops to improve the company's capabilities in the areas that will make the most difference to its business.

SHARING IN GROWTH – SUPPORTING SMES IN THE UK'S AEROSPACE AND CIVIL NUCLEAR SECTOR

IfM ECS is one of the partners delivering a £110m programme aimed at developing the capabilities of UK aerospace and civil nuclear suppliers. The government-funded programme provides training and development to tackle barriers to growth, boost exports and grow the number of high-value jobs in the UK.

SUPPORTING SMES IN THE EAST OF ENGLAND

- **PrISMS**

Practical and Innovation Solutions for Manufacturing Sustainability (PrISMS) is a programme funded by the European Regional Development Fund and other agencies to support the sustainable growth of 50 start-ups and 70 SMEs across the East of England over three years. From the initial 60 firms assessed, it has helped create 125 jobs and safeguard 50 more.

- **Essex mentoring scheme**

This provides free mentoring for manufacturing SMEs and start-ups funded by Essex County Council.

Working with government

www.ifm.eng.cam.ac.uk/services/overview/government

IfM ECS has worked with both the UK Government and with other national and regional governments around the world to understand the opportunities for developing thriving industrial sectors and creating the conditions that will turn new ideas into emerging industries.

PROJECTS INCLUDE:

UK High Value Manufacturing (HVM) Landscape

IfM ECS has been commissioned by Innovate UK to update the HVM landscape study first carried out in 2012. The aim of this new study is to outline High Value Manufacturing opportunities in the UK to inform Government policy for the development of industrial capabilities and competences across key sectors, both nationally and regionally.

Regional studies on the future for high value manufacturing

IfM ECS has carried out two regional studies, one for the Liverpool City Region and one for Swindon and Wiltshire. Both studies were commissioned by the Local Enterprise Partnership for the respective areas.

Quantum technologies roadmap for the UK

Innovate UK asked IfM ECS to run roadmapping workshops to define a vision for the commercialisation of quantum technologies in the UK out to 2040. Researchers from CSTI also worked with EPSRC to review international research priorities for quantum technologies.

Standards for emerging technologies

This review of international approaches to standards development in support of emerging technologies was commissioned by the UK Department of Business, Innovation and Skills and by the British Standards Institution.

International policy workshops

Working with the UK Government, IfM ECS is convening a series of international workshops at which senior government, agency and industrial representatives from the UK – with research input from the IfM – can build closer links with key countries and share lessons and good practices relating to:

- manufacturing policy development
- manufacturing foresight
- manufacturing policy institutions

Workshops have already taken place in India, Japan and the United States.

An industrial strategy for Yucatán

IfM ECS is working with the government of the state of Yucatán, Mexico to develop its industrial strategy. Led by Dr Carlos López-Gómez, from the IfM's Centre for Science, Technology and Innovation Policy, the project aims to define the state's strategic options for industrial growth, job creation and the improvement of its competitiveness as a manufacturing location.

Executive and professional development

www.ifm.eng.cam.ac.uk/executiveeducation

IfM ECS is an experienced provider of executive and professional development offering a range of tailored and open courses based on research carried out at the IfM and developed by educational specialists to deliver real and lasting benefits to organisations.

Our executive education is based on:

- Active research programmes so that delegates get access to the latest thinking from the University of Cambridge in a wide range of manufacturing management areas such as: technology and innovation management, sustainability, global operations networks and service capability.
- An unrivalled understanding of manufacturing industry, the change it is undergoing and the challenges it faces.
- Excellent teaching practice that changes mind-sets and gives delegates a wide range of skills and tools that are immediately applicable in the workplace.
- A proven track record of working with industry both through consultancy and the delivery of education.

TAILORED PROGRAMMES

IfM ECS designs and delivers programmes to meet manufacturing or technological companies' strategic and talent development needs. We offer:

- Short, in-company programmes on a particular theme, typically lasting one to three days.
- Longer programmes of several weeks aimed at talented technology, R&D and manufacturing business specialists who have the potential to take on senior and strategic roles in the company. These are typically delivered in three or four one-week modules over a six month period.

OPEN COURSES

IfM ECS runs a series of successful open courses and workshops covering a range of manufacturing management themes, including:

- Roadmapping – aligning your organisation's strategic and technology objectives
- Visual approaches for strategy and innovation management – using visual design to present management information
- Technology and innovation management – maximising the potential of new technologies
- Technology intelligence – identifying technological opportunities and threats that could affect the future of your business
- Valuing and selecting technology projects – applying tools and techniques to help you choose the right technology projects
- 'Make or buy' – a structured approach to deciding whether to produce in-house or use an outside supplier
- New tools for sustainable businesses – learn where and how to get new and sustainable value from your business
- Making the shift to services – how to design new services and improve existing ones.

OUTREACH

UNIVERSITY OF CAMBRIDGE SCIENCE FESTIVAL

The IfM took part in the University's annual Science Festival once again in March 2015. This highly popular event is now a firm fixture in our annual calendar and we welcomed well over 1,000 children and their parents to the IfM to take part in a wide range of activities. These included tours of the laser labs, seeing water droplets freeze in mid-air and using a laser to power rockets along a line.

Dr Tim Minshall, Reader in Technology and Innovation Management and Head of the Technology Enterprise Group, gave a talk on how engineers make the world a better place, using new technologies such as 3D printing, smartphones and solar energy.

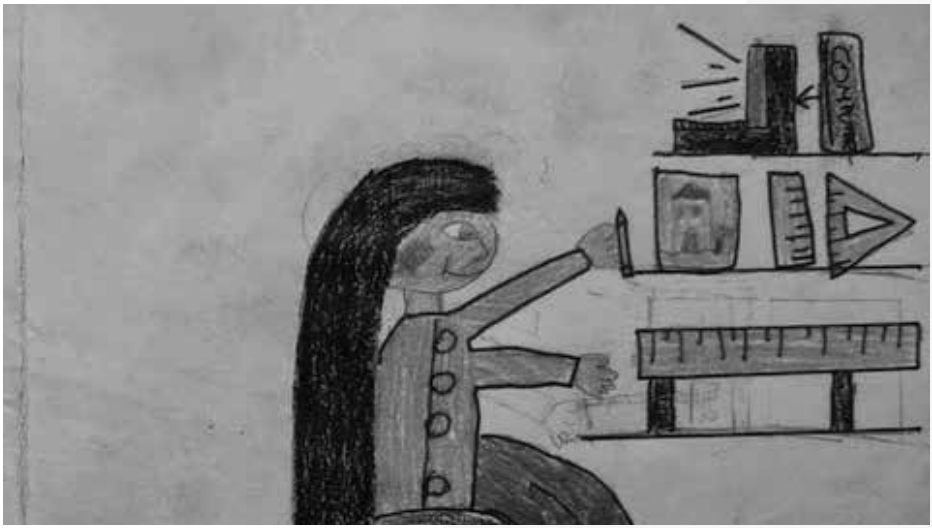
ENGINEERS OF THE FUTURE

A group of 14 and 15-year-olds from Chelmer Valley College in Chelmsford visited the IfM to find out more about the excitement of engineering in a university research environment. The students were challenged to build a load-bearing crane using paper and cardboard tubes.

The students also listened to Tim Minshall talking about 'what engineers really do' before playing 'the JIT game', led by Derek Ford, in which participants apply elements of Just-in-Time manufacturing to better understand this management philosophy.

ENGINEERING IN A CONNECTED WORLD

In March, Tim Minshall gave a TEDX Cambridge talk on how engineers are predisposed to work collaboratively and how new communications technologies are making it easier for them to do so. Other technologies such as 3D printing are also playing their part, with engineers on different sides of the world able to co-develop new solutions to some of the world's most pressing problems.



An engineer at work drawn by a pupil at school in Italy. This is part of an IfM research project comparing how primary school children in different countries perceive engineers.

INSTITUTE FOR MANUFACTURING (IfM)

The IfM is part of the University of Cambridge. It brings together expertise in **management**, **technology** and **policy** to address the full spectrum of issues which can help industry and governments create sustainable economic growth.

Management: covering a wide range of topics including the development of sustainable industrial practice, capturing value from innovation, optimising global operations networks and moving from product to service-based business models. The IfM is an international centre of excellence for roadmapping, a powerful technique for aligning business and technology objectives.

Technology: including inkjet and laser-based manufacturing process technologies, carbon nanomaterials, advanced information systems and automated identification technologies, all with a wide range of industrial applications.

Policy: programmes, processes and practices for translating publicly-funded R&D (in particular science and engineering research) into new technologies, industries and economic wealth.

In each of these areas of expertise, the IfM carries out:

Research: bringing together specialists in management, technology and policy to provide a unique perspective on the challenges facing manufacturers of all sizes, from start-ups to multinationals.

Education: giving the next generation of manufacturing leaders a thorough grounding in management and manufacturing technologies, based on real industrial experience.

Practice: working with industry and government to put IfM research into practice and to inform future research activities.

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