

The Manufacturing Engineering Centre Cardiff School of Engineering Cardiff University

Queen's Buildings
The Parade
Newport Road
Cardiff CF24 3AA, UK

www.mec.cf.ac.uk



CENTRES OF EXCELLENCE
CANOLFANNAU RHAGORIAETH

Dr. Michael S Packianather
PackianatherMS@cf.ac.uk



**SEAMEO Regional Training Center (SEAMEO RETRAC),
35 Le Thanh Ton, Dist 1, Ho Chi Minh City, Vietnam.**

Presentation Outline

- Introduction
- Specialist Areas
- Examples of Research Projects / Activities
- Management Structure
- External Funding
- Examples of Research Products
- Facilities Available for Research and Industry
- Postgraduate Research
- Links with Vietnam
- MEC video & Quotes

The Manufacturing Engineering Centre

Director: Professor D.T. Pham OBE,
FREng, FSME, BE, PhD, DEng, CEng, FIEE
awarded with the Freedom of the City of London
for his work with industry in 2004.



Operations Director:
Prof. Stefan Dimov Dipl.Eng, PhD



Director of Postgraduate Research
Studies: Dr Michael Packianather
BSc(Hons), MSc, PhD, CEng, MIET

Introduction: General

- **Mission:** To conduct world-class research and development in key areas of Advanced Manufacturing and use the output to assist industry
- R&D (Basic and Strategic Research, Applied research and Technology Transfer), PhD training, and ISO 9001:2000 accredited industrial consultancy and technology transfer
- **WAG** Centre of Excellence in Technology and Industrial Collaboration
- Founding partner in the **EPSRC** Innovative Manufacturing Research Centre at Cardiff University
- The Queen's Anniversary Prize and the Secretary of State's First Prize

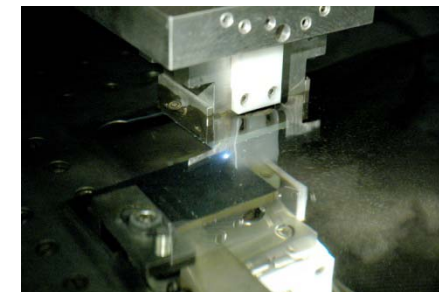
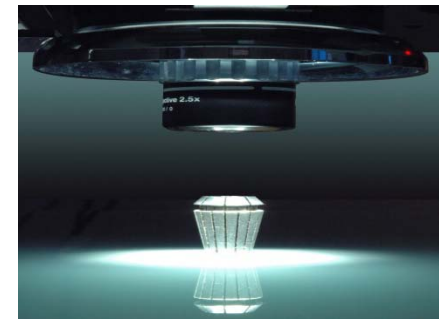


Introduction: Location



Introduction: Statistics

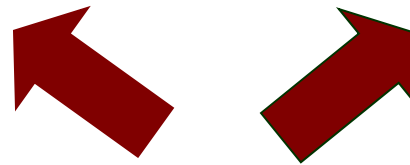
- 40-50 full-time engineers and researchers
- Active customer base of over **3000 companies**
 - 5000 projects undertaken since 1996
 - Partnership with 8 multinational corporations
- Income totaling > £60M
 - Research grants £30M (45 projects)
 - Industrial Matched funding £15M
 - Commercial income £10M



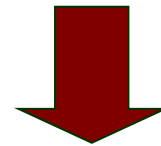
Specialist Areas

Manufacturing Engineering

- Advanced Manufacturing
- Micro/Nano-Manufacture
- Rapid Manufacturing



Management



Systems Engineering

- Intelligent Manufacturing
- Inspection and Quality
- Intelligent Control

Industrial Engineering

- Operations Management
- Concurrent Engineering
- ICT in Manufacture

Examples of Research Projects

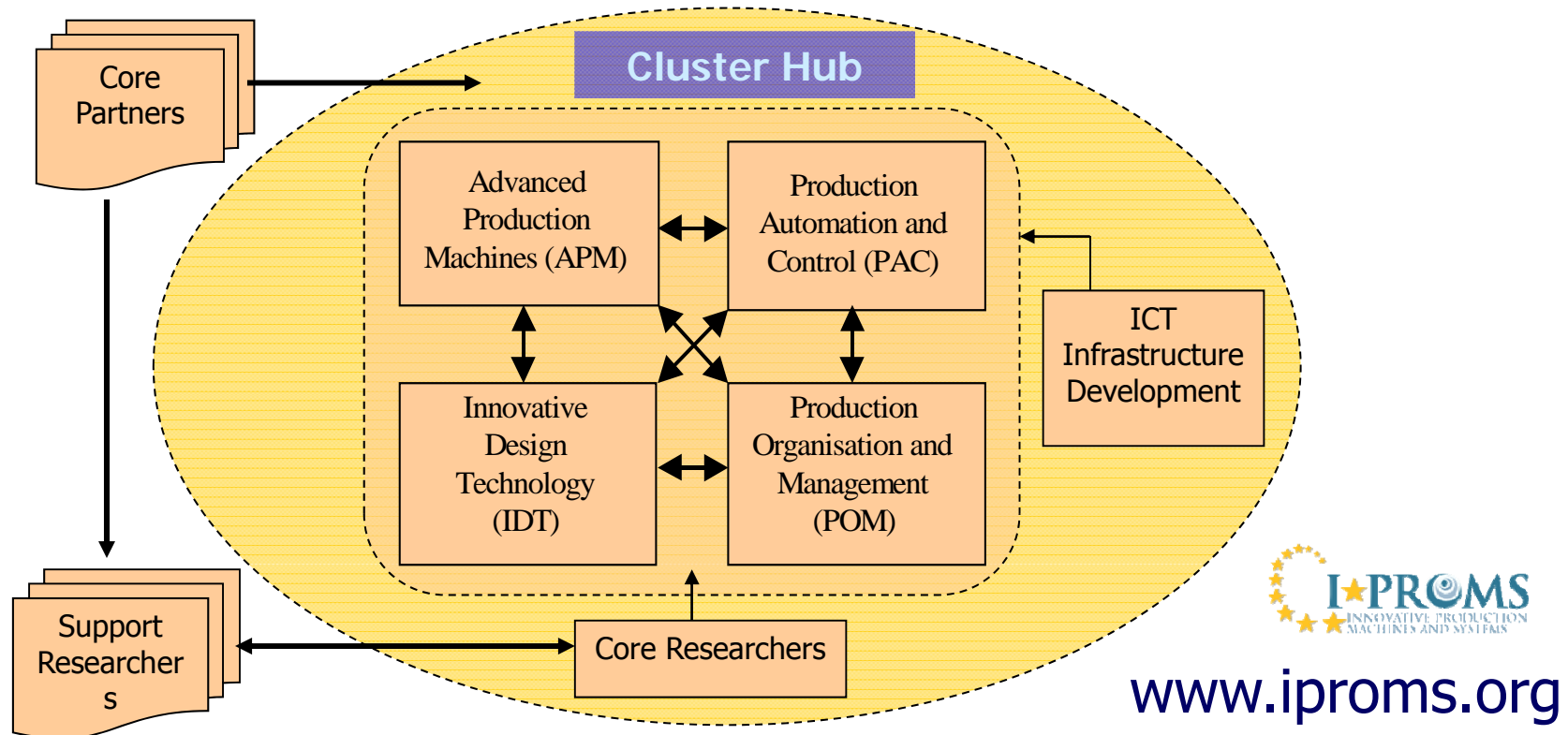
- Flexible Tooling for the manufacture of free-form architectural cladding and façades (FlexiTool)
- Development of Lithography Technology for Nanoscale Structuring of Materials Using Laser Beam Interference (DELILA)
- Surface Enhanced Micro Optical Fluidic Systems (SEMOfS)
- Improvement of the Emergency Risk Management Through Secure Mobile Mechatronic Support to Bomb Disposal (RESCUER)
- Multi-Role Shadow Robotic System for Independent Living (SRS)
- Hybrid ultra precision manufacturing process based on positional-and self-assembly for complex micro-products (HYDROMEL)
- Robotic Physiotherapy Supporting Rehabilitation of Disabled using Industrial Robots for Upper Limb Motion Therapy (REHAROB)
- Bees Algorithm: Nature-inspired Optimisation Techniques (BA)

Examples of Research Projects: I*PROMS and 4M

- In 2004 the EC awarded 14 NoE
 - Of these the UK was awarded 3
 - MEC won 2 of the 3
 - MEC is engaged in 7 major European research projects.
- Innovative Production Machines and Systems (**I*PROMS**)
 - 30 core partners from 14 countries
- Multi-Material Micro Manufacture (**4M**)
 - 30 partners from 15 countries
- € 7.5M each, over 4-5 years

Research Project: I*PROMS

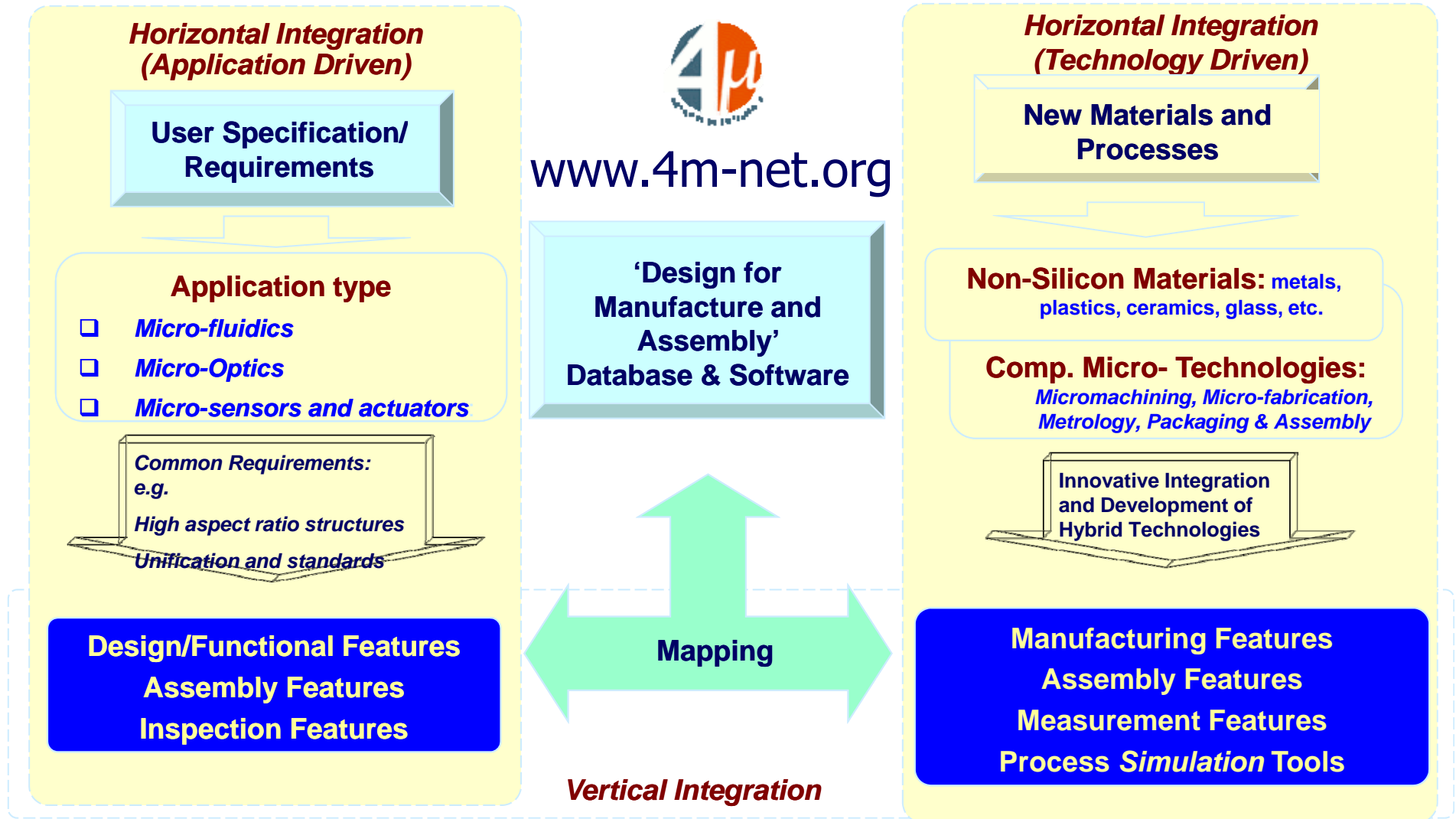
Innovative Production Machines and Systems (I*PROMS) – Co-ordinator: MEC



I = Innovative, intelligent, individualised*

*I*PROMS: umbrella network covering the whole area of knowledge-based technology and organisation*

Research Project: 4M



Multi-Material Micro Manufacture (4M) - Co-ordinator: MEC



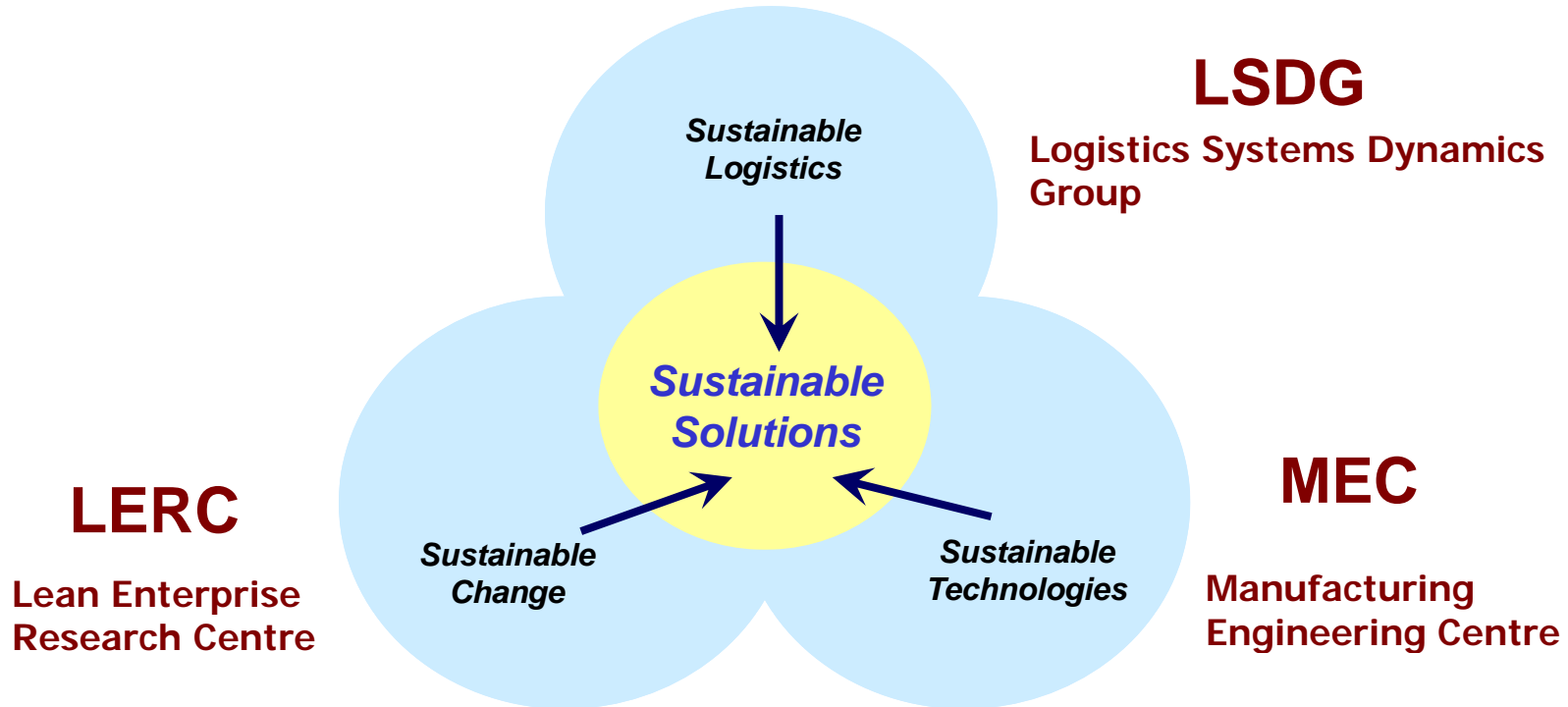
Research Projects: IPROMS & 4M Conferences

- I*PROMS - Innovative Production Machines and Systems
(for more information go to - <http://www.iproms.org/>) Conferences
 - Location: World Wide Web
 - 500,000 participants from 78 countries
 - Nobody used an airline or got into their car – ZEROISH CARBON FOOTPRINT - **the greenest conference on Earth!**
- IPROMS 2010: 15–26 Nov 2010 on the *world wide web!*
- IPROMS 2011: 14–25 Nov 2011 on the *world wide web!*
- 4M - Multi-Material Micro Manufacture
(for more information go to - <http://www.4m-net.org/>) Conferences
- 4M2010 Conference: 17-19 Nov 2010, Oyonnax, France.
- 4M2011 Conference: 8-10 Nov 2011, Stuttgart, Germany.



Research Project: CUIMRC

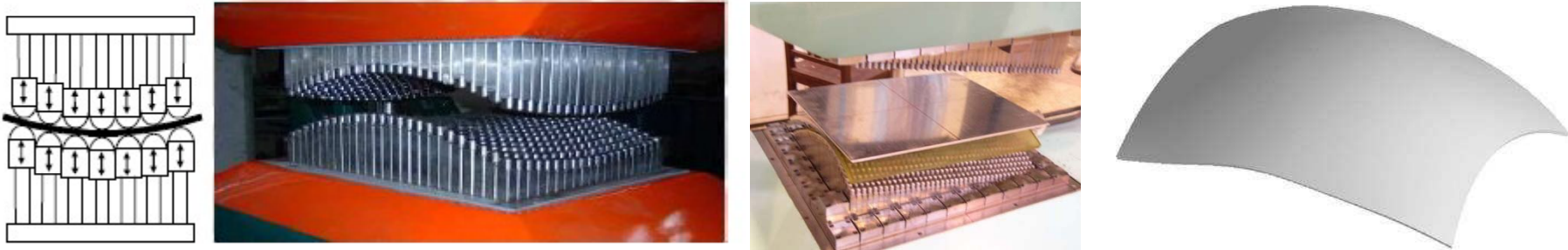
CU Innovative Manufacturing Research Centre: MEC & CARBS



CUIMRC aims to assist in the evolution of the UK Manufacturing sector by the provision of sustainable solutions research focussed on the critically interrelated areas of business change, logistics and advanced manufacturing technologies, through the integration of wide ranging sets of complementary business and engineering capabilities.

Research Project: FlexiTool

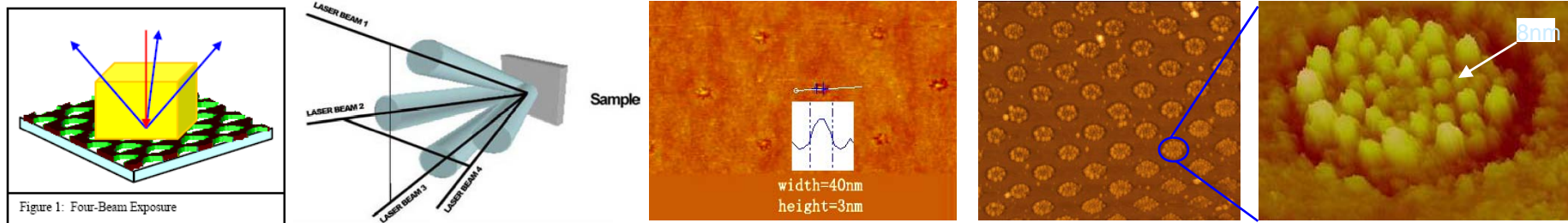
Flexible Tooling for the manufacture of free-form architectural cladding and façades (FlexiTool): Co-ordinator MEC



The project focuses on development of a digitally controlled variable geometry tooling and implantation market for manufacture of 3D architectural panels in high performance composites for the construction industry.

Research Project: DELILA

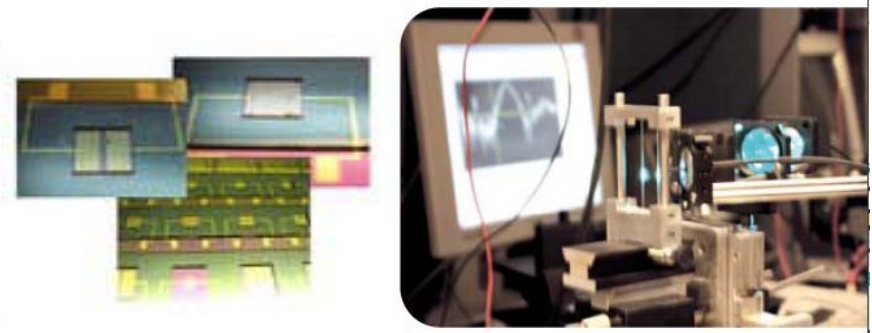
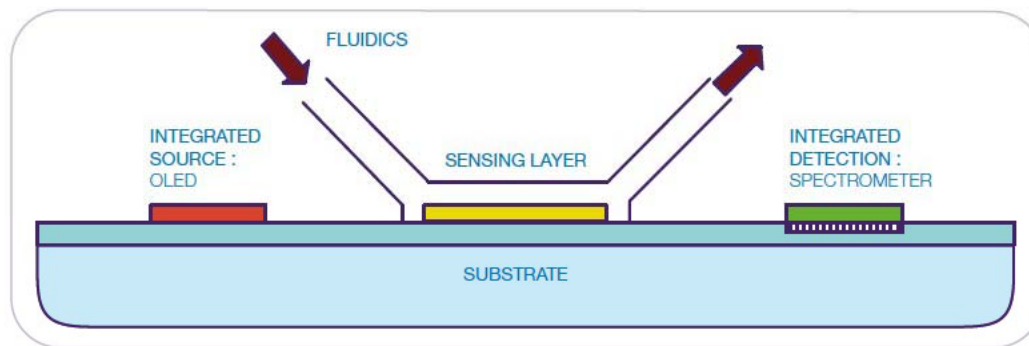
Development of Lithography Technology for Nanoscale Structuring of Materials Using Laser Beam Interference (DELILA): Co-ordinator MEC



The aim of DELILA is the development and application of multiple beam interference lithography technology for nanoscale 2D and 3D structuring of materials in nano photonics, electronics and fabrication.

Research Project: SEMOFS

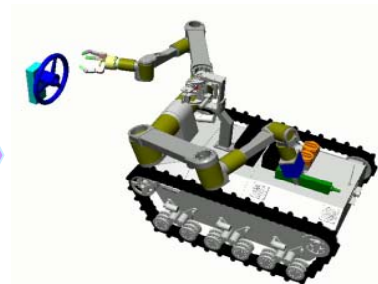
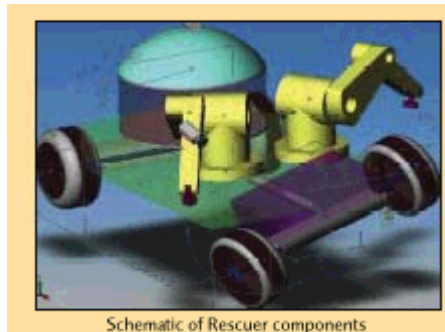
Surface Enhanced Micro Optical Fluidic Systems (SEMOFS)



The aim of SEMOFS project is to carry out research at the frontier of knowledge for the development of a next generation of biosensor: a polymer-based card type integrated solution of "Plasmonics enhanced SPR"-sensor.

Research Project: RESCUER

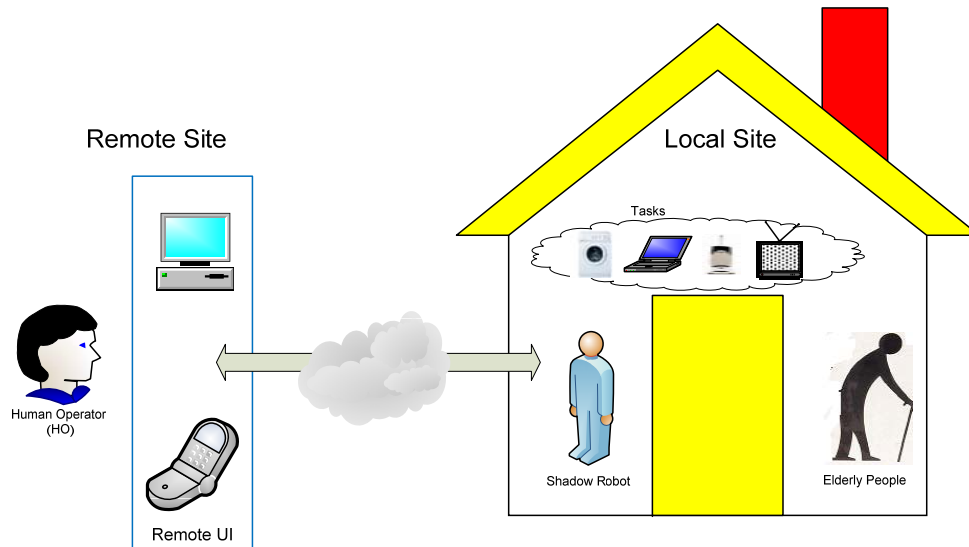
Improvement of the Emergency Risk Management through Secure Mobile Mechatronic Support to Bomb Disposal (RESCUER)



The RESCUER project focuses on the development of an intelligent Information and Communication Technology and mechatronic Emergency Risk Management tool and on testing it in five Improvised Explosive Device Disposal, and Civil Protection Rescue Mission scenarios.

Research Project: SRS

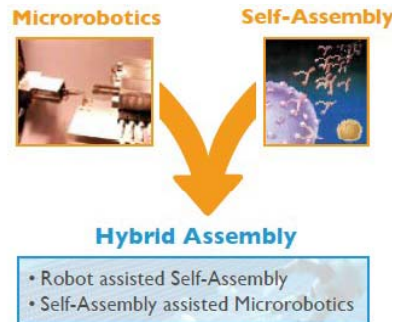
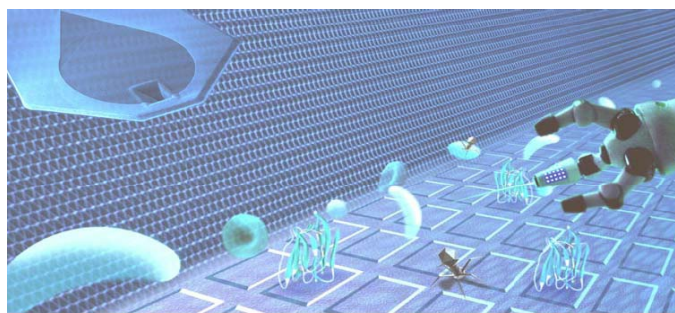
Multi-Role Shadow Robotic System for Independent Living (SRS): Co-ordinator MEC



The project focuses on the development and prototyping of remotely-controlled, semi-autonomous robotic solutions in domestic environments to *support* elderly people. In particular, *the SRS project* will demonstrate *an innovative, practical and efficient system called "SRS robot" for personalised home care.*

Research Project: HYDROMEL

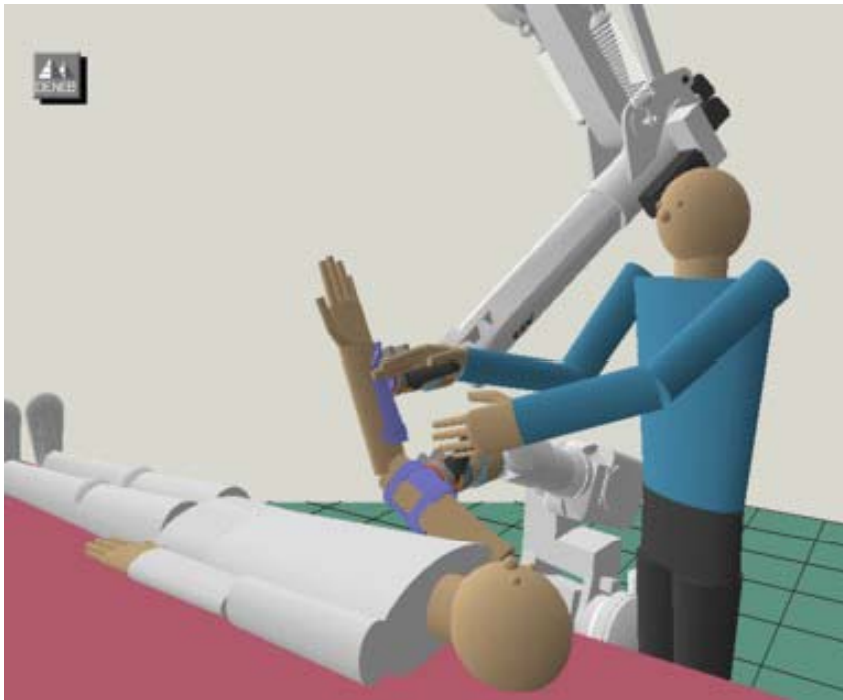
Hybrid ultra precision manufacturing process based on positional- and self-assembly for complex micro-products (HYDROMEL)



HYDROMEL aims at developing a technology platform for hybrid assembly in order to develop new versatile 3D automated production systems for complex micro-devices through the innovative combination of micro-robotics and self-assembly.

Research Project: REHAROB

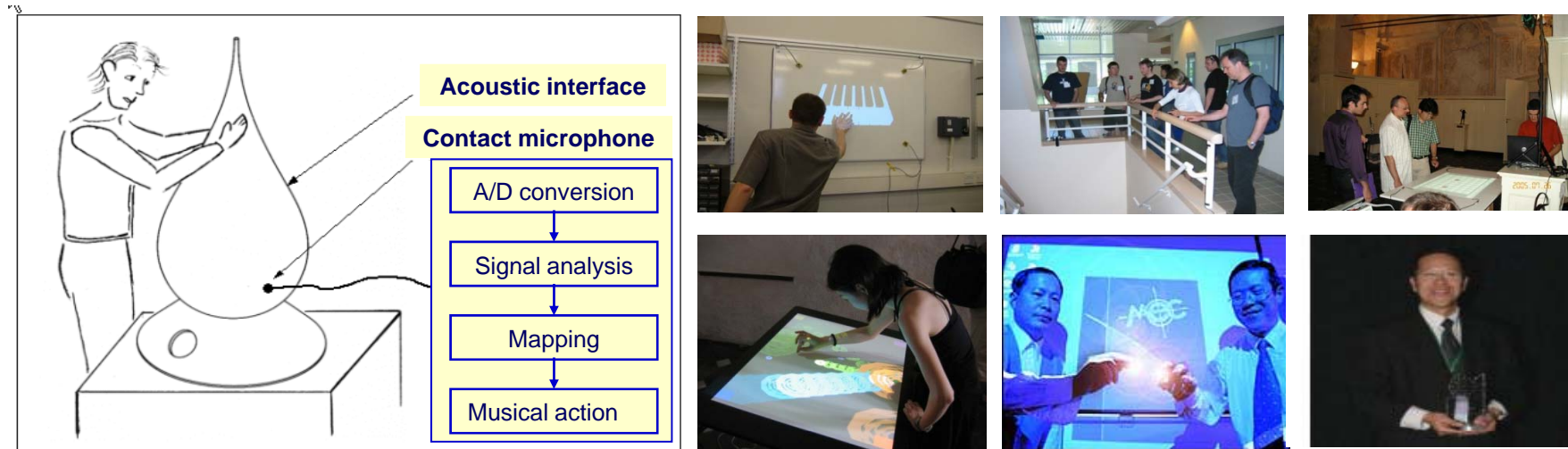
Supporting rehabilitation of disabled using industrial robots for upper limb motion therapy (REHAROB)



The aim of REHAROB is to provide personalised, three-dimensional motion therapy for patients with neuro-motor impairments. REHAROB is a robotic rehabilitation system for upper limb motion therapy for the disabled. The therapy will be driven by industrial robots utilising intelligent identification of the required physiotherapy motions.

Research Project: TAI-CHI

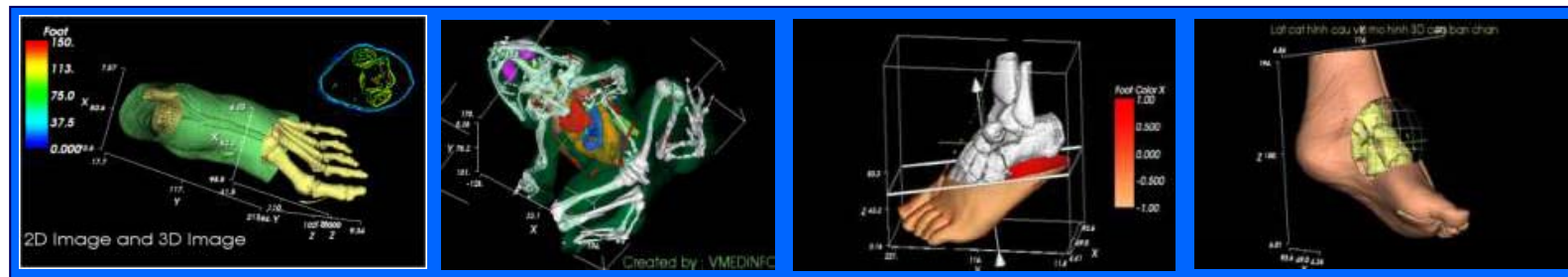
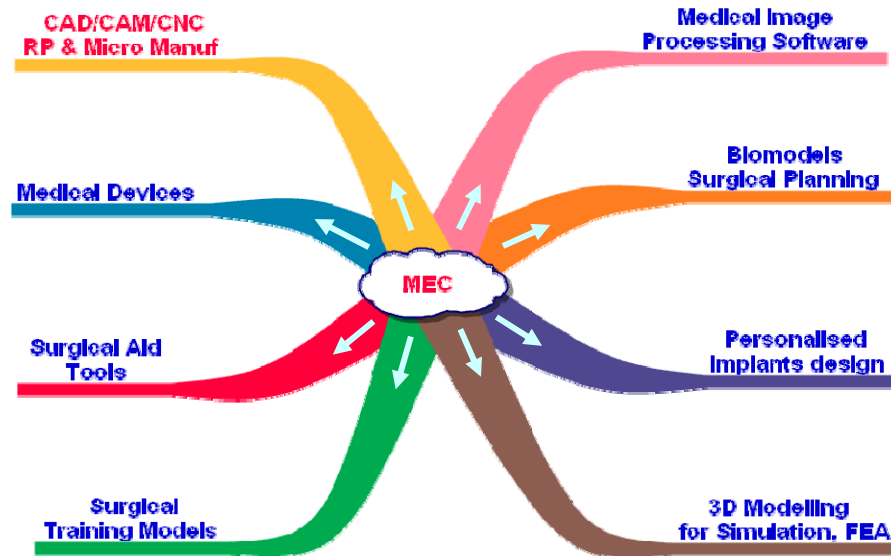
Tangible Acoustic Interfaces for Computer-Human Interaction (TAI-CHI): Co-ordinator MEC



The main goal of Tai-Chi project is to develop acoustics-based remote sensing technologies which can be adapted to virtually any physical object to create tangible interfaces, allowing the user to communicate more freely with a computer, an interactive system or the cyber-world.

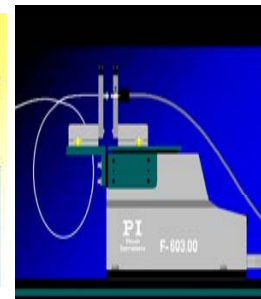
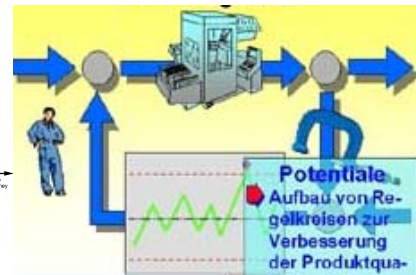
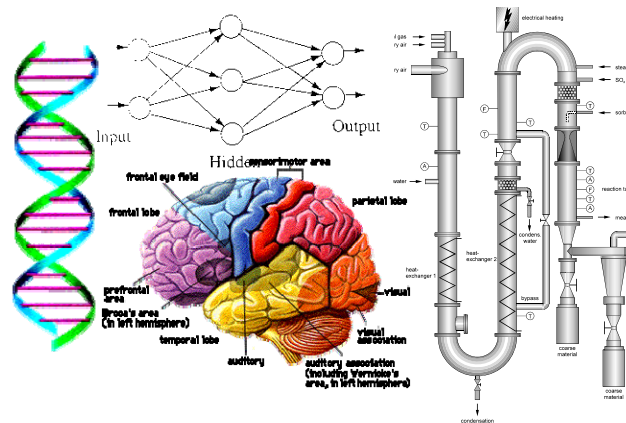
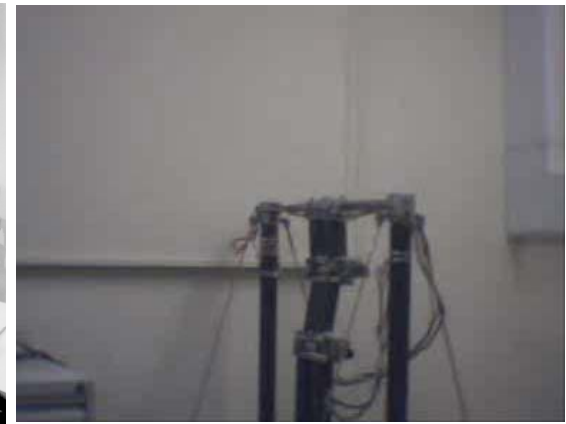
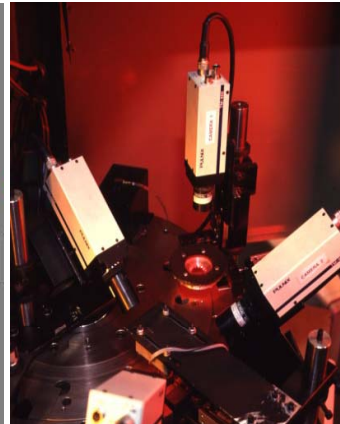
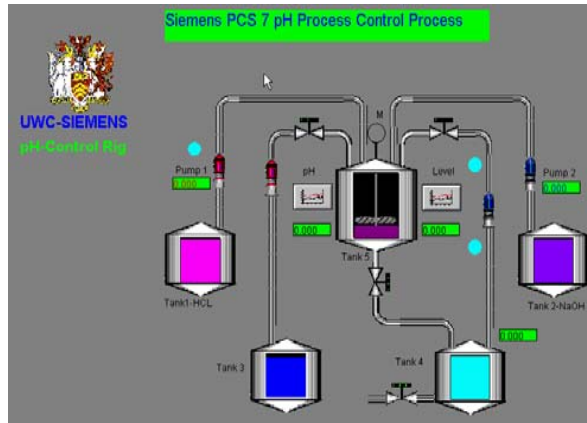
Tai-Chi project wins Best Exhibit prize at IST 2006

Research Activities: Manufacturing Engineering



- Rapid manufacturing, Rapid prototyping and Rapid tooling
- Reverse engineering
- Micro manufacturing
- Nanotechnology

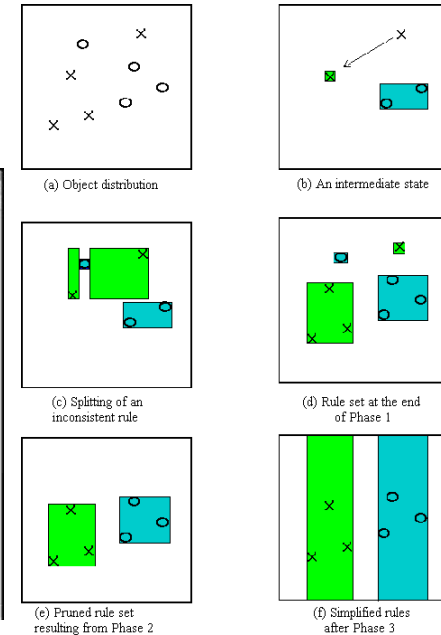
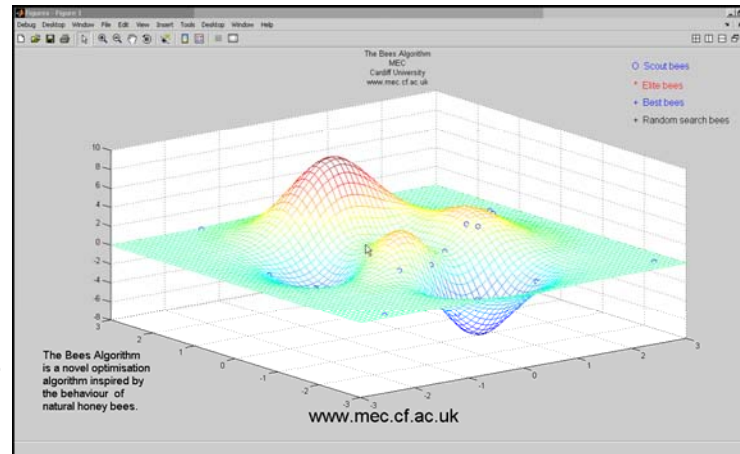
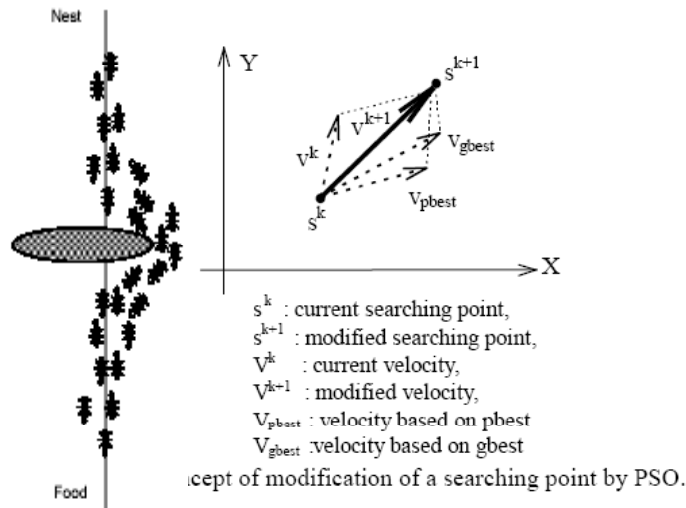
Research Activities: Systems Engineering



- Intelligent process modelling and control systems
- Intelligent information systems
- Intelligent manufacturing
- Intelligent systems techniques
- Mobile robots and mechatronics

- Data mining, neural networks and machine learning
- Genetic algorithm, ant algorithm and bees algorithm
- Fuzzy Logic

Research Activities: Industrial Engineering



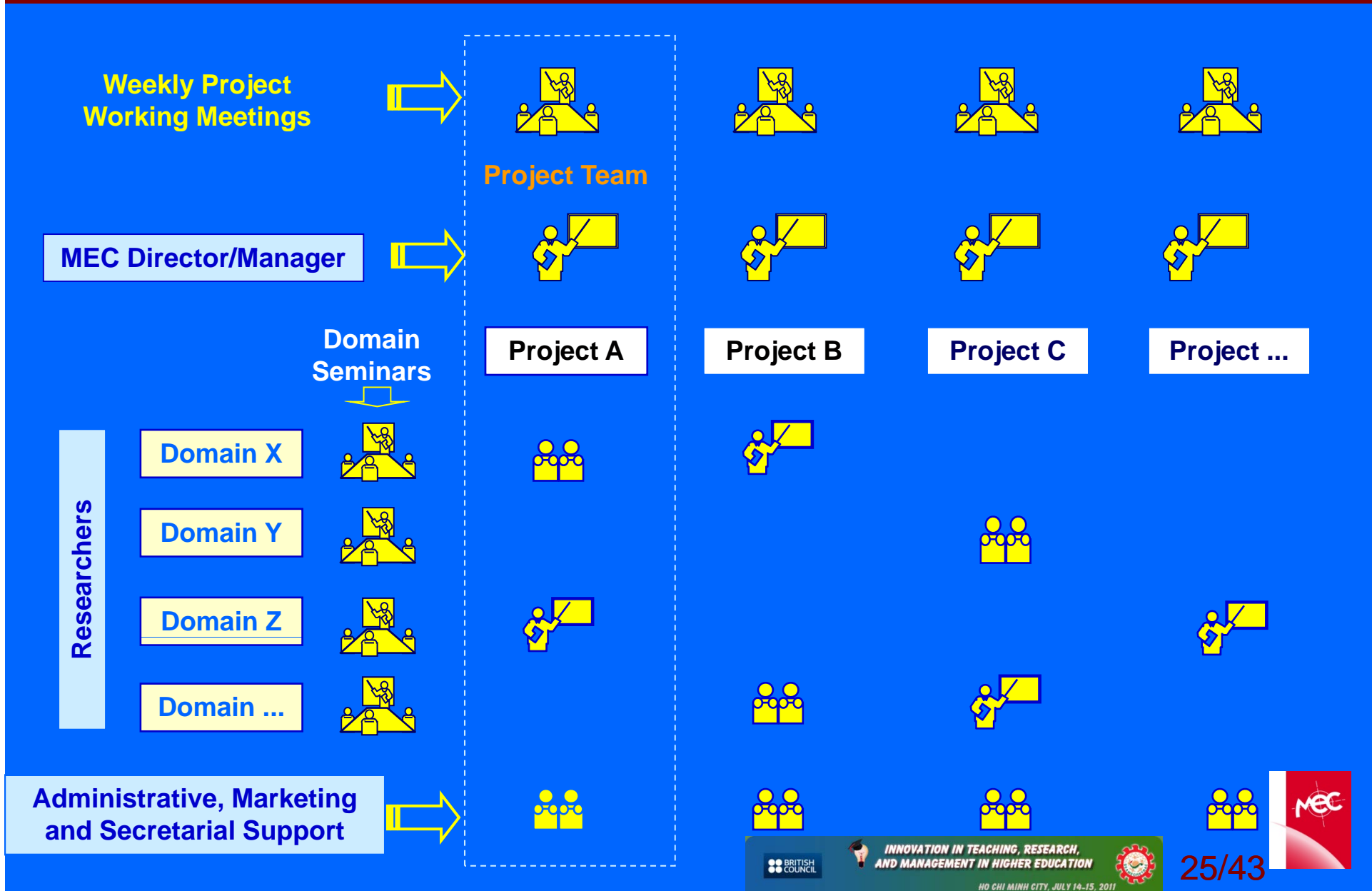
ANTS PSO

BEES

RULES family

- Concurrent engineering
- Workflow management
- Innovative design
- Data mining and machine learning
- Genetic algorithm, ant algorithm and bees algorithm
- Fit manufacturing and Sustainable manufacturing

Management Structure



External Funding: National

PROJECT	DURATION	FUNDING BODY
Astute - Advanced Sustainable Manufacturing Technology (ASTUTE)	05/10-04/15	WEFO
Development of a combinatorial Smart Matrix pro-angiogenic scaffold with micro-structured silicone backing for full thickness skin reconstruction.	07/10-03/11	TSB
Laser rapid prototyping and tooling solutions (LRPTOOL)	10/09-09/10	WAG (A4B)
Expansion of the MEC Micro and Nano Manufacturing Facilities	12/08-03/10	WAG (A4B)
Facilities for Micro-Machining and Micro Fabrication of Non-Silicon Components (MicroBridge)	09/05-08/10	WAG, DTI, MNT
Centres of Excellence (CoE)	06/04–05/07	WAG
Tooling for Non-Silicon Micro Components (μ Tooling)	01/05–12/07	EPSRC
Innovative Manufacturing Research Centre (IMRC)	01/04–12/08	EPSRC
Supporting Innovative Product Engineering and Responsive Manufacturing (SUPERMAN-II)	01/05-12/07	ERDF, Obj. 2



External Funding: EC

PROJECT	DURATION	FUNDING BODY
Flexible Tooling for the manufacture of free-form architectural cladding and façades (FlexiTool)	10/10-09/12	EC FP7, SME
Flexible Compression Injection Moulding Platform for Multi-scale Surface Structures (IMPRESS)	05/10–04/13	EC FP7, NMP
Multi-Role Shadow Robotic System for Independent Living (SRS)	02/10–01/13	EC FP7, ICT
Printable, Organic and Large-Area Realisation of Integrated Circuits (POLARIC)	01/10–12/13	EC FP7, NMP
Integrating European research infrastructures for the micro-nano fabrication of functional structures and devices out of a knowledge-based multimaterials' repertoire (EUMINAFab)	03/09-02/13	EC FP7, Infrastructure Programme
STREP: Tangible acoustic interfaces for computer human interaction - TAI CHI	01/04–12/06	EC FP6, IST
NoE: Multi Material Micro Manufacture (4M)	10/04–09/08	EC FP6, NMP
NoE: Innovative Production Machines and Systems (I-PROMS)	10/04–09/08	EC FP6, NMP



External Funding: Gov/Industry

PROJECT	DURATION	FUNDING BODY
Simulation and optimisation for Ford Bridgend	09/10-08/12	KTP & FORD
Development of a combinatorial Smart Matrix pro-angiogenic scaffold with micro-structured silicone backing for full thickness skin reconstruction	07/10-03/11	TSB & ALTRIKA LTD
U tooling for non-silicon micro components	06/05-07/09	Various Industries
Mass customised collaborative logistics for sustainable manufacture	08/04-07/09	Various Industries
Venturing Wales (VW)	05/06–06/08	Parametric Technology Corporation
Supporting Innovative Product Engineering and Responsive Manufacture	07/01-01/04	Various Industries

External Funding For Research Projects: Royal Society & British Council

PROJECT	DURATION	FUNDING BODY
Distinguished visiting fellowship scheme 2	10/09-31/12	The Royal Academy of Engineering
Distinguished visiting fellowship scheme 1	05/09-12/09	The Royal Academy of Engineering
3D human body modelling for medical and engineering applications	06/04-05/11	Royal Society
Nano-image processing and control techniques in Nanoassembly	07/04-06/06	British Council

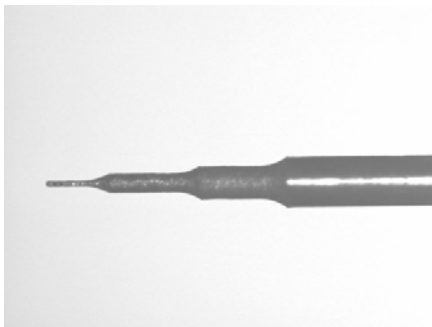
Examples of Research Products: Fishing Line & Electrode



Micro and nano engineering and fabrication in non-silicon materials.



A revolutionary fishing line for fly fishing. The line allows the angler to cast further and with greater control and accuracy than with traditional lines.



The smallest electrode (0.006 mm diameter) – Guinness world record.

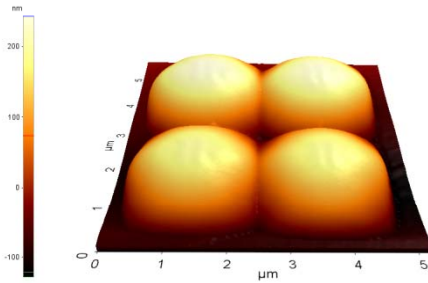
THIS IS A WORLD FIRST



Examples of Research Products: Moth-Eye Lens



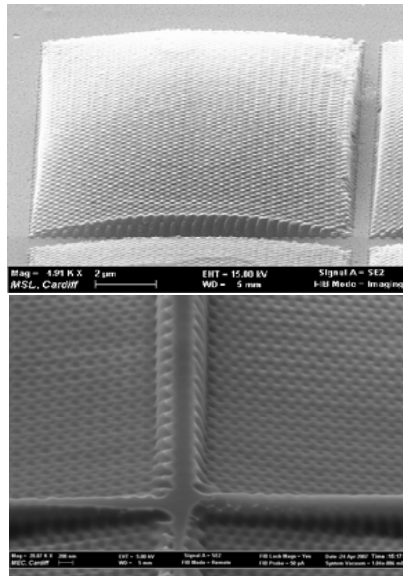
Micro and nano engineering and fabrication in non-silicon materials.



File Name	lens2 cropped
Head Mode	HC-AFM
Source	Topography
Data Width	168 (pts)
Data Height	168 (pts)
X Scan Size	5.18 (µm)
Y Scan Size	5.18 (µm)
Scan Rate	0.5 (Hz)
Set Point	-1.2 (µm)
Data Gain	-120.54E-6 (µm/step)

AFM image of a Step and Flash imprint lithography structure for Moth-eye lens

The structures on the surface of the new lens are less than 100 nanometres in height. They need to be smaller than the wavelength of light to avoid disrupting the light as it enters the lens.

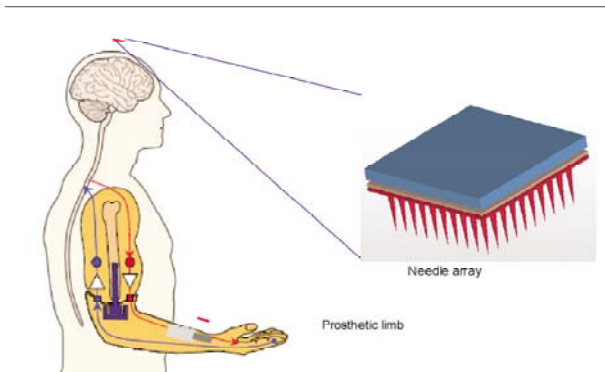


The MEC is looking at using the lens in optoelectronics and photovoltaic applications in semiconductors, including solar cells, where loss of light is a major problem. The lens also has potential uses in fibre optics, sensors and medical diagnostic devices.

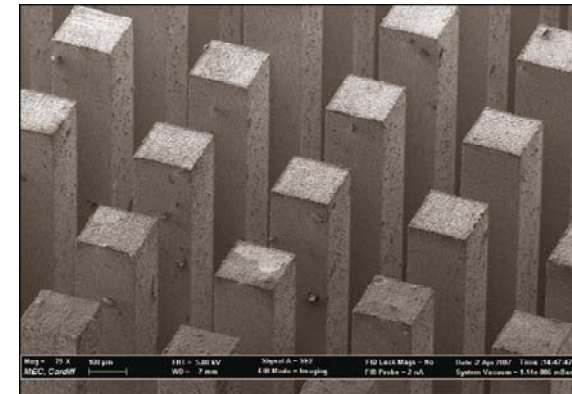
THIS IS A WORLD FIRST



Examples of Research Products: Man/Machine Interface



MAN/MACHINE INTERFACE AND PROSTHETIC LIMB CONTROL SYSTEM.



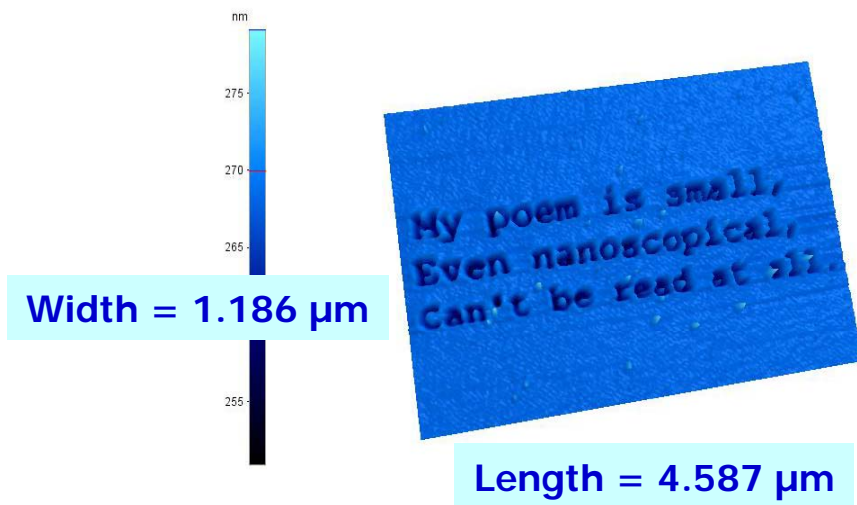
ARRAY OF NEEDLES, EACH 120 MICRONS WIDTH, AS SUPPLIED TO UTAH UNIVERSITY.

Researchers at Utah University and the MEC have been developing a multiple-needle brain implant which is inserted into patients brains in an area of the brain responsible for motor function.

Examples of Research Products: Nanotechnology (Haiku)

The area of the haiku is 300 times smaller than the cross section of a human hair (Human hair diameter $\approx 100 \mu\text{m}$)

Did you spot anything?



File Name	070416032004 cropped
Head Mode	C-AFM
Source	Topography
Data Width	226 (pxl)
Data Height	152 (pxl)
X Scan Size	5.94 (μm)
Y Scan Size	3.99 (μm)
Scan Rate	0.5 (Hz)
Set Point	20.01 (mN)
Data Gain	-126.54E-6 ($\mu\text{m}/\text{step}$)

This haiku was written by Miss. Kim Pham.

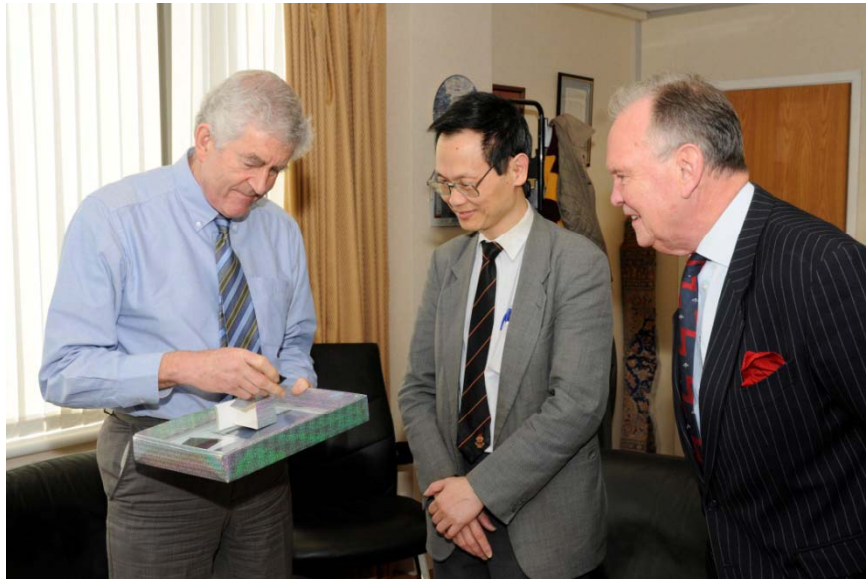
Dimension of each letter = 164.3 x 164.3 nm

The smallest haiku carved onto the point of a needle

THIS IS A WORLD FIRST

Examples of Research Products: Nanotechnology (Haiku)

The Purest Gold on Earth!



The Haiku was presented to the FM on 20 November 2009.

The haiku is in fact written 4 times on the surface of the plaque – three are readable through the lens but the fourth is so tiny it can't be read at all except with a scanning electron microscope. The Haiku is :

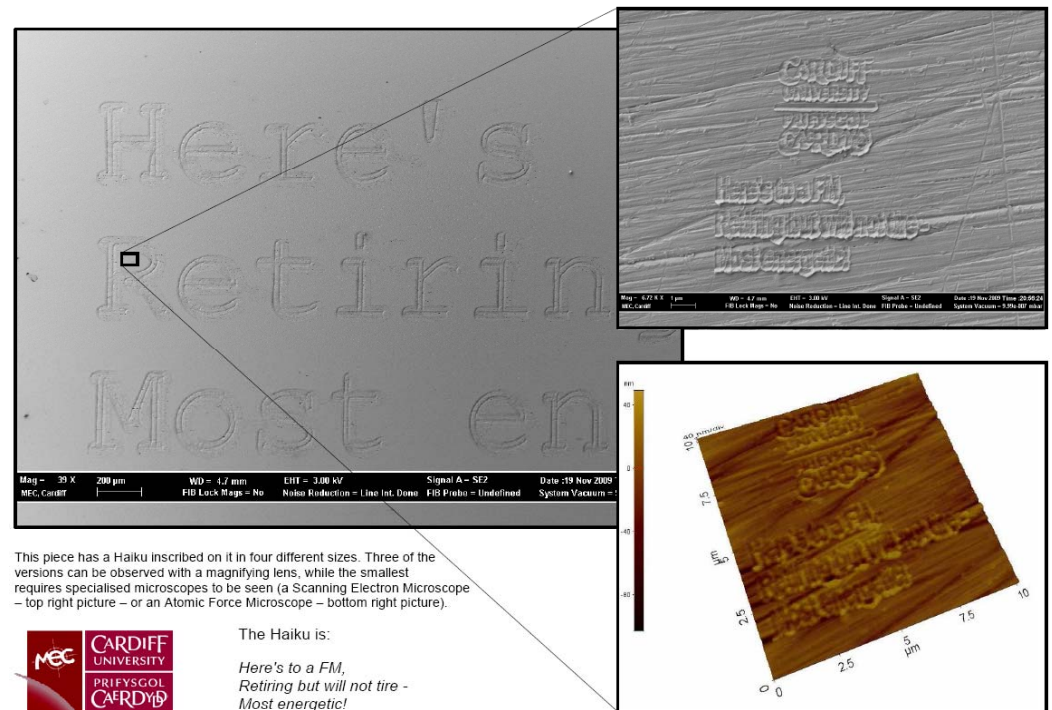
microscope. The Haiku is :

Here's to a FM

Retiring but will not tire –

Most energetic !

It is a small plaque which has inscribed on its surface, using Lasers and an Atomic Force Microscope, a tiny Haiku which was written by Kim Pham. The plaque was then finished in gold using a Sputtering machine. The thickness of the gold is 110 nanometers. It is approximately 99.9% and represents the purest sample of gold on Earth!



Examples of Research Products: Recent World First Achievements

- The smallest electrode (0.006 mm diameter) – Guinness world record
- The smallest haiku carved onto the point of a needle
- The high pressure laboratory for maintaining the life of bacteria and other creatures from 1500 m below the ocean bed in the Gulf of Mexico (1000 atmospheres)
- The moth-eye lens
- The thinnest metal casting (0.22 mm)
- The Beyond Lean “Fit Manufacturing” Paradigm
- The RULES family of inductive learning algorithm
- The Bees Algorithm a swarm-based optimisation technique

Facilities Available For Research and Industry

HIGH SPEED MACHINING CNC
MICRO MILLING
LASER MILLING
WIRE EDM
MICRO EDM
SLA
SLS
RAPID INVESTMENT CASTING
MICRO INJECTION MOULDING
HOT EMBOSSING
CMM
QUICK VISION
WHITE LIGHT INTERFEROMETER

Recent acquisitions in Nanotechnology

- Dual Beam, Focused Ion Beam Machine
- Pico & Nano second Laser Ablation system
- SEM (scanning electron microscope)
- Nano Imprint Lithography (NIL)
- AFM (Atomic Force Microscope)



MICRO EDM



QUICK VISION

Postgraduate Research

Doctoral Students: 30
 PhD Supervisors: 6
 RAE Rating: 5



New Taught course: MSc Advanced Mechanical Engineering

Application Information
<p>Entry Requirements: Normally an upper second class Honours degree (or equivalent) from a British or recognised overseas university. Minimum requirements for English language are IELTS 6.5, TOEFL 600 (iBT 90).</p>
<p>Awards: Research Programmes lead to a doctoral (PhD) award or a research Masters (MPhil) degree.</p>
<p>Duration: PhD full-time three years; MPhil full-time one to two years. Part-time opportunities are available.</p>
<p>Start Date: Entry for PhD/MPhil students is fixed at four points: 1st January, 1st April, 1st July and 1st October each year.</p>
<p>Number of Places: 30</p>
<p>Funding: Funding for research is provided by the Research Councils, Government Agencies, Industry and Overseas Governments. The MEC funds a limited number of research scholarships. Eligible applicants will be considered on the basis of their research application form.</p>
<p>Assessment: The results of research are presented in a thesis and by oral examination (viva-voce).</p>
<p>Application Process: Applications for most postgraduate programmes can now be submitted online</p>

i	Contact Details
<p>The Research Office</p> <p>Tel: +44 (0)29 2087 4642</p> <p>Fax: +44 (0)29 2087 5902</p> <p>Email: engineering-pgr@cardiff.ac.uk</p>	
<p>www.cardiff.ac.uk/engin</p>	

www.mec.engineering.cf.ac.uk/research

www.engineering.cf.ac.uk/research



Links with Vietnam

Vietnamese Ambassador's visit to the MEC–27 Sept 2006



HE. Mr. Trinh Duc Du, Vietnamese Ambassador to the UK (left)

Professor. Duc Truong Pham, Director of the MEC (right)

Mr. Nguyen Chinh Phong, First Secretary

Mr. Duong Hai Hung, Third Secretary

Other distinguished guests from Vietnam visiting the MEC–13 Nov 2007

Dr. Dao Quoc Tri, Director,

Information security Commission, Personnel department, Vietnam.

Dr. Ho Van Huong, Director,

Socio-economic information security centre, Vietnam.

Dr. Tran Van Huong, Director,

Investment & Planning Ministry, Personnel department, Vietnam.

Dr. Phung Duy Hung, PECEPE,

Ministry of Education and Training, Vietnam.

Links with Vietnam

Nha Trang University delegation's visit to the MEC-26 Nov 2009

Dr. Vu Van Xung, Rector

Prof. Nguyen Van Ba, Vice Rector

Dr. Tran Danh Giang, Manager of the Training Dept.

Mr. Phan Thanh Liem, Manager of the Human Resources Dept.

Mr. Nguyen Tien Hoa, Manager of the Student Affairs Dept.

Dr. Trang Si Trung, Coordinator SRV2701 Project

Mrs. Tran Thi Mai Hoa, Staff of the Faculty of Aquaculture

Mrs. Tran Thi Thu Huong, Staff of the Faculty of Basic Sciences

Mrs. Nguyen T Minh Tam, Lecturer in the Political Science Dept.



Dr. Chi Hieu Le addressing the delegates during the tour of the MEC

From l to r: Dr. Tran Danh Giang, Mrs. Tran Thi Thu Huong, Dr. Trang Si Trung, Mr. Phan Thanh Liem, Dr Vu Van Xung, Mrs. Tran Thi Mai Hoa, Prof. Nguyen Van Ba, Mrs. Nguyen T Minh Tam, Mr. Nguyen Tien Hoa, and Mr. Pham Dinh Trung

Links with Vietnam

Researchers from Vietnam visiting / studying / working at the MEC



Mrs. Paulette Pham (left), Professor Duc Truong Pham (middle) and Miss. Kim Pham (right)

Mrs. Paulette Pham, MEC, Cardiff School of Engineering, UK.

Dr. Nguyen Duc Cuong – School of Computer Science & Engineering, International University, HCMC, Vietnam .

Mr. Pham Dinh Trung, MEC, Cardiff School of Engineering, UK - Nha Trang University, Vietnam.

Dr. Chi Hieu Le - Engineering Systems, School of Engineering, University of Greenwich, UK.

Dr. Q. Tuan Pham - School of Chemical Sciences and Engineering, University of New South Wales, Sydney, Australia.

MEC Video



A short video introducing the MEC and highlighting the activities and achievements.



Quotes

Quote- First Minister, Rt.Hon. Rhodri Morgan AM, Wales

"We have long recognised the powerful and increasing contribution the MEC makes to the competitiveness of business, I commend the MEC on the impressive work in all departments."

Quote- Mr Atushi Inoue, Director General of Japanese External Trade Organisation (JETRO), London

"I was most impressed by this brilliantly equipped centre, with its wide variety of innovative machines and excellent staff."

Quote- Mr John Griffiths AM, Wales, Deputy Minister for Skills

"The work being undertaken at ME is extremely impressive. It is fantastic to see a Welsh institution leading the way in scientific and technological research both here in the UK and internationally."

Quote- HE Mr Trinh Duc Du, Ambassador of Vietnam in the UK

"We were delighted with the interesting and helpful discussions with Cardiff University and the Manufacturing Engineering Centre which helped to explore the possible opportunities for cooperation in the area of university education."

The MEC

“International R&D Centre of Excellence for Advanced Manufacturing and Information Technology”



Thank you!