The University of Nottingham

UNITED KINGDOM • CHINA • MALAYSIA

Engineering Research
The University of Nottingham Malaysia Campus

www.nottingham.edu.my/engineering/research

Contents

The three University of Nottingham international campuses (Malaysia, China and the UK) are committed to carrying out world-leading research. Moreoever, we would like our research to impact not only the scientific community but also the industrial sector, as well as the wider community.

Our mission statement says, "By bold innovation and excellence in all that we do, we make both knowledge and discoveries matter". Our world leading researchers, at our Malaysia campus, is enabling us to deliver on that promise and we hope that we can work with others, both from the scientific community as well as from the industrial sector, to continue to contribute to the core mission of the university.

The Faculty of Engineering encompasses all the major engineering disciplines, these being Chemical and Environmental, Civil, Electrical and Electronic and Mechanical, Materials and Manufacturing.

Our engineering research is internationally recognised covering a wide range of diverse research areas, including Aerospace, Green Technologies and Renewable Energy. In addition, we host many international workshops and conferences and work with industrial partners, both nationally and internationally.

In this brochure, we have tried to illustrate the broad spectrum of research taking place within the Faculty of Engineering. We hope that you find it interesting, and invite you to contact us to talk about our research and how we might be able to work together on some of these exciting initiatives.

Professor Graham Kendall
Vice-Provost for Research and Knowledge Transfer

"By bold innovation and excellence in all that we do, we make both knowledge and discoveries matter"

In the most recent UK Research Assessment Exercise 90% of all research at Nottingham was classified of an 'international standard' and 60% as 'world-leading' or 'internationally excellent'. The University of Nottingham Malaysia Campus achieved 4* rating (the maximum is 5*) for research activities and publications in the 2011 Malaysian Research Assessment Exercise (MyRA).

Introduction

In the most recent UK Research Assessment Exercise 90% of all research at Nottingham was classified of an 'international standard' and 60% as 'world-leading' or 'internationally excellent'.

The University of Nottingham is internationally recognised for world-changing and award-winning research. Nottingham academics won two Nobel Prizes in 2003 and the Shaw Prize in 2008.

Our ground-breaking research consistently places Nottingham amongst the elite in the international academic arena. Research excellence is at the core of the University's mission, and the Malaysia Campus honours this mission by conducting world-class research activities in the region.

Our research strength is reflected in our tremendous success in attracting considerable local research funding and industry collaboration. We have won a significant number of international research awards and honours, and over the last few years we have invested heavily in our research infrastructure to nurture our next generation of researchers, ensuring that we sustain and further escalate our research success.

Our modest aim is to become the regional leader in all our areas of research expertise and, with our quality research deliverables, we wish to play our part in helping to change the world environment for the better. We invite you, as prospective research student or industry collaborator, to join our mission, embark on this exciting and meaningful journey and be part of our success story.

Professor Andrew Chan
Director of Research, Faculty of Engineering

Research and knowledge transfer priority groups

The University of Nottingham has established a number of research and knowledge transfer priority groups. These are areas of key focus, which support the delivery of excellence in research and knowledge transfer.

- Advanced Manufacturing
- Aerospace
- Biomedical Imaging
- Centre for Advanced Studies
- Clinical Translational Research
- Drug Discovery
- Energy
- Facilities
- Global Food Security
- Integrating Global Society
- International
- Operations in a Digital World
- Science, Technology and Society

Nine priority groups are in key thematic areas with the potential to grow and deliver an influential amount of world-class research and knowledge transfer addressing global issues and challenges. Four priority groups underpin capabilities across the University with the objective of leveraging significant external funding.

Research priority groups will:

- maximise the visibility and impact of the University's research
- secure significant levels of external funding to support their research activities
- become an institutional champion for their topic
- incorporate interdisciplinary collaborations of international quality
- provide a first-class environment for career development and training
- attract high quality staff, postgraduates and strategic partnerships

It is envisaged that priority groups will have a maximum life-span of five years in order to allow for new thematic areas to emerge. These will be dependent on the University's evolving priorities and changing global challenges.

Find out more about our global research priority groups at **www.nottingham.ac.uk/research/priorities**

PhD student Shridharan Parthasarathy working on the ultrasound reactor in the Combustion Room.

PhD student Joanna Chia Su Yuin dehydrating a food sample.

UNMC Research priority groups in engineering

The University of Nottingham Malaysia Campus has developed thirteen research priority groups, which complement and overlap with the global priorities of the University. They also reflect priorities unique to Malaysia and Southeast Asia. Five of these groups are based in the Faculty of Engineering.

- Aerospace
- Food and Bioproduct Processing
- Green Technologies
- Nanotechnology and Advanced Materials
- Renewable Energy

Our groups range from centres which have an established history of producing leading research to newly identified 'emerging areas' which represent new and exciting developments at the Malaysia Campus.

Through our links with higher education and research institutions in Malaysia, we are raising the profile of Malaysia as a key player in research that addresses global issues that transcend national and traditional disciplinary boundaries.

For further information about Research Priority Groups at The University of Nottingham Malaysia Campus visit **www.nottingham.edu.my/research/priority**

Aerospace

Global Priority Group: Aerospace

Our focus is research relevant to the field of Aerospace Engineering, and the education and training of experts for Malaysia's emerging aerospace industry. We conduct research across the wide range of topics from fluid dynamics and spacecraft propulsion to control systems and from energy capture, storage and management to the recycling of composite materials and the integration of antennas into composite UAV airframes. Through this work and consultancies, we hope to contribute to the long term development and sustainability of Malaysia's aerospace sector.

Areas of research

Biofuels
Propulsion
Avionics and Actuators
Structures and Materials
Antennas and Electromagnetics

Key research themes and expertise

Renewable aviation bio-fuel
Combustion and internal combustion engine
Micro-propulsion systems for satellite
Propellants
Super-capacitors
Energy harvesting
Unmanned aerial vehicles
Fault tolerance
Multi-agent / high-integrity systems
Electric actuators
Nonlinear signal processing
Recycled carbon fibres
Polymer-derived ceramics
Antennas for aerospace applications

Partnerships and collaborations

Aerospace Malaysia Innovation Centre (AMIC)
Composite Technology Research Malaysia (CTRM)
Unmanned Systems Technology (UST)
Angkasa
Nottingham Innovative Manufacturing Research Centre (NIMRC)
Boeing
Cradle
Carotech
Malaysia Palm Oil Board
Intel
University Putra Malaysia

Contact us

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Contributing to a sustained and sustainable aerospace industry in Malaysia through training future experts, research and development and consultancy.

PhD student, Chan Wai Loon, working on an engine test bed

Professor Law Chung Lim operating a low temperature dehydrator

Food and Bioproduct Processing

Global Priority Group: Global Food Security

The Food and Bio-Product Processing research centre works extensively to research and develop processing technologies that give the food and bio-product industry a competitive advantage in the global marketplace. Established in 2006, a distinctive strength of this Centre is developing value-added products and advanced processing technology for better quality food and bio-product.

We are interested in maximising the retention of bio-active ingredients – such as antioxidants, vitamins, sialic acids, and polysaccharides – in processed foods and enhancing the quality of processed products including textural and sensory attributes, as well as food safety. We are also working towards the development of unit operations such as dehydrators, fryers, extractor and scrubbers for processing foods and bio-products.

Additionally, the centre provides professional services and consultancy to companies wishing to develop new food products, diversify product range, and processing products with new technologies that yield better product quality and minimise operating cost.

Areas of research

The centre focuses on two main areas of research: developing new techniques and processing technologies of food; and bio-product and developing new value-added foods and bio-products.

Key areas of focus for our research include:

- Developing low temperature drying technology that is suitable to process heat sensitive materials which can maximise the retention of heat sensitive bio-active ingredients such as antioxidant, vitamins, glycoproteins
- Developing healthier snack foods such as dehydrated fruits and vegetables. Products developed so far include dehydrated salak, ciku, chempedak, jackfruit, kiwi, papaya with enhanced quality
- New techniques of processing herbal products such as ganoderma, piper betel that can maximise the retention of its bio-active ingredients and thereafter its extraction yield
- New techniques of processing agricultural products such as paddy, cocoa beans that can enhance its product quality
- Processing of bio-polymers such as alginate for transdermal drug delivery purpose
- Processing of high-value bio-products such as edible swiftlet bird's nest and developing novel method to minimise nitrite content and colour change

Key research projects and expertise

Our research projects and expertise are clustered around a number of groups, including:

- Industrial drying and dehydration group – focuses on developing new processing and drying unit operations for the preservation of food and bio-product
- Edible swiftlet bird's nest group – develops processing technique to preserve bio-active ingredients and studies its benefits to human health
- Cocoa processing group – focuses on developing new techniques to enhance cocoa flavour
- Mushroom processing group – focuses on maximising the retention of bioactive ingredients in mushrooms
- Extraction and membrane technology group – explores extraction and separation technologies to extract and purify bio-active ingredients from agricultural and bio-origin products
- Mathematical modelling group – focuses on the transport phenomena of water, solvent and bio-active ingredients transport in food and bio-product

Partnerships and collaborations

The centre works in collaboration with a range of research institutions, universities and industries to increase the quality and effectiveness of our research. Key partnerships include:
Ganofarm
B-nes
BN Bio
Nam Yong Fah i-Lab Instrument
Forest Research Institute Malaysia
Malaysian Cocoa Board
Association for Swiftlet Nests Industry
Universiti Putra Malaysia
Universiti Teknologi MARA
Universiti Kebangsaan Malaysia
Universiti Malaya

Contact us

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Green Technologies

Global Priority Group: Advanced Manufacturing

Green technologies refer to the development of environmentally friendly products and processes. The University of Nottingham Malaysia Campus established the Centre of Excellence for Green Technologies (CEGT) in 2006. In 2010, the Malaysian government identified green technologies as a major growth area under the National Green Technology Policy and CEGT is actively engaged with this initiative to promote the use of green technologies in Malaysian industry.

Bridging the gap between research innovation and industrial application is the main objective of the centre. CEGT organises various professional courses in the area of green technologies, and hosts conferences that promote the use of green technologies for sustainable development. Additionally, the centre provides specific advice for industrial practitioners through consultancy services. CEGT also explores various commercialisation opportunities for their established technological expertise.

The centre is actively involved in both computational and experimental studies which range from bench-scale research to proof of concept using prototypes. The research activities include conceptual design based on process simulation and optimisation, and pilot plant scale investigation which will eventually lead to patent development and commercialisation. CEGT has to date attracted more than RM3.5 million of research grants from various public and private institutions and has had more than 150 international refereed journal papers published.

Key activities of our centre include:

- Consultation – providing specific advice for industrial practitioners in solving problems in the areas of green technologies
- Professional courses – providing professional training (e.g. workshops, in-house courses) to train personnel in applying various green technologies
- Research commercialisation – exploring opportunities to commercialise potential research projects
- Conferences – organising conferences on green technologies topics

Research expertise

The centre's main areas of expertise include: water and waste-water technologies; urban climate and pollution control; waste recycling and minimisation; energy and sustainability; membrane technology; renewable energy; system analysis computational tools (computation fluid dynamics – CFD, pinch analysis, process modelling and optimisation).

Partnerships and collaborations

The centre works in collaboration with a range of research institutions, universities and industries to increase the quality and effectiveness of our research. With our close international collaborators such as from many reputable institutions, we have produced significant research output for the past six years.

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Malaysia government identified green technology as a major growth area under the National Green Technology Policy in 2009. Since its establishment in 2006, CEGT has been actively engaged with the use of green technologies in Malaysian industry.

PhD student Sulainian Salisu working on a furnace which is used for carbonisation.

Nanotechnology and Advanced Materials

Global Priority Group: Advanced Manufacturing

The Centre for Nanotechnology and Advanced Materials (CENTAM) at The University of Nottingham Malaysia Campus was established to support and foster interdisciplinary research within the area of nanotechnology and advanced materials.

The centre provides expertise and state-of-the-art instruments and infrastructure for academic, industrial, government agencies and international researchers with the aim of helping to generate new scientific insights, create innovative nanostructured materials with intriguing functionality, and contribute significantly to the advancement of environmental, pharmaceutical, and energy-related research and development programmes. The centre also actively cultivates collaborative efforts for both non-proprietary and proprietary research with renowned research institutes worldwide.

Members of CENTAM address a broad spectrum of advanced and cutting-edge nano-related research themes. There is particular focus on materials design and discovery at the nano-scale, energy storage development and optimisation, as well as the advancement of nanostructured devices fabrication and manipulation. Most of the research projects within the centre are financially supported by highly reputable funding agencies and dedicated industrial partners, either locally or internationally.

Areas of research

Key areas of focus for our research include:

- Nano-engineering of advanced functional materials: nano-photocatalysis and organic photovoltaic applications
- Microfluidics and miniaturisation technology: aerospace and molecular biology application
- Enhanced extrusion and molding technology: polymer and composite processing
- Fabrication of novel bio-scaffold and brushite materials: tissue engineering
- Development of highly efficient nano-ion storage materials: nano-electronics
- Utilisation of ultrasonic cavitation technology: pharmaceutical nano-emulsion generation
- Advanced nano-materials synthesis: using soft-chemistry templating technique

Key research projects and expertise

To date, the centre has undertaken the following key research projects:

- Development of sustainable solar detoxification system based on novel magnetic nano-photocatalysis material
- Novel strategy of ultrasonic cavitation for the generation of nano-emulsions and nano-suspensions in pharmaceutical preparations
- Augmenting the removal of active ingredients of ganoderma lucidum and their encapsulation in the nano-sized liquid vehicles (NLVs) to improve the bioavailability using ultrasonic cavitation
- Fundamental study of the charge carrier dynamic for the magnetic nano-photocalyst materials
- Process to enhance coatings for core-shell structure of metallic and non-metallic materials

Partnerships and collaborations

The centre has established a strategic partnership with Malaysian Institute of Microelectronic Systems (MIMOS) to develop ultrasensitive biosensor using graphene nano-materials. The centre has also made agreements with Platinum Energy to develop energy efficient cavitation based reactors for the physical and chemical transformations. There is also a collaborative research effort between the centre with Universiti Malaya (UM) on the fabrication of high performance magnetic nano-photocatalyst that potential to be employed in the wastewater treatment systems.

Contact us

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Renewable Energy

Global Priority Group: Energy

Centre for Renewable Energy and Sustainable Technology (CREST) was established to provide the technical support and the research infrastructure for the researchers in the field of the renewable energy. The field of renewable energy includes all types of energy resources that are renewable, such as solar, wind, biomass, tidal and sea wave energy.

The centre is open to all types of renewable energies with a special interest in technologies suitable for the tropical regions, such as solar energy, especially solar thermal applications, biomass, small hydro and wind energy. This research centre is fostering research on different areas of renewable energy that requires the efforts of many researchers from multidisciplinary backgrounds including Mechanical, Electrical and Chemical Engineering, Science and Social Sciences. CREST has wide range of collaboration within The University of Nottingham (Intercampus collaborations) and with local, regional and international partners. The centre has attracted a significant amount of research funds during the past few years.

Areas of research

- Solar energy (thermal systems and photovoltaic)
- Biofuels production from conventional and new sources
- Biomass energy systems
- Hydrogen generation from biomass
- Geothermal energy
- Low speed wind energy applications
- Wave and tidal energy systems
- Modelling and simulation of renewable energy systems
- Renewable energy storage and distribution systems
- Renewable energy conversion systems
- Control and integration of different sources of renewable energies
- Socioeconomic impact of renewable energy and dissemination studies

Partnerships and collaborations

CREST has established strong research collaboration with the SCORE project (UK) and the Chinese Academy of Sciences (China) on biomass and solar energy conversion. Promising collaboration projects are on-going with a number of local research institutions and industries in Malaysia on areas related to local resources of renewable energy and solutions for the tropical regions.

Strategic objectives

CREST works through international and local partnerships to increase the level of utilisation of the renewable energy resources in the tropical regions, taking into consideration the unique characteristics of the region.

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CREST is an umbrella of research on any source of usable renewable energy intended to replace conventional energy sources with special focus on tropical regions

Research divisions

Following the strategies of the UK Campus, research is organised cross-disciplinarily across the various academic departments. This fundamental change to the traditional departmental structure was made to integrate the faculty better in terms of research. We broke down traditional academic 'walls' to enhance multi-disciplinary research and the results are the five main research divisions:

- Electrical Systems and Applied Mathematics
- Energy, Fuel and Power Technology
- Environment
- Manufacturing and Industrial Processes
- Materials, Mechanics and Structures

Each division comprises of staff members from different academic departments and this creates an exciting forum of synergy from various expertise, experience, knowledge and perspectives. Most importantly this division moves away from traditional demarcation and reflects the modern day perspective on research areas, industry needs and societal concerns. We are now well positioned and better focussed to identify new collaboration and investment opportunities and react efficiently and responsively to emerging global multidisciplinary challenges.

Each engineering research division contains a number of research groups from across the faculty as indicated below.

Electrical Systems and Applied Mathematics

Applied Electromagnetics and Communication

Applied Mathematics

Intelligent Systems

Power Electronics, Machines and Control

Energy, Fuel and Power Technology

Fuels and Sustainability

Internal Combustion Engines

Renewable Energy

Environment

Sustainable Process Integration

Urban Climate and Pollution

Water and Wastewater Treatment

Manufacturing and Industrial Process

Engineering Management

Food and Pharmaceutical Engineering

Mechatronics

Nanotechnology

Materials, Mechanics and Structures

Advanced Materials

Bioengineering

Geomechanics

Polymer Composites

System Dynamics and Integrity

Technician working on a bio-reactor

Electrical Systems and Applied Mathematics

A wide range of research is carried out in the division covering various areas including electrics, communications, machines and applied mathematics. One of the main focuses of this division is to invent and apply state of the art technologies, intelligence, computational and mathematical algorithms to various domains to improve current systems and processes for the benefit of mankind. The research groups within the Electrical Systems and Applied Mathematics division are:

- Applied Electromagnetics and Communications
- Applied Mathematics
- Intelligent Systems
- Power Electronics, Machines and Control

Current domains that the division is intensely pursuing are in the areas of renewable energy and automotive systems. The division also has in-depth technical expertise and is conducting research in the areas of audio-visual systems, wireless communications, optical communications, antennas, power electronics, machines and embedded systems.

The division is heavily involved with the industry contributing to valuable advancements. One such involvement that can sum up all research areas in the division is the "Active cars of the future" project. An industrial collaboration to research and incorporate possible modern techniques such as remote diagnosing and reporting of near feature faulty parts, integrating auto drive systems and modernising the dashboard with state-of-the-art touch panels to the next generation cars. The research collaboration is heading also towards harvesting all possible energy waste and reusing it.

Find out more

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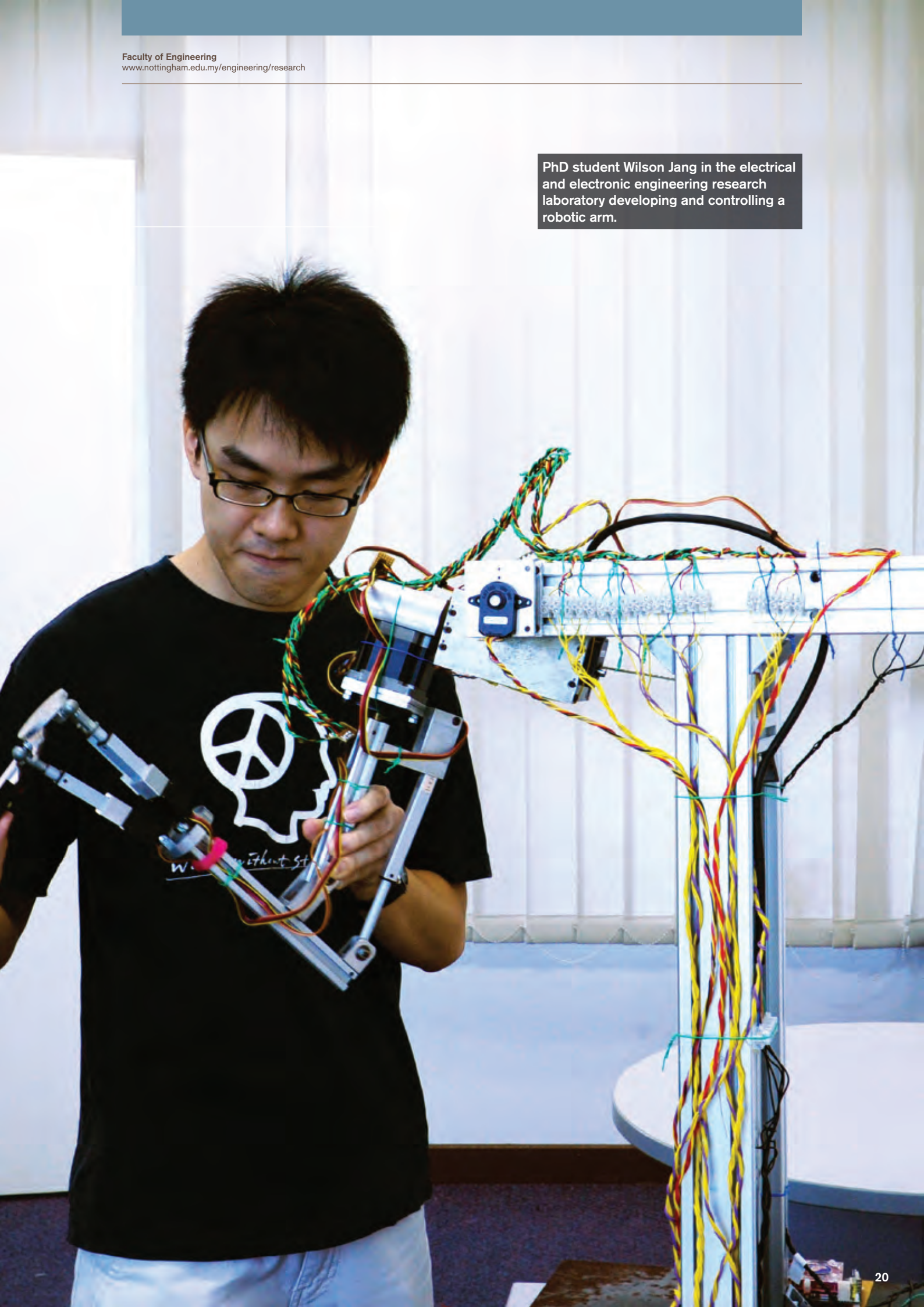
We believe in smart and active automotive systems that not only drive us around but take actions to protect us. Systems that entertain us when we are onboard. Systems that are equipped with state of the art and energy efficient technologies contributing to a green planet.



PhD student Wilson Jang in the electrical and electronic engineering research laboratory developing and controlling a robotic arm.

Applied Electromagnetics and Communications

Key research themes

- Blind equalisation to eliminate the bandwidth-wasteful training sequence
- Novel combination of space-time-block-codes (STBC) and spatial multiplexing (SM) techniques to increase capacity or effective data throughput
- Simplifying TURBO decoding algorithm
- Design of novel near maximum-likelihood (ML) MIMO detection algorithms with much lower computational complexity than the optimal ML algorithm
- Design and analysis of very efficient near-optimal equalization and decoding algorithms for broadband wireless MIMO systems
- Reducing the computational complexity of TURBO codes
- Develop new detection algorithms that increase data throughput which are suitable for IEEE standards
- Design of fast convergence blind equalization algorithms, for both single antenna as well as multiple-antenna systems

Research expertise

- Equalisation algorithm design and analysis
- Detection algorithm design and analysis
- Matlab based simulations

Find out more

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Applied Mathematics

This research group applies mathematical techniques to solve problems in various domains such as mathematics, physics and engineering. The members of this group are actively involved in research in quantum information, quantum field theory, probability and statistics, fractional calculus and asymptotic analysis.

Areas of research

- The Casimir effect (Ministry of Higher Education)
- Statistical analysis of non-parametric estimators
- The Kochen-Specker theorem
- Fractional integrations on discrete time scales

Find out more

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Intelligent Systems

The common thread in the research activities of this group is the use of intelligent systems for pattern recognition and machine learning in order to predict an outcome and/or decide on a suitable course of action in engineering and industrial processes. The inference engine used is the Support Vector Machine, a linear classifier with good generalisation capability.

Areas of research

- Pipeline riser defect prediction using Support Vector Machines
- SmartVehicle System to protect drivers and motor cyclists on Malaysian Roads (Ministry of Science Technology and Innovation)
- SVM based battery – Super-capacitor energy management system for Electric Vehicles (Ministry of Science Technology and Innovation)
- Detection and Prediction of Lung Cancer Using the zNose with the Support Vector Machine Classifier (Ministry of Science Technology and Innovation)
- Modelling and Analysis of Maglev Vertical Axis Wind Turbine

Find out more

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Power Electronics, Machines and Control

Areas of research

- Power electronics
- Energy conversion systems
- Renewable energy conditioning
- Regenerative Braking/Supercapacitor charge storage
- Energy management
- Electric machines and drives
- FACTS and HVDC systems
- Control Systems; Intelligent, Robust, Real-Time with Embedded systems.

Find out more

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Dr David Lim studying the performance of a horn-shaped antenna in the anechoic chamber

Key Project: Sahz nano supercapacitor pilot plant

Sponsor: Ministry of Science, Technology and Innovation; Sahz Holdings

The only current viable solution to the problem faced by electric vehicles is to combine a high energy storage device such as an electrochemical battery or fuel cell with a high power device such as an Electric Double Layer Capacitor (EDLC) or ultra-capacitor or more often called a super-capacitor. Usually, a bi-directional buck-boost converter executing an energy management control algorithm is used to interface the battery bank and super-capacitor array to the load bus. It is the aim of this project to design an intelligent buck-boost converter with a Support Vector Machine (SVM) based energy management algorithm which will optimize the power flow from the battery pack to the load power flow from the battery pack to the load

Find out more

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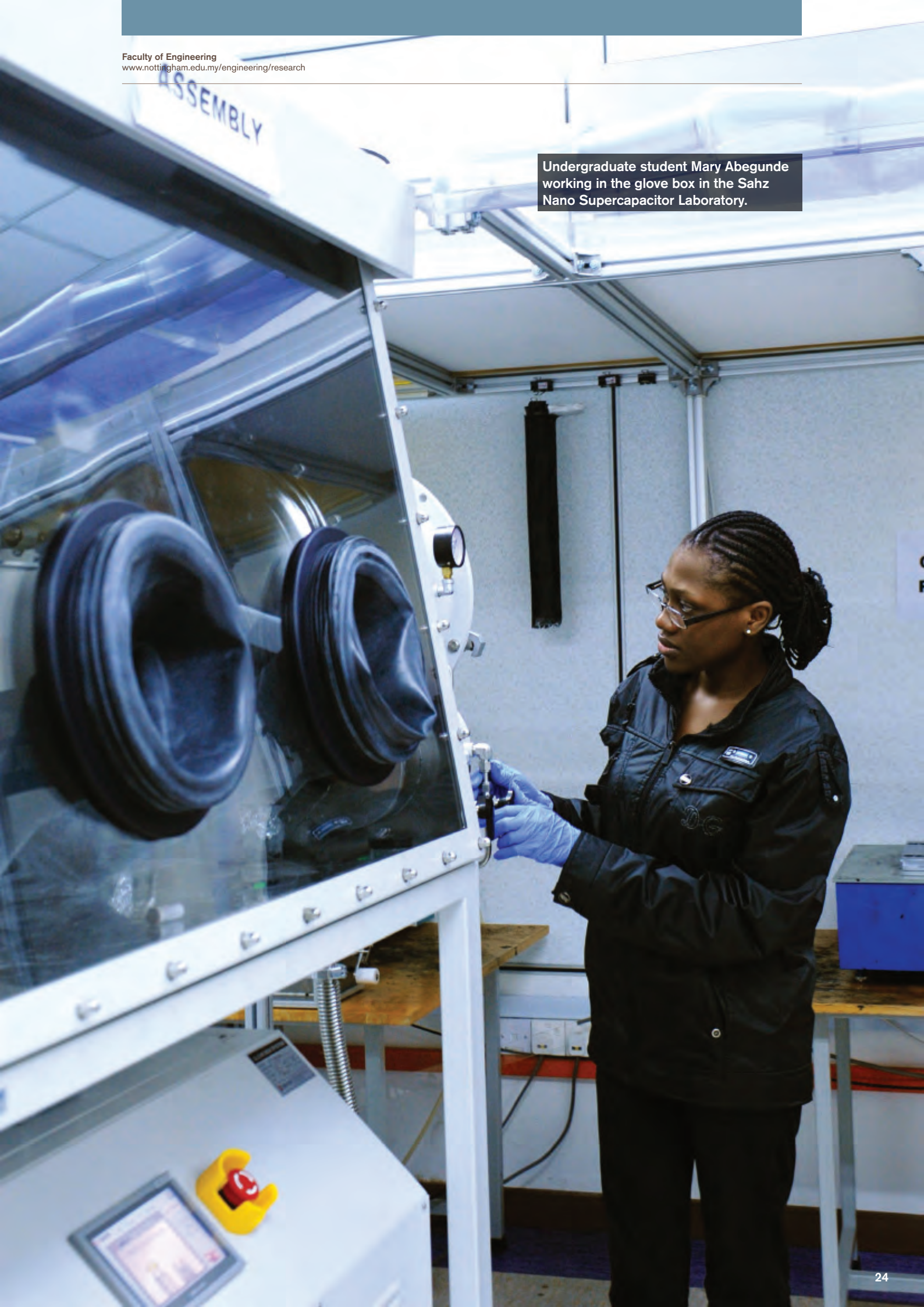
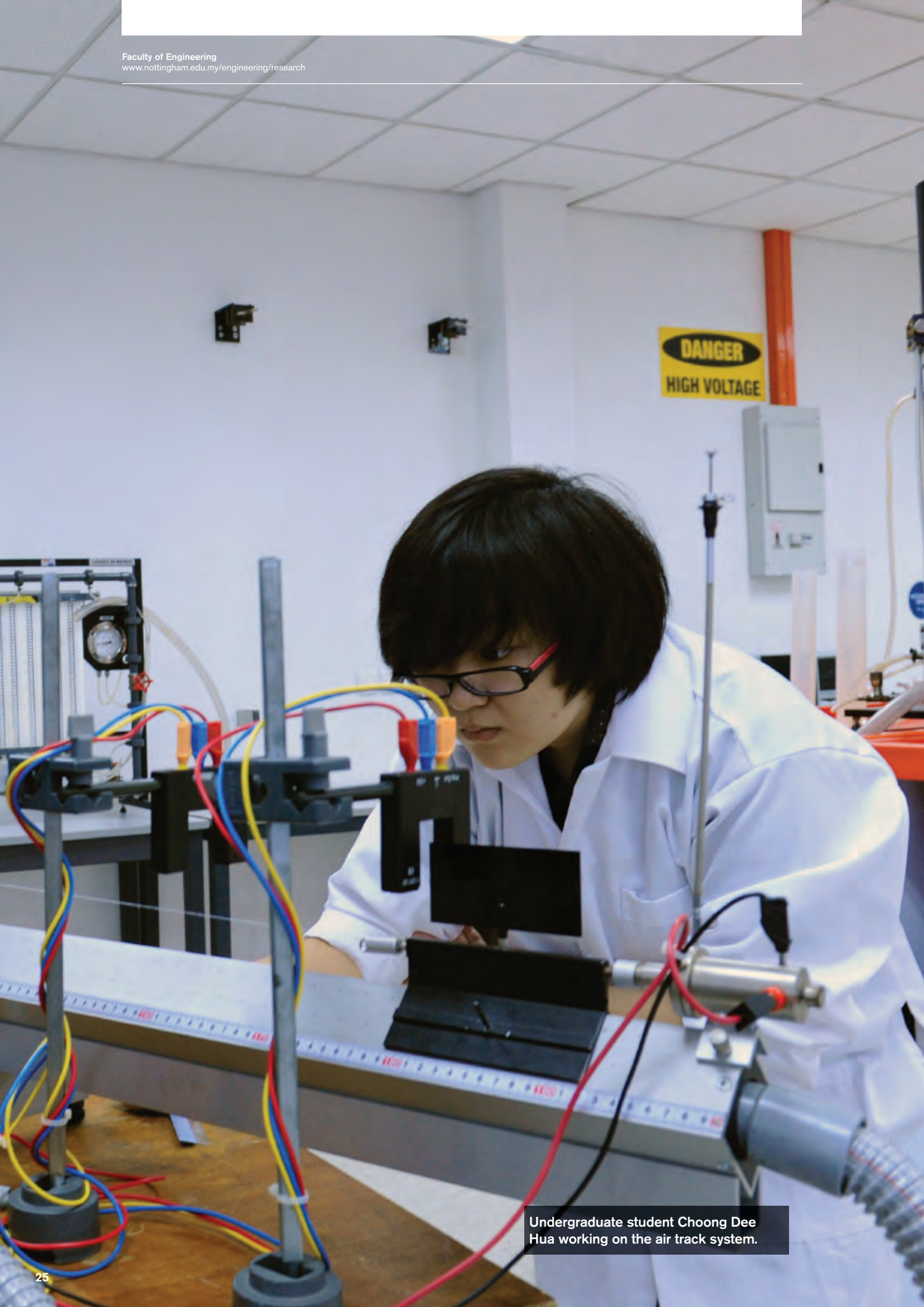
An electric double-layer capacitor (EDLC), also known as super-capacitor, super-condenser, electrochemical double layer capacitor, or ultra-capacitor, is an electrochemical capacitor with high energy density. Their energy density is typically hundreds of times greater than conventional electrolytic capacitors.



Undergraduate student Mary Abegunde working in the glove box in the Sahz Nano Supercapacitor Laboratory.



Undergraduate student Choong Dee Hua working on the air track system.

Energy, Fuel and Power Technology

The central theme of this research division is the development of renewable energy and sustainable, alternative fuels through a broad range of innovative experimental and computational studies. The research undertaken within the division adopts a multidisciplinary approach with international and local collaborative partners.

The division's work is mainly supported by the Malaysian government (e.g. Ministry of Science, Technology and Innovation (MOSTI) and the Ministry of Higher Education (MOHE)), governmental agencies and industry. The division also has dedicated facilities for both fundamental and applied research, as well as internationally recognised expertise within the following four research groups:

- Internal combustion engines
- Renewable energy
- Fuels and sustainability

Find out more

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"Our dependence on fossil fuels amounts to global pyromania, and the only fire extinguisher we have at our disposal is renewable energy."

Dr. Hermann Scheer (1944-2010), Member of the German Parliament, President of the European Association for Renewable Energy EUROSOLAR, Chairman of the World Council for Renewable Energy (WCRE).

Internal Combustion Engines

The research group works on an array of combustion-related topics, with a particular emphasis on sustainable energy conversion technologies for ground transportation. The group's strength lies in advanced computational research focussed on improving in-cylinder modelling of diesel-biodiesel combustion and emissions. The wide-ranging computational studies are complemented by experimental research activities on biofuels production and its use in engines. The current projects include development of surrogate fuel and reduced chemical kinetic models for biodiesel blends, in-cylinder soot transport behaviour in diesel engines, greener biodiesel production technologies, as well as effects of biofuel composition on physico-chemical properties and engine-out responses and durability.

Partnerships and collaborations

- Malaysia Palm Oil Board
- Politecnico di Milano, Italy
- Technical University of Denmark, Denmark

Funded projects

- Development of a fundamental model of reduced reaction mechanism and fuel physical properties for the combustion simulation of palm biodiesel (Ministry of Higher Education)
- Investigation of high biodiesel fuel blend on material compatibility, fuel storage and lubricating oil in a light-duty diesel engine (Malaysian Palm Oil Board)
- Surrogate fuel modelling using large hydrocarbons (Ministry of Higher Education)
- Heterogeneous transesterification of crude palm oil using palm oil mill flyash-based solid catalyst (Ministry of Higher Education)

Find out more

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Renewable Energy

The Renewable Energy goup focusses on many types of renewable energy research, such as solar energy (including solar thermal applications and solar desalination), biofuel production and engines optimisation, biomass pyrolysis, gasification and biogas generation from biomass, small hydro/wind energy and energy storage systems for renewable energy. The Renewable Energy Group has attracted significant amount of funds from different sources.

Partnerships and collaborations

- The SCORE (Stove for Cooking, Refrigeration and Electricity) Project UK
- Panasonic Research and Development
- Intel
- Megaduct

Funded projects

- Development of thermoacoustic engine for rural areas (Ministry of Science, Technology and Innovation)
- Optimisation study on the SCORE engine (SCORE)
- Design and fabrication of a lab scale pyrolysis reactor for biomass (Ministry of Science, Technology and Innovation)
- Optimisation studies for low speed wind power generation in Malaysia (Intel; Megaduct)
- Energy storage and buffering for photo-voltaic applications (Sahz Holdings)

Find out more

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Fuels and Sustainability

This research group focuses on sustainable energy solutions to address depleting fossil fuel reserves as well as emissions of greenhouse gases and other pollutants from the use of fossil fuels. The group specialises in developing low carbon fuels in addition to carbon reduction and mitigation technologies.

Areas of research

- Chemical and thermo-chemical conversions of biomass, oil and lipid to produce bio-fuel, chemical precursors, and bio-diesel
- Environment impact assessment for oil & gas well drilling relief well drilling, gas treatment plant, and gas collector network
- Well blow-out monitoring, disaster management plan, and implementation

Funded projects

- Production of biofuel from agricultural residues via fast pyrolysis process and upgrading (Ministry of Science, Technology and Innovation)
- AI enhanced lead acid battery rejuvenator using super-capacitors (Ministry of Higher Education)
- Experimental and modelling investigation of Malaysian biomass co-firing with coal (University of Nottingham UK)
- Production and physico-chemical characterisation of bio-oil from the pyrolysis of Jatropha curcas wastes (Ministry of Agriculture & Agro-Based Industry)
- Production of biofuel from agricultural residues via fast pyrolysis process and upgrading (Ministry of Science Technology and Innovation)
- Environment impact assessment for oil & gas well drilling, relief well drilling, gas collection network, gas processing plant, well blowout monitoring and disaster management (Niko Resources)

Find out more

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PhD student David Wee analysing the thermo-acoustic effect.

Key Project: Development and optimisation of a thermoacoustic heat engine for electric generation

The SCORE (Stove for Cooking Refrigeration and Electricity) Centre in Malaysia

About 20% of the rural population worldwide have no access to grid electricity and most of them are using inefficient cooking stoves or open fire for cooking. The thermoacoustic project has successfully developed a cost-effective stove-engine which has a lower wood consumption, lower smoke generation and generates electricity for remote rural areas.

This engine operates by converting heat into sound energy that drives a linear alternator to generate electricity. It has minimal moving parts, making it more robust, reliable but with lower production cost. The project objective is to design and build a low-cost, high efficiency woodstove that uses about half the amount of wood compared an open wood fire cooking, creates less smoke and uses its waste heat to power a thermoacoustic generator therefore produce electricity to the benefit of over 1.4 billion population worldwide who do not have access to grid electricity. The project helps to provide healthy indoors environment and improves the life style of the remote rural communities. One of the significant features of this project is that it is one of the few thermocoustic developments using air as the working fluid at low pressure concept, which is more suitable for rural applications.

Areas of research

A series of studies are on-going to optimise the engine and reduce the cost of producing the final product. There are two studies working on the development of new concepts on thermoacoustic applications. The first on is the "Development of low pressure low cost thermoacoustic engine" and the second one is the "Developing a thermoacoustic refrigerator using low cost materials". Both have resulted in prototypes that require more work towards the final commercial products. At the same time, a number of fundamental investigations are conducted to provide the knowledge required for understanding all the parameters involved for the optimisation of the engine, such as the feedback loop loss, heat transfer and regenerator construction of the engine.

Key research themes

The project was adopted by the SCORE project consortium at the UK to be the SCORE Centre in Malaysia. All investigations done by the centre and all results are shared and discussed with the other members of the consortium. There are two main research themes at the centre:

- Design and development of new concepts of thermoacoustic engines and cooling devices focusing on cost reduction and improving efficiency
- Fundamental research for the optimisation of the thermoacoustic systems, such as, acoustic flow visualisation and measurement using Particle Image Velocimetry (PIV), detection of non-linear effects such as secondary flows and streaming and heat transfer issues.

Find out more

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About 20 % of the rural population worldwide have no access to grid electricity and most of them are using inefficient cooking stoves or open fire for cooking.

Environment

Sustainable development is the eventual goal for all human activities, which is also the main aim for the research division. This research division and its research groups are hence dedicated to the development of various process and product technologies in achieving the sustainable development goal, ranging from upstream waste minimisation to downstream end-of-pipe waste treatment. Specifically, these technologies address various air, wastewater and solid waste management problems.

The sesearch groups within the Environment Division are:

- Sustainable Process Integration
- Urban Climate and Pollution
- Water and Wastewater Treatment
- Fuels and Sustainability

Find out more

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"Research work on environment will ensure our sustainable development goal for the nation and global earth."

Professor Dominic Foo and a PhD student Wendy Qin in the Centre for Green Technologies.

Sustainable Process Integration

Process integration is a holistic approach to process design, retrofitting, and operation which emphasises the unity of the process. This research group makes use of various process integration techniques (e.g. pinch analysis, mathematical optimisation, etc.) to design and optimise various process networks for sustainable development goal.

Partnerships and collaborations

- Biomass Processing and Integrated Biorefineries (The University of Nottingham)
- Process network synthesis and optimisation of palm oil biomass utilisation (Global Green Synergy)
- Products Supply Chain Synthesis of Palm Oil Biomass (Global Green Synergy)

Awards

- WaterInno Awards 2009 (Silver), Water Malaysia 2009.
- "Top-75 most cited articles" in the IChemE journals 2006 – 2009, Elsevier
- Innovator of the Year Award 2009 of Institution of Chemical Engineers UK (IChemE) –Professor Dominic Foo
- 2010 Young Engineer Award of the Institution of Engineers Malaysia (IEM) –Professor Dominic Foo
- "Top 20 most cited IChemE papers (2008-2010)" Elsevier (2010)
- Best paper award in UNESCO Conference on Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatia, 25 – 29 September 2011

Find out more

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Urban Climate and Pollution

This research group focusses on the urban climate and pollution problems, in particular microclimate and air pollution in the urban built environment. The group develops various technologies in understanding and mitigating these pollution issues.

Partnerships and collaborations

- Urban heat island effects in Malaysia (Ministry of Science, Technology and Innovation)
- Remote sensing of urban heat island in Malayisa (Ministry of Higher Education; Universiti Teknologi MARA)

Find out more

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Water and Wastewater Treatment

This research group conducts various research projects on water and wastewater treatment ranging from quality monitoring, biological treatment system (anaerobic and aerobic), coagulation and flocculation, adsorption, membrane separation and cavitation technology.

Partnerships and collaborations

- Biogas generation as renewable energy from palm oil mill effluent (POME) using mixed culture microbes via hybrid anaerobic-aerobic bioreactor (Ministry of Science Technology and Innovation)
- Adsorption of Boron from Industrial Wastewater by using novel impregnated Palm Oil Mill Boiler (POMB) Fly Ash (Federal Land Development Agency FELDA)
- Asian Coastal Ecosystems: An Integrated Database and Information Management System (DIMS) for assessing impact of Climate change and its appraisal (Asia Pacific Network)
- Data Mining on hidden parameters of Water Quality Index for safe drinking water using artificial neural networks and Fuzzy logic systems (Ministry of Science, Technology and Innovation)
- Biodiesel Production from Crude Palm Oil (CPO) and High Acid Oil by Using Novel Multiphase Membrane Reactor (Malaysian Palm Oil Board)
- Glycerin Co-digestion with Oleochemical Effluent to Boost Methane Production (BIOTEC International Asia and Palm-Oleo)
- Pilot Scale Study of Integrated Anaerobic-Aerobic Bioreactor (IAAB) for Palm Oil Mill Effluent (POME) Treatment (Malaysian Palm Oil Board)

Find out more

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Professor Dominic Foo and Dr Denny Ng giving a presentation on the Resource Conservation Network

Professor Law Chung Lim inspecting a waste water treatment rig.

Key Project: Adsorption of boron from industrial wastewater by using novel impregnated palm oil mill boiler (POMB) ash

Sponsor: Malaysia Palm Oil Board

In present research, adsorption using POMB ash is proposed for the removal of boron from wastewater. POMB ash is a natural carbon-based adsorbent, which contains high carbon content and is porous in nature.

The discharge of boron-containing wastewater to the environment causes severe pollution problems due to its high solubility in water. Hence, boron content should be controlled to an appropriate level.

Currently there are many technologies for boron removal i.e. ion exchange, reverse osmosis and etc. However, most of these technologies are costly and unfeasible for large-scale operation. Hence in present research, adsorption on novel impregnated POMB ash for the removal of boron is investigated. The adsorption of boron on the virgin POMB ash is analysed to obtain a basic benchmark of minimum boron adsorption capacity. The POMB ash is further functionalised with the impregnation of selected chemical compound to become a novel boron-selective adsorbent to enhance boron removal from industrial wastewater.

Areas of research

Wastewater treatment aims to remove boron from the polluted water stream. The removal of boron by using readily available POMB ash, which contains high surface area that can be substituted with activated carbon. Hence, the cost of usage of activated carbon is reduced significantly. Boron is widely used in ceramic industry for enhancing mechanical strength of the tiles. The discharge of boron containing wastewater to the environment causes severe pollution problems due to its high solubility in water. Boron is dangerous for human consumption and causes organisms' reproductive impediments if the safe intake level is exceeded.

Find out more

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The preliminary experiment found that, POMB bottom ash at certain particle sizes is suitable to adsorb boron in wastewater. At optimum operating conditions, boron removal up to 80% can be achieved by batch adsorption. Boron concentration of the treated wastewater were reduced to 3 mg/L which satisfying the Standard B discharge limit required by Department of Environment, Malaysia.

Manufacturing and Industrial Processes

Efficient product and process development and manufacturing are paramount for all the industrial activities and are the core theme of this research division. Various novel technologies have been emerged from the dedicated and coordinated activities of the members. Establishment of research collaborations as well as projects have been obtained from various private and government agencies and much of the research has been funded by Shell, Petronas, Malaysian Palm Oil Board (MPOB), The Institute of Materials, The Project Management Institute and Ministry of Science, Technology and Innovation (MOSTI).

The research groups within the Manufacturing and Industrial Processes division are:

- Food and Pharmaceutical Engineering
- Nanotechnology
- Mechatronics
- Engineering Management

Find out more

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"Our research encompasses a wide spectrum of physical, chemical or mechanical processes for the mass production of various technological products, while carefully looking into the process improvements and cost savings."

Process esearch being carried out by PhD student Asad Rahman in the continuous distillation rig.

Food and Pharmaceutical Engineering

The Food and Pharmaceutical Engineering research group works extensively to research and develop advanced technologies for processing of food and pharmaceutical products. The research group has a distinctive strength in developing advanced processing technology for producing excellent quality food and pharmaceutical products which contain high amount of medicinal bio-active ingredients beneficial to human health and developing value added products from bio-origin products which are marketable in health care industry.

The research group is also working towards the development of unit operations such as dehydrators, fryers, extractor and scrubbers for processing foods and pharmaceutical products. Additionally, the centre provides professional services and consultancy to companies wishing to develop new food and pharmaceutical products, diversify product range, and processing products with new technologies that yield better product quality and minimise operating cost.

Partnerships and collaborations

Key major projects that the research group has completed and investigating:

- New processing technique to minimize colour change and nitrate content of edible swiftlet bird's nest (Ministry of Higher Education)
- Production of high polyphenols cocoa (Theobroma cacao L.) by adsorption drying technique (Ministry of Science Technology and Innovation)
- Development of an optimal dehydration technique in minimizing the degradation of antioxidant polyphenols in cocoa during post-harvesting process (Ministry of Agriculture)
- Development of 2-Stage Heat Pump Dryer-Cooler (Ministry of Science Technology and Innovation)

Find out more

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Nanotechnology

Nanotechnology research group is actively engaged in a broad as well as in cutting-edge research activities in nano and advanced materials for a variety of novel technological applications. This group is extremely successful in attracting external funding from government as well as from private sectors and involves extensively in establishing substantial collaborations with renowned researchers nationally and internationally. It is also actively involved in providing collaborative technical services and consultations in the area of advanced materials and manufacturing to local/international research organizations, government-linked companies (GLC) and industries. A large number of international research publications have been made from the research activities. Major research activities include the following:

- Nano-engineering of advanced functional materials for nano-photocatalysis and organic photovoltaic application
- Microfluidics and miniaturization technology for aerospace and molecular biology application
- Fabrication of novel bio-scaffold and brushite materials for tissue engineering
- Utilization of ultrasonic and hydrodynamic cavitation technology for the generation of nano-pharmaceutical materials

Partnerships and collaborations

- Development of sustainable solar detoxification system based on novel magnetic nano-photocatalysis material (Ministry of Science Technology and Innovation)
- Novel strategy of ultrasonic cavitation for the generation of nano-emulsions and nano-suspensions in pharmaceutical preparations (Ministry of Science, Technology and Innovation)
- Cerafusion Technology for physico-chemical responses and decay of selected tropical fruits and vegetables (MedKlinn International)
- Augmenting the removal of active ingredients of Ganoderma lucidum and their encapsulation in the nano-sized Liquid Vehicles (NLVs) to improve the bioavailability using ultrasonic cavitation (Ministry of Science, Technology and Innovation)
- Process to Enhance coatings for Core Shell structure of Metallic and Non-metallic Materials (Tensor Technology Engineering)
- Designing a Novel Nano-scale Drug Delivery Platform using Graphene, Dye and Pluronic F127 as Nanohybrid vehicle for improved efficacy of Curcumin into cancer cells (Ministry of Higher Education).

Find out more

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Student working on an electromagnetic vibrator prototype

Mechatronics

Mechatronics reflects a professional discipline that encompasses electrical, electronic and mechanical engineering with intelligent embedded control. It draws on large array of technologies from various disciplines into one specialised field. Some of the areas of research interests include:

- Electromechanical Actuation: Investigate multi-lane electromechanical applications for aerospace industry
- Industrial Robotics: Execute the design & instrumentation of new benchmark multivariable nonlinear robotic arms
- Mobile Robots and Unmanned Flying Robots: Utilise virtual environments to find real-time solutions
- Medical Applications: Instrumentation integration in life support equipment and technologies towards minimal invasive surgery
- Welding Technology: Develop of novel techniques for precision welding

Find out more

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Engineering Management

Core areas of research in this group include: Project financing, Project planning and scheduling, Project management, Life cycle costing, Construction ethics, Construction corporate social responsibility, Construction law, Research methodology in construction management, Sustainable construction, Culture in international construction, Quality management, Railway engineering and materials characterisation and failure analysis.

Find out more

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Key Project: Industrial drying of bio-origin products

Sponsor: Ministry of Agriculture

Industrial drying is one of the most energy intensive operations in industry. As energy cost is skyrocketing over the years, the operating cost of industrial drying becomes a key issue in industry. Industrial dryers typically operate at an efficiency of 30-60%. A few percentage improvements in energy efficiency of industrial scale dryers results in millions of saving in operating cost. Therefore, industrial players who use dryers in their operation and dryer manufacturers are looking for energy efficient dryers.

Thermal drying is typically used to remove water or solvent in solid and particulate materials. It is essential for minimising and mitigating microbial growth in food products and therefore avoids the generation of toxins. This in turn prolongs the shelf-life of a food product. In addition, dehydrated product weights lighter hence transportation cost is reduced appreciably. The main concern in drying and dehydration is product quality as improper drying may denature and damage the bio-essence or bio-active ingredients in the drying materials, to render it to loss its nutritional values and its bio-activity.

The University of Nottingham has a group of experts dedicated to research and develop advanced drying technologies suitable for processing of various products. The group has received research funding from Ministry of Science, Technology and Innovation, Ministry of Agriculture, Ministry of Higher Education and local machinery manufacturers.

Areas of research

- Industrial drying, fluidised bed drying, low temperature drying, enhancing drying performance and dryer energy efficiency, product quality of drying materials, safety aspect of drying
- Drying of foods, vegetables, fruits and bio-products (ciku, salak, ganoderma lucidium, cocoa beans, paddy, chempedak, apple, papaya, jack fruits, roselle, piper betel, mangosteen, rice noodles, edible swiftlet bird's nest)
- Development and design of industrial dryers (intermittent dryer, hybrid dryer, heat pump assisted dryer, fluidised bed dryer, cross flow dryer)

Find out more

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Hybrid drying combining low temperature drying and conventional drying can retain 50% more bio-active ingredients in dehydrated ganoderma lucidium than freeze drying.

Materials, Mechanics and Structures

Materials, Mechanics and Structures research division is a collaborative effort dedicated to support cutting edge research activities that cover all aspects of mechanics, materials processing, and structural engineering design. The mission of the division is to promote high quality multidisciplinary research, from fundamental to applications, in the areas of aerospace, biomaterials and biomechanics, computational mechanics, dynamic systems and control, geomechanics, advanced nano-materials and polymer composites processing.

The division aims to provide an ideal environment for carrying out any theoretical, computational and experimental works, which are supported by modern instrumental facilities and fast computational technologies. Most of the research projects within the division are financially supported by Ministry of Science, Technology and Innovation (MOSTI), Ministry of Higher Education (MOHE), Ministry of Finance (MOF) and various industrial collaborators and partners.

The research groups within the Materials, Mechanics and Structures division are:

- Structural Integrity and Dynamics
- Polymer Composites
- Advanced Materials
- Bioengineering
- Geomechanics

Find out more

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"With the ability to control, manipulate and manoeuver the unique mechanical property of engineered material from micro to nano-scale, applied mechanics and material research promises huge potential for the advancement of industrialisation, economies and societies development."

PhD student Chan Park Hinn working on injection moulding

Polymer Composites

The Polymer Composites research group is formed by a dedicated team with expert knowledge in design, manufacture and performance optimisation of both polymer and advanced fibre reinforced composites. Fundamental principles are applied, and 'state-of-the-art' techniques are utilized to ensure that the properties and performance of the end products are perfectly adapted to design specifications. The research themes combine curiosity-driven research with application-driven objectives, leading the development of advanced synthetic/natural fibre reinforced composites.

The key activities include:

- Development of novel manufacturing processes
- Materials characterization
- Optimization of performance/cost ratio in processing of thermoplastics and thermosets
- FEA and CFD modelling relate to mechanical performance and process simulation
- Crashworthiness studies of automotive vehicle
- Textile composites

Partnerships and collaborations

- Effects of Palm and Kenaf fibres reinforcement on the properties of PLA composites (PolyComposites)
- Kinetic Model Development for Coupled Heat & Cure Reaction In Analysing Chemical & Physical Attributes of Epoxy Curing (The University of Nottingham)
- In-Situ Composite Pipe Riser Repair for the Oil and Gas Industry (The University of Nottingham)

Find out more

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Advanced Materials

The Advanced Materials research group was established with the purpose to support and foster multidisciplinary research on advanced materials in science and engineering among the division members. The key areas of our research focus include:

- Engineering of advanced nano-materials for photocatalysis, organic photovoltaic and microelectronic application
- Design and development of microfluidic devices via miniaturization technology for aerospace and biological assays application
- Fabrication of novel metal oxides, quantum dots and graphene nano-materials for molecular sensing application

Partnerships and collaborations

The key on-going projects of the research group include:

- Fundamental Study of the Charge Carrier Dynamic for the Magnetic Nano-photocatalyst Material (Ministry of Higher Education)
- Fundamental Studies on Charge Storage Property of Manganese Oxide/Carbon Nanotube (MnO2/CNT) Nano-composites for High Performance Supercapacitor System (Ministry of Higher Education)
- Development of Eco-friendly and Biocide-Free Maritime Antifouling Coating Based On Silver Nano-engineering Technology (Ministry of Science, Technology and Innovation)

Find out more

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Concrete beam testing

Bioengineering

Bioengineering research group aims at the excellence of research in the areas of Tissue Engineering (TE) and Biomaterials. TE provides an advanced alternative therapy to the patients with diseased or damaged organs through regeneration of tissue. The overall goal is to contribute to the better and healthier human lives.

Currently, the group is ambitiously focused on the development of scaffold library by means of rapid prototyping (RP) technology in combination with novel biopolymers to cater for tailored TE applications. The overall research includes computational modelling and simulation of the scaffold design, fabrication and characterization of physical scaffold, in vitro and in vivo tissue generation and finally clinical trial for TE application.

Partnerships and collaborations

- Electrospun Nanofibre Matrix for Wound Healing and Antibacterial Activity - Development and In vitro Evaluation (Ministry of Higher Education)
- Characterization and failure analysis of in-situ bone substitute materials (The University of Nottingham)
- Design and fabrication of tissue engineering scaffolds incorporating rapid prototyping (RP) technology and synthetic biopolymers – Towards the development of a scaffold library (Hospital Universiti Kebangsan Malaysia)

Find out more

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Geomechanics

Current research focuses on development and improvement in the design and construction aspects of some common engineering works in the construction industry. The research outputs are intended for practical civil engineers to improve their knowledge and competency in carrying out design and construction works.

A summary of the current research activities in this group follows.

- Ageing effects on mechanical and physical characteristics of bituminous mixtures
- Bearing and settlement behaviours of piled-rafts in soft clay
- Improving bearing capacity of circular footings using key wall
- Prediction of shaft- and base resistance factors from static maintained load tests
- 3-D finite element modeling and full scale measurements of pull-out capacities on single-plate and multiple-plate discrete deadman anchors

Partnerships and collaborations

- Coupled model of dissociation process in gas hydrate bearing sediments (Ministry of Higher Education)

Find out more

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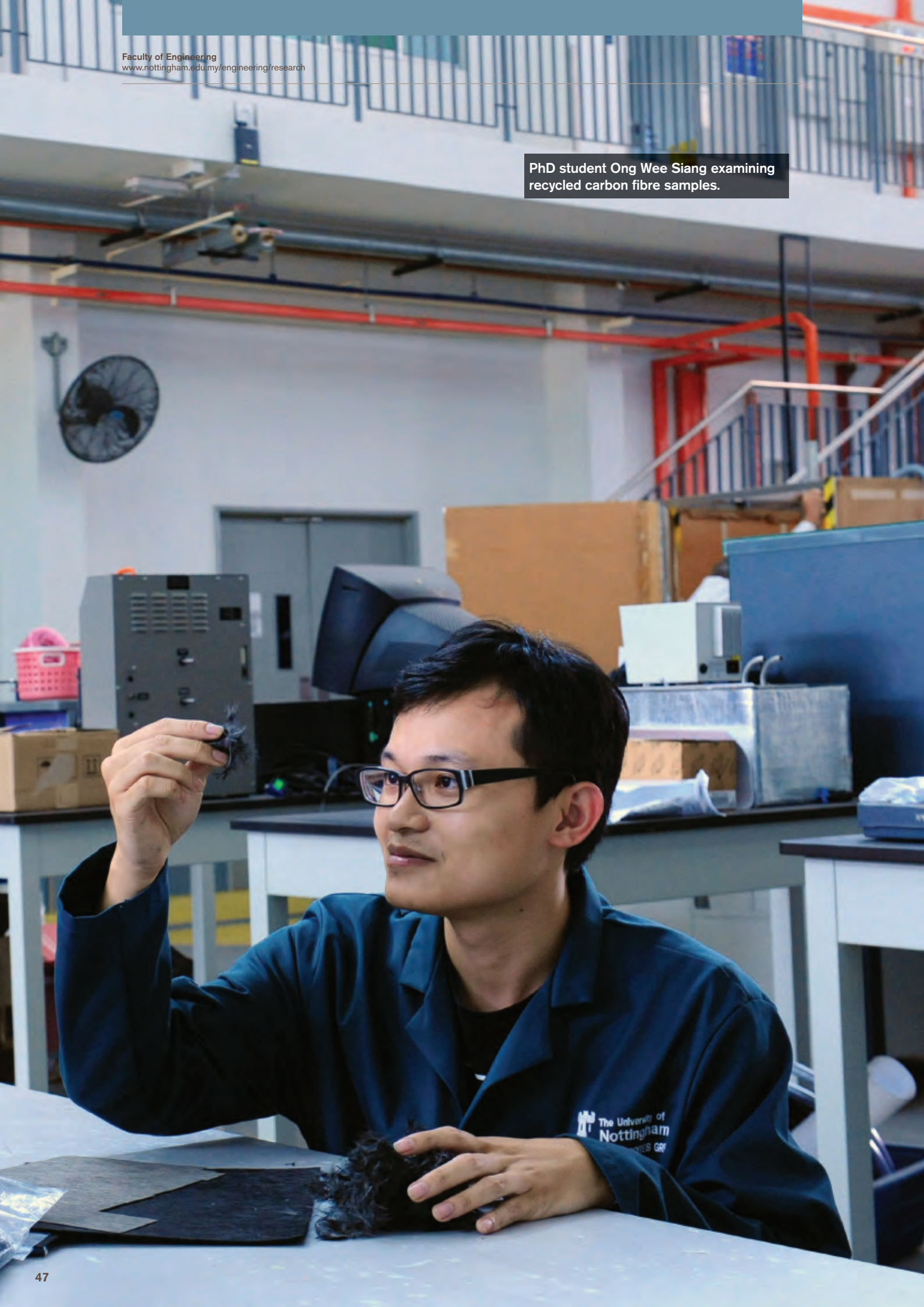

PhD student Ong Wee Siang examining recycled carbon fibre samples.

Key Project: Aerospace engineering

Sponsor: Boeing, Cradle

This research group studies the properties and characteristics of various polymer and composites for use in reinforcement in aerospace structures. In particular the group is very active in the studied of the recycling of carbon fibres and has developed state-of-the-art techniques to produce end products that match the aerospace industry requirements.

Partnerships and collaborations

- Recycled carbon fibre for sustainable manufacturing (Nottingham Innovative Manufacturing Research Centre)
- Cooling fabric for industrial, medical and delivery use (Cradle)
- Alignment of microfibres in a liquid-dispersion or fluidised system (Boeing)
- Recycling of carbon fibres from aircraft scraps to carbon yarns (Aerospace Malaysia Innovation Centre)

Awards

- JEC Composite Research Innovation Award, Recycled carbon fibres, JEC Composite 2011

Find out more

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"Right now fibreglass is cheap, right now fibreglass is available and when we put a technology like [recycled carbon fibre] on an airplane it's all well and good to do it with a good environmental message."

Bill Carberry, Boeing

MPhil and PhD opportunities

There are a number of MPhil and PhD opportunities within all Schools in The Faculty of Engineering. If you are interested in doing an MPhil or PhD at The University of Nottingham Malaysia Campus we recommend that you contact the relevant research supervisor to discuss your research project proposal in the first instance. You will find a list of academic staff members on each School's website. Visit our applications page to find out how to apply at **www.nottingham.edu.my/applications**

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