Faculty of Engineering, Computing and Mathematics

Research to Change the World

Engineering for Remote Operations
Bioengineering
Pure Mathematics
Global impact and industry support

Located in Perth, The University of Western Australia is a world-top 100 university in the World University rankings and a member of the ‘Group of Eight’ – a coalition of the best research-intensive universities in Australia.

UWA is also one of only two Australian universities to belong to the Worldwide Universities Network, a partnership of 16 research-led universities from Europe, North America, North Asia and Australia.

The Faculty of Engineering, Computing and Mathematics has a rich heritage of over 100 years of achievement and an international reputation for excellent research.

Research destination

Ranked as one of the most liveable cities in the world, Perth is a global oil, gas and mining hub, with over 500 resource companies located in the city.

At UWA we enjoy unprecedented opportunities to capitalise on the success of Western Australia’s energy and resource sector and its global connections by undertaking cutting-edge research and attracting academic talent from around the world.

Industry investment

Our Faculty has formed key partnerships with leading Australian and international organisations such as BHP Billiton, Chevron, Fugro, Quadrant Energy, Rio Tinto, Shell and Woodside. Many of these global organisations have made multi-million dollar investments into UWA’s Engineering research and funding including:

- Chevron Chair in Gas Process Engineering
- Shell EMI Chair in Offshore Engineering
- Fugro Chair in Geotechnics
- BHP Billiton Research Fellow in Engineering for Remote Operations

Funding growth

The Faculty’s research teams also attract significant grants from the Nation’s peak research funding body, the Australian Research Council (ARC). Some of our recent successes include two leading offshore oil and gas research groups securing nearly $10 million in new funding from ARC – the funding will see $5 million granted to an ARC Research Hub for Offshore Floating Facilities and $4.6 million to an ARC Training Centre for Liquefied Natural Gas Futures at UWA.

Building on this success, and investment from industry, our Faculty is currently in the process of appointing three new Professorial Chairs in the fields of Complex Engineering Systems (Professor Michael Small was appointed in 2015), Robotics and Automation, and Ocean Engineering.
World-leader in remote operations

The Faculty has adopted a single, faculty-wide, strategic research initiative on the theme of Engineering for Remote Operations (ERO).

ERO draws on both established and future research strengths in the Faculty in engineering, mathematics and computer science to find novel solutions to the challenges provided by remote operations.

Unique collaboration

The interdisciplinary, integrated approach and solutions within ERO are relevant internationally, nationally and in Western Australia itself. The ERO initiative encompasses:

- Mining exploration, development and operations
- Coastal and offshore infrastructure for the oil and gas industry
- Agriculture and aquaculture
- Transport, energy, communication and water supply networks
- Remote community development

To meet the challenges of ERO, a number of large-scale multidisciplinary research groups exist within the overall ERO theme, including:

- Advanced Sensing Technologies
- Big Data Processing and Mining
- Complex Data Modelling
- Engineering, Communities and Environment
- Engineering System Health
- Fluid Science and Resources
- Offshore Facilities and Ocean Systems
- Real-time Optimisation, Scheduling and Logistics
- Robotics and Automation
- Structural Mechanics, Geomechanics and Computation

These research groups provide outstanding opportunities for collaboration between industry, Faculty staff, postgraduates and early career researchers to conduct ground-breaking multidisciplinary research in remote operations.

Future opportunity

The Faculty is currently involved in a $250 million investment program for a revolutionary new Engineering Zone (EZONE UWA) – a flexible teaching and research space that will foster further collaborative research innovation for the benefit of Australian and International Communities.

Find out more about our Faculty’s unique ERO research initiative at ecm.uwa.edu.au/research
Advanced Sensing Technologies

Delivering innovative sensor and monitoring systems for a range of remote applications

Our focus is developing the next generation of sensing technologies needed to solve remote operational challenges within agriculture, environmental monitoring, mining, oil drilling and defence.

The group’s wide-ranging and multidisciplinary capabilities span the sensing arena, from sensor materials through to sensors of fundamental parameter, to sensors of complex parameters, to sensor readouts and data analysis, to networking of the sensors into an intelligent entity.

Example research areas
- New sensor materials
- Novel sensor architectures and readout technologies
- Extracting information from sensor data
- Development of algorithms to process data from sensors
- Development of suitable networking architectures
- New imaging sensors and sensing systems for unmanned aerial vehicle (UAV) based sensing platforms and related applications
- Integration of sensors systems

Big Data Processing and Mining

Advancing big data technology for remote engineering

Interdisciplinary research in the Big Data Processing and Mining research group focuses on developing technology and software tools to help address the challenges of processing high-volume, high-velocity data sets.

Big data sets contain invaluable knowledge. For example, in marine environments data sets are collected from sensors deployed in floating buoys, underwater remote vehicles and offshore oil and gas platforms. In mining operations, data sets are collected on process control, operating, transportation and maintenance operations. Successful and reliable use of these information channels depends on understanding the patterns within this data.

Example research areas
- Real time online analytical processing on a hybrid high-performance computing platform
- Fast parallel subspace clustering to explore large, unknown datasets
- Cleaning and using unstructured data for large scale asset management tasks
- Intelligent urban water systems: smart water meters data analysis and mining environmental sensor networks

“From equipment and safety monitoring, to movement sensors and cameras, to satellites and mobile communications, every remote operations activity will have projects that demand new techniques and systems for the management of big data.”

Associate Professor Rachel Cardell-Oliver
Complex Data Modelling

Developing mathematical, statistical and computational methodology to support engineering projects

Our main research focus is on the challenges of model-building in the face of engineering data – big or small. Examples include estimating and managing the remaining useful life of assets in a mine; foundational and structural mechanics in offshore platforms; stability and management of distributed and heterogeneous power grids; spread of infection or wildfire; and image recognition and signal processing in robotic systems.

Example research areas
- Modelling of infectious diseases, crowd dynamics and social interaction
- Behaviour and stability of complex systems
- Designing remaining useful life models for mining machinery
- Flexible methods for dealing with longitudinal data with applications to asset management

“Our experts are able to interpret and model huge amounts of complex data using computational simulation and analytic methods.”
Professor Michael Small

Engineering, Communities and Environment

Engineering for remote communities and their environments

Our researchers aim to maximise positive and minimise negative impacts of engineering activities on remote communities, establish best practice guidelines and co-create with local communities, solutions which are sustainable and equitable for all.

The group’s cross-disciplinary researchers collaborate with industry and government, and a broad range of professionals, including anthropologists, archaeologists, philosophers, historians, Indigenous studies scholars, lawyers and psychologists, to find solutions to the challenges faced by remote communities.

Example research areas
- Mining and remote communities
- Engineering education and engagement
- Energy and water for remote communities
- Social impact assessments
- Engineering and agricultural communities

“Our research group brings together a new generation of interdisciplinary researchers focussing on the impact and potential of engineering on remote communities and their environments.”
Professor Caroline Baillie
Engineering System Health

Designing asset health measurement, prediction and risk solutions to advance remote engineering operations and systems

Remote engineering involves asset intensive industries such as energy, mining, infrastructure and transportation.

Projects for these industries often include a myriad of assets diversified by function, geographic location and environmental and cultural context.

Our researchers aim to bring significant change in the field of asset health management with improved sensing diagnostics and prognostics.

Example research areas
- Fleet system health measures
- Underwater near-field acoustics for early failure detection
- System health input to mine production optimisation
- Prediction and control of haul truck noise for environmental noise management
- Nano-porous silicon for next generation MEMS sensors
- Wireless active noise and vibration sensors and control for remote health

“Using system health measures is vital for remote operations and maintenance.”

Professor Melinda Hodkiewicz
BHP Billiton Research Fellow in Engineering for Remote Operations

Fluid Science and Resources

Understanding fluids to optimise resource recovery and minimise environmental impact

Global energy demands are projected to increase by 50% by 2030, requiring exploration and production for hydrocarbons in hostile and/or inaccessible environments.

As these conventional oil and gas resources provide the input to a wide variety of industries – including fuels, plastics, rubbers, and explosives – a deeper understanding of fluid behaviour in the reservoir, pipelines, and refining systems is necessary to support the industry’s exploration and production in harsh environments.

Example research areas
- Maximising the value of the remote/inaccessible assets through new operational understanding and novel technologies enabling new frontiers of production
- Innovative fluid characterisation techniques and laboratory technologies (existing and future) to better understand the knowledge gaps within the industry
- Provide a critical point of technology to build future relationships with industry

“Humanity’s long-term prosperity depends on the ability to supply energy.”

Professor Eric May
Chevron Chair in Gas Process Engineering
Offshore Facilities and Ocean Systems

Engineering for the design, construction and operation of offshore ocean facilities

The Offshore Facilities and Ocean Systems research group delivers solutions for the safe and sustainable development of resources for energy, minerals and food production in the ocean environment.

The group has capabilities in offshore oil and gas, floating liquefied natural gas (FLNG), offshore and coastal renewable energy, offshore mining, marine aquaculture and ocean management.

Example research areas
- Design, operation and asset management of FLNG and other Australian floaters
- Safe and efficient cyclone prediction and responses for offshore facilities
- Deployment of renewable energy devices offshore Australia
- Design and asset management of subsea facilities
- Environmental effects offshore spill monitoring and responses; rigs to reefs connectivity; efficient asset decommissioning

Real-time Optimisation, Scheduling and Logistics

Tackling some of the most challenging remote engineering automation, scheduling, and logistics problems to optimise real-time decisions and mitigate time-delay, environmental and resource related impacts

Our researchers develop optimisation, scheduling and control solutions for the mining and offshore extraction sectors and associated operations, such as transport, energy supply and the servicing of remote communities.

The group has extensive experience in applied engineering and combinatorial mathematics in a range of industrial applications.

Example research areas
- Optimising operational decision-making in industrial settings
- Dynamic adaptive scheduling using evolutionary algorithms and formal modelling
- Optimising maintenance scheduling
- Offshore oil and gas logistics
- Dynamic control of new generation high-density thickeners

"Intelligent automation technologies route vehicles, control storage, schedule labour and resources, organise maintenance and respond to unforeseen events."

Professor Andy Fourie
Robots and Automation

Underpinning the future strength of remote engineering structures

Our overall goal is to ensure the long-term stability of onshore and offshore structures, open pits and underground excavation in remote locations through improvements to safety and productivity, including tunnels, underground mines, and petroleum or geothermal operations.

Our researchers use computational models to predict mechanical structural behaviour and to integrate information supplied from sensors and monitoring for real-time modelling.

Example research areas

- Mechanics and dynamics of fragmented solids and interlocking
- New monitoring techniques and methods of measurement
- Real-time finite element and meshless computational methods for large deformation solid mechanics
- Bi-phasic (porous media) models
- Fracture mechanics and mechanics of rock failure

Developing smarter autonomous systems

Providing expertise and solutions to spatial awareness and remote autonomous operations of robotic systems. Unmanned and remote autonomous systems and self-directed, maneuverable and interactive robots will allow us to go boldly where no one has gone before.

Robotics and Automation will address the challenges and problems of applications that revolve around engineering systems where continuous human presence is either undesirable or impossible, and where tele-operation and automation are desirable or necessary.

Example research areas

- Robotics
- Computer vision
- Signal and Image Processing
- Autonomous Drive Systems
- Electric Drive Systems
- Telepresence and Remote Control

Developing novel modelling and remote monitoring methods for mining, petroleum and geothermal activities is critical for safety, and productivity and sustainability.

Professor Arcady Dyskin

Structural Mechanics, Geomechanics and Computation

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Professor Arcady Dyskin
Further research strengths

Along with a unique focus on Engineering for Remote Operations, our Faculty has extensive international expertise in Bioengineering and Pure Mathematics.
Integrating knowledge in engineering, medicine and the life sciences to support ground-breaking advances in medicine and healthcare

Our researchers collaborate with leading international medical institutes and scientists to design new technologies, robots and computer systems to improve medical services.

For example, our Optical + Biomedical Engineering Laboratory have invented a ground-breaking hypodermic camera to guide surgeons and help cure cancer.

Example research areas include:

- Computational and systems biology and computational physiology
- Biomechanics (computational, soft tissue, prosthesis design and integration with biological systems)
- Biomaterials (tissue properties and engineering, bio-replacement materials)
- Biosensors and systems
- Biomedical optics, biophotonics, and bioimaging
- Clinical medicine (medical device engineering, biomedical diagnostics, surgical guidance and simulation, medical imaging and analysis, mathematical medicine, e-health informatics)
Pure Mathematics

Exploring the abstract concepts that provide the foundations for developments in applied mathematics and technology

The Pure Mathematics research group brings together an internationally recognised team of pure mathematicians with a diverse skill set.

Research expertise covers:
• Finite group theory
• Group actions
• Algebraic graph theory
• Algebraic combinatorics
• Dynamical systems
• Approximation theory
• Differential geometry
• Mechanics
• Matroid theory
• Finite geometry
• Algorithm design
• Graph theory
• Ergodic theory
• Inverse scattering
• Spectral theory

Institutes

Staff from the Faculty of Engineering, Computing and Mathematics also participate in University-wide institutes, including the Energy and Minerals Institute and Oceans Institute.

Discover more about our Faculty’s leading research at ecm.uwa.edu.au/research

UWA’s unique engineering modelling facilities include the world’s busiest geotechnical centrifuges and an ‘O-Tube’ cyclone simulator.