2012 UQ ENGINEERING POSTGRADUATE RESEARCH CONFERENCE

Monday 4 June – Hawken Engineering Building (50),
The University of Queensland, St. Lucia Campus
WELCOME

Welcome to the 4th Postgraduate Student Conference for the Schools of Mechanical & Mining Engineering; Civil Engineering; Chemical Engineering; Information Technology and Electrical Engineering (ITEE) and the Advanced Water Management Centre (AWMC).

The Engineering Postgraduate Research conference provides post graduate students with the opportunity to present their research projects to academia and industry, improve presentation skills and network with potential employers and research partners.

There are limited opportunities for post graduate students to present research to peers in a conference setting, so this occasion provides an important platform for students to gain vital experiences in a supportive environment.

The conference also presents a great opportunity for attendees to interact and gain an overview of post graduate research in the different engineering schools at UQ.

At the end of this meeting you should have an enhanced appreciation of the many and varied research activities being undertaken across the broad fields of research in engineering at UQ. You may also feel some pride in belonging to a community that pursues excellence in research, promotes collaboration, fosters integrity, and encourages creativity and innovation.

I anticipate you will enjoy this meeting and I hope that you find it both interesting and educative.

Professor Graham Schaffer
Executive Dean
Faculty of Engineering, Architecture, and Information Technology
MESSAGE FROM THE CONFERENCE CHAIR

Welcome to the 2012 UQ Engineering Postgraduate Research Conference for the Schools of Information Technology and Electrical Engineering; Mechanical & Mining Engineering; Civil Engineering; Chemical Engineering and the Advanced Water Management Centre! We extend a warm welcome to all delegates from industry and academia who join us for the dissemination of new ideas and technical discussions.

The 2012 UQ Engineering Postgraduate Research Conference covers contemporary topics in the field of Engineering, such as Signals Processing and Control, Computational Intelligence and Computer Systems, Energy Systems, Mining and Minerals Processing, Nano and Advanced Materials, Environmental Engineering and Sustainability, Materials Manufacturing and Processing, Continuum Mechanics and Computational Fluid Dynamics, Structure and Transport Engineering, Biotechnology and Bioengineering and Numerical Methods, Simulation and Modelling etc. The conference also provides a chance for attendees to interact and gain an overview of research across the different Engineering schools and to see the latest research from UQ Engineering.

On behalf of the organizing committee, we would like to express our heartfelt thanks to all the authors for their outstanding contributions, and in particular, the members of the program board for their competent evaluation of the large number of submissions. Likewise, we would also like to express our appreciation to the program and awards committee, keynote speaker Dr David Noon of Ground Probe, as well as to our high calibre speakers Professor Andrew Bradley, Professor Ross McAree, Professor Ling Li, Associate Professor Peter Nielsen, Dr Timothy Nicholson and Dr Bogdan Donose for their wonderful and knowledgeable presentations in the information sessions held on 15, February 2012 and 15, March 2012. The aim of the information session was to assist postgraduate students with the preparation of their abstract and presentation, ensuring the students gained maximum benefits from the experience.

We would like to sincerely thank our financial supporters and sponsors of the 2012 UQ Engineering Postgraduate Research Conference: Schools of Information Technology and Electrical Engineering, Mechanical & Mining Engineering, Civil Engineering, Chemical Engineering and the Advanced Water Management Centre, Marketing & Communication department, The Faculty of Engineering, Architecture and Information Technology (EAIT), The University of Queensland, John Morris Scientific, LSE Pty Ltd and Bio Scientific Pty Ltd.

Finally, we wish to thank the 2012 UQ Engineering Postgraduate Research Conference steering committee members, the host organization The University of Queensland, Mr Trent Leggatt (Marketing & Communications Manager, The Faculty of EAIT), Ms Izaael Koh (Marketing & Events Officer, The Faculty of EAIT) and the volunteers for their assistance in organizing this conference. We also wish to thank you for attending the conference and being a part of this very important event.

Vinita Nahar
Chairperson: The UQ Engineering Postgraduate Research Conference, 2012
MESSAGE FROM THE CONFERENCE VICE-CHAIR

It’s my great pleasure to welcome you to the 4th annual UQ Engineering Postgraduate Research Conference. This conference offers an opportunity to Engineering RHD candidates to present their work in front of a wide variety of audiences from academia and industry.

As part of the organising committee, I have had great pleasure working with this enthusiastic team. I would like to extend my gratitude and thanks to the academic, administrative and technical staff for their support in making the 4th conference possible.

I hope that you will enjoy the day and will be able to use the opportunity to exchange ideas.

Kazi Nazmul Hasan
Vice-Chair: The UQ Engineering Postgraduate Research Conference, 2012

MESSAGE FROM THE CONFERENCE SECRETARY

Welcome to the 2012 Postgraduate Conference

The goal for this year’s conference is that;

“The UQ Engineering Postgraduate Conference will provide an opportunity for engineering postgraduate students to present their research to academia and industry, improve presentation skills, and network with potential employers and research partners. The conference also provides a chance for attendees to interact and gain an overview of research across the different engineering schools.”

Since our planning began in July last year the conference committee have made every effort to meet this goal. Throughout this process we have had the assistance of many people including those formally acknowledged and many more informally and I would like to thank them all. We hope you enjoy the day and that it is a worthwhile investment of your time.

Being a part of the organising committee has been an enjoyable experience, which has allowed me to learn many new skills. I would encourage you to consider joining the committee to plan a bigger and better conference in 2013.

Heather Shewan
Secretary: The UQ Engineering Postgraduate Research Conference, 2012
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KEYNOTE SPEAKER

Dr. David Noon, PhD (UQ), Co-founder, GroundProbe, FATSE, FAusIMM

David Noon is a co-inventor of the patented Slope Stability Radar technologies and co-founder of GroundProbe. David has led the successful global commercialization of this new technology with GrondProbe, which is now considered world’s best practice in mining with over 150 installations in 19 countries. Prior to forming GroundProbe, David was a Senior Research Fellow at the University of Queensland (1996-2003), working in a team to develop and commercialize radar technologies for the mining industry. The intellectual property and business plan resulting from his team’s efforts created GroundProbe. David graduated from The University of Queensland with a Bachelor of Engineering in Electrical Engineering with First Class Honors in 1991 and with a PhD Degree in 1996. Since then he has completed executive management training at both Stanford and MIT. David is a Fellow of the Australian Academy of Technological Sciences and Engineering, and a Fellow of the Australasian Institute of Mining and Metallurgy Engineers.
PARTICIPATING SCHOOLS AND CENTRES

SCHOOL OF CIVIL ENGINEERING
Civil Engineering at UQ performs research in six disciplines as listed below. In each discipline, the research is to various degrees theoretical, respectively applied and similarly very international versus locally inspired in different areas.

Conference advisory board: Associate Professor Peter Nielsen

DISCIPLINE AREAS:
- Structural engineering
- Environmental engineering
- Geotechnical engineering
- Transportation engineering
- Environmental Fluid Mechanics
- Coastal and Hydraulic Engineering

SCHOOL OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING
The School of ITEE carries out research in all areas of Information and Communication Technology, combining academic excellence with social and industrial impact.

Conference advisory board: Associate Professor Andrew Bradley (RHD Director, ITEE)

DISCIPLINE AREAS:
- Biomedical Engineering
- Cognitive System Engineering
- Complex & Intelligent Systems
- Data & Knowledge Engineering
- Microwave & Optical Communications
- Systems & Software Engineering
- Power & Energy Systems
- Security & Surveillance
- Ubiquitous Computing
- e-research

SCHOOL OF MECHANICAL & MINING ENGINEERING
The School of Mechanical and Mining Engineering conducts research to meet diverse and evolving needs of society. The School has established strengths in Light Metals, Mining Technology and Equipment, and Hypersonics. These are complimented by evolving strengths in composites, geothermal energy, metals, manufacturing and rock mechanics.

Conference advisory board:
Professor Ross McAree, Professor David St John, Associate Professor Rowan Truss, Professor Michael Smart, Professor Hal Gurgenci, Mr Matthew Dargusch and Associate Professor Han Huang

DISCIPLINE AREAS:
- Light Metals
- Polymers and Composites
- Rail Engineering
- Hypersonics
- Geothermal Energy
- Combustion and Coal Gasification
- Ultrasonics
- Mining Technology and Equipment
- Smart Machines
SCHOOL OF CHEMICAL ENGINEERING

The School of Chemical Engineering is a premier Australian research school and leads the world in a number of identified research strengths.

The School’s researchers are constantly pushing the boundaries to achieve international research breakthroughs in a diverse range of areas, including bioengineering, nanomaterials, high performance polymers, metallurgical engineering as well as waste and water resource management.

UQ chemical engineers work in partnership with many international institutions and companies, and have an impressive track record of technology transfer.

Conference advisory board:
Professor Peter Halley, Dr Timothy Nicholson

DISCIPLINE AREAS:
- Adsorption and Reaction Engineering
- Nanomaterial, Biomaterials and Polymers
- Food
- Water and Resource Management
- Energy and Environment Engineering
- Biological and Bimolecular Engineering
- Tissue Engineering and Microfluidics
- Hydrometallurgy and Pyro metallurgy
- Mineral Processing and Interfacial Processes

ADVANCED WATER MANAGEMENT CENTRE

The Advanced Water Management Centre (AWMC) is an internationally recognized centre of excellence in innovative water technology and management research. The AWMC thrives on both challenges and opportunities, and is embracing the changes, particularly in the urbane and industrial water context.

We have already a well established and highly successful research program in the sewer management area and the emerging reality of the sewer system becoming part of the overall water supply system will put more emphasis on the source management and control aspects in the urban sanitation system.

The AWMC strength is in the team of engineers, chemists and biomolecular scientists that lead multidisciplinary research programs. We are confident that we can maintain and further grow our strong credentials and we are keen to engage with the broader environmental industry over the coming year.

Conference advisory board:
Associate Professor Damien Batstone

DISCIPLINE AREAS:
- Sewer research
- Water recycling
- Anaerobic processes
- Nutrient removal and bio-products
- Greenhouse gases
- Microbial ecology
- (Bio) electrochemical systems
- Tissue Engineering and Microfluidics
- Hydrometallurgy and Pyro metallurgy
- Mineral Processing and Interfacial Processes
# SESSION TIMES

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<tr>
<th>Time</th>
<th>Program details/ venue</th>
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<tr>
<td>8.00-8.40am</td>
<td>Registration <strong>Venue: 50-T203</strong></td>
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<tr>
<td>8:40-8:50am</td>
<td>Welcome Address</td>
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<tr>
<td>8.50-9.20am</td>
<td>Keynote speech by David Noon <strong>Venue: 50-T203</strong></td>
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<tr>
<td>9.25-10.30am</td>
<td>Energy Systems <strong>Venue: 50-T203</strong></td>
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<td>Materials Manufacturing &amp; Processing <strong>Venue: 50-N201</strong></td>
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<td>Computational Intelligence and Computer Systems <strong>Venue: 50-T103</strong></td>
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<td>Continuum Mechanics &amp; CFD <strong>Venue: 50-N202</strong></td>
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<tr>
<td>10:35-10:55am</td>
<td>Morning Tea <strong>Venue: Hawken Bldg (50) Corridor</strong></td>
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<td>11.00am-12.45pm</td>
<td>Energy Systems <strong>Venue: 50-T203</strong></td>
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<td>Materials Manufacturing Process Processing &amp; Biotech and Bioengineering <strong>Venue: 50-N201</strong></td>
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<td>Mining &amp; Minerals <strong>Venue: 50-T103</strong></td>
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<td>Signals Processing &amp; Control <strong>Venue: 50-N202</strong></td>
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<tr>
<td>12:50-1.30pm</td>
<td>Lunch <strong>Venue: Hawken Bldg (50) Corridor</strong></td>
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<tr>
<td>1.35-3.10pm</td>
<td>Environmental Engineering and Sustainability <strong>Venue: 50-T203</strong></td>
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<td>Nano and Advanced Materials <strong>Venue: 50-N201</strong></td>
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<td>Numerical Methods <strong>Venue: 50-T103</strong></td>
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<td>Structure &amp; Transport Engineering <strong>Venue: 50-N202</strong></td>
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<tr>
<td>3:10-3:30pm</td>
<td>Afternoon tea <strong>Venue: Hawken Bldg (50) Corridor</strong></td>
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<tr>
<td>3.35-4.40pm</td>
<td>Environmental Engineering and Sustainability <strong>Venue: 50-T203</strong></td>
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<td>Nano and Advanced Materials <strong>Venue: 50-N201</strong></td>
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<td>Numerical Methods <strong>Venue: 50-T103</strong></td>
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<td></td>
<td>Structure &amp; Transport Engineering <strong>Venue: 50-N202</strong></td>
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<tr>
<td>4:40-4:50pm</td>
<td>Break</td>
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<tr>
<td>4:50-7.00pm</td>
<td>Prize Awards and Conference Networking <strong>Venue: 1st Year Learning Centre</strong></td>
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## CONFERENCE PROGRAM

### 9.25-10.30 Session 1

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<tbody>
<tr>
<td><strong>Presenting Author</strong></td>
<td><strong>Energy Systems (5)</strong></td>
<td><strong>Materials Manufacturing and Processing (5)</strong></td>
<td><strong>Computational Intelligence and Computer Systems (5)</strong></td>
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<tr>
<td><strong>9.25</strong></td>
<td>Carlos André de Miranda Ventura</td>
<td>Numerical Model for the Preliminary Design and Performance Estimation of Radial Inflow Turbines Coupled with a Thermodynamic Cycle Analysis</td>
<td>Luigi-Jules Vandi</td>
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<tr>
<td><strong>9.38</strong></td>
<td>Jeffery C. Chan</td>
<td>Condition Monitoring and Fault Diagnosis of Power Transformer Based on Partial Discharge Pattern Recognition</td>
<td>Reza Salimi</td>
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<tr>
<td><strong>10.04</strong></td>
<td>Nadali Mahmoudi</td>
<td>Energy Procurement by an Electricity Retailer Considering Demand Response</td>
<td>Dekui Mu</td>
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<td>Time</td>
<td>Author(s)</td>
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<tr>
<td>10.17</td>
<td>Huong-Mai Nguyen</td>
<td>Power System Stability due to Long Distance Transmission</td>
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<tr>
<td>10.17</td>
<td>Ubong Ubong Ntuk</td>
<td>Development of a novel process for recovering fluoride and other valuables from spent pot-lining</td>
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<tr>
<td>10.17</td>
<td>Vinita Nahar</td>
<td>Analysis and Prediction of Emerging Sensitive Social Events</td>
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<tr>
<td>10.17</td>
<td>Shujun Ma</td>
<td>A simple resonant method that can simultaneously measure elastic modulus and density of thin films</td>
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<tr>
<td>11.00</td>
<td>Jie Zhang</td>
<td>Mixed-Fluid Organic Rankine Cycles for Low-Temperature Power Conversion</td>
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<tr>
<td>11.00</td>
<td>Yang Xia</td>
<td>The effect of Co on sintering of gamma TiAl based alloys</td>
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<tr>
<td>11.00</td>
<td>Peter Beasley</td>
<td>A linear relaxation solution to the Tactical Movement Problem</td>
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<tr>
<td>11.00</td>
<td>Tristan J. Shelley</td>
<td>Application of Wavelet Parameters for Impact Damage Detection in Plates</td>
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<tr>
<td>11.13</td>
<td>Rajinesh Singh</td>
<td>Operation of a Closed Brayton power generation cycle</td>
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<tr>
<td>11.13</td>
<td>Robin Dawson</td>
<td>Use of Rheometry to understand Structure Development during Coking: Implications for Controlling and Predicting Coke Strength Indices</td>
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<tr>
<td>11.13</td>
<td>Tyson Phillips</td>
<td>Employing Range Scanners for the Automation of Mining Equipment</td>
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<tr>
<td>11.13</td>
<td>Mohammad Amanzadeh</td>
<td>Development of a tapered fibre sensor head for measuring methane in underground coal mines</td>
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<tr>
<td>11.26</td>
<td>Ampon Chumpia</td>
<td>Improving the performance of air-cooled condensers by using metal foams – Preliminary results</td>
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<tr>
<td>11.26</td>
<td>Imam Santos</td>
<td>Phase Equilibria Studies of Cu-S and Cu-Fe-S systems</td>
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<tr>
<td>11.26</td>
<td>Weng Fu</td>
<td>The Mechanisms of Secondary Nucleation of Alumina Trihydrate in Bayer Process</td>
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<td>11.26</td>
<td>Xingrang Liu</td>
<td>Optimizing Combustion Process by Adaptive Tuning Technology Based on Integrated Genetic Algorithm and Computational Fluid Dynamics</td>
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<tr>
<td>11.39</td>
<td>Kazi Nazmul Hasan</td>
<td>Emission Pricing and Locational Signal Impact on Generation Portfolio in Large Scale Queensland Network</td>
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<tr>
<td>11.39</td>
<td>David Konigsberg</td>
<td>A Novel On-Line Rheometer</td>
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<td>11.39</td>
<td>John Dudley</td>
<td>Motion feedback applied to assist non-line-of-sight teleoperation of a bulldozer</td>
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<tr>
<td>11.39</td>
<td>Aleš Neubert</td>
<td>Clinically-based MRI analysis of spine anatomies</td>
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<tr>
<td>11.52</td>
<td>Mohd Fairouz Mohd Yousof</td>
<td>Assessment of Transformer Winding Deformation using Frequency Response Analysis</td>
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<tr>
<td>11.52</td>
<td>Heather M. Shewan</td>
<td>Exploring the Liquid-Like and Solid-Like Rheology of Soft Particle Suspensions</td>
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<tr>
<td>11.52</td>
<td>Nima Noraei Danesh</td>
<td>Experimental Simulation of Flow Behaviour in Pre-drainage Boreholes</td>
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<tr>
<td>11.52</td>
<td>John Varghese</td>
<td>The importance of neural noise in attempting to unravel the neural code.</td>
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<tr>
<td>Time</td>
<td>Name</td>
<td>Title</td>
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<tr>
<td>12.05</td>
<td>Rakibuzzaman Shah</td>
<td>Interaction Analysis of Power System with High Penetrations of Renewable Generators and FACTS Controllers</td>
<td>Aarti Tobin</td>
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<td>1.35</td>
<td>Moritz Schwing</td>
<td>Coupled mechanic, hydraulic and dielectric material properties of fine-grained soils</td>
<td>Zheng Xing</td>
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<td>1.48</td>
<td>Wei Han</td>
<td>Algal composting</td>
<td>Lei Yang</td>
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<tr>
<td>2.01</td>
<td>Patrick Littlejohn</td>
<td>Resin-in-Pulp for Acid Mine Drainage Remediation</td>
<td>Guang Han</td>
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1.35-3.10 Session 3

Venue: 50-T203

Presenting Author: Environmental Engineering and Sustainability (7)

Venue: 50-N201

Presenting Author: Nano and Advanced Materials (7)

Venue: 50-T103

Presenting Author: Numerical Methods (7)

Venue: 50-N202

Presenting Author: Structure & Transport Engineering (7)
| 2.27 | Changlei Qin | Behavior of CaO/CuO Based Composite in a Combined Calcium and Copper Chemical Looping Process | Ying Yang | Effects of Different Activated Solvents on the Gas Adsorption Properties of Cu-BTC | To Huu Duc | Sphere packing algorithm for soil structure simulation | Ilya K. Othman | The Influence of Pressure Gradient on Swash Zone Sediment Transport |
| 2.40 | Fangzhou Du | Metal removal and recovery from anaerobic sludge using (bio)electrochemical systems | Anshun He | Mechanical Properties and Deformation of LiTaO3 Single Crystals Characterised by Nanoindentation and Nanoscratch | Hong Tao Xie | Finite element analysis for Nano indentation and indentation-induced delamination of biayer thin film | Hamid R. Safi | Comparing GPS-Based Prompted-Recall Household Travel Surveys and Proposing a New Framework |
| 2.53 | Katrin Doederer | Assessment of disinfection by-products during the production of High Quality Recycled Water | Yen Thien Chua | Ordered mesoporous silica membrane for desalination using membrane distillation | Sicong ZHU | Regression model variable selection by Genetic algorithm | Mehran Zeynalian | An analytical model for nonlinear hysteretic performance of a bilinear hysteretic system |

### 3.35-4.40 Session 4

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<tr>
<th>Presenting Author</th>
<th>Environmental Engineering and Sustainability (5)</th>
<th>Presenting Author</th>
<th>Nano and Advanced Materials (4)</th>
<th>Presenting Author</th>
<th>Numerical Methods (5)</th>
<th>Presenting Author</th>
<th>Structure &amp; Transport Engineering (3)</th>
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<tr>
<td>3.35 Marie-Laure Pype</td>
<td>Development of surrogates to monitor reverse osmosis membrane integrity and performance during filtration of pre-treated secondary effluent</td>
<td>Gianni Olguin</td>
<td>Cobalt Silica Membranes for Gas Separation: Structural Modification via Cationic Surfactant</td>
<td>Tomas Storck</td>
<td>Individual and variable geometry based modelling of direct interspecies electron transfer in microbes</td>
<td>Shijie Jiang</td>
<td>Validation of railway rolling noise prediction model under Australian conditions</td>
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<tr>
<td>3.48 Neetu Bansal</td>
<td>Determination of Mercury Departent in the Bayer Process and Opportunities for its Removal</td>
<td>Guang Zeng</td>
<td>Effect of Zn, Au and In on the polymorphic phase transformation in Cu6Sn5 intermetallics</td>
<td>Van T. Nguyen</td>
<td>Application of Kinetic Monte Carlo Method in the Microscopic Description of Argon Vapour-Liquid Equilibrium and Adsorption on Graphite</td>
<td>Vui CAO VAN</td>
<td>Damage assessment for concrete</td>
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<tr>
<td>Time</td>
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<td>4.01</td>
<td>Steven Kenway</td>
<td>Analysis of Water-Related Energy in a Queensland Household</td>
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<td></td>
<td>Nor Aida Zubir</td>
<td>Synthesis and characterization of water dispersible graphene oxide-Fe3O4 nanocomposites</td>
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<td>Duong Quoc Hung</td>
<td>Optimal Operating Strategies of Distributed Generation Unit for Loss Reduction in Primary Distribution Systems</td>
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<td></td>
<td>Xiaogang Liu</td>
<td>The investigation on generation mechanism of curve squeal</td>
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<td>4.14</td>
<td>Rikke Krogshave Laursen</td>
<td>The influence of a major inflow event on the thermal stratification of a water supply reservoir</td>
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<td>Mingyuan LU</td>
<td>Indentation induced delamination of SixNy film on (001) GaAs substrate</td>
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<td></td>
<td>Kristian Weegink</td>
<td>Computational Models for Understanding Pathological Behaviour in Microelectrode Recordings</td>
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<td>4.27</td>
<td>Yuting Pan</td>
<td>The Effect of H2S on N2O Accumulation in wastewater treatment plant</td>
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<td>Somayeh Behraftar</td>
<td>Review of mathematical models for prediction of the well trajectory</td>
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## JUDGES

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<th>Category</th>
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| Energy systems                                                   | Dr. Kamel Hooman  
                     Prof Hal Gurgenci  
                     Dr Vince Wheatley  |
| Computational intelligence and computer systems                  | Dr. Paul Bellette  
                     Professor Andrew Bradley  
                     Dr David Mason  |
| Continuum mechanics and CFD                                      | Prof Ling Li  
                     Assoc Prof. Lydia Kavanagh  
                     Dr. Chandima Ekanayake  |
| Materials manufacturing and processing and biotechnology and bioengineering | Dr Howard Leemon  
                     Dr Bogdan Donose  
                     Dr Timothy Nicholson  |
| Mining and minerals processing                                   | Dr Bill Daniel  
                     Dr Aleks Atrens  |
| Signals processing and control                                   | Professor Andrew Bradley  
                     Dr. Chandima Ekanayake  
                     Dr David Mason  |
| Environmental engineering and sustainability                      | Prof Ling Li  
                     Dr Bogdan Donose  |
| Nano and advanced materials                                      | Dr Hui Ma  
                     Dr Timothy Nicholson  |
| Numerical methods, simulation and modelling                       | Dr. Kamel Hooman  
                     Prof Peter Halley  
                     Dr David Mason  |
| Structure and transport engineering                              | Dr Aleks Atrens  
                     Dr Howard Leemon  |
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ABSTRACTS

THEME: BIOTECHNOLOGY AND BIOENGINEERING

A Novel On-Line Rheometer
David Konigsberg, Chemical Engineering

Oscillatory squeeze flow rheometers offer a novel measurement geometry setting them apart from rotational shear rheometers allowing them to operate at much higher frequencies and to be used for on-line, or potentially in-line, quality and process control. Using computer simulations and practical trials, an oscillatory squeeze flow rheometer is shown to be capable of measuring the rheological profile of a fluid with an accuracy rivalling that of conventional oscillatory shear rheometers. Future research plans to show the operational parameter range of this technique and applications of this technology for the measurement of large amplitude oscillatory squeezing (LAOSq) are discussed.

Exploring the Liquid-Like and Solid-Like Rheology of Soft Particle Suspensions
Heather M. Shewan, Chemical Engineering

Complex suspensions of soft spheres such as emulsions, micelles and plant cells are an integral part of each day from your morning yoghurt to your night cream. These complex suspensions are solid-like at rest, but liquid-like under shear. This behaviour is influenced by the particle volume, easy to define for hard particles but a moving target for soft particles as volume is not constant with suspension concentration. We use a model system of spherical agarose microgels and present a unique method, Inverse Quemada Analysis, to elucidate this volume influence at low concentration, to investigate behaviour at high concentration and to explore suspension rheology in narrow gaps.

Designing safe to swallow foods for dysphagia
Aarti Tobin, Chemical Engineering

Dysphagia (swallowing disorder) sufferers are fed normal food that has been reduced in size through the process of either mincing or pureeing. When plant based materials are processed from minced to pureed consistency, the overall composition of the system in terms of the ratio of viscous (cellular fluid) and elastic (cell clusters and single cells) components change. How these multi-dispersed, solid-like systems with a large variation in particle shape and size pack, impacts on the rheological behaviour of these foods. The challenges in characterising these systems and understanding which aspects of their microstructure make them safe to swallow.
The flow of thickened infant formula through a range of bottle teats

*Cindy September, Chemical Engineering*

Infants with swallowing problems are fed thickened formula to prevent aspiration. Arising issues on how to control the (i) thickness of the thickened formula and (ii) flow through the teats were addressed in this work. Infant formula thickened with a food thickener and pre-thickened anti-regurgitate formula were characterised using a rheometer and the flow as a function of pressure-drop measured across a range of different sized teats. This will lead to the development of a model of flow through the teat as function of fluid, teat shape and suction which will enable clinicians to better prescribe a combination of thickened formula and teat size.

THEME: COMPUTATIONAL INTELLIGENCE AND COMPUTER SYSTEMS

Long Summer Days: Grounded Learning of Words for the Uneven Cycles of Real World Events

*Scott Heath, ITEE*

Time and space are fundamental to human language and embodied cognition. In previous work, Lingodroids, the robots with the ability to build their own maps could evolve their own spatial and temporal languages. This work will demonstrate how words and concepts like morning, afternoon, dawn and dusk can be grounded through experience with features of events rather than merely the time measured by clocks or calendars. Created terms are then tested by scheduling meetings. 9/10 meetings were successful, with an average waiting time of 12s and meeting distance of 0.4m. These studies show that using sunlight grounded time to schedule meeting tasks has a high success rate and is convenient when describing a task that must co-occur with an event.

The Development of Web Table Search Engine

*Han Su, ITEE*

The structure data type is widely used by the relational tables since it is a good carrier of valuable information in web. However, a proper index method for tables is still lacking. In this work we propose an indexing method, which can index both content and structural query, e.g. Entity-Attribute(EA) pattern, Concept-Attribute(CA) pattern and other four 4 patterns. We build a novel table-based search engine to give users the direct answers of query without the users’ selection and collection.
OGDL: A framework of Ontology Guided Data Linkage for Information Sharing

Mohammed Gollapalli, ITEE

There has been a surge of interests in developing probabilistic techniques for linking semantic equivalent datasets. The key objective is to transform the structure of the induced data into a concise synopsis. Current techniques primarily focus on performing pair-wise attribute matching and pay little attention in discovering direct and weighted correlations among ontological clusters through multi-faceted classification. In this research, we introduce a novel Ontology Guided Data Linkage (OGDL) framework for self-organising and discovering schema structures through constructing a hierarchical cluster mapping trees. We will demonstrate the accuracy, robustness and scalability of OGDL through extensive numerical evaluations on real-world datasets.

Context Aware Integration of End-to-End and Opportunistic Communication

Ranjana Pathak, ITEE

One of the research topics in the area of wireless mobile networks is on finding a new communication paradigm/protocol that can deal with dynamically changing connections between nodes. Connections between nodes may not be stable for long time in the networks, in which the end-to-end paths between source-destination pairs may not be available to allow message delivery. Due to unstable end-to-end paths, performance of traditional end-to-end transport communication protocols (i.e. TCP, UDP, RTP) degrades dramatically and are not able to deliver packets to the destination. There has been a substantial amount of research on opportunistic communication that can make use of intermittent connections for pair-wise delivery between nodes with packets opportunistically hopping between nodes until they reach their destination. This research aims to integrate end-to-end and opportunistic modes of communication based on the gathering of current network situation, which can be obtained from a variety of sources, both local and global.

Analysis and Prediction of Emerging Sensitive Social Events

Vinita Nahar, ITEE

This research investigates data-mining methods for the effective detection of emerging sensitive social events. Previous studies on the sensitive events such as cyber bullying have considered detection under supervised learning. However, the exponential growth of unlabelled online content makes these approaches impractical to combat real-world sensitive events detection effectively. We proposed an ensemble based, one-class classification scheme for the streaming text of sensitive events detection based on key-word search, which was collected from previous similar works. It also identifies “predators” and “victims” through the ranking algorithms, which have been applied on a graph model to identify the most influential predators and the most offended victims. The preliminary results indicate 99.50% of accuracy of proposed data modelling. Our proposed method outperformed the other detection methods and was able to find the most influential “predators” and “victims”. This research will further investigate the proposed method in the real world scenario to identify confirmed sensitive cases based on the communication pattern of the user.
THEME: CONTINUUM MECHANICS AND COMPUTATIONAL FLUID DYNAMICS

Scaling Studies of an Inlet Fuelled Axisymmetric Radical Farming Scramjet Engine

Daniel Oberg, Mechanical and Mining Engineering

Ground test facilities used for scramjet testing and development have size limitations that require the use of scaled down models. Without knowledge of the effects of geometric scale on scramjet performance, the ability to apply ground test data to full scaled prototypes is limited.

A study into the effects of geometric scale on the performance of an inlet fuelled axisymmetric radical farming scramjet engine is presented. A numeric parametric scaling study demonstrated that the underlying coupled flow physics and chemistry are complex and do not follow the scaling criteria derived from an analytical similarity study based on a simplified scramjet model. This presentation examines these findings and discusses the effects of geometric scale on the coupled flow and chemistry phenomena.

Development of Two-phase Modelling Capability for the Simulation of Condensing Flows in Turbomachinery

Peter Blyton, Mechanical and Mining Engineering

Large power generation systems typically use turbines to convert thermal energy to mechanical work, which is then converted to electrical energy in a generator. Nearly always, the expanding fluid (steam) remains as a single, gaseous phase throughout the expansion process that occurs within the flow path of the turbine. This project involves the development of a two-phase model for use in designing turbines that experience partial condensation of the expanding working fluid. This presentation will demonstrate the use of realistic gas models in the analysis of flow behaviour and will discuss the plans to extend these real gas models to incorporate the secondary, condensing fluid phase.

Forced Transition of Hypervelocity Boundary Layers

Dylan Wise, Mechanical and Mining Engineering

It is well documented that in order to provide the most robust scramjet propulsion system, a turbulent boundary layer is required at the inlet interface. As scramjets are pushed into the hypervelocity regime for access-to-space, the ability to reliably predict and control the state of the boundary layer becomes vital for both flight and tunnel testing. Little hypervelocity transition data within the literature meant that to successfully test scramjets at hypervelocity conditions in T4 a transition experiment was required. These experiments on a flat plate resulted in a trip configuration capable of tripping a boundary layer at 3.5 km/s.
Superorbital re-entry shock layers: flight and laboratory comparisons

Elise Fahy, School of Mechanical and Mining Engineering

Superorbital re-entry vehicles must withstand significant heating upon descent through the atmosphere, yet their thermal protection systems are still being designed with a lack of understanding of the basic processes involved. Spectral radiation measurements were taken by UQ during the Hayabusa capsule re-entry over Woomera in 2010, and this project will attempt to replicate the flight conditions in the UQ expansion tunnels. Comparison between ground testing, flight data and theory will help to reduce uncertainties in thermal protection systems, ultimately leading to smarter design of re-entry vehicles by improving safe design margins and increasing the mass available for payload.

A simple resonant method that can simultaneously measure elastic modulus and density of thin films

Shujun Ma, Mechanical and Mining Engineering

By measuring the resonant frequencies of cantilever beams without and with thin films deposited, and with the use of the Euler–Bernoulli beam theory, the elastic modulus and density of thin films can be determined simultaneously. This simple resonant method was validated using a sputtered Ni film/Si substrate system. The elastic modulus of the Ni film obtained from this method was in excellent agreement with that measured by use of nanoindentation.

THEME: ENERGY SYSTEMS

Numerical Model for the Preliminary Design and Performance Estimation of Radial Inflow Turbines Coupled with a Thermodynamic Cycle Analysis Procedure

Carlos André de Miranda Ventura, Mechanical and Mining Engineering

The integration between a comprehensive preliminary design and performance estimation approach for radial inflow turbines and a thermodynamic cycle analysis procedure is described in the present work. Two original codes were written in Python and validated so they could be integrated and coupled solutions between these two models could be attained. This approach provides a better/more consistent approximation for the overall efficiency of the cycle as conventional methods typically assume predefined/fixed values for the efficiency of the turbomachinery employed in the cycle.

In the present work, results for several ranges of fluids and operating conditions are tested and discussed.
Condition Monitoring and Fault Diagnosis of Power Transformer Based on Partial Discharge Pattern Recognition

Jeffery C. Chan, ITEE

Power transformer plays a crucial role in power grids. To ensure the reliable delivery of electricity, transformer insulation system must be continuously monitored. Partial discharge (PD) detection is a key technique for providing information on transformer insulation system. Due to the stochastic nature of PD phenomenon and its susceptibility to noise, the interpretation of PD data is a non-trivial task. This research develops algorithms for interpreting PD measurements on a number of transformer fault models. The preliminary results show that the developed algorithms can provide an accurate indication on the condition of transformer insulation.

An Investigation of Voltage Ride-Through Issue with Wide Penetration of Small Distributed Generators

Tareq Aziz, ITEE

Different environmental and economic benefits have led to wide-scale integration of small distributed generation (DG) units into distribution systems. Wind, solar, biomass and other broad range of primary energy sources have been utilized through different generation technologies. These may include conventional synchronous and induction generator as well as recently developed power-electronic interfaced generators. However, there is a major concern that these generators lack under-voltage and over-voltage ride through capability and thus demand frequent tripping under current grid standards. Possible remedies to this problem have been developed in this research, which can be utilized to keep such small DG units connected to the grid.

Energy Procurement by an Electricity Retailer Considering Demand Response

Nadali Mahmoudi, ITEE

After power systems restructuring, electricity retailers have become responsible for procuring energy from wholesale markets to supply consumers. While their main aim is to minimize the cost of purchasing from different contracts, they might still face high prices due to the uncertainties in price and consumers’ load.

To solve this issue, a multistage stochastic problem is proposed in this research, where an incentive-based demand response is considered as a virtual energy resource. In this method, a retailer offers adequate rewards to consumers to decrease their load during high prices and therefore, lessens its risk of procuring energy from expensive contracts.
Power System Stability due to Long Distance Transmission

Huong-Mai Nguyen, ITEE

Australia has a target of providing 20% generation from renewable sources by 2020, which is greatly dependent on the exploitation of geothermal and wind energies. However, both of those resources are located very far from the main load centres, which are primarily distributed unevenly along the South East coastal area of Australia. Therefore, the integration of geothermal and wind energies to the existing power grid poses some significant technical challenges. This work addresses the issues of design and operation of long transmission system, which is required for interconnecting the remote geothermal and wind sources to the existing High Voltage AC grid.

Mixed-Fluid Organic Rankine Cycles for Low-Temperature Power Conversion

Jie Zhang, Mechanical and Mining Engineering

In recent years, reducing the consumption of fossil fuels and solving environmental problems has become more and more important. Geothermal energy is one of the popular ways to deal with these problems for electricity generation. In a real cycle, all of the fluid properties have a huge influence on the losses of the whole cycle. So the purpose of this project is to explore and optimize fluid mixtures with Organic Rankine Cycle at low-moderate temperatures of geothermal resources in both subcritical and supercritical conditions to maximize the specific brine benefit for power conversion.

Operation of a Closed Brayton power generation cycle

Rajinesh Singh, Mechanical & Mining Engineering

Closed Brayton Cycles (CBC) potentially offer an alternative to conventional power generation due to their simplicity and applicability over a wide range of temperatures and to a wide variety of heat sources. There is little known about the stability and transient response of the CBC and required control strategies for stable and reliable cycle operation. This work presents experimental results on the transient response of a 1.5 kilowatt laboratory scale CBC using air as the working fluid. The influences of variations in compressor speed and heat addition on thermodynamic parameters are demonstrated along with the requirement and effect of mass removal as a control strategy for design point operation of the cycle.
Improving the performance of air-cooled condensers by using metal foams – Preliminary results

Ampon Chumpia, Mechanical and Mining Engineering

Metal foam-wrapped heat exchangers are being tested for their heat transfer performance and pressure drop in a wind tunnel under a range of air velocity representing that within natural draft cooling towers (0.5 to 5 m/s). Preliminary results of single tube heat exchangers covered with aluminium foam of different thickness, arranged in cross-flow inside the tunnel are presented in comparison with those of a conventional finned surface heat exchanger made of the same material and having comparable dimensions.

This experimental work forms part of a study to validate the previous numerical work done at Queensland Geothermal Energy Centre of Excellence (QGECE). The full project also aims to investigate the suitability and performance of bundles of metal foam heat exchangers under different configurations to be used as an air-cooled, condensing unit for the power cycles of geothermal power plants.

Emission Pricing and Locational Signal Impact on Generation Portfolio in the Queensland Power Network

Kazi Nazmul Hasan, ITEE

This research analyzes possible impacts on the generation portfolio and electricity price that may emerge due to the implementation of the ‘Clean Energy Bill, 2011’ in the Australian National Electricity Market (NEM). An analytical study is presented, simulating the Queensland part of the Australian NEM. Simulation results show market signals for generation investments, highlighting considerable change in the energy matrix and electricity price in the coming decade. The significance of this research will be its comprehensiveness and practicability for the ‘Cooper Basin Geothermal’ connection to the Australian NEM network. Results from this research are expected to improve the investment planning of the NEM network.

Assessment of Transformer Winding Deformation using Frequency Response Analysis

Mohd Fairouz Mohd Yousof, ITEE

Frequency response analysis (FRA) is a technique for assessing the integrity of power transformer winding with the challenge being to properly interpret the measurement results to provide reliable information regarding winding condition. This research implements a highly accurate multi-conductor transmission line (MTL) model to investigate the frequency response of transformer winding prototype from available geometry information. Winding deformation is simulated on this model to demonstrate the impact pattern in corresponding generated frequency response. Finally, FRA measurement on systematically aged transformer (5kVA) which showed minor variation before and after the ageing process will also be presented and discussed.
Interaction Analysis of Power System with High Penetrations of Renewable Generators and FACTS Controllers

Rakibuzzaman Shah, ITEE

Renewable energy based generators are becoming one of the growing components in power systems to combat the contribution of the power sector to climate change. In the mean time, the use of Flexible AC Transmission System (FACTS) device has been increased significantly in power systems for its reliable and secure operation. However, the wide spread concurrent deployment of renewable generators and FACTS devices might lead to the possible negative interactions among power system dynamic components. In this research, a case study of controller interactions in power system in the presence of high penetrations of renewable generators and FACTS are presented. And results show that there there is the possibility of adverse controller interactions during high penetrations of renewable generations.

Stability Analysis of Power System with DFIG-based Wind Farm Connected through Series FACTS Device Compensated Line

A. Kunwar, ITEE

Wind farms are often located in remote locations as they need to be positioned in areas of maximum wind exposure. Therefore, series compensation may be required to transfer power from large wind farms to distant power system through weak transmission line. This paper investigates the small signal stability and transient stability issues of power systems connected to wind farms through series Flexible AC Transmission System (FACTS) compensated transmission lines. The small signal stability analysis shows an increase in damping ratio for most of the oscillatory modes. The transient analysis of three-phase fault indicates improvement in transient stability with the compensation.

Investigation of the impact of moisture and ageing on the polarisation based diagnostics of power transformers.

Raj B. Jadav, ITEE

Power transformers are one of the most important pieces of equipment in the power system. The life of a transformer is mostly restricted to the condition of its oil-paper insulation. Recently, dielectric response measurements namely Polarisation and Depolarisation Current (PDC) and Frequency Domain Spectroscopy (FDS) have been widely applied to diagnose transformer insulation. However, it still remains a challenge to separate the effects of moisture and amount of ageing from the dielectric responses of transformer insulation. Hence, insulation ageing experiments are designed to understand insulation degradation process and how dielectric responses are affected by different parameters during the insulation ageing process. In this work PDC and FDS response of pressboard samples with 1%, 2%, 3% and 4% moisture contents are presented and DP measurements, Furan analysis and Dissolved Gas analysis on oil/paper samples are given after 168 Hrs., 336 Hrs., 504 Hrs. and 672 Hrs. of insulation ageing.
THEME: ENVIRONMENTAL ENGINEERING AND SUSTAINABILITY

Coupled mechanic, hydraulic and dielectric material properties of fine-grained soils

*Moritz Schwing, Civil Engineering*

Geophysical methods are more and more often used to characterise hydraulic and mechanic parameters of soils. However, the interconnection of the multi-physical electric, hydraulic and mechanic parameters is still not fully understood and there exists a lack of combined investigations on these parameters.

The contribution presents experimental results in which the shrinkage behaviour of six cohesive soils was investigated with a simultaneous record of its dielectric permittivity. Furthermore, the soil suctions, describing how strong the water is bound within the soil matrix, were measured in order to take it into account the investigation on the multi-physical parameters.

Algal composting

*Wei Han, Chemical Engineering*

Nowadays, there is a worldwide interest in climate change and greenhouse gas. Compared to high level plants, algae have gained a lot more attention as they are of a higher photosynthetic rate to fix CO2 for the accumulation of valuable biomass and can be cultivated in simple open saline ponds so their production does not compete for arable land. However, in some cases, uncontrolled growth of algae can become a problem for eco-systems or some industrial operations. A simple and practical method for such organic waste, algae degradation and stabilization is composting.

Resin-in-Pulp for Acid Mine Drainage Remediation

*Patrick Littlejohn, Chemical Engineering*

Some of the tools developed for the processing of nickel laterite ore by resin-in-pulp (RIP) may be applied to remediation of acid mine drainage (AMD). In both cases, recovery of metal value and production of a stable waste stream appropriate for long term storage is desired. AMD typically has the additional challenge of also containing toxic low-value metals. Seen in this light, recent innovations in RIP reactor configuration, selective elution strategies and novel synthetic IX resins become useful tools for taking on the AMD challenge in a way that maximizes both environmental and economic benefit.
Carbon molecular sieve membrane for desalination via membrane distillation

Yingjun Song, Chemical Engineering

Fresh water scarcity is one of the most serious global challenges of our time [1]. Membrane distillation (MD) has been considered as an alternative to conventional reverse osmosis (RO) processes [2], but has yet to achieve commercial status as a water desalination process. In this work, we report the performance of carbon molecular sieve (CMS) membranes that have the potential to overcome low flux barrier which is the main impediments to commercial application [3]. Our CMS membranes delivered high water fluxes of up to 13.5 lm-2h-1 and salt rejections of up to 99% for typical sea water salt concentrations (~3.5 wt% NaCl) at room temperature.

Behavior of CaO/CuO Based Composite in a Combined Calcium and Copper Chemical Looping Process

Changlei Qin, Mechanical and Mining Engineering

Integration of chemical looping combustion into calcium looping is an attractive approach to solving the problem of energy requirement for the regeneration of CaO-based sorbent. In this work, the behavior of MgO supported CaO/CuO composite in the new combined process (CaCuCL) was investigated. It was found that the component of CuO/Cu has a significant influence on the cyclic performance of CaO due to the “wrapping” of CuO/Cu outside. Fortunately, this negative effect can be greatly eliminated by using appropriate operating conditions. Although loss-in-capacity of CaO was still observed, the synthetic composite demonstrated reasonable reversibility and reactivity during cyclic tests suitable for the CaCuCL process.

Metal removal and recovery from anaerobic sludge using (bio)electrochemical systems

Fangzhou Du, Advanced Water Management Centre

Wastewater treatment plants produce large quantities of sludge, which is fairly expensive to dispose. Applying sludge as fertilizer is strictly regulated for its high heavy metal content. The bioleaching process can solubilize metal sulphides to metal sulphates. Metal ions can potentially be reduced to the elemental form, either electrochemically or biologically. In this work, we reviewed the advances in bioleaching research and its applications to sludge disposal, and propose microbial metal nanoparticle synthesis and metal reduction by bioelectrochemical systems. Subsequently, we plan to integrate metal leaching and reduction into a single (bio)electrochemical system to remove and recover metals from sludge.
Assessment of disinfection by-products during the production of High Quality Recycled Water

Katrin Doederer, Chemical Engineering (AWMC)

Advanced Water Treatment Plants produce high quality recycled water from wastewater secondary effluents using chemical disinfectants to protect reverse osmosis membranes employed. Disinfection by-products (DBPs) of health concern are formed when organic and inorganic substances in water react with chemical disinfectants. In general DBPs are not well rejected by reverse osmosis membranes in comparison to their parent compounds. Hence, the understanding of DBP formation is crucial to minimize their formation prior to filtration. DBP formation from secondary effluent was studied at different pH, temperature, disinfection strategy and reaction time. Response surface modelling allowed the assessment of parameters affecting DBP formation.

Development of surrogates to monitor reverse osmosis membrane integrity and performance during filtration of pre-treated secondary effluent

Marie-Laure Pype, Chemical Engineering (AWMC)

Wastewater is converted to high quality recycled water (HQRW) through an advanced water treatment process (AWTP). To satisfy legislation in place to protect public health, the treatment performance of AWTPs must be validated for 9.5 log removal of viruses (LRV) before it is possible to use HQRW for indirect potable reuse. Reverse osmosis (RO) is an efficient process to produce HQRW, but the method to verify its integrity is very conservatively assessing virus rejection.

This PhD investigates new on-line methods to measure the real LRV of viruses for RO process by intact and impaired membranes (e.g. fouling).

Determination of Mercury Deportment in the Bayer Process and Opportunities for its Removal

Neetu Bansal, Chemical Engineering

The toxicity of mercury metal, its compounds and their adverse effects on human health and ecosystem has caused the alumina industry to pay considerable attention to emissions into the environment. Most of the mercury is coming in with bauxite ore which is the feed material to the refinery and going into the environment. The current research focus is to develop a robust method for determining the mercury concentration input stream i.e. bauxite and output streams i.e., red mud, waste water of the alumina refinery as well a circuit stream i.e. Bayer liquor.
Analysis of Water-Related Energy in a Queensland Household

*Steven Kenway, Chemical Engineering (AWMC)*

Understanding households is important for management of water and related energy consumption and greenhouse gas emissions. A mathematical flow analysis model of materials, energy, CO2 emissions and costs was created, in collaboration with the Swiss Federal Institute of Aquatic Science and Technology. A specific Brisbane household was simulated and validated with monitored data. Detailed scenarios investigations showed that for this household, technical improvements alone, without changing to a solar hot-water system, result in less than a 15% change in energy use and greenhouse gas emissions. In contrast, combined behavioural and technical changes have a much higher reduction potential.

The influence of a major inflow event on the thermal stratification of a water supply reservoir

*Rikke Krogshave Laursen, Civil Engineering*

Thermal stratification refers to the vertical layering of a water body due to density differences caused by water temperature variations with depth. For water resource managers the behaviour of this vertical structure under various destratifying forces (e.g., wind, inflow, outflow) is of interest as it affects the circulation, mixing and water quality. Data from a sub-tropical reservoir showing the influence of a major inflow event on the thermal stratification will be presented. Such inflow events are significant to the field of limnology and are of particular interest in sub-tropical systems as presentation of data on these systems is rare.

The Effect of H2S on N2O Accumulation in wastewater treatment plant

*Yuting Pan, Advanced Water Management Centre*

A series of batch experiments were conducted to assess the potential inhibitory effects of sulfide on nitrate, nitrite and N2O reduction by a methanol utilizing denitrifying culture. Hydrogen sulfide was found to be strongly inhibitory to N2O reduction, with 50% inhibition observed at an H2S concentration of 0.02 mg H2S-S/L. In comparison, nitrite reduction was inhibited by 34% at 1.5 mg H2S-S/L, while nitrate reduction was not affected by H2S at up to 2 mg H2S-S/L (the highest concentration studied). N2O accumulation was observed during nitrite and nitrate reduction at 0.23 and 1.0 mg H2S-S/L, respectively. The results also showed that hydrogen sulfide (H2S), rather than sulfide, was the true inhibitor.
THEME: MATERIALS MANUFACTURING AND PROCESSING

Using SEM-EDX to characterize an epoxy/fluoropolymer interface: optimization and solution to fluorine mobility

Luigi-Jules Vandi, Mechanical Engineering and Mining

Precisely characterizing epoxy/thermoplastic interfaces on the nanometre scale using SEM-EDX represents a current challenge due to the large X-rays generation volume and specimen decomposition. This paper investigates the co-cured interface between an aerospace grade epoxy based on a TGDDM/DDS formulation and a semi-crystalline fluoropolymer. Monte Carlo simulation is used to evaluate the effect of X-rays generation volume, charging and other phenomena arising from specimen decomposition. The results indicate that fluorine mobility due to specimen damage by electron beam irradiation is the principal factor affecting interface width measurements. An effective solution using a microtome sliced specimen allows accurate interface width measurements.

Supersaturation controlled crystallization of tricalcium aluminate for use as a Bayer liquor filter aid

Reza Salimi, Chemical Engineering

Tricalcium aluminate hexahydrate (TCA) is an important filter-aid for Bayer liquor polishing. TCA is typically produced at alumina refineries by mixing Bayer liquor with slaked lime. Specific properties are required from the TCA to ensure adequate filter throughput, lifetime and importantly effective reduction of solid/colloidal impurities from solution. The aim of this study is to develop a controlled crystallization process that will allow for TCA of optimal quality to be produced. To do this, new information regarding the solubility, metastability, nucleation and crystal growth kinetics must be generated.

Finite elements modeling of laser assisted machining of titanium alloy

X.Yao, Mechanical and Mining

Titanium alloys are known as difficult-to-machine materials due to their high strength, low thermal conductivities and their high reactivity with cutting tools. A localized laser beam in front of the cutting tool can preheat and soften the workpiece, therefore reducing the cutting forces and improving the machinability. In this paper, a finite analysis of laser assisted machining is presented. The model simulates the laser preheating process and the mechanical cutting process simultaneously. In particular, cutting force, chip morphology and temperature are taken into account due to their predominant roles determining machinability and tool life.
Critical properties of Cu6Sn5 for lead-free soldering applications

**Dekui Mu, Mechanical and Mining Engineering**

The effect of Co on conventional sintering of gamma TiAl based alloys was investigated. Near full densification (> 99% theoretical density) was achieved at 1300 °C by pressureless sintering through small additions of cobalt (≤1.5 at.%). Cobalt facilitates the sintering of Ti-48Al-2Cr-2Nb by the formation of a wettable sintering liquid in two steps, Co + [\(\alpha\)]-TiAl → Al2CoTi + Liquid at 1256.2 °C and Al2CoTi + [\(\alpha\)]-TiAl + Liquid at 1267.2 °C. The new alloy, Ti-48Al-2Cr-2Nb-1.5Co, possesses excellent compression strength (2100 MPa) and ductility (33.3%), while the tensile ductility is limited (0.23%) due in part to the high oxygen content (1700 ppm).

Development of a novel process for recovering fluoride and other valuables from spent pot-lining

**Ubong Ubong Ntuk, Chemical Engineering**

The electrolytic production of aluminium is carried out in steel pots lined with carbon cathodes. After a while, the pots degrade and have to be changed. The discarded pot lining, together with impurities is termed spent pot lining (SPL).

SPL is classified as a hazardous waste, due to its leachable fluoride and cyanide contents. Previous research has suggested methods of treatment/recovery that have fallen short of widespread acceptance.

This work aims at minimizing the shortcomings of previous researches by providing a low energy, economically attractive and environmentally friendly process for recycling the useful components of SPL.

The effect of Co on sintering of gamma TiAl based alloys

**Yang Xia, Mechanical and Mining Engineering**

The effect of Co on conventional sintering of gamma TiAl based alloys was investigated. Near full densification (> 99% theoretical density) was achieved at 1300 °C by pressureless sintering through small additions of cobalt (≤1.5 at.%). Cobalt facilitates the sintering of Ti-48Al-2Cr-2Nb by the formation of a wettable sintering liquid in two steps, Co + [\(\alpha\)]-TiAl → Al2CoTi + Liquid at 1256.2 °C and Al2CoTi + [\(\alpha\)]-TiAl + Liquid at 1267.2 °C. The new alloy, Ti-48Al-2Cr-2Nb-1.5Co, possesses excellent compression strength (2100 MPa) and ductility (33.3%), while the tensile ductility is limited (0.23%) due in part to the high oxygen content (1700 ppm).
Use of Rheometry to understand Structure Development during Coking: Implications for Controlling and Predicting Coke Strength Indices

Robin Dawson, Chemical Engineering

Within a blast furnace metallurgical coal is primarily used in the form of coke as a permeable support. This requires high mechanical strength and is determined by the viscoelastic properties of the coal during carbonisation. By using low amplitude oscillatory shear stress rheometry the viscoelastic properties of this process can be intimately studied. It is hoped that by doing so a fundamental understanding of coke structure formation can be described and related to industrial standard coke strength tests. From this understanding coke strength prediction models can be created and novel additives used to optimise coke quality for a wide range of coals.

Phase Equilibria Studies of Cu-S and Cu-Fe-S systems

Imam Santoso, Chemical Engineering

The study of phase equilibria in the Cu-Fe-S system at high temperature is important for improving the operation of copper smelting and converting processes. To investigate this system, the experimental procedures developed at the Pyrometallurgy Research Centre (PYROSEARCH) at the University of Queensland have been used, which involve equilibration of mixtures at high temperatures, rapid quenching, and measurement of phase compositions using electron probe x-ray microanalyses (EPMA). The phase equilibria of Cu-S, and Cu-Fe-S systems have been characterized. The results show that the experimental technique can be applied successfully for accurate determination of phases in the Cu-Fe-S system, such as copper-rich liquid, matte and solid iron.

THEME: MINING AND MINERAL PROCESSING

A linear relaxation solution to the Tactical Movement Problem

Peter Beasley, Mechanical and Mining Engineering

The Tactical Movement Problem seeks to determine the minimum cost mission for a robotic agent tasked to complete an assignment that involves both moving through its environment and manipulating that environment. The problem arises in several contexts including open-pit mining automation when a robotic excavator is tasked to remove a designated area of material. The objective is to complete the task in minimum time or at a minimum energy cost or some similarly motivated cost function. The problem becomes one of determining the optimal path that the excavator should take and the dig operations that should be completed at each point along the path. In this work the problem is posed as a linear relaxation that is solved successively to near optimality.
Employing Range Scanners for the Automation of Mining Equipment

*Tyson Phillips, Mechanical and Mining Engineering*

The Australian mining industry is on a relentless march towards automation of large equipment including excavators and haul trucks. There is a lack of clarity among equipment manufacturers, technology developers, and the end-user mining companies about how to develop and operate automated machinery.

Range scanning sensors are commonly used in the autonomous operation of machinery. Range-bearing information has previously been employed to deliver solutions to terrain mapping, navigation, collision avoidance, and obstacle identification problems. This presentation will examine the key question: How do we evaluate if a ranging sensor is capable of generating data suitable for surface mining automation applications.

The Mechanisms of Secondary Nucleation of Alumina Trihydrate in Bayer Process

*Weng Fu, Chemical Engineering*

Alumina production is one of Australia’s most significant industries. In 2010, Australia exported 16 million tonnes of smelter grade alumina (valued at AU$5 000 million). However, the Bayer Process adopted in refining alumina trihydrate from bauxite is costly. By improving alumina crystallization process operations, significant cost and environmental savings will be possible, which will add significant value to Australia’s alumina industry. The industrial importance of the nucleation lies in its effects on the yield and product size distribution of alumina crystals. This presentation will provide an overview of existing knowledge of the mechanisms of the secondary nucleation of alumina trihydrate.

Motion feedback applied to assist non-line-of-sight teleoperation of a bulldozer

*John Dudley, Mechanical and Mining Engineering*

Teleoperation provides an attractive means of removing humans from direct exposure to hazardous environments but often at the cost of reduced performance levels. Experiments have been conducted to investigate the potential for motion feedback to improve performance in teleoperation. The specific application considered is teleoperation of a bulldozer. A six degrees-of-freedom motion-base has been integrated with a bulldozer teleoperation system to enable evaluation of the effect of introducing different motion cues. Results demonstrating the potential to reduce the completion time of an idealised bulldozing task by 11% through the provision of isolated pitch motion feedback will be presented and discussed.
Experimental Simulation of Flow Behaviour in Pre-drainage Boreholes  
*Nima Noraei Danesh, Mechanical and Mining Engineering*

The formation of horizontal gas drainage boreholes changes due to post drilling failures over time. Study of flow behaviour contributes to effective methane drainage from horizontal boreholes and reservoir management. An experimental simulation of methane gas flow behaviour in drainage boreholes is carried out by measuring the variation of gas (Air) temperature due to change in gas flow rate. Resistance Temperature Detectors (RTDs) are utilised for temperature measurements. A laboratory rig has been developed and utilised to simulate the drainage boreholes. The results of this study show variations in the gas temperature as the gas flow rate changes.

Simultaneous Localization and Mapping in Unstructured Terrain  
*Iain Williams, Mechanical and Mining Engineering*

This paper presents a new method of locally determining the pose of autonomous mobile equipment working in unstructured terrain. The terrain is modelled using a patchwork of Bézier surfaces and this model is used in a simultaneous localization and mapping (SLAM) probabilistic framework, replacing the traditional landmark features. The method is implemented on an electric rope shovel working in a quarry. The results show the successful pose estimation of the vehicle as well as the production of a consistent representation of the terrain. These results are validated using pose data collected using a highly accurate GPS/INS system and terrain data collected using a three dimensional laser scanner.

This new method removes the need to rely on definable landmarks in the autonomous vehicle’s workspace to provide reliable vehicle localization, whilst also providing rich information about the workspace itself. With this innovation, SLAM techniques will be able to move into new areas of autonomous operation.

One of the most significant industries where these new capabilities may be useful is in surface mining. Surface mining automation remains one of the key research questions in the future innovation of mining practices and this work potentially provides a stepping stone for the automation of mobile mining plants, like the electric rope shovel.

Numerical and Phenomenological Study on the Effect of Attack Angle of Point Attack Picks in Hard Rock Cutting  
*Mehdi Serati, Civil Engineering*

Experimental observations at CSIRO indicate that the attack angle of point attack picks controls the behaviour of associated cutting forces while hard rock cutting. That is, by increasing the attack angle, normal force gradually decreases while tangential force reaches its minimum value at a certain attack angle through a nonlinear variation. To comprehend this behaviour, initially, a series of FEM numerical studies is conducted. Additionally, based on the philosophy of linear elasticity, a conceptual model is developed. The model demonstrates that contact area and cut profile are predominant factors affecting the cutting force response as a function of attack angle.
THEME: NANO AND ADVANCED MATERIALS

Titania-based materials for visible light water splitting
Zheng Xing, Chemical Engineering

“Solar hydrogen”, which is produced with the assistance of solar energy, is a good replacement of traditional fossil fuels considering the high energy capacity and environmental friendliness. Hydrogen can be produced via photocatalytic water splitting in the presence of powder photocatalysts, such as titanium dioxide. Titania is a stable photocatalyst with relatively low cost, but it is only active in UV region.

This research extended titania's activity to visible spectrum by doping and facet control. Fluorine and nitrogen co-doped titania with dominant active {001} facets was successfully prepared. It exhibited high oxygen evolution rate of 600μmol·h⁻¹·g⁻¹ under visible light.

Understanding of the growth mechanism of tri-fold tellurium nanowires
Lei Yang, Mechanical and Mining Engineering

Uniform tellurium nanowires with tri-fold morphology have been successfully synthesized through a facile and green solvothermal route and their structural characteristics were investigated using SEM and TEM. The morphological modification of Te nanowires has been achieved by using different surfactants in the process. The hexagonal tellurium crystal grows at a high reaction temperature and pressure to form a tri-fold symmetric nanostructure. The mechanism of the formation of tri-fold tellurium nanowires has also been discussed by analysing the experimental results and modelling simulation.

The synthesis of new-phase indium selenide flowerlike nanostructures
Guang Han, Mechanical and Mining Engineering

Indium selenide flowerlike nanostructures have been facilely synthesized by a solvothermal method. Scanning electron microscopy (SEM) investigation reveals these flowerlike nanostructures are composed of nanosheets with a thickness about 100 nm. Transmission electron microscopy (TEM) and X-ray diffraction (XRD) analysis show the synthesized indium selenide belongs to a new rhombohedral structure.

Indium selenides are a group of important III-VI inorganic semiconductors, and their nanostructures are projected to have higher thermal and electrical properties in comparison with their bulk counterparts. Indium selenide nanostructures will show potential applications in energy-related areas, such as thermoelectric generators and solar cells.
Determination of Contact Angle by Molecular Simulation using Number and Atomic Density Contours

Hong Peng, Chemical Engineering

The contact angles of Lennard-Jones fluid droplets on a structure-less solid surface, simulated using Monte Carlo simulation, are calculated by fitting isochoric surfaces and making a number of assumptions about the droplet. The results show that there are significant uncertainties in the calculated contact angles due to the choice of these assumptions, such as the grid size used in tracking the isochoric density profile, the omission of isochoric data points near the surface, and the function used to fit the isochoric profile. In this study, we propose a new method of calculating density contours based on atomic density instead of number density. This method results in a much smaller variation in contact angle when applying different assumptions compared to using number density for isochoric contours. The most consistent results, across a range of assumptions about the droplet and the contact angle, come from averaging the contact angle from several isochoric density profiles. In addition, this gives a measurement of the variation due to the choice of isochoric density.

Effects of Different Activated Solvents on the Gas Adsorption Properties of Cu-BTC

Ying Yang, Chemical Engineering

Cu-BTC is a type of MOFs which fortunately or unfortunately is not new. The pursuit to achieve the resemblance of the reported material has been so intense that everyone meticulously repeated the same steps to obtain the same material. Interestingly, the Cu-BTC framework characteristics as well as its adsorption properties could be tailored to the requirement by simple amendments in the synthesis steps. In this work, by changing the polarity of the activated solvents we could bring about significant change in the surface area, pore size and adsorption properties of the material without any additional cost implication.

Mechanical Properties and Deformation of LiTaO3 Single Crystals Characterised by Nanoindentation and Nanoscratch

Anshun He, Mechanical and Mining Engineering

This project reports the nanoindentation and nanoscratch study of Lithium Tantalate single crystal. The elastic modulus and hardness of Lithium Tantalate obtained from nanoindentation were 251 GPa and 12.6 GPa, respectively. During indenting, pop-in events occurred when indentation load was in the range from 305 to 640 μN. Nanoscratching showed that there existed a threshold normal load of 2.5 mN, above which cracks were generated and the material removal was in the brittle regime.

The finding shed light on the mechanical properties and deformation of LiTaO3, which is important to optimise the fabrication process of LiTaO3 crystal wafers.
Ordered mesoporous silica membrane for desalination using membrane distillation

Yen Thien Chua, Chemical Engineering

Desalination using membrane distillation is a promising technology, yet requiring many improvements in utilizing waste heat as energy source. Therefore, development of robust membrane with excellent performance is highly desired. Inorganic silica membrane with ordered meso-structure coated on top of macroporous alumina substrate was synthesized and tested in a vacuum membrane distillation module. Preliminary results showed that water permeation flux of 3 – 6 kg/m²·hr and salt rejection >99% were obtained from 1.5g/L NaCl solution at room temperature. The morphology and pore geometry of the mesoporous silica membrane were characterized systematically by various instruments including TEM, SEM, N₂ adsorption and XRD.

Cobalt Silica Membranes for Gas Separation: Structural Modification via Cationic Surfactant

Gianni Olguin, Chemical Engineering

Microporous silica membranes offer an attractive alternative for gas separation. However, the limited pore size control and hydrothermal stability have hindered the complete industrial adoption of this technology. Whilst the incorporation of metal oxides or surfactants inside the silica matrix has separately delivered positive outcomes, we are particularly interested in synergistic effects of integrating both into the matrix. In this preliminary work, we report the change in porosity of cobalt containing silica which was previously modified by surfactant. As a result, silica varied from microporous to mesoporous structures at higher surfactant concentrations, delivering flexibility and precision in pore size tailoring.

Effect of Zn, Au and In on the polymorphic phase transformation in Cu₆Sn₅ intermetallics

Guang Zeng, Mechanical and Mining Engineering

The effect of Zn, Au and In on the hexagonal to monoclinic polymorphic transformation in Cu₆Sn₅ intermetallics is investigated using variable temperature Synchrotron X-ray diffraction (XRD) and differential scanning calorimetry (DSC). It is revealed that, as in the case of trace Ni additions, the alloying elements Zn and Au completely stabilise the hexagonal Cu₆Sn₅ and prevent the phase transformation. In contrast, they only partially stabilise the hexagonal Cu₆Sn₅.
Synthesis and characterization of water dispersible graphene oxide-Fe3O4 nanocomposites
Nor Aida Zubir, Chemical Engineering

Water dispersible graphene oxide-Fe3O4 (GO-Fe3O4) nanocomposites were synthesized through a facile and scalable co-precipitation of iron ions by basic solution in the presence of an aqueous dispersion of GO. GO-Fe3O4 composites were characterized by Fourier transform infrared (FTIR) spectroscopy, N2 adsorption-desorption and transmission electron microscopy (TEM) at various addition ratios of GO. The overall results showed that dense Fe3O4 nanoparticles within the size of 6 to 15 nm were chemically deposited onto GO sheets. Good water dispersibility can be observed with the increase in GO ratio. These findings could provide new insight for practical applications in aqueous-based separation.

Indentation induced delamination of SixNy film on (001) GaAs substrate
Mingyuan LU, Mechanical and Mining Engineering

This work investigated an approach for determining the interfacial adhesion of silicon nitride coating on (001) GaAs substrate induced by nanoindentation. Both pop-in and pop-out were observed from the load-displacement relation, when the applied load reached a critical value. Pop-in was found to be caused by plane-slip in (001) GaAs and pop-out was proven to be the response of interfacial delamination. Finite elements modelling (FEM) was performed to analyse the stress distribution during unloading. We found that the stress at the interface evolved from compression to tension with the receding of the tip and pop-out occurs at a critical tension stress, which is considered associated with interfacial delamination.

THEME: NUMERICAL METHODS, SIMULATION AND MODELLING

The Modelling of Binary Gas Mixtures by Molecular Sieving Silica (MSS) Membrane at High Temperatures
Guozhao Ji, Chemical Engineering

In this work we present a model to take into account the influence of different operating conditions on the performance of silica derived membranes for gas separation. In our model, one dimensional mesh in the axial direction is used as the concentration polarization is very weak in the case of silica membrane separation. The governing equations are continuity equation, solution equation and Hagen–Poiseuille equation.

Our simulated results were validated against experimental results. We further discuss the effect of the feed flow rate and pressure on permeate flow rate, recovery, purity and separation factor.
Multicomponent Diffusion of Fluid Mixtures through Porous Media: Modeling and Simulation

*Mauricio R. Bonilla, Chemical Engineering*

The infiltration of fluid mixtures into the voids of porous frameworks is common to several technologies for gas separation and storage, and optimizing their performance requires deeper understanding of how the matrix morphology affects the flow. Although several techniques exist for the estimation of the effective diffusivity for single fluids, this is not the case for mixtures. In this work, a novel theory for the calculation of the effective transport coefficients of fluid mixtures in porous media is introduced. Comparison with simulation of diffusion of binary and ternary gas mixtures in large pore networks demonstrates the power of the theory.

A Graph Theoretic Approach to Facilitate the Preliminary Design Process of an Airport Terminal Check-in Layout

*Sarah Shuchi, Queensland University of Technology*

A graph theoretic approach is proposed to generate a preliminary space layout plan for an airport terminal. In particular, the proposed method is aimed at facilitating the designers to develop a systemic design approach to attain an initial physical layout of airport terminal facilities. Allocation of various terminal facilities should be optimized to accommodate a wide range of changes in operations and facilities. Graph theory has been employed to identify the relationships among relevant objects (building facilities, rooms etc) and to utilize the initial space allocation data from the modified process model. The results are expected to be used as a reference model for further design development of airport terminals.

The confinement effect on the benzene-water mixture adsorption

*Phuong T. M. Nguyen, Chemical Engineering*

The adsorption benzene-water mixture in graphitic slit pore was investigated using molecular simulation. We observed that the adsorption of mixture starts with the adsorption of benzene on the graphite surfaces which then acts as anchors for water molecules to adsorb. High loadings of water in pores significantly affect the arrangement and orientation of benzene molecules. We also observed that the adsorption of water is dominant at the expense of benzene adsorption at high pressures. These observations demonstrate the significant influences of water on the adsorption of benzene in pores and these phenomena are unique for a sufficiently narrow, confined space.

Sphere packing algorithm for soil structure simulation

*To Huu Duc, Civil Engineering*

Soil has a granular structure, however, most numerical simulations use continuous environment for soil modelling. Therefore, some phenomena such as suffusion, which have a solid relationship with granular structure, could not be simulated well. In this case, the sphere packing algorithm seems to be a good choice because of its quick calculation speed. The idea comes from the combination of Apollonian gasket and trilateration equations. A program for soil structure simulation has been built, and the result is compared with empirical data. The numerical data are exported to discrete element program for further studies.
Finite element analysis for Nano indentation and indentation-induced
delamination of bilayer thin film

Hong Tao Xie, Mechanical and Mining Engineering

A finite element model was developed to simulate an indentation experiment on a bi-layer thin film. The FE model was validated by previous experimental results and optimised by parametric study. It shows a capability to deconvolve the mechanical properties of thin film layers and to obtain interfacial toughness from an indentation load-displacement curve obtained from an indentation experiment. This model was created to analyse the indentation-induced delamination mechanism of silicon nitride films on a gallium arsenide substrate. The numerical results provided significant information including the nucleation and propagation mode of an interfacial crack, and the critical tension stress associated with delamination.

Regression model variable selection by Genetic algorithm

Sicong ZHU, Civil Engineering

Currently, the black box model is utilized in different research fields. When facing numerous candidature variables, Genetic Algorithm approach is cost-effective and capable of solving combinatorial optimization problems by variable binary coding and combination selection fitness function. The coding method transforms the multiple-variable combination solution into binary code. As the GA procedure starts to shortlist an optimized solution from population to deliver a robust model establishment result by a new designated fitness function balancing model overall prediction accuracy and individual variable statistical significance. It has a good performance on a black box emission modelling.

Individual and variable geometry based modelling of direct interspecies
electron transfer in microbes

Tomas Storck, Chemical Engineering (AWMC)

Syntrophic interaction between different microbial species is a key aspect for many biochemical processes. In particular, the way in which organisms share energy and substrate is of importance for both feasibility of processes and sensitivity to environmental conditions. This has been assessed to some extent using simple tools, but both geometry and metabolic interactions play a major role in obtaining realistic outcomes. We have developed a new approach based on modelling microbes using a variable geometry. This not only allows cells to be physically and realistically represented but also allows simulation of novel modes of microbial interaction such as electrical “nanowires” and interspecies “glues”.

Application of Kinetic Monte Carlo Method in the Microscopic Description of Argon Vapour-Liquid Equilibrium and Adsorption on Graphite

Van T. Nguyen, Chemical Engineering

We present an application of kinetic Monte Carlo (kMC) in the canonical ensemble to a calculation of vapour liquid equilibrium (VLE) and to describe adsorption of argon on a flat graphite surface and in a slit-like graphitic pore. The kMC method is simple to implement and, unlike conventional Monte Carlo, no rejection trials are necessary. The only move is the uniform sampling of the volume space, which makes the determination of the chemical potential straightforward using the real particles in the simulation, in the same spirit as the Widom inverse potential distribution. This avoids the need to freeze the real particles before the trial insertion of test particles as is necessary in other methods, such as the Widom method and its variants.

Optimal Operating Strategies of Distributed Generation Unit for Loss Reduction in Primary Distribution Systems

Duong Quoc Hung, ITEE

We present an analytical approach for placement and operation of distributed generation (DG) unit for minimizing distribution system power losses. In this methodology, the optimal size and power factor of DG unit at various locations is calculated using analytical expressions. A computational procedure based on these analytical expressions is also developed to identify the best placement at which the system loss is the lowest. The results obtained on a 33-bus distribution system demonstrate the effectiveness of the proposed methodology and computational procedure. It is also shown that optimal power factor operation plays a crucial role in maximizing DG penetration while minimizing power losses and enhancing voltage profiles.

Computational Models for Understanding Pathological Behaviour in Microelectrode Recordings

Kristian Weegink, Mechanical and Mining Engineering

Deep brain stimulation (DBS) is a treatment used for Parkinson’s disease. How this treatment works is not understood. During the operation to implant the (DBS) electrode a microelectrode recording (MER) of brain activity in the stimulation area is acquired. To better understand the behaviour of these structures we have created a statistical model to simulate the MER with good agreement to patient data. This model has been extended to a nonlinear model to look at the information exchanged between an MER field and a neuron. This work will be used to look at the role of the MER field in characterizing pathological behaviour.
THEME: SIGNAL PROCESSING AND CONTROL

Application of Wavelet Parameters for Impact Damage Detection in Plates

Tristan J. Shelley, Mechanical and Mining Engineering

In this study, ultrasonic guided waves were used in a laser vibrometer setup to measure impact damage responses in carbon fibre epoxy composite plates. By identifying a change in the baseline signal compared to the damage response signal and quantitatively characterising it, the impact damages in the specimens could be detected.

In general, it was found that the larger the impact energy and therefore the larger the physical damage area, the greater the calculated value of the damage index. This provides potential means of quantifying the impact damage in composites with improved efficiency compared to that of raw signal analysis.

Development of a tapered fibre sensor head for measuring methane in underground coal mines

Mohammad Amanzadeh, Mechanical and Mining Engineering

Methane gas is the main source of hazard in underground coal mines. Currently, infrared sensor based systems are widely used in industry, which is a complicated and expensive technology. An all-fibre sensor network is a spectroscopic based method for methane detection. It is a reliable, well-distributed, safe and cheap method. Tapered fibres can be a robust sensor network detecting methane by absorption of evanescent field. This paper reports on tapered fibre development and characterization along with suitable tapering process.

Optimizing Combustion Process by Adaptive Tuning Technology Based on Integrated Genetic Algorithm and Computational Fluid Dynamics

Xingrang Liu, ITEE

Coal fired power plants still play the dominant role in electricity generation even though they are responsible for a large percentage of the carbon emissions. Recently some research works developed neural network based methods to improve the boiler efficiency and consequently decrease the emission. However, boiler combustion is still a challenging problem since it is often experienced with complexity due to the frequently varying fuel quality and boiler’s conditions in a power plant. This research proposes new methods to improve the boiler efficiency by simulating real time combustion processes inside the boiler based on the combination of Genetic Algorithm (GA) with computational fluid dynamics to fine tune the existing conventional controlling system of the boiler. The simulation results demonstrate the proposed methods can improve boiler efficiency and decrease the gas emissions in power plants.
Clinical-based MRI Analysis of Spine Anatomies

Aleš Neubert, ITEE

This work presents an accurate algorithm for automatic segmentation of vertebral bodies and intervertebral discs in three dimensions (3D) from high resolution spine magnetic resonance images (MRI). The algorithm is based on statistical shape models (SSM), which capture variations in a database of training shapes. We will show the potential of applying the novel information encoded by the 3D SSM to morphological analysis and automatic detection of disc degeneration. An automatic classification tool can effectively aid the study of the disc degenerative disease, of which the causes and progression are still being investigated.

The importance of neural noise in attempting to unravel the neural code

John Varghese, Mechanical & Mining Engineering

Recent neurophysiology experiments involving the acquisition of non-spike sorted deep brain recordings from the Sub Thalamic Nucleus have been analysed using the Non-Markov Parameter from stochastic processes theory. The results have identified statistically significant correlations between the signals analysed and the controlled experimental factors. This is in contrast to the deep brain recordings which were spike sorted and did not display correlations. These results are interesting because they suggest that the ‘neural noise’ which is due to the contribution of non-nearest neighbour neurons, which is typically discarded in the data analysis, may contain important information necessary to unravel the neural code.

Multipoint Fibre Optic Methane Measurement System

Javad Shemshad, Mechanical and Mining Engineering

This talk outlines a new approach to the measurement of methane concentration in an underground coal mine environment by introducing sequential multipoint gas cells connected via a fibre optic cable. Analytical and experimental investigations, for the first time, have been developed based on a tunable diode laser and wavelength modulation technique to measure the average methane concentration in the area where the gas cells are located.

The proposed technique will provide the mining industry with a real time methane measurement system to overcome the issues, such as time lag, inaccuracy, and occasional measurements, of the current systems deployed in the mine.

Study of radiative heat transfer in Titan atmospheric entry

Hadas Porat, Mechanical and Mining Engineering

The hypersonic flow forming in front of a capsule during a Titan entry is simulated in an expansion tunnel in order to measure the radiative heat flux in the shock layer. Measurements are done using emission spectroscopy and radiation gauges. Emission spectroscopy provides information about the radiating species in the shock layer, and radiation gauges measure the total radiative heat flux on the surface of the cylindrical model. Predicting and measuring the aero heat loads is a critical aspect of the thermal protection system design of an atmospheric entry vehicle. Preliminary measurements and calibration procedures will be discussed.
THEME: STRUCTURE AND TRANSPORT ENGINEERING

Investigating Mode Coupling Effects in Composites Beams with Delamination Damage

Jiawen Su, Mechanical and Mining Engineering

This project investigates mode coupling effects in laminated composite beams with delamination damage using both analytical and numerical modelling. A 3D explicit finite element simulation is developed to analyse the propagation and scattering behaviour of the Lamb waves. The results from the 3D numerical model are in good agreement with analytical solutions derived from the global matrix method in terms of phase velocity of the fundamental anti-symmetric mode.

The project is part of the general shift towards structural health monitoring to improve the safety of critical infrastructure and the efficiency of maintenance strategies for complex materials and structures.

Buckle Interaction in Deep Subsea Pipelines

Hassan Karampour, Civil Engineering

Two major types of global buckling in pipelines, upheaval buckling and lateral buckling are comprehensively studied. Analytical and numerical solutions are provided in both cases. A comparison of the two shows the upheaval buckling to produce higher local strains. Knowing that, interaction of upheaval buckling with propagation buckling is studied. The results are shown as plots of collapse depth versus service temperatures/internal pressures of common pipes used in offshore practice. This interaction has not been investigated before and is of utmost significance to designer engineers.

Planes, trains & simulators: Diffusion of technology in transport industries.

Gregory Tibbits, Mechanical and Mining Engineering

The rail industry is a complex technological and social system. Technologies that may be suited technically for the rail industry may not be compatible socially. This research reports on technologies simulator technology used within the aviation industry and how it is not suited socially for the rail industry. The findings of this research are extended to other technologies that could be implemented within the rail industry. This information is of use to engineers of all disciplines operating within the rail industry.
Energy-based Design Method for Seismic Retrofitting using Passive Energy Dissipation Devices

Ali Habibi, Civil Engineering

Passive energy dissipation is a reliable, effective and relatively inexpensive technique for mitigating seismic risks to civil structures. Significant amount of seismic input energy can safely be dissipated by designated sacrificial energy dissipation devices (EDDs), leaving the main structural elements relatively intact.

Implementation of EDDs as a seismic retrofit solution would require nonlinear time-history analysis of the parent structure subjected to ground acceleration. This type of analysis is complex and time consuming. For this purpose a new practical design method is proposed for seismic retrofitting with EDDs. The speaker will briefly review recent development of the dissipation devices followed by presentation of the step-wise energy-based design method and some examples to demonstrate the robustness and effectiveness of the proposed method.

The Influence of Pressure Gradient on Swash Zone Sediment Transport

Ilya K. Othman, Civil Engineering

The influence of pressure gradient to the total transport prediction is explored and compared to the laboratory measurements. The measurements are performed via the dam break swash analogy using fine and coarse sand on horizontal and sloping beds. The finding suggests that the contribution of a pressure gradient in the uprush reduces the transport prediction but significantly improved the prediction on a horizontal bed. The incorporation of pressure gradient brings the horizontal and sloping beds data closer. This demonstrates the importance of a pressure gradient in the sediment transport calculations although the impact is small for fine sand because of the grain size scaling.

Comparing GPS-Based Prompted-Recall Household Travel Surveys and Proposing a New Framework

Hamid R. Safi, Civil Engineering

Conventional household travel survey methods are expensive and involve considerable inaccuracies; moreover, they impose a significant task on the respondents and thereby adversely impact the quality and quantity of data. This paper compares previous studies on GPS based surveys, and presents a new framework for a prompted-recall household travel survey, using GPS-enabled smart phones. The suggested framework provides an opportunity to collect the travel behaviour of individuals from the transmitted data of their GPS-equipped phones and not only increases the accuracy of survey, but also decreases the implementation costs of HTS surveys significantly.
An analytical model for nonlinear hysteretic performance of a bilinear hysteretic system

*Mehran Zeynalian, Civil Engineering*

Nonlinear hysteretic performance under dynamic loading is one of the main characteristics in most structures. A differential model is presented, to show the behaviour of general hysteretic systems considering all relevant structural characteristics, including pinching, stiffness degradation, load deterioration, and sliding. A single-degree-of-freedom system is used to develop the hysteretic model by writing a system of ordinary differential equations.

The proposed model captures the key features of the hysteretic cycles of any structure using some measurable system parameters through tests. A few examples are provided to show that the descriptions of the force-displacement performance of general hysteretic systems are realistic.

Validation of railway rolling noise prediction model under Australian conditions

*Shijie Jiang, Mechanical and Mining Engineering*

This research provides the experimental validation of the RRNPS (Railway Rolling Noise Prediction Software) model for the prediction of railway rolling noise in Australia. It is validated by means of several experiments. They have been performed along a straight railway line. Through comparisons of predicted noise levels with measured ones, it is shown that the RRNPS model gives reliable predictions. It predicts the spectrum trend and amplitudes of rolling noise accurately.

The RRNPS model will be helpful to reduce railway noise in Australia and promote rail transport and thereby improve sustainability.

Damage assessment for concrete

*Vui CAO VAN, Civil Engineering*

It is common to evaluate the damage level in structures (global scale), elements (intermediate scale) and sections (local scale) with a single parameter called the “Damage Index”. Part of the damage attributed to the local scale relates to the damage sustained by the materials of which the section is made. This study investigates the damage of concrete subjected to monotonic compressive load using three different damage models - the proposed and two other well-known models. The analytical results show that the proposed model is promising yet simple and effective for evaluating the damage of concrete. It can be used as a useful tool in the damage assessment of concrete in existing or new structures.
The investigation on generation mechanism of curve squeal

**Xiaogang Liu, Mechanical and Mining Engineering**

The railway noise mainly includes ground noise, impacting noise, flange noise, rolling noise and curve squeal noise. For most of them, the sound generation mechanisms have been clarified. For the curve squeal, however, it is not easy to reach a consensus. The squeal noise is very unattractive due to its tonal characteristic in frequency component and high sound pressure level in volume. This research is about the investigation of the generation mechanisms of curve squeal, including negative damping theory and mode coupling hypothesis. Both experimental methods and the Finite Element Method have been applied to conduct this research.
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