IRIS INSTITUTE FOR RESOURCE INDUSTRIES AND SUSTAINABILITY

CQUniversity AUSTRALIA RESEARCH

2nd IRIS POSTGRADUATE STUDENTS CONFERENCE:

Resourcing for the Future

BE WHAT YOU WANT TO BE

2nd Annual Conference of the IRIS Postgraduate Students: 'Resourcing for the future' Conference Program

Chair: Prof Richard Clegg, Dr Anna Thomas
Coordinator: Dr Christelle Catuogno, Ms Karen Chapman

Morning session	
9.00 am – 9.10 am	Registration
9.10 am – 9.20 am	Welcome by Dr Anna Thomas, Director of the Institute for Resource Industries and Sustainability Presentation of our Judges
9.20 am – 9.40 am	Mr Glenn Schumacher – Gladstone PowerStation
9.40 am – 11.00 am	**Mohammad Arif, Power Engineering Research Group** Energy storage and its strategic impacts on Smart Grid **Wayne Boyd, Centre for Environmental Management** Assessing the success of ecosystem rehabilitation on open cut coal mining in the Bowen Basin, Queensland Australia **Ben Kele, Centre for Plant and Water Science** Volcanic Rock Filters in Decentralised Wastewater Treatment **Richard Egelstaff, Process Engineering and Light Metals Centre** Modelling intangible asset life cycle costing by using learning, unlearning and asset utilisation **Md Rahat Hossain, Power Engineering Research Group** Hybrid Forecasting System of Renewable Energy with Smart Grid for a Sustainable Future Including question time
11.00 am – 11.30 am	Morning tea
11.30 am – 1.00 pm	**Vineela Challagulla, Centre for Plant and Water Science** Screening, Optimizing and Near Infrared Application to Algal Lipids for Biodiesel Production **Pubudu Warusamanna, Power Engineering Research Group** Harmonic Mitigation Methodology in Low Voltage Distribution Networks **Ian McNeilly, Process Engineering and Light Metals Centre** A rotating parallel disc device for flow-accelerated corrosion research **Matthew Kennedy, Centre for Intelligent and Networked Systems** Internet Security – Detecting Botnets **Sumaira Tasnim, Power Engineering Research Group** Power Loss in Transmission in a Wind Farm Including question time
1.00 pm – 2.00 pm	Networking lunch

Afternoon session	
2.00 pm – 2.20 pm	Mr Paul Walmsley – Regional Manager DPI DEEDI
2.20 pm – 3.40 pm	**Megan Star, Centre for Environmental Management** Targeting resource investments to achieve sediment reductions and improved reef health **William Thomsen, Centre for Railway Engineering** New Affordable Level Crossing Protection Systems for Passive Level Crossings **Maria Tyler, Business research Group** The influence of a changing social and political environment on corporate emissions disclosures of Australian companies **Gyas Uddin, Centre for Railway Engineering** Wayside Lubricator Placement Model for Heavy Haul Lines **Rasel Mahamud, Process Engineering and Light Metals Centre** A simulation model to improve the energy efficiency of post combustion carbon capture process in coal power plant Including question time
3.40 pm – 4.00 pm	Afternoon tea
4.00 pm – 4.30 pm	Announcement of the student's prizes for best presentations

CONTACT DETAILS

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DIRECTOR'S MESSAGE

Pursuing the vision 'driving the development of a knowledge based economy', the Institute for Resource Industries and Sustainability (IRIS) provides multidisciplinary capabilities and expertise specifically structured to meet business improvement needs of Australian industries and to engage in sustainable programs beneficial to the wider community.

The second conference of the IRIS postgraduate students, "Resourcing for the future", showcases future leaders of industry and academia. This conference is an excellent opportunity for future employers to meet a wide range of graduate students and showcases a sample of our postgraduate research. Importantly, the conference also provides an opportunity for our students to present and receive critical feedback from peers and experts in the field. IRIS especially values feedback from industry delegates who can provide important insights into the application of research in their fields.

To make the most of this opportunity, I encourage all students and guests attending to make this a forum to discuss research, future directions and trends, and career opportunities.

Dr Anna Thomas

Gladstone Ports Corporation
Growth, Prosperity, Community.

This event is kindly sponsored by the community support program of the Gladstone Port Corporation Limited,
40 Goondoon Street,
Gladstone 4680 Queensland.

THE INSTITUTE'S RESEARCH CENTRES

CENTRE FOR ENVIRONMENTAL MANAGEMENT (CEM)

CEM is well known for undertaking research and consultancies for large and small businesses and government organisations in all major areas related to environmental management, regional economics and social development. Areas of expertise include ecotoxicology and industrial water quality; freshwater terrestrial, marine and coastal ecology; and environmental economics and sustainable regional development.
www.cem.cqu.edu.au

CENTRE FOR PLANT AND WATER SCIENCE (CPWS)

CPWS is a recognised provider of expertise and training in the areas of bioengineering and treatment of drinking, rain and wastewaters and subsurface irrigation systems; quality food and integrated production systems including non-invasive product quality assessment; biological farming and new crop opportunities; revegetation of industrial sites and landfills; and biofuel production.

CENTRE FOR INTELLIGENT AND NETWORKED SYSTEMS (CINS)

CINS has staff with extensive expertise in the development of ICT and control solutions for the transportation, manufacturing and resource industry sectors. Some of these areas of expertise are networked control systems, robotics systems for industrial applications, scheduling applications; automation of distributed power systems, virtual reality based training and data mining.

CENTRE FOR RAILWAY ENGINEERING (CRE)

This internationally recognised centre has broad expertise covering all major areas of the railway industry and undertakes both engineering and human factors research. The centre has capabilities and expertise in the development of industrial and commercial ready products and technologies.

PROCESS ENGINEERING AND LIGHT METALS CENTRE (PELM)

With a team of internationally respected research personnel, and advanced analytical and experimental facilities, PELM specialises in materials reliability, engineering asset management, and industrial processes. PELM also undertakes consultancies including corrosion testing, fracture and fatigue analysis, metallurgical assessment; air quality analysis and odour testing, fluid mechanics and multiphase flow, rheology and material flow characterisation, and management and thermo-fluid process and transport.

POWER ENGINEERING RESEARCH GROUP (PERG)

PERG works with our industry partners to shape the future of electricity generation, transmission and distribution in its many forms such as smart grid technologies, renewable energy systems, power quality, electrical asset management, and seeks improvement of existing generation, transmission and distribution systems.

BUSINESS RESEARCH GROUP (BRG)

The Business Research Group is driven by industry needs to secure access to adequate human and other resources, suppliers, and new markets to remain competitive. Areas of expertise include valuations of financial assets including land and property; emerging markets, finance and investments; accounting issues for resource industries; regional labour markets, workforce development and human resource management; regional business development; and research into the planning, implementation, and effectiveness of marketing strategies (including social services, events, tourism, and international marketing).

GUEST SPEAKERS

Glenn Schumacher

Glenn Schumacher, BEng(Mech) *UTS*, GradCertHRM *USQ*, MEng(PwrGen) *Qld*, MBA *Deakin*, FIEA, NPER3, MCME is currently the General Manager, Director and Australian Public Officer of NRG Gladstone Operating Services Pty Ltd.

In this role, Glenn is responsible for the overall management and leadership of the Gladstone Power Station. He is also responsible for representing NRG and the Gladstone Power Station in the Gladstone and wider communities.

Prior to joining NRG, Glenn held a number of positions in the electricity generation industry and other heavy manufacturing industries, including at the Tarong Energy Corporation, the Hazelwood Power Station, the SILCAR Yallourn Power Station and Australian Defense Industries Ltd.

Glenn is currently a doctoral candidate in the field of business administration with a focus on recruitment and retention strategies for young professionals.

Paul Walmsley

Paul Walmsley is Director, Strategic Planning and Projects with Department of Employment, Economic Development and Innovation (DEEDI). Paul was Regional Director DPI&F prior to the establishment of DEEDI with statewide responsibility for regional planning. As a Director Paul primary responsibility is to lead the development of a DEEDI regional plan that capitalises on the significant growth opportunities possible in Central Queensland.

PRESENTATION ABSTRACTS

Storage and its strategic impacts on Smart Grid

Mohammad Arif, PhD candidate, PERG

Energy storage is an essential enabling technology in energy management. Increased number of population, more industrialisation trends and more electrical energy centric development forced to think about the future energy potential. In conventional ways of producing electricity, the main sources of energy are Coal, natural gas and petroleum oil. All these sources are carbon-based and store carbon as potential energy and release it when burned which causes greenhouse gas emission a major culprit in climate change and global warming. Australia's reliance on coal-fired power makes it one of the world's highest per-capita greenhouse gas emission rates. To meet the future electricity demand and to minimise the emission of greenhouse gases, renewable energy (RE) sources like wind, solar, hydro, tidal, biomass or geothermal are the alternative options to adopt and they are naturally replenished.

The greatest problem associated with renewable forms of energy, such as wind and solar is that of variability of supply. Variability occurs due to natural factors like day/night cycle, location, cloud, temperature, change of air pressure, sun and moon effect on earth etc. Due to these factors it is not possible to achieve continuous supply from solar and wind and also level of energy fluctuation exists. To overcome these issues, a safe and efficient means of storing renewable energy is needed so that all available energy from the renewable source can be captured and supplied to the grid or the user when it is needed. Energy storage is therefore often referred to as the key to unlocking the door of renewable energy.

According to the weather data from Bureau of Meteorology (BoM), Australia, NASA and Warwick Weather it is found that Australia has great potential for solar and wind energy. From different form of energy storing methods Pumped hydro, Compressed Air Energy Storage (CAES), Thermal Energy Storage (TES), flywheel, hydrogen, batteries, capacitors, and Superconducting Magnetic Energy Storage (SMES) are used in different renewable energy conservation process. The use of grid-connected intermittent energy sources such as solar and wind can benefit from grid

energy storage system. While interconnecting RE sources and storage system to the grid, the grid receives supply from all these sources and depending upon the load demand and the energy intensity of wind and solar these sources output power will vary. The focus of this study is to find the impacts on the grid ie assessing the power quality of the grid at load side when supply comes from storage as well as RE sources and the grid. This research will finally develop the mitigation techniques to overcome these impacts of storage on smart grid by evaluating the power quality at the load side. This will be helpful for the power utility companies and communities to develop a climate-friendly sustainable power system for the future.

In order to find the impacts a real life experiment will be done at the CSIRO RE Integration facility and a simulation model will be developed using PSS SINCAL to find the mitigation techniques and finally it will be validated at the CSIRO facility again.

Assessing the success of ecosystem rehabilitation on open cut coal mining in the Bowen Basin, Queensland Australia

Wayne Boyd, PhD candidate, CEM

Achieving mine closure is intrinsically linked to the selection and successful rehabilitation of a suitable post mining land use. The diverse localities and nature of mining operations require flexible, adaptable and progressive rehabilitation techniques in order to achieve this objective. Similarly, standardised, comparative and repeatable methods for assessing the success of ecosystem rehabilitation are desirable. In Queensland Australia environmental evaluations, that quantify the risk of a rehabilitated site failing, are vital to obtaining progressive or final rehabilitation sign off.

Key aspects important to rehabilitated ecosystem assessments are characterisation of their states, identifying their transitional trajectories and assessing their resilience. A two stage assessment process is presented. The first stage involves comparative analyses of rehabilitation site monitoring data against reference or analogue sites (similarity assessments) and the second stage consists of scenario based future state simulations to determine resilience and to assess risk based potential failure (prognostic simulations). Ecological structure analysis (clustering and ordination) and probability based cellular automata spatial modelling are the respective tools and techniques employed.

Screening, Optimising and Near Infrared Application to Algal Lipids for Biodiesel Production

Vineela Challagulla, PhD candidate, CPWS

Selection of appropriate species and design of rapid lipid screening methods are the immediate requirements of the algal biodiesel industry. These are based on both qualitative and quantitative analyses of lipids. My study evaluates different species of algae from central Queensland, optimising growth conditions for selected species and applying Near Infrared technology to determine and estimate lipid content. To date two species of diatoms, one species of a filamentous green alga and two species of unicellular green algae were isolated. Based on their lipid and biomass content, two species will be selected for optimisations and rapid lipid screening. This project will identify two potential species of algae and a rapid lipid screening method for biodiesel production.

Modelling intangible asset life cycle costing by using learning, unlearning and asset utilisation

Richard Egelstaff, PhD candidate, PELM

Common standards in asset management identify both tangible and intangible assets; they also declare that both are critical to the long term success of the organisation. Although, there has been substantial work in the definition and management of tangible assets there has been less, accomplished, with intangible assets. The objective of this research is therefore, to develop a management model explaining how the intangible asset capacity to 'learn' and 'unlearn' or reframe is a critical and essential element in the process of overall organisational asset management. As a result, by applying a systematic and structured learning and unlearning process, organisations will ultimately, be able to realise a better utilisation of both their physical and non-physical assets. Therefore, if management understands and embraces learning and unlearning, and then encourages honest and reflective appreciation of the need to reframe or forget prior recipes of success, organisations will be able to realise more effective change outcomes and innovation. Consequentially for organisations, this research will be able to demonstrate how to achieve an enhanced overall asset utilisation and, most importantly, provide a focus on the means of valuing intangible assets.

Hybrid Forecasting System of Renewable Energy with Smart Grid for a Sustainable Future

Md Rahat Hossein, PERG

Solar and wind energy systems are considered as promising power generating sources due to its availability and topological advantages in local power generations. However, a drawback, common to solar and wind options, is their unpredictable nature and dependence on weather changes. Wind and solar energy resources, unlike dispatchable central station generation, produce power dependable on external irregular source and that is the incident wind speed which does not always blow and solar radiation which does not always emission when electricity is needed. This results in the variability, unpredictability, and uncertainty of wind and solar resources. Therefore, the forecasting of wind and solar energy present a major challenge to power system. Both of these energy systems would have to be forecasted accurately to make them completely reliable.

Fortunately, the problems caused by variable nature of these resources can be overcome by integrating these two resources as a hybrid system. However, with the increased complexity in comparison with single energy systems, optimum forecasting of hybrid system becomes most challenging and complicated. Such hybrid forecasting has significant impact on the optimum power flow, transmission congestion, power quality issues, system stability, load dispatch, and economic analysis.

Therefore, this study aims to develop a novel hybrid system for wind and solar energy forecasting with smart grid for a sustainable future. The proposed model is dedicated to short-term forecasting (three-hour ahead). Two separate modules, one for wind and another for solar will be developed for the purpose of hourly forecasting of wind speed and solar radiation as well as converting the speed and radiation to wind and solar energy respectively based on the delivered data. Each of these modules is consisting of several trained networks for hourly wind and solar energy forecasting based on the supplied historical weather data. The third module is connected to the two earlier mentioned modules. The later module will play the role to merge the forecasted wind and solar energy output provided by those two connected modules. Eventually the output from the system is the hourly hybrid forecasting of energy where the renewable energy sources of that hybrid system are wind and solar. Since the hybrid forecasting system is quite a novel approach, the accuracy of the system will be revealed

by comparing the results with the corresponding values of a reference forecasting model referred to as the persistent model.

By statistically investigating the long-term hourly solar and wind data, subtropical climate areas are found to have favourite solar and wind power resources compared with other areas, which validates the practical applications in subtropical climate area.

It is anticipated that the outcome of the research will provide noteworthy contribution to the Australian energy industries that will facilitate the most to implement smart grid with renewable energy replacing conventional grid for a sustainable future.

Volcanic Rock Filters in Decentralised Wastewater Treatment

Benjamin Kele, PhD candidate, CPWS

Water scarcity has increased the use and acceptance of recycled water in the Australian community. The high cost of transporting recycled water is one of the last major inhibiting factors to the more widespread usage of treated effluent. The use of decentralised wastewater treatment systems which are constructed in-situ eliminates the need for recycled water to be transported from off-site locations. A decentralised treatment system allows for the wastewater produced at a location to be treated and recycled within the site. The most common purpose for recycled water is as irrigation water. Recycled water applied to soil as irrigation water may have long term sustainability issues in regards to salinity and sodicity concentrations. Traditional desalination techniques, such as reverse osmosis membranes, are capital and operationally expensive, which may make them economically unsustainable to produce irrigation water. This project examines the use of volcanic rock filter media, such as zeolite and scoria, which can reduce salinity and sodicity concentrations via cation exchange processes. The volcanic rock filter media have been trialed with wastewater from eco-villages, special events venues, and coal seam gas mines.

Internet Security – Detecting Botnets

Matthew Kennedy, PhD candidate, CINS

Bots are computer programs that perform tasks with some degree of autonomy. Bots can be used for malicious purposes including sending spasm, spying on private data, distributing malicious software, phishing attacks and ddos attacks. Botnets are networks of bots controlled remotely by bot-herders.

As a rule bot-herders make efforts to hide their botnet and implement schemes to prevent detection. Generally bots are installed by tricking the user in to agreeing to install the software or by exploiting faults in the operating system, browsers or applications. The bots are designed and tested to avoid detection by antivirus programs. Malware kits can be purchased to construct botnets or ready built botnets can be bought or hired. Botnets are widely considered to be a major security threat on the Internet. Reports indicate 95% of spam is sent by botnets. Banking fraud, using credentials captured by botnets, is becoming an increasing problem.

The question arises on a well managed enterprise computer networks using "security in depth" policy are undetected botnets a problem? If botnets are not a problem what are the security measures that prevent infection?

Detecting botnets can involve active static analysis or behavioral analysis. Static analysis involves using signatures of know malware or blacklists of IP's or URL's. Behavioral analysis attempts to identify the malicious activities of the bots. Honeypot/Honeyclient systems may be used to trap bots. By searching historical network data using updated detection systems it is possible to identify bots that were previously undetected. By this research a greater understanding of real world botnets can be obtained, leading to improved prevention and detection techniques.

All computer administrators and users benefit from improved computer security.

A simulation model to improve the energy efficiency of post combustion carbon capture process in coal power plant

Rasel Mahamud, PhD candidate, PELM

Carbon capture and storage (CCS) is considered as a promising option to reduce carbon dioxide (CO2) emissions by power plants that use fossil fuels. However, it consumes significant amount of energy raising the cost of power generation, hence CCS technology may not be a long term viable option for reducing CO2 emissions. Reducing energy penalty through process integration has significant importance for CCS adoption by the power generation industry.

Pinch technology is being used for process integration analysing overall process energy requirements to find economically optimal design. Exergy analysis, on the contrary, can reveal the major causes of thermodynamic imperfection of the processes and thus provides more insights for effective thermodynamic process design. Combining the strengths of both methods, this project will develop a simulation model to improve the process energy efficiency of post combustion carbon capture process in coal power plant.

A rotating parallel disc device for flow-accelerated corrosion research

Ian McNeilly, PhD candidate, PELM

In industry high fluid flow rates are a major cause of enhanced corrosion damage to exposed metal surfaces. With inherent difficulties in the monitoring of corrosion in plant environments, there is often a need to resort to small scale laboratory systems and attempt correlation of corrosion rates between the two systems by using conditions of similarity based on parameters such as mass transfer coefficients or wall shear rates. Currently available simple geometries include rotating electrode geometries such as the rotating disc electrode (RDE) and the rotating cylinder electrode (RCE). While hydrodynamic flow and mass transfer attributes remain well defined over a wide range of fluid velocities, these geometries are limited to modelling plant corrosion rates for comparatively mild flows up to a maximum shear rate of about 380 s-1. Industrial plant wall shear rates can be as high as 105 or 107 s-1 and other larger scale geometries such as the flow loop and the jet impingement cell are able to model turbulent plant flows

at comparable wall shear rates. However turbulent and unpredictable fluid flow characteristics of these systems make the collection of meaningful electrochemical measurements difficult. Therefore, correlation to plant environments through conditions of similarity can also be complex.

This presentation introduces a novel Parallel Disc Device (PDD) that is capable of generating very high wall shear rates at the surface of a metal electrode under flow conditions that are presumed laminar. The device has been electrochemically characterised by studying, as a function of both gap distance and top disc rotation, the diffusion limited reduction of hexacyanoferrate(III) at a nickel working electrode and the diffusion limited reduction of dissolved oxygen at a copper electrode.

Mass transfer data recorded for these electrochemical reaction systems have been used to validate an empirical mass transfer model for the PDD in terms of the Sherwood number (Sh), Reynolds number (Re), and Schmidt number (Sc) dimensionless variables. This model is valid for PDD gap sizes ranging from 0.250 mm to 1.00 millimetres up to a maximum wall shear rate of 30,000 s-1.

Harmonic Mitigation Methodology in Low Voltage Distribution Networks

Pubudu Padmaharsha Warusamanna, MEng Candidate, PERG

Harmonic distortion, one of the most important aspects of power quality, is generated by equipment which does not draw linear currents. Since the introduction of many modern electrical appliances and industrial equipment, harmonic distortion has become an increasing problem for utilities. It is necessary that harmonic distortion limits in power systems be kept below compatibility levels to stop equipment failure or malfunction, to ensure equipment operate within ratings and to minimise adverse impact on the life expectancy of connected equipment.

With more disturbing loads and distributed generation being connected to the low voltage distribution network, the industrial partner of this research project Ergon Energy expects that it will need to resort to harmonic mitigation methods to ensure that harmonics in the distribution network remain within acceptable limits.

The proposed research aim is to develop a toolkit of options available for a Distribution Network Service Provider, such as Ergon Energy to mitigate harmonics in the low voltage distribution network.

This entails a literature review encompassing national and international standards applicable to harmonics for distribution systems and for equipment connected to such systems. Then simulations will be developed with sections of Ergon Energy's low voltage network that replicates recorded power quality phenomena in the network. Next identification and modelling of the suitable harmonic mitigation techniques will be carried out. Based on these the suitable mitigation methods will be identified for Ergon Energy to minimise the future impact of harmonics in the Low Voltage distribution network, taking into account relevant facets such as a brief on design, costs, risks and operational issues.

Targeting resource investments to achieve sediment reductions and improved reef health

Megan Star, PhD candidate, CEM

The increased impact of excessive sediment loads entering the Great Barrier Reef lagoon has lead to further awareness of the importance of ground cover in grazing lands. Ground cover has been identified as an important factor in reducing sediment loads, and the most efficient and targeted method to improve ground cover has presented a difficult task for reef stakeholders in both the Fitzroy basin. To further inform these decisions an optimising linear programming model based on paddock scale information in conjunction with land type mapping was developed. This identifies at a catchment scale which land types allow the largest sediment reduction to be achieved at least cost. The results suggest that from the five land types modelled the lower productivity land types present the cheapest option for sediment reductions, and represent a large percentage of the reef catchments. The study allows more informed decision making for natural resource management organisations to target investments. The analysis highlights the importance of efficient allocation of natural resource management funds achieving sediment reductions through targeted land type investments.

Key Words: grazing, natural resource management, investment, linear programming, land type mapping, Great Barrier Reef.

New Affordable Level Crossing Protection Systems for Passive Level Crossings

William Thomsen, PhD candidate, CRE

This project addresses the need for evaluation of new level crossing protection systems from Human Factors perspectives early in the process of identification and selection of candidate systems. Installation of any new system will be at risk of wasting public and rail industry resources for little improvement of system safety unless new technologies are proven to generate compliant, safe responses from road users. Data has been gathered from a range of sources to gain understanding of road user responses to different situations encountered at passive level crossings. Through analysis of this data, criteria will be developed for evaluation of technologies to determine whether they result in improvement of user responses at passive crossings. Applying these criteria will ensure cost effective use of industry and government resources, as well as a reduction in frequency of collisions at passive crossings across Australia.

The influence of a changing social and political environment on corporate emissions disclosures of Australian companies

Maria Tyler, PhD candidate, BRG

This study examines the specific emissions disclosures in annual and sustainability reports of Australian companies over a seven year period. This period (1 July 2003 to 30 June 2010) covered significant changes in the Australian social and political environment, including a change in Australian government and the introduction of the National Greenhouse and Energy Reporting Act 2007. The study grounds itself on existing traditional accounting theories of legitimacy and stakeholder, and furthers these by proposing an evolving multi-theoretical accounting model. It then applies the theoretical model to practice, testing its predictive and explanatory abilities by investigating Australian corporate emissions reporting over a change in their social and political environment. The study expects to find that (a) changes in emissions disclosures can be explained by an evolving overlap of legitimacy to managerial stakeholder theories, and (b) specific emissions disclosures are reflective of the more prominent concerns of their social and political environments. Hence, this research contributes both to existing accounting theory literature as well as to practice. These findings (a) extend the current accounting theoretical literature by developing the predictive and explanatory power of transitioning theories, and (b) inform those involved with designing future emissions policy, particularly in Australia.

Wayside Lubricator Placement Model for Heavy Haul Lines

Md Gyas Uddin, PhD candidate, CRE

Effective rail curve lubrication plays an important role in rail wheel interface friction management. Therefore Wayside lubrication method is widely used in rail industry to provide cost effective lubrication and reduce rail/wheel wear, energy consumption, maintenance cost and noise. Research on lubrication practice in Australian heavy haul networks is limited. The performance of lubricants in the track could have significant difference based on weather conditions, track/traffic characteristics, dispensing equipment, lubricant type and dedication of lubricator's maintenance activities. There is a need for considering the effect of applicator bars (short and long bars), location and position of bars on the gauge face of the rail, track geometry, direction of traffic and other important factors. Wayside lubricator placement for maximum benefits is a function of product carryover and product carryover is affected by many track and traffic based parameters. Thus it is essential to generate model of lubricator placement based on combined effect of lubricants, applicator bars, locations and track/traffic characteristics. Experimental field data is collected and analysed for development of the model and estimation of model parameters. A worldwide literature review has been completed on the current lubricator technology to determine the best practice in heavy haul industry. Experience on lubrication current practice shows that mechanical or hydraulic systems need relatively higher maintenance requirements, and do not activate effectively at low train speeds. But the electric lubricators need low-maintenance and perform better with significant control of grease application. The Objective of the research is to minimise lubricant consumption and the number of lubricators necessary to achieve the desired gauge face coefficient of friction (μ) through optimal placement of the lubricators. Optimal settings of the electric lubricators were evaluated and found there was minimal wastage of grease with coal traffic.

The latest knowledge of optimal placement of lubricators was achieved to optimise lubrication management strategy. Controlled in-field testing has been undertaken on the Queensland Rail network to establish the reliability, efficiency and cost-benefit analysis of wayside lubricators.

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