ACRI Research Projects

ACRI Heavy Haul Research Program

Moving Vehicle Rail Foot Flaw Detection – review
A method is required to inspect for fail foot fatigue defects that can be deployed at speeds at least as high as the current ultrasonic processes (~20 km/hr). This initial literature review identified existing technologies and assessed their suitability for use in an Australian context.

Moving Vehicle Rail Foot Flaw Detection – main project
A method is required to inspect for fail foot fatigue defects that can be deployed at speeds at least as high as the current ultrasonic processes (~20 km/hr). This project will deliver research on possible measurement methods and practical instrumentation concepts through the use of simulation studies with experimental validation for a variety of detection techniques.

Broken Rail Detection Without Insulated Rail Joints - review
New alternative traffic technologies such as Communication-Based Train Control (CBTC) and Positive Train Control (PTC) are emerging that do not require the existing track circuits-based signalling systems. A solution is required to enable Broken Rail Detection without IRJ’s (that is without traditional signalling track circuits). This research seeks to determine a cost-effective method to detect broken rails, which will provide the option to remove track circuit-based signalling altogether, eliminating a significant component of per-kilometre maintenance costs. An initial review investigated existing technologies for broken rail detection and discussed the strengths and weaknesses.

Broken Rail Detection Without Insulated Rail Joints - main project
New alternative traffic technologies such as Communication-Based Train Control (CBTC) and Positive Train Control (PTC) are emerging that do not require the existing track circuits-based signalling systems. A solution is required to enable Broken Rail Detection without IRJ’s (that is without traditional signalling track circuits). This research seeks to determine a cost-effective method to detect broken rails, which will provide the option to remove track circuit-based signalling altogether, eliminating a significant component of per-kilometre maintenance costs. This project will develop a prototype device based on multiple existing technologies and test the device on a live rail line.

Track Structures vs Train Dynamic and Load Effects - review
Traction/braking impacts on the permanent way. Limited research has been undertaken to date regarding the specific impact on the permanent way, the ability for different track structures to manage this load, the best methods of damage prevention/rectification and the cost impacts. An initial review identified the way forward for a main project.

Track Structures vs Train Dynamic and Load Effects – main project
Traction/braking impacts on the permanent way. Limited research has been done to date regarding the specific impact on the permanent way, the ability for different track structures to manage this load, the best methods of damage prevention/rectification and the cost impacts. This project will investigate the impact and cost of increasing traction on track and associated infrastructure and provide insight into damage prevention, rectification and maintenance.
Permanent Way Condition Monitoring and Inspection Best Practice
Increasing the number and frequency of trains has an adverse effect on life of civil assets due to additional wear and fatigue. This reduction in asset life requires an increase in condition monitoring and more frequent maintenance interventions to ensure reliable train operations. This research reviewed current practices in regard to Permanent Way Condition Monitoring and identified approaches that are associated with Inspection Best Practice.

Empty Train Aerodynamic Improvements
This project investigated the effects of aerodynamics on empty trains, identifying potential cost savings in fuel from covered trains and applied the findings to typical Heavy Haul routes in Australia.

End of Train Devices – review
The current problem with End of Train devices is around the high cost for existing devices that are not fully suited to Australian conditions. An initial review identified the existing state of EOT usage in Australia.

End of Train Devices – main project
The current problem with End of Train devices is around the high cost for existing devices that are not fully suited to Australian conditions. This project will investigate whether a more appropriate device could be developed to better suit the Australian context.

Flash Butt Welding
This project will investigate permutations and combinations of commonly used rail steels to provide a recommendation for the optimal welding technologies and conditions for joining each type, and mixed types, of steel.

Pilbara Level Crossing Investigation
An investigation into the underlying human factors leading to level crossing incidents and near-misses specific to the Pilbara.

ACRI Level Crossing Research Program

Evaluation of a Level Crossing Enforcement system
This project evaluated the impact of a Level Crossing Enforcement System on the frequency of road user transgressions at a busy level crossing site in Victoria, to determine the effect of enforcement systems on driver behaviour.

VectorLX System Evaluation
An independent assessment was carried out of the accuracy of the functionality of the Vysionics VectorLX enforcement system at a busy level crossing site in Victoria.

Level Crossing Sighting Distances
This project examined the ability of drivers’ to sight approaching trains at level crossings and sought to determine how drivers’ judgement is affected by train distance and speed. The outcomes fed into the review of standard AS1742.7.
Impact of Waiting Times on Risk and Standardisation of Waiting Times

Differences in warning / waiting times at level crossings can lead to detrimental driver behaviour leading to incidents. This leads to the question of how longer waiting times affect motorists’ assessment of risk and how long motorists are prepared to wait at level crossings before undertaking risky behaviour. This research investigated how drivers’ behaviour changes with longer waiting times.

Passive crossings and table-top carriages

There is an existing issue around the poor visibility of table-top train carriages at night at passive level crossings and the likelihood for motorists colliding with these types of carriages. This research investigated if there is a passive engineering solution to highlight the moving or stationary train carriages to reduce the likelihood of incidents of this nature.

Passive crossings and table-top carriages – stage 2

There is an existing issue around the poor visibility of table-top train carriages at night at passive level crossings and the likelihood for motorists colliding with these types of carriages. An initial literature review was conducted in 2015/16 and following from this, the second stage of this project will investigate passive engineering solutions to highlight the moving or stationary tabletop carriages at level crossings.

Better stimulus around Level Crossing control

Following the Kerang crash coroner’s inquiry, recommendations were made to investigate improvements to overcome road users’ ‘habitual behaviour’ leading to missing level crossing active warning controls. This research sought to evaluate new level crossing counter measures to alert motorists to the presence of an approaching train, to allow motorists (especially heavy vehicle drivers) to respond safely to level crossing controls.

Better stimulus around Level Crossing control – stage 2

Following the Kerang crash coronial inquiry, recommendations were made to investigate improvements to overcome road users’ ‘habitual behaviour’ leading to missing level crossing active warning controls. This project is being rescoped following an exploratory first stage in 2015/16 and will investigate whether changes to the flash rate and size of lights at actively controlled level crossings can be improved, to determine the optimal configuration to alert drivers to the presence of the crossing.

Rail Flange Gap risk reduction

The rail flange gaps at pedestrian crossings have always been an issue for pedestrians, cyclist and wheel chairs / mobility device users to negotiate. This project will conduct an investigation of available treatments for rail flange gaps and trial a variety of solutions to provide advice on the safest and most suitable solution.

Active “Expect Trains” Sign Trial

KiwiRail has initiated a programme to evaluate whether new “Expect Trains” active signs are effective in improving motorist checking behaviour for trains. This main project – conducted and funded by KiwiRail – focuses on evaluating the reliability of this active signage, as well as its effects on compliance and approach speeds at level crossings.

ACRI is proposing to conduct a parallel trial to complement the evaluation conducted by KiwiRail at one of the sites where the signage has been installed in New Zealand. This proposed parallel study specifically focuses on evaluating the effects on driver visual scanning and search behaviours to confirm whether ‘checking activity’ increases upon installation of the signs. It will use a modern, in-vehicle eye tracking system to determine where drivers are looking when passing the signs and on approach to the crossing,
to better understand the impact of the new signage. The results will complement the KiwiRail Trail and KiwiRail have agreed to share their findings with ACRI Participants.

**Low Cost RLX Risk and Legal Evaluation**

This project undertook a Legal Review of the risk and economic arguments for low cost level crossing protection and included the creation of a decision making tool for industry.

**Affordable Level Crossings stage 2**

This project involved the development and evaluation of new technologies for lower cost level crossing protection, including a practical assessment of a variety of systems.

**Baseline RLX Video**

An investigation of video capture technology was undertaken to record and categorise near-misses at level crossings in a consistent way.

**Klaxon Investigation**

Most of the current literature focuses on the noise generated by train horns (klaxons), to address nuisance complaints by residents who live near railway tracks/level crossing whistle boards. Very little information is available on how effective klaxons are as a device to warn motorists and pedestrians at the approach to level crossings. This project will investigate the effectiveness of the klaxon in alerting pedestrians and motorists to the presence of a train, particularly taking into account:

- The nature of level crossing protection (e.g. comparative benefit of klaxon sounding at active or passive level crossings)
- The geographical location of level crossing (urban v rural/regional)
- The noise inside and immediately outside the motor vehicle (or if the vehicle windows are closed)
- Surrounding noise and use of mobile phones/earphones by pedestrian users
- Other driver/pedestrian distractions.

**Alternative Level Crossing Protection**

A major limitation of providing active level crossing protection is the high cost of installing track-circuit based protection systems. Increasing the affordability and cost-effectiveness of level crossing protection can allow a greater number of sites to be protected.

The project aims to determine through homologation testing if alternative active level crossing systems designed for level crossings in remote locations with low road and train traffic volumes (including occupational level crossings) are viable solutions.

**ACRI Passenger/Freight Research Program**

**Slips, Trips and Falls – stage 1**

A study to determine the underlying causes of slip, trip and fall incidents and provide recommendations to mitigate the human factors contributing to these incidents. Stage one of the project involved an identification of the underlying causes and existing interventions in relation to slips, trips and falls.
Slips, Trips and Falls – stage 2
Stage 2 will comprise of an evaluation of the design characteristics of railway stations that lead to slips, trips and fall incidents, through the investigation of four selected railway stations around Brisbane (2 with high rates of slips, trips and falls, 2 with low rates of slips, trips and falls).

Slips, Trips and Falls – stage 3
Stage 3 will involve an investigation of high risk rail users’ behaviours at railway stations through the use of eye-tracking technology, to analyse what passengers are looking at while travelling through stations and on trains.

Advanced Transport Model
This research will look at the role the human element plays in efficient operational systems. As an organisation evolves through incorporating technological advances, the human component must also adapt and evolve—in particular to ensure that the maximum benefit is gained, that safety is ensured and that worker competency, workload and wellbeing is maintained. This project will develop a customisable architecture framework model of a generic rail organisation to enable scenario planning for the introduction of new technologies across the organisation.

Track Worker Safety
This project aims to investigate the application of technology solutions to track side safety risk, and will specifically look at how new technology is integrated with existing processes.

Other Research

Occupational Health and Safety Survey
A survey has been created based upon research conducted by the CRC for Rail Innovation, intended for use by rail operators to self-assess their safety culture. The survey findings provide a roadmap to improve organisational health and safety within the organisation. This survey is being made available to industry through the Rail Industry Safety and Standards Board (RISSB).

Investigator Course
A course has been created to provide a qualification for Incident Investigation based upon research conducted by the CRC for Rail Innovation. The course has received accreditation through the Australian Skills Quality Authority (ASQA). Following a competitive selection process a Registered Training Organisation was selected and the course made available by ACRI.

Pilbara Level Crossing
This project will investigate the underlying human factors that lead to level crossing incidents specific to the Pilbara region of Australia, with its particular climate, terrain and type of traffic (predominantly heavy road and rail).

Jointly Funded Research Projects

Performance of recycled rubber inclusions for improved stability of railways
This jointly funded research project will test the performance of track stabilised with shock mats, using fundamental geotechnical models. This report delivers a comprehensive review of state-of-the-art
technologies relevant to rail foot flaw detection, giving emphasis to their use in the detection of rail foot flaw defects at practical inspection vehicle speeds.

**ARC Project – Train Driver Health**

The specific aim of the research will be to shift focus from reactive to proactive health management and demonstrate improvements in the health and productivity of train drivers. It will develop an evidence-based toolkit that will enable organisations to effectively, systematically, and reliably undertake risk assessments associated with train driver health, and enable it to be viewed as a model of shared responsibility between the driver and the organisation.

**ARC Project – Training Centres**

The Australian Research Council (ARC) now funds Industry-based Training Centres for the training of PhD students and Postdoctoral Fellows who can contribute to industry. The proposed centre is focused on Rail Technologies specifically for Australian conditions (and similar markets). The R & D technology will include key industry issues with respect to: Above Rail, At Rail and Below Rail, encompassing the fields of Civil, Mechanical, Electrical, Mechatronic and Materials Engineering. The Centre will also pursue research into Safety, cognitive learning, applied Mathematics and computer science.

**ARC Linkage Project – Prevention of Subgrade Instability under Fast Heavy Haul Trains**

A significant proportion of the population of Australia resides in rural and regional areas. Track renewal and construction is an ongoing process across regional and rural NSW and QLD. These areas contain soft subgrade soils and marginal granular fills, and currently pose challenging geotechnical problems for the newly planned Australian heavy haul networks (e.g. Inland rail, Hunter region). Along coastal areas, soft soils and estuarine deposits can often exist to depths exceeding 30m and are characterised by low permeability, high compressibility and high lateral yield upon loading and low shear strength and bearing capacity. In poorly drained situations, the increase in excess pore pressures generated by cyclic loads (e.g. high speed heavy haul rail) can decrease the effective load bearing capacity of the soil foundation. Under such circumstances, the occurrence of soil slurry (i.e. mud pumping) beneath rail tracks can initiate excessive differential settlement followed by undrained subgrade failure and damage to track infrastructure. The application of sub-surface drainage to improve stability of soft ground has the potential to significantly reduce construction and maintenance costs and enhance the performance of infrastructure, through better drainage, greater load bearing capacity and reduced settlement of the improved soil.