ANNUAL REPORT 2016–17

RAIL MANUFACTURING CRC

Rail Manufacturing CRC Ltd.

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Strategic Intent

To foster, sponsor and direct collaborative research and commercialisation partnerships between key stakeholders in the rail manufacturing sector.

Vision

To assist the Australian rail manufacturing sector to develop industry-led R&D solutions to industry-identified challenges, to encourage innovation and to foster increased engagement in the global supply chain.

Mission

To assist the rail manufacturing supply chain to develop new technologies and products to increase productivity and play a key part in attracting and supporting the next generation of highly qualified engineers and scientists to bring their skills and talent to the rail industry.

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

Message from the Chair and MD

Welcome to the third annual report for the Rail Manufacturing CRC, which represents the halfway point of our Centre's six-year lifespan.

The past 12 months have seen the maturing and consolidation of a number of the Centre's start-up activities and the development of new projects. We have acquired a number of new participants, including a rail operator, and a range of SME businesses and non-rail entities interested in diversifying into the rail sector.

The Centre has also had to face a number of external challenges due to the continued rationalisation of the global rail industry through mergers and acquisitions, in turn impacting on our industry partners' Australian business operations.

Nevertheless, the Rail Manufacturing CRC's Board and Management teams have actively worked to continue growing the Centre during the 2016–17 Financial Year, with a renewed interest and vigour from our participants in the Centre's operations and projects.

Due to delays in securing and commencing projects, and project postponements, research expenditure was $5.9M lower than budgeted for the year.

The Commonwealth maintained its original funding payments schedule, however contributions from participants, along with associated project research and development expenditures, were re-phased into the later years of the Centre's six year life. While the Centre has underspent to-date, we have still maintained a portfolio of projects that seeks to deliver on the majority of our Commonwealth Milestones, while we are also in late stage negotiations with two large industry participants for three forthcoming projects which, if they proceed, will result in new cash contributions of approximately $2 million.

Continued investment in passenger rail

Since the inception of the Rail Manufacturing CRC in 2014, the Australian rail industry has experienced many changes in demand. With the decrease in the heavy haul sector, coupled with a significant increase in the passenger rail sector, the rail industry has restructured to take advantage of these changes as seen through various global mergers and acquisitions occurring in traditional and large rail manufacturing entities.

Many significant rail projects have been committed to in the coming years, with $20 billion allocated in the 2017–18 Federal Budget for investment in rail infrastructure to ease congestion and boost productivity. Some exciting upcoming rail initiatives to occur at State and Federal levels include:

- The Melbourne to Brisbane Inland Rail high-capacity freight link through regional Australia
- Melbourne's Metro tunnel and new high capacity train fleet
- Sydney's north-west metro rail line, the Harbour to CBD line and light rail projects
- Brisbane's Cross River Rail and southeast Queensland train corridors.

These commitments provide Australia's rail manufacturers with a more sustainable pipeline of work compared to when the Centre first formed and will assist in long-term workplace and R&D activity planning. With the continued emphasis on passenger rail projects across Australia, the Rail Manufacturing CRC has also continued working to develop new projects and to attract new participants working in the passenger rail sector.

Roadmap still on track

One of our core objectives is to ensure that the work being conducted by the Rail Manufacturing CRC is aligned to industry needs in the short and long term.

In 2012, the rail industry collaborated on the *On Track to 2040 – Preparing the Australian Rail Supply Industry for Challenges and Growth* Roadmap, which defined priority areas and the activities within each, to drive industry innovation.

The three areas originally defined – *Power and Propulsion, Materials and Manufacturing,* and *Monitoring and Management* – were subsequently amended and used as the Rail Manufacturing CRC's three key research theme areas:

- Power and Propulsion
- Materials and Manufacturing
- Design, Modelling and Simulation.

Given five years has passed since the roadmap's creation, the Centre has reviewed the original activities to determine if those topics are still relevant to the rail manufacturing industry and the Centre's goals and objectives.

Through consultations with the Centre's participants and the broader rail manufacturing sector during events such as the Rail Manufacturing CRC Participants Forums, and participation in key industry events, it is pleasing to note that the priorities and goals set are still seen as highly relevant and valuable to achieve for our industry.

While the sector has seen a re-emphasis in priorities from heavy haul to passenger rail, current industry needs are still aligned with those expressed in the *On Track to 2040* Roadmap.

Education is vital

This year saw the establishment of a number of exciting initiatives in the education space, each with the potential to positively impact our industry and research participants.

Working closely with our university organisations, the Rail Manufacturing CRC established the Rail Innovators PhD Scholarships – focused on partnering with our universities to award scholarships for leading postgraduate students undertaking PhD research relating to rail.

With 14 students awarded scholarships in 2016–17, this supports the rollout of industry-leading research projects that provide the rail sector with improved capability in the future.

Some of these scholarship project topics include:

- condition monitoring of rail components in real-time
- unmanned aerial vehicles for infrastructure assessment
- laser cladding technologies for rail components
- augmented reality and virtual reality technologies
- big data analytics for condition monitoring
- automated assembly of rolling stock fabrication
- stabilising ballast in rail tracks
- smart axle condition monitoring.

The Rail Manufacturing CRC's Board and Management teams remain very impressed with the efforts of our research organisations in leading and driving innovative change in rail, and the Rail Innovators PhD Scholarships program would not be possible without the continued support of our university participants.

In addition to these scholarships, the Rail Manufacturing CRC is in the process of trialling an internship program, where two Queensland University of Technology PhD students were selected to receive a top-up scholarship and 12-week internship work placements in Industry organisations Queensland Rail and Aurizon, complemented by knowledge sharing from the Queensland Government's Department of Transport and Main Roads.

Funded jointly by the Centre and the TrackSAFE Foundation, a key priority of the program was identifying rail students working in the area of level crossings, and providing them with an opportunity to apply their knowledge in an industrial environment. The program also gave industry representatives the opportunity to see the benefits that postgraduate students can bring to their organisations, hopefully inspiring them to consider hiring qualified researchers within their business in the future.

Paul Johnson MBE
Chair

Dr Stuart Thomson
CEO

Chair’s Report

Continued engagement with stakeholders

In the past 12 months, the Board and Management teams have continued to closely engage with our participant industry and research organisations, as well as encouraging greater collaboration with the broader rail sector. The Rail Manufacturing CRC has received good support from industry peak bodies such as the Australasian Railway Association (ARA), the TrackSAFE Foundation and the Australasian Centre for Rail Innovation (ACRI), who have assisted the Centre in developing relationships with the broader rail industry.

Special thanks also go to the ARA for appointing the Rail Manufacturing CRC as a member of the ARA’s Rail Industry Group. This enables the Centre to engage with the rail sector on key priorities, programs and innovative research and development matters.

The Rail Manufacturing CRC’s industry participants have continued to support the Centre, with subsequent growth in projects and participant numbers. New participants to join the Centre in 2016–17 include:

- HEC Group
- Sydney Trains
- Knorr-Bremse
- Global Synthetics
- Foundation QA
- TrackSAFE Foundation
- UGL Rail

The Centre has also been working with inaugural industry participants to develop their commitment to fund future projects. The Rail Manufacturing CRC is in the process of signing a number of new or amended projects with CRRC, Downer, HEC Group and Knorr-Bremse, while also having discussions with a number of other organisations and research institutions looking to join the Rail Manufacturing CRC.

The Centre also continues to work with the Advanced Manufacturing Growth Centre (AMGC), a Commonwealth Government-backed initiative aimed at coordinating industry-led approaches to drive innovation, productivity and competitiveness. A memorandum of understanding has been executed with the AMGC, and the two parties meet regularly to collaboratively share information and assist with co-engagement of our collective industry networks.

Great achievements this year

In addition to the large increase in new participants and the number of students being supported by the Centre, there has also been a variety of project success stories in 2016–17, including the:

- Downer-UTS passenger tracking project (R3.1.2) being extended to incorporate late stage trials of the technologies used
- delivery of a prototyped battery system by CSIRO for their project with CRRC (R1.3.1)
- continued strong partnership between Airlinx and RMIT University (R3.6.1), with the project’s scope now extending to include 3D ventilation modelling
- significant increase in the number of SMEs conducting research projects with the Centre, highlighting the benefit of the CRC program to niche organisations.

None of these successes would be possible without the efforts of our Essential Participants, Other Participants, Third Party Participants and the Federal Government’s Business Cooperative Research Centres Programme. Thanks also to industry organisations such as the ARA and AMGC for supporting our Centre with invaluable information sharing, collaboration and participation throughout the year.

To our Board members and the Centre’s Management team, thank you for your continued efforts in working to drive innovation in Australian rail manufacturing. We look forward to sustaining and building upon this momentum during the next three years.

Paul Johnson MBE
Chair – Rail Manufacturing CRC

Dr Stuart Thomson
CEO – Rail Manufacturing CRC

Keeping the Centre *on track*

3 **Years into six**
years of operation

28 essential
and Other Participant
organisations committed

17 **Rail Manufacturing CRC**
projects underway

$42M available to fund
rail innovation projects

22 students
now financially supported

6 PhD students working on Centre projects

14 PhD students on funded scholarships

2 PhD students on industry work placements

About the Rail Manufacturing CRC

The strategic direction for Australian rail manufacturing was outlined in the *On Track to 2040 – Preparing the Australian Rail Supply Industry for Challenges and Growth* Roadmap, developed in 2012 following intensive engagement and collaboration with over 210 industry participants.

Australian Government
Department of Industry, Innovation and Science

Business
Cooperative Research
Centres Programme

The roadmap identified the need for a collaborative research entity dedicated to innovation in rail manufacturing, which subsequently supported the establishment of the Rail Manufacturing Cooperative Research Centre (CRC).

The Rail Manufacturing CRC began operations in 2014, with a focus to drive the development of new products, technologies and supply chain networks to enhance the competitiveness of Australia's rail manufacturing industry.

The Centre manages collaborative research and commercialisation partnerships between key stakeholders, such as rail manufacturing multinationals, innovative small-to-medium enterprises, leading research and development providers, industry peak bodies, and State and Federal Governments.

Funded jointly by participating Australian rail organisations and the Federal Government's Department of Industry, Innovation and Science under its Business Cooperative Research Centres Programme, the Rail Manufacturing CRC will operate for six years, finishing up at the end of the 2019–20 Financial Year.

By turning research-based industry solutions into timely market innovations and products, the Rail Manufacturing CRC will support the development of technologies that will lead to new opportunities for Australian manufacturers.

Achievements

Research and collaboration

In its third year, the Rail Manufacturing CRC's research program has made solid progress across most of its projects, as well as signing up seven new Rail Manufacturing CRC projects and an additional 14 PhD projects under the Rail Innovators PhD Scholarships program in 2016–17. The high degree of end-user collaboration within these projects is particularly pleasing, with another seven new participant organisations also joining the Centre.

'The high degree of end-user collaboration within these projects is particularly pleasing'

To support the rollout of the Rail Manufacturing CRC's research programs, University of Queensland Professor Paul Meehan was appointed as new Program Leader for Research theme 2 – Materials and Manufacturing. Professor Meehan replaced Gary Savage from CSIRO, who resigned from the Centre in December 2016 to take up a new role in the defence sector. We wish Gary well with his future endeavours. Professor Meehan is a leading researcher working in railway mechanics and noise, and also currently leads two of the Centre's projects: Project R2.3.2 – *Axle bearing maintenance optimisation* and Project R2.3.4 – *Monitoring and control of false brinelling*.

There have been a number of successes in the continued rollout of the Centre's projects in 2016–17. The development of on-board energy systems for rail (Projects R1.3.1 – 1.3.4) progressed well during the year with strong collaboration between CSIRO researchers and CRRC employees. The strength of the project team was also highlighted with CSIRO researcher Dr. Marzi Barghamadi, who was working on Project R1.3.3 – *High energy supercapacitor development*, being awarded an Endeavour Research Fellowship and travelling to Münster Electrochemical Energy Technology in Germany to learn more about Li-ion battery manufacturing.

Another example of strong collaboration was shown between Bombardier and the University of Queensland during their two projects: Project R2.3.2 – *Axle bearing maintenance optimisation* and Project R2.3.4 – *Monitoring and control of false brinelling*. Both projects benefited due to Bombardier supplying real-life parts and equipment for the university to analyse, in addition to enabling the instrumentation and monitoring of bearings for Project R2.3.4.

In Research Program theme 2 – Materials and Manufacturing, two new projects: R2.5.1 – *Performance of recycled rubber inclusions for improved stability of railways* and Project R2.5.2 – *Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading* are focused on investigating alternate materials to use to improve rail ballast stability, which has the potential to reduce track degradation by approximately 30 per cent in heavy haul applications. These projects involve a wide range of participant organisations, including Tyre Stewardship Australia, the Australian Centre for Rail Innovation, Global Synthetics, Foundation QA and the University of Wollongong.

Research Program theme 3 – Design, Modelling and Simulation, includes Project R3.1.2 – *Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system*, a partnership between Downer and the University of Technology Sydney to develop a Responsive Passenger Information system. This project is looking to provide rail operators with systems that monitor passenger numbers and movement at congested stations, and has involved active participation during the year from operators Queensland Rail and Sydney Trains to pilot the technology.

The Rail Manufacturing CRC is also continuing its commitment to engaging with key industry groups to communicate the importance of rail innovation. Participation in numerous rail industry forums has enabled the Centre to develop key relationships with rail manufacturers, rail operators and government organisations. The Centre has participated in a number of joint industry briefings, conferences, forums and advisory groups, while also working closely with rail peak bodies, including the Australasian Railway Association (ARA).

The Centre promoted rail innovation at a number key forums, including Innotrans 2016, the AusRAIL Conference in November 2016, the Depot Upgrades and Workshop Modernisation Conference 2017 and the Rail Manufacturing CRC's Participant Forums (August 2016 and May 2017).

Another priority has been the Centre's continued relationship with the Advanced Manufacturing Industry Growth Centre, working together to strengthen the rail manufacturing sector and highlight the value that research and education will bring to the industry.

Commercialisation and utilisation

The Rail Manufacturing CRC's model for commercialisation and utilisation was developed in close consultation with its participant organisations to support and facilitate industry-led research outcomes in an independent manner.

All current projects have commercial outcomes defined, with commercial and intellectual property terms agreed via contractual arrangements prior to the projects commencing. To-date, Utilisation Plans have been developed for all relevant projects to advance the strategies for commercialisation and refine potential market opportunities.

'Utilisation Plans have been developed for all relevant projects to advance the strategies for commercialisation and refine potential market opportunities.'

As of June 2017, three Rail Manufacturing CRC projects have been completed: R1.3.1 – *Supercapacitor energy management system*, R1.3.2 – *Supercapacitor development and scale up for manufacture* and R2.3.3 – *Manufacturing processes for rolling stock fabrication*.

The project outputs have been assessed by the industry parties and commercial decisions have been made based on data generated during the projects. In the case of Project R1.3.1, CRRC has replicated the project hardware in China and the industry organisation is moving forward with this work, commencing with follow-on Project R1.3.4. – *Supercapacitor energy management system stage 2*.

In addition to the three completed projects, two projects in the Design, Modelling and Simulation research theme area were extended with increased resources to facilitate the commercialisation of the project outputs:

» Project R3.1.2 – *Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system* was extended by industry participant Downer to support the technology's rollout

» Project R3.6.1 – *Experimental and computational study on the key ventilation issues affecting air quality and thermal comfort in train cabins* was also extended to enable the investigation and fabrication of various diffuser ventilation designs that could be manufactured by industry participant Airlinx.

Education and training

The Rail Manufacturing CRC is actively working to help develop the next generation of experienced postgraduate rail students. With less than one per cent of postgraduate students working in rail, it is vital to promote the industry as an attractive employment prospect, while also recognising the value that these highly trained students could bring to the industry.

A real success for the Centre in 2016–17 has been the development of new initiatives to increase the number of PhD students joining the Centre. These initiatives have included:

» ongoing funding of PhD students working on projects in the Rail Manufacturing CRC's project portfolio,

» selection of students to receive a Rail Innovators PhD Scholarship for aligned rail projects

» rollout of a new Internship work placement program for PhD students, initially being trialled in Queensland.

Thanks to these programs, the Rail Manufacturing CRC is currently supporting 22 PhD students in total, with six PhD students working on Rail Manufacturing CRC projects, 14 students receiving a Rail Innovators PhD Scholarship during the past year and two students participating in the Queensland industry 12-week work placement internships. The delivery of these three initiatives would not be possible without the continued support of the Centre's university participants, who are driving real change in the rail industry.

In relation to Commonwealth Milestones, the Centre achieved its two PhD student commencement milestones in Program areas 2 and 3. It did not achieve this milestone in Program area 1, which was the commencement of four PhD students within that research area. Instead, just one PhD student commenced in Program area 1, in addition to the one other PhD student who commenced in 2015–16. More students are expected to join within this Program area in the coming months.

Risks and impediments

The Rail Manufacturing CRC continues to work with its current and prospective participants to develop projects that will have significant positive impact to the organisations involved and the broader rail manufacturing industry as a whole.

Following the guidance of the overarching CRC Committee, the Rail Manufacturing CRC's Board and Management teams have taken steps in 2016–17 to revise the Centre's participant membership, to review and update the project portfolio, to continue consulting with its participants and to instigate new projects with current and new participants.

The key risks to the Rail Manufacturing CRC primarily relate to the slow uptake of projects by industry in the initial years of the Centre, due to downturns in commodity prices which affected demand to heavy haul equipment, the increased demand in passenger rail manufactured products and organisational restructures that have occurred within a majority of our industry participants.

'...to develop projects that will have significant positive impact to the organisations involved'

In the early stages of the Centre, these impacts led to the delay or cancellation of a number of initial projects that were due to start in 2014–15. Subsequently, a number of initial Commonwealth Milestones were amended.

Response to impacts this year

As detailed in last year's annual report, the Centre has focused on mitigating the risks associated with the abovementioned economic and corporate issues, and has subsequently focused on:

- growing the centre by increasing its number of industry participants
- developing new projects with its current and potential participants
- increasing its focus on passenger rail projects
- increasing its engagement with the postgraduate community via specialised competitive grants
- working with industry peak bodies, such as the Australasian Railway Association, to engage and inform the rail manufacturing industry through forums and industry groups.

Over the last 12 months, the Centre has continued to implement the above-mentioned strategies, which has resulted in growth that's enabled the Centre to increase its performance against its Commonwealth Milestones, better engage and build long term relationships with its research and industry participants, and develop closer ties to key industry peak bodies such as the Australasian Railway Association (ARA) and the Advanced Manufacturing Growth Centre (AMGC).

This has resulted in the following Rail Manufacturing CRC achievements in 2016–17:

- the appointment of seven new participants to the Centre
- partnering with research institutions to initiate two new PhD programs – the Rail Innovators PhD scholarships and the Queensland industry Internship program
- the commencement of a new Bombardier / University of Queensland project (Project R2.3.4 – *Monitoring and control of false brinelling*)
- Downer committing to an extension of its current project with the University of Technology Sydney (R3.1.2 – *Integrated passenger behaviour, train operations diagnostics and vehicle health monitoring system*), while also working with the Centre on new project concepts
- CRRC in late stage negotiations on two major new projects with the Centre
- Airlinx recently extending its project with the Centre for an additional three years
- Knorr-Bremse committing to two new feasibility projects.

The risks associated with any research and development activities in the manufacturing sector are typically dependent on the global economic environment, domestic and international demand for manufactured products, the nature of competitive global supply, the general level of confidence within the sector and the capacity of domestic manufacturers, who are often subsidiaries of overseas primes, to invest in research, innovation, capital equipment and human resources.

The Rail Manufacturing CRC has not been immune to some negative impacts of such external factors, however the Centre has managed to navigate through these difficult times. The Centre's capacity for flexibility and its close working relationship with its participants has enabled it to continue to gain momentum over the last year.

Impacts

The Rail Manufacturing CRC has been active in developing new projects, with seven new project agreements executed during the last 12 months:

- Project R1.1.1 – *New generation lithium-ion batteries with high energy and long service life for rail industry applications*, HEC Group / University of Technology Sydney
- Project R2.3.3 – *Manufacturing process for rolling stock fabrication*, UGL / University of Wollongong
- Project R2.3.4 – *Monitoring and control of false brinelling*, Bombardier / University of Queensland
- Project R2.5.1 – *Performance of recycled rubber inclusions for improved stability of railways*, Tyre Stewardship Australia / Australasian Centre for Rail Innovation / University of Wollongong
- Project R2.5.2 – *Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading*, Global Synthetics / Foundation QA / University of Wollongong
- Project R3.2.1 – *Development of a responsive passenger information system for the Sydney Trains network*, Sydney Trains / University of Technology Sydney
- Project R3.3.1 – *Detection and monitoring on trains – feasibility study*, Knorr-Bremse / University of Technology Sydney

Not only will these projects deliver key outcomes for the Centre's industry participants, but they will also assign four new PhD students to the CRC's PhD program who will be working directly with the Rail Manufacturing CRC's industry participants to deliver project outcomes.

During 2016–17, the Rail Manufacturing CRC also launched its Rail Innovators PhD Scholarships program, where the Centre and participating universities co-fund PhD scholarships for selected students working in rail research. During the reporting period, 14 students commenced their PhD studies under this scheme.

Project progress this year

In **Program 1 – Power and Propulsion**, six projects have commenced, which includes four with industry participant CRRC and one project with new participant HEC Group.

The CRRC projects being undertaken with CSIRO (Projects R1.3.1, R1.3.2, R1.3.3 and R1.3.4) focus on the development of improved supercapacitors and prototype energy management systems to power a catenary-free electric tram system.

Using the Centre's projects as inaugural activities, CRRC have set up a research hub with CSIRO at their Clayton campus, with this long-term investment likely to lead to ongoing projects in rail (and other sectors) that serves CRRC well as it seeks to make further investments in Australia.

HEC Group initiated Project R1.1.1 with the University of Technology Sydney to study improved battery technologies for rail applications. The project is currently assessing new lithium-based chemistries for battery applications, and is the first project in what hopefully will be a portfolio of three projects with HEC Group. Like CRRC, HEC Group has also been seeking to invest further in its Australian operations.

Program 2 – Materials and Manufacturing consists of seven projects.

Bombardier has two projects in collaboration with the University of Queensland (Projects R2.3.2 and R2.3.4) which are focused on the prediction and monitoring of bearing wear in their Queensland railway operations. The project is providing valuable insights into new and in-service bearing wear, which will enable Bombardier to better understand the processes of condition monitoring and maintenance requirements pertaining to initial manufacture and subsequent maintenance intervals.

Knorr-Bremse has undertaken Project R2.3.1 with CSIRO to develop an improved understanding of the operational constraints in their rail air conditioning systems, while OneSteel and Monash University have undertaken Project R2.4.1 to understand and improve steel manufactured for current sleeper and rail products. The project initially proceeded ahead of expectations but was recently postponed for two years due to OneSteel's parent organisation Arrium being put into voluntary administration.

In **Program 3 – Design, Modelling and Simulation**, four projects have commenced to date.

Project R3.6.1 is a collaboration between Airlinx and RMIT University which utilises computer modelling to predict the airflow and the temperature field in high-speed train cabins. The project has recently been extended to utilise the outcomes of phase one to focus on the design of new and improved ventilation geometries to meet the needs of rail manufacturers and passengers.

Project R3.1.2 involves a collaboration between Downer and University of Technology Sydney to develop a system that can monitor the movement of passengers boarding trains at busy stations. The results of the initial project have been successful and the project has been extended to enable prototype systems to be developed, trialled and assessed for future commercialisation activities.

'The Rail Manufacturing CRC has been active in developing new projects'

Performance against activities

01 Power and Propulsion

Research aim: energy and cost efficiency and improved competitive performance in advanced rail manufacturing through research, development and commercialisation in:

- Energy Regeneration and Storage
- Advanced Braking Systems
- Electronic Motors and Systems

02 Materials and Manufacturing

Research aim: competitive cost, durability and performance in advanced rail manufacturing through research and commercialisation in:

- High Performance Materials For Heavy Haul
- Advanced Manufacturing
- Advanced Lightweight Materials
- Low Cost Manufacturing Systems

03 Design, Modelling and Simulation

Research aim: safety and efficiency in advanced rail manufacturing to enhance industry competitiveness through research and commercialisation in:

- Advanced Design and Simulation
- Automated Health Monitoring
- Advanced Data Analysis and Information Systems
- Advanced Operations Management Systems
- Energy Use Management Tools

In the 2016–17 Financial Year, Rail Manufacturing CRC's Research Program has again made solid progress in its portfolio of projects underway and completed during the year.

The Centre's Research Program incorporates three key themes – **Power and Propulsion, Materials and Manufacturing,** and **Design, Modelling and Simulation** – which were originally defined (and tweaked) during the development of the *On Track to 2040 – Preparing the Australian Rail Supply Industry for Challenges and Growth* Roadmap in 2012.

Program 1 – Power and Propulsion

This research theme has the potential to significantly change the rail industry through the development and implementation of energy storage solutions utilising high energy density lithium ion batteries or supercapacitors.

Supercapacitors can charge and discharge very quickly for potentially 100,000 cycles, but don't have the ability to store much energy, so supercapacitor energy storage would traditionally be too bulky. There are a number of applications for energy storage in rail including backup power and regenerative braking, but the largest application exists for catenary-free light rail systems where the overhead lines are replaced by charging stations at the tram stop platforms.

The Rail Manufacturing CRC has a number of related projects in this program area that are looking to address the challenge of increasing the performance of energy storage devices for use in rail applications. This includes research to increase cycle life in high energy density lithium ion batteries and to increase the energy density of supercapacitors through changes to cell chemistry.

This research area continued the excellent collaboration between China Railway Rolling Stock Corporation (CRRC) and CSIRO in Projects R1.3.1, R1.3.2, R1.3.3 and R1.3.4 to develop supercapacitor energy storage systems for rail applications. Work has also begun with HEC Group and the University of Technology Sydney in Project R1.1.1 to improve the performance of lithium ion batteries.

Performance

Program 2 – Materials and Manufacturing

This theme incorporates a variety of projects relating to maintenance and durability of rail track and rolling stock, which has emerged as a key focus for industry. This is likely due to the integration of build-and-maintain agreements that span the life expectancy of the rolling stock, which support the need to efficiently maintain and service rail assets.

Six of the seven projects underway in this research area involve the durability analysis of critical rail componentry, where the performance of materials and systems in these projects enables maintenance programs to better match durability properties.

'...durability of rail track and rolling stock, which has emerged as a key focus for industry'

The development of accelerated durability testing of rail components at CSIRO in Project R2.3.1 will enable Knorr-Bremse to validate the high reliability requirements of equipment in a range of environments, with a test protocol developed during the reporting period.

Two new projects, R2.5.1 and R2.5.2, are focused on researching materials used to enable rail ballast stability, with Project R2.5.1 focused on the use of recycled tyres, which has the potential to reduce track degradation by approximately 30 per cent in heavy haul applications.

Another project R2.3.3 investigated fabrication processes and was completed during the year. It will enable the industry participant UGL to assess processes for potential future builds.

This program area also includes two projects between Bombardier and the University of Queensland, both of which could significantly reduce maintenance and overhaul requirements. Project R2.3.2 involves the development and testing of a new optimised predictive maintenance system for bearings, while Project R2.3.4 is investigating a type of wear in bearings called false brinelling, which occurs during the transportation of bearings due to vibration and/or load on the bearing. Progress on both of these projects was enhanced by the close involvement of Bombardier providing materials for testing.

Program 3 – Design, Modelling and Simulation

With Industry 4.0, automation, the internet of things and Virtual Reality gaining headlines over the last year, this theme focuses on the use of design and simulation techniques to model operations, develop more efficient processes and equipment solutions, and increase efficiency and extend asset life of rail systems.

Within this research theme, the University of Technology Sydney and Downer Rail are well advanced on Project R3.1.2 involving the development of an autonomous system capable of sensing and interpreting passenger behaviour and train events to monitor the movement of passengers on and off trains.

The interest in responsive passenger information systems resulted in project trials at rail operator sites in Sydney and Brisbane during the reporting period.

Following this, the Rail Manufacturing CRC has agreed with Downer on an extension to the project that will enable UTS to develop hardware and software for use in commercialisation of the Responsive Passenger Information System. This system has great potential, with future applications of this base technology likely to find use in predicting passenger movement and potential security requirements.

Sydney Trains embarked on new Project R3.2.1 during the year to scope passenger information system technologies for use on its train network.

'The interest in responsive passenger information systems resulted in project trials at rail operator sites in Sydney and Brisbane'

In Project R3.6.1, RMIT University and Airlinx are collaborating on the use of computational fluid dynamics to create simulated models to design improved ventilation systems. Based on the project outputs to date, the project parties have agreed to a three year extension which will double the project budget and enable the investigation of diffuser geometries for controlling airflow in rail cabins.

Rail Manufacturing CRC Projects underway during reporting period

	Program	Project number	Project	Participants
1	Program 1	R1.1.1	New generation lithium-ion batteries with high energy and long service life for rail industry applications	HEC Group / University of Technology Sydney
2	Program 1	R1.2.1	Propulsion of intelligent magnetically levitated track-vehicle	Simplex / Deakin University
3	Program 1	R1.3.1	Supercapacitor energy management system	CRRC / CSIRO
4	Program 1	R1.3.2	Supercapacitor development and scale up for manufacture	CRRC / CSIRO
5	Program 1	R1.3.3	High energy supercapacitor development	CRRC / CSIRO
6	Program 1	R1.3.4	Supercapacitor energy management system stage 2	CRRC / CSIRO
7	Program 2	R2.3.1	Accelerated life testing and characterisation of critical components	Knorr-Bremse / CSIRO
8	Program 2	R2.3.2	Axle bearing maintenance optimisation	Bombardier / University of Queensland
9	Program 2	R2.3.3	Manufacturing process for rolling stock fabrication	UGL / University of Wollongong
10	Program 2	R2.3.4	Monitoring and control of false brinelling	Bombardier / University of Queensland
11	Program 2	R2.4.1	Advanced steel development for rail and sleepers	OneSteel / Monash University
12	Program 2	R2.5.1	Performance of recycled rubber inclusions for improved stability of railways	Tyre Stewardship / Australasian Centre for Rail Innovation / University of Wollongong
13	Program 2	R2.5.2	Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading	Global Synthetics / Foundation QA / University of Wollongong
14	Program 3	R3.1.2	Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system	Downer / University of Technology Sydney
15	Program 3	R3.2.1	Development of a responsive passenger information system for the Sydney Trains network	Sydney Trains / University of Technology Sydney
16	Program 3	R3.3.1	Detection and monitoring on trains – feasibility study	Knorr-Bremse / University of Technology Sydney
17	Program 3	R3.6.1	Experimental and computational study on the key ventilation issues affecting air quality and thermal comfort in train cabins	Airlinx / RMIT

Commonwealth Milestone status at 30 June 2017

Milestone Number	Milestone	Due Date	Status
R1.1.1	Report approved for feasibility study for Lithium Battery Energy Storage Systems for rail applications including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	30 Jun 2017	Achieved
R1.2.2	First prototype delivered and report on cruise specifications approved	31 Dec 2016	Not achieved
R1.3.2	Development and Design of hardware and software completed. IP strategy (patents/know-how/designs/software) defined	30 Jun 2017	Achieved
R1.5.1	Report approved for feasibility study for advanced braking system for locomotives including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	30 Jun 2017	In progress
R1.6.2	Commencement of 4 PhD students	30 Jun 2017	In progress
R2.1.1	Report approved for feasibility study for improved performance including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	31 Dec 2016	Achieved
R2.1.2	Report approved for performance and design constraints. Define IP strategy (patents/know-how/designs/software)	31 Dec 2016	Achieved
R2.1.3	Develop material-process-property relationships to predict performance completed	30 Jun 2017	Achieved
R2.3.1	Report approved for feasibility study for rolling stock build and maintenance cost reduction technology including on patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	30 Jun 2017	Achieved
R2.4.3	Software model to predict performance completed	30 Jun 2017	Achieved
R2.5.1	Report approved for feasibility study for Substructures for reduced vibration and enhanced stability including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	31 Dec 2016	Achieved
R2.7.2	Commencement of 3 PhD students *	30 Jun 2016	Achieved
R2.7.3	Commencement of 6 PhD students	30 Jun 2017	Achieved
R3.1.1	Report approved for feasibility study for Automated on-line health monitoring system including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	31 Dec 2016	Achieved
R3.1.2	Review of performance and design constraints completed. Define IP strategy (patents/know-how/designs/software)	30 Jun 2017	Achieved
R3.2.3	Report on know-how for advanced detection technologies for rail applications approved	30 Jun 2017	Achieved
R3.3.1	Report approved for know-how for train handling algorithms for rail applications	30 Jun 2017	Not achieved
R3.4.1	Report approved for feasibility study for Advanced software tool for evaluating mechanical design of wagons including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	30 Jun 2017	Not achieved
R3.5.1	Report approved for feasibility study for Advanced software tool for energy management and optimisation including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility	30 Jun 2017	Achieved
R3.6.3	Software model to predict performance completed	30 Jun 2017	Achieved
R3.7.2	Commencement of 3 PhD students *	30 Jun 2016	Achieved
R3.7.3	Commencement of 8 PhD students	30 Jun 2017	Achieved

* Milestones from 2015–16 which were held over and achieved this Financial Year

Performance

Publications list in 2016–17:

Articles in Scholarly Refereed Journals

Ngo, N.T., Indraratna, B. and Rujikiatkamjorn, C. (2017). "Stabilisation of track substructure with geo-inclusions – experimental evidence and DEM simulation." *International Journal of Rail Transportation*, 5(2), pp: 63-86.

Ngo, N.T., Indraratna, B. and Rujikiatkamjorn, C. (2017). "A study of the geogrid–subballast interface via experimental evaluation and discrete element modelling." *Granular Matter*, 19(3), pp: 54.

Yan, Y., X. Li, L. Yang and J. Tu (2016). "Evaluation of manikin simplification methods for CFD simulations in occupied indoor environments." Energy and Buildings 127: 611-626. Published on 01/09/2016.

Yan, Y., X. Li and J. Tu (2017). "Numerical investigations of the effects of manikin simplifications on the thermal flow field in indoor spaces." Building Simulation 10(2): 219-227. First online 08/09/2016.

Yan, Y., X. Li, Y. Yan and J. Tu (2017). "Overall performance evaluation of underfloor air distribution system with different heights of return vents." Energy and Buildings 147: 176-187. Published online 30/04/2017.

Yan, Y., X. Li, Y. Shang and J. Tu (2017). "Evaluation of airborne disease infection risks in an airliner cabin using the Lagrangian-based Wells-Riley approach." Building and Environment 121: 79-92. Published online 10/05/2017.

Full written conference paper – refereed proceedings

Indraratna, B., Ngo, N.T. and Rujikiatkamjorn, C. (2017). "Improved Performance of Ballasted Rail Tracks Using Plastics and Rubber Inclusions." *Procedia Engineering*, 189, pp: 207-214.

L. Yang, X.D. Li, J.Y. Tu. Numerical study of diffuser type effects on transport characteristics of contaminants in high-speed train cabins. *The 20th Australian Fluid Mechanics Conference* (AFMC 2016). 5-8 Dec, 2016. Perth, Australia.

Ngo, N.T, Indraratna, B., and Rujikiatkamjorn, C. (2017). "Performance assessment of geocell-reinforced subballast: modelling and design implications". Geotechnical Frontiers 2017, Orlando, Florida USA.

Education and training

The Rail Manufacturing CRC is actively working to help develop the next generation of experienced postgraduate rail students. With less than one per cent of postgraduate students working in rail, it is vital to promote the industry as an attractive employment prospect, while also recognising the value that these highly trained students could bring to the industry.

In response, the Centre is supporting students via three different initiatives in 2016–17:

- Funding PhD students working on projects within Rail Manufacturing CRC's project portfolio
- Co-funding PhD scholarships with partnering universities
- Selecting PhD students to participate in industry work placement internships

The delivery of these three initiatives would not be possible without the continued support of the Centre's university participants, who are driving real change in the rail industry.

Students working on the Centre's projects

In 2016–17, the Rail Manufacturing CRC funded the PhD studies of six students working on projects being delivered by the Centre. This includes the following students:

- Zhang Yin, Queensland University of Technology (Project R1.3.3)
- Alexander Virgona, University of Technology Sydney (Project R3.1.2)
- Julien Collart, University of Technology Sydney (Project R3.1.2)
- Cameron Milne, University of Queensland (Project R2.3.2)
- Matthew Pozzebon, University of Queensland (Project R2.3.2)
- Osama Brinji, University of Queensland (Project R2.3.4)

In addition to these six students, it is expected that three more project students will join the Rail Manufacturing CRC in 2017–18 as per signed project agreements, in addition to any further students working on new projects to commence.

PhD Scholarships

A real success in 2016–17 was the establishment of the Rail Innovators PhD Scholarships, where the Centre co-funds PhD scholarships with participant universities. Scholarships have been awarded to selected students working on PhDs relating to one of the Centre's three rail research themes – Power and Propulsion, Materials and Manufacturing, and Design, Modelling and Simulation.

The Rail Manufacturing CRC approached all of its university participants to identify which were interested in taking part, with Central Queensland University, University of Wollongong, Swinburne University, University of Technology Sydney and Monash University coming on board. In all, 14 students were selected to receive a Rail Innovators PhD scholarship from these universities.

A number of the students' project topics (listed in the table on page 28) are investigating research that is truly industry-leading, providing the potential for real future-focused growth in rail and related industries. In addition to the 14 scholarship recipients, there are also still five students being recruited for scholarships that received Rail Manufacturing CRC Board approval to proceed.

PhD Internships

Another initiative occurring towards the end of 2016–17 was the creation of the joint Rail Manufacturing CRC / TrackSAFE Foundation Internship program, where successful students were awarded with top-up scholarships and a 12-week work placement in three leading Queensland rail businesses – Queensland Rail, Aurizon and the Queensland Government's Department of Transport and Main Roads.

The prospective students' current PhD studies were required to relate to one of the three Rail Manufacturing CRC research theme areas and also aligned to the field of level crossing safety (TrackSAFE Foundation's focus).

Queensland University of Technology PhD students Don Kushlani Ranmal Ranasinghe and Zheshuo Zhang were selected to participate in the internship program, starting their work placement at Queensland Rail in June 2017.

The work placements have been an ideal opportunity to provide research-focused students with real-life rail projects to work on, while also highlighting the real value that postgraduate students can provide to industry. It is planned to fund future cycles of the internship program dependent on industry and university organisations' interest levels in participating.

Support for students

With this large increase in students coming on board to the Centre in 2016–17, the Rail Manufacturing CRC will be working to develop a schedule of professional and personal activities for the students, including funding their attendance at key rail industry events, developing a private LinkedIn group for students to communicate to each other within, and organising a large-scale annual PhD student event to share the latest rail news, collaborate on their projects and provide development opportunities.

Status against milestones

The Centre didn't achieve Milestone R1.6.2, which was the commencement of four new PhD students in Research theme 1 – Power and Propulsion. In 2016–17, one new PhD student commenced, in addition to the one other PhD student who started in 2015–16. More students are expected to come on board in 2017–18.

With Milestone R2.7.3, the Centre did achieve the commencement of six new PhD students in Research theme 2 – Materials and Manufacturing, with seven new PhD students commencing, in addition to the two PhD students who began in 2014–15 and 2015–16.

With Milestone R3.7.3, the Centre did achieve the commencement of eight new PhD students in Research theme 3 – Design, Modelling and Simulation, with nine new PhD students commencing, in addition to the two PhD students who started in 2014–15.

Current list of commenced PhD students – as of 30 June 2017

#	Student name	Degree	Start date	Expected completion date	Research program area	Project title	Research institute	Student's country of origin
1	Zhang Yin	PhD	2/05/2016	1/11/2019	1 – Power and Propulsion	High energy supercapacitor development	Queensland University of Technology	China
2	Esteban Bernal Arango	PhD	23/06/2017	23/06/2020	1 – Power and Propulsion	Smart axle transducer transmitter for freight wagon condition monitoring systems	Central Queensland University	Colombia
3	Cameron Milne*	PhD	12/01/2015	12/01/2018	2 – Materials and Manufacturing	Axle-bearing maintenance optimisation	University of Queensland	Australia
4	Matthew Pozzebon	PhD	28/04/2016	28/04/2019	2 – Materials and Manufacturing	Axle-bearing maintenance optimisation	University of Queensland	Australia
5	Osama Brinji	PhD	13/04/2017	13/04/2020	2 – Materials and Manufacturing	Monitoring and control of false brinelling	University of Queensland	Saudi Arabia
6	Chuhao Liu	PhD	28/04/2017	28/04/2020	2 – Materials and Manufacturing	The performance of stabilised ballast in rail tracks	University of Wollongong	China
7	Vu Trong Thien	PhD	27/02/2017	27/02/2020	2 – Materials and Manufacturing	Automated assembly for rolling stock fabrication in rail industry	University of Wollongong	Vietnam
8	Hang Su	PhD	27/03/2017	27/03/2020	2 – Materials and Manufacturing	Optimisation of rail welding process parameters to mitigate rolling contact damage	Monash University	China
9	Pravin Urudra	PhD	01/03/2017	01/03/2020	2 – Materials and Manufacturing	Evaluating the suitability of laser cladded rail steel in heavy haul application	Monash University	Malaysia
10	Don Kushlani Ranmal Ranasinghe	PhD	27/06/2016	27/06/2019	2 – Materials and Manufacturing	Optimal design of raised rail - road crossing structure	Queensland University of Technology	Sri Lanka
11	Zheshuo Zhang	PhD	17/11/2015	16/11/2018	2 – Materials and Manufacturing	Effect of raised rail - road crossing to the safety of road vehicles	Queensland University of Technology	China
12	Alexander Virgona	PhD	29/08/2014	29/08/2018	3 – Design, Modelling and Simulation	Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system	University of Technology Sydney	Australia
13	Julien Collart	PhD	05/02/2015	05/02/2019	3 – Design, Modelling and Simulation	Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system	University of Technology Sydney	France
14	Mahdi Saki	PhD	01/12/2016	30/11/2019	3 – Design, Modelling and Simulation	Ultra-reliable and cost effective communication infrastructure for future IoT-based railway applications	University of Technology Sydney	Iran
15	Zhibin Li	PhD	02/03/2017	02/03/2020	3 – Design, Modelling and Simulation	Big data analytics for condition based monitoring and maintenance	University of Technology Sydney	China
16	Amir Eslami	PhD	01/06/2017	01/06/2020	3 – Design, Modelling and Simulation	Drive-by bridge inspection: the use of instrumented revenue wagons for structural health monitoring of rail bridges	Monash University	Iran
17	Yu Fung Lee	PhD	27/02/2017	27/02/2020	3 – Design, Modelling and Simulation	Nonlinear vibro-acousto-ultrasonic waves for fatigue cracking detection in key rail components	Monash University	China
18	Chi Hei Vong	PhD	27/02/2017	27/02/2020	3 – Design, Modelling and Simulation	Control and navigation of micro UAV in small railway culverts and tunnels	Monash University	Portugal
19	Yong Pang	PhD	30/05/2017	30/05/2020	3 – Design, Modelling and Simulation	System for real-time monitoring and sensing railway conditions by laser light	Monash University	China
20	Dongyu Zhang	PhD	01/03/2017	01/03/2020	3 – Design, Modelling and Simulation	Hybrid unmanned aerial system for railway inspection	Monash University	China
21	Nalin Randeniya	PhD	01/05/2017	01/05/2020	3 – Design, Modelling and Simulation	Augmented reality manufacturing and maintenance modules in High Capacity Metro Train for enabling effective engagement and faster learning curves.	Swinburne University	Sri Lanka
22	Andrew Danylec	PhD	01/05/2017	01/05/2020	3 – Design, Modelling and Simulation	Develop and establish augmented reality tools in High Capacity Metro Train for productivity and quality enhancements	Swinburne University	Australia

* Student has withdrawn from the project as of 30 April 2017

SME engagement

With small-to-medium enterprises (SMEs) playing such a large role in rail manufacturing and maintenance, effectively working with these businesses is key to the Rail Manufacturing CRC's success.

The Centre has a number of SME participants working on a variety of projects, while the Rail Manufacturing CRC also engages with other SMEs through alliances and partnerships.

Given not all SMEs have the capacity or financial means to become participants in the Rail Manufacturing CRC's programs, the Centre looks at each research program theme and individual project to see how their involvement can best be incorporated.

The Centre's SME engagement included the following activities in 2016–17:

- Delivery of two Rail Manufacturing CRC Participants Forums – held at Sydney in August 2016 and at Melbourne in May 2017
- Direct engagement with the Centre's CEO and key staff through participation in rail industry events and forums – including key rail conferences, Australasian Railway Association events and Federal and State Government forums
- Regular communication about the Centre's activities and progress through the Rail Manufacturing CRC's Communications Strategy, including monthly email newsletters, website and social media updates, and face-to-face meetings.

Increasing the number of SME participants

During the reporting period, the Rail Manufacturing CRC had five SMEs participating with the Centre in ongoing projects.

With Project R3.6.1 – *Experimental and computational study on the key ventilation issues affecting air quality and thermal comfort in train cabins*, Airlinx is deriving a greater understanding of its ventilation products through modelling and simulation research being undertaken in collaboration with RMIT University. A recent extension to the project's incorporating studying further aspects of delivering commercial outcomes.

Tyre Stewardship Australia, the Australasian Centre for Rail Innovation and the University of Wollongong are participating in a joint project investigating the use of recycled rubber tyres for rail ballast applications in Project R2.5.1 – *Performance of recycled rubber inclusions for improved stability of railways*. This project could have two significant outcomes, firstly addressing and enhancing the rail ballast properties and secondly, exploring new sustainable uses for a problematic waste material.

Project R2.5.2 – *Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading* is between Global Synthetics, Foundation QA and the University of Wollongong. This project aims to address the implementation of technologies to solve unique challenges involving rail ballast infrastructure.

Another key SME engagement has been with the TrackSAFE Foundation, who the Centre is partnering with to rollout the trial Queensland industry work internship program for PhD students. Dependent on future university and industry interest levels, it is hoped to fund future internship cycles across Australia.

During the reporting period, the Centre has also been in direct contact with a number of other SMEs and is working with these entities to develop potential future projects.

The Rail Manufacturing CRC is also continuing to identify and match business opportunities for a number of SMEs through its awareness of industry participant needs and SME capabilities, emphasising the importance of building collaborative networks in the broader rail manufacturing supply chain.

Commercialisation

The Rail Manufacturing CRC's model for commercialisation and utilisation was developed in close consultation with its industry and research participants, where the overarching principle was to support and facilitate industry-led research outcomes in an independent manner.

This model is tailored to each project and is dependent on factors, such as the:

- capacity of the participants to use and commercialise project outcomes
- research and commercial inputs to the project
- benefit to Australia
- contributions of parties to intellectual property
- commercial viability of the research outcomes.

The model limits the number of organisations seeking input into commercial decisions and ensures that the Centre's participants investing in the project receive benefit from any commercial returns, and that the Rail Manufacturing CRC plays an independent role in project decision making.

Before projects commence, all commercial outcomes and intellectual property terms and conditions are determined through transparent and upfront contractual negotiations, which limits any potential IP legacy issues in future years.

Projects completed in 2016–17

As of June 2017, three Rail Manufacturing CRC projects have been completed:

- R1.3.1 – CRRC / CSIRO Project – *Supercapacitor energy management system*
- R1.3.2 – CRRC / CSIRO project – *Supercapacitor development and scale up for manufacture*
- R2.3.3 – UGL / University of Wollongong project – *Manufacturing process for rolling stock fabrication*

Project R1.3.1 was the first stage in constructing an Energy Management System (EMS) used to power light rail vehicles using supercapacitors. Outputs from this project have been used as input to Project R1.3.4 – *Supercapacitor energy management system stage 2.*

Project R2.3.3 was completed after stage 1 of the project, with UGL to assess the potential to implement project outputs in the future.

Project extensions

To assist with potential commercialisation activities, two projects in Program 3 research area – Design, Modelling and Simulation were extended during the Financial Year:

- Project R3.1.2 – Downer / University of Technology Sydney – *Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system*
- Project R3.6.1 – Airlinx / RMIT University – *Experimental and computational study on the key ventilation issues affecting air quality and thermal comfort in train cabins*

Utilisation milestones

The Utilisation Plans developed during the reporting period for relevant projects have resulted in all Utilisation milestones being completed.

Project	Milestone	Due Date	Status
U1.3.1	Grant of Utilisation rights to Industry Participant	31 Dec 2016	Completed
U2.1.1	Grant of Utilisation rights to Industry Participant	31 Dec 2016	Completed
U2.3.1	Grant of Utilisation rights to Industry Participant	30 Jun 2017	Completed
U3.1.1	Grant of Utilisation rights to Industry Participant	30 Jun 2017	Completed
U3.3.1	Grant of Utilisation rights to Industry Participant	30 Jun 2017	Completed

Intellectual property management

The Rail Manufacturing CRC Ltd is a company limited by guarantee, meaning it has members rather than shareholders.

As has been the case since its inception, the Rail Manufacturing CRC is focused on transferring the intellectual property that results from its projects in the most effective manner to its participants and to ensure maximum benefit and impact are derived.

The Rail Manufacturing CRC does not seek to own intellectual property nor seek royalties from the technology it develops. Instead, the Centre seeks to ensure that the technologies its projects deliver will provide the maximum benefit to project partners.

Ownership and use of the project intellectual property is defined during the development of individual project agreements between the respective project participants to ensure that the process is transparent and beneficial to all parties.

Communications

The Rail Manufacturing CRC recognises the importance in delivering professional, timely and accurate information to its participants, the broader rail industry and interested parties using a variety of communication channels.

Since June 2016, the Centre's communication function is run by a Communications Manager (0.6 FTE), who is responsible for developing the Rail Manufacturing CRC's Communications Strategy and rolling out key messages and communications collateral.

The Centre's Communications Strategy is to:

» provide internal and external stakeholders with timely, consistent and informative communications about the Rail Manufacturing CRC's direction and activities

» maintain strong and collaborative relationships with the Centre's industry and research institute participants and key external stakeholders

» evaluate the communication channels used via surveys, feedback, website analytics, social media engagement and newsletter readership

The communications function has two key audiences – **internal** and **external**.

Internal communications

Internal communications is focused on communication with the Centre's participant organisations, and the overarching Federal Government's Business Cooperative Research Centres Programme Committee. This includes:

» providing timely communications to ensure staff, students and industry participants are aware of the Centre's programs, projects and key initiatives

» supporting effective collaboration and information sharing across the rail manufacturing industry

» promoting key rail manufacturing industry news.

In addition to the key communication channel of the Centre's monthly newsletter, another priority channel in 2016–17 was running Participant Forum events, where current and potential participants were invited to hear the latest news and collaborate on key activities and issues impacting the rail industry as a whole. Two Participant Forums were held in the past 12 months – at Sydney in August 2016 and at Melbourne in May 2017.

External communications

External communications is focused on communicating with all interested or related parties, which includes representatives working in rail manufacturing, transport, research, State and Federal Government, and the Australian general public. This includes:

» promoting a positive outlook for the Australian rail manufacturing sector by sharing general news, key project updates and Rail Manufacturing CRC successes

» raising the profile of the Rail Manufacturing CRC to encourage the development of new projects and new participant organisations joining the Centre

» encouraging representatives from other industries to apply their skills to the challenges faced in rail manufacturing.

Alongside the Rail Manufacturing CRC website, which is regularly updated with latest news, participants information and project listings, the Centre also manages two key social media channels via **LinkedIn** and **Twitter**.

The **LinkedIn** channel has two purposes – one is a publicly-facing company page where latest news, key successes and rail updates are posted to page followers. At the end of 2016–17, a trial private LinkedIn group was also established to connect together the Centre's growing list of PhD students, giving them the ability to communicate privately with each other, ask questions and provide support.

The **Twitter** account also provides the ability to communicate directly with interested organisations and individuals, with a concerted effort in the past 12 months to actively engage with the Centre's participants also on Twitter to cross-promote key activities and support their successes.

Rating the effectiveness of communications

With all communication activities undertaken, each channel has its own metrics to rate effectiveness, such as the monthly newsletter's open rate, website hit rates, conducting evaluation surveys post events and requesting ongoing feedback.

A new evaluation activity beginning in July 2017 was the new annual Participants Survey, where an online survey sent to one key representative per participant organisation asked respondents to rate the performance of the Centre for 2016–17 across a variety of different factors, while also requesting suggestions for improvement in the coming Financial Year.

In the inaugural 2016–17 survey, over 71 per cent of respondents across 17 participant organisations reported they were satisfied or very satisfied with the collaboration between their organisation and the Rail Manufacturing CRC in the past year, while over 64 per cent also agreed or strongly agreed that the Centre's communications program was effectively managed.

Moving forward, the survey will be conducted annually each July as a key measurement of participant engagement.

Alignment to CRC Programme Branding

As required, all communications activities adhere to proper use of CRC Programme Branding, as specified in the Funding Agreement. This has included the appropriate promotion of logos and inclusion of content used in presentations delivered, on printed communications collateral and online via the Centre's website and social media channels.

Governance

The Rail Manufacturing CRC Limited ("RMCRC"; "Company"; "Centre") is a public company limited by guarantee, incorporated and domiciled in Australia. The Rail Manufacturing CRC is registered as a charity with the Australian Charities and Not-for-profits Commission.

As a registered charity, the Australian Taxation Office granted income tax exemption, a Fringe Benefits Tax rebate on capped employee fringe benefits and certain GST concessions to the Centre. As a result, no provision for income tax has been made in the Centre's financial accounts.

Directors' Meetings

The Rail Manufacturing CRC Board met six times during 2016–17:

25 August 2016, 27 October 2016, 24 November 2016, 23 February 2017, 27 April 2017 and 1 June 2017.

During the year ended 30 June 2017, the number of Board meetings held while each Director was in office, and the number attended by each Director, was as follows:

Name	Role	Key skills	Independent / Organisation	Appointed (Resigned)	A*	B#
Current Directors						
Paul Johnson	Chair	Executive management, R&D, engineering, business administration, transport industry expertise, experience as a non-executive director	Independent	31/10/2014	6	6
Bronwyn Constance	Independent Director	Financial management, business administration, manufacturing industry administration, experience as a non-executive director	Independent	31/10/2014	6	5
Stuart Thomson	Executive Director (CEO)	Business administration, executive management, IP, commercialisation, R&D, experience as an executive director	Rail Manufacturing CRC	20/03/2015	6	6
Michael Miller	Industry Nominee	Financial management, business administration, manufacturing industry administration, IT	Downer EDI Rail	14/10/2015	6	5
Grant Stanley	Research Nominee	R&D, commercialisation, higher education expertise, experience as a non-executive director	Central Queensland University	14/04/2016	6	4
Alan Beacham	Industry Nominee	Manufacturing industry administration, engineering, experience as a non-executive director	UGL	26/09/2016	5	3
Michael McLellan	Industry Nominee	Manufacturing industry administration, commercialisation, M&A, experience as a non-executive director	Knorr-Bremse Australia	26/09/2016	5	4
Former Directors						
Stuart Inglis	Industry Nominee	Executive business administration, engineering expertise, manufacturing industry administration	Bombardier Transportation Australia	14/10/2015 (24/11/2016)	3	2

*A = Number of meetings held while the Director held office

#B = Number of meetings attended

The Board is responsible to its members and participants for the company's performance. The Board's election, composition, function and responsibilities are set out in the Company's Constitution and in the Participants Agreement.

The filling of casual director vacancies is the responsibility of the Remuneration and Nominations Board Committee as follows:

- **Nominee directors** - nominations are sought from the relevant industry or research Essential Participants (EPs), such that only industry EPs may nominate candidates to replace industry nominee directors and only research EPs may nominate candidates to replace research nominee directors. Likewise, voting is by nominee type EP only.
- **Independent directors** - nominations are sought from suitable candidates, always keeping in mind the need to ensure that, collectively, the directors have skills and experience across a constitutionally established minimum set of fields.

The Board sets the Rail Manufacturing CRC company strategy and performance targets, it reviews and approves all company policies and it oversees the implementation of procedures to ensure that the Management team meets the Board's objectives. The Board meets at least quarterly for scheduled meetings.

The Chair is an independent director, and the Company's Constitution requires that the Board include:

- up to four persons elected by a vote of the Industry Essential Participants
- up to one person elected by a vote of the Research Essential Participants
- up to three independent non-executive directors elected by a vote of Essential Participants
- the CEO.

Governance

Board

CHAIR - PAUL JOHNSON MBE

DIP, MSC, MAICD.

INDEPENDENT DIRECTOR AND BOARD CHAIR SINCE 31 OCTOBER 2014.

CHAIR OF RMCRC RESEARCH AND DEVELOPMENT, AND REMUNERATION AND NOMINATIONS BOARD COMMITTEES.

EXPERIENCE AND EXPERTISE:

After an extensive career in the Royal Australian Navy as an Aircraft Artificer and an Engineering Officer, Paul joined General Electric (USA) as the Australian Manager of Business Development. He was later assigned to Singapore as the ASEAN countries Regional Director for Business Development and in 1994 was promoted to regional President for South Asia and Australasia. In May 2003, Paul was appointed as Managing Director and CEO of Lockheed Martin Australia, while also acting as Chairman of the Australian Industry Group's Defence Industry Executive Council.

Since retiring from Lockheed Martin in July 2011, Paul has been involved as a director on the Boards of a number of institutions, currently including a member of the Air Force Board, director for Industry Defence Security Aerospace Ltd and Co-Chair Centre for Defence Industry Capability Advisory Board. He was awarded the MBE in 1980 in recognition of his contribution to the advancement of Naval Aircraft Engineering and is a Member of the Australian Institute of Company Directors.

BRONWYN CONSTANCE

FCPA, FAICD, FCIS.

INDEPENDENT DIRECTOR SINCE 31 OCTOBER 2014.

CHAIR OF RMCRC AUDIT AND RISK BOARD COMMITTEE.

EXPERIENCE AND EXPERTISE:

Bronwyn has held many senior executive positions including finance director of Kraft Foods Limited Australia and New Zealand, Vice President Finance of Kraft Foods Asia, Executive General Manager Finance and Administration of Pasminco Limited and Finance Director of Nylex Limited. She spent her early career with the ACI Group of companies. Bronwyn is an independent director and chairs the Audit and Risk Committees of the DMTC Ltd. She is a former independent director of the Melbourne Market Authority, Plantic Technologies Limited, The Just Group Limited, CRC for Advanced Automotive Technology and CRC CARE Pty Ltd.

DR STUART THOMSON

BSC, BSC(HONS), PHD, GCTMLP, GAICD.

EXECUTIVE DIRECTOR SINCE 20 MARCH 2015. CHIEF EXECUTIVE OFFICER SINCE 1 APRIL 2015.

MEMBER OF RMCRC RESEARCH AND DEVELOPMENT BOARD, AND RESEARCH AND DEVELOPMENT MANAGEMENT COMMITTEES.

EXPERIENCE AND EXPERTISE:

Stuart received his PhD in Physical Chemistry from the University of New South Wales, and subsequently worked in various research roles at UNSW, the Max-Planck-Institut für Kohlenforschung and the Australian Nuclear Science and Technology Organisations (ANSTO). Stuart went on to be appointed Program Leader of an internationals safeguards research program at ANSTO, before being appointed Technical Development Manager at Note Printing Australia. Stuart has served as Chief Operating Officer at CRC Mining and Executive Director and Board member of the Grape and Wine Research and Development Corporation. In 2015 he was appointed to the role of CEO and Managing Director of the Rail Manufacturing CRC.

MICHAEL MILLER

BEC, CA.

DIRECTOR SINCE 14 OCTOBER 2015 (INDUSTRY NOMINEE).

MEMBER OF RMCRC AUDIT AND RISK, AND REMUNERATION AND NOMINATIONS BOARD COMMITTEES.

EXPERIENCE AND EXPERTISE:

Michael joined Downer EDI Limited in August 2011. He was appointed the CEO of Rail in October 2016, having previously held the CFO position for both the Rail division and for the Waratah Train Project. Prior to joining Downer, Michael held executive positions within the IT and Telecommunications industry, including Hewlett Packard and Nortel Networks.

PROF. GRANT STANLEY

BE(CHEM), PHD.

DIRECTOR SINCE 14 APRIL 2016 (RESEARCH AND DEVELOPMENT NOMINEE).

MEMBER OF AUDIT AND RISK, RESEARCH AND DEVELOPMENT, AND RENUMERATION AND NOMINATIONS BOARD COMMITTEES.

EXPERIENCE AND EXPERTISE:

Grant holds undergraduate and postgraduate degrees from the University of Melbourne and has a background in Applied Microbiology/Biochemical Engineering, with ongoing research interests in biofuel production. He has experience in research and teaching and has published over 110 scientific papers, an international patent, has received a number of Commonwealth and Industry funding grants and supervised 15 PhD students. Grant was the Head of Molecular Sciences at Victoria University, he then joined CQUniversity Australia as the Dean of Medical and Applied Sciences. In 2013 he became the Pro Vice-Chancellor (Research) and is currently the Deputy Vice-Chancellor (Research) at CQUniversity. Grant has sat on a number of Boards including the SmartWater Research Board and Queensland Cyber Infrastructure Board, and is currently a member of the Advance Queensland Expert Panel.

ALAN BEACHAM

B.ENG (HONS) C.ENG MIEE.

DIRECTOR SINCE 26 SEPTEMBER 2016.

EXPERIENCE AND EXPERTISE:

Alan leads the Rail & Defence businesses for UGL, reporting to the CEO. He joined the business in 2010 and has held a range of senior management roles. Alan has spent most of his career in the transport industry. His early career started in aviation with Rolls-Royce Plc in the UK. He then moved to F1 working for Mercedes-Ilmor Ltd. After a move to Australia, Alan returned to aviation working with Qantas before setting up a lean manufacturing consultancy KM&T Australasia supporting clients in the Rail, Marine, Automotive, Defence, FMCG and Healthcare sectors. Alan sits on a number boards including Metro Trains Melbourne and Sydney, the ARA and is chair of the Rail Industry Group.

MICHAEL MCLELLAN

B.ENG, POST.GRAD.DIP

DIRECTOR SINCE 26 SEPTEMBER 2016.

EXPERIENCE AND EXPERTISE:

Michael has been Managing Director of Knorr-Bremse Australia Pty Ltd since 2004. He was also appointed Managing Director of Sigma Air Conditioning Pty Ltd following Knorr-Bremse acquiring the business in 2010, as well as his appointment as non-executive director of Sydac Pty Ltd after leading the acquisition in 2009. Prior to joining Knorr-Bremse, Michael worked in a variety of management positions across organisations such as GUD, Honeywell and Caterpillar.

STUART INGLIS

BENG(HONS), MBA.

DIRECTOR FROM 14 OCTOBER 2015 TO 24 NOVEMBER 2016.

EXPERIENCE AND EXPERTISE:

Stuart is an experienced senior executive in the rail industry, currently working as a General Manager for UGL. With well-developed commercial and operational capabilities, including extensive global manufacturing experience and expertise, Stuart previously led the operations functions for Bombardier Australia.

Committees

The **Audit and Risk Board Committee (ARBC)** is a subcommittee which reviews and provides recommendations to the Board on financial reporting, statutory audit functions, internal control functions, risk management, compliance and governance. The ARBC is chaired by an independent non-executive director and its membership includes an industry representative director and a research provider representative director. The Committee met on five occasions in 2016–17 and the current members are:

- Bronwyn Constance (Chair)
- Grant Stanley (research representative member)
- Michael Miller (industry representative member).

The **Research and Development Board Committee (RDBC)** is a subcommittee which reviews and provides recommendations to the Board on project proposals and project progress and expenditure. Membership of the RDBC consists of an independent, non-executive director as Chair and a research representative director. The Committee met on two occasions in 2016–17 and the current members are:

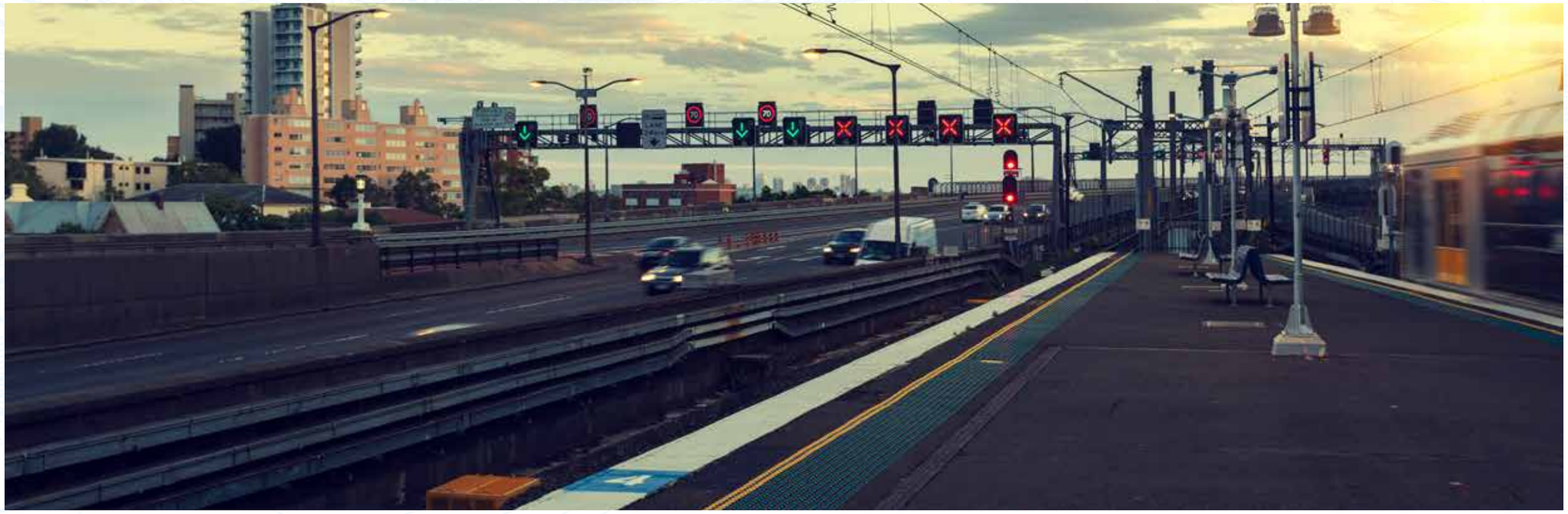
- Paul Johnson (Chair)
- Stuart Thomson (Managing Director)
- Grant Stanley (research representative member).

The **Remuneration and Nominations Board Committee (RNBC)** assesses nominations for the Board and reviews remuneration of the Centre's Management and Independent Directors. The committee is chaired by an independent non-executive director and its membership includes an industry representative director and a research representative director. The Committee met on one occasion in 2016–17 and the current members are:

- Paul Johnson (Chair)
- Grant Stanley (research representative)
- Michael Miller (industry representative member).

The **Research and Development Management Committee (RDMC)** provides advice to the CEO on technical research areas and meets quarterly to discuss the Rail Manufacturing CRC's project portfolio with the appropriate research and industry participant representatives. The Committee met on seven occasions in 2016–17 and the current members are:

- Larry Jordan (Chair, RMCRC Research Director)
- Colin Cole (CQU, RMCRC Program Leader)
- Paul Meehan (UQ, RMCRC Program Leader) from 1 March, 2017 (replacing Gary Savage, CSIRO)
- Stuart Thomson (RMCRC CEO).



Management team

DR STUART THOMSON

BSC, BSC(HONS), PHD, GCTMLP, GAICD.

CHIEF EXECUTIVE OFFICER SINCE APRIL 2015.

EXPERIENCE AND EXPERTISE:

Stuart has extensive experience in leading strategic research and development programs in both government and commercial organisations, having held senior management positions in the private and public sectors. His past roles have included technical development roles in manufacturing companies, Chief Operating Officer and Director of Research roles at CRCMining, and the Executive Director of the Grape and Wine Research and Development Corporation.

DR LARRY JORDAN

BSC, MSC, PHD.

RESEARCH DIRECTOR SINCE AUGUST 2015.

EXPERIENCE AND EXPERTISE:

Larry manages the delivery of Rail Manufacturing CRC's research program to ensure high quality collaborative research is provided to the rail industry. With a background in materials science and experience in research, including electrochemical sensors, fuel cells and materials durability, Larry has worked in building construction, nanotechnology and automotive industries. Larry's past roles include Research Manager at the Advanced Manufacturing CRC and Chief Scientist at General Motors Holden.

SHELLEY BRESICK

ASSOC.DIP.

BUSINESS MANAGER SINCE SEPTEMBER 2015.

EXPERIENCE AND EXPERTISE:

Shelley is responsible for the financial project management for the Rail Manufacturing CRC, ensuring achievement of reporting, securing funding from the Federal Government, and managing external grants and milestone payments. She also manages the Centre's Payroll, Accounts Payable and Receivable functions, Executive and Board administration, office management and organisational safety. Shelley previously worked as Finance Manager for the Dairy CRC and the Advanced Manufacturing CRC.

SHARON SALPIGHIDIS

BCOM, DIP.ED, CPA.

FINANCIAL CONTROLLER AND COMPANY SECRETARY SINCE SEPTEMBER 2016.

EXPERIENCE AND EXPERTISE:

Sharon provides strategic and operational management of the Rail Manufacturing CRC's financial activities and ensures the Centre complies with its statutory obligations. Sharon has previously held senior management positions across listed public companies and fast-growing private start-up enterprises including facilitating multiple mergers, acquisitions and divestments. She has worked in diverse industries including telecommunications, healthcare, construction and the education sectors both locally and overseas.

KATIE RIZZO

B. ARTS, GRAD.CERT.

COMMUNICATIONS MANAGER SINCE JUNE 2016.

EXPERIENCE AND EXPERTISE:

Katie is responsible for managing the communications function for the Rail Manufacturing CRC, which includes marketing, media engagement, event management and internal communications activities. Prior to joining the Centre, she worked in corporate communications, marketing and online communications roles across a number of sectors, including manufacturing, telecommunications, banking, energy and water.

PROF COLIN COLE

B.ENG, M.ENG, PHD.

PROGRAM LEADER SINCE APRIL 2015.

EXPERIENCE AND EXPERTISE:

Colin is the Director of the Centre for Railway Engineering (CRE) and also currently serves as a Program Leader in the Rail Manufacturing CRC. His work history in railway engineering started in 1984 in Queensland Railways, and he's spent the past 22 years working specifically in railway research. Colin's PhD thesis was on Longitudinal Train Dynamics, and he has also completed 20 rail research projects related to train dynamics, simulation and development of on-board intelligent systems and devices. He has published over 100 technical papers, one book, two book chapters and two patents.

PROF PAUL MEEHAN

B.ENG(HON1), PHD.

PROGRAM LEADER SINCE MARCH 2017.

EXPERIENCE AND EXPERTISE:

Paul is an expert in railway mechanics and noise, leading The University of Queensland research in rail mechanics as part of the Centre for Advanced Materials Performance and Manufacturing (AMPAM). He has initiated and led many successful large industry collaborative R&D projects totalling more than $12 million in competitive research funding. He also teaches several intermediate and advanced level courses in mechanics including railway noise. He has authored over 120 internationally refereed publications and 3 international patents.

Name*	Organisation	Position title	Time commitment
Dr Stuart Thomson	Rail Manufacturing CRC	Managing Director and CEO	100%
Dr Larry Jordan	Rail Manufacturing CRC	Research Director	100%
Shelley Bresick	Rail Manufacturing CRC	Business Manager	80%
Sharon Salpighidis	Rail Manufacturing CRC	Financial Controller and Company Secretary	60%
Katie Rizzo	Rail Manufacturing CRC	Communications Manager	60%
Professor Paul Meehan	Rail Manufacturing CRC / University of Queensland	Program Leader	55%
Professor Colin Cole	Rail Manufacturing CRC / CQ University	Program Leader	51%

* Employees during this period also included:
Glenn Raines as Financial Controller and Company Secretary (August 2015 to September 2016)
Gary Savage as Program Leader (April 2015 to December 2016).

Participants

Changes to participants during the reporting period

A number of new participants joined the Centre in 2016–17:

- **TrackSAFE Foundation** – Other Participant
- **Knorr-Bremse Australia** – Other Participant
- **Sydney Trains** – Other Participant
- **Foundation QA** – Other Participant
- **Global Synthetics** – Other Participant
- **HEC Group** – Other Participant
- **UGL Rail Services** – Other Participant

At the end of 2015–16, **Faiveley Transport** advised its intention to leave the Rail Manufacturing CRC as an Essential Participant, giving 12 months' notice. As such, Faiveley Transport officially left the Centre as of 30 June 2017.

At the end of 2016–17, **Sigma** advised its intention to leave the Rail Manufacturing CRC, with all projects to be transferred to its parent company **Knorr-Bremse Australia**.

The Rail Manufacturing CRC is currently in dispute with **Simplex Factory Automation Pty Ltd** (Simplex), an Essential Participant, and has recently terminated its project R1.2.1.

Essential Participants

Participant name	Participant type	ABN	Organisation type
Bombardier Transportation Australia Pty Ltd	Essential	73 010 699 804	Large Industry
Central Queensland University	Essential	39 181 103 288	University
China Railway Rolling Stock Corporation (CRRC)	Essential	Not applicable	Large Industry
CSIRO	Essential	41 687 119 230	Australian Government
Deakin University	Essential	56 721 584 203	University
Downer EDI Rail Pty Ltd	Essential	92 000 002 031	Large Industry
Faiveley Transport Australia	Essential	41 000 611 898	Large Industry
Monash University	Essential	12 377 614 012	University
OneSteel Manufacturing Pty Ltd	Essential	42 004 651 325	Large Industry
Queensland University of Technology	Essential	83 791 724 622	University
Sigma Air Conditioning Pty Ltd	Essential	31 000 900 970	Large Industry
Simplex Factory Automation Pty Ltd	Essential	81 094 159 896	Individual SME
Swinburne University of Technology	Essential	13 628 586 699	University
The University of Queensland	Essential	63 942 912 684	University
University of Technology Sydney	Essential	77 257 686 961	University
University of Wollongong	Essential	61 060 567 686	University

Other Participants

Participant name	Participant type	ABN	Organisation type
Airlinx Heating and Cooling Pty Ltd	Other	28 094 691 791	Individual SME
Australasian Centre for Rail Innovation (ACRI) Ltd	Other	52 164 764 167	Other
Australasian Railway Association	Other	64 217 302 489	Other
Foundation QA	Other	78 090 519 289	Individual SME
Global Synthetics	Other	71 120 519 520	Individual SME
HEC Group	Other	18 165 129 260	Large Industry
Knorr-Bremse Australia Pty Ltd	Other	31 092 562 671	Large Industry
Royal Melbourne Institute of Technology	Other	49 781 030 034	University
Sydney Trains	Other	38 284 779 682	State Government
TrackSAFE Foundation	Other	98 155 604 872	Other
Tyre Stewardship Australia Ltd	Other	44 164 971 939	Individual SME
UGL Rail Services Pty Ltd	Other	58 000 003 136	Large Industry

Third Party Participants

Participant name	Participant type	ABN	Organisation type
Aurizon Network Pty Ltd	Third Party	78 132 181 116	Large Industry
Austrade	Third Party	11 764 698 227	Government
Industry Capability Network Ltd	Third Party	85 068 571 513	Government
Queensland Rail Ltd	Third Party	47 564 947 264	Large Industry
The State of Queensland (Department of Transport and Main Roads)	Third Party	39 407 690 291	State Government

Collaboration

To promote ongoing collaboration, the Rail Manufacturing CRC has explored a number of initiatives for enhancing engagement between its industry participants, research participants and third party organisations.

One key activity included the call for project proposals through the Rail Manufacturing CRC Innovation Gateway Project program in November 2016, seeking research ideas from organisations currently working in the rail industry or with the interest to do so. In the past two years, two rounds of the Gateway call for projects have been initiated, with several projects currently in discussion and the commencement of three new projects:

- Project R2.3.4 – *Monitoring and control of false brinelling*, Bombardier / University of Queensland
- Project R2.5.1 – *Performance of recycled rubber inclusions for improved stability of railway*, Tyre Stewardship Australia / Australasian Centre for Rail Innovation / University of Wollongong
- Project R2.5.2 – *Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading*, Global Synthetics / Foundation QA / University of Wollongong

The Centre has also created a PhD scholarship program with its university participants aimed at sponsoring rail research projects to be conducted by postgraduate students. The scholarships aim to foster the development of highly skilled graduates through postgraduate education, while also initiating a number of projects that the rail industry can monitor and potentially become involved in at a future date.

The Rail Manufacturing CRC's current suite of projects are providing considerable benefit to its participants, with a number of project examples underway:

- Projects R2.3.2 – *Axle bearing maintenance optimisation* and R2.3.4 – *Monitoring and control of false brinelling* being undertaken at the University of Queensland, could potentially significantly reduce maintenance and overhaul requirements
- Project R2.3.1 – *Accelerated life testing and characterisation of critical components* is developing new technologies for monitoring component performance, with the outcomes of this study having the capacity to add considerable benefit to Knorr-Bremse and its customers
- Supercapacitor technology being developed jointly by CRRC and the CSIRO (Projects R1.3.1 - 1.3.4) hold significant opportunities for the domestic and global rail sector, with the capacity to significantly impact on the future of rail
- Project R3.1.2 – *Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system* being delivered by Downer and the University of Technology Sydney will offer an array of benefits to rail operators, enabling them to operate more efficiently and effectively, along with the potential to reduce railway operation costs. This project has recently been extended to focus on developing first phase prototypes for further studies.

More broadly, the Rail Manufacturing CRC's participation in numerous rail industry forums has enabled the Centre to develop relationships with rail manufacturers, rail operators and government organisations across the world. The Centre has participated in a number of joint industry briefing, conferences, forums and peak body advisory groups. The Centre continues to work closely with rail peak bodies, including the Australasian Railway Association (ARA).

The Centre also participated and promoted rail innovation at a number key forums, including Innotrans 2016, the AusRAIL Conference in November 2016, the Depot Upgrades and Workshop Modernisation Conference 2017 and the Rail Manufacturing CRC's Participant Forums (August 2016 and May 2017).

Financial management

For the year ended 30 June 2017, the Rail Manufacturing CRC expended its financial resources on:

- contracting new research projects
- managing and supporting existing research projects
- awarding student PhD scholarships
- bringing new participants into the Centre
- developing its pipeline of potential new research projects with both existing, and potentially new, participants.

Financial Performance

For the year ended 30 June 2017, the Rail Manufacturing CRC earned revenue of $4.48 million and other income of $0.13 million, and incurred expenses of $4.61 million, resulting in a $nil operating profit. Revenue of $4.48 million comprised $2.93 million of CRC Programme Funding from the Department of Industry, Innovation and Science and $1.55 million from Participants. Expenditure of $4.61 million included $3.27 million of Research costs, $1.05 million of Employee benefits costs and $0.29 million of Administration and depreciation expenses.

Research expenditure was $5.9 million lower than budgeted for the year, reflecting delays in securing and commencing projects and some timeline adjustments to existing projects.

Cash Flows

During the year, the Rail Manufacturing CRC received $9.04 million of operating cash inflows (inclusive of GST), consisting of $7.28 million from the Commonwealth CRC Programme, $1.65 million from participants and $0.11 million in interest receipts. Operating cash outflows totalled $5.17 million (inclusive of GST), consisting of $3.34 million of Research payments and $1.83 million of Administration payments.

There were no investing cash flows this year.

In-kind Contributions

Total in-kind contributions of $7.2 million for the year ended 30 June 2017 comprised $6.4 million of staff in-kind and $0.8 million of non-staff in-kind contributions, being non-cash contributions to the Rail Manufacturing CRC's research programs by research and industry participants, representing contributions of people, equipment and facilities.

Financial Position

As at 30 June 2017, Total Assets were $12.3 million and Total Liabilities were $12.3 million. Total Assets are comprised predominantly of Cash and Cash Equivalents of $11.8 million, Trade and Other Receivables of $0.2 million and Prepayments of $0.3 million. Total Liabilities was comprised of Deferred Revenue of $10.3 million, Trade and Other Payables of $2.0 million and Provisions of $0.04 million.

Financial Issues

The key financial challenges, for the next and subsequent years, in order to meet the Centre's current obligations to the Commonwealth, are to:

(i) source and secure $4.7 million of research contributions from new participants in order to match the Commonwealth's CRC research funding

(ii) agree and finalise research projects to the value of approximately $8.5 million with existing participants.

CRC future plans and transition arrangements

The Rail Manufacturing CRC began operations in 2014, with a mandate to operate for six years in total, finishing up at the end of the 2019–20 Financial Year. Following this period, there are two transition options for the Rail Manufacturing CRC to consider:

- **Option 1** – The Rail Manufacturing CRC, staff and centre operations transition to a new entity
- **Option 2** – The Centre closes up, with the business deregistered and the legal entity wound up

Option 1 – Transition

The Rail Manufacturing CRC may seek to transition its activities to support new research endeavours in relation to the rail sector and, more broadly, the transport sector, providing that the Centre meets its financial and operation objectives and has the continued support of its industry and research participants.

In transitioning, the Centre would seek to operate in a manner similar to its current objectives, but with a renewed focus on the application of its priority areas in the broader transportation domain. Continuing to operate as it currently does, the Centre could also implement its established and articulated policies with respect to:

- The participants' cooperation in research through the Centre and its Committee structures
- An industry driven research portfolio designed and prioritised though the Centre
- Board governance
- Business and risk management
- Intellectual Property structures
- Budgeting, internal control and financial reporting.

These policies and processes are already documented in the Rail Manufacturing CRC Annual Report and other reports to the Commonwealth. By transitioning to a new entity, there would be a number of sources of untied income that the Centre will seek to access, including:

- Direct Industry funding
- CRC grants and CRC-P grants
- Other Commonwealth Government grants
- State Government grants.

Option 2 – Centre closes

The second option for the Rail Manufacturing CRC is to close down operations and cease its existence. The following outlines the steps that would be undertaken to achieve this:

- Identify those projects that have Rail Manufacturing CRC commitments extending into the Financial Year ending 2019–20
- Identify any key projects, current or proposed, that are of importance to Rail Manufacturing CRC in terms of possible industry funding and/or commercialisation
- Identify any projects from the above that can be readily transferred to a self-funding spin-off company
- In consultation with industry partners, identify any projects that will be entirely industry funded beyond the 2019–20 Financial Year, which can continue if funding is forthcoming and will most likely be transferred to a member research provider
- In consultation with research provider participants, identify those projects (or programs) that the research provider would like to absorb
- Plan to complete all other projects by 31 December 2019.

Proceeding with this option also includes the wrap-up of activities covering the Centre's employees, students, existing and new contracts, Intellectual Property, assets, document archiving and insurance.

Prior to 31 October 2019, the Rail Manufacturing CRC would prepare a schedule, in consultation with the Centre's solicitors, for deregistering the business. The process would take into account the Centre's obligations to it Essential Participants, Members and Other Participants and would incorporate discussions with both the Australian Charities and Not-for-profits Commission.

(ACNC) and the Australian Securities and Investments Commission (ASIC) to ensure the Rail Manufacturing CRC legal entity is appropriately wound up.

Relating to final year budgets, while at the present time it's not possible to provide an accurate budget for the 2019–20 Financial Year, contingencies have been made to reserve funds for the necessary legal, financial and auditing services that would be required. It is intended to furnish the Commonwealth with a more substantial final year budget in the latter years of the Centre's operations as more information becomes available.

Other matters for consideration

Regardless of the option selected, the following activities will occur during the wrap-up of the Rail Manufacturing CRC post 2019–20:

- The Centre will submit a wind-up plan to the Commonwealth by 31 October 2019 in the penultimate Annual Report and will again submit the wind-up plan by 31 October 2020 as part of the final Annual Report
- The Centre will submit an exit report to the Commonwealth by 31 October 2019 in the penultimate Annual Report and again by 31 October 2019 as part of the final Annual Report
- The Centre will submit a final Annual Report to the Commonwealth, which covers the last Financial Year of the grant period – prior to 31 December 2019, the Centre will put in place a plan for achieving this outcome by 31 October 2020.

Performance review

No CRC review was conducted in the 2016–17 period. The Commonwealth conducted an official third year review in July 2017 with positive feedback received on the Centre's progress to date, although formal notification of the review outcome is pending.

Full details of this review will be published in the 2017–18 Rail Manufacturing CRC Annual Report.

Other activities

In 2016–17, the Rail Manufacturing CRC signed a Memorandum of Understanding with the Advanced Manufacturing Growth Centre (AMGC), responsible for driving industry-led approaches that drive innovation, productivity and competitiveness in Australian manufacturing.

Glossary of terms

ACRI	Australasian Centre for Rail Innovation
ACNC	Australian Charities and Not-for-profits Commission
AMGC	Advanced Manufacturing Growth Centre
ARA	Australasian Railway Association
ARBC	Audit and Risk Board Committee
ASIC	Australian Securities and Investments Commission
CQU	Central Queensland University
CRC	Cooperative Research Centre
CRRC	China Railway Rolling Stock Corporation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Essential Participant	Those persons, bodies and organisations who provide essential support (including cash or in-kind contributions) for the activities of the CRC
ICN	Industry Capability Network
IP	Intellectual Property
Other Participant	A participant who is not an Essential Participant who has signed an agreement with the CRC
QUT	Queensland University of Technology
R&D	Research and Development
RDBC	Research and Development Board Committee
RDMC	Research and Development Management Committee
RMCRC (or 'the Centre')	Rail Manufacturing CRC
RNBC	Remuneration and Nominations Board Committee
SMEs	Small-to-medium enterprises
UQ	University of Queensland
UTS	University of Technology Sydney
UoW	University of Wollongong