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.

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.

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

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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 lines
» Sydney’s north–south 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, Modeling 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 Forum, 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 organizations, 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.

On Track to 2040 – Preparing the Australian Rail Supply Industry for Challenges and Growth

Paul Johnson MBE
Chair

De Stuart Thomson
CEO
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 modeling
- 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.

Chair and MD

Paul Johnson MBE
Chair – Rail Manufacturing CRC

Dr Stuart Thomson
CEO – Rail Manufacturing CRC
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.

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.

*About the Rail Manufacturing CRC*

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Executive summary

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.

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 Barghamedi, 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.

Research and collaboration

Achievements

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

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.
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. 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.

Summary
...to develop projects that will have significant positive impact to the organisations involved'
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, CRCC 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, trialed and assessed for future commercialisation activities.

**The Rail Manufacturing CRC has been active in developing new projects**
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.
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.

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.

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.

‘The interest in responsive passenger information systems resulted in project trials at rail operator sites in Sydney and Brisbane’
Rail Manufacturing CRC Projects underway during reporting period

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<td>New generation lithium-ion batteries with high energy and long service life for rail industry applications</td>
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<td>R1.2.1</td>
<td>Propulsion of intelligent magnetically levitated track-vehicle</td>
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<tr>
<td>2</td>
<td>R2.3.2</td>
<td>Axle bearing maintenance optimisation</td>
<td>Bombardier / University of Queensland</td>
</tr>
<tr>
<td>2</td>
<td>R2.3.3</td>
<td>Manufacturing process for rolling stock fabrication</td>
<td>UGL / University of Wollongong</td>
</tr>
<tr>
<td>2</td>
<td>R2.3.4</td>
<td>Monitoring and control of false brinelling</td>
<td>Bombardier / University of Queensland</td>
</tr>
<tr>
<td>2</td>
<td>R2.4.1</td>
<td>Advanced steel development for rail and sleepers</td>
<td>OneSteel / Monash University</td>
</tr>
<tr>
<td>12</td>
<td>R2.5.1</td>
<td>Performance of recycled rubber inclusions for improved stability of railways</td>
<td>Tyre Stewardship / Australian Centre for Rail Innovation / University of Wollongong</td>
</tr>
<tr>
<td>13</td>
<td>R2.5.2</td>
<td>Application of geogrids for minimising track deformation and degradation under high frequency cyclic and heavy haul loading</td>
<td>Global Synthetics / Foundation Q&amp;A / University of Wollongong</td>
</tr>
<tr>
<td>14</td>
<td>R3.1.2</td>
<td>Integrated passenger behaviour, train operations diagnostics and vehicle condition monitoring system</td>
<td>Doosan / University of Technology Sydney</td>
</tr>
<tr>
<td>15</td>
<td>R3.2.1</td>
<td>Development of a responsive passenger information system for the Sydney Trains network</td>
<td>Sydney Trains / University of Technology Sydney</td>
</tr>
<tr>
<td>16</td>
<td>R3.3.1</td>
<td>Detection and monitoring on trains - feasibility study</td>
<td>Inno-Bremse / University of Technology Sydney</td>
</tr>
<tr>
<td>17</td>
<td>R3.6.1</td>
<td>Experimental and computational study on the key ventilation issues affecting air quality and thermal comfort in train cabins</td>
<td>Airlinx / RMIT</td>
</tr>
</tbody>
</table>

Commonwealth Milestone status at 30 June 2017

<table>
<thead>
<tr>
<th>Milestone Number</th>
<th>Milestone</th>
<th>Due Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1.1.1</td>
<td>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</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R1.2.2</td>
<td>First prototype delivered and report on cruise specifications approved</td>
<td>31 Dec 2016</td>
<td>Not achieved</td>
</tr>
<tr>
<td>R1.3.2</td>
<td>Development and Design of hardware and software completed. IP strategy (patents/know-how/designs/software) defined</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R1.5.1</td>
<td>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</td>
<td>30 Jun 2017</td>
<td>In progress</td>
</tr>
<tr>
<td>R1.6.2</td>
<td>Commencement of 4 PhD students</td>
<td>30 Jun 2017</td>
<td>In progress</td>
</tr>
<tr>
<td>R1.11</td>
<td>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</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.1.1</td>
<td>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</td>
<td>31 Dec 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.1.2</td>
<td>Report approved for performance and design constraints. Define IP strategy (patents/know-how/designs/software)</td>
<td>31 Dec 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.1.3</td>
<td>Develop material-process-property relationships to predict performance completed</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.3.1</td>
<td>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</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.4.3</td>
<td>Software model to predict performance completed</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.5.1</td>
<td>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</td>
<td>31 Dec 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.7.2</td>
<td>Commencement of 3 PhD students</td>
<td>30 Jun 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R2.7.3</td>
<td>Commencement of 6 PhD students</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R3.1.2</td>
<td>Review of performance and design constraints completed. Define IP strategy (patents/know-how/designs/software)</td>
<td>30 Jun 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R3.1.3</td>
<td>Report on know-how for advanced detection technologies for rail applications approved</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R3.1.4</td>
<td>Report approved for know-how for train handling algorithms for rail applications</td>
<td>30 Jun 2017</td>
<td>Not achieved</td>
</tr>
<tr>
<td>R3.1.5</td>
<td>Report approved for feasibility study for Advanced software tool for evaluating mechanical design of designs including patent and literature landscape, performance benchmark and confirm approach in terms of technical and economic feasibility</td>
<td>30 Jun 2017</td>
<td>Not achieved</td>
</tr>
<tr>
<td>R3.1.6</td>
<td>Software model to predict performance completed</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
<tr>
<td>R3.2.2</td>
<td>Commencement of 3 PhD students</td>
<td>30 Jun 2016</td>
<td>Achieved</td>
</tr>
<tr>
<td>R3.3.3</td>
<td>Commencement of 8 PhD students</td>
<td>30 Jun 2017</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

* Milestones from 2015-16 which were held over and achieved this Financial Year
Publications list in 2016–17:

Articles in Scholarly Refereed Journals


Full written conference paper – refereed proceedings


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 Yi, 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 participating 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 Kushthali Ramal Ranasinghe and Zechiu 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

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

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

<table>
<thead>
<tr>
<th>Project</th>
<th>Milestone</th>
<th>Due Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1.3.1</td>
<td>Grant of Utilisation rights to Industry Participant</td>
<td>31 Dec 2016</td>
<td>Completed</td>
</tr>
<tr>
<td>U2.1.1</td>
<td>Grant of Utilisation rights to Industry Participant</td>
<td>31 Dec 2016</td>
<td>Completed</td>
</tr>
<tr>
<td>U2.3.1</td>
<td>Grant of Utilisation rights to Industry Participant</td>
<td>30 Jun 2017</td>
<td>Completed</td>
</tr>
<tr>
<td>U3.1.1</td>
<td>Grant of Utilisation rights to Industry Participant</td>
<td>30 Jun 2017</td>
<td>Completed</td>
</tr>
<tr>
<td>U3.3.1</td>
<td>Grant of Utilisation rights to Industry Participant</td>
<td>30 Jun 2017</td>
<td>Completed</td>
</tr>
</tbody>
</table>

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 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.

**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:

- evaluating 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.

**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:

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:

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

*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 the Essential Participants
- the CEO.
CHAIR - PAUL JOHNSON
MBE
DFC, FEDS, FICS
INDEPENDENT DIRECTOR
AND BOARD CHAIR SINCE 31
OCTOBER 2014
CHAIR OF INTRAC, RESEARCH
AND DEVELOPMENT, AND
REMUNERATION AND
NOMINATIONS BOARD
COMMITTEES.

EXPERIENCE AND
EXPERTISE:
After an extensive career in the
Royal Australian Navy as an Aircraft
Airman and an Engineering Officer,
Paul joined General Electric in 1980 as the
Manager of Business Development. He was
later assigned to Singapore as the
ASEAN countries Regional Director
for Business Development and in 1984 was
promoted to regional President for South
Asia and Australia. 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 of Defence Industry
Executive Council for
Advanced Automotive
Technologies Limited, and
Chair of the DMTC Ltd. She is
a former independent
director of the Melbourne
Market Authority, Plantic
Technologies Limited, the
Just Group Limited, CRC
technologies Limited, The
Market Authority, Plantic
Science and Technology
Organisations (ANSTO).
Stuart went on to be
appointed Program
Leader of an internationals
sustainable research
program at ANSTO before being appointed Technical
Development Manager at
Note Printing Australia.
Stuart has served as Chief
Operating Officer at CRC,
Metro Trains Melbourne and
as Technical Director
and Board member of the
Head of Molecular Sciences
at Victoria University. In 2007 he
then joined QUT as Vice
Chancellor and subsequently
president at Victoria University. In 2015 he
became the Pro Vice-
Chancellor (Research) and is currently the
Deputy Vice-Chancellor (Research) at
QUT. Dr. Day has sat on a number
of Boards, including
the Smartwater Research
Board and Queensland Cyber
Infrastructure Board, and is a
current member of the
Governance 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
Plasticas Limited and Financial Director of Nixal
Limited. She spent her
entire career with the
ACI Group of companies.
Bronwyn is an independent
director and chairs the
Audit and Risk Committees
of the DHFVC Ltd. She is
a former independent
director of the Melbourne
Market Authority, Plantic
Technologies Limited, the
Just Group Limited, CRC
technologies Limited, The
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Just Group Limited, CRC
technologies Limited, The
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Organisations (ANSTO).
Stuart went on to be
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sustainable research
program at ANSTO before being appointed Technical
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Note Printing Australia.
Stuart has served as Chief
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Metro Trains Melbourne and
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Chancellor (Research) and is currently the
Deputy Vice-Chancellor (Research) at
QUT. Dr. Day has sat on a number
of Boards, including
the Smartwater Research
Board and Queensland Cyber
Infrastructure Board, and is a
current member of the
Governance Committee.
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 (RDPC) is a subcommittee which reviews and provides recommendations to the Board on project proposals and project progress and expenditure. Membership of the RDPC 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, BEng(Hons), PhD, CITP, GAICD
Chief Executive Officer since April 2015

**Dr Larry Jordan**
BSc, MSc, PhD
Research Director since August 2015

**Shelley Bresick**
Assoc.Cof
Business Manager since September 2015

**Sharon Salpighidis**
BCom, DFIO, CIA
Finance, Control and Company Secretary since September 2016

**Katie Rizzo**
BEng, MEng, PhD
Communications Manager since June 2016

**Prof Colin Cole**
BEng, MEng, PhD
Program Leader since April 2015

**Prof Paul Meehan**
BEng(Hons), PhD
Program Leader since March 2015

**Gary Savage**
as Program Leader (April 2015 to December 2016).

**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 | Finance Control and Company Secretary | 80%

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 / CQU University | Program Leader | 55%

* Employees during this period also included: Patricia Sheehan as Finance and Company Secretary (August 2015 to September 2016)

**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, managing R&D, new business development programs and strategic research and development activities. He also has experience in 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 $32 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.

**EXPERIENCE AND EXPERTISE:**
Larry manages the delivery of Rail Manufacturing CRC’s research programs 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 diverse industries including construction and automotive industries. Larry’s past roles include Research Manager at the Advanced Manufacturing CRC and Chief Scientist at General Motors Holden.

**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 internal grants and milestone payments. She also manages the Centre’s payroll, Accounts Payable and Receivable, Executive and Board administration, office management and organisational safety. Shelley previously worked as Finance Manager for the Dairy CRC and the Advanced Manufacturing CRC.

**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 divestitures. She has worked in diverse industries including telecommunications, healthcare, construction and the education sectors, both locally and overseas.

**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.

**EXPERIENCE AND EXPERTISE:**
Colin is the Director of the Centre for Railway Engineering (CRC) 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 10 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.
### 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 R2.2.1.

### Participants

#### Essential Participants

<table>
<thead>
<tr>
<th>Participant name</th>
<th>Participant type</th>
<th>ABN</th>
<th>Organisation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bombardier Transportation Australia Pty Ltd</td>
<td>Essential</td>
<td>13 010 699 804</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Central Queensland University</td>
<td>Essential</td>
<td>38 181 103 286</td>
<td>University</td>
</tr>
<tr>
<td>China Railway Rolling Stock Corporation (CRRC)</td>
<td>Essential</td>
<td>Not applicable</td>
<td>Large Industry</td>
</tr>
<tr>
<td>CRRC</td>
<td>Essential</td>
<td>44 687 129 230</td>
<td>Australian Government</td>
</tr>
<tr>
<td>Deakin University</td>
<td>Essential</td>
<td>56 761 584 203</td>
<td>University</td>
</tr>
<tr>
<td>Downer EDI Rail Pty Ltd</td>
<td>Essential</td>
<td>92 000 002 031</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Faiveley Transport Australia</td>
<td>Essential</td>
<td>41 100 812 898</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Monash University</td>
<td>Essential</td>
<td>12 377 634 012</td>
<td>University</td>
</tr>
<tr>
<td>OneSteel Manufacturing Pty Ltd</td>
<td>Essential</td>
<td>62 004 653 325</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Queensland University of Technology</td>
<td>Essential</td>
<td>81 791 724 622</td>
<td>University</td>
</tr>
<tr>
<td>Sigma Air Conditioning Pty Ltd</td>
<td>Essential</td>
<td>51 000 903 970</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Simplex Factory Automation Pty Ltd</td>
<td>Essential</td>
<td>81 204 159 896</td>
<td>Other</td>
</tr>
<tr>
<td>Swinburne University of Technology</td>
<td>Essential</td>
<td>11 628 586 099</td>
<td>University</td>
</tr>
<tr>
<td>The University of Queensland</td>
<td>Essential</td>
<td>61 942 912 684</td>
<td>University</td>
</tr>
<tr>
<td>University of Technology Sydney</td>
<td>Essential</td>
<td>77 257 686 981</td>
<td>University</td>
</tr>
<tr>
<td>University of Wollongong</td>
<td>Essential</td>
<td>61 060 567 486</td>
<td>University</td>
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</table>

#### Other Participants

<table>
<thead>
<tr>
<th>Participant name</th>
<th>Participant type</th>
<th>ABN</th>
<th>Organisation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airlinx Heating and Cooling Pty Ltd</td>
<td>Other</td>
<td>28 094 691 791</td>
<td>Individual SME</td>
</tr>
<tr>
<td>Australasian Centre for Rail Innovation (ACRI) Ltd</td>
<td>Other</td>
<td>52 164 764 167</td>
<td>Other</td>
</tr>
<tr>
<td>Australian Railway Association</td>
<td>Other</td>
<td>64 217 352 499</td>
<td>Other</td>
</tr>
<tr>
<td>Foundation QA</td>
<td>Other</td>
<td>78 090 513 289</td>
<td>Individual SME</td>
</tr>
<tr>
<td>Global Synthetics</td>
<td>Other</td>
<td>71 120 533 920</td>
<td>Individual SME</td>
</tr>
<tr>
<td>HEC Group</td>
<td>Other</td>
<td>64 165 212 200</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Knorr-Bremse Australia Pty Ltd</td>
<td>Other</td>
<td>31 092 562 671</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Royal Melbourne Institute of Technology</td>
<td>Other</td>
<td>49 781 030 034</td>
<td>University</td>
</tr>
<tr>
<td>Sydney Trains</td>
<td>Other</td>
<td>58 084 779 682</td>
<td>State Government</td>
</tr>
<tr>
<td>TrackSAFE Foundation</td>
<td>Other</td>
<td>98 155 604 872</td>
<td>Other</td>
</tr>
<tr>
<td>Tyre Stewardship Australia Australia Ltd</td>
<td>Other</td>
<td>44 104 977 938</td>
<td>Individual SME</td>
</tr>
<tr>
<td>UGL Rail Services Pty Ltd</td>
<td>Other</td>
<td>58 000 003 136</td>
<td>Large Industry</td>
</tr>
</tbody>
</table>

#### Third Party Participants

<table>
<thead>
<tr>
<th>Participant name</th>
<th>Participant type</th>
<th>ABN</th>
<th>Organisation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurizon Network Pty Ltd</td>
<td>Third Party</td>
<td>78 152 381 116</td>
<td>Large Industry</td>
</tr>
<tr>
<td>Australian Centre for Rail Innovation (ACRI) Ltd</td>
<td>Third Party</td>
<td>11 764 368 207</td>
<td>Governments</td>
</tr>
<tr>
<td>Industry Capability Network Ltd</td>
<td>Third Party</td>
<td>99 068 576 513</td>
<td>Government</td>
</tr>
<tr>
<td>Queensland Rail Ltd</td>
<td>Third Party</td>
<td>67 564 947 264</td>
<td>Large Industry</td>
</tr>
<tr>
<td>The State of Queensland (Department of Transport and Main Roads)</td>
<td>Third Party</td>
<td>39 407 690 291</td>
<td>State Government</td>
</tr>
</tbody>
</table>
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 small 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.

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 through 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

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