ALERTNESS SAFETY AND PRODUCTIVITY

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

# 2017 Annual Report

ACN 163 458 982 Ground Floor, Building 1, 270 Ferntree Gully Road, Notting Hill, Victoria 3168 | www.alertnesscrc.com

"In the 2016–17 financial year, it is estimated that in the Australian economy alone the cost of inadequate sleep was $66.3 billion. This includes $26.2 billion in financial costs and $40.1 billion in the loss of wellbeing. This was due to the fact that four in ten Australian adults – 7.4 million people – frequently suffered from a lack of good sleep, leading to poor alertness, sleep health issues, and a general loss of workplace productivity."

**"Asleep on the Job" Sleep Health Foundation Report (https://www.sleephealthfoundation.org.au/public-information/special-reports/asleep-on-the-job.html)**

# Sleep Loss: Costs to Australia

**The total cost of inadequate sleep in Australia was estimated to be**

**$66.3 billion** in 2016–17

**$26.2 billion**
in financial costs
made up of:

**$40.1 billion**
in loss of wellbeing costs
**$5,420 per person affected**

Health system costs of **$1.8 billion**, **$246 per person affected**

Productivity losses of **$17.9 billion**, **$2,418 per person affected**

Informal care costs of **$0.6 billion**, **$82 per person affected**

Other financial costs, including deadweight losses, of **$5.9 billion**, **$802 per person affected**

# Contents

# Executive Summary

The fourth year of the Alertness CRC has laid a strong foundation for the creation of leading-edge alertness prediction and sleep health management tools. The data generated by this research is now driving product concept planning and prototype development with strong support and direction from our industry partners.

The research program structure of the Alertness CRC provides the high-level strategic direction required to link the development of measurement and prediction capabilities with the proposed countermeasures and individualised approaches:

## **Program One:** Prediction

Developing and verifying tools to measure current alertness, sleep and circadian states accurately, to predict these states into the future, and to intervene before sleep-wake disturbances cause impaired alertness, safety and productivity.

## **Program Two:** Workplace Safety

Demonstrating that alertness can be maximised at individual, workplace and community levels to deliver measurable improvements in safety and productivity. Systems and devices shown to improve alertness will have widespread applications, particularly in safety-critical occupations.

## **Program Three:** Individualised Treatment

Developing new personalised and effective sleep health management tools and guidelines that collectively enable substantially more personalised and effective sleep disorder diagnosis and treatments.

The Alertness CRC continues to develop detailed commercialisation profiles around key outputs, and build an understanding of the opportunities for value creation through the current participant group and the broader target markets. These include:

1) Artificial Intelligence-based sleep health management decision support tools
2) Insomnia treatments
3) Individualised sleep management software
4) Enterprise work scheduling software
5) Alertness testing and road safety monitoring
6) Advances in clinical sleep disorder screening
7) Best practices in lighting design
8) Non-invasive measures of sleep and wake.

The industry participant group remains well-aligned with CRC objectives and, together with the broader stakeholder network, provides strong field test opportunities and research translation pathways in the transport, mining, and health sectors.

Moving forward, the Alertness CRC will maintain its focus on commercialisation and the development of specific end-user driven technologies in alertness management and sleep health. The research program will see more discrete industry-led project plans around key product concepts, field validation and initial market testing, and the further development of the core capabilities that underpin these tools.

## Figure 1: Alertness CRC Participants

**Technology and Development End-Users**

SOLEMMA · COGSTATE · OPTALERT · BIOPLATFORMS AUSTRALIA · PHILIPS · SMART CAP · LightingScience · seeingmachines · GREY INNOVATION TECHNOLOGY COMMERCIALISATION · ELECTRO LIGHT · fmi · OPTURION

**Industry and Employment End-Users**

Austin Health · ICMM International Council on Mining & Metals · asmof nsw · Government of South Australia SA Health

**Policy, Regulatory and Insurance End-Users**

TAC Transport Accident Commission · WorkSafe Victoria · Bupa · NTC Australia National Transport Commission

**Research, Education and Training**

Australasian SleepTrials Network · Sleep Health Foundation · IBAS Institute for Breathing & Sleep · Woolcock Institute of Medical Research · Flinders University · The University of Sydney · CSIRO · Monash University · NeuRA Discover. Conquer. Cure.

# 1 Research

The research program structure of the Alertness CRC continues to provide a robust framework through which target areas for innovation can be pursued to deliver:

- Improved workplace and community safety and alertness through the development of effective, low-cost, validated tools for alertness assessment, including real-time fitness-for-duty and portable (roadside) alertness tests;
- Improved group-level scheduling solutions where healthcare and mining partners provide key high-risk target sectors for early adoption;
- Tailored and improved lighting in workplaces to increase worker alertness levels, reducing accidents and errors;
- A better understanding of sleep disorders and individual differences to enable more personalised use of treatments; and
- The development of new clinical and consumer devices and systems to improve utilisation and access to effective treatments of major sleep disorders such as sleep apnea and insomnia.

With the platform activities coming to the end of their three-year lifespan, the projects have been yielding high quality and novel datasets across the laboratory, clinic and field settings. We have also seen a significant increase in more targeted project agreements moving towards well-defined product concepts or other key outputs.

With smaller, more focused project teams, the quality of the collaboration between the industry and academic partners has increased dramatically. Additional business development expertise has been assigned to project teams to ensure plans are based on key requirements and the preferred commercialisation pathway.

Our research program leadership, through a newly formed Research Committee, continues to provide high quality academic oversight of all project activity with the assistance of Chief Investigators, Project Leaders, postdoctoral fellows and students.

# 1 Research

## Program One – Alertness Measurement, Testing and Prediction

*Professor Shantha Rajaratnam, Monash University*

The primary objective of Research Program One is to develop and verify tools to measure current alertness levels accurately, to predict the risk of future critical lapses, and to intervene before poor alertness impairs productivity and safety. Monitoring in workplace settings using validated technologies and biomarkers will permit individualised alertness assessment and use of targeted countermeasures.

The program is on target to deliver the following three main research outputs.

### 1) Personalised sleep-wake management tool for shift workers.

This tool will provide an online personalised sleep-wake management tool for the user, taking into account the individual's work schedule, social constraints and user experience/feedback. To mitigate risks of non-adoption and limited engagement of consumers/organisations, participation in this project is being sought by multiple potential end-user organisations from commercial transport/aviation, law enforcement, mining and healthcare sectors.

### 2) Ocular-based test of alertness, suitable for deployment as a fitness-to-drive/-work test.

Ocular biomarkers of alertness have been shown to be sensitive to fluctuations in alertness state due to sleep loss or circadian rhythms. We are further validating these biomarkers under field conditions in instrumented vehicle studies, and working to deploy them in devices developed by the partner organisations.

### 3) Proof-of-concept biomarkers of alertness and circadian states, to deploy as roadside/fitness-for-duty tests or diagnostic tests.

Chemical biomarkers of alertness and circadian states will have utility in a range of situations and devices, including tests of alertness (e.g.,roadside or workplace fitness-for-duty) and diagnostic tests for sleep and circadian disorders. We continue to validate a novel metabolomic approach to assessing alertness and circadian states in laboratory and field conditions, and will further develop algorithms for single-point assessment of these markers.

We have already achieved the following research outcomes:

- Evaluation of metabolites that are influenced by sleep loss and circadian timing, in a rigorous and highly controlled in-laboratory study.
- Laboratory and field validation of ocular biomarkers of alertness (and driving) impairment.
- Validation, refinement and further development of biomathematical modelling, neural network modelling and statistical methods to predict circadian timing using wristactigraphy and ambient light information.
- Further development of biomathematical models to predict alertness state.
- Proof-of-concept implementation of a personalised sleep-wake management program for shift workers in a healthcare setting, to test efficacy of the program and to inform the development of the automated tool.
- Development of portable light sensors, suitable for research studies that require monitoring of ambient light spectrum and intensity (ongoing).

The level of industry participation is high, particularly within healthcare, mining, commercial, and transport/aviation. Our partners continue to be engaged in both project planning and implementation where required, and as a precursor to more final involvement. For example, our Road Safety Workshop engaged participants with a broad range of key stakeholders, to help ensure that our research program aligns with industry and end-user needs. At this Workshop, sleep and circadian researchers and biomarker and technology development experts came together with road safety stakeholders from transport and safety government policy and regulatory groups, industry safety advocates, and law enforcement (e.g., Victoria Police), to identify the barriers and opportunities informing future policy development and legislation in this area.


## Program Two – Safety and Productivity Improvements

*Professor Steven W Lockley, Monash University*

The primary objective of Research Program Two is to help develop, test and validate new tools and approaches to improve alertness, and to then assess the efficacy of these tools on safety and productivity improvements in real-world operational settings.

The program has four outputs under two main research areas – scheduling, and smart lighting.

### 1) Development of prototype of work/duty scheduling software system and scheduling guidelines for groups of employees.

The product concept developed from this work is a scheduling software system and associated guidelines for group work scheduling that has been proven to promote safer and more productive work schedules. We have partnered with Melbourne-based optimisation company Opturion Pty Ltd to combine state-of-the-art rostering software with the biological principles underpinning alertness and sleep, summarised in our 'Best Practice Recommendations'. The product is the first of its kind, combining logistics modelling software, 'alert-safe' scheduling principles, and state-of-the-art biomathematical modelling into a single user-friendly tool. An initial product launch is anticipated in 2018.

While the initial focus is on scheduling solutions for healthcare, the program has expanded to manufacturing and rail transportation, where similar sleepiness-related and logistics challenges exist. In addition to expanding the potential market for this product, broadening the scope will also mitigate risks of non-adoption in specific sectors where unique challenges are uncovered.

# 1 Research

### 2) Development of a prototype of an individual-level scheduling system suitable for safety-critical occupation groups, with capacity to measure and predict alertness.

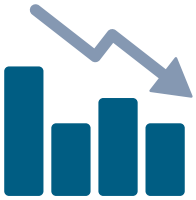
The work in this area will expand the capability of the scheduling software to predict and counteract high-risk levels of sleepiness at an individual level, rather than a group level. The software will incorporate novel individual-level models of alertness predication currently under development by the Alertness CRC.

"The Alertness CRC has brought together optimisation software company Opturion Pty Ltd, the Institute of Breathing and Sleep, and the Monash Institute of Cognitive and Clinical Neurosciences to undertake an Australian-first body clock rostering system trial at Austin Health and Monash Health, with the aim of improving doctors' performance and wellbeing and enhancing patient safety. We anticipate that, through the implementation of our sleep-smart rosters, enrolled staff will feel fresher and more alert on the job. We are hopeful that these changes will result in improved vigilance and alertness, reduced errors and improved safety for both staff and patients."

**Associate Professor Mark Howard,**
**Sleep and Respiratory Specialist,**
**Austin Health and Institute for Breathing and Sleep**

### 3) Development of prototype of lighting design systems to maximise alertness, safety and productivity.

We have partnered with one of the world's leading lighting design software products, DIVA-for-Rhino by Solemma, to develop a software module that will allow designers to model the non-visual effects of light and ultimately predict the alertness, safety and productivity benefits of their design. The tool is called 'Adaptive Lighting for Alertness' (ALFA). The full commercial launch is planned for early 2018. This state-of-the-art tool will revolutionise the ability of designers to incorporate the non-visual effects of light at the same time as all other design considerations, in a single comprehensive and unique package.



**In 2016–17, Australia witnessed productivity losses of**

**$17.9 billion,**

**or $2,418 per person due to inadequate sleep**

### 4) Development of prototype of lighting design systems and prototype portable lighting to maximise alertness, safety and productivity.

Laboratory-based testing has established lighting solutions for implementation in workplace settings, for example, vehicles, hospitals and mines. Outputs from Research Program One, such as alertness monitoring devices and biomarker-based tests for alertness, are in progress for assessing the efficacy of the lighting solutions.

As important background to the ongoing research activities, the Alertness CRC has already achieved the following research outcomes:

- Completion of two clinical trials of the implementation of an Alertness CRC-recommended compliant work schedule for doctors in two major Victorian Intensive Care Units, in collaboration with Opturion. Data analysis is ongoing and due for release in 2018.
- Development of two clinical trials of the implementation of an Alertness CRC-recommended compliant work schedule for nurses in two major Victorian ICUs, in collaboration with Opturion. Data collection is due to commence in 2018.
- Further development of biomathematical models to predict alertness state for group and individual-level predictions and ongoing integration of these models with the Opturion logistics software (due for completion by the end of 2017).
- Proof-of-concept implementation of a personalised sleep-wake management program for shift workers in a healthcare setting to test efficacy of the program and to inform the development of the automated tool.

## Program Three – Sleep Health

*Professor Ron Grunstein, Woolcock Institute of Medical Research*

The primary objective of Research Program Three is to develop new systems for phenotyping and managing patients with insomnia and obstructive sleep apnea (OSA).

The team's work in relation to OSA involves a respiratory phenotyping stream and a Vulnerability to Alertness Failure (VAF) phenotyping project. The development of novel insomnia treatment approaches forms the basis of the third stream of activity.

### 1) Stream A: OSA Respiratory Phenotyping.

This project was designed to test and refine deployable methods to allow personalised treatment of OSA, using therapies targeted to each individual's main causal deficits. The results demonstrate the clinical utility of respiratory phenotyping to effectively treat a sub-group of patients with an unstable respiratory control phenotype using oxygen.

### 2) Stream B: OSA Vulnerability to Alertness Failure (VAF) Phenotyping.

This project is designed to develop and test a novel sleep laboratory alertness failure phenotyping toolkit that is readily deployable in clinical practice and able to identify patients who are at high or low risk of alertness failure, with a high level of clinical significance. Activities will now focus on validating this laboratory VAF phototyping approach against retrospective real-world outcomes of driving performance, safety, productivity and healthcare costs.

### 3) Stream C: The Insomnia Research Program.

The research activity in this set of projects has explored how insomnia phenotypes respond to digital Cognitive Behavioural Therapy (CBT). The research has focused on deep phenotyping of insomnia patients, evaluating subjective and objective sleep and circadian phase to determine if patient phenotypes respond differently to therapy. We also evaluated objective biomarkers (sleep, actigraphy, EEG signals), using data science models to predict subjective sleep quality and daytime performance. The aim is to develop algorithms to enhance phenotyping accuracy and improve monitoring of treatment.

A new project has also become active, aiming to develop online decision support tools to help screen and manage sleep problems. The decision support phase one validation trial has been successfully completed, and the project has moved to the next phase with a clear roadmap and timelines for product launch and commercialisation.

Another project to develop a sleep consolidation smart phone application is underway, with a minimum viable product scheduled for the end of 2017. In addition the research team has commenced planning of a media-rich intervention program for other aspects of insomnia management.

# CASE STUDY 1

## Opturion and alert-safe rostering

Opturion Pty Ltd is an Australian-based SME that specialises in optimisation.

Through their involvement with the Alertness CRC, Opturion has been able to develop and implement an alert-safe rostering technique and associated software in the healthcare sector.

This prototype software has been successfully deployed in the intensive care departments of the Austin Health and Monash Medical Centre in Victoria, with parallel studies underway to demonstrate the impact of this approach in terms of absenteeism and medical error rates.

The Alertness CRC is working with Opturion to expand the application of the tool into the manufacturing environment. This project plan leverages the enthusiasm and network of Opturion and presents a significant opportunity for the company to increase its market penetration (both in Australia and internationally) through a unique combination of cost-effective schedule optimisation techniques and evidence-based, objective alertness management constraints.

"Opturion is unique in its ability to build rosters that ensure complex service levels and compliance requirements are met at minimum cost. Alert safety is a further level of compliance sophistication, so it was a natural extension. We see this as a major opportunity for the health sector to improve performance and control costs, and we now have the software to deliver those outcomes."

**Alan Dormer, CEO, Opturion.**

"The trial is also likely deliver long-term benefits. In addition to the immediate improvement in workplace effectiveness, and the safety of staff and patients, we expect a positive impact on the long-term wellbeing and health of doctors and nursing. It is a rich area for future research."

**Professor Yahya Shehabi, Director Research, Critical Care and Perioperative Medicine, Monash Medical Centre**

# 1 Research

## Education and Training

The Alertness CRC Education Program is overseen by the Education Committee comprising:

- Professor Ron Grunstein, Woolcock Institute for Medical Research (Chair)
- Associate Professor Clare Anderson, Monash University
- Dr Peter Catcheside, Flinders University
- Dr Chris Gordon, The University of Sydney.

The committee oversees the selection, training and interaction of students and postdoctoral awardees of the Alertness CRC, in the context of their institutional opportunities for training and professional development.

The Education Program itself is designed to include students and Early Career Researchers (ECRs) in all aspects of the collaborative process, including direct contact with industry partners. We support placements and professional development through dedicated funding, and host an annual training event to further enhance the capacity of these future research leaders.

### Postdoctoral Training

A total of 25 postdoctoral fellows are currently involved in 15 research projects, across the three research programs.

These ECRs have been instrumental in the successful completion of a significant and complex research load during the reporting period. Eight are Project Leaders, facilitating project planning, execution, and the regular review and reporting of project status. They continuously engage with project parties across several research institutions and end-user participants, with the guidance and consultation of the respective Program Leaders, Theme Leaders and Chief Investigators. They also closely supervise the remaining 17 postdoctoral fellows in the day-to-day running of research activities, and are crucial in assisting the respective Project Leaders and working closely with Alertness CRC management.

### PhD and Masters Program

We currently have 18 PhD students, with one additional PhD student having already been identified and approved to commence.

We also recruited four Masters students, two of whom were successfully transitioned to the PhD Program, and a third who is successfully completing their PhD.

We are also strong supporters of the Industry Based Learning (IBL) Program, established at Swinburne University, and have provided scholarships and opportunities for an additional five IBL students, bringing the total to 16 IBL students since the commencement of the Alertness CRC.

### Industry Placement

We provided industry placement opportunities for five PhD students, all of whom have now completed their placements. End-user participants hosting these placements included Bioplatforms Australia, Cogstate Pty Ltd., Philips Respironics, and Seeing Machines Ltd.

## Alertness CRC Research Meeting 2017

In February 2017, the Alertness CRC ran a two-day Research Meeting in Melbourne.

The meeting provided a platform for the Alertness CRC's postdoctoral fellows and PhD students to build their confidence and sharpen their presentation skills.

It also helped to consolidate project-related research findings and identify synergies across the range of Alertness CRC outputs.

The two-day event was well received, with 46 researchers attending across six research nodes. New ideas were shared and conceptualised, and later presented to the end-user participants for incorporating into new projects.

# 2 Results

"The Alertness CRC is leading a project to develop a practical, workable solution for roadside testing for fatigue. VicRoads has a keen interest in reducing the number of motor vehicle crashes caused by fatigue, and working with the Alertness CRC has ensured that rigorous scientific methods are used to test these devices before we consider further opportunities for field-based testing."

**Robyn Seymour, Director,**
**Road User and Vehicle Access,**
**VicRoads**

## Commercialisation

With the addition of new participant organisation, Solemma LLC, the Alertness CRC now brings together 31 organisations, and a much broader stakeholder network, in the pursuit of high impact solutions in alertness management and sleep health.

The completion of the platform projects has generated key outputs and enabling capabilities that present multiple commercialisation options, business models, risks and timeframes.

To optimise the value of this unique portfolio of opportunities, we have invested heavily in the detailed analysis of each key output and the commercialisation potential available through the current participant organisations and the broader marketplace.

Where high impact deployable outputs consistent with the objectives of the Alertness CRC have been identified, the focus is on harnessing the drive and the specific requirements of the industry partners when building and testing prototype concepts. This then leads to further assessment of target market opportunities and commercial strategies, and the creation of well-defined milestones and deliverables around key market assumptions and known execution risks.

Where product concepts are still unclear or in development, the Commercialisation Committee is tasked with formally mapping the output flow, interrelationships and business cases, to further refine research requirements, project review opportunities, and commercialisation partners.

## Communications

In the 2016–17 financial year we continued to communicate news and events as they were happening.

The following are the major stories that appeared on our and other websites, and within industry magazines.

*Media Release: New partnership between the Alertness CRC and NTC designed to examine heavy vehicle driver fatigue* – In a first for the Australian heavy vehicle industry, a new partnership between the Alertness CRC and the National Transport Commission, is, through a combination of rigorous field and laboratory-based research, evaluating the impacts of the Heavy Vehicle National Law (HVNL) on heavy vehicle driver fatigue.

*KnowHow Magazine article: Improving alertness and performance in critical environments* – Partnering with Melbourne-based tech company Opturion, the Alertness CRC has integrated shift work recommendations into state-of-the-art rostering technology, combining logistical planning and workplace sleepiness reduction into a single, cost-effective software tool.

*Coach online article: How changing your light globes could help get your sleep cycle back in sync*: Alertness CRC Program Leader, Professor Steve Lockley, discussed how light can affect alertness and circadian rhythm, and provided some practical hints, tips and solutions to improved alertness through lighting changes.

# 2 Results

## CASE STUDY 2

### Introducing Philips SmartSleep™

During deep sleep, the body conducts its mental rejuvenation and memory consolidation process, and the brain is refreshed by its naturally occurring “slow waves”.

The strength of these waves determines the quality of your deep sleep. For many people, they start strong, but can weaken by the end of the phase.

In partnership with the Alertness CRC, Philips set out to enhance these “slow waves” using tones at a specific and customised timing, volume, and frequency, making the slow waves stronger and keeping them strong throughout the whole deep sleep phase.

And so SmartSleep™ was launched.

Philips SmartSleep™ is a soft fabric headband that is worn during sleep. Using a disposable sensor that is placed behind the ear, it measures when you have reached your deep sleep phase. Through speakers cushioned in soft foam, it generates tones at a scientifically validated frequency that are not noticed during sleep.

The companion mobile app syncs with the headband, providing sleep metrics, and quantifying the “Sleep Boost” – the increase in Slow Wave Activity - provided by the SmartSleep product.

The technology is supported by iOS 9+ and Android 5.0+, and the measurable metrics include:

- Quantified Sleep Boost
- Total Sleep Score
- Sleep stages
- Sleep/wake times
- Tips for improving engagement.

SmartSleep™ is already changing people’s lives for the better; by enabling improved sleep, users are experiencing improved alertness and daytime energy.

## Road Safety Briefing Workshop

The Alertness CRC in partnership with the Transport Accident Commission, the National Transport Commission, VicRoads, Victoria Police and WorkSafe Victoria, has established a Road Safety Steering Committee.

The Committee held a Road Safety Briefing Workshop for an array of national and state-based road safety stakeholders.

Sleep and circadian researchers and biomarker and technology development experts came together with road safety stakeholders from transport and safety government policy and regulatory groups, industry safety advocates, and law enforcement, to identify the barriers and opportunities informing future policy development and legislation in this area. Four key areas for development were identified, as follows:

- Identification of the research gaps and next steps to determine the level of evidence required for a roadside tool to be implemented.
- Strategies for raising public awareness through education, achieving behaviour change, and police socialisation.
- Establishing the government and regulatory pathways required for implementation of a roadside test for alertness and identification of major barriers to overcome.
- How best to ensure the sustainability of a campaign to implement a roadside test of alertness by identifying critical milestones and major stakeholders to support a campaign.

# 3 Resources

The Alertness CRC continues to support a research and development collaboration that is focused on innovation and commercialisation with strong governance and access to an extensive array of industry and academic expertise.

## Governance – Board, Committees and Key Staff

### The Board

The Governance structure is represented in Figure 2, the Alertness CRC Board Members are listed in Table 1, and the Alertness CRC Board of Directors Meetings for 2017 are outlined in Table 2.

The Board of the Alertness CRC Ltd comprises four independent Directors led by Chair, Deena Shiff. In an effort to provide more focus on commercialisation initiatives, the Board appointed Jan Bingley in October 2016 as a Director and Member of the Board. Jan was subsequently appointed as Chair of the Commercialisation Committee in December 2016.

### Committees

The Board continues to operate with the oversight of the Finance, Audit and Risk (FAR) Committee, and the Commercialisation Committee.

The FAR Committee meets biannually and is chaired by Ian Farrar. Its primary functions are to review the appropriateness of the Alertness CRC's:

- Financial planning;
- Performance reporting;
- System of risk oversight and management;
- System of internal control;
- Risk management framework (monitoring), and making recommendations to the Board on changes to the framework;
- Recommendations to the Board on the appointment, assessment and removal of external auditors, and oversee their independence;
- Recommendations to the Board on the approval of annual audited financial reports;
- Annual review and approval of the external audit fees, plans and their audit scope;
- Monitoring of the internal control environment and procedures designed to achieve compliance with laws, regulations, internal standards and policies; and
- Overseeing of compliance with statutory and other legal requirements.

# 3 Resources

The Commercialisation Committee continues to ensure that the Alertness CRC demonstrates impact in the field through the commercialisation of our outputs and measurable economic benefit to Australia. This Committee meets monthly as required and is tasked with:

- Assessing the commercial value of project proposals;
- Setting performance milestones;
- Identifying industry partners to attach to a project;
- Offering mentoring or business support by arrangement with specialists within participating universities and relevant partners;
- Reviewing proposed commercialisation structures and returns for Alertness CRC project parties; and
- Making recommendations to the Alertness CRC Board regarding resource allocation to project activities.

In accordance with the Essential Participants Agreement, two participant panels have been convened by the Board to assist them in their governance role: the Strategic Review Panel and the Research Translation Panel. All participant representatives are eligible to be a member of both panels.

**The Strategic Review Panel:**

- Advises the Board on the project activities and research direction of the Centre;
- Meets biannually in person or via telephone or video link;
- Is Chaired in any one financial year by a representative of the end-user Essential Participants, depending on which of these has the largest cumulative annual cash contribution budgeted for the financial year when the meeting is held, and who will report directly to the Board as required;
- Includes one representative from each end-user participant, who chooses to make an appointment; and
- Includes the CEO, research Program Leaders and the Education and Training Unit Leader as ex-officio members.

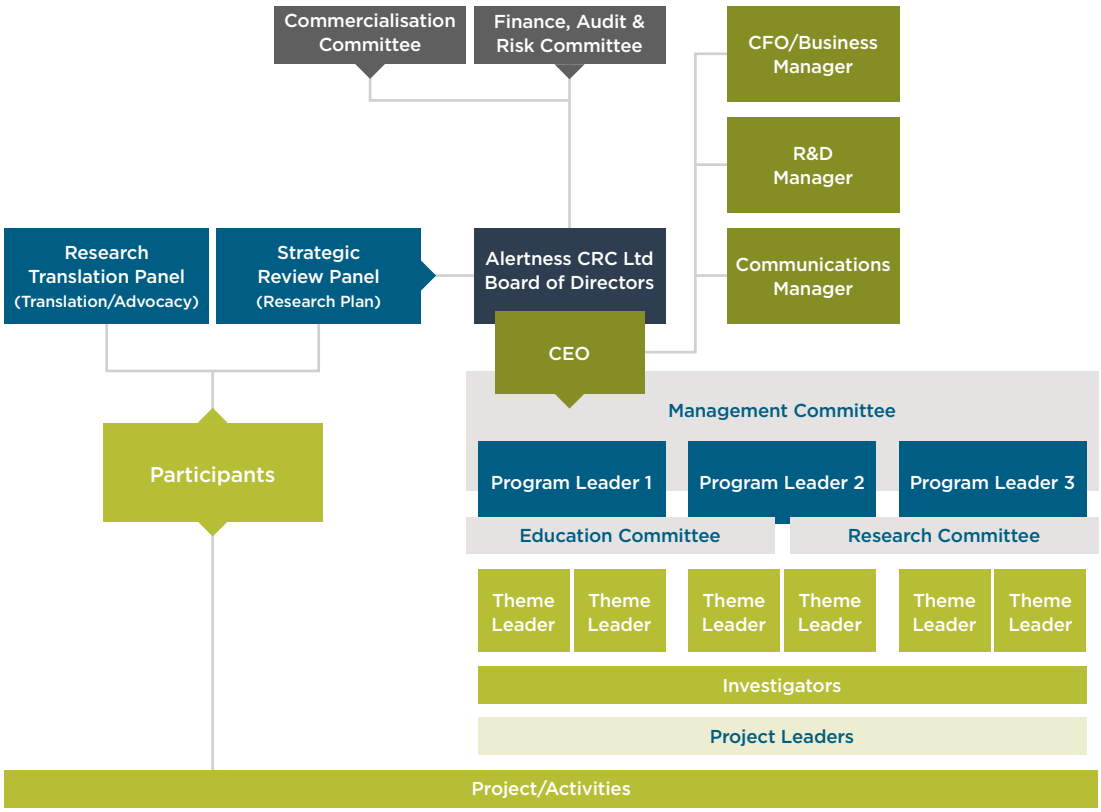
**The Research Translation Panel:**

- Advises the Board on the research translation activities of the Centre;
- Meets biannually in person or via telephone or video link;
- Is co-Chaired by representatives of the Sleep Health Foundation and BUPA, until either party ceases to be an Essential Participant, or the Board decides to replace either or both co-Chairs at its discretion;
- Is comprised of up to one representative from each end-user participant, who chooses to make an appointment; and
- Includes the CEO, research Program Leaders and the Education and Training Unit Leader as ex-officio members.

Members of the two panels met in Melbourne during October 2016. An update was provided by our Program Leaders on each of the Research Programs, and industry participants also presented their priorities and the challenges facing their respective industries. In addition, an industry match-up initiative was undertaken, providing a platform for participants with common interests to meet and collaborate. The Alertness CRC CEO also hosted a dedicated academic round table session, providing an opportunity for the Board and key representatives from each participating research institution to meet and discuss the issues pertaining to the institutions' activities.

In June 2017, the Alertness CRC also hosted a Research Plan Webinar, where the Research Program Leaders provided further updates to the participant representatives.

### Figure 2: Alertness CRC Governance structure



# 3 Resources

**Table 1: Board Members**

| Name | Role | Key skills | Independent/ Organisation |
|---|---|---|---|
| Deena Shiff | Chair | Deena Shiff, B. Sc (Econ) Hons; B.A. (Law) Hons, has had a senior executive and a legal career and has held senior roles in the public sector. Deena served as a Group Managing Director at Telstra Corporation between 2005 and 2013, during which time she led the Wholesale Division, established Telstra's Business Division and was the founding CEO of Telstra's corporate venture capital arm, Telstra Ventures. Prior to that, Deena was a Partner at Mallesons, in house corporate and regulatory counsel at Telstra, and a senior executive and adviser on legal and social policy reforms for the Australian Government. Deena serves as a director on a number of boards including ASX listed Appen and the Citadel Group. She chairs the global board of BAI Communications Ltd and is a director of Infrastructure Australia. | Independent |
| Anthony Williams | CEO | Anthony Williams, B. App. Sci., MPH, is a research and development professional with extensive experience and a proven track record in clinical research and business development. Anthony has expertise in research management, financial modelling, corporate governance, intellectual property management and contract development. He is an output focused operator with exceptional project management, communication and negotiation skills. He has worked in the area of sleep and alertness for over eighteen years and has developed extensive networks and relationship across industry and academia, both in Australia and internationally. | Independent |
| Ian Farrar | Board Member | Ian Farrar, B. Comm, ANU, has extensive experience in research management. For over 20 years he held a number of senior executive positions in CSIRO, Australia's premier research organisation. These included Senior Principal Advisor (Special Projects) and General Manager (Corporate Resources). In 1992 he was appointed Chairman/CEO of the Joint Coal Board which had responsibility for monitoring the health and welfare of NSW coal miners. He chaired the JCB Health and Safety Trust which funded research in the health and safety area. He is also a member of the Advisory Board of the Climate Change Institute at the ANU. | Independent |

| Name | Role | Key skills | Independent/ Organisation |
|---|---|---|---|
| Jan Bingley | Board Member | Jan Bingley, Bbus (Accounting); RTTP; ACSA; CPA; FAICD, has more than 17 years of experience in the financial sector, including 11 years at the Sydney Futures Exchange, where she managed research and business analysis for market and product design projects, including that of a 'carbon credit' market. In 2000 Jan formed Universal Carbon Exchange Ltd with three partners, which was active in facilitating funding in Australia for technologies promoting green energy and coupling those projects with secured carbon credits. Jan joined CSIRO in 2004 where she headed up CSIRO's Business Development and Commercialisation team and was responsible for developing commercialisation strategies involving IP protection, culminating in a wide range of transactions involving equity and commercial licensing. Jan left CSIRO in 2015 and has undertaken a number of consulting roles since then with a current full time executive role with the Global CCS Institute where she is responsible for business development and developing their next 5-year strategy which will see the Institute transform to a more commercial operation. Jan has been a board member of several spin-out companies, was a board member of Commercialisation Australia and was on the Executive Committee of Knowledge Commercialisation Australasia. She is currently on the federal governments Innovation Investment Committee and is on the Investment Committee for TankStream Ventures – a Sydney based seed investing firm. | Independent |

# 3 Resources

**Table 2: Board of Directors Meetings, 2017**

| Name | Number eligible to attend | Number attended |
|---|---|---|
| Deena Shiff | 4 | 4 |
| Anthony Williams | 4 | 4 |
| Ian Farrar | 4 | 4 |
| Jan Bingley | 3 | 3 |

## Key Staff

Alertness CRC key staff are listed in Table 3.

Alertness CRC operations are managed by the CEO, with the assistance of the Business Manager, Research & Development Manager and Communications Manager. The CEO also chairs a Management Committee with the research Program Leaders. This Management Committee is supported by our Education Committee and Research Committee, the latter of which was only recently formed. The Research Committee is chaired rotationally by the Program Leaders, with all Theme Leaders participating to ensure direct communication between the executive and research teams.

**Table 3: Alertness CRC Key Staff as at 30 June 2017**

| Name | Organisation | Position/Role |
|---|---|---|
| Anthony Williams | Alertness CRC Ltd | CEO |
| Wee Mong Wong | Alertness CRC Ltd | CFO/Business Manager |
| Andrew Tucker | Alertness CRC Ltd | General Manager Research & Development |
| Susan Waterer | Alertness CRC Ltd | Communications Manager |
| Ron Grunstein | Woolcock Institute of Medical Research | Program Leader |
| Shantha Rajaratnam | Monash University | Program Leader |
| Steven Lockley | Monash University | Program Leader |
| Sanjay Chawla | The University of Sydney | Theme Leader |
| Clare Anderson | Monash University | Theme Leader |
| Doug McEvoy | Southern Adelaide Local Health Network | Theme Leader |
| Karen Reynolds | Flinders University | Theme Leader |
| Mark Howard | Institute for Breathing and Sleep/Austin Health | Theme Leader |

| Name | Organisation | Position/Role |
|---|---|---|
| Mark Wallace | Monash University | Theme Leader |
| Svetlana Postnova | The University of Sydney | Acting Theme Leader & Project Leader |
| Peter Robinson | The University of Sydney | Chief Investigator |
| Sean Drummond | Monash University | Chief Investigator |
| Bradley Edwards | Monash University | Site Investigator |
| Andrew Vakulin | Flinders University | Project Leader |
| Bryn Jeffries | The University of Sydney | Project Leader |
| Chris Gordon | The University of Sydney/ Woolcock Institute of Medical Research | Project Leader |
| Peter Catcheside | Flinders University | Project Leader |
| Suzanne Ftouni | Monash University | Project Leader |
| Tracey Sletten | Monash University | Project Leader |
| Christoph Reinhart | Solemma LLC | Project Leader |
| Michelle Magee | Monash University | Project Leader |
| Jade Murray | Monash University | Project Leader |
| Sherry Randhawa | Flinders University | Co-investigator |
| Amy Jordan | Institute for Breathing and Sleep | Co-Investigator |
| David Berlowitz | Institute for Breathing and Sleep | Co-investigator |
| Fergal O'Donoghue | Institute for Breathing and Sleep | Co-Investigator |
| Peter Rochford | Institute for Breathing and Sleep | Co-Investigator |
| Maree Barnes | Institute for Breathing and Sleep/Austin Health | Co-Investigator |
| Sean Cain | Monash University | Co-investigator |
| Philip Berger | Monash University | Co-Investigator |
| Bei Bei | Monash University | Co-Investigator |
| Somwrita Sarkar | The University of Sydney | Co-investigator |
| Nathaniel Marshall | The University of Sydney/ Woolcock Institute of Medical Research | Co-investigator |

# 3 Resources

| Name | Organisation | Position/Role |
|---|---|---|
| Chris Miller | Woolcock Institute of Medical Research | Co-investigator |
| James Williams | National Transport Commission | Manager, Policy |
| Danny Eckert | Neuroscience Research Australia | Co-investigator |
| Alan Dormer | Opturion | CEO |
| Bill Gaussa | Philips Respironics | Chair of Alertness CRC Strategic Review Panel & Clinical/Advance Innovation Leader |
| Birpal Sachdev | Philips Respironics | Sr. Manager Advanced Innovations |
| David White | Philips Respironics | Chief Medical Officer |
| Gary Garcia Molina | Philips Respironics | Senior Clinical Scientist |
| Henning Maass | Philips Respironics | Principal Scientist |
| Monica Bush | Philips Respironics | Sr. Global Product Manager |
| Nancy Bullock | Philips Respironics | Program Director |
| Nathan Zimmerman | Philips Respironics | Director, Diagnostics and Software Applications |
| Peter Hill | Philips Respironics | Principal Engineer |
| Sara Sibernaller | Philips Respironics | Project Manager |
| Sharon Baer | Philips Respironics | Director of Advanced Innovation |
| Xavier Aubert | Philips Respironics | Research Scientist |
| Mike Lenné | Seeing Machines | Chief Scientific Officer, Human Factors |
| Jon Sargent | Solemma | Vice President of Product |

## Participants

Alertness CRC Participants are listed in Table 4.

In February 2017, Solemma LLC joined the Alertness CRC as an Other Participant. Based in the U.S., Solemma comprises of a group of designers, building scientists, lighting consultants and architectural educators committed to providing intuitive, cutting-edge environmental analysis tools. Solemma's specific focus areas are daylighting, glare, occupant comfort and operational energy use. In collaboration with Alertness CRC sleep experts, Solemma has developed ALFA – Adaptive Lighting for Alertness – a new circadian lighting design software for architects and lighting professionals. ALFA will support the calculation of the circadian impact of lighting design to help optimise both the visual and non-visual benefits of lighting.

In January 2017, Transport for New South Wales joined as a third party, to collaborate on the Heavy Vehicle National Law (HVNL) project. The project aims to aims to scientifically evaluate how different work and rest features of heavy vehicle truck driving under the current HVNL impact drivers' sleep, alertness and measures of driving impairment under naturalistic driving conditions.

### Table 4: Alertness CRC Participants

| Participant Name | Participant Type | ABN/ACN | Organisation Type |
|---|---|---|---|
| Austin Health | Essential | 96 237 388 063 | State Government |
| Australian Sleep Trials Network | Other | 88 002 198 905 | Other |
| Australian Salaried Medical Officers Federation | Essential | 56 536 563 722 | Other |
| Bioplatforms Australia Limited | Essential | 40 125 905 599 | Other |
| Brain Resource Limited | Essential | 24 094 069 682 | Industry/Private Sector |
| BUPA Foundation (Australia) Pty Ltd | Essential | 67 113 817 637 | Industry/Private Sector |
| Cogstate Pty Ltd | Other | 80 090 975 723 | Industry/Private Sector |
| Constraint Technologies International Pty Ltd | Essential | 13 054 631 462 | Industry/Private Sector |
| Commonwealth Scientific and Industrial Research Organisation | Other | 41 687 119 230 | Australian Government |
| Electrolight Pty Ltd | Other | 93 288 579 088 | Industry/Private Sector |
| Fatigue Management International | Other | UK company registration 06431894 | Industry/Private Sector |
| Grey Innovation Pty Ltd | Other | 14 083 304 214 | Industry/Private Sector |

# 3 Resources

| Participant Name | Participant Type | ABN/ACN | Organisation Type |
|---|---|---|---|
| Institute for Breathing and Sleep | Essential | 39 093 685 879 | Other |
| International Council of Mining and Metals | Essential | UK based | Industry/Private Sector |
| Lighting Science Group Corporation | Essential | US based | Industry/Private Sector |
| Monash University | Essential | 12 337 614 012 | University |
| National Transport Commission | Essential | 67 890 861 578 | Australian Government |
| Neuroscience Research Australia | Other | 94 050 110 346 | Other |
| Optalert Australia Pty Ltd | Other | 79 121 747 591 | Industry/Private Sector |
| Opturion Pty Ltd | Other | 13 146 662 053 | Industry/Private Sector |
| Respironics Inc – A Phillips Healthcare Company | Essential | 24 008 445 743 | Industry/Private Sector |
| Seeing Machines Limited | Other | 34 093 877 331 | Industry/Private Sector |
| SmartCap Technologies Pty Ltd (f.k.a EdanSafe Pty Ltd) | Other | 61 094 352 959 | Industry/Private Sector |
| Solemma LLC | Other | US based | Industry/Private Sector |
| Southern Adelaide Local Health Network | Essential | 14 227 133 467 | State Government |
| The Flinders University of South Australia | Essential | 65 542 596 200 | University |
| The Sleep Health Foundation | Essential | 91 138 737 854 | Other |
| The University of Sydney | Essential | 15 211 513 464 | University |
| Transport Accident Commission | Essential | 22 033 947 623 | State Government |
| Woolcock Institute of Medical Research | Essential | 88 002 198 905 | Other |
| Worksafe Victoria | Essential | 90 296 467 627 | State Government |

## Collaboration

The Alertness CRC has moved from broad end-user support for key platform project activities to a series of discrete, output-focused projects that will generate the unique product concepts for the consortium.

The level of general collaboration remains high, and the increased focus on specific product concepts has allowed industry participants and other end-user partners to identify the key outputs and planned product concepts that have maximum synergy with their current strategic plans.

Table 5 shows the level of participant involvement across project areas. In addition, we continue to encourage communication between the participant organisations with the development and release of a customised online administration portal providing real-time access to specific project roles, responsibilities, milestone progress and equity. This increased transparency and other more targeted matchmaking processes has allowed the Alertness CRC to bring the ideal combination of industry and academic partners together across a range of well-defined commercialisation goals.

"With our 24-hour society, more Australians are working shifts or getting less shut-eye, and suffering serious sleep problems like insomnia as a result. Their body clocks get confused and their alertness flags, which has a worrying knock on-effect for workplace productivity and injury statistics. We continue to partner with the Alertness CRC to help implement changes and keep Australians alert, safe and healthy."

**Professor Dorothy Bruck,**
**Chair of the Sleep Health Foundation**

# 3 Resources

**Table 5: Alertness CRC Projects and Participant Collaboration**

| No | Project Name | End-user Participants | Research Participants |
|---|---|---|---|
| 1 | Laboratory-based development of systems and biomarkers to assess circadian, sleep and alertness states. | 9 | 3 |
| 2 | Modelling and software development for prediction of alertness and optimisation of scheduling and a data fusion system for the estimation, prediction and control of individual alertness dynamics. | 5 | 4 |
| 3 | Assessing individual vulnerability to shift work and integrated interventions for alertness management in the healthcare setting. | 19 | 5 |
| 4 | Sleep disorder phenotyping. | 9 | 6 |
| 5 | Evaluation of Nanoparticle Chemiresistor sensor arrays to detect changes in alertness state – Stage 1. | 1 | 5 |
| 6 | Development of Software System for Group Work Scheduling. | 2 | 3 |
| 7 | Prediction and Measurement of Circadian Phase in Patients with Delayed Sleep Phase Disorder or Insomnia. | 1 | 4 |
| 8 | Assessing vulnerability to shift work in the healthcare setting: monitoring alertness and driving performance during work commutes. | 1 | 2 |
| 9 | Development of sleep restriction therapy “Sleep Right Tonight” App for behavioural management of insomnia. | 1 | 2 |
| 10 | Development and validation of circadian lighting design software for architects and lighting designers: Adaptive Lighting for Alertness (ALFA). | 2 | 3 |
| 11 | Sleep companion consumer entry decision tree and CRC sleep health management decision support system. | 2 | 5 |
| 12 | Heavy vehicle driver fatigue research project. | 2 | 2 |
| 13 | SmartSleep: Enhancing Slow Wave Sleep and Cognition. | 2 | 4 |

# CASE STUDY 3

## Improving alertness levels: the future looks bright

The focus on lighting solutions continues to grow, as the market recognises more and more that light has a huge impact on our alertness, safety and productivity, both at home and in the workplace.

This financial year, in partnership with end-user participants, the Alertness CRC has progressed the development of 'smart' and dynamic lighting systems, as well as a customised lighting intervention to improve daytime wakefulness and night-time sleep for hospital patients.

In addition, the team has made its partnership official with US-based lighting design software company, Solemma LLC, resulting in the development of a prototype of ALFA – Adaptive Lighting for Alertness.

ALFA is a new circadian lighting design software for architects and lighting professionals. It is a new software module that promises to enhance Solemma's existing leading software product, DIVA-for-Rhino, by allowing designers to model the non-visual effects of light and ultimately predict the alertness, safety and productivity benefits of their design.

Professor Steven Lockley, Program Leader for the Alertness CRC, presented the ALFA prototype at DIVA Day 2017, with the official Australian launch set to happen in the 2017–18 financial year.

# 4 Financial Management

During the financial year 2016–17, the Alertness CRC received total cash contributions of $5.380 million. Of the total cash contributions received, 62% was provided by the Commonwealth through the CRC funding agreement, 24% was received from participant organisations and the remaining 14% was made up of interest income and other revenue from third party participants, as shown in Figure 3.

### Figure 3: Composition of Cash Received during FY17 vs Agreement

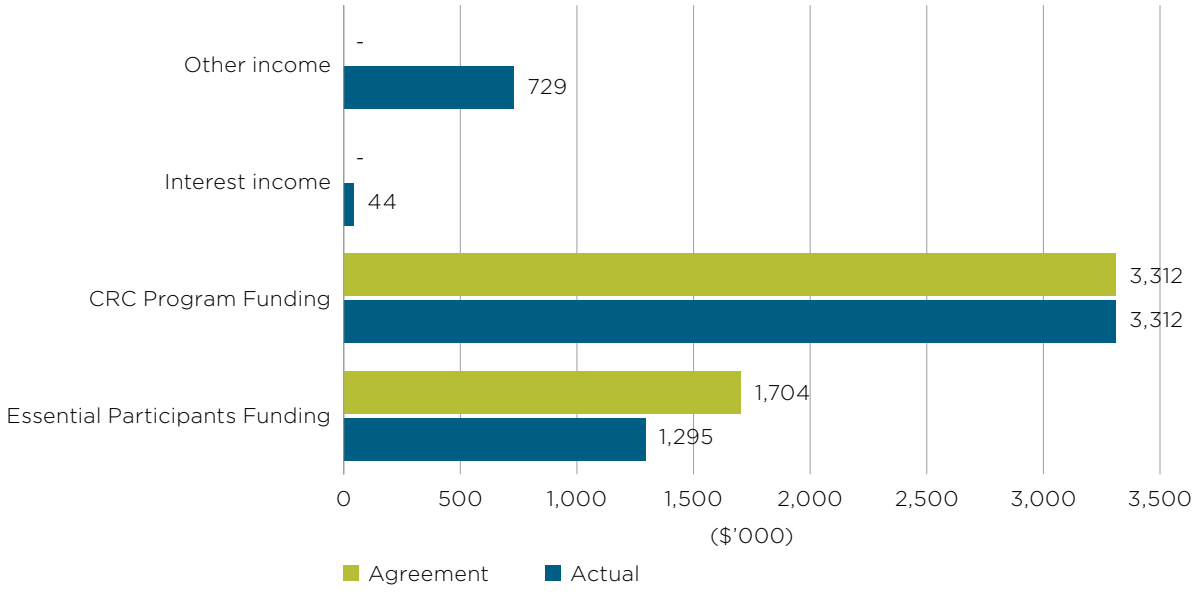
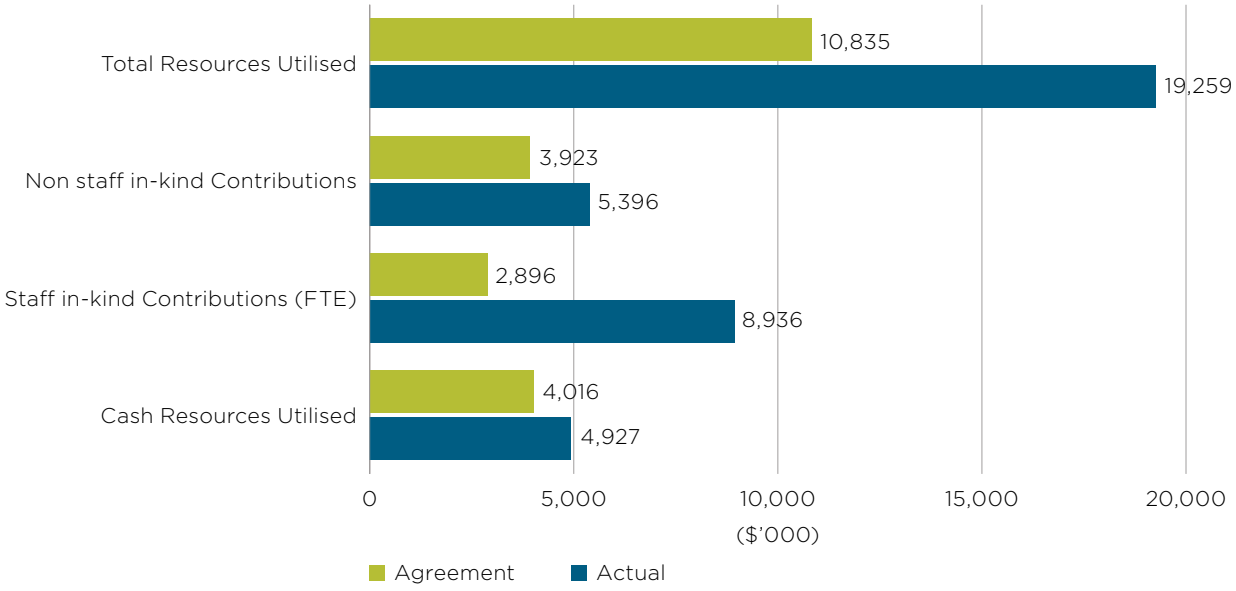



Figure 4 highlights the breakdown of the Year 4 resources utilised by category relative to original participant commitments in financial year 2016–17.

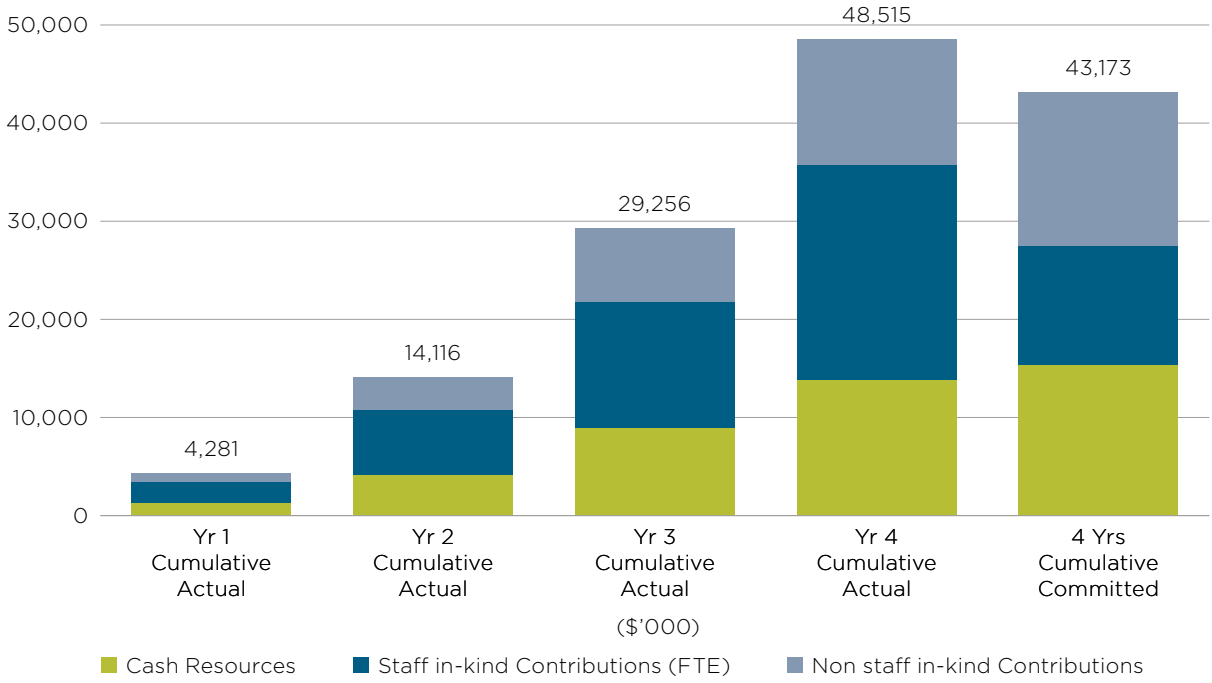
### Figure 4: FY17 Allocation of Utilised Resource Category – Actual vs Agreement



# 4 Financial Management

As at 30 June 2017, Alertness CRC recorded a surplus of $5.342 million in the total resources utilised over the cumulative four years as compared to its commitment to-date, as shown in Figure 5.

**Figure 5: Four Years Cumulative Resources – Actual vs Agreement**




The independent auditor's report to the members of the Alertness CRC, for the financial year 2016–17, confirms that the financial reports have been prepared in accordance with Division 60 of the Australian Charities and Not-for-profits Commission Act 2012, and comply with the Australian Accounting Standards – Reduced Disclosure Requirements and Division 60 of the Australian Charities and Not-for-profits Commission Regulation 2013.

Their opinion further states that:

- The financial statements as at 30 June 2017 give a true and fair view of the Company's financial position as at that date and of its financial performance for the year ended on that date;
- Contributions both cash and in-kind have been made and recorded in accordance with the budget as specified and in accordance with the terms of the Commonwealth Agreement;
- The Commonwealth funding and the contributions have been expended solely for the activities and inaccordance with the Commonwealth Agreement and Australian accounting concepts and applicable Australian standards; and
- All transactions for the activities as specified in the Commonwealth Agreement have been conducted through the Account.

# Appendices

5

## Appendix 1: Publications

### Accepted articles in peer reviewed journals

Miller CB, Bartlett DJ, Mullins AE, et al.; 2016; Clusters of Insomnia Disorder: An Exploratory Cluster Analysis of Objective Sleep Parameters Reveals Differences in Neurocognitive Functioning, Quantitative EEG, and Heart Rate Variability. Sleep;39:1993-2004. https://www.ncbi.nlm.nih.gov/pubmed/27568796

Sletten TL, Ftouni S, Nicholas CL, Magee M, Grunstein RR, Ferguson S, Kennaway DJ, O'Brien D, Lockley SW, Rajaratnam SMW; 2017; Randomised controlled trial of the efficacy of a blue-enriched light intervention to improve alertness and performance in night shift workers; Occup Environ Med. pii: oemed-2016-103818. doi: 10.1136/oemed-2016-103818. [Epub ahead of print] https://www.ncbi.nlm.nih.gov/pubmed/28630378

Murray JM, Sletten TL, Magee M, Gordon C, Lovato N, Bartlett DJ, Kennaway DJ, Lack LC, Grunstein RR, Lockley SW, Rajaratnam SM; Delayed Sleep on Melatonin (DelSoM) Study Group. Prevalence of Circadian Misalignment and Its Association With Depressive Symptoms in Delayed Sleep Phase Disorder. Sleep. 2017 Jan 1;40 (1). https://www.ncbi.nlm.nih.gov/pubmed/28364473

Postnova S, Lockley SW, Robinson PA. Sleep Propensity under Forced Desynchrony in a Model of Arousal State Dynamics. J Biol Rhythms. 2016 Oct;31 (5):498-508. doi: 10.1177/0748730416658806. Epub 2016 Jul 17. https://www.ncbi.nlm.nih.gov/pubmed/27432116

Dodds KL, Miller CB, Kyle SD, Marshall NS, Gordon CJ; 2017; Heart rate variability in insomnia patients: A critical review of the literature. Sleep medicine reviews;33:88-100. https://www.ncbi.nlm.nih.gov/pubmed/28187954

Magee M, Marbas EM, Wright KP Jr, Rajaratnam SM, Broussard JL. Diagnosis, Cause, and Treatment Approaches for Delayed Sleep-Wake Phase Disorder. Sleep Med Clin. 2016 Sep; 11 (3):389-401. [Review] https://www.ncbi.nlm.nih.gov/pubmed/27542884

### Papers in refereed conference proceedings

Stone J.E., Sletten Tracey L. Magee M. Howard M. Lockley S.W. Rajaratnam S.M.W. Inter-individual variability in adaptation of the circadian system to consecutive night shifts in intensive care unit (ICU) workers Journal of Sleep Research Special Issue: Abstracts of the 23rd Congress of the European Sleep Research Society, 13–16 September 2016, Bologna, Italy September 2016 Volume 25, Issue Supplement S1.

Ganesan S., Sletten Tracey L., Magee M., Howard M., Lockley Steven W., Rajaratnam S., Impairments in Alertness and Neurobehavioral Performance During Night work in Intensive Care Nurses. Journal of Sleep Research Special Issue: Abstracts of the 23rd Congress of the European Sleep Research Society, 13–16 September 2016, Bologna, Italy September 2016 Volume 25, Issue Supplement S1.

Magee, M., Sletten, TL., Archer, S., Gordon, C., Lovato, N., Bartlett, DJ, Kennaway, DJ., Lockley, SW, Lack, L., Grunstein, R.R., Rajaratnam, SM and the Delayed Sleep on Melatonin Study Group. The role of PERIOD3 gene polymorphisms in the response to melatonin treatment in Delayed Sleep Phase Disorder Journal of Sleep Research Special Issue: Abstracts of the 23rd Congress of the European Sleep Research Society, 13–16 September 2016, Bologna, Italy September 2016 Volume 25, Issue Supplement S1.

# 5 Appendices

## Papers presented at conferences

Dodds, K., Miller, C., Kyle, S., Marshall, N., Gordon, C. The Beat Up on Heart Rate Variability in Insomnia Patients: A Critical Literature Review. *Sleep Down Under 2016*, Adelaide, Australia.

Wasnik, S. Prediction of drowsiness and impending crashes in AusEd driving simulator test; abstract submitted for 10th International Conference on Managing Fatigue; 20–23 March 2017; San Diego, CA.

Sletten, TL, Magee, M, Murray, J., Gordon, C. Lovato, N., Kennaway, DJ, Bartlett, D. Lockley, SW., Lack., L., Grunstein, R. R., Rajaratnam, SMW Melatonin for improving sleep initiation and daytime impairments in delayed sleep phase disorder. Journal of Sleep Research Special Issue: Sleep DownUnder 2016, 'Connections' Abstracts. 28th ASM of Australasian Sleep Association and Australasian Sleep Technologists Association, 20-22 October 2016, Adelaide, Australia Volume 25, Issue Supplement S2 Pages 1–98.

## Invited presentations

Health XL, 11 November 2017, Melbourne, Australia – Presentation by Dr Andrew Tucker, General Manager Research Translation Partnerships, Alertness CRC and Prof Shantha Rajaratnam, Program Leader, Alertness CRC, at the Melbourne Workshop – Exploring New Models of Care, Title: 'Personalised sleep-wake management solution for shift workers'

## Research papers

Jeffries, B., McCloskey, S. Research Paper for Biosignals Journal: Novel Cluster Analysis of Insomnia with Physiological-based qEEG Variables; 2017

## Posters

Stone, J. Inter-individual variability in adaptation of the circadian system to consecutive night shifts in intensive care unit (ICU) workers; European Sleep Research Society conference; September 2016

Grant, L. Circadian and wake-dependent changes in the human plasma metabolome; *Sleep 2017*; 3–7 June 2017; Boston, US

Mulhall, M. Sleepiness and driving incidents in nurses commuting to and from work shifts; *Sleep 2017*; 3–7 June 2017; Boston, US

McMahon, W. Improvement in cognition during the wake maintenance zone following sleep loss is dependent on cognitive domain; *Sleep 2017*; 3-7 June 2017; Boston, US

Ftouni, S. Interindividual relationships between plasma and salivary melatonin and urinary aMT6s; *Sleep 2017*; 3-7 June 2017; Boston, US

Ftouni, S. Speech as a marker of alertness under conditions of acute sleep deprivation; *Sleep 2017*; 3–7 June 2017; Boston, US

## Presentations

Kuo, J. 6th International Symposium on Naturalistic Driving Research; Distraction in shift-workers during naturalistic driving; 7–9 June 2017; The Hague, Netherlands

## Submitted Abstracts

Postnova S., Lockley SW., Robinson PA. Sleep propensity under forced desynchrony in a model of arousal state dynamics; abstract submitted for European Sleep Research Society conference; September 2016.

Dodds, K. The beat up on heart rate variability in insomnia patients: a critical literature review; abstract submitted for Sleep Down Under 2017; October 2016

Grant, L.K., Ftouni, S., Nijagal, B., De Souza, D., Rajaratnam, S.W., Lockley, S.W., Anderson, C. Inter-individual differences in human circadian plasma metabolome.

McMahon, W.R., Ftouni, S., Drummond, S.P.A., Maruff, P., Rajaratnam, S.M.W., Anderson, C. Improvement in cognition during the wake maintenance zone following sleep loss is dependent on cognitive domain.

Diep, C., Ftouni, S., Drummond, S.P.A., and Anderson, C. Enhancing slow wave activity via an automated phase locked acoustic stimulation.

Ftouni, S., Zhou, R. Grant, L., Rajaratnam, S.W., Cain, S., Anderson, C. Inter – and intra-individual relationships between plasma and salivary melatonin and urinary aMT6s.

Ftouni, S., McMahon, W.R., Vogel, A.P., Rajaratnam, S.W., Anderson, C. Speech as a reliable marker of alertness and performance impairment under conditions of acute sleep deprivation.

Dormer, A. Alert-safe' rostering for ICU medical staff; abstract submitted for hic 2017; 7–9 August 2017, Brisbane, Australia.

Booker, L. Shift work disorder is related to depression and anxiety severity amongst nurses; abstract submitted for Sleep Down Under 2017; for conference 25–28 October 2017, Auckland, NZ.

McMahon, B. Higher order cognition is preserved in the wake maintenance zone during 40h sleep deprivation; abstract submitted for Sleep Down Under 2017; for conference 25–28 October 2017, Auckland, NZ.

Stone, J. Temporal dynamics of circadian phase shifting response to consecutive night shifts in healthcare workers: Role of light-dark exposure; abstract submitted for World Sleep Congress 2017; for conference 7–11 October 2017, Prague, Netherlands.

Stone, J. A neural network model to predict circadian phase in normal living conditions; abstract submitted for World Sleep Congress 2017; for conference 7–11 October 2017, Prague, Netherlands.

Mullins, A. Greater spindle density in insomnia is associated with subjective measures of morning alertness and better performance on a task of sustained attention; abstract submitted for Sleep Down Under 2017; for conference 25–28 October 2017, Auckland, NZ.

Booker, L. Shift work disorder is related to depression and anxiety severity amongst nurses; abstract submitted for Transplant Nurses Association, November 2017; for conference in November 2017, Auckland, NZ.

# 5 Appendices

## Appendix 2: Education

### Post-Doctoral Fellows 2016–17

| Name | Research Project (No.#) | Research Organisation |
|---|---|---|
| Alexander Wolkow | Heavy Vehicle Driver Fatigue Research Project (RP1 & RP2) | Monash University, Australia |
| Andrew Vakulin | Sleep disorder phenotyping (RP3) | Flinders University, Australia |
| Angela D'Rozario | Sleep disorder phenotyping (RP3) | Woolcock Institute of Medical Research, Australia |
| Angus Wallace | Device Development (RP1, RP2 & RP3) | Flinders University, Australia |
| Ben Fulcher | Laboratory (RP1) | Monash University, Australia |
| Bradley Edwards | Sleep disorder phenotyping (RP3) | Monash University, Australia |
| Bryn Jeffries | Database Development (RP3) | The University of Sydney, Australia |
| Christopher Gordon | Sleep disorder phenotyping (RP3) | The University of Sydney/Woolcock Institute of Medical Research, Australia |
| Christopher Miller | Sleep disorder phenotyping (RP3) | Woolcock Institute of Medical Research, Australia |
| David Stevens | Sleep disorder phenotyping (RP3) | Flinders University, Australia |
| Emily Andersons | Device Development (RP1, RP2 & RP3) | Flinders University, Australia |
| Gleb Belov | Group Work Scheduling (RP2) | Monash University, Australia |
| Jennifer Cori | Healthcare (RP2) & Sleep disorder phenotyping (RP3) | Institute for Breathing and Sleep, Australia |
| Jong Won Kim | Modelling and Data Fusion (RP1) | The University of Sydney/Woolcock Institute of Medical Research, Australia |
| Maria Comas | Sleep disorder phenotyping (RP3) | Woolcock Institute of Medical Research, Australia |
| Michelle Magee | Healthcare (RP2) | Monash University, Australia |
| Nicole Lovato | Sleep disorder phenotyping (RP3) | Flinders University, Australia |
| Pasquale Alvaro | Healthcare (RP2) | Institute for Breathing and Sleep, Australia |
| Peter Catcheside | Sleep disorder phenotyping (RP3) | Flinders University, Australia |
| Romesh Abeysuriya | Modelling and Data Fusion (RP1) | The University of Sydney, Australia |
| Shane Landry | Sleep disorder phenotyping (RP3) | Monash University, Australia |
| Simon Joosten | Laboratory (RP1) & Sleep disorder phenotyping (RP3) | Monash University, Australia |

| Name | Research Project (No.#) | Research Organisation |
|---|---|---|
| Suzanne Ftouni | Laboratory (RP1) | Monash University, Australia |
| Svetlana Postnova | Modelling and Data Fusion (RP2) | The University of Sydney, Australia |
| Tracey Sletten | Healthcare (RP2) | Monash University, Australia |

# denotes:
Research Program 1 (RP1) – Alertness Measurement, Prediction and Testing
Research Program 2 (RP2) – Safety and Productivity Improvements
Research Program 3 (RP3) – Sleep Health

## PhD Degree Scholarships 2016–17

| No | Name | Date Commenced | Research Project (Program No.#) | Research Title | Research Organisation | Expected Completion Date |
|---|---|---|---|---|---|---|
| 1 | Amal Osman | 14-Jul-15 | Sleep disorder phenotyping (RP3) | Development of A Simple Clinical Technique to Quantify Upper Airway Collapsibility. | Neuroscience Research Australia (NeuRA)/ UNSW | 13-Jul-18 |
| 2 | Anna Mullins | 22-Jan-15 | Sleep disorder phenotyping (RP3) | Quantitative EEG Biomarkers for Sleep Disorder Phenotyping and Personalised Sleep Health Quantitative Analysis of Polysomnography: From Sleep Macrostructure to Microstructure. | The University of Sydney, Australia | 21-Jan-18 |
| 3 | Charmaine Diep | 22-Feb-16 | Laboratory (RP1) | Laboratory-based development of systems and biomarkers to assess circadian, sleep and alertness State. | Monash University, Australia | 22-Feb-19 |
| 4 | Devaang Kevat | 22-Jan-15 | Healthcare (RP2) | Examining Worker Safety and Productivity In The Healthcare Setting. | Monash University, Australia | 21-Jan-16 |
| 5 | Haidar Naqvi | 01-Sep-14 | Sleep disorder phenotyping (RP3) | Neurobehavioural effects of sleep loss in patients with obstructive sleep apnoea. | Woolcock Institute of Medical Research, Australia | 31-Aug-17 |

# 5 Appendices

| No | Name | Date Commenced | Research Project (Program No.#) | Research Title | Research Organisation | Expected Completion Date |
|---|---|---|---|---|---|---|
| 6 | Jade Murray | 01-Feb-14 | Healthcare (RP2) | Investigating Circadian Misalignment in a Population of Patients with Symptoms of Delayed Sleep Phase Disorder (DSPD). | Monash University, Australia | 31-Jan-17 |
| 7 | Julia Stone | 02-Mar-15 | Healthcare (RP2) | Assessing Individual Vulnerability To Shift Work and Integrated Interventions For Alertness Management in the Healthcare Setting. | Monash University, Australia | 01-Mar-18 |
| 8 | Kelsey Bickley | 01-Feb-15 | Sleep disorder phenotyping (RP3) | To perform a comprehensive investigation of daytime functioning in individuals with insomnia across a range of insomnia subtypes. | Flinders University, Australia | 31-Jan-18 |
| 9 | Lauren Booker | 21-Dec-15 | Healthcare (RP2) | Impact of Insomnia, shift work and OSA management on individual outcomes in healthcare shift workers. | Monash University, Australia | 20-Dec-18 |
| 10 | Leilah Grant | 01-Feb-14 | Laboratory (RP1) | Identification And Validation of Biological And Physiological Biomarkers of The Alertness State. | Monash University, Australia | 09-Feb-17 |
| 11 | M S Zobaer | 01-May-15 | Modelling and Data Fusion (RP1) | Proposal on Evoked Potentials and K Complexes in Sleep: Underpinning of Potential Biomarkers. | The University of Sydney, Australia | 30-Apr-18 |
| 12 | Marie Jinny Collet | 27-Jan-16 | Laboratory (RP1) | Specific vulnerability of attention mechanisms due to sleep loss, circadian misalignment and age. | Monash University, Australia | 26-Jan-19 |
| 13 | Megan Mulhall | 01-Mar-16 | Healthcare (RP2) | Assessing Individual Vulnerability To Shift Work and Integrated Interventions For Alertness Management in the Healthcare Setting. | Monash University, Australia | 01-Mar-19 |

| No | Name | Date Commenced | Research Project (Program No.#) | Research Title | Research Organisation | Expected Completion Date |
|---|---|---|---|---|---|---|
| 14 | Rohit Philips | 01-Feb-15 | Sleep disorder phenotyping (RP3) | To determine the vulnerability to alertness failure (impaired driving performance and vigilance function) in OSA patients, using an extended wakefulness challenge paradigm; to develop and validate electrophysiological biomarkers (EEG and ECG) to distinguish between patients who are vulnerable to alertness failure; and, to validate this laboratory phenotyping approach against real world questionnaire outcomes. | Flinders University, Australia | 31-Jan-18 |
| 15 | Sachinkumar Nilkantha Wasnik | 01-Sep-14 | Sleep disorder phenotyping (RP3) | Across modelling/data fusion and phenotyping projects with potential value in biomarkers and healthcare. | The University of Sydney, Australia | 31-Aug-17 |
| 16 | Saranea G | 22-Jan-15 | Healthcare (RP2) | Cognitive Markers of Shift Work Vulnerability. | Monash University, Australia | 21-Jan-18 |
| 17 | Simon Joosten | 01-Sep-14 | Laboratory (RP1) & Sleep disorder phenotyping (RP3) | Test a simplified method for sub-classifying OSA patients into their underlying causal phenotype. | Monash University, Australia | 31-Aug-15 |
| 18 | William McMahon | 01-May-15 | Laboratory (RP1) | Predicting individual vulnerability to alertness challenges following sleep deprivation. | Monash University, Australia | 30-Apr-18 |

# denotes:
Research Program 1 (RP1) – Alertness Measurement, Prediction and Testing
Research Program 2 (RP2) – Safety and Productivity Improvements
Research Program 3 (RP3) – Sleep Health

# 5 Appendices

## Master Degree Scholarships 2016–17

| No | Name | Date Commenced | Research Project (Program No.#) | Research Title | Research Organisation | Expected Completion Date |
|---|---|---|---|---|---|---|
| 1 | Helenmary McMeekan | 22-Jan-15 | Sleep Disorder Phenotyping Platform (RP3) | Individual-level Toolkit for Sleep Health Management in Occupational Settings. | Flinders University, Australia | Withdrew in Mar-16 |
| 2 | Kirsty Dodds | 22-Jan-15 | Sleep Disorder Phenotyping Platform (RP3) | Cardiovascular markers of autonomic dysregulation in Insomnia Disorder. | The University of Sydney, Australia | 21-Jan-17 |

# denotes:
Research Program 1 (RP1) – Alertness Measurement, Prediction and Testing
Research Program 2 (RP2) – Safety and Productivity Improvements
Research Program 3 (RP3) – Sleep Health

## Short term project funding 2016–17

| Name | Date Commenced | Research Project (Program No.#) | Research Title | Research Organisation | Expected Completion Date |
|---|---|---|---|---|---|
| Baptiste Jolivet | 11-May-15 | Modelling and Data Fusion (RP1) | Stretched exponential functions in modelling the effects of chronic sleep restriction on alertness | The University of Sydney, Australia | 17-Aug-15 |
| Gunther Klobe | 16-Nov-15 | Modelling and Data Fusion (RP1) | Mechanisms of the variability in the phase angle between DLMO and sleep onset | The University of Sydney, Australia | 15-Mar-16 |
| Merijn Driessen | 10-Jan-16 | Modelling and Data Fusion (RP1) | Modelling effects of sleep inertia on alertness in a quantitative model of sleep – wake cycles | The University of Sydney, Australia | 9-Jul-16 |
| Stephen McCloskey | 13-Jan-15 | Modelling and Data Fusion (RP1) | Incorporation of the direct alerting effects of white light in the physiologically based model of sleep-wake cycle developed at The University of Sydney | The University of Sydney, Australia | 24-Feb-15 |
| Thibaut Lacroix | 11-May-15 | Modelling and Data Fusion (RP1) | Modelling the effects of prophylactic naps on alertness and sleep | The University of Sydney, Australia | 10-Aug-15 |

# denotes:
Research Program 1 (RP1) – Alertness Measurement, Prediction and Testing
Research Program 2 (RP2) – Safety and Productivity Improvements
Research Program 3 (RP3) – Sleep Health

## Industry Based Learning scholarships 2016–17

| Name | Date Commenced | Research Program No.# | Research Organisation | Expected Completion Date |
|---|---|---|---|---|
| **Completed** | | | | |
| Adrienne Bell | 27-Jan-15 | Research Program 1 | Swinburne University, Australia | 26-Jan-16 |
| Michelle Bravo | 27-Jan-15 | Research Program 1 | Swinburne University, Australia | 26-Jan-16 |
| Aaron Johnson | 27-Jan-15 | Research Program 2 | Swinburne University, Australia | 26-Jan-16 |
| Matthew McLaren | 27-Jan-15 | Research Program 2 | Swinburne University, Australia | 26-Jan-16 |
| Jessica Papaleo | 27-Jan-15 | Research Program 2 | Swinburne University, Australia | 26-Jan-16 |
| Todd Pickering | 27-Jan-15 | Research Program 1 | Swinburne University, Australia | 26-Jan-16 |
| Elly Spiteri | 27-Jan-16 | Research Program 1 | Swinburne University, Australia | 26-Jan-17 |
| Kaitlyn Crocker | 27-Jan-16 | Research Program 2 | Swinburne University, Australia | 26-Jan-17 |
| Niamh McDonald | 27-Jan-16 | Research Program 2 | Swinburne University, Australia | 26-Jan-17 |
| Phaybian Penita | 27-Jan-16 | Research Program 1 | Swinburne University, Australia | 26-Jan-17 |
| David Litewka | 27-Jan-16 | Research Program 1 | Swinburne University, Australia | 26-Jan-17 |
| **Current** | | | | |
| Ellen Carter | 23-Jan-17 | Research Program 1 | Swinburne University, Australia | 19-Jan-18 |
| Karina Tasker | 23-Jan-17 | Research Program 2 & 3 | Swinburne University, Australia | 19-Jan-18 |
| Liam Drury | 23-Jan-17 | Research Program 1 & 2 | Swinburne University, Australia | 19-Jan-18 |
| Sarah Zivkovic | 06-Feb-17 | Research Program 2 & 3 | Swinburne University, Australia | 02-Feb-18 |
| Aleksander Hart | 20-Feb-17 | Research Program 1 & 2 | Swinburne University, Australia | 16-Feb-18 |

# denotes:
Research Program 1 – Alertness Measurement, Prediction and Testing
Research Program 2 – Safety and Productivity Improvements
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# 5 Appendices

## Glossary of Terms

**Actigraphy** – provides measurement of the motion associated with rest and activity. In the case of sleep studies, a watch-like device is attached to the wrist.

**Biomarker** – short for biological marker, it is a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, disease or the effect of an intervention.

**Biomathematics** – a discipline that combines the use of both Biology and Mathematics.

**Chemiresistor** – a material that changes its electrical resistance in response to changes in the nearby chemical environment.

**Circadian rhythms** – are physical, mental and behavioural changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in an organism's environment. They are found in most living things including animals and plants.

**CPAP** – Continuous Positive Airways Pressure Treatment for sleep apnea to keep the airways open.

**EEG** – An electroencephalogram (EEG) is a test that detects electrical activity in your brain using small, flat metal discs (electrodes) attached to your scalp. Your brain cells communicate via electrical impulses and are active all the time including during sleep.

**Electrophysiological** – the production of electrical phenomena, particularly in the nervous system, and their consequences in the living organism.

**Melatonin** – a hormone naturally secreted with the onset of fading natural light which helps tune the circadian rhythm as it moves in to a sleep cycle.

**Metabolomics** –the non-targeted detection and quantification of small molecules (metabolites) in biological materials (e.g., plasma, urine, tissue, plant and microbial extracts).

**Nanoparticle** – a particle between 1 and 100 nanometres in size.

**Obstructive sleep apnea (OSA)** – when the airway at the back of the mouth is repeatedly partly or completely blocked during sleep reducing or stopping breathing altogether. When oxygen levels fall, the sleeper wakes up briefly and starts breathing again.

**Phenotype** – the observable characteristics of a person in the context of specific trait, behaviour or susceptibility to a certain condition.

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