Australian Centre for Space Engineering Research (ACSER)
2015 ANNUAL REPORT
Australian Centre for Space Engineering Research (ACSER)
Contents

Director's Report 2
About ACSER 4
ACSER Objectives 4
ACSER Strategy 5
Supporters 6

Our Research 7
YEAR IN REVIEW: Projects 8
  Off-Earth Mining 8
  QB50 9
  SMILE 10
  Reconfigurable Systems for Space 11
  Biarri 12
  GNSS Interference Detection and Localisation 13
  Cooperative Intelligent Transport Systems (C-ITS) 14

Our Events 15
YEAR IN REVIEW: Workshops & Events 16
  Launching CubeSats For and From Australia 19
  Off Earth Mining Forum 21
  ACSER Seminar Series 25
YEAR IN REVIEW: Other Highlights 26
  Media & Publicity 30

Our Students 31
Undergraduate Education 32
  BLUEsat 32
  Honours Supervision 34
  Taste of Research 35
Postgraduate Coursework & Research Practicums 36
  Higher Degree Research 37
  PhD Student Profiles 38

Our People 39
  2015 Industry Partners and Collaborators 46

Governance 47

Publications 52
Director’s Report

This is the fifth Australian Centre for Space Engineering Research (ACSER) annual report, covering our fifth full calendar year of operation, 2015. This was a year of consolidation and commencement of new projects.

In 2015, we were looking forward to launching our new ARC research projects, launching some of our satellites and payloads into space, and had the prospect of being moved out of the Electrical Engineering building.

In the previous year (2014), it had been important to stabilise the centre in the wake of the end of ASRP funding. In 2015, that process of stabilisation was confirmed as we did not lose any staff this year. This may seem a minor victory, but given the momentous drop in centre funding in 2013 and “holding the fort” during 2014, it meant that 2015 was a year where the centre could consolidate and start producing outputs from the various projects.

The QB50 and Biarri programs were again delayed, so launches for them are expected now in 2015, and for the SMiLE payload. As 2015 drew to a close, QB50 was ready for final test and the Biarri Namuru GPS receiver payloads were awaiting integration in the US. Excitingly, the University of Sydney QB50 satellite that had withdrawn from the program was made viable again after intervention from ACSER and ANU, so we are now involved with two QB50 satellites.

The two projects related to locating GPS interference with our industrial partner GPSat Systems, Linkage “Protecting Critical Transport Infrastructure using Hybrid Approaches for Interference and Spoofier Detection and Localisation” and CTD “Geolocation of GPS RF Interference to Support Defence Operations” both commenced without delay and began producing results.

The two ARC projects that required recruitment, Linkage “Rapid Recovery from Radiation-induced Errors in Reconfigurable Hardware” and Discovery “Designing Radiation-Tolerant Reconfigurable Systems for Space” were both delayed, the Linkage due to signing the project agreements, and the Discovery because a fraction of the proposed funds were awarded and as a result the project team was reconfigured. Both had commenced by the end of the year with new staff appointed.

Our first major project with NASA's Jet Propulsion Laboratory, “An Integrated Economic Model for ISRU in support of a Mars Colony” started and ended in 2015, with results reported at the Off-Earth Mining Forum. At the end of the year we are hoping to progress a project with NASA's Kennedy Space Centre, which would see a UNSW researcher and PhD student visiting NASA for a period of months in 2016.

Delta V, the space business accelerator, aimed to create a space business ecosystem in Sydney, had a frustrating year, unable to gain the first major investor or sponsor.

Events continued to be an area of impact for ACSER. The first large event was the “Launching Cubesats for and from Australia” workshop in April, which had 37 speakers in a packed schedule, presenting live from 9 countries, with over 100 people attending. The second major 2015 event was the Second Off-Earth Mining Forum. The first Forum was an incredible media success, and not surprisingly, that was not repeated. However, the Forum itself was much
more focussed, with higher quality presentations, and a general agreement that water would be the first resource
to be exploited. 36 presentations were made and over 90 people attended. Keynotes and public lectures were from
Monica Grady (UK) on Rosetta, and Brian Muirhead (JPL) on the Asteroid Redirect Mission. A further significant public
lecture was presented by Warwick Holmes, of the European Space Agency titled “The European Space Agency’s
Rosetta Mission To Comet 67P”. We hosted talks by many Australian speakers as well as international visitors such as
visitors from Harbin Engineering University (China), International Space University, Ecole Polytechnique Federale De
Lausanne (Switzerland), and Universidade Federal de Santa Catarina (Brazil).

We did make the move to the Material Sciences Building so life will be more difficult for the two years where we are well
separated from our lab.

The coming year presents some interesting challenges, but optimistically, could see five launches for us (Biarri x 2,
QB50x2 and SMiLE). A problem we’d like to have!

Professor Andrew Dempster
Director
Australian Centre for Space Engineering Research

About ACSER

The Australian Centre for Space Engineering Research (ACSER) was launched at the University of New South Wales on the 22 November 2010 by former astronaut Dr. Jan Davis. The centre aims to establish UNSW as a significant player in increasing Australia’s capabilities in space.

The centre draws on the huge expertise of Australia’s largest Engineering faculty. ACSER resides in the School of Electrical and Telecommunications Engineering in the Faculty of Engineering at UNSW and interacts with most of the Schools in that Faculty: Mining Engineering, Mechanical and Manufacturing Engineering, Computer Science and Engineering, Civil and Environmental Engineering, Photovoltaic and Renewable Energy Engineering as well as the Engineering and Information Technology School of UNSW Canberra. Collaborations have been developed with the Faculties of Science, Business, Law, and Arts and Social Sciences. Future opportunities are being examined with Chemical Engineering.

Current projects include the QB50 cubesat program, where 50 cubesats are being developed around the world for ionospheric monitoring and also to carry payloads for the individual satellite developers. The Biarri project will carry ACSER GPS receivers on its cubesat constellation led by the US Air Force Research Laboratory. The new Masters in Satellite Systems Engineering has begun enrolling students.

ACSER regularly organises workshops and seminars on a range of space-related topics of interest to the wider space community. In 2013, ACSER hosted the world’s first Off-Earth Mining Forum, co-hosted the Australian Space Science Conference, hosted three external workshops, as well as several internal to UNSW.

The year ahead offers many opportunities and challenges, including delivery of outcomes in several projects, the relaunch of the SNAP Lab, and new research funding initiatives.

ACSER Objectives

Vision
To provide national leadership for Australian space engineering research.

Purpose
To develop space capabilities relevant to Australia’s needs through research, innovation and education.
ACSER Strategy

Our Vision
To provide national leadership for Australian space engineering research.

To foster collaborations between researchers, industry and government and to nurture links between our national and international partners to achieve Australia’s space ambitions.

In pursuing the vision, ACSER upholds the principles underpinning its foundation.

- Advance Australia’s space aspirations
- Enhance the reputation of UNSW
- Promote collaboration between the schools, faculties and campuses of UNSW

Our Purpose
To develop space capabilities relevant to Australia’s needs through research, innovation and education.

Engage the Community
Promote collaborations between ACSER, groups with space capabilities and the Australian market for space services, technologies and expertise.

Ensure Market Suitability
Pursue programs and activities that fit the needs, expectations and constraints of the domestic and international space markets.

Pursue Excellence & Innovation
Create and transfer new knowledge in space capabilities, technologies and applications.

Educate
Raise Australian awareness of issues and developments in space, and educate a new generation of space professionals.

Capabilities
- Enable access to facilities for ACSER collaborators.
- Strengthen the ACSER expertise base through strategic recruitment and post-graduate education.

Resources
Develop a funding and operational model that guarantees ACSER’s long-term viability.
Supporters

In 2015 we received external donations and sponsorships from GPSat, the National Space Society of Australia (NSSA), the Space Industry Association of Australia and Kea GNSS Ltd. Without the ongoing support of these companies we could not continue to bring researchers together to present and discuss ideas at the cutting edge of space technologies, nor could we offer outreach events to school groups and the wider community. We offer great thanks to these companies and organisations for their faith in what we do.

Internally we would also like to thank the School of Electrical Engineering and Telecommunications, the School of Mining Engineering, the School of Mechanical and Manufacturing Engineering and the Faculty of Engineering who have assisted ACSER and the BLUEsat team both financially and with in-kind support throughout the year.
Our Research
YEAR IN REVIEW: Projects

Off-Earth Mining Activities

A/Prof Serkan Saydam spent a significant proportion of his sabbatical (Jun-Dec 2015) visiting potential off-earth mining (OEM) collaborators and developing proposals for ongoing research. This is in addition to the work on the project with NASA's JPL, and the two events; the Future Mining Conference and the Off-Earth Mining Forum.

As part of his travels, Serkan visited Caltech, MIT, Virginia Tech, Univ. Central Florida, NASA's Jet Propulsion Laboratory (CA), Kennedy Space Centre (FL), and Defence Advanced Research Projects Agency (DC). He gave invited talks in the US on "An Integrated Economics Model for ISRU in Support of a Mars Colony" to NASA SSERVI (Solar System Exploration Research Virtual Institute) CLASS (Centre for Lunar and Asteroid Sciences), Defence Advanced Research Projects Agency (DARPA), Washington DC, Massachusetts Institute of Technology (MIT), Boston, MA, Swamp Works, Kennedy Space Centre, NASA, Orlando, FL. He initiated MOUs with JPL/Caltech, MIT, and UTEP.

He also produced the application “Comprehensive Modelling for Off-Earth Mining Optimization and Resource Processing” under the STTR scheme, i.e. a Government research grant (CAT 3) with Easi, VTech and NASA KSC ($174,975).

Off-Earth Mining Project:
An Integrated Economics Model for ISRU in Support of a Mars Colony


Partners: NASA Jet Propulsion Laboratory, Massachusetts Institute of Technology

The project aimed to develop an integrated set of risk-based financial and technical models to evaluate multiple Off-Earth Mining scenarios. This quantitative, scenario-based tool helps identify combinations of market variables, technical parameters, and policy levers that will enable the expansion of the global economy into the solar system and return economic benefits. As part of the project four models were developed: Mars Colony Architectural Model, Extraction Process Model, Mars Infrastructure and Integrated Logistical Support Model and Economics Integration Model. UNSW Australia’s team was led by A/Prof Saydam, with Prof Dempster, Dr Coulton and Mr Tapia Cortez. The group involved developing multiple optimised mining systems to extract water from the Mars surface.

There are currently 5 students undertaking PhDs in this area: 2 under Mechanical Engineering, 2 under Electrical Engineering and 1 in Mining Engineering.
QB50

QB50 is a network of 50 CubeSats that is due to be launched at the end of 2016 into a ‘string-of-pearls’ configuration. The orbit will be a sun synchronous dawn-dusk orbit with a low starting altitude (400km) allowing direct sampling of the thermosphere. The CubeSat constellation will comprise a mix of atmospheric double CubeSats and double or triple CubeSats for science and technology demonstration.

There are three Australian CubeSats being developed to participate in this project, with UNSW providing one, ‘UNSW EC0’, as well as providing significant support to a second iNSPIRE-2. UNSW EC0 is a 2U CubeSat that will host a ion/neutral mass spectrometer provide by MSSL as well as incorporating three additional payload boards: A new space GPS board (Kia) developed at UNSW; a systems computer board (sel4Bit) running sel4, a robust microkernal operating system developed by NICTA; and a robust FPGA based systems computer board (RUSH). These payloads will allow the investigation of two GPS based remote sensing techniques, radio occultation and GPS reflectometry, as well as demonstration of a variety of error correcting and fault tolerant algorithms on the systems computer boards. In addition to these payloads, UNSW EC0 also incorporates one of the first thermoplastic 3D printed satellite structures (RAMSES) to be flown in space.

During 2015 the UNSW QB50 project completed the Assembly, Integration and Testing Review. The cubesat design progressed, with key developments in: algorithm developed for detumbling, pointing and tracking; operational code written and deployed to the flight controller board; and integration of the major subsystems into a flight configuration. The payload teams have completed development of the engineering and flight boards ready for integration. Several versions of the flight structure, RAMSES, have been produced, with the manufacturing process finalised. The first stack integration and full functional testing was completed, and the client payload, INMS (inertial neutral mass spectrometer), was tested in both software and hardware.

In 2015 the CubeSat design reached a final level of definition, and assembly and functional test was progressed. The team is now well established in their roles, and there is a good coverage of required skills. All up there are 28 UNSW and NICTA personnel working on the project. There has been $252,000 of cash committed to the project, and this has leveraged a further $464,000 of in-kind contribution through labour and technology development.
SMiLE

This project aims to carry out an experimental investigation into the dynamics of droplet production in a reduced gravity environment onboard the International Space Station (ISS). The experiment has been designed to interface with and occupy a 1U (11cm x 10cm x 10 cm) slot in the nano labs rack provided by NanoRacks. The investigation will focus on clearly identifying the dynamics of a newly identified drop formation process present in reduced gravity environments (akin to a dripping tap in reduced gravity). The experiment comprises a flow chamber (where the drops are formed and observed), a syringe pump to provide the flow, two control valves, two USB cameras and a microcontroller. The assembly is housed in a rotating drum, allowing the system to be spun and introducing a centrifugal force to separate the fluid from the air in the flow chamber. Flow rate control allows adjustment of fluidic parameters such as Reynolds and Weber number. Cameras monitor the fluid flow into the chamber and provide the principle data output. Outcomes from this investigation will be the experimental identification of the measure of the chaos present in this system and a refinement of the understanding of the transitions into and out of this flow regime. Applications of this work are relevant to industries that rely on drop on demand processes such as ink-jet, PCB, flexible electronics and genome printing.

There are two partner organisations key to this project; 1. The International Space University (ISU) in France and 2. NanoRacks in the US. From these institutions this project has a current team of four academics, one researcher and two undergraduates. However, this project has been running for the past 5 years and has had the prior contribution of three other academics, 2 researchers and 17 undergraduates over this time. Throughout the duration, the project has attracted $110,000 in real terms leveraging approximately a further $255,000 in in-kind contributions.

Due to the compact and complex nature of this experiment, 3D manufacturing techniques are heavily employed to create complex components. The preparation of three versions (two flight models and one engineering model) of the experiment has been completed. Functional testing of the key fluid systems was carried out.

In partnership with CNES and ISU, the SMiLE team was able to test key technologies onboard the Novespace A310 parabolic flights (93 parabolas each 20-25second of 0g). The experiment was tested under of conditions in microgravity and the centrifugal water system was verified. In addition a custom control board based on a Raspberry Pi was developed along with software designed to control the experiment in space. The launch contract was reviewed by Nanoracks and ISU with experiment included in the launch manifest of the SpaceX CRS-11 mission. The project is aiming for a Q4 2016 handover of flight hardware for an expected February 2017 launch and operations.
The processing speed, cost and flexibility requirements of future satellite-based applications cannot be satisfied with conventional radiation-hardened processors or custom integrated circuits. SRAM-based Field Programmable Gate Arrays (FPGAs) provide an opportunity for meeting these requirements with off-the-shelf hardware. The main challenge of using FPGAs for space applications is mitigating the effects of radiation-induced Single Event Upsets (SEUs).

The aim of the two projects supported in part by the Australian Research Council’s Linkage (LP140100328) and Discovery (DP150103866) Projects funding schemes is to develop key technology to enable off-the-shelf hardware to be customized for this use without compromising reliability. The projects will develop the design methods needed to implement a given set of satellite applications on a processing platform composed of application-specific soft processors and accelerator circuits hosted on conventional reconfigurable logic devices. Crucially, the solution architecture will be sufficiently hardened against radiation-induced errors to meet reliability targets while satisfying performance and energy use constraints. During the course of these projects, these techniques will be demonstrated and tested in-orbit on the RUSH payload for the UNSW-EC0 CubeSat which is a part of the international QB50 CubeSat program funded by the European Union Framework project.

During 2015 a part-time researcher was identified and appointed in late 2015 on the LP140100328 project and a full-time researcher was identified and will take up his position early in 2016 on the DP150103866 project. Research work concentrated on the design and reliability aspects of the reconfiguration control network and its performance evaluation. In tandem with this, current research is looking at fault-tolerant reconfiguration network controller design. Research was also undertaken to reduce the overheads associated with using Dynamic Partial Reconfiguration (DPR) to overcome configuration memory errors in TMR systems.

In addition to these, a considerable amount of activity has focused on the QB50 RUSH payload design and experiment. The payload board was designed and built while the firmware was developed. The payload supports two configurations, one looking at the efficacy of recovering from radiation-induced SEUs using our proposed modular recovery approach and another which uses the traditional scrubbing approach. The payload has been successfully integrated into the UNSW-EC0 CubeSat bus and has passed the thermal and vacuum environmental tests with flying colours. These will be followed by vibration tests in 2016 and subsequent shipment of the CubeSat for launch to Europe around June 2016.
Project Biarri is a 5-Eyes Cubesat mission in which Australia has been working with the New Zealand, Canada, the United Kingdom and the United States to explore cubesat formation flying, better understand the drag and lift forces experienced by the CubeSats and verify the performance of the ACSER developed Namuru V32R3A GPS receivers and the Electro Optic Systems (EOS) space situational awareness infrastructure.

With delivery of the four flight model Namuru GPS receivers to the Defence Science and Technology (DST) Group in late 2013 and assembly, integration and testing to taking place at the US Air Force Research Laboratories (AFRL) in 2014 and early 2015, it was fully expected that the Biarri mission spacecraft would have been deployed last year. However, as is often the case with such projects, the launch has been delayed.

The latest advice from DST Group is that the Biarri mission is to be split into two separate missions; namely a risk mitigation mission called Biarri Point in which a single spacecraft is deployed in October 2016, followed by deployment of the remaining three CubeSats in 2017 or 2018 called Biarri Squad.

In the meantime, UNSW has signed a contract with DST Group to provide on-going support for the Namuru V32R3 GPS receivers. This support will be vital once Biarri Point has been deployed and it becomes necessary to analyze the performance of the receiver and undertake the various experiments designed for the mission.

ACSER also continues to work with DST Group on additional projects.
Interference Detection and Localisation (GEMS, GEMS – II and CTD)

GPS has become ubiquitous in daily life, to an extent that the position, and often more importantly, the time delivered by GPS has become embedded in an increasing number of critical systems. However, given their low received power levels, GPS signals are very susceptible to Radio Frequency Interference (RFI) from either intentional or unintentional sources. In addition to RFI, Spoofing attacks, where fake GPS signals are broadcast to trick the operation of a GNSS receiver, present a serious threat to GNSS reliability and security. This vulnerability is aggravated as satellite navigation becomes more central to the operation of airports, ports railways, and communications systems.

During 2015 a research associate was identified and appointed to work on the follow on Australian Research Council (ARC) sponsored Linkage project partnering with ACSER, the University of Adelaide and GPSat Systems. This project aims to further extend the capability of GEMS, which was developed as part of the earlier ARC Linkage project with the same partners, to pinpoint attempts to jam or fake GPS signals (spoofers), before either has serious consequences.

Research work to date concentrated on formulating the 3D Angle of Arrival (AOA) based geo-localization of interference sources, and deriving the dilution of precision and Cramer Rao Lower Bound (CRLB) expressions which characterises the accuracy of the proposed approach. Furthermore, an estimator whose performance approaches the CRLB is also developed. Another strand of work is concentrating on the joint AOA and Time Difference of Arrival (TDOA) based geo-localisation.

2015 also saw the Capability and Technology Demonstrator (CTD) project successfully completing the design review process and manufacture of the multi-channel processing platform with extensive tests planned for 2016.
Cooperative Intelligent Transport Systems (C-ITS)

Triggered by recent developments in vehicular safety, driverless vehicles etc., cooperative intelligent transport systems (C-ITS) has become a major research area. Over the past decade ACSER has developed a strong heritage in multi-sensor integration for land navigation, as evidenced by numerous high quality journal publications. ACSER has focussed on enhancing accuracy and resilience of GNSS-based navigation in vehicular applications by combining GNSS with other on-board sensors. The exploitation of channel parameters from vehicle-to-vehicle (V2V) communications has resulted in significant improvement in not only positioning accuracy but also availability, allowing resilient navigation in semi-urban environments where typical standalone GPS receivers will intermittently fail. Expanding this idea to networked vehicles enhances the overall positioning accuracy of the entire network of vehicles.

ACSER’s prominence in this field of research attracted the attention of Thales Alenia Space France (TAS), who approached us to study the benefits of integrating Inertial Measurement Unit (IMU), GNSS and V2V sensors, and how redundancy in such multi-sensor integrations mitigate the signal distortions due to multipath and Non-Line-of-Sight by rejecting measurements from effected signals. The study attracted a €40,000 consultancy fee during 2014 from TAS and concluded that using non-conventional estimators can indeed significantly reduce positioning errors. Due to lack of funding, little progress was made on this project in 2015, however it is hoped that further investigations using a modified particle-filter to improve capability in rejecting distorted signals can be carried out in the future.
Our Events
YEAR IN REVIEW: Workshops & Events

Mr Peeter Wilkinson
European Space Agency

Project Controller for the Future Missions Office under the Science Programme (Cosmic Vision 2015-2025)

13 January 2015

Mr Wilkinson, a UNSW Alumnus (and ex-BLUEsat Team), will provide an overview of ESA activity along with personal insights based on his 8 years of service with the organisation. He is presently the Project Controller for the Future Missions Office under the Science Programme. Cosmic Vision 2015–2025 is the current cycle of ESA’s long-term planning for space science missions. It is the latest in a series of mechanisms through which ESA’s science missions are implemented and provides the stability needed for activities which typically take over two decades to go from initial concept to the production of scientific results. For more information on Cosmic Vision 2015–2025 visit the ESA website.

Developing Projects in the Brazilian Space Program Context: A Case Study in the Design and Implementation of a Critical Embedded System for Space Applications

Prof. Eduardo Bezerra, Universidade Federal de Santa Catarina (UFSC), Brazil

5 March 2015

The Brazilian Space Program started in 1961 as a government initiative named “Group for the Organisation of the National Space Activities Commission” (GOCNAE). In all these years, in order to cope with the deadlines and requirements associated to the variety of missions, very specific procedures and standards have been adopted. The presentation will briefly introduce the Brazilian Space Program, and how academic institutions manage to develop joint projects with the National Institute for Space Research (INPE). As a case study, the design flow and implementation of the communications subsystem of an on-board computer (OBC) will be presented.

The whole communications subsystem has been developed in a Brazilian university, under an INPE’s contract by a consortium formed by two Brazilian companies. The Telecommand/Telemetry (TC/TM) subsystem has been designed according to the Consultative Committee for Space Data Systems (CCSDS) recommendations, and the European Space Agency (ESA) standards.

Prof. Eduardo Bezerra is a Researcher and Lecturer of Computer Engineering at Universidade Federal de Santa Catarina (UFSC), Brazil, where he is with the Department of Electrical and Electronics Engineering since 2010. He was formerly with the Faculty of Informatics, Catholic University (PUCRS), Brazil, from 1996 to 2010. He received his Ph.D. in Computer Engineering from the University of Sussex (Space Science Centre), England, UK, in 2002. He is the author and co-author of papers published covering a broad range of scientific topics within the disciplines of Computer Engineering. His research interests are in the areas of embedded systems, space applications, computer architecture, reconfigurable systems (FPGAs), software and hardware testing, fault tolerance and microprocessor applications. At PUCRS, he was the head of the Embedded Systems Group (GSE) where he led and managed several research projects funded by Brazilian Government Agencies and also by the industry. In 2004 he set up a company named Innalogics at PUCRS Technological Park. Innalogics is a spin-off of GSE aiming the improvement of industry-university collaboration in the field of embedded systems design.
THE EUROPEAN SPACE AGENCY’S ROSETTA MISSION TO COMET 67P:

The first interplanetary space exploration mission to successfully orbit and land a scientific probe on the surface of a comet more than 500 million km from Earth

Warwick Holmes, Avionics System Engineer & Former ESA Rosetta Team Member

3rd August 2015

Warwick Holmes is 53 years old, was born in Sydney and also lived in Adelaide and Canberra during his early years. Warwick attended Sydney University graduating with a Bachelor of Science and Electrical Engineering and later a Masters degree in Technology Management from UNSW.

For the last 29 years Warwick has been working in Europe exclusively on the development of European Space Agency spacecraft including: Scientific, Earth Observation, Telecommunications, Navigation and Manned spacecraft programs. He is an Avionics System Engineer specializing in the integration and testing of spacecraft hardware and software and project management. He was an ESA staff member that worked on the Rosetta program for 5 years during the building, testing and launch phases of this mission.

Warwick has performed five launch campaigns at the ESA launch base in French Guiana, South America, with the Ariane-3, Ariane-4, Ariane-5 and Soyuz-STB launch vehicles. He was designated as the “Spacecraft Support Team leader” (SST) responsible for giving the final “Go-for-Launch” call from French Guiana to the Flight Operations Director in ESOC Germany to start the final automatic launch countdown sequence of the Rosetta Mission on 2nd March 2004.

The Rosetta spacecraft has been in interplanetary flight through the solar system for more than 11 years traveling a total distance of 7 billion kilometres, four times around the Sun to reach Comet-67P. Rosetta has achieved several “firsts” in space exploration history being the first spacecraft to orbit and land a science probe directly onto the surface of a comet.

This event was proudly presented in a joint venture between the Australian Centre for Space Engineering Research and the UNSW Branch of the American Institute of Aeronautics & Astronautics

BLUEsat Mars Rover In Poland

The UNSW BLUEsat OWR Poland Team: Christopher Miller, Helena Kertesz, Yilser Kabaran, Daniel Krajsic, Harry Day

9th October

The BLUEsat Off-World Robotics team arrived back from Poland where they competed in the European Rover Challenge and came 15th out of 40 teams! Their Mars analogue Rover competed with teams from India, USA and Canada in several challenges, including remote control and rough terrain traversal. The team presented on their Rover design and their journey to the European Rover Challenge. The Rover itself made a guest appearance during the lecture!

BLUEsat Off-World Robotics is a student lead project at UNSW that aims to design, build and operate Rovers designed for the Moon, Mars and beyond. To date the team has completed two major expeditions with two models of rover, including the BLUEtongue Rover which competed in the 2015 European Rover Challenge.

The OWR team consists of over 15 undergraduate Electrical, Mechanical and Computer Science Engineers and is part of the greater BLUEsat Undergraduate Space Research group at UNSW. BLUEsat is currently recruiting any interested university students.
Launching CubeSats For and From Australia Workshop  
1st April 2015

This event brought together international and domestic experts in small satellite mission design, construction and launch to examine the challenges of launching small satellites for Australia, and eventually from Australia. A varied cross section of stakeholders attended to discuss the current state of the art and constructive ideas for advancing Australia’s position in the space industry. Below is the list of speakers. Over 110 RSVPs were received for this event, far exceeding expectations and indicating the level of interest there is in Australia for small-scale Space 2.0 ventures.

<table>
<thead>
<tr>
<th>Speaker Name</th>
<th>Organisation</th>
<th>Topic/Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Dempster</td>
<td>ACSER, UNSW</td>
<td>Space 2.0</td>
</tr>
<tr>
<td>Tim Parsons</td>
<td>Delta-V</td>
<td>The Delta-V Space Start-Up Accelerator</td>
</tr>
<tr>
<td>Craig Clark</td>
<td>Clyde Space (remotely)</td>
<td>Getting ‘Down Under’ up – Considerations on launching nano-satellites</td>
</tr>
<tr>
<td>Michiel van Bolhuis</td>
<td>Innovative Solutions in Space (Netherlands)</td>
<td>Investigating the Middle and Lower Thermosphere using a Cubesat Constellation: the QB50 Mission and its Particular Challenges</td>
</tr>
<tr>
<td>Davide Masutti</td>
<td>VON Karman Institute (Belgium)</td>
<td>GAUSS Alternative Launch Solutions (Video)</td>
</tr>
<tr>
<td>Chantal Cappelletti</td>
<td>Launch Services (Brazil)</td>
<td>Woomera Rebooted - Building Our Next-Generation National Test Range Capability (Video)</td>
</tr>
<tr>
<td>Lindsay Campbell</td>
<td>RAAF Woomera Test Range</td>
<td>Overview of the Space Activities Act</td>
</tr>
<tr>
<td>Roz Cook</td>
<td>Space Coordination Office (SCO)</td>
<td></td>
</tr>
<tr>
<td>Donna Lawler</td>
<td>Optus</td>
<td>Cubesats: how do I get my driver’s licence? (Part 1)</td>
</tr>
<tr>
<td>Elias Aboutanios</td>
<td>ACSER, UNSW</td>
<td>Cubesats: how do I get my driver’s licence? (Part 2)</td>
</tr>
<tr>
<td>Peter Beck</td>
<td>Rocket Lab (NZ)</td>
<td>The Electron Launch Vehicle (Video)</td>
</tr>
<tr>
<td>Onno C. J. Verberne</td>
<td>Nammo AS (Norway)</td>
<td>Launch Opportunities For and From Australia (Video)</td>
</tr>
<tr>
<td>Stuart McAndrew</td>
<td>OzQube-1</td>
<td>OzQube-1 - Australia's First PocketQube Satellite</td>
</tr>
<tr>
<td>Solange Cunin</td>
<td>Quberider</td>
<td>A new level of access to space</td>
</tr>
<tr>
<td>Tim Parsons</td>
<td>Delta-V</td>
<td>The Delta V Cubesat</td>
</tr>
<tr>
<td>Russell Boyce</td>
<td>UNSW Canberra</td>
<td>UNSW Canberra’s spacecraft flight capability development and planned missions</td>
</tr>
<tr>
<td>David Lingard</td>
<td>Defence Science and Technology Organisation (DSTO)</td>
<td>Cubesat Experimentation at the DSTO</td>
</tr>
<tr>
<td>Mike Petkovic</td>
<td>Advanced Instrumentation Technology Centre (AITC), ANU</td>
<td>Advanced Instrumentation Technology Centre</td>
</tr>
<tr>
<td>Jason Held</td>
<td>Saber Astronautics</td>
<td>Mission Control for the 21st Century</td>
</tr>
<tr>
<td>Christine Charles</td>
<td>ANU</td>
<td>Development of Australian cold gas and electric thrusters for CubeSats</td>
</tr>
<tr>
<td>Thien Nguyen</td>
<td>BLUEsat, UNSW</td>
<td>Tracking Aircraft via Low Earth Orbit CubeSat constellations</td>
</tr>
<tr>
<td>Andreas Antoniades</td>
<td>University of Newcastle</td>
<td>UNSW Cubesat Project: Affordable Hardware for Education and Exploration</td>
</tr>
<tr>
<td>Tom Walkinshaw</td>
<td>PocketQube (Alba Orbital) (UK)</td>
<td>PocketQube (Video)</td>
</tr>
</tbody>
</table>
Off Earth Mining Forum

4 - 6 November 2015

In November 2015, ACSER hosted the 2nd Off Earth Mining Forum jointly with the UNSW School of Mining Engineering at the Australian Technology Park.

The first Off-Earth Mining Forum (OEMF) at UNSW Australia’s Kensington campus in February 2013 was an extraordinary event. Media coverage had a reach of over 8 million people across the world, with radio coverage in the UK and US, newspaper coverage in India and New Zealand and coverage by all Australian television networks. The second Off-Earth Mining Forum did not have the same media penetration but was more significant, both in terms of attendees and the degree to which the research directions have settled.

The OEMF (chaired by Prof Andrew Dempster and A/Prof Serkan Saydam) was co-located with the third International Future Mining Conference (FMC), also chaired by A/Prof Serkan Saydam. The aim was for the two communities to mix freely – the technology-active members of the mining industry and those interested in space resources. This was achieved in a number of ways, including half a day of joint sessions (i.e. both events in a single room), including the keynote address “Space Exploration and Mining – A Potential Common Journey” delivered by René Fradet, Deputy Director, Engineering and Science Directorate, NASA Jet Propulsion Laboratory.

The two other keynotes for the OEMF also gave those keynotes as public lectures in the Clancy auditorium on the UNSW campus: “Landing on a Comet: ESA's Rosetta Mission” delivered by Prof Monica Grady CBE, Professor of Planetary and Space Sciences, Open University, and “The Asteroid Redirect Robotic and Crewed Missions” by Brian Muirhead, NASA ARRM Project Manager.

The forum hosted speakers from across the spectrum of off-earth mining issues: missions, resources, mining technologies, robotics, automation, instrumentation, legal impediments, business risks, and ethical considerations. Participation was welcomed from active domestic and international researchers, as well as interested parties from industry, government and the public.

Over 80 people attended with 35 invited speakers (no papers), including 2 keynotes, 3 plenary speakers, 5 panelists, and 7 presentations streamed over the internet. The sponsors were the Space Industry Association of Australia, UNSW Faculty of Engineering, UNSW School of Mining Engineering, and UNSW School of Electrical Engineering and telecommunications. It resulted in 29 media stories, estimated to have a PR value of $118k.

With the area developing rapidly, we plan for the third forum to be held in 2017.

<table>
<thead>
<tr>
<th>PUBLIC LECTURE: TUESDAY 3RD NOVEMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof Monica Grady</td>
</tr>
<tr>
<td>Open University UK</td>
</tr>
<tr>
<td>6:30pm, Clancy Auditorium</td>
</tr>
<tr>
<td>UNSW Kensington Campus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRE-FORUM EVENT: WEDNESDAY 4TH NOVEMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening Night Welcome Cruise</td>
</tr>
<tr>
<td>in conjunction with the Future Mining Conference</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PUBLIC LECTURE: THURSDAY 5TH NOVEMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian Muirhead</td>
</tr>
<tr>
<td>NASA Jet Propulsion Laboratory</td>
</tr>
<tr>
<td>6:30pm, Clancy Auditorium</td>
</tr>
<tr>
<td>UNSW Kensington Campus</td>
</tr>
</tbody>
</table>
## DAY 1: THURSDAY 5TH NOVEMBER

### Registration Desk Opens 8am

<table>
<thead>
<tr>
<th>Time</th>
<th>Session/Location</th>
<th>Speaker(s)</th>
<th>Organisation</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:45 - 9:10</td>
<td>Main Theatre</td>
<td>Event Welcome &amp; Session Chairs: Prof Andrew Dempster &amp; Prof Serkan Saydam (Australian Centre for Space Engineering Research &amp; UNSW School of Mining Engineering)</td>
<td></td>
<td>Space Exploration and Mining - A Potential Common Journey</td>
</tr>
<tr>
<td>9:10 - 9:50</td>
<td>Main Theatre</td>
<td>Rene Fradet</td>
<td>Deputy Director, NASA JPL</td>
<td>JPL Space Exploration and Mining - A Potential Common Journey</td>
</tr>
<tr>
<td>10:15 - 10:40</td>
<td></td>
<td></td>
<td></td>
<td>Morning Tea</td>
</tr>
<tr>
<td>10:40 - 11:05</td>
<td>Main Theatre</td>
<td>Robert Shishko</td>
<td>NASA JPL</td>
<td>An Integrated Economics Model for ISRU in Support of a Mars Colony</td>
</tr>
<tr>
<td>11:05 - 11:30</td>
<td>Main Theatre</td>
<td>Craig Lindley</td>
<td>CSIRO</td>
<td>A Multilayer Three-dimensional Index Tool for Recursive Block Models Supporting Terrestrial and Extraterrestrial Mine Planning</td>
</tr>
<tr>
<td>11:30 - 11:55</td>
<td>Main Theatre</td>
<td>Scott Dorrington</td>
<td>UNSW Australia (ACSER / School of MME)</td>
<td>Trajectory Design and Economic Analysis of Asteroid Mining Missions to Asteroid 2014 EK24</td>
</tr>
<tr>
<td>11:55 - 12:20</td>
<td>Main Theatre</td>
<td>S Ata, G Bournival and M Manefield</td>
<td>UNSW Australia</td>
<td>Resource Recovery in Space</td>
</tr>
<tr>
<td>12:20 - 13:10</td>
<td>Theatrette 6B</td>
<td>Introduction &amp; Session Chair: David Ball</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:25 - 13:45</td>
<td>Business &amp; Economy Theatre</td>
<td>Dr Roger Launius (via internet)</td>
<td>Smithsonian National Air and Space Museum</td>
<td>Historical Analogues</td>
</tr>
<tr>
<td>13:45 - 14:00</td>
<td>Business &amp; Economy Theatre</td>
<td>Dr Thom van Dooren and Dr Matthew Kearnes</td>
<td>The Australian Centre for Sustainable Mining Practices (UNSW) &amp; Faculty of Arts and Social Sciences (UNSW)</td>
<td>The ethics of off-earth mining: expanding the discussion</td>
</tr>
<tr>
<td>14:00 - 14:20</td>
<td>Business &amp; Economy Theatre</td>
<td>Dr Philip Metzger (via internet)</td>
<td>UCF Florida Space Institute</td>
<td>Rules for Space Mining Radicals</td>
</tr>
<tr>
<td>14:20 - 14:25</td>
<td></td>
<td></td>
<td></td>
<td>5-minute Break</td>
</tr>
<tr>
<td>14:25 - 15:00</td>
<td>Theatrette 6B</td>
<td>Prof Steven Freeland</td>
<td>Western Sydney University</td>
<td>Common Heritage or Common Law?: Legal Regulation of the Exploitation of Natural Resources in Outer Space</td>
</tr>
<tr>
<td>15:00 - 15:20</td>
<td>Theatrette 6B</td>
<td>Dr Alice Gorman</td>
<td>Dept of Archaeology, Flinders University</td>
<td>Dust mitigation in lunar mining and the implications for cultural heritage management</td>
</tr>
<tr>
<td>15:40 - 16:00</td>
<td></td>
<td></td>
<td></td>
<td>Afternoon Tea</td>
</tr>
<tr>
<td>16:00 - 16:30</td>
<td>Theatrette 6B</td>
<td>Prof Monica Grady CBE</td>
<td>Professor of Planetary and Space Sciences, Open University</td>
<td>Landing on a Comet: ESA's Rosetta Mission</td>
</tr>
<tr>
<td>16:30 - 17:05</td>
<td>Theatrette 6B</td>
<td>Prof Ian Wright</td>
<td>Open University, UK</td>
<td>Off-Earth Mining: the Rosetta Experience</td>
</tr>
<tr>
<td>17:05 - 17:15</td>
<td>Theatrette 6B</td>
<td>Prof Trevor Ireland</td>
<td>Australian National University</td>
<td>JAXA's Hayabusa Mission Update</td>
</tr>
<tr>
<td>17:15</td>
<td></td>
<td></td>
<td></td>
<td>Day End</td>
</tr>
</tbody>
</table>
## DAY 2: FRIDAY 6TH NOVEMBER

### Registration Desk Opens 8am

**SESSION** | **TIME** | **SPEAKER NAME** | **ORGANISATION** | **TOPIC**
--- | --- | --- | --- | ---
Keynote Speaker | 8:45 – 8:50 | Introduction & Session Chair: Prof Serkan Saydam |  |  |
 | 8:50 – 9:30 | Brian Muirhead | NASA ARRM Project Manager | The Asteroid Redirect Robotic and Crewed Missions |
Lunar Resources | 9:30 – 9:50 | Prof Ian Crawford (via internet) | Department of Earth and Planetary Sciences, Birkbeck College London | Lunar resources |
 | 9:50 – 10:10 | Kyle Acieno | ispace technologies | Lunar Resource Exploitation with Swarm Rovers |
 | 10:10 – 10:30 | Dr Kris Zacny (via internet) | Honeybee Robotics | Lunar Resource Prospector Drill System |
Theatrette 6B | 10:30 – 10:50 | Morning Tea |  |  |
Level 1

### Plenary Speakers

**Theatrette 6B**

**Level 1**

**Session Chair:** Dr Naomi Tsafnat

**12:25 Lunch**

**Session Chair: Dr Tim Parsons**

**14:25 – 14:45 Afternoon Tea**

**Session Chair: Dr Tim Parsons**

**15:45 – 15:50 5-minute Break**

**Session Chair: Dr Tim Parsons**

**17:00 Forum Ends**
### ACSER Seminar Series

ACSER’s lunch-time seminar series plays an important role in achieving several of its aims: outreach, engagement within and without the faculty and university, mentoring of staff, and research training for postgraduate students. The series kept up its momentum in 2015 with audiences of up to 50 people at some events, including not just staff and students from UNSW, but also attracting students from other universities and interested people from industry and the wider community.

<table>
<thead>
<tr>
<th>Title</th>
<th>Speaker/s</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>satellite time synchronization systems based on remotely disciplined VCXOs</td>
<td>Mr Xiaoobo GU, ACSER PhD Practicum student</td>
<td>Wednesday, 6 February 2015</td>
</tr>
<tr>
<td>Embedded Systems for Space Applications at UFSC/Brazil</td>
<td>Prof. Eduardo Bezerra, Universidade Federal de Santa Catarina (UFSC), Brazil</td>
<td>Monday, 16 February 2015</td>
</tr>
<tr>
<td>Bistatic Radar using signals of Opportunity</td>
<td>Mr Cameron Cooke, ACSER Thesis Student</td>
<td>Tuesday, 10 March 2015</td>
</tr>
<tr>
<td>BLUESat Stratospheric Balloon Testing: Serving UNSW space research activities by providing a vehicle for testing space systems and space hardware in near-space conditions</td>
<td>Ian Bartlett, BLUESat President</td>
<td>Thursday, 12 March 2015</td>
</tr>
<tr>
<td>System Engineering of a Martian Ice Miner for In Situ Resource Utilization in Support of a Mars Colony</td>
<td>Mr Thierry De Roche, UNSW School of Mining &amp; Ecole Polytechnique Federale De Lausanne</td>
<td>Monday, 16 March 2015</td>
</tr>
<tr>
<td>Arkaroola Mars Robot Challenge Expedition *Joint event with the Australian Centre for Astrobiology</td>
<td>Dr Jon Clarke, Mars Society Australia</td>
<td>18 March 2015</td>
</tr>
<tr>
<td>Development of a space habitat simulator: SHEE - Self-deployable Habitat for Extreme Environments</td>
<td>Dr Barnaby Osborne, ACSER / International Space University</td>
<td>Thursday, 26 March 2015</td>
</tr>
<tr>
<td>Find out about Saber’s story as a space engineering startup in Australia, and their journey to modernize the way the space industry conducts Mission Control</td>
<td>Dr Jason Held, Saber Astronautics / UNSW</td>
<td>Tuesday, 14 April 2015</td>
</tr>
<tr>
<td>LaunchBox is an educational programme intended to put CubeSat technologies inside Australian Schools</td>
<td>Flavia Tata Nardini, LaunchBox</td>
<td>Tuesday, 28 April 2015</td>
</tr>
<tr>
<td>Cooperative Positioning</td>
<td>A/Prof Fang Shen, College of Automation, Harbin Engineering University (China) &amp; Visiting Fellow, ACSER UNSW</td>
<td>Tuesday, 12 May 2015</td>
</tr>
<tr>
<td>ACSER IGNSS Presentations</td>
<td></td>
<td>9 July 2015</td>
</tr>
<tr>
<td>Modelling and Mitigating Multipath and NLOS for Cooperative Positioning in Urban Canyons</td>
<td>Dr Joon Wayn Cheong (ACSER Research Associate)</td>
<td></td>
</tr>
<tr>
<td>Autonomous Physical Time Synchronization Method for Navigation Systems</td>
<td>Dr Eamonn Glennon (ACSER Senior Research Associate)</td>
<td></td>
</tr>
<tr>
<td>Results from kea V4.1 FPGA-based GPS Receiver Performance Testing</td>
<td>Dr Eamonn Glennon (ACSER Senior Research Associate)</td>
<td></td>
</tr>
<tr>
<td>Detecting the Presence of Spoofers using Multipath Detection Techniques</td>
<td>Ms Laure Demicheli (ACSER Practicum exchange student)</td>
<td></td>
</tr>
<tr>
<td>An Efficient Secondary Code Transition Correlator for Fast MultiGNSS Acquisition</td>
<td>Mr Vinh Tran (ACSER PhD candidate)</td>
<td></td>
</tr>
<tr>
<td>Programmable Custom Multi-Core Architectures for Multi-Constellation GNSS Receiver</td>
<td>Mr Vinh Tran (ACSER PhD candidate)</td>
<td></td>
</tr>
<tr>
<td>ProtoSAT: Educational Satellite Hardware</td>
<td>Andreas Antoniades, Obelisk Systems</td>
<td>Friday, 4th September 2015</td>
</tr>
<tr>
<td>The Australian Space Eye</td>
<td>Dr Lee Spitler, Macquarie University &amp; Australian Astronomical Observatory</td>
<td>Monday, 19th October</td>
</tr>
</tbody>
</table>
YEAR IN REVIEW: Other Highlights

Fly me to the USA

In January Andrew Dempster, Eamonn Glennon and Kevin Parkinson (the GPS “receiver team”) visited NASA’s Jet Propulsion Laboratory. In these pictures, you can see them i) with the full-sized Curiosity replica used for simulating the rover’s exploration of Mars, and ii) with Rene Fradet and Bob Shishko to discuss off-earth mining.

They also visited Space X at their Hawthorne, CA headquarters.

In September, Andrew Dempster and Serkan Saydam were back at JPL again to discuss off-earth mining, seen here with Aussie Dr Rob Reid and his asteroid robot “Hedgehog”.

Global Space Balloon Challenge

April 2015

On the back of their 2014 success in winning “Best Experiment” at the Global Space Balloon Challenge, a team of six comprised of UNSW PhD students and graduates (mainly from Mechanical Engineering) designed and launched a high altitude balloon as part of the 2015 Challenge. It reached 34,000 meters and tested a novel, passively solar heated, payload container. The test was a success despite weather conditions outside of the expected range. Media coverage was wide ranging, including local media and university media:


Space Industry Association of Australia (SIAA) Annual General Meeting

November 2015

For the 2nd year in a row ACSER played host to an SIAA Executive Meeting and the Annual General Meeting. We’re please to announce that Prof Dempster was re-elected to the SIAA Executive Council.
66th Annual International Astronautical Congress in Jerusalem, Israel

12 - 16 October 2015

ACSER renewed its status as a member of the International Astronautical Federation and was again fortunate enough to be represented at the Congress by staff and students affiliated with ACSER, namely Dr Naomi Tsafnat and PhD students William Crowe and Scott Dorrington (all from the School of Mechanical Engineering).

We also congratulate UNSW canberra student Siddharth Pandey who won a 2015 Emerging Space Leaders grant for his research in the field of off-earth mining. That’s the second UNSW winner in as many years, riding on the back of ACSER PhD student Sanat Biswas winning in 2014.


IGNSS 2015 on the Sunshine Coast

13 - 16 July 2015

Another year and another big contingent of ACSER speakers at the IGNSS Symposium. This year we were fortunate enough to have our French practicum student (Laure Demicheli) present in Australia while the conference was on and we were proud to support her attendance and paper presentation at the event.

IGNSS2015 ACSER Delegates, L-R: Vinh Tran, Prof Andrew Dempster, Dr Craig Roberts, Prof Chris Rizos, Dr Eamonn Glennon, Laure Demicheli, Dr Joon Wayn Cheong

Off Earth Mining Presentation

May 2015

Prof Dempster and A/Prof Saydam were invited to present to the Global Change and Energy Sustainability Initiative at the Australian Department of Defence in Canberra.
Optus Groundstation Visit

August 2015

BLUEsat students arranged a field trip to tour the secure operations at the Optus Groundstation located in Belrose, on the northern outskirts of Sydney. They kindly offered ACSER staff and QB50 team members an opportunity to join in (on the proviso that we could drive them!). Both fun and educational for the team, it provided yet another opportunity to strengthen ties between UNSW and Optus, with one of our QB50 and Masters in Satellite Systems students snapping up a rare graduate position in the Groundstation not long after this tour.

UNSW Open Day

September 2015

This was the first year the ACSER participated in Open Day with BOTH the Schools of Mechanical Engineering and Electrical Engineering. Volunteers discussed our many research projects with high school students and their parents, passing around the QB50 3D printed model, while BLUESat performed a balloon demonstration.
UNSW PhD Student wins 2015 Move an Asteroid Competition

18 October 2015

UNSW Mechanical & Manufacturing Engineering PhD student William Crowe has been awarded first place in the 2015 Space Generation Advisory Council Move an Asteroid competition held in conjunction with 2015 International Astronautical Congress (IAC) and Space Generation Congress (SGC) in Jerusalem.

The competition challenged students and young professionals worldwide to come up with original ideas relating to Near Earth Objects (NEOs), with each entrant required to submit a technical paper of up to ten (10) pages long, describing their design. Submissions were sought regarding any of the following topics:

- Safe deflection of an Earth-bound NEO
- NEO study, characterisation and detection
- Global NEO impact warning system
- NEO resource utilisation
- Proposals/concepts for NEO missions aiming at planetary defence, exploration, resource utilisation
- NEO impact consequences
- NEO education programs and strategies

Put simply, William’s proposition was to visit asteroids that come very close to the Earth, rather than travel great distances over many years to reach those that are far away. The prize included transport and entry to the 2015 IAC and SGC, including the opportunity to present the winning paper.

We congratulate William on a fantastic job!

---

ION GNSS+ 2015 in Tampa, USA

16 - 18 September 2015

Prof Dempster presented a paper on behalf of our PhD student Sanat Biswas, this was received quite well and generated plenty of discussion after the session concluded. Similarly, Prof Dempster chaired a session featuring a paper on our work with GPSat, which also attracted questions and follow up leads afterwards.

In 2015 the Australian contingent was fairly small, Prof Dempster being only one of six Australian delegates, amongst others from other Australian universities, industry and government.

---

ACSER Annual Report 2015
Media & Publicity

As expected, ACSER media attention in 2015 was dominated by the 2nd Off Earth Mining Forum in November, however a steady inflow of general media enquiries seeking expert comment on all space-related matters shows that we are maintaining, if not growing, our reputation as national leaders in space.

2015 Media Coverage:

- High-altitude balloon provides foray into final frontier (UNSW Newsroom, 15th April 2015)
- Space treaties are a challenge to launching small satellites in orbit (The Conversation, 17th April 2015)
- ISS Progress Comes Crashing Back to Earth (Radio Interview with Prof Dempster on ABC World Today (ABC Radio National, ABC Local), 21 July 2015)
- Mining the moon could make space travel to Mars a possibility (Radio Interview with Prof Dempster on ABC World Today (ABC Radio National, ABC Local), 22nd June 2015)
- Hommade satellites herald new age for Australian space industry (Radio Interview with Prof Dempster on ABC World Today (ABC Radio National, ABC Local), 21 July 2015)
- Mining in space could cost less than a gas plant, Hong Kong Economic Journal (6 Nov 2015)
- Mining in space could cost less than a gas plant, Moneyweb (South Africa) (6 Nov 2015)
- Deep space mining seen costing $27 billion, or half the price of huge Aussie gas terminal, The Japan Times (6 Nov 2015)
- Mining in space could cost less than a gas plant, TODAY (Singapore) (6 Nov 2015)
- At $27 billion, mining in space could cost less than a gas plant, Chicago Tribune (USA) (8 Nov 2015)
- Mining in space could cost less than a gas plant, The Daily Herald (USA) (8 Nov 2015)
- Space mining might cost less than a gas plant on Earth, The Herald (USA) (9 Nov 2015)
- At $27 billion, mining in space could cost less than a gas plant, Tulsa World (USA) (9 Nov 2015)
- Mining in space cheaper than setting up a gas plant, Times of India (9 Nov 2015)
- Intriguingly, costs of mining in space found to be in reach, Northwest Arkansas Democrat-Gazette (USA) (9 Nov 2015)
- Mining in space a steal at a mere $27B, National Post (Canada) (9 Nov 2015)
- Space mining might cost less than a gas plant on Earth, Salt Lake Tribune (USA), (10 Nov 2015)
- At $27 billion, mining in space could cost less than a gas plant, The Jakarta Post (Indonesia), (11 Nov 2015)
- At $27B, mining in space could cost less than a gas plant on Earth, The Bulletin (USA), (12 Nov 2015)
- Auf den Mond schießen oder in den Hut stecken: Die 10 ungewöhnlichsten Investments, Das Investment Magazine (Germany) , (13 Nov 2015)
- US senate passes space mining bill, Australian Mining, (19 Nov 2015)
- Space Mining Opens Door To Mars Missions, The Huffington Post, (25 Nov 2015)

Full list with links available from: acser.unsw.edu.au/acser-in-the-news
Our Students
Undergraduate Education

BLUEsat

The BLUEsat Group is a collection of undergraduate students at UNSW Australia dedicated to creating easy-to-access space technology.

The mission of the group is to take on practical space engineering projects and in doing so, give undergraduate engineering students hands-on experience on space technology. The group is currently undertaking four projects:

- Development of a satrospheric balloon vehicle for scientific experiments
- Design of a CubeSat for entry into the Canadian Satellite Design Challenge (CSDC)
- Construction of a Mars Rover for entry into the European Rover Challenge (ERC)
- Construction of a Groundstation for communicating with satellites, in particular the UNSW EC-0 QB50 satellite

Club History

BLUEsat was started in 1997 as the Basic Low-Earth Orbit UNSW Experimental Satellite (BLUEsat) project, aimed at designing, building and launching the first undergraduate satellite in Australia. With the completion and demonstration of our first prototype in early 2013, the Group expanded its operations to include research into emerging CubeSat technologies, off-world rovers and near space experimental platforms.

From 2010 BLUEsat was taken under the wing of the Australian Centre for Space Engineering Research.

The club also celebrated the relaunch of their website in 2015 and a renewed social media focus. Their affiliation with the new Michael Crouch Innovation Centre has attracted new attention and new talent to the group.

Satellite Project

In 2015, the BLUEsat Satellite team participated in the Canadian Satellite Design Challenge participating and presenting in design review sessions in Winnipeg and Vancouver. The team then consolidated efforts into reviewing their satellite’s system architecture, after which the team started developing and building a 2-unit CubeSat power system from scratch.

Ground Station

In 2015, five BLUEsat technicians gained their amateur radio licences, and with the help of the St George Wireless club, developed and implemented a ground station for ACSER’s QB50 project.

Stratospheric Balloon Testing

BLUEsat’s stratospheric testing initiative sends high-altitude sounding balloons up to 30,000m with a suite of tracking and telemetry sensors to facilitate the near-space...
testing of flight hardware, as well as a state-of-the-art separation mechanism to ensure flight control. The flights are also used for high altitude experiments for academic groups within UNSW.

After an inaugural launch in late 2014, the Balloon team conducted several launches in 2015, successfully launching and recovering two balloons from the Muswellbrook region, and one from Temora. Footage from the flights has become a prominent component of BLUEsat’s branding.

Off World Robotics

The BLUEsat Off-World Robotics group provides an opportunity for students to develop robotic systems with a particular focus on extra-terrestrial exploration. In the long term the group aims to develop a versatile rover, capable of performing a variety of tasks in an environment similar to what would be experienced on the surface of the moon or Mars.

Off World Robotics (OWR) was formed during the starting weeks of the first student semester of 2014 and after only several months has designed and built their very first rover “Buttercup”. In 2014 this rover and a team of four flew to Arkaroola to take part in the Mars Robot Challenge.

On the back their success at Arkaroola, in 2015, the BLUEsat OWR team became the first Australian team to qualify for the European Rover Challenge in Poland. They competed and placed 15th out of 40 international teams, a considerable achievement considering the small team size and relative inexperience. The team is currently redesigning the rover for entry into the 2016 ERC.
### Honours Supervision

ACSER projects have made an exciting and enriching contribution to the range of fourth year thesis topics available to UNSW Engineering students. In particular, the QB50 cubesat satellite project has provided a wide range of topics for students to study with both practical applications and accessible testing materials.

Projects currently span the Schools of Mining Engineering, Mechanical and Manufacturing Engineering and Electrical Engineering and Telecommunications. Listed below are the students and topics supervised by ACSER staff and affiliates.

<table>
<thead>
<tr>
<th>Year &amp; Semesters</th>
<th>Name</th>
<th>School</th>
<th>Supervisors</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2 2014 - S1 2015</td>
<td>John Heath III</td>
<td>MME</td>
<td>Nathan Kinkaid</td>
<td>In-Situ Structural Testing of a 3D-Printed Satellite</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Lewis Cowper</td>
<td>MME</td>
<td>Nathan Kinkaid</td>
<td>Investigation of the minimal structure of a satellite assembled on-orbit</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Lingxiao Li</td>
<td>MME</td>
<td>Nathan Kinkaid</td>
<td>The application of electric propulsion on asteroid mining</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Fiona Keniry</td>
<td>MME</td>
<td>Nathan Kinkaid</td>
<td>Electromagnetic launch systems for assisting in the launch of payloads into orbit</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Scott Lee</td>
<td>MME</td>
<td>Nathan Kinkaid</td>
<td>Identifying the accessibility of asteroids for asteroid mining</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Vikas Sewani</td>
<td>EET</td>
<td>Joon Wayn Cheong</td>
<td>Developing a Multicore GNSS Receiver on an FPGA</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Yishi Sun</td>
<td>EET</td>
<td>Andrew Dempster</td>
<td>Monitoring space junk using optical telescopes in space</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Xiaotong Huang</td>
<td>EET</td>
<td>Andrew Dempster</td>
<td>Live video imaging wireless transmission from UAV</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>David Reid</td>
<td>MME</td>
<td>Naomi Tsafnat, Barnaby Osborne</td>
<td>QB50 material outgassing testing of PEEK</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Marty Deaker</td>
<td>MME</td>
<td>Naomi Tsafnat, Barnaby Osborne</td>
<td>In-situ testing of the structural characteristics of a novel cubesat structure</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Jaryl Sim</td>
<td>MME</td>
<td>Naomi Tsafnat, Barnaby Osborne</td>
<td>QB50 Satellite Ground Station Upgrade</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Thomas Hile</td>
<td>MME</td>
<td>Naomi Tsafnat, Barnaby Osborne</td>
<td>Thermal analysis and design for QB50</td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Shogan Aversa-Druesne</td>
<td>MME</td>
<td>Naomi Tsafnat, Barnaby Osborne</td>
<td>Automated Satellite Tracking System for QB50</td>
</tr>
<tr>
<td>S2 2014 – S1 2015</td>
<td>Aykan Ermis</td>
<td>EET</td>
<td>Ediz Cetin, Garth Pearce</td>
<td>Space based solar power</td>
</tr>
<tr>
<td>S2 2014 – S1 2015</td>
<td>Elle Xiao Wang</td>
<td>EET</td>
<td>Elias Aboutanios</td>
<td></td>
</tr>
<tr>
<td>S2 2014 - S1 2015</td>
<td>Gavin Baxter</td>
<td>MME</td>
<td>Ediz Cetin, Garth Pearce</td>
<td>3D Printing of Functional Structures for Space Applications</td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Cameron Cooke</td>
<td>EET</td>
<td>Andrew Dempster, Eamonn Glennon</td>
<td>High Dynamics GNSS Receiver</td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Zi Teng (Jason) Wang</td>
<td>EET</td>
<td>Andrew Dempster, Eamonn Glennon</td>
<td>GPS Timing Receiver</td>
</tr>
</tbody>
</table>


top

continued....

<table>
<thead>
<tr>
<th>Year &amp; Semesters</th>
<th>Name</th>
<th>School</th>
<th>Supervisors</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Richard Croker</td>
<td>EET</td>
<td>Andrew Dempster, Eamonn Glennon</td>
<td>GPS on a tumbling spacecraft</td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Chun-Kan Leung</td>
<td>EET</td>
<td>Ediz Cetin</td>
<td>Space Based Tracking of Aircraft on CubeSats</td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Vincent Si Hua</td>
<td>EET</td>
<td>Ediz Cetin</td>
<td>Energy Scavenging and Harvesting for Mobile Devices</td>
</tr>
<tr>
<td></td>
<td>Ngui</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Zhengyuan Chen</td>
<td>EET</td>
<td>Ediz Cetin</td>
<td>Evaluation of Mismatch Effects in TI-ADC Converters for SDR</td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Divya Jindal</td>
<td>MME</td>
<td>Ediz Cetin, Garth Pearce</td>
<td>3D Printing of Functional Structures for Space Applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Johannes De Hoop</td>
<td>MME</td>
<td>Ediz Cetin, Garth Pearce</td>
<td>Feasibility Study of a Near-Earth Asteroid Mining Operation using Energy/Mass Balance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 2015 – S2 2015</td>
<td>Lachlan Colley</td>
<td>MINE</td>
<td>Serkan Saydam</td>
<td>Investigating Selective Laser Sintering as a Manufacturing Method for Creating Mine Infrastructure in Off Earth Mines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Chris Josifowski</td>
<td>MME</td>
<td>Naomi Tsafnat, Jason Held</td>
<td>Integrating Performance Outcomes of Space Mission Control Operators with Idealised Software</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 2015 - S2 2015</td>
<td>Shannon Green</td>
<td>EET</td>
<td>Joon Wayn Cheong</td>
<td>A Low-Resource Viterbi Decoder for the Namuru GNSS Receiver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 2015 - S1 2016</td>
<td>Nathan Doyle</td>
<td>MME</td>
<td>Naomi Tsafnat</td>
<td>Design of crewed mission to Mars</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 2015 - S1 2016</td>
<td>Bo Chen</td>
<td>EET</td>
<td>Andrew Dempster, Ediz Cetin</td>
<td>ADS-B Receiver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 2015 - S1 2016</td>
<td>Yue Xi</td>
<td>EET</td>
<td>Andrew Dempster, Ediz Cetin</td>
<td>AIS Receiver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 2015 - S1 2016</td>
<td>Patrick V</td>
<td>EET</td>
<td>Ediz Cetin</td>
<td>Stereo Vision and Character Recognition for the Raspberry Pi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 2015 - S1 2016</td>
<td>Tong Wu</td>
<td>CSE</td>
<td>Oliver Diessel, Ediz Cetin</td>
<td>Reliable Reconfiguration Control Processor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Taste of Research**

Our staff have also participated in offering Taste of Research projects and Science Without Borders projects over the summer to local and international undergraduate students.

<table>
<thead>
<tr>
<th>Program</th>
<th>Year/ Semester</th>
<th>Name</th>
<th>School (of Student)</th>
<th>Supervisor/s</th>
<th>Topic or Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste of Research</td>
<td>Nov 2014 – Feb 2015</td>
<td>Yue Kang</td>
<td>EET</td>
<td>Oliver Diessel/Ediz Cetin</td>
<td>Real-time Programming for the RUSH QB50 Payload</td>
</tr>
<tr>
<td>Science Without Borders</td>
<td>Nov 2014 – Feb 2015</td>
<td>Jessé Barreto</td>
<td>EET/Brazil</td>
<td>Ediz Cetin/ Oliver Diessel</td>
<td>FPGA Configurations for the RUSH QB50 Payload</td>
</tr>
<tr>
<td>Taste of Research</td>
<td>Nov 2015 - Feb 2016</td>
<td>Divya Jinda</td>
<td>MME</td>
<td>John Page</td>
<td>Space Hedgehog Swarms for Asteroid Exploration</td>
</tr>
</tbody>
</table>
Postgraduate Coursework and Research Practicums

Master of Engineering Science (Satellite Systems Engineering)

In 2014, the University replaced the 8539 Master of Engineering Science Extension program with the 8338 Master of Engineering Science program. Therefore the ELECS8539 stream was revised to fit the new program and the new stream is now called the ELECS8338 Master of Engineering Science in Satellite Systems Engineering (the ELECS8338 Satellite Systems Engineering stream). The ELECS8338 stream now comprises 8 core courses, 4 electives and a project. The recommended structure for full time study is listed below. The masters also saw a coordinated advertising campaign with the help of the Faculty. This led to applications and subsequently enrolments. The number of enrolments currently is around 9. Efforts are continuing to advertise the program. In 2015 we ran the AERO9500, ELEC9762, AERO9610 courses again, and ELEC9764 and ELEC9781 Supervised Reading (in place of of ELEC9765) for the first time.

**SEMESTER 1**

4 core courses:
1. AERO9500 Space Systems Architectures and Orbits
2. ZEIT8012 Space Systems Engineering
3. ELEC9762 Space Mission Development
4. ELEC9765 Space Law and Radio Regulations

**SEMESTER 2**

4 core courses:
1. ELEC9764 The Ground Segment and Space Operations
2. AERO9610 The Space Segment
3. ZEIT8013 Space Applications 1
4. GMAT9765 Space Applications 2 (although this will eventually become either a Civil or Electrical course).

**SEMESTER 3**

2 Electives, year-long project

**SEMESTER 4**

2 Electives, year-long project

Other Postgraduate Coursework Thesis Supervision

<table>
<thead>
<tr>
<th>Program</th>
<th>Year/Semester</th>
<th>Name</th>
<th>School</th>
<th>Supervisor/s</th>
<th>Topic or Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEngSc (Electrical Eng.)</td>
<td>S2 2014 - S1 2015</td>
<td>Yingliang Nie</td>
<td>EET</td>
<td>Ediz Cetin/ Garth Pearce</td>
<td>Planning for Space-based Solar Power Stations</td>
</tr>
</tbody>
</table>

International Postgraduate Research Students on Exchange

**Supervised by ACSER Staff and Affiliates in Space-Engineering Topics**

<table>
<thead>
<tr>
<th>Student</th>
<th>Program Type</th>
<th>School</th>
<th>Dates / Duration</th>
<th>ACSER Funded Scholarship/ Stipend</th>
<th>Topic</th>
<th>Supervisor/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiaobo GU</td>
<td>PhD Practicum (Beihang University, China)</td>
<td>EET</td>
<td>1 year, 2014 - 2015</td>
<td>Inter-Satellite Timing Synchronisation</td>
<td>Andrew Dempster</td>
<td></td>
</tr>
</tbody>
</table>
| Pai WANG         | PhD Practicum (Beihang University, China) | EET      | 1 year, 2015 - 2016 |                                    |                                                                     | Andrew Dempster;
| Laure DEmICHELI  | Masters Practicum, École Nationale de l’Aviation Civile (ENAC) | EET      | 6 months, Feb - Jul 2015 | $6000                | Detecting the Presence of Spoofers using Multipath Detection Techniques | Andrew Dempster, Ediz Cetin  |
### Higher Degree Research

#### Postgraduate Research Students in Space Engineering

*Supervised or Co-Supervised by ACSER Staff and Affiliates*

<table>
<thead>
<tr>
<th>Student</th>
<th>Program Type</th>
<th>School</th>
<th>Commencement/End Year</th>
<th>ACSER Funded Scholarship/Stipend</th>
<th>Topic</th>
<th>Supervisor/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiangrong Wang</td>
<td>PhD</td>
<td>EET</td>
<td>2011-2105</td>
<td></td>
<td>Array signal processing for interference mitigation in GNSS applications</td>
<td>Elias Aboutanios, Andrew Dempster</td>
</tr>
<tr>
<td>Kai Zhao</td>
<td>Masters by Research</td>
<td>EET</td>
<td>2012 - 2015</td>
<td></td>
<td></td>
<td>Andrew Dempster</td>
</tr>
<tr>
<td>Vaidhya Mookiah</td>
<td>Masters by Research</td>
<td>EET</td>
<td>2012-2015</td>
<td>$25,000 / year for 3 years</td>
<td></td>
<td>Andrew Dempster</td>
</tr>
<tr>
<td>Jendi Kepple</td>
<td>PhD</td>
<td>MME</td>
<td>2012-2015</td>
<td></td>
<td>Robust Optimisation of Launch Vehicle Structures</td>
<td>Garth Pearce</td>
</tr>
<tr>
<td>Joshua Brandt</td>
<td>PhD</td>
<td>MME</td>
<td>2013</td>
<td></td>
<td>Dynamics and Control of a Chaotic Dripping Regime in Reduced Gravity</td>
<td>Barnaby Osborne, Naomi Tsafnat</td>
</tr>
<tr>
<td>Sanat Biswas</td>
<td>PhD</td>
<td>EET</td>
<td>2013</td>
<td>$25,000 / year for 3 years</td>
<td>Real-time On-board Satellite Navigation using Multi-GNSS Receiver</td>
<td>Andrew Dempster, Li (Lily) Qiao</td>
</tr>
<tr>
<td>Scott O’Brien</td>
<td>PhD</td>
<td>EET</td>
<td>2013</td>
<td></td>
<td>GNSS Reflectometry</td>
<td>Andrew Dempster</td>
</tr>
<tr>
<td>Vinh Tran</td>
<td>PhD</td>
<td>EET</td>
<td>2013</td>
<td></td>
<td></td>
<td>Andrew Dempster</td>
</tr>
<tr>
<td>Madeleine Sabordo</td>
<td>PhD</td>
<td>EET</td>
<td>2014</td>
<td></td>
<td>Moving Target Detection and Tracking using Radar in Heterogeneous Clutter</td>
<td>Elias Aboutanios</td>
</tr>
<tr>
<td>Scott Dorrington</td>
<td>PhD</td>
<td>MME</td>
<td>2014</td>
<td></td>
<td>Trajectory design for asteroid mining missions</td>
<td>Nathan Kinkaid, John Olsen</td>
</tr>
<tr>
<td>William Crowe</td>
<td>PhD</td>
<td>MME</td>
<td>2014</td>
<td></td>
<td>Characterising asteroids using spacecraft swarms</td>
<td>Nathan Kinkaid, John Page and John Olsen</td>
</tr>
<tr>
<td>Carlos Tapia Cortez</td>
<td>PhD</td>
<td>MINE</td>
<td>2014</td>
<td></td>
<td>Off Earth Mining Water Extraction - Mars’ Mining Model (WEM³)</td>
<td>Serkan Saydam</td>
</tr>
<tr>
<td>Benjamin Southwell</td>
<td>PhD</td>
<td>EET</td>
<td>2015</td>
<td></td>
<td>Positioning and navigating spacecraft near asteroids</td>
<td>Andrew Dempster</td>
</tr>
<tr>
<td>Arunkumar Rathinam</td>
<td>PhD</td>
<td>EET</td>
<td>2015</td>
<td></td>
<td>Autonomous navigation of spacecraft near an asteroid utilising Simultaneous Localisation and Mapping (SLAM)</td>
<td>Andrew Dempster</td>
</tr>
</tbody>
</table>

Over 150 email enquiries from around the world were received during 2015 regarding PhD topics listed on the ACSER PhD website: [acser.usnw.edu.au/phd-opportunities](mailto:acser.usnw.edu.au/phd-opportunities)
Sanat Biswas is a PhD student in the School of Electrical Engineering and Telecommunications at the University of New South Wales (UNSW). He received BE (2010) in Instrumentation and Electronics from Jadavpur University and M. Tech (2012) in Aerospace Engineering from Indian Institute of Technology Bombay. Sanat is currently associated with Australian Centre for Space Engineering Research (ACSER) and Satellite Navigation and Positioning (SNAP) Laboratory. He has been awarded the Emerging Space Leaders Grant 2014 by the International Astronautical Federation.

Research Profile
Sanat’s research focus is non-linear estimation techniques for on-board space vehicle navigation using GNSS receivers. He has developed two new fast Unscented Kalman Filter (UKF) algorithms called the Single Propagation Unscented Kalman Filter (SPUKF) and the Extrapolated Single Propagation Unscented Kalman Filter (ESPUKF). These algorithms can reduce the processing time of the UKF up to 90 percent. The application of the SPUKF and ESPUKF is not limited to space vehicle position estimation and can be applied to any non-linear estimation problems where the UKF can be used.

Contact
Sanat K. Biswas
Postgraduate Research Student
Australian Centre for Space Engineering Research
School of Electrical Engineering and Telecommunications
Kensington Campus, Building G17
The University of New South Wales
E: s.biswas@unsw.edu.au

Vinh Tran is a PhD candidate in the School of Electrical Engineering and Telecommunications at the University of New South Wales (UNSW). He received B.Eng. (2007) in Computer Science and M.Sc. (2009) in Information Processing and Communication from the School of Information and Communication Technology, Hanoi University of Science and Technology. Currently. He is currently associated with Australian Centre for Space Engineering Research (ACSER) and Satellite Navigation and Positioning (SNAP) Laboratory.

Research profile
Vinh’s research focus is dynamically configuration and programmable baseband receiver design for multi-GNSS signals. He has developed a pipeline programmable baseband correlator that can dynamically configure to process 16 GPS L1 C/A, 8 BEIDOU B1I, 4 GALILEO E1 or 1 GPS L5/GALILEO E5 channels. Combining the advantage of the hardware interleaving technique and the proposed dynamically configurable MAV decimator, the proposed pipeline correlator implemented on the Xilinx Artix-7 FPGA reduces resources utilization from 15.2% to 94.6% and power consumption from 16.2% to 65.7% compared to the corresponding conventional digital correlator. Besides that, he also developed a hardware-based model that accurately evaluates the effect of the sampling frequency, front-end filter bandwidth, Doppler frequency, and the received signal to noise ratio on the correlation output as well as the Delay Locked Loop (DLL) tracking error. This result can be used as a guideline for sampling frequencies and coherent integration time selection for GNSS receiver design.

Contact
Vinh Tran, Postgraduate Research Student
Australian Centre for Space Engineering Research,
School of Electrical Engineering and Telecommunications,
Kensington Campus, Level 6, Material Science Building,
University of New South Wales.
Email: vinh.tran@student.unsw.edu.au
Our People
Our People

Academic Staff

Professor Andrew Dempster is Director of the Australian Centre for Space Engineering Research (ACSER) in the School of Electrical Engineering and Telecommunications at the University of New South Wales (UNSW). He has a BE and MEngSc from UNSW and a PhD from University of Cambridge in efficient circuits for signal processing arithmetic. In the late 80s he was system engineer and project manager for the first GPS receiver developed in Australia and has been involved in satellite navigation ever since.

His current research interests are in satellite navigation receiver design and signal processing, areas where he has seven patents, and new location technologies. He is leading the development of space engineering research at ACSER.

Dr Elias Aboutanios is currently conducting research in the areas of nuclear magnetic resonance spectroscopy, global navigation satellite systems, radar target detection, biologically inspired signal processing, and theoretical signal processing. He is also active in the research of teaching methodologies and course design. In particular, Dr Aboutanios has developed a new course on electrical engineering design. He currently has a large grant to develop a new masters program in satellite systems engineering. He also has an active interest in satellite technology and in particular cubesats. He has secured money for and initiated UNSW’s involvement in the European QB50 project, which aims to launch 50 cubesats into low earth orbit in 2015.

Core Research Team

Dr Barnaby Osborne is currently an Academic Fellow at UNSW in spacecraft engineering with research interests in CubeSats, hybrid and solid propulsion, space composites, microgravity physics and microgravity facility design. Prior to his appointment at UNSW he was the field leader for the Astronautics and Space Systems group at Kingston University in the UK. Additionally he has worked as a testing and instrumentation engineer, research and design engineer and space engineering consultant.

Dr Ediz Cetin is a Senior Research Associate at the Australian Centre for Space Engineering Research (ACSER), University of New South Wales, Australia. He received his B.Eng. (Hons) degree in Control and Computer Engineering and Ph.D. degree in Unsupervised Adaptive Signal Processing for
Wireless Receivers from the University of Westminster, London, United Kingdom. His research interests encompass interference detection and localization, fault-tolerant reconfigurable circuits for space applications, adaptive techniques for RF impairment mitigation for communications and Global Navigation Satellite Systems (GNSS) receivers and design and low-power implementation of digital circuits.

Dr Eamonn Glennon’s first employment in the Australian Space Industry occurred 18 months after he graduated from UNSW with a B.Sc in Computer Science and BE (Hons I) in Electrical Engineering when he started work at Canberra based Auspace Ltd. There he worked on what was Australia’s very first GPS receiver and has not looked back since. This work continued when the GPS technology was sold to Melbourne based Sigtec Pty Ltd and SigNav Pty Ltd was founded. At SigNav he was responsible for much of the firmware that forms the core of a GPS receiver, including development of GPS related algorithms and customisation of that firmware for applications ranging from tracking taxis using GPS combined with dead-reckoning through to putting GPS receivers into phone handsets and high precision GPS timing. During his time at SigNav, he also completed part time a MEngSc and a PhD in GPS signal processing. Following completion of his PhD he commenced work at UNSW where he continues to work on the UNSW FPGA based GPS receiver, with the aim of customising it for operation in cubesats and other space related applications.

Dr Joon Wayn Cheong is currently a Research Associate at the School of Electrical Engineering, University of New South Wales (UNSW) where he is currently developing the firmware for the space-qualified Namuru family of GPS/GALILEO integrated receivers under the Garada and QB50 project. He received his PhD from UNSW where he cracked the Locata pseudolite positioning system’s code and derived hybrid conventional/Collective Detection algorithm. His other research interests in the GNSS field include weak signal acquisition, A-GPS, GNSS/pseudolite integrated signal processing, GNSS interference and spoofing. He authored more than 15 peer-reviewed publications.

Dr Lingkan (George) Gong is currently a Research Associate with the Australian Centre for Space Engineering Research, in a research team under the School of Computer Science and Engineering (UNSW).

Support Staff

Cheryl Brown is the administrator for the Australian Centre for Space Engineering Research, looking after all aspects of Centre operations such as marketing and events, finance and HR. She also has a hand in overseeing the BLUEsat student space-projects society, of which she was a founding member in her undergraduate days at UNSW in the 90s.

After leaving a BSc in Physics and Astronomy to pursue Arts majors in Philosophy and The History and Philosophy of Science, she worked a variety of roles in the not-for-profit sector before commencing with UNSW Engineering in student services in 2007. In 2011 she left that role to travel across Europe, Russia & Mongolia. She returned to Sydney after a year to concentrate on completing a Masters in Ancient World Studies at Sydney University while working part time with UNSW Built Environment, performing assorted admin roles and assisting the Associate Dean (Education).

Cheryl joined the Australian Centre for Space Engineering Research at the start of 2014 as their sole administrator. She continues to pursue her love of history and travel, participating her first archaeological dig on the Greek island of Andros in October 2014.
Affiliated Research Staff

**Professor Chris Rizos** is Professor of Geodesy and Navigation, School of Civil & Environmental Engineering, the University of New South Wales (UNSW), Sydney, Australia. Chris is president of the International Association of Geodesy (IAG), a member of the Executive and Governing Board of the International GNSS Service (IGS), and co-chair of the Multi-GNSS Asia Steering Committee. Chris is a Fellow of the IAG, a Fellow and current president of the Australian Institute of Navigation, a Fellow of the U.S. Institute of Navigation, and an honorary professor of Wuhan University, China. Chris has been researching the technology and applications of GPS and other navigation/positioning systems since 1985, and is an author/co-author of over 600 journal and conference papers.

**Dr Craig Roberts** is a Senior Lecturer majoring in Surveying/ GPS/ Geodesy in the Surveying and Geospatial Engineering group at the School of Civil and Environmental Engineering, University of New South Wales, Sydney, Australia. He graduated from the South Australian Institute of Technology with a Bachelor of Surveying in 1988. He began his career as a private surveyor in Adelaide and has since worked as a Geodetic Engineer at UNAVCO, USA involved with GPS for geodynamic studies in Nepal, Ethiopia, Argentina and Indonesia. He worked as a scientific assistant at the GeoForschungsZentrum, Germany where his main focus was orbit determination and prediction for a number of geodetic research satellites. He completed his PhD thesis on volcano monitoring using low-cost GPS networks in March 2002. He has lectured at RMIT University in Melbourne for two years. His current research interests involve implications of datum modernisation and leveraging CORS infrastructure for practical application to surveying and geospatial information.

**Dr Mazher Choudhury** is currently working at the School of Civil and Environmental Engineering as a Research Associate. He obtained his PhD from UNSW where he investigated and analysed the potentiality of Locata Positioning Systems into deformation monitoring system. Currently he is involved in investigating real-time precise point positioning using multi GNSS observations. Previously he was involved in testing the space qualified FPGA-based multi GNSS Integrated receiver for the GARADA Formation Flying. His research interests include land as well as space based GNSS positioning and navigation, multi-GNSS integration algorithms for navigation, GNSS data analysis procedure and improvement of testing procedure for receivers, Locata integration with GNSS.

**Dr Garth Pearce** is a researcher in Aerospace Engineering, specialising in aerospace structures & composite materials. Garth’s interest in space research began with a concept for a composite, inflatable and rigidisable boom structure for volume limited payloads. He has co-supervised a number of honours and masters research projects with ACSER investigating the rigidisable boom concept as well as more exotic topics; functional additive manufacture in space and space-based solar power.

**Dr Nathan Kinkaid** earned his PhD in Mechanical Engineering from the University of California, Berkeley in 2004. He subsequently worked for 3 years in the Structural Dynamics Department of the Aerospace Corporation where he performed research and oversight tasks in support of national security space programs. Nathan joined the School of Mechanical and Manufacturing Engineering at UNSW in 2007, and his current research interests include off-earth mining, on-orbit assembly of spacecraft, operation of swarms of spacecraft and bicycle
dynamics. He is currently supervising 2 PhD students who collaborate with ACSER on off-earth mining topics and is involved in the design of in-situ structural tests for UNSW’s QB50 satellite.

Dr Naomi Tsafnat is a Lecturer in Aerospace Engineering where she teaches orbital mechanics and spacecraft engineering. Her current research projects include the design of asteroid capture and bio-mining missions, and the study of bio-nimetic approaches to aerospace engineering. Dr Tsafnat has worked in the US at Lockheed Martin Missiles and Space in satellite thermal design and analysis, and was involved in various projects with NASA Ames Research Center. Dr Tsafnat supervises a PhD student and several undergraduate honours thesis students in space engineering projects, including QB50 and SMiLE.

Dr John Olsen is a Lecturer with the School of Mechanical and Manufacturing Engineering. His research interests include:
- Turbulence.
- Simulation philosophy.
- Swarms.
- Co and Trigeneration systems.
- Hybrid vehicles.
- Combined heat & power systems.
- Thermodynamics, heat transfer and fluid mechanics.
- Entropy generation minimisation and exergy analysis.
- The simulation of gas turbine engines, power stations, reciprocating piston engines, refrigeration systems, living systems, entropy, etc.

Mr John Page moved to a Senior Lecturer post at the University of New South Wales in 1987 where he has; been responsible for design and simulation, was the founding Chairman for the Aviation program, was a founding member for the Cooperative Research Center for Aerospace Structures and headed the Aerospace Engineering Department from 1990-2000. His teaching areas have included Aerospace Design, Flight Dynamics and Simulation, while his research has covered Simulation, Flight Track Development (Qantas PhD,) and Swarms. Previously he was a Senior Lecturer in aerospace engineering at Kingston Polytechnic with research interests focused on Aerospace Policy Studies with the NASA Commercial Office, and Military/Civil Conversions.

Dr Oliver Diessel gained a B.Math. and BE in Computer Engineering with Honors in 1990 and a PhD in Computer Science in 1998 from the University of Newcastle, NSW. From 1986–1990 he was a Trainee Engineer and from 1991–1992 he was a Systems Engineer with Tomago-based Allco Steel Constructions. He joined UNSW as a lecturer following postdoctoral research from 1998–2000 at the University of South Australia. Since then, he has been a Senior Researcher at National ICT Australia (NICTA), an Assistant Professor at UNSW Asia in Singapore, and become a Senior Lecturer, primarily involved in teaching digital systems and conducting research into the design, application and support of dynamically reconfigurable hardware. Oliver has had visiting appointments at CalTech and Ho Chi Minh City University of Technology in 2003 and Harbin Institute of Technology since 2014.

Associate Professor Serkan Saydam received his BSc, MSc and PhD degrees in Mining Engineering from the Dokuz Eylul University, Izmir, Turkey and completed his Postdoctoral Fellowship at the University of Witwatersrand, Johannesburg, South Africa. Serkan joined the School of Mining Engineering as a Senior Lecturer in 2006 and was recently promoted to Associate Professor. He currently holds two ARC Linkage Projects and one ACARP research grants worth of over $4 million on Ground Control area. In addition, he has recently successfully established a research collaboration with NASA’s JPL. His fields of research include mine planning & design, new mining methods and ground control.

Associate Professor Serkan Saydam received his BSc, MSc and PhD degrees in Mining Engineering from the Dokuz Eylul University, Izmir, Turkey and completed his Postdoctoral Fellowship at the University of Witwatersrand, Johannesburg, South Africa. Serkan joined the School of Mining Engineering as a Senior Lecturer in 2006 and was recently promoted to Associate Professor. He currently holds two ARC Linkage Projects and one ACARP research grants worth of over $4 million on Ground Control area. In addition, he has recently successfully established a research collaboration with NASA’s JPL. His fields of research include mine planning & design, new mining methods and ground control.
2015 Visiting Fellows

Dr Nagaraj C Shivaramaiah is currently a researcher with the Colorado Centre for Astrodynamics Research at the University of Colorado, Boulder. He is also a visiting fellow at the Australian Centre for Space Engineering Research, UNSW Sydney where he was involved in the ASRP funded Garada project during 2011-2014. He is also a research consultant at his own consulting firm GNSS LABS and an advisor to Sensus Technologies Pvt. Ltd. Bangalore an indoor navigation start-up. His current research interests include multi-GNSS receiver design and development, systems engineering and signal processing for wireless communication and navigation technologies at large. He is a senior member of the IEEE and the Aerospace and Electronics Systems Society.

Ryan J. R. Thompson is a PhD graduand at the School of EET, UNSW, Australia. He received his BEng in Electrical Engineering from the same university in 2008. His current research activities are focused on the localization of Radio-Frequency Interference (RFI) that impacts ground-based GNSS augmentation systems. He is now working out of the ACSER officers for ACSER’s industry partner GPSat on a number of collaborations.

Dr Feng Shen is an associate professor with the College of Automation, Harbin Engineering University, China. He received his PhD in 2009 from Harbin Engineering University. He developed the signal acquisition and tracking of the Spread spectrum receiver for the GPS ground-based augmentation systems. His research interests include BOC signal tracking, and GNSS/INS integrated navigation system. From May 2014 to May 2015, he is a visiting academic with the Australian Centre for Space Engineering Research (ACSER) at the University of New South Wales (UNSW). During his visiting, he worked on the Cooperative Positioning in Intelligent Transportation Systems (ITS) which was based on fusing the measurements of Global Positioning System (GPS), Ultra-Wide Bandwidth (UWB) and Inertial Navigation System (INS).
2015 ACSER Team

Front Row: Dr Joon Wayn Cheong, Dr Nathan Kinkaid, Dr Ediz Cetin, Prof Andrew Dempster, Dr Barnaby Osborne, Dr Eamonn Glennon, Dr Craig Roberts, Mr William Crowe

Second Row: Ms Cheryl Brown, Mr Sanat Biswas, Mr Soumen Das, Mr James Bultitude, Mr Tim Broadbent, Mr John Lam, Mr Yiwei Han, Mr Mark Yeo, Mr Shannon Green, Mr Cameron Cooke

Back Row: Mr Joshua Brandt, Ms Lingling (Lily) Shi, Ms Sharmila Kayastha, Mr Chun-Kan Leung, Mr William Huynh, Mr Benjamin Southwell, Mr Daniel Sherratt
2015 Industry Partners and Collaborators

Jet Propulsion Laboratory
California Institute of Technology

UNSW Australia

Canberra

Australian Centre for Astrobiology, UNSW

NATIONAL SPACE SOCIETY OF AUSTRALIA LTD

DELTA-V
Australia’s Space Startup Accelerator

INTERNATIONAL SPACE UNIVERSITY

THE UNIVERSITY of ADELAIDE

BAE SYSTEMS

GPSat Systems Australia Pty Ltd

NANORACKS

GENERAL DYNAMICS

Kea GNSS

Optus D3

THALES
Governance
ACSER Governance

Steering Committee

This Committee is comprised of internal UNSW executive as listed below.

**Professor Andrew Dempster** is Director of the Australian Centre for Space Engineering Research (ACSER) at the University of New South Wales (UNSW). He is also Director Research in the School of Surveying and Spatial Information Systems and Director of Postgraduate Research in the Faculty of Engineering. He has a BE and MEngSc from UNSW and a PhD from University of Cambridge in efficient circuits for signal processing arithmetic.

Andrew was system engineer and project manager for the first GPS receiver developed in Australia in the late 80s and has been involved in satellite navigation ever since. He is leading the development of space engineering research at ACSER.

**Professor Russell Boyce** holds the position of Chair for Space Engineering at UNSW Canberra, where he leads the UNSW Canberra Space Research effort. He brings to this role a research approach developed throughout 25 years in the field of hypersonics, coupling computational and experimental research with flight testing, most recently via the SCRAMSPACE scramjet flight experiment program which he led as Chair for Hypersonics at the University of Queensland. Professor Boyce also chairs the Australian Academy of Science’s National Committee for Space and Radio Science, sits on the Executive Council of the Space Industry Association of Australia, and is an Associate Fellow of the American Institute for Aeronautics and Astronautics (AIAA). Professor Boyce’s current research focus is mainly in the arena of Space Situational Awareness.

**Professor Chris Tinney** is head of the Exoplanetary Science at UNSW research group within the Australian Centre for Astrobiology, in the School of Physics. My research interests are centered on “exoplanets” (planets that orbit other stars), as well as the very cool low-mass “star-like” bodies known as brown dwarfs (which share many properties with exoplanets). The study of both these classes of object tell us how stars and planets form and evolve, which is key to understanding how prevalent habitable environments are near the Sun, throughout the Galaxy and elsewhere in the Universe. I have worked at Observatories and Universities in Australia, Europe and the USA, and carry out my research with in concert with collaborators across Australia, Europe, the UK, USA and Chile.

He has a PhD in Astronomy (California Institute of Technology, 1992) and a BSc Hons in Physics (University of Sydney, 1987).

**Professor Martin Van Kranendonk** is a Professor of Geology, with 28 years of mapping complex Precambrian terrains. His main interest is on the early history of the Earth and he has developed an international reputation for my work on Archean tectonics and the geological settings of early life on Earth. More recently, as Chair of the Precambrian Subcommission of the International Commission on Stratigraphy, he has commenced a wholesale review of Precambrian stratigraphy with the aim of revising the Precambrian timescale. His particular skills are mapping and the ability to integrate a wide range of geological data into 4-D models, from the craton to micrometre scale.

Prof Van Kranendonk is also the Assistant Director of the Australian Centre for Astrobiology, co-leader of IGCP-SIDA Project 599 “The Changing Early Earth”, and Core Member of the International Precambrian Research Centre of China, as well as being on the editorial boards of Precambrian Research, Geology, Astrobiology, and Episodes.

**Professor Eliathamby Ambikairajah** is Head of School of Electrical Engineering and Telecommunications, University of New South Wales (UNSW), Australia. Professor Ambikairajah’s research interests include speech enhancement, speaker recognition, language recognition, emotion detection and biomedical signal processing. He has authored and co-authored more than 250 conference and journal papers, and is also a regular reviewer for several IEEE, IET and other journals and conferences. He was the Technical Program Co-Chair for the inaugural APSIPA Summit and Conference in 2010. For his contributions to speaker recognition research, he was invited as a Visiting Scientist to the Institute of Infocomms Research (A*STAR), Singapore in 2009, where he is currently a Faculty Associate.

He received his BSc(Eng) degree from the University of Sri Lanka and received his PhD degree in Signal Processing from Keele University, UK. He was appointed as Head of Electronic Engineering and later Dean of Engineering at the Athlone Institute of Technology in the Republic of Ireland from 1998 to 1999. His key publications led to his repeated appointment as a short-term Invited Research Fellow with the British Telecom Laboratories, U.K., for ten years from 1989 to 1999.

Professor Ambikairajah received the Vice-Chancellor’s Award for Teaching Excellence in 2004 for his innovative use of educational technology, the School Awards for Teaching Excellence in 2003, and Academic Management in 2001. He is a currently an APSIPA Distinguished Lecturer for the 2013-14 term. He is a Fellow and a Chartered Engineer of the IEEE and Engineers Australia and is a Member of the IEEE and APSIPA.

In accordance with the outcomes of the 2014 Centre Review by the Centres Secretariat, it was resolved that after 2014 the ACSER Management Committee would be replaced with a Steering Committee to bring Centre governance in line with UNSW Guidelines.

Two Steering Committee Meetings were held in 2015. Following are the dates and attendees, with the December meeting representing the final assembly of this Committee.

**2nd June 2015**
- Prof Mark Hoffman (Chair)
- Prof Russell Boyce
- Prof E. Ambikairajah
- Prof Chris Tinney
- Prof Andrew Dempster

**3rd December 2015**
- Prof Mark Hoffman
- Prof Russell Boyce
- Prof E. Ambikairajah
- Prof Martin Van Kranendonk
- Prof Andrew Dempster

**Professor Mark Hoffman** is the Dean of UNSW Engineering. Prior to his current appointment, Mark was the University’s Pro-Vice-Chancellor (Research) and also held the positions of Associate Dean (Research) in the Faculty of Science and Head of its School for Materials Science and Engineering for six years.

Professor Hoffman was the Presiding Member of the University’s Committee on Research from 2010-13. He holds a BE (1985) and PhD (1994) from the University of Sydney and Masters of Business and Technology from the University of New South Wales.

**Professor Russell Boyce**

**Professor Chris Tinney**

**Professor Martin Van Kranendonk**

**Professor Eliathamby Ambikairajah**
Donna Lawler is a commercial satellite lawyer for Optus and a member of the International Institute of Space Lawyers. She has provided legal advice on all aspects of the Optus Satellite business since joining Optus in 1999, and has had key involvement in the build and launch programmes for six satellites, including the negotiation of satellite purchase and launch contracts on behalf of Optus and its parent company SingTel. During more than a decade in the satellite industry, Donna has secured the use of orbital slots, advised on risk, liability and insurance issues for space-related projects and negotiated satellite capacity contracts with Australian broadcasters, international satellite operators and government entities, including the NBN. She has published papers on Space Law topics and is a regular guest lecturer in Space Law at several universities locally and overseas.

Professor Chris Rizos is currently Head of the School of Surveying & Spatial Information Systems at the University of New South Wales, Sydney, Australia. Chris has been researching the technology and applications of GPS since 1985, and established over a decade ago the Satellite Navigation and Positioning group at UNSW, today the largest academic GPS/GNSS and wireless location technology research laboratory in Australia. Chris is the President of the International Association of Geodesy (IAG), and a member of the Executive and Governing Board of the International GNSS Service (IGS). Chris is currently Chair of the working group developing the strategic plan for GNSS for Australia.

Dr Nick Stacy was born in Adelaide Australia. He received a B.E. from the University of Adelaide in 1984, a M.S. from Stanford University in 1985 and a Ph.D. from Cornell University in 1993, all in Electrical Engineering. He worked at Arecibo Observatory from 1985 to 1986 and at British Aerospace Australia from 1987 to 1989. His work has included the acquisition and analysis of Arecibo Observatory radar data from Venus. He joined the Australian Defence Science and Technology Organisation in 1993 where he is a radar specialist working in the field of imaging radar signal processing and backscatter analysis primarily using the Ingara airborne radar system.

Mr Michael Davis was appointed the Chair of the SIAA in 2013 bringing with him a wealth of experience as a legal practitioner in the Australian space industry and other sectors. A graduate of the Master of Space Studies program at the International Space University, he has been involved in a wide range of space related pursuits including chairing the Advisory Board of the UniSA institute of Telecommunications Research, attending UN and ITU space meetings, representing Australian and overseas clients involved in commercial launch, satellite and other space-related projects, co-authoring policy submissions on behalf of the association and organising the 2004 ISU Space Studies Program and the 2011-2013 Southern Hemisphere Summer Space Programs in Adelaide.

Mr Kirby Ikin is a global leader in commercial space development with advanced negotiation, risk management, and analytical skills. At Asia Pacific Aerospace Consultants, he advises the aerospace industry and national governments on finance, insurance, market analysis, project management and launch services. This includes a feasibility study for an Australian spaceport, satellite valuation, and analysis of the regional applications for a new satellite-based service. Kirby earlier created a new aerospace division within a major insurer (GIO Space), managed the commercial operations of a project to create a breakthrough service to extend the profitable working lives of communications satellites (Orbital Recovery Ltd in the UK), and is Chairman of the Board of the National Space Society, one of the world’s leading space advocacy organizations.

The last Advisory Committee Meeting was held in 2014. Following is the list of attendees.

11th December 2014
Kirby Ikin (chair)
Donna Lawler
Chris Rizos
Andrew Dempster
The following grants cover funding received by ACSER during 2015. In addition to below, there were a number of carried over funds from grants relating to existing projects.

<table>
<thead>
<tr>
<th>Grant</th>
<th>Project Period</th>
<th>Research Topic</th>
<th>Partners</th>
<th>Granting Organisation</th>
<th>Awarded Amount</th>
<th>ACSER’s Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatibility &amp; Technology Demonstrator</td>
<td>2015 to 2017</td>
<td>The development of new techniques to process multi frequency time difference of arrival and spoofer data sets to support the geolocation of GPS RF interference for defence operations.</td>
<td>GPsat Systems Australia, Defence Science and Technology Organisation</td>
<td>Defence Science and Technology Organisation</td>
<td>$300,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>ARC Discovery Project</td>
<td>2015 to 2017</td>
<td>Designing Radiation-Tolerant Reconfigurable Systems for Space</td>
<td>School of Computer Science and Engineering (CSE)</td>
<td>Australian Research Council</td>
<td>$340,300</td>
<td>$340,300</td>
</tr>
<tr>
<td>ARC Linkage Project</td>
<td>2015 to 2017</td>
<td>Rapid Recovery from Radiation-induced Errors in Reconfigurable Hardware</td>
<td>General Dynamics New Zealand</td>
<td>Australian Research Council</td>
<td>$321,899</td>
<td>$321,899</td>
</tr>
<tr>
<td>ARC Linkage Project</td>
<td>2015 to 2019</td>
<td>Protecting Critical Transport Infrastructure using Hybrid Approaches for Interference and Spoof Detection and Localisation</td>
<td>GPSat Systems, University of Adelaide</td>
<td>Australian Research Council</td>
<td>$505,087</td>
<td>$365,654</td>
</tr>
<tr>
<td>Collaborative Intelligent Transport Systems</td>
<td>2014</td>
<td>Nav/Com/Ins coupling techniques Demonstrator</td>
<td>Thales Alenia Space (France)</td>
<td>Thales Alenia Space (France)</td>
<td>€40,000 ($58,080)</td>
<td>€40,000 ($58,080)</td>
</tr>
<tr>
<td>Biarri</td>
<td>2011 - 2015</td>
<td>BIARRI GPS Receiver</td>
<td>BAE Systems</td>
<td>Defence Science &amp; Technology Organisation (DSTO)</td>
<td>$282,000</td>
<td>$282,000</td>
</tr>
<tr>
<td>QB50</td>
<td>2013 - 2015</td>
<td>An International Network of 50 CubeSats</td>
<td>UNSW</td>
<td>UNSW</td>
<td>$75,000</td>
<td>$75,000</td>
</tr>
<tr>
<td>QB50</td>
<td>2013 - 2015</td>
<td>An International Network of 50 CubeSats</td>
<td>UNSW</td>
<td>UNSW Faculty of Engineering</td>
<td>$45,000</td>
<td>$45,000</td>
</tr>
<tr>
<td>ACSER Centre Support Funds</td>
<td>2011 - 2014 (account closed 2015)</td>
<td>Preliminary development of a propulsion and GN&amp;C subsystem capable of providing orbital correction and de-orbiling manoeuvres on a CubeSat</td>
<td>UNSW</td>
<td>UNSW</td>
<td>$600,000</td>
<td>$600,000</td>
</tr>
<tr>
<td>RAPID3</td>
<td>2016-2018 (awarded in 2015)</td>
<td>Preliminary development of a propulsion and GN&amp;C subsystem capable of providing orbital correction and de-orbiling manoeuvres on a CubeSat</td>
<td>ZARM, Germany</td>
<td>Go8 - Germany Joint Research Cooperation Scheme</td>
<td>$20,118</td>
<td>$20,118</td>
</tr>
</tbody>
</table>
## Financial Report

### Aus Ctr Space Engineering Res

#### Statement of Financial Performance

**For the Year Ended December 2015**

<table>
<thead>
<tr>
<th>Note</th>
<th>REVENUE</th>
<th>EXPENSE</th>
<th>TOTAL CONTRIBUTION - SURPLUS/(DEFICIT)</th>
<th>Cashflow Funded Capital Expenditure (CAPEX)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>$'000</strong></td>
<td><strong>$'000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>REVENUE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Research Revenue:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Donations &amp; Bequest - Draw downs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>UNSW Contributions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Faculty Contributions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Other Restricted Revenue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Commercial Activity - Fees for Service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sundry Other Revenue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Revenue</td>
<td>693</td>
<td>659</td>
<td>1,137</td>
</tr>
<tr>
<td><strong>EXPENSE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Salaries, Oncosts and other staff costs</td>
<td>476</td>
<td>448</td>
<td>1,102</td>
</tr>
<tr>
<td>2</td>
<td>Scholarship Stipends</td>
<td>41</td>
<td>58</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>Contract &amp; Consulting Services</td>
<td>23</td>
<td>42</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Repairs and Maintenance</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Consumables</td>
<td>124</td>
<td>54</td>
<td>69</td>
</tr>
<tr>
<td>6</td>
<td>Travel</td>
<td>47</td>
<td>38</td>
<td>152</td>
</tr>
<tr>
<td>7</td>
<td>Equipment Non Capitalised</td>
<td>3</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>Entertainment</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Marketing</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Miscellaneous Expenses</td>
<td>47</td>
<td>(27)</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>Total Non-People Costs</td>
<td>289</td>
<td>172</td>
<td>504</td>
</tr>
<tr>
<td></td>
<td>Total Expenses</td>
<td>764</td>
<td>620</td>
<td>1,606</td>
</tr>
<tr>
<td></td>
<td>TOTAL CONTRIBUTION - SURPLUS/(DEFICIT)</td>
<td>$ (71)</td>
<td>$ 39</td>
<td>$ (649)</td>
</tr>
<tr>
<td></td>
<td>Depreciation</td>
<td>16</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>SURPLUS / (DEFICIT) after Depreciation</td>
<td>$ (88)</td>
<td>$ 24</td>
<td>$ (474)</td>
</tr>
<tr>
<td></td>
<td>Cashflow Funded Capital Expenditure (CAPEX)</td>
<td>-</td>
<td>112</td>
<td>30</td>
</tr>
</tbody>
</table>

#### Notes:

1. Revenue in Advance will be noted in Creditors & Other Liabilities.
2. UNSW Budget model includes other revenue items
3. Surplus and deficit will be noted in Surplus or Deficit.
4. Creditor & Other Liabilities will be noted in the same manner as above.
5. Total non-people costs are calculated as total expenses minus total non-people costs.
6. Surplus or Deficit is calculated as total revenue minus total expenses.
7. Cashflow Funded Capital Expenditure (CAPEX) is calculated as cashflow minus total capital expenditure.
8. UNSW has central provisions in respect of payments made to employees and taxation. Such provisions will not be reflected in this Centre’s Statement of Financial Position.
9. Property Plant & Equipment is depreciated over the expected useful life of the asset.
10. UNSW Division of Advancement holds donated funds centrally. Draw down of funds to the Centre is reflected in the Statement of Financial Performance.

### Statement of Financial Position

**As at December 2015**

<table>
<thead>
<tr>
<th>Note</th>
<th>UNSW Australia Internal Cash</th>
<th>Accounts Receivable</th>
<th>Sundry Assets</th>
<th>Investments</th>
<th>Property Plant &amp; Equipment</th>
<th>Creditors and Other Liabilities</th>
<th>NET ASSETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6 260 95 167</td>
<td>7 30 0 0</td>
<td>-</td>
<td>-</td>
<td>8 124 140 43</td>
<td>1 15 0 117</td>
<td>$ 399</td>
</tr>
<tr>
<td>2</td>
<td>6 260 95 167</td>
<td>7 30 0 0</td>
<td>-</td>
<td>-</td>
<td>8 124 140 43</td>
<td>1 15 0 117</td>
<td>$ 235</td>
</tr>
<tr>
<td>3</td>
<td>6 260 95 167</td>
<td>7 30 0 0</td>
<td>-</td>
<td>-</td>
<td>8 124 140 43</td>
<td>1 15 0 117</td>
<td>$ 93</td>
</tr>
</tbody>
</table>

Report provided by Cheryl Brown
Approved with amendments by Faculty Management Accountant
Hanny Lie on 6 June 2016

ACSER Annual Report 2015
Publications
Publications

Journal Articles


PhD Thesis

Refereed Conference Papers


### Abstract-refereed Conference Papers

- **BRANDT, J.D., OSBORNE, B., BARBER, T., CETIN, E., WELCH, C., TSAFNAT, N., 2015.** "Design and drop tower testing of a liquids experiment investigating the chaotic dripping regime in low gravity conditions", 66th International Astronautical Congress, October 2015
- **CROWE, W., 2015.** "Small body mass estimation from spacecraft swarm flyby dynamics", which was an abstract-reviewed paper at IAC 2015 and just had me affiliated with ACSER
- **DORRINGTON, S., KINKAID, N., OLSEN, J., 2015.** Trajectory Opportunities to Arijuna-type Asteroids for Asteroid Mining Missions, 66th International Astronautical Congress, Jerusalem, September 2015
- **KLAS, M., 2015.** Microbial Resource Extraction on Asteroids: Occupying the Niche. 2nd Off Earth Mining Forum, Sydney Australia, November 4-6, 2015
- **SAYDAM, S., 2015.** "An Integrated Economics Model for ISRU in Support of a Mars Colony”. NASA SSERVI (Solar System Exploration Research Virtual Institute)

### Abstract-refereed Conference Presentations

- **PHILLIPS, M., 2015.** "Development of a low-cost Software-Defined-Radio based student groundstation" ASRC 2015
- **MILLER, C., KABARAN, Y., 2015.** "A review of steering with Rocker Bogie chassis design" ASRC 2015

### Non-refereed Conference Papers


### Opinion

- **DEMPSTER, A.G.** “Let’s talk about the space industry in Australia’s election campaign”, The Conversation, 27 June, 2016
- **DEMPSTER, A.G.** “Space mining is closer than you think, and the prospects are great”, The Conversation, 7 Aug 2015

### Submitted/Accepted

### Invited Lectures

**DEMPSTER, A.G., 2015.** "Spaceup Sydney" July 25

**DEMPSTER, A.G., 2015.** "Cubesats – where are we?", SADIG workshop Sydney 1 April


**DEMPSTER, A.G., 2015.** "Off-Earth Mining: The Market?"

**DEMPSTER, A.G., 2015.** "Off-Earth Mining: The State of Play" ASRC 2015, 30 Sep

**DEMPSTER, A.G., 2015.** "Positioning Research at ACSER" CAESIE Indoor Event 6 Mar

**DEMPSTER, A.G., 2015.** "SBAS as critical infrastructure", SBAS workshop Canberra, Mar

**DEMPSTER, A.G., 2015.** "Space Engineering Research at ACSER", Aerospace Futures 11 July

**DEMPSTER, A.G., 2015.** "Space Engineering Research at ACSER", INTERSECT, April

**DEMPSTER, A.G., 2015.** "Space Engineering Research at ACSER", JPL Jan

**DEMPSTER, A.G., 2015.** "Space Engineering Research at ACSER", NSSA Mar

**DEMPSTER, A.G., 2015.** "Space Engineering Research at ACSER", Space X Jan

**DEMPSTER, A.G., 2015.** "Space no Longer the Final Frontier: Australia in the changing space sector" Global Change and Energy Sustainability Initiative Seminar, 26 May 2015, Canberra


**RIZOS, C., 2015.** Precise GNSS Positioning: Not Just a Niche Technology. Pres. at the UN’s International Committee on GNSS (ICG) Experts Meeting, Vienna, Austria, 14-18 December.


**RIZOS, C., 2015.** Precise GNSS Positioning – Past, Present & Future. Lecture pres. at Korea Aerospace University, Hwajeon, South Korea, 12 November.

**RIZOS, C., 2015.** The International GNSS Service (IGS) in a Multi-Constellation World. Invited presentation, Xi’an, P.R. China, 12 May.

**RIZOS, C., FISHER, S., NEILAN, R.E., 2015.** The IGS Real-Time Service: A Spur to Innovation. Pres. at 10th Meeting of the UN’s International Committee on GNSS (ICG), Boulder, Colorado, USA, 2-6 November.

**RIZOS, C., KUTTERER, H., NEILAN, R., PEARLMAN, M., 2015.** The GGOS Initiative to Improve Disaster Early Warning & Response. Invited pres. in session ”U2 Integrated Disaster Risk Science: Accounting for Extremes”, 26th IUGG General Assembly, Prague, Czech Republic, 24 June.


**ROBERTS, C., 2015.** GNSS practice in the rural cadastral environment, SA Surveyors Board workshop, June 27.


**SAYDAM, S., 2015.** “An Integrated Economics Model for ISRU in Support of a Mars Colony”, Massachusetts Institute of Technology (MIT), Boston, MA, USA, 13th October 2015.


**SAYDAM, S., 2015.** Invited by Planetary & Terrestrial Mining Sciences Symposium (PTMSS) 9-13 May 2015, Montreal Canada to give a speech on Off-Earth Mining Research.


