Australian Research Centre for Aerospace Automation (ARCAA)

Annual Report

Commencement to December 2008

Executive Summary

This is the inaugural annual report of the Australian Research Centre for Aerospace Automation – or ARCAA. In light of this, we have decided to incorporate some of our activities conducted prior to the formal establishment of ARCAA to capture work completed to date.

So in this report, you will find touches briefly on activities from 2005 to 2007 when ARCAA existed as a Tier 2 University Research Centre – created in response to a rapidly growing research group and a successful Smart State Research Facility grant. Activities conducted in 2008 are also included, this being the first year of operation since the agreements with the Queensland State Government and QUT/CSIRO were finalised.

Over this period our staff have been busy maintaining a comprehensive portfolio of activities, covering education, community engagement, industry and market development and research.

You will read about how we have grown to just under 30 staff (from less than 10); have new major research projects underway with Boeing Research and Technology, Ergon Energy and the CRC for Spatial Information, CRC for National Plant Bio-Security and the Defence Science and Technology Organisation. About our two international conferences in Brisbane and the technical support we have provided to the UAV Outback Challenge competition (2007 - 2009). You will hear of the national leadership we provide through initiating an industry lobby group "UAS Australia" and as chair of the Australian Aerospace Industry Forum sub-committee on UAS regulations and Certification.

Our vision is "to see autonomous aerospace technologies increasingly serve the needs of humanity, and to enhance Australia's economic, social and environmental prosperity."

We are a dedicated team of researchers, engineers and pilots aiming to make this vision a reality. I hope you enjoy our first annual report.

Prof Rod Walker
Director

Prof Rodney Walker

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1 Highlights, Breakthroughs and Difficulties

This annual report follows a template provided by the Queensland State Government.

1.1 Building progress

The building concept and architectural design progressed in 2007. Conceptual drawings were distributed towards the end of 2007, along with cost projections. In January 2008 a value management workshop was conducted to refine and finalise the costing, scope and design of the ARCAA facility.

The revised plans were signed off by the ARCAA user group in March of 2008. Subsequent to this the architects entered a detailed design phase in preparation for the tender process. During this phase, numerous additional issues (air-conditioning capacity, sun shade design and room layout) were refined.

The final design includes:

- Provision for 24 research personnel (students and project personnel) and five staff/academics,
- Three custom laboratories
- Large general purpose workshop
- Meeting facilities
- Parking and support for our Mobile Operations facilities

Figure 1 – Artist's impression of the building with some of our flying vehicles

Detailed illustrations of the layout and elevations of the ARCAA building are provided in Appendix A.

At the end of August 2008, the design documentation went to tender with a closing date of 01 October 2008.

After lengthy negotiations with the Brisbane Airport Corporation (BAC), the university Vice-Chancellor executed the lease for the ARCAA building site on the 8 December. On the following day the VC approved the building contract with the recommended builder (Badge Constructions).

Figure 2 - Piling and foundation work as at May 09

Currently, the building is scheduled for practical completion in early 2010.

1.2 Openings

Nil.

1.3 ARCAA Research Projects

ARCAA currently has several major projects underway. These include:

- CRC for Spatial Information Systems – Project 6.07 "Improvement of Ergon Business Processes"
- Smart Skies
- CRC for National Plant Bio-security "Flying Spore Trap"
- Commercial Research Contract with the Defence Science and Technology Organisation (DSTO) - UAS Risk Assessment Tool
- Commercial Research Contract with Teledyne – Evaluation of UAS Collision Avoidance Radar

The following sections contain brief highlights of the projects.

1.3.1 CRCSI – Project 6.07

This project relates to the development of automated aerial remote sensing technologies in order to assist Ergon Energy manage their powerline infrastructure. This infrastructure spans over 140,000km across the state of Queensland with most of it in remote areas. With spiralling maintenance costs, Ergon Engergy is keen to explore alternate methods for managing this expansive infrastructure.

Figure 3 - An aerial photograph of Ergon power line collected from a UAV

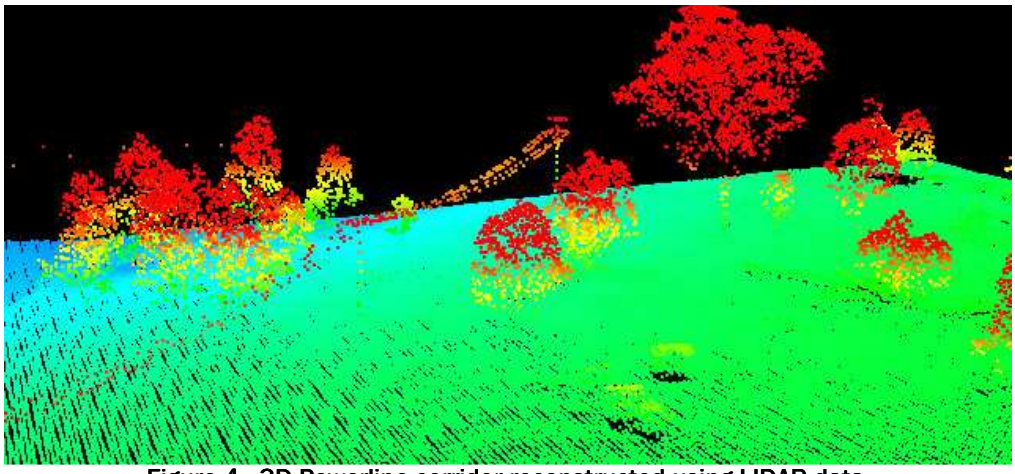

Figure 4 - 3D Powerline corridor reconstructed using LIDAR data

1.3.1.1 CRCSI Project Personnel

Name	Position	Background
Troy Bruggeman	Post Doc	Troy is a former ARCAA PhD student who has gained employment in this project. He is an expert of aircraft modelling, navigation and control. He is exploring methods for controlling UAS precisely over powerline infrastructure.
Jinhai Cai	Post Doc	Dr Jinhai Cai is an expert of computer vision. Jinhai is working on techniques to process airborne remote sensing data from stereo cameras and laser scanners. He is working towards developing automated algorithms that will detect vegetation encroachment problems on Ergon powerlines.
George Curran	Business Development	Mr George Curran was employed as a Business Development Manager for QUT's node of the CRCSI. George has extensive experience in ARCAA's areas of interest having previously provided Business Development support to the Autonomous Systems Laboratory at the CSIRO ICT Centre.

Steven Mills	PhD Candidate	Mr Steven Mills is a PhD candidate within ARCAA and is employed on the CRC project. He is working towards developing computer vision algorithms that will allow future inspection aircraft to be able to track powerlines automatically. This "powerline tracking cruise control" will ensure that the laser and camera sensors are always tracking the powerlines below. These algorithms are applicable to both manned and unmanned aircraft.
Marcos Paul Gerardo Castro	Research Assistant	Mr Castro joined the group from DLR in Germany. He is an expert on navigation systems and is currently working on processing the laser sensor data from our airborne experiments.

1.3.2 Smart Skies

The Smart Skies Project is a research collaboration between Boeing Defence Australia, Boeing Research & Technology (BR&T), and the Australian Research Centre for Aerospace Automation (ARCAA) a joint venture between Commonwealth Scientific and Industrial Research Organisation (CSIRO), and Queensland University of Technology (QUT). The aim of the project is to explore the development of future aviation technologies that will promote the more efficient utilisation of airspace. A significant component of the project is a series of flight tests that have the aim of demonstrating concept technologies under real world conditions.

The Smart Skies Project is supported by the Queensland State Government National and International Research Alliances Program (NIRAP) Round II 2007. The NIRAP funding agreement between Queensland University of Technology (QUT) and the Queensland State Government was signed in December 2007. In accordance with the NIRAP funding grant the total project value (cash and in-kind contributions) is AUD$9,679,554.00, spread over three years.

The official start date of the Smart Skies Project was the 1st of March 2008.

The primary aim of the Smart Skies Project is to develop and demonstrate future technologies supporting the safe and efficient use of airspace by both manned and unmanned aircraft. More specifically, the aims of the project are to:

1. Develop and demonstrate automated separation management technologies that facilitate greater utilisation of the National Airspace System (NAS) by both manned and unmanned aircraft through the integration of information and communications technologies.

2. Utilise the information and experiences gained to support the further development of standards, regulations and safe operating practices for civil and commercial UAS in Australia and overseas.

1.3.2.1 Smart Skies Project Personnel (ARCAA only)

NIRAP – "Smart Skies Project"

Ryan Carnie	Ryan was employed in two roles. Initially to develop software to simulate the performance of a new collision avoidance radar system under development by Teledyne in Brisbane. Subsequently he was employed on the Smart Skies project to

	develop and aircraft simulation environment for use in Smart Skies flight experiments. Ryan left the group in late December.
Reece Clothier	Reece is a finishing PhD student from ARCAA. He has taken on the role of Smart Skies Project Manager since September 2008. He is a skilled organiser and has kept the project on track.
Shane Degen	Shane is a PhD student in receipt of top-up funding from the Smart Skies project. He is working on vision-based aircraft collision avoidance algorithms.
Richard Glassock	Richard was a Master's student in ARCAA for the first half of 2008. Since then he has been employed as research engineer within ARCAA. He is responsible for the safe modification, maintenance and piloting of ARCAA's fixed wing UAS fleet.
Duncan Greer	Duncan is a continuing PhD student who has taken full-time employment within ARCAA as a research engineer. He developed the Airborne Systems Laboratory during the latter half of 2008.
Brenden Menkens	Brendan is an undergraduate Aerospace Avionics student employed part-time to assist in the design and procurement of the ARCAA Mobile Operations centre for Smart Skies.
Rhys Mudford	Rhys is a software engineer employed early in 2008. He has extensive experience in the development of software systems for aircraft simulators. He has developed the software for the onboard systems of the ASL and the UAS.
Lachlan Mutch	Lachlan is an undergraduate Aerospace Avionics student employed part-time to assist in the development of ARCAA's UAS operations procedures.
Nicholas Rutherford	Nicholas is an undergraduate Aerospace Avionics student employed part-time to assist in the testing and analysis of the communications systems required for Smart Skies.
Bradley Spencer	Brad was employed as the initial project manager for Smart Skies. He brought his industry experience from his previous employment with Boeing and established the project management processes to be used by Smart Skies. He left in October 2008 to pursue other interests.
Dmytriy Stepchenkov	Dmytriy is an undergraduate Aerospace Avionics student employed part-time to assist in the development of ARCAA's UAS operations procedures.
Onvaree Techakesari	Onvaree was employed part-time to develop aircraft seperation algorithms. She has since accepted a PhD scholarship within Smart Skies.
Christopher Turner	Chris is a graduate of QUT's Aerospace Avionics course. He was employed part time and then full-time to develop the communications infrastructure required for the Smart Skies experiments. He has just won the Master's of Navigation and Related Application scholarship to study at Politechnico Di Torino for 1 year. This funding was provided by the Queensland Government and ARIA-QLD (Association for Research between Italy and Australasia).

Alexander Wainwright	Alex is an undergraduate Aerospace Avionics student employed part-time to develop software for communicating with the Irdium satellite constellation. This software is used by the ASL and UAS.
Jiezhan “Sean” Fan	Sean is a PhD student in receipt of top-up funding from the Smart Skies project. He is working on automated aircraft separation algorithms.

1.3.2.2 Smart Skies Project Outcomes

The expected high level outcomes from the Smart Skies Project include:

- The development of I.P. in enabling technologies for commercialisation by industry partners;
- The generation of high-quality research publications;
- Participation in national and international aerospace conferences;
- Recommendations to CASA and other stakeholders in the development of standards and regulations for civil UASs.

1.3.3 CRC for National Plant Bio-security “Flying Spore Trap”

In late 2007, ARCAA was asked to work with the CRC for National Plant Bio-Security to assist in evaluating the concept of a Flying Spore Trap. This small project (~$20,000) required ARCAA to demonstrate UAVs flying in an agricultural application.

The motivation for the project was to determine the feasibility of using UAVs as a rapid means of determining whether broad scale agricultural paddocks contained any diseased produce. This is particularly relevant with the North American Free Trade agreement where there is a burden on Australia to prove that our crops are free of disease.

In February 2008, the ARCAA team travelled to Watt’s Bridge with a contingent from DPI and demonstrated the capabilities of a UAV in an agricultural scanning application.

Figure 5 - Aerial View of Paddocks collected from ARCAA UAV

Figure 6 - Reconnaissance Pod mounted on the Superang UAV

1.3.4 Commercial Research Contract with the Defence Science and Technology Organisation (DSTO) - UAS Risk Assessment Tool

In 2008 ARCAA worked diligently to secure a new project with DSTO in the area of risk modelling of UAVs. Due to the Federal election this project was delayed with effective approval not taking place until March 2009. The project will run from July 2009 to March 2010. Mr Paul Wu (a completing PhD candidate from ARCAA) has been recruited. Paul will develop a decision support tool to assist in the operation of UAV operating near populous areas. This tool will advise as to whether a proposed operation has an adequate level of safety. It is expected that this project will be extended beyond 2010.

1.3.5 Commercial Research Contract with Teledyne – Evaluation of UAS Collision Avoidance Radar

In 2007 ARCAA received a $70,000 consultancy to evaluate the utility of a MIMO radar concept, being developed by Teledyne in Brisbane, for the UAV collision avoidance application. Mr Ryan Carnie was employed to conduct a literature review and to develop a comprehensive simulation tool for use in evaluating the concept.

A report of the findings was delivered to Teledyne in late 2007 with subsequent presentations to representatives from the UK. Advanced discussions have taken place regarding the continued development of this product with testing planned on the ARCAA Airborne Systems Laboratory. Funding has been jointly sought from the DSTO Capability Technology Demonstrator Program.

1.4 Appointment of Staff

ARCAA currently has several major projects underway with approximately 30 staff employed by QUT. The new staff listed below were employed in late 2007 or early 2008. The new staff are listed by project area:

NEW ARCAA STAFF 2008

CRCSI Staff

Troy Bruggeman	Troy is a former ARCAA PhD student who has gained employment in this project. He is an expert of aircraft modelling, navigation and control. He is exploring methods for controlling UAS precisely over power line infrastructure.
Jinhai Cai	Dr Jinhai Cai is an expert of computer vision. Jinhai is working on techniques to process airborne remote sensing data from stereo cameras and laser scanners. He is working towards developing automated algorithms that will detect vegetation encroachment problems on Ergon powerlines.
George Curran	Mr George Curran was employed as a Business Development Manager for QUT's interests within the CRCSI. George has extensive experience in ARCAA's areas of interest having previously provided Business Development support to the Autonomous Systems Laboratory at the CSIRO ICT Centre.
Steven Mills	Mr Steven Mills is a PhD candidate within ARCAA and is employed on the CRC project. He is working towards developing computer vision algorithms that will allow future inspection aircraft to be able to track powerlines automatically. This "powerline tracking cruise control" will ensure that the laser and camera sensors are always tracking the powerlines below. These algorithms are applicable to both manned and unmanned aircraft.
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	wing UAS fleet.
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Alexander Wainwright	Alex is an undergraduate Aerospace Avionics student employed part-time to develop software for communicating with the Irdium satellite constellation. This software is used by the ASL and UAS.

UAV Challenge

In 2007 and 2008 ARCAA provided technical support for the safe operation of the UAV Outback Challenge held at Kingaroy.

Lennon Cork	Lennon is a continuing PhD student from ARCAA who took part-time employment to manage the technical aspects of

	the 2007 UAV challenge. He was also paid to organise the 2006 UAS conference hosted by ARCAA.
Rhys Ward	Rhys was an under-graduate student in the Aerospace Avionics course who was employed part-time to manage the technical aspects of the 2008 UAV challenge.

1.5 Major Equipment Purchases

2008 marked the commencement of procuring equipment for the new facility. Key items of equipment were required for current ARCAA projects and have been purchased in advance of the completion of the building. Key items of equipment include:

Spirent GNSS Constellation Simulator: This specialised piece of electronics equipment allows Global Positioning System (GPS) technology to be evaluated and tested. This item is particularly useful for ARCAA in the development of new navigation algorithms and hardware oriented towards aviation and UAS. The Spirent GNSS Constellation Simulator cost approximately $130,000 and was delivered in September 2008. In 2009 the simulator be upgraded to include the new L5 frequency that will cost a further $150,000. The L5 is a new frequency that will be used by Civil aviation for dual-frequency corrections in the future, vastly improving accuracy and integrity of navigation to aviation users.

Airborne Systems Laboratory (ASL): One of the centre pieces of ARCAA's equipment is the ASL. This aircraft is a flying laboratory designed to provide the ability to evaluate new avionics concepts and air traffic management processes. It is also used as a surrogate in evaluation UAS technologies in the airborne environment. This unique facility has been created by engineers at ARCAA with equipment purchased through the SSRFF funds. This item has cost approximately $270,000.

Figure 7 – ARCAA's Airborne Systems Laboratory in flight over Burrandowan, Kingaroy (VH-EWW)

ARCAA Uninhabited Aerial Systems (UAS): ARCAA has procured equipment to manufacture several UAS. These include UAS helicopters and UAS fixed wing aircraft. Three helicopter systems and 4 fixed wing UAS systems have been created. Some of these are shown in development in the figures below.

Figure 8 – ARCAA's Uninhabited Aerial System during flight testing at Burrandowan

Figure 9 – ARCAA (CSIRO) Uninhabited Helicopters in front of some of the flight test ground support equipment at Burrandowan

Mobile Operations Centre (MOC): ARCAA's research predominantly takes place in remote field environments and, as such, access to mobile laboratory space is premium. To this end a mobile operations facility has been designed. In 2008 the truck that this is based on has been procured. As at early 2009 the truck is at Giblin's Motor Body builders undergoing modification. The approximate cost of this item is $200,000.

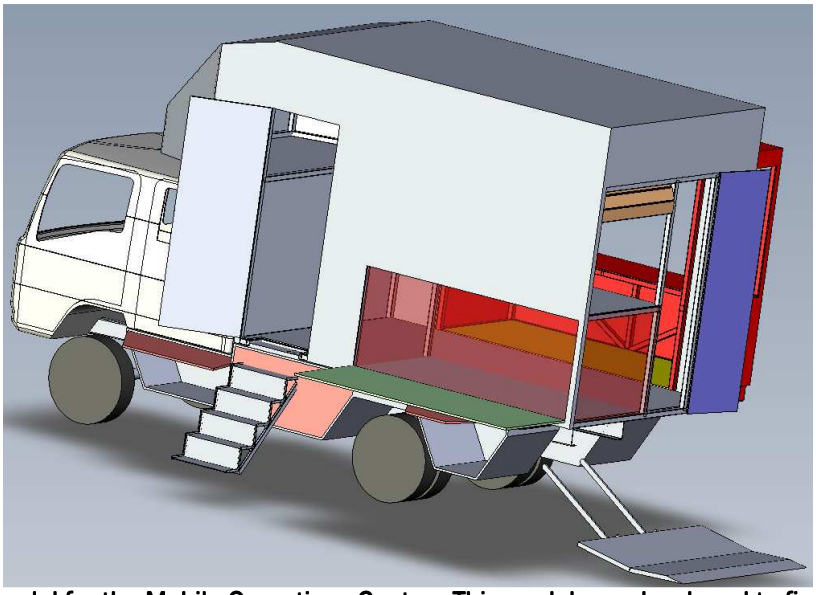


Figure 10 - CAD model for the Mobile Operations Centre. This model was developed to finalise the concept for the vehicle and to ensure it would be correctly constructed.

1.6 New fellowships

Nil

1.7 Publications 2008

Publication Name	Publication	Authors
Refereed Journal Article		
Pilotless aircraft: the horseless carriage of the twenty-first century?	Journal of Risk Research	Mr Reece Clothier, Dr Neale Fulton, Prof Rodney Walker
Computer Vision Onboard UAVs for Civilian Tasks	Journal of Intelligent and Robotics Systems	Prof Pascual Campoy, Mr Juan Fernando Correa, Mr Ivan Fernando Mondragon, Ms Carol Martinez, Mr Luis Mejias Alvarez, Mr Miguel Olivares, Mr Jorge Artieda
Robust design optimisation using multi-objective evolutionary algorithms	Computers and Fluids	Mr Dong Seop Lee, Dr Felipe Gonzalez, Prof Jacques Periaux, Dr Kavita Srinivas
Fast reconstruction of aerodynamic shapes using evolutionary algorithms and virtual nash strategies in a CFD design environment	Journal of Computational and Applied Mathematics	Dr Jacques Periaux, Mr Dong Seop Lee, Dr Felipe Gonzalez, Dr Kavita Srinivas
Computational fluid dynamics analysis of externally blown flap configuration for transport aircraft	Journal of Aircraft	Mr Hamish A Griffin, Dr Felipe Gonzalez, Dr Kavita Srinivas
Robust evolutionary algorithms for UAV/UCAV aerodynamic and RCS design optimisation	Computers & Fluids	Mr Dong Seop Lee, Dr Felipe Gonzalez, Prof Jacques Periaux, Dr Kavita Srinivas
Journal: Other Refereed Contribution		
The Future of UAS: Standards,	Aerospace and Electronic	Mr Lennon Cork, Mr Reece

Regulations, and Operational Experiences	Systems Magazine	Clothier, Dr Felipe Gonzalez, Prof Rodney Walker
Multidisciplinary Approach to Intelligent Unmanned-Airborne-Vehicles Mission Planning	Journal of Aircraft	Mr Iain McManus, Prof Rodney Walker
Conference: Full written paper – Refereed		
Hidden Markov model filter banks for dim target detection from image sequences	Proceedings of Digital Image Computing: Techniques and Applications	Mr John Lai, Dr Jason Ford, Prof Peter O'Shea, Prof Rodney Walker
A study of morphological pre-processing approaches for Track-Before-Detect dim target detection	Proceedings of the 2008 Australasian Conference on Robotics & Automation	Mr John Lai, Dr Jason Ford, Prof Peter O'Shea, Prof Rodney Walker, Dr Michael Carsten Bosse
Evaluation of machine vision techniques for aerial search of humans in maritime environments	Digital Image Computing: Techniques and Applications (DICTA 2008)	Mr Paul Westall, Dr Jason Ford, Prof Peter O'Shea, Dr Stefan Hrabar
Multimodal hybrid powerplant for unmanned aerial systems (UAS) robotics	Proceedings of the 2008 Australasian Conference on Robotics & Automation	Mr Richard Glassock
Robust Motion Estimation for Camcorders Mounted in Mobile Platforms	Proceedings - Digital Image Computing: Techniques and Applications	Dr Jinhai Cai, Prof Rodney Walker
Conference Other: Abstract Refereed / Industry Seminars		
ARCAA	Queensland State Government Aviation and Defence Day, Jan 08	Mr Reece Clothier
Lessons in history: The regulation of "horse-less carriages" and "pilot-less aircraft".	3rd Annual Conference of the Australian and New Zealand Chapter of the Society for Risk Analysis	Prof Rodney Walker, Dr Jason Ford, Dr Luis Mejias, Mr Reece Clothier
ARCAA Research	2008 Shepard UV Pacific Conference	Prof Rodney Walker, Dr Jason Ford, Dr Luis Mejias, Mr Reece Clothier

1.8 Research highlights

Without question, the Phase 1 Flight Trial campaign for the Smart Skies Project was one of the highlights of ARCAA to date. This campaign required the coordination of 15 researchers based simultaneously in Brisbane, Seattle (USA) and Burrandowan at Kingaroy. The logistics associated with coordinating this experiment were complex, whilst involving QUT, CSIRO, Boeing US and Boeing Australia personnel.

The culmination of a years effort in developing technologies came together flawlessly for a week long campaign of flight testing. Our international collaborators were very impressed with the professionalism of the ARCAA group at conducting experimental flight test campaigns.

Figure 11 - Panorama of the conditions at Burrandowan Flight Test Location

Figure 12 - The road to Burrandowan - ARCAA researchers have become very familiar with this trip

Figure 13 - ARCAA personnel following helicopter UAV as safety pilots

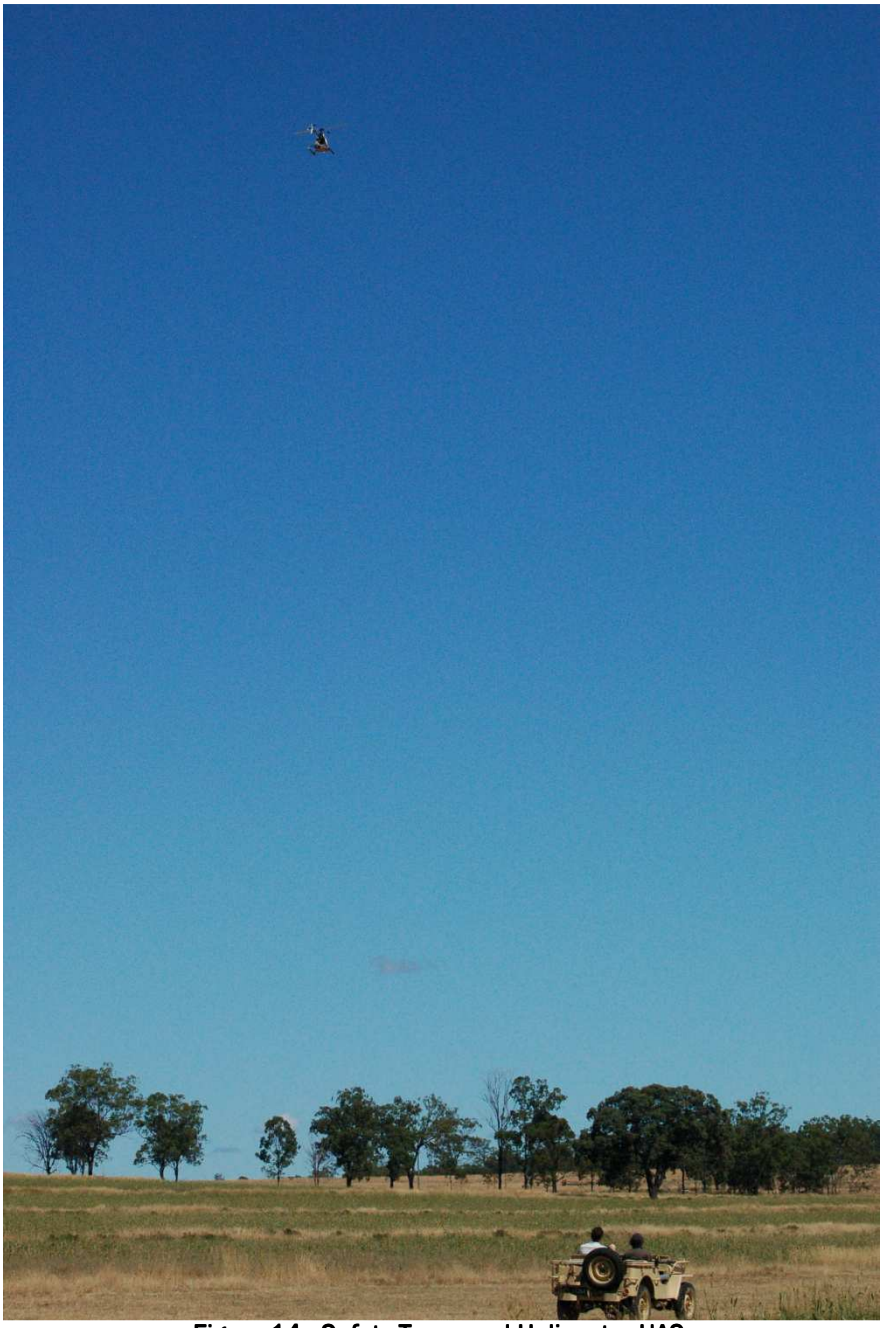


Figure 14 - Safety Team and Helicopter UAS

Figure 15 - Professor Rod Walker at the Burrandowan Flight Test Location

Figure 16 - One of many flight test days in preparation for Phase 1

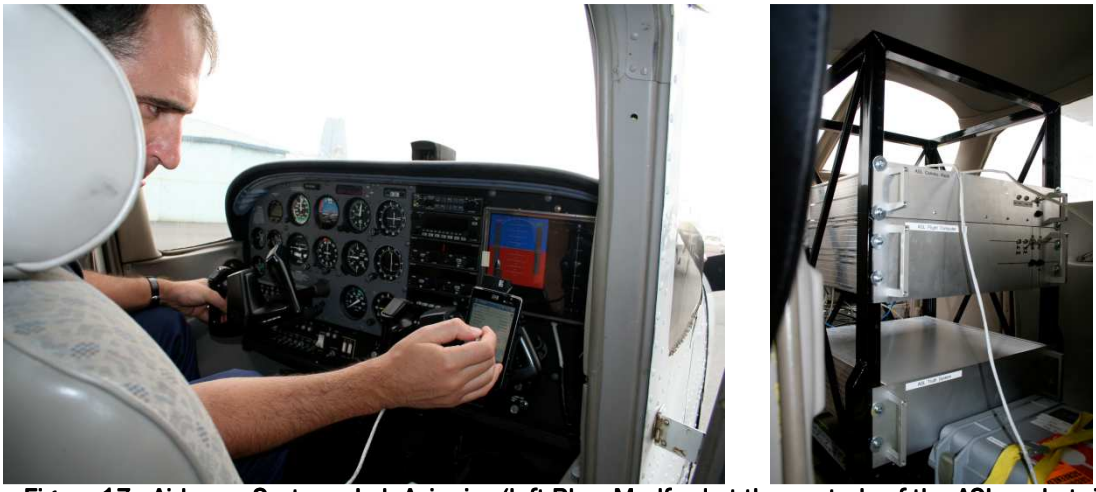


Figure 17 - Airborne Systems Lab Avionics (left Rhys Mudford at the controls of the ASL and at right the avionics rack that makes it work)

Figure 18 - The pilot's view of the innovative Smart Skies avionics

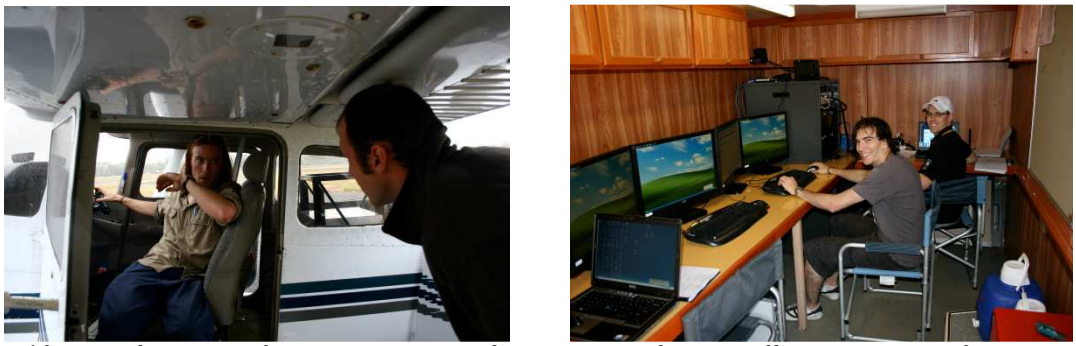


Figure 19 – At left, Duncan Greer and Rhys Mudford preparing for take-off and at right, ARCAA Flight Test Director Reece Clothier and Chris Turner in the command centre

Figure 20 - Boeing Research and Technology Australia employee Dr Michael "Team" Wilson monitors the experiment

1.9 Conferences/Competitions

ARCAA hosted two international conferences in 2005 and 2006 which was prior to the SSRFF grant. These events attracted approximately 100 attendees on each occasion. Participants came from as far away as India, Japan, UK, New Zealand and the USA. Many of the research directions that ARCAA has followed were developed at these two national workshops.

We also hosted a national workshop *"Small UAS for a secure Australia"* in conjunction with the Australian Centre for Policing Research in 2007. This workshop saw representatives of the nations Police Technology units converge at QUT to participate in a 2 day workshop. Local suppliers VTOL aerospace and Boeing were also participants to this workshop.

In 2007 ARCAA initiated the UAV Outback Challenge – a competition designed to promote excellence in aerospace in high school students, amateurs and university students. This competition offers cash prizes of $50,000. The event has run in 2007 and 2008 with great success at the high school level. The amateur or open level has seen teams travel from as far away as the USA, however no team has claimed the prize yet. The event in running again in 2009, with ARCAA providing technical management.

Figure 21 - High School students preparing their entry in the 2008 UAV Outback Challenge

1.10 Breakthroughs

Key outcomes and learning's for the research to date.

- Commencement of the Smart Skies Project;
- Successful completion of engineering, planning and operational capabilities in support of the Smart Skies Project P1FT;
- Successful flight trials as part of the CRCSI. Data collection campaigns:
    - Vegetation mapping (3D power line corridor reconstruction using LIDAR data);
    - Geo-location of poles and power lines;
    - Data to support research into vision-based guidance and control of UAS;

1.11 Difficulties

Despite the funding application for SSRFF being approved by the State Government in March 2005, it has taken several years to realise the benefits of this for the research group. Delays to the procurement of equipment have caused impeded research progress. However, a process for SSRFF equipment procurement and administration (i.e., draw down) has now been defined and it is hoped that this will alleviate future frustrations.

With the success of ARCAA, new employees and researchers have been recruited which in turn has created pressures in the area of space management. Workshop space is at a premium on the QUT Gardens Point Campus but is unavoidable given the scheduled redevelopment of the Science and Technology Precinct. As a consequence, ARCAA has had difficulties in accessing

adequate workshop facilities. These pressures will be alleviated once the new building is operational.

Until recently there has been limited administration and reporting support for ARCAA which has resulted in valuable researcher time being allocated to administrative tasks. In the absence of adequate administrative support, research personnel and academics were spending a significant amount of time away from the core functions, thus impeding research. With the recent appointment of a full time Administrative staff member for ARCAA it is hoped that researchers will be able to devote less time to administrative functions and be able to redirect their attentions to the research at hand and to further developing research partnerships for the future.

Due to the continuing success of ARCAA projects there is an increasing interest in ARCAA as a public relations vehicle. Whilst ARCAA directly benefits from the increased exposure, the amount of external relations activities needs to be managed. ARCAA staff hope to work more closely with QUT External Relations to maximise benefits from targeted media exposure.

The changes in value of the Australian Dollar over the last year has made estimating the cost of equipment purchases difficult and it is strongly encouraged within ARCAA to take advantage where possible of any upward trends in the Dollar value to ensure maximum benefit from available funds.

1.12 Progress

The focus ARCAA to date has been the Smart Skies Project. Within this project activity has been in two areas:

1. Engineering and operational capabilities in support of Phase One Flight Trials (P1FT), and
2. Project management and administration.

In summarising these two sections, the key points describing the progress to date include:

1. Engineering and operational capabilities in support of P1FT:
    a. Definition of the first flight trials activity, and the subsequent commencement of planning and engineering to support this activity.
    b. Completion of a comprehensive flight operations manual, logistics and safety management systems.
    c. Management of insurance and approvals to operate.
    d. Procurement, development and modification of a unique flight test aircraft; the Cessna 172 Airborne Systems Laboratory (ASL).
    e. Development of a management and operational framework for the custodianship of the ASL.
    f. Procurement and development of the QUT Unmanned Aircraft Flamingo.
    g. Development of the Mobile Operations Centre (MOC) support vehicle.
    h. The design and commencement of procurement of the MOC with Giblins.
    i. The development and characterisation of a Common Information Network (CIN), comprising of both Telstra Next G and Iridium communications system.

j. The development and testing of the aircraft simulator Simulated Air Segment (SAS), located at CSIRO Brisbane.

k. Procurement and development of the Vario Gasser CSIRO Unmanned Aircraft System (CUAS).

l. The continued development of the Detect Sense and Avoid (DSA) systems for both the QUAS and CUAS platforms.

As a result of these significant engineering and capability development activities, the project successfully completed its P1FT in March 2009. 48 separate flight experiments were successfully completed over a period of two weeks.

2. Project management and administration.

a. Convened four project workshops bringing together national and international research partners.

i. Brisbane, February 08

ii. Seattle, April 08

iii. Denver, June 08

iv. Brisbane, November 08

b. Successfully completed two NIRAP reporting milestones (six month and twelve month reports).

c. Continued to support the UAS Outback Challenge through the provision of equipment, personnel and logistics.

d. Held several meetings relating to the formation of the UAS Australia Industry body – an non-profit industry body established to address regulatory issues facing Unmanned Aircraft System operations in Australia.

i. Successful application under the Faculty of Built Environment and Engineering, External Relations Initiatives Grant for travel support and the development of a website.

ii. www.uasaustralia.org

The project team has continued to demonstrate a positive and progressive working relationship. Has successfully strengthened partner relationships and actively promoted Smart Skies, ARCAA, and in turn the SSRFF State Government involvement.

1.13 Students

1.13.1 Phd Completions 2008

Dando, Aaron J	Robust Adaptive Control of Rigid Spacecraft Attitude Manoeuvres
Spencer, Troy A	Inverse Diffraction Propagation Applied to the Parabolic Wave Equation Model for Geolocation Applications

1.13.2 Masters by Research Completions 2008

Gurtner, Alex	Investigation of Fisheye Lenses for Small UAV Aerial Photography.

1.13.3 Current PhD Students

Bruggemann, Troy S	Aircraft Dynamic Models in Global Positioning System Integrity Monitoring for Approaches with Vertical Guidance.
Clothier, Reece A	Risk Assessment for UAS Operations over Inhabited Areas.
Cork, Lennon R	Flight Performance Assessment for Low-cost, Fault-tolerant UAV Avionics.
Degen, Shane C	An Integrated Flight Control & Collision Avoidance System for an Unmanned Aerial Vehicle.
Dusha, Damien	A Unmanned Airborne Vehicle (UAV) Forced Landing Planning and Execution System Using Machine Vision Techniques.
Eng, Pillar C	Trajectory Generation for a Fixed-Wing UAV Forced Landing using Motion Primitives.
Fan, Jiezhen S	Centralized Aircraft Traffic Separation Management in Realistic Measurement Environments.
Greer, Duncan G	Integrity Augmentation of a Ground-based Regional Augmentation System Airborne Navigation Receiver using Low-Cost Inertial Micro-Electromechanical Sensor Devices for General Aviation Aircraft Operations.
Hung, Jane Y	Reconfigurable path planning in a forced landing for an autonomous unmanned aerial vehicle (UAV).
Lai, John S	Decision-Making and route Planning Strategies for Collision Avoidance Systems on UAVs
Liu, Xi	Real Time Multi-Criteria Decision Making to Rank and Select Landing Sites for UAV Forced Landing.
Mills, Steven J	Visual Guidance for Fixed-Wing Unmanned Aerial Vehicles Using Feature Detection and Tracking: Application to Power Line Inspection.
Narayan, Pritesh P	Sequential Multi-Objective UAS Flight Management in Time Constrained Uncertain Urban Environments.
Todd, Carl A	Autonomous Control for Satellite Formation Flying.
Westall, Paul	Human Detection in a Maritime Search Environment using Machine Vision for UAVs.
Wu, Paul P	Multi-Objective Mission Flight Planning in Civil Unmanned Aerial Systems.

1.13.3.1 Current Masters by Research Students

Glassock, Richard R	Aircraft Hybrid Powerplant.
Hitch, Michael L	Aerospace systems: A fundamental analysis of the regulatory environments.

1.14 Collaboration and External Relations

1.14.1 Media and External Relations

There are have been numerous media events for ARCAA, some of which were:

- Pilotless solar plane completes 3-day flight
  ABC PM Radio Program - Monday, 25 August, 2008 18:42:00
  Presenter: Mark Colvin

- Multiple media coverage of the 2008 UAV Challenge

- Creation of the ARCAA website www.arcaa.aero

1.14.2 Formal ARCAA Collaborations in 2008

- ARCAA: Collaboration between QUT and CSIRO – ICT Centre.

- Smart Skies Project: Collaboration between QUT, CSIRO – ICT Centre, Boeing Defence Australia and Boeing Research and Technology.

- CRC – Spatial Information: Collaboration between QUT, Ergon Energy, V-Tol Aerospace Pty Ltd and Integrate Systems Pty Ltd.

- CRC – Plant Biosecurity: Collaboration between QUT, Murdoch university, the State of Western Australia

1.14.3 ARCAA Industry and Government Networks in 2008

ARCAA has continued to foster new, and strengthen existing relationships with a number of key industry and government organisations, including:

- Telstra: Wireless Planning

- DGTA: Directorate General Technical Airworthiness (Australian Defence Force).

- DSTO: Defence Science & Technology Organisation.

- AsA: Airservices Australia.

- BAE Systems: BAE Systems Australia.

- CASA: Civil Aviation Safety Authority.
- Aviation & Defence Dept , QLD State Government.
- AUVSI: Association of Unmanned Vehicle Systems International.
- DITRDLG: Federal Department of Infrastructure, Transport, Regional Development and Local Government
- AUSAero: Australian Aerospace

1.14.4 Public/Industry Relations Events

ARCAA has maintained an active involvement with industry and Government through workshops, presentations, competitions and conferences. In addition, ARCAA has supported numerous QUT External Relations Events. Some significant industry and public relations exercises include:

- Formation of UAS Australia – a non-profit industry body addressing issues relating to the regulation of the Australian Civil Unmanned Aircraft Industry. Outcomes from this initiative include:
    - Four national meetings
    - Two formal submissions:
        - A response[1] to the Federal Government's Issues Paper: Towards a National Aviation Policy Statement,
        - Feedback to CASA on the regulation of the Australian UAS industry[2].
    - Creation of a website to provide industry with information on civil UAS regulations
- Some of the external relations events in 2008, include:
    - Queensland State Government Aviation and Defence Day, January 08
    - ARCAA UAV Pacific Industry Conference, May 08
    - Invited participants to the AUVSI America Workshop on UAS Research and Regulations, June 08
    - Attendance to AUVSI International Trade Show and Exhibit, June 08
    - Postgraduate Student Presentations (many)
    - Participation in Smart Systems Theme Conference

[1] Australian Unmanned Aircraft Systems (UAS) Industry Position Paper, *Response to the Department of Infrastructure, Transport, Regional Development and Local Government Issues Paper: "Towards a National Aviation Policy Statement"*, 24th June 2008.

[2] Australian Unmanned Aircraft Systems (UAS) Industry Position Paper, *Industry feedback to the Civil Aviation Safety Authority (CASA),* 5th January 2009.

1.15 Key Performance Indicators

	KPI	Year 2008 Project Outcome
Commercialisation	1 Patent application, copyright, trade mark or new licence generated on average every 2 years	Copyright achieved in all publications listed in report above. Two staff completed Blue Box commercialisation and IP training. Two staff finalists in the 2008 "Out of the Box" commercialisation competition
Employment of Professional Staff	Increase the number of research, technical or business development staff and post graduate students engaged in ARCAA by 5% per annum to the capacity of the facility (around 25 including post-graduate students) within 5 years of practical completion.	28 staff employed as at 2008
Education and Skills Development	At least 3 PhD and/or Masters Degree students graduating per annum averaged over any 5 year period Average of 1 visiting national or international visiting scientists per annum, averaged over 5 years	18 PhD students enrolled in 2008 3 Masters by Research students enrolled in 2008 2 PhD completions in 2008. 1 Masters by Research completion in 2008. 2 visiting students from Pusan University in Korea Visit by Professor John Hansman of MIT International Centre for Air Transportation 2 visits and a seminar by Dr Neale Fulton CSIRO Mathematical and Information Sciences 2 PhD students from the University of Florida studied at QUT for 3 months
Research and Development Excellence	3 refereed scientific papers, published in national or international journals or books per annum (averaged over 5 years). 8 conference papers, articles or industry reports published per annum (averaged over 5 years)	9 refereed scientific papers 3 conference papers
Technology Transfer	3 policy submissions, information publications, media releases or events promoting uptake of ARCAA Research results on average per annum. 2 conferences, seminars, forums or workshops, professional education activities organised per annum.	Establishment of UAS Australia with four industry meetings/workshops. 2 policy submissions 1 meeting with Mr John Bromley, Civil Aviation Safety Authority (CASA) 1 direct invitation to research workshop on UAS and regulations (United States)
Investment in Research	Secure $200,000 per annum of external funding for ARCAA activities for the five year period following practical completion of the ARCAA Building. From 5th to 10th Year of the term, maintain external funding for ARCAA Activities at not less than $250,000 per annum (adjusted annually to reflect changes in the Consumer Price Index).	Practical Completion due in early 2010. KPI not set until after PC. Discussion undertaken with DSTO resulting in project collaboration to commence in 2009.$145,000 (detailed earlier in report) Fostering formal collaborations with Telstra
Community Engagement	Average of 2 presentations per year to community groups: Average of 6 presentations or publications per year to avionics industry groups,	Practical Completion due in early 2010. KPI not set until after PC. First Building Open Day to be held in 2010

	schools, TAFE's, government bodies, etc; Involvement in QUT Train displays every two years; Hold Open Day at ARCAA Building at Brisbane Airport Annually.	

1.16 Proceeds of Commercialisation Agreement

Reporting and Accounts

In 2008, there were no proceeds of commercialisation due and payable or received by ARCAA and no legal entities were created.

QUT Intellectual Policy has changed and QUT is currently preparing a notification advice detailing the new Intellectual Policy, this notification will be forwarded to the Department and will be valid for all SSRFF Funded projects for QUT.

No material changes were made to research plans.

Research activities conducted in 2008 that involved ARCAA Plant and Equipment were:

- QUT - ARCAA,
- CSIRO – ICT Centre,
- Ergon Engergy,
- Boeing Defence Australia,
- Boeing Research and Technology
- Department of Primary Industries and Fisheries.

It is envisaged that these partners will be undertaking research activities again in 2009. There is no projects intellectual property subject to commercialisation activities as at the date of this annual report.

Currently a register of intellectual property for ARCAA projects is under development to ensure clear identification of intellectual property.

Contributions

QUT is currently preparing draw down documentation that encompasses the 2008 financial information.

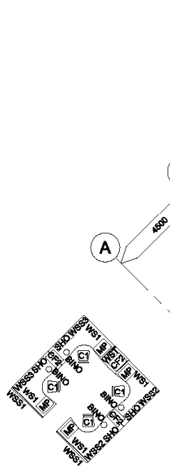
Conclusion and other matters

The year 2008 was the first year under the SSRFF Agreement. A building phase for the group has been undertaken with staffing, equipment procurement and partnership building at the forefront of ARCAA Activities. Success in research is already being seen as is evident in the Smart Skies project and the CRCSI. Partner confidence is high following this success and it is expected that 2009 will see an increase in partnership and collaboration opportunities. With completion of the building due at in early 2010, it is expected that a more rapid expansion of activities will result.

ARCAA staff and students are excited about the coming years and the opportunities that will be available following ARCAA's moves into the new facility.

2 Appendix A – ARCAA Building Architectural Drawings

FFE ABBREVIATION LEGEND	
BEW	BENCH, WORKSHOP
BLV	VENETIAN BLIND
BC12	BOOKCASE 1200mm LONG
BC15	BOOKCASE 1600mm LONG
BE	BENCH, JOINERY ITEM
BINO	BIN, OFFICE TYPE
BINWH	BIN, WHEELIE
BINR	BIN RECYCLING
C1	OFFICE CHAIR
C2	VISITOR'S CHAIR
C3	MEETING CHAIR
C4	MULTI-USE CHAIR
C5	LOUNGE CHAIR
CF2	FILING CABINET - No. DRAWERS
CR	CREDENZA - LENGTH AS SHOWN
CRS	CURTAIN, SHOWER TYPE
FEB	FIRE BLANKET
MP	MOBILE PEDESTAL
MP2	MOBILE PEDESTAL - EXECUTIVE
MW	MICROWAVE
PR	PRINTER (BY OTHERS)
PJS	PROJECTION SCREEN
LCD	TV SCREEN
REF	REFIGERATOR (BY OTHERS)
SHL	SHELVING, LIBRARY
SHLS	SHELVING, WORKSHOP
SHO	SHELF, OVERHEAD
SHC	SHELF, CLEANERS
T1	TABLE TYPE 1
T2	TABLE TYPE 2
T3	TABLE TYPE 3
WBE	WALL BOARD ELECTRONIC
WBW	WALL BOARD WHITE
WSD	WORKSTATION CREDENZA - EXECUTIVE
WS1	WORKSTATION TYPE 1
WS2	WORKSTATION TYPE 2
WST	WORKSTATION TABLE
WSS1	WORKSTATION SCREEN TYPE 1
WSS2	WORKSTATION SCREEN TYPE 2
WSS3	WORKSTATION SCREEN TYPE 3
WSS4	WORKSTATION SCREEN TYPE 4



TYPICAL WORKSTATION LAYOUT

01 GROUND FLOOR F.F.E. PLAN
SCALE 1:100

ISSUE	REVISION	DATE	APP'D
06	Tender	24.06.2008	
05	Consultant Issue	17.06.2008	
04	CS Issue 2	13.06.2008	
03	CS Issue 1	06.06.2008	
02	Consultant Issue	16.05.2008	
01	Consultant Issue	28.04.2008	

[TENDER]

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QUEENSLAND UNIVERSITY OF TECHNOLOGY

AUSTRALIAN RESEARCH CENTRE FOR AEROSPACE AUTOMATION
DA VINCI PRECINCT BRIS. AIRPORT

GROUND FLOOR F.F.E. PLAN

DO NOT SCALE DRAWING VERIFY ALL DIMENSIONS AND LEVELS ON SITE

SCALE (AT A1)	DATE	DRAWN	APPROVED
1:100	JUN 2008	KR	DJG

PROJECT NO.	DRAWING NO.	ISSUE
07063	CD_A_211	06

NORTH ELEVATION

CONRAD GARGETT
ARCHITECTURE

AUSTALIAN RESEARCH CENTRE FOR AEROSPACE AUTOMATION

QUT BRISBANE AIRPORT

07063 CGA-A-003

SOUTH ELEVATION

CONRAD GARGETT ARCHITECTURE

AUSTALIAN RESEARCH CENTRE FOR AEROSPACE AUTOMATION

QUT BRISBANE AIRPORT

07063 CGA-A-002