

Aerospace Industry Opportunities in Australia
UNMANNED AERIAL VEHICLES (UAVs)
- Are They Ready This Time? Are We?

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It should be noted that, portions of this paper are adapted from the Final Draft Aerospace Technology Forum Report titled “Study of the Unmanned Aerial Vehicle (UAV) Market in Australia”, by Dr KC Wong, Dr C Bil, Mr D Gordon, and Dr PW Gibbens (August 1997).



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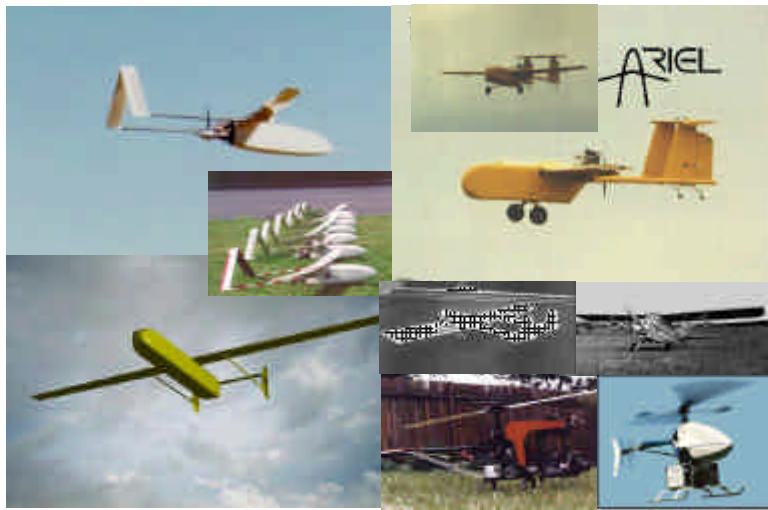
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Abstract

Unmanned Aerial Vehicles (UAVs) have been around since the dawn of aviation, and Australia has been developing UAVs since the early 1950s. What are some of the factors leading to the recent renewed interest in UAVs?

The UAV Systems market between 1998 and 2003 is estimated to be AUD\$26 billion globally. A recent Australian UAV market study, commissioned by the Aerospace Technology Forum, identified a potential national defence UAV market worth up to AUD\$1.7 billion over this period, and an immediate nationwide civilian UAV market worth AUD\$20 million per year! Key UAV System technologies were identified to be in: airframes; propulsion units; autonomous flight controllers; launch and recovery; navigation and guidance; self-protection; ground control stations; payloads; and data communication, storage, processing, and dissemination (Information Technology).

Is the Australian Aerospace Industry ready for this revival?

¹ Dr. K.C. Wong, a lecturer at Sydney University's Department of Aeronautical Engineering, has been working on research UAVs for more than 10 years. He has presented UAV R & D work at various international conferences. Recently, Dr. Wong led a joint university/industry team that completed a study of the UAV market in Australia for the Aerospace Technology Forum (ATF - a federal government's Department of Industry, Science, and Tourism (DIST) initiative).

1 Introduction

Unmanned Aerial Vehicles (UAVs) have been around since the dawn of aviation, and Australia has been developing some form of UAVs since the early 1950s. Since the 1970s, there have been repeated claims that Remotely Piloted Vehicles (RPVs) are about to take over various roles of piloted aircraft. With the exception of niche military applications, these claims have not been widely upheld for a number of reasons, one of which being that an RPV still requires a skilled pilot on the ground. Current technology allows the development of fully autonomous systems, hence the accepted use of the term, Unmanned Aerial Vehicles (UAVs), for such airborne systems. There are a number of developments which have contributed to this situation:

- the availability of compact, lightweight, inexpensive motion detecting sensors essential to the flight control system, including carrier phase Differential Global Positioning Systems (DGPS);
- compact lightweight low-cost computing power for autonomous flight control and development; and
- the mature aeronautical and control system design capabilities, and the ability to draw upon the extensive worldwide UAV knowledge-base.

It is more recently accepted in the aerospace industry that technologies required for autonomous capabilities for UAVs are mature enough for more widespread use. The significance of unmanned aircraft research as a national resource and potential export earner is illustrated by some aerospace industry news reports, eg. the internationally acclaimed weekly news magazine, *Flight International* reported in their 19-25 July 1995 issue the following:

Nearly 8000 unmanned air-vehicles (UAVs) worth \$3.9 billion [US\$], will be produced worldwide between 1994 and 2003. The reconnaissance market is expected to double in size over the ten-year period, according to the Teal Group s UAV annual forecast.

The forecast released at the 1995 unmanned-systems show organised by the Association of Unmanned Vehicle Systems in Washington DC, estimates that 5250 target drones worth \$1.3 billion and 2650 reconnaissance systems worth \$2.6 billion will be procured during the decade. The estimate does not consider the cost of related hardware such as ground-control stations. It only covers air-vehicle costs, which constitute as little as 15% of many UAV systems.



Figure 1 UAV Market Assessment (1990-2002) - presented at AUVSI '96

Figure 1 shows a 1990-2002 UAV Market Assessment by the US-based Electronics Industries Association presented at the 1996 meeting of the *Association of Unmanned Vehicle Systems International* (AUVSI '96 Symposium) in Orlando, Florida, USA. It shows the strong growth in the military

applications market starting to settle over the next few years, while the market for civilian UAV applications is predicted to grow significantly over the next five years.

Strong cases were presented at the AUVSI '96 Symposium which promoted the use of UAVs for Environmental Monitoring, Weather Research, Agriculture Support, and Mineral Exploration. In the Australian context, the CSIRO Office of Space Science and Applications (COSSA) sponsored the inaugural Australian national **UAV Symposium** on 30-31 October 1996 in Canberra. This meeting, attended by over 90 people from research organisations, academia, and industry, served well to indicate local interest in UAVs. A follow-on meeting in early 1997 initiated the Australian UAV Special Interest Group (SIG) to foster UAV activities in Australia. Furthermore, the Aerospace Technology Forum (ATF) - a Federal Government initiative which funds an aerospace industry network - has recently completed a study of the UAV market². Some of the findings from that study are also presented in this paper.

2. Existing UAVs

UAVs are highly capable unmanned aerial vehicles flown without an on-board pilot. These robotic aircraft are often computerised and fully autonomous. UAVs have unmatched qualities that make them the only effective solution in specialised tasks where risks to pilots are high, where beyond normal human endurance is required, or where human presence is not necessary. Furthermore, UAVs offer new and cost-effective capabilities not previously attainable.

Table 1 shows a widely accepted classification for UAVs, with examples shown in Figure 2. It is noted that the category *Tier I* is also known as **Tactical** UAV, *Tier II* as **Operative** UAV, *Tier II Plus* as **Strategic HAE** (High Altitude Endurance) UAV, and *Tier III Minus* as **Strategic LO** (Low-Observable) **HAE** UAV.

Table 1: UAV Tier Classification and Characteristics³

Category	Designation	Max Alt	Radius	Speed	Endurance	Example
Tier I	Interim-Medium Altitude, Endurance	Up to 15,000 ft	Up to 250km	60-100 kts	5 - 24 hrs	Pioneer; Searcher
Tier II	Medium Altitude, Endurance	3,000 ft to 25,000 ft	900 km	70 kts cruise	More than 24 hrs	Predator (Used in Bosnia)
Tier II Plus	High Altitude, Endurance	65,000 ft max	Up to 5,000 km	350 kts cruise	Up to 42 hrs	Global Hawk (expected to fly Dec 96)
Tier III Minus	Low Observable - High Altitude, Endurance	45,000 ft to 65,000 ft	800 km	300 kts cruise	Up to 12 hrs	Darkstar (enters service 1999)

Defence related UAVs that have been developed in Australia include the very successful GAF/ASTA/Boeing **Jindivik** target drone, the HdeH **Enmoth** RPV, various experimental RPVs developed by the DSTO in the 1970's, and of course the recent success of the BAeA **Nulka**

² Wong, K.C., Bil, C., Gordon, D., Gibbens, P.W. (1997). "Study of the Unmanned Aerial Vehicle (UAV) Market in Australia", Final Draft, August 1997, Aerospace Technology Forum Report.

³ Lax, M. & Sutherland, B. (1996). "An Extended Role for Unmanned Aerial Vehicles in the Royal Australian Air Force", Air Power Studies Centre Paper Number 46, July 1996, p11.



Figure 2 Common UAV Category Definitions and Examples

hovering rocket decoy. It is noteworthy that the *Jindivik*, which has been in continuous production for over forty years, has been exported to Sweden, the UK, and the USA. The Nulka decoy appears to have the same potential, judging from recent export success to Canada. UAVs that have recently been operated for the Australian Defence Forces (ADF) in various capacities include the British *Banshee* target drone, and the Israeli *Scout* surveillance UAV.

UAVs are also active in the Australian civilian domain. The biggest success here is probably the Bureau of Meteorology (B of M)/Sencon Environmental Systems (SES)'s *Aerosonde*, a UAV specialised for meteorological work. Besides the B of M, its sponsors have included the US Office of Naval Research, National Oceanic and Atmospheric Administration, and Department of Energy, and the Taiwan Central Weather Bureau. The *Aerosonde* is currently in operation and remains unique globally in its capabilities, having export customers from Taiwan and the USA. Sydney University has been working on UAVs for flight research for over 10 years, and has developed and operated several UAVs, ranging from the *KCEXP-series* UAVs, to *UAV Ariel*, and more recently the *UAV Brumby*. RMIT's Wackett Centre has also been involved in research studies on UAVs, such as the multi-role *Jabiru* and the atmospheric research *Sarus*. There are also numerous small organisations who have used small UAVs for aerial photography.

3. Are UAVs suitable for Australia?

The following outlines the Strengths, Weaknesses, Opportunities and Threats (SWOT) in establishing a viable UAV industry in Australia⁴:

Strengths:

- currently has good UAV-related research being undertaken in DSTO, CSIRO, Bureau of Meteorology, and universities;

⁴ Wong, K.C., Bil, C., Gordon, D., Gibbens, P.W. (1997). "Study of the Unmanned Aerial Vehicle (UAV) Market in Australia", Final Draft, August 1997, Aerospace Technology Forum Report.

- Australia is a vast country which has:
 - clear surveillance requirements for defence, coastwatch, and the monitoring and protection of the environment and coastal natural resources;
 - rich mineral wealth deposits which needs to be exploited with due consideration to environmental impact;
 - a harsh climate, requiring understanding to support the population areas; and hence
 - potentially a good domestic market.
- has a strong UAV Research, Development and Production record, e.g. *Jindivik*, *Nulka*, and *Aerosonde*;
- has a strong aerospace manufacturing base, e.g. Boeing ASTA, Hawker de Havilland, British Aerospace Australia, Gippsland Aeronautics, and several smaller GA aircraft manufacturers;
- there is a national focus on advancing Information Technology, which UAVs could play a significant role;
- a positive by CASA relating to the operation of UAVs, e.g. there is current a working group on UAVs;
- many groups and organisations have a strong yearning for low-cost, moderately capable, and small operational airborne platforms (UAVs) to research and develop applications to:
 - build up a national UAV experience-base so that consultants (such as universities, DSTO and RAAF ARDU) could provide appropriate “smart” advice to specific customer requirements; and to
 - enable smaller organisations to have opportunities share and exploit Information Technologies derived from UAVs.

Weaknesses:

- UAV interest and activities have been fragmented due to geographical separation and lack of national coordination;
- there is a general lack of initiative;
- there is a general lack of cooperation between Australian companies to present national products resulting in over-competitiveness between companies;
- there is a general culture to purchase from overseas;
- commercial organisations generally have an over-conservative approach to the market in relation to high technology aerospace products; and
- there remains a lack of appreciation of the potentially high value use of IT for specific needs.

Opportunities:

- An undertaking to establish a national airborne research facility for applications-based UAV Research and Development;
- a complete UAV system design project for the Australian community:
 - to be complete aerospace system providers rather than just component manufacturers;
 - at an affordable investment scale;
 - to maintain and build up the national high technology expertise (Note: a lot of high technology aerospace expertise has already been lost through the closing of major programmes, e.g. *Jindivik*, *Nomad* and others.);
 - a national collaborative aerospace undertaking, based on UAVs, could provide the “glue” for high technology companies to work together;
 - for the ADF to become “smart” customers for specific requirements, e.g. JP-129.
- CASA, being one of the world leaders in having a working group on national UAV regulations could provide regional Asia-Pacific expertise;
- there are potentially numerous spin-offs to other high technology industries in:
 - Robotics and Mechatronics;
 - Image and signal processing;
 - Software engineering;

- Miniature sensor technologies; and
- Information Technology (IT).

Threats:

- Overseas competition - the general attitude to buy from overseas;
- the gradual loss of national aerospace capabilities;
- the poor history of taking innovative products from concept to commercial production and operation;
- Research and Development funding is very constrained and limited.

4. Is Australia Ready for UAVs?

4.1 Key Technologies for UAV Development

Core technologies required for successful development of UAVs include the following:

- Airframes - the flight platform is obviously a key component of a UAV system. Given the unique requirements for specific tasks, the airframes and their flight performance should be developed to suit them, eg. high manoeuvring performance required for low level terrain-following.
- Propulsion units - this is particularly significant for high altitude and/or long endurance requirements. Likewise, there may be special fuel or engine material-property requirements.
- Autonomous Flight Controllers - the key to wide application potential of UAVs. Globally, there has not yet been many UAVs capable of completely autonomous operations.
- Launch and Recovery - key phases of UAV flight. Launch and recovery requirements are often dependant on task and operational requirements. Current launching techniques range from the use of runways, catapults, rockets, to the use of trucks. The significance of recovery technologies is illustrated by US Navy's experience with their operation of the *Pioneer* UAVs from their ships, where each recovery from any mission incurs damage averaging US\$15,000.
- Navigation and Guidance - the common availability of Global Positioning Satellite Navigation Systems has had a prominently positive impact on navigation in general, and likewise their use in UAVs. The integration of satellite navigation and inertial sensor data with flight control systems enable wider application potential for UAVs.
- Self-Protection - safety for the possibly valuable on-board sensors and airframes, from external interference and damage, to keep costs low.
- Ground Control Station (GCS) - the UAVs would need to be monitored from base in some form, and the possibility to update task requirements mid-way through a mission.
- Payloads - innovation and imagination remains the key to using UAVs to carry payloads and sensors, ranging from surveillance sensors to possibly express parcel delivery systems.
- Data Communication, Storage, Processing, and Dissemination - secure data links, and information technology.

It is noted that most of the enabling technologies to develop successful UAV systems are currently available in Australia. A more detailed survey and analysis could easily identify the capabilities of companies and organisations.

4.2 UAV Market Potential

International UAV market analyses have estimated the total value of the global UAV Systems market to be worth in excess of US\$19.5 billion over the next six years (1998 to 2003). Assuming that Australia might be expected to claim approximately 10% of this market, this could represent a total Australian UAV market in the vicinity of AUD\$ 2.6 billion over the next few years.

From published market predictions (Figure 1), it is noted that the military UAV market was worth US\$250million in 1992, rapidly increasing to US\$600million in 1997, but projected to level off at US\$700million in 2002. However, it is noted that the civilian UAV market is projected to increase from the insignificant level in 1997 to an incredible US\$500million in 2002!

Analysis of the scope of the Australian commercial market for air based sensing applications shows the total air operation costs to be as follows⁵:

Market	Nationwide	Global	Potential UAV share	Notes
Environment Control / Weather Research	\$5million?	\$100million currently used on weather balloons	60%	Data source from Bureau of Meteorology
Mineral Exploration	\$20million in aerial survey; and a conservative estimate of \$3million in ground survey	\$100million	30%	Data source from companies currently providing service.
Unexploded Ordnance location	\$0.5million?	\$100million	50%?	Data source from companies currently providing service. Market is rapidly expanding
Crop Monitoring	\$2.5million based on current manned aircraft		80%?	500,000 hectares per annum need to be monitored nationwide - currently only 10% covered, using manned aircraft.
Coastwatch	\$30million		5%?	Currently 14,500 hours flown by manned aircraft annually
Telecommunications	\$500million?	Satellite-based market worth up to \$26billion by 2005.	1%?	Rough estimate from miscellaneous sources
News Broadcasting	\$15million		5%?	Based on current estimate of operating aeroplanes and helicopters for news gathering purposes nationwide.
Remote Sensing of Marine Resources	\$10million		10%	Estimates from discussions with CSIRO Marine Labs, Hobart
Miscellaneous	\$1million		100%	Direct civilian UAV applications, as identified through market survey questionnaire.

⁵ Wong, K.C., Bil, C., Gordon, D., Gibbens, P.W. (1997). "Study of the Unmanned Aerial Vehicle (UAV) Market in Australia", Final Draft, August 1997, Aerospace Technology Forum Report.

Of the civilian market sectors listed, there are a number of key sectors that would benefit significantly from the utilisation of UAVs. The most prominent in terms of market value are:

- Mineral exploration;
- Media resources;
- Environmental control and monitoring;
- Telecommunications;
- Crop monitoring; and
- Unexploded ordnance detection.

UAVs offer potential benefits to these sectors in the forms of either reduction of operation costs in fulfilment of commercial objectives, increased efficiency of operation, and/or increased work (information acquisition) rate.

Through discussions with commercial aircraft operators in these fields, it has been determined that between 1% and 80% of their total business could be covered by UAVs, depending on the field. Based on these proportions, a conservative estimate places the commercial UAV market potential in the vicinity of \$20M between 1998 and 2003.

Defence projects represent substantial investment in the part of the nation. Current projects in which UAVs are potentially implementable, and in which UAVs may return significant savings in capital expenditure or increase in capabilities include⁶:

JP 129	WARRENDI	Airborne Surveillance for Land Operations	Phase 1: Category 3: \$200m - \$500m.
LAND 53	NINOX	Land Force Surveillance/Observation Equipment	Phase 3: Category 4: \$20m - \$200m.
JP 2044		Space-based Surveillance	Phase 1: Category 5: \$20m.
JP 7		ADF Future Aerial Target System	Phase 4: Category 2: \$500m - \$1000m.

Total Projects containing **some** UAV element is estimated to be:
 AUD\$740m - \$1700m. / USD\$555m - \$1275m.

Currently, only a very small proportion of the potential commercial UAV markets has been tapped. There has been a small amount of commercial activity in the areas of atmospheric monitoring and aerial photography in the past few years, together with some experimental activity in mineral exploration. These have shown significant promise and growth. However, large scale use of UAVs is thwarted by the hesitancy of potential commercial UAV users to invest in the development of UAVs for their purposes. In addition, many potential users of UAVs are unaware of the level of preparedness of research and development organisations to implement operational UAV systems. Without funding, these organisations are unable to demonstrate functional systems. A stalemate exists, and so external influence and direction is required to develop interest and collaborative initiative amongst potential industry participants in order to expedite rapid progress in UAV development and growth of a UAV industry in Australia.

⁶ Wong, K.C., Bil, C., Gordon, D., Gibbens, P.W. (1997). "Study of the Unmanned Aerial Vehicle (UAV) Market in Australia", Final Draft, August 1997, Aerospace Technology Forum Report.

Consultations with potential UAV users, service providers and research and development organisations have been made through surveys and discussions. The outcome was a clear indication that there is significant interest from all elements in establishing developmental programmes aimed at implementing viable UAV systems to service the commercial market. Although there are many UAV systems either in operation or under development world-wide, there are few that could be considered affordable to commercial operators that have attributes suitable to operation for commercial purposes. High costs are partly because most systems have been developed for military markets and roles, and therefore subject to stringent military specifications. It is believed that developments specifically aimed at commercial operations and therefore with attributes tailored to commercial requirements are more likely to be acceptable to the civilian UAV market.

The technologies necessary for UAV development, and the current capabilities of Australian industrial and R&D organisations to provide them, are considered mature enough to realise operational systems. Hence, there exists a broad view amongst service providers and R&D organisations that the most effective way to establish viable UAV programmes is through collaborative development amongst Australian industry and R&D participants. Indeed it seems reasonable that shared resources and collective capital investment will produce the most efficacious and expedient results.

If collaborative development initiatives are to be undertaken, then a widely acceptable strategy must be identified which will optimally target the requirements of UAV customers. Development should therefore be directed toward the most viable markets and their requirements. The majority of commercial UAV customer requirements, although covering wide ranges in payload, range, endurance and speed, can be loosely grouped into two categories. These are a lower weight/endurance bracket (up to 25 kg payload, 100-200 km/h airspeed, 4-5 hrs' endurance), and a medium weight/endurance bracket (~100 kg payload, 50-100 km/h airspeed, 24 hrs' endurance). These broadly mirror the *Tactical* and *Strategic* military UAV categories.

Apart from mission-specific system characteristics, the fundamental flight and navigation systems technologies are common between these categories. Given that the sensing payload will typically be supplied by the customer, the main differences between the categories lie in their sizes, and accordingly, the technologies required in their construction, performance and propulsion. While the markets are large in either category, the impetus of the mining industry in searching for high value mineral deposits, together with the political sensitivity attached to unexploded ordnance, would suggest that these might be more immediately viable. Coupled with the lower risks, lower costs, and less significant developmental problems associated with the smaller and typically shorter range applications, it is considered more prudent to encourage immediate development of a generic *tactical* category UAV capability. This would also provide a vehicle to satisfy the requirements of the myriad of smaller UAV users. *Strategic* level UAV developments would evolve from this in the medium term, thereby benefiting from lessons learned from development on the smaller scale. While a generic aircraft will not perfectly fit the requirements of any one commercial application, it is considered that an aircraft designed with characteristics that would suit most of the requirements of most customers, and in excess of the requirements of others would provide a broadly applicable and sought after facility. While a system with excess capabilities may be slightly more expensive to operate, the reduction in capital costs due to collective development of a small number of generic types would be far more significant. Accordingly, a focus on development in the *tactical* category will produce products that are more versatile and easier to sell on both the domestic and global UAV markets, and may lead to substantial export opportunities to assist developments at the *strategic* level. The

products would also represent viable options for defence UAV applications, which would not require the usual large scale developmental and capital spending on the part of the government.

A unique opportunity exists for the development of a strong aerospace-based industry in Australia. Market analysis has identified that significant progress must be made within a five-year period to 2002 toward realisation of *tactical* level systems if the potential of the *tactical* UAV markets is to be optimally captured. If this need is not met, the full potential of *tactical* level UAV customers in capturing their own target markets will be substantially hindered. Accordingly, it is imperative that operationally capable and reliable UAV systems be demonstrated within this five-year period, and be ready for large scale manufacture, sale and deployment.

It is proposed that the most effective way to expedite the proliferation of a UAV industry would be to form a consortium of industry partners who are prepared to collaboratively engage and invest in developmental programs, and for the government, through the ATF, to set in place initiatives to promote the formation of such a body and inducements to attract potential partners to join that body. As far as potential Australian UAV operators are concerned, both civilian and defence, it may well be in the interests of potential Australian UAV operators collectively, if a national UAV development initiatives were to be directed toward provision of vehicles that could fulfil a range of roles for various operators (both civilian and defence). This would present advantages in terms of development cost minimisation and resource utilisation, involvement of a broad range of industries and R&D organisations, utilisation of Australian expertise, and the development of a national UAV capability. As a whole this would result in growth of the UAV related aerospace industry, thereby stimulating employment growth, productivity, and export potential. Indeed, the Australian UAV industry situation, represents a case example of an aerospace industry where a burgeoning home market may justify its (re-)development, leading to substantial export potential.

4.3 Conclusions

From market surveys, it can be seen that the Australian UAV market is very positive. The current market atmosphere is likewise optimistic. Customer requirements, service providers, and R & D support can be fairly clearly identified. Business linkages between R & D groups and commercial organisations are not so easily identified. The way forward to take advantage of this great aerospace industry potential is to take immediate action, to demonstrate an operational UAV system by 2002.

4.4 Recommendations

In order not to get left behind (again), the Australian aerospace industry should:

- support demonstrator UAV projects to better evaluate market opportunities;
- organise and participate in UAV special interest meetings, bringing together commercial, government and research organisations, to discuss levels of interest and commitment in a collaborative demonstrator UAV development, and to evaluate their preparedness to invest in the formation of a national UAV centre and to be part of a consortium that will operate it;
- consider developing a complete demonstrator “Tactical” UAV system, based on existing Australian UAV and related R&D expertise;
- liaise with CASA to investigate the regulatory and legal aspects for operating UAVs in Australia; and
- take advantage of existing UAV R&D in the country, to meet local and global market opportunities.

5. UAVs at Sydney University

At Sydney University, current research in Unmanned Aerial Vehicles (UAVs) has produced promising results towards the development of fully autonomous capabilities. Previous experience with instrumented UAVs include the experimental *KCEXP series* UAVs, and the *UAV Ariel*. An aircraft currently being operated is the UAV named *Brumby*. Like its namesake, it is designed to operate in rugged environment. Being developed primarily to provide a flight research platform in support of various research activities, *UAV Brumby* is also used to enhance skills in airframe design and fabrication, instrumentation, flight control systems, and operational aspects of UAVs. It forms the basis of a technology demonstrator for many aspects of aeronautical engineering. Current UAV related research activities include the following:

- Wind-tunnel and flight based experimental research in aerodynamics and flight performance;
- Modelling of engine/propeller performance and aircraft stability characteristics;
- High fidelity aircraft model development for simulation based control system validation;
- Trajectory optimisation and autonomous guidance for unmanned aircraft;
- Sensor fusion strategies for state estimation using multiple redundant sensors, including Global Positioning Systems (GPS);
- Using GPS for aircraft attitude determination;
- System Identification methods and neural networks for fault detection and reconfiguration;
- Robustness analysis of control laws in the presence of uncertain dynamics and wind gusts;
- Robust nonlinear high-performance manoeuvre tracking for autonomous aircraft;
- Autonomous launch and recovery of a UAV;
- Terrain Following and Terrain Aided Navigation;
- Integration of available UAV technologies into operational systems;
- Real-time flight control software synthesis; and
- Design and fabrication of airframe components using advanced composite materials.

UAV Brumby (picture of aircraft during its initial flights on next page) is a delta wing unmanned aerial vehicle, designed with a standard dual fin, pusher propeller configuration. It employs an extremely modular construction for simple and cost effective manufacture, as well as high maintainability and damage recovery. Already prototyped as a multi-purpose flight research vehicle, it has been demonstrated as a stable flight platform well suited to flight navigation research. It is noteworthy that the first prototype flew successfully only 6 weeks after work commencement, and that includes tooling and composite mould fabrication.

The vehicle is designed to fly in excess of 80 knots and currently has an endurance of ½ to 1 hour flight time. The aircraft has the capacity to carry up to six kilograms payload when remotely piloted, or four kilograms when operated autonomously. Furthermore, the maximum design weight will be extendable by an additional 3-5 kilograms once the initial flight test program is complete. This is initially constrained to keep within the Australian Civil Aviation Orders Part 95.21, relating to model aircraft which permits a maximum Operational Empty Weight (OEW - that is maximum take-off weight minus fuel) of 25 kg. Previous UAVs operated by the research group have been flown outside these regulations (maximum weight of 36 kg), requiring a Civil



Aviation Safety Authority (CASA) Australia Permit-To-Fly. The group has also flown UAVs within controlled airspace with the co-operation of CASA and the Federal Airports Corporation (FAC), and is working with CASA to formulate new regulations specifically for UAVs. Hence, there is growth potential for the proposed airframes.

6. CONCLUSIONS

Australian research activities show advanced capabilities in design, construction, system development, flight control and guidance, and operation of UAVs. These capabilities and UAV technologies have either been demonstrated in-flight or through simulation. Given the positive current local market atmosphere for using UAVs for various tasks, the Australian aerospace industry should collaborate with local R & D organisations to launch into mission-specific UAV technology demonstrators.

Hence, in response to the initial questions, the author believes that the time for wider use of UAVs is indeed here, and Australian R & D work on UAVs is mature enough to develop mission-specific systems. However, it still remains unclear as to specific industry and government commitment to be involved in this very exciting field of robotic aircraft.