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AUSTRALIAN PRODUCED SELF PILOTED STEALTH AIRCRAFT DEPLOYED BY THE AUSTRALIAN DEFENCE FORCE AND IN AID OF CIVILIAN AUTHORITIES

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The ...

INTRODUCTION

In December 1907, the Australian Prime Minister Alfred Deakin observed that the Federal Government, newly responsible for the defence of the realm, faced an intractable problem. A country of 7,682,300 square kilometres and with 36,735[1] kilometres of coast line, populated by four million people and with limited financial resources would have difficulty defending itself in the event of hostilities. Deakin realised that military practices developed in Europe needed modification for effective employment in Australia’s circumstances.

In 1994 the problem facing the Australian Defence Force (ADF), and civil authorities, is exacerbated by a world where a burgeoning population places increasing pressure on scarce resources. The problem of financing the defence of Australia’s abundant natural resources with a small population remains.

There is, however, a convergence of technology that would allow Australia to enhance the capabilities of its defence force and civil agencies at low cost. In some cases new capabilities would be introduced, in other instances expensive and vulnerable systems would be replaced with less expensive and more survivable systems.

This paper examines the use of self piloted stealth aircraft that can be used by the ADF and by civil authorities to complete missions at lower cost and/or higher effectiveness than existing systems or to enhance the combat power of existing systems.

THE EFFECT OF THE CONVERGENCE OF TECHNOLOGIES

The pace of technological development has accelerated rapidly in the latter half of the 20th century. A characteristic of this development is the multi-disciplinary nature of technology. New technologies can converge to produce new products. This is the case with Self Piloted Stealth Aircraft (SPSA).

Self Piloted Aircraft have held promise for some time. One of the earliest uses of unmanned weapons occurred during the closing stages of World War II when V1s[2] and V2s deployed against targets in the United Kingdom. Despite the rudimentary guidance systems, these advanced weapons caused such consternation that considerable effort was diverted to attempt to counter the weapon systems. In the case of the V2, there was no defence against the missile after it had been launched, and the

[1] Australia’s coastline is 91.77% of the circumference of the earth, and the more remote parts are distant from airfields from which routine operations may be conducted.

[2] New Scientist, 4 June 1994, reports that approximately 8,600 V1s were launched at Britain. The weapon could carry a 1 tonne warhead a distance of 220 km at a speed of 560 km/hr. Initially many penetrated through the defences. Only the convergence of microwave radar, gun predictor, servo controlled artillery and proximity fuse technology saved British cities from substantial damage. By the time the allied invasion over ran the launch sites, the new technology was destroying over 80% of the V1s. Nonetheless, some 75,000 buildings were damaged or destroyed, and 5,479 killed and over 40,000 injured as a result of V1 attacks.

only effective countermeasure was to destroy launch sites. Even then, substantial numbers of both types of weapons reached their targets.
After the principles for the use of this type of weapon were absorbed by military planners, development of missile systems proceeded rapidly and it was a convergence of technologies that enabled the developments. Rocket propulsion technology, guidance technology, materials technology and communications provided the vehicles. Weapons technology, especially the miniaturisation of atomic fission and fusion, provided the combat power of the weapons system.

At the same time, the technology of the early rocket missile weapons was combined with search and guidance radar to produce interceptor weapons. The resulting vulnerability of piloted aircraft shifted the balance of combat power to missiles and for some time there was serious doubt whether a piloted aircraft could be usefully employed in an environment where missiles abounded, or even whether piloted aircraft were cost effective in comparison with a range of offensive missile systems. Substantial shifts in defence expenditure occurred, for example to hardened missile silos housing ICBMs, missile equipped submarines and rocket propelled tactical nuclear weapons.

The tide turned again when another technology emerged: ‘smart’ systems based on miniaturised sensors and computers. Sensors were developed to detect the emissions of search and guidance radars, and means of jamming or deceiving these sensors were developed to the degree where the vulnerability of aircraft was reduced to acceptable levels. Other weapons system developments included the use of short range airborne radar to look ahead and avoid terrain, enabling aircraft such as the F111 to fly below the coverage of search radars. Using a similar tactic, self piloted cruise missiles use vertical radars and a stored profile map to fly at altitudes below the radar horizon to precise points.

Even when the environment becomes too hostile for a high value piloted aircraft to penetrate at an acceptable risk, stand-off weapons provide the range to reach targets. With specialised on-board guidance systems, these precision guidance weapons destroy targets with far fewer missions than the number required by ‘dumb’ bombs and delivery platforms.

The latest technology to become operational is ‘stealth’: reducing the radar, infra-red and visual signature of an aircraft to reduce the probability of detection. This development has allowed piloted aircraft to enter a heavily defended area and deliver precision guided weapons onto high value targets.

From a nadir point where the value of piloted aircraft was being critically evaluated by politicians and defence analysts, technology developments have transformed aircraft into the weapon of choice, especially where short, low casualty conflict is required. The value of piloted aircraft could now be approaching its zenith.

Continued technological developments can enable new aircraft systems to be developed that will extend the use of air power to new users and uses, and to enhance existing systems. These technologies are:

a. composite construction materials such as fibreglass and kevlar;

b. precision navigation systems;

c. programmable auto-pilots;

d. miniature sensors and payload;

e. reliable communications;

f. image processing techniques;

g. inexpensive fuel efficient engines; and

h. advanced aerodynamic designs.

While Remotely Piloted Vehicles (RPVs) and Unmanned Aerial Vehicles (UAVs)[3] have been available for several decades, these new technologies allow a more capable class of aircraft of this type to be produced. To reflect the more advanced capabilities of these aircraft, they are described in this paper as 'Self Piloted Stealth Aircraft (SPSA)'.

CAPABILITIES OF A SELF PILOTED STEALTH AIRCRAFT

In this section of the paper, the application of each of the technologies listed above to the development of a SPSA will be discussed.

Composite Construction Materials

Composite materials are being used in increasing amounts in aircraft construction. For an equivalent total cost, composite materials are lighter and stronger than metals - both important attributes in aircraft design. While subject to degradation from ultra-violet radiation (although surface finishing overcomes this problem), these materials are much more resistant to corrosion and stress fatigue than metals. Complex structures can be fabricated simply and at relatively low cost using moulding techniques. By contrast, equivalent metal structures must be built up from many sub-components adding to cost and construction complexity. A current example of the application of this technology in the ADF is the superstructure of the Collins class submarines which must operate reliably for decades in the hostile undersea environment.

When used in a SPSA, almost all the structure may be formed from composite materials which bestows a special benefit - a very small radar cross section. Metal stealth aircraft use planar surfaces or radar absorbent materials to reduce radar

[3] Unmanned Aerial Vehicles (UAVs) is the set of a range of aircraft without a human crew that is generally understood to exclude guided missiles. Remotely Piloted Vehicles (RPVs), while being a part of the UAV set, require continuous guidance during the mission. This command link is vulnerable to interception or interruption, in which case the vehicle will generally be lost. The Self Piloted Stealth Aircraft (SPSA) is also part of the UAV set, but has special capability of having on-board piloting systems that allow it to complete its mission without frequent external intervention.

reflectivity, but aerodynamic capability and available payload are compromised by this approach. The airframe of the low speed SPSA envisioned in this paper can be almost entirely made of composite materials and can be crafted into an aerodynamically efficient shape.

There is one composite material that cannot be used in stealth aircraft where reliance is placed on radar transparency - carbon fibre. This material is conductive and hence reflects radar quite well.

If a SPSA is constructed of composite materials such as fibreglass, foam, kevlar and bonding resins, it can be constructed quickly, inexpensively, be virtually radar invisible and have a long operational life.

Precision Navigation Systems

The US Global Positioning System (GPS) and the (formerly) USSR GLONASS[4] now provide precision positioning, anywhere in the world, with 24 hour coverage and a resolution of 100 or 10 metres in three dimensions, depending respectively on whether the receiver is qualified for civilian or military use. This precision may be further enhanced if a local, short range (200 km) station is deployed. Precision approaches may be flown when a local 'differential' GPS transmitter is used. All weather operations may be successfully completed using GPS alone in these more precise modes.

GPS is vulnerable to jamming, and if a SPSA is to enter a hostile environment where interference is probable, then the navigation system must be supported by a backup system. Solid state laser gyros have been developed that are more reliable and less expensive than the mechanical versions and can be used accurately over short ranges.

A third navigation system currently in use by cruise missiles relies on terrain profile matching. A low power vertical radar beam maps the terrain profile under the craft and a computer matches the profile with an internally stored map to fix a precise location. Position updates and course corrections are possible when over land exhibiting distinctive vertical features.

If two systems or other similar navigation systems are operated in parallel and monitored with a system that has the ability to select the most accurate position, and if the position can be modified en route, then a SPSA can accurately fly its planned mission profile even when GPS is being jammed.[5] For a low level of hostility - the

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[4] The Global Positioning System (GPS) uses 24 satellites orbiting the earth in polar obit, and spaced so that several are visible to a receiver at any time. Using very accurate timing references, each satellite transmits its position continuously. A receiver detects signals from several satellites simultaneously. When the signal is received from three satellites, a ground position is computed. Four satellites allow height to be computed as well, while additional satellites increase the accuracy and reliability of the position fix. A receiver can store successive position 'fixes' and compute speed and direction in addition to position. The accuracy of military GPS is about 10 metres, but this is deliberately reduced for civilian use. Both the USA and Russia maintain GPS systems, and some receivers can receive signals from both systems simultaneously.

[5] When GPS is being jammed, the aircraft may be unable to accurately fix its position from GPS. Using intelligent software to monitor and compare the position estimations from (say) a GPS receiver and an inertial navigation system, the true position can be estimated. Typically, the GPS position will

majority of missions envisaged for the SPSA - a single GPS based navigation system would suffice.

These developments in precision navigation enable the guidance systems of a SPSA to ‘know’ at all times the location of the craft in three dimensions, typically to 100 metres accuracy, and more precisely if a military GPS is used and local GPS stations are employed.

Programmable Auto-Pilots

Computer technology has advanced to the point where there is a personal computer on most desks. Computational power extends far beyond this application, with devices such as calculators, facsimile machines, car engine managers, portable telephones, even washing machines, relying on a dedicated computer to control functions. A special purpose computer could be based on the components found in a desktop Personal Computer, with the control program placed in read only memory (ROM) and the way-points stored in random access memory (RAM). Mission programs could be stored in non-volatile memory, programmed outside the SPSA, and be literally ‘plugged in’ during flight preparation. Special care would be needed to protect the programs from vibration, electromagnetic pulses and to provide a stable source of power.

The outputs from the control system would be fed to control servos. These could take a number of forms, but if continuous electric power is required for the computer, electric servos would probably be the simplest. A scaled up version of the servos used in radio control models would suffice. These servos are fed with a train of pulses modulated in width, moving it to a defined position depending on the pulse width. Set in a feedback loop consisting of the required flight position, the attitude and location of the aircraft and the position of the controls, the computer can smoothly adjust the control surfaces to fly the mission.[6]

A dedicated flight management computer could be programmed to control a flight by storing way-points, and comparing a position readout from the precision navigation system to guide the flight. Aircraft attitude sensors would be needed to maintain control in turbulent conditions. Communication links could reprogram way-points so that the SPSA could respond to changes in mission profile while airborne.

The flight management system might be ‘layered’ firstly to maintain control of the aircraft, secondly to navigate and thirdly to respond to contingencies or opportunities and lastly to advise of the aircraft’s position or provide output from its sensors.

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be used to update the inertial position as the latter system suffers from ‘drift’, typically a couple of kilometres per hour. However, if the GPS receiver gives an erratic position or ceases to provide a position, the on-board systems can use logic to conclude that GPS is unreliable, and then switch to the less accurate, but still acceptable inertial navigation system for terminal guidance. Military GPS is more resistant to deception jamming, but the receiver is typically an order of magnitude more expensive than a civilian receiver ($1,000 versus $10,000). Trade-offs between cost, reliability of reception and accuracy would need to be made to optimise mission capability.

[6] An observation from the author: as a pilot it is somewhat annoying to watch a well designed autopilot fly an aircraft with much greater accuracy than a skilled human pilot, even when the human pilot concentrates only on flying. Computers don’t blink!

Aircrew have an aphorism that describes this philosophy in terms of a hierarchy of importance, namely: 'aviate, navigate, operate, communicate'.
A lightweight, inexpensive automatic recovery system is one of the greatest challenges for SPSA. An 'auto-land' system might use GPS for horizontal placements and a ground proximity sensor (eg an ultrasonic probe or a light based rangefinder similar to an auto-focus camera) to auto-land the aircraft at the end of a mission.

With this type of control, a SPSA could fly missions in all weather conditions, day or night.

Miniature Sensors and Payload

One of the main uses for a SPSA is as a sensor platform. The ability to gather detailed visual and infra-red 'real time' images has many military and civilian uses. Television cameras with zoom and pan capability are readily available from commercial sources. For night operations, low light and infra-red cameras could be part of the payload.

Attempting to penetrate airspace which is heavily defended by radar directed missile systems can be a lethal exercise for conventional aircraft. A stealth aircraft fitted with a high speed electronic warfare computer could deceive radar systems by receiving a pulse, delaying and frequency shifting it to inject false targets into either pulse or Doppler radars, thereby generating phantom targets at a location and speed far from its actual position. Even if a simple 'switchable' radar reflector or transponder is used, the threat would have to be dealt with. Thus, SPSAs could act as decoys to dissipate defence capabilities, enabling piloted aircraft to penetrate to a target with lower risk.

A SPSA could act as an attack weapon in its own right. With an explosive payload the aircraft could penetrate a hostile area using its inherent stealth characteristics, and deliver the explosive with precision. The low speed and limited payload mass (a 300 kg combined payload of fuel and mission specific equipment is suggested, with a 100 kg minimum of mission specific equipment,) would limit the targets that could be attacked, but there is still a wide variety of targets that cannot be hardened against this type of weapon. GPS could provide precise guidance to the target area, within the limits suggested above, which could be supplemented by terminal guidance similar to that used in weapons such as the Maverick/AGM-65[7].

The SPSA could act as an electronic intelligence (ELINT) collector. With a receiver, signal processor and recorder as the payload, the aircraft could use its stealth characteristics to penetrate into an area of interest and passively monitor the electronic spectrum. One strategy would be to record the transmissions for later analysis. Another would be to use on-board assessment and to transmit intelligence when a predetermined signal signature is received. Either strategy could be useful when the long endurance of the SPSA is considered.

[7] There are several terminal guidance systems available. In the case of a SPSA, a stored target image could be compared with one obtained from a small forward looking TV camera. The SPSA would fly to the target area with an accuracy of tens of metres, then switch to terminal guidance mode for the final phase. Using this technology, it is quite feasible to direct a SPSA with sufficient accuracy to fly (say) through a window.

Image Processing Techniques

Passing a continuous stream of images back to a base station requires a high bandwidth and any transmission from an aircraft compromises its stealth profile. Image processing can be used to reduce the communications flow. An example would be a SPSA conducting ocean surveillance. If ships are the subject of interest, an infra-red sensor could look for hot spots on a cold ocean, and be programmed to ignore land sources of heat.

A surveillance SPSA must collect, store and transmit data, and the smaller the amount of data, the greater the capability. Hence, there is a need to minimise the amount of stored data. There is considerable commercial interest in techniques to compress data, as the broadcasting industry pays for the bandwidth it uses. Compression ratios approaching 100-to-1 are now possible with minimal loss of information. Many applications do not require continuous imaging, for example battlefield surveillance may only require an update every few minutes. Using these techniques allows the required information to be gathered and transmitted while minimising the risk to the SPSA.

If ‘real-time’ surveillance is not required, then the data collected may be recorded for later analysis. An example could be a mission to detect illegal drug crops. The SPSA would fly a detection pattern over the area of interest and record images to provide stereo interpretation capability. If the camera has a resolution of 1,000 * 1,000 pixels, a 1 metre per pixel ground resolution is required, the flight is conducted at 3,000 metres at 150 km/hr, safe endurance in area is 15 hours and 90% overlap is required between images, then an image is required each 2.4 seconds. Some 2,250 images need to be recorded and the area covered per flight would be 2025 square kilometres, allowing for a 10% overlap on the edges. If each pixel in the image requires 16 bytes of information, and data compression of (say) 30:1 is used, then the mission would generate 1.2 gigabytes of data. Current technology digital data recording allows about 4 gigabytes of data to be recorded on a tape the size of a standard music cassette tape. Thus, a SPSA could retain a full record of its images gathered in a mission for later analysis.[8]

The conclusion is that modern image processing methods open many missions to a suitably equipped SPSA.

Reliable Communications

Two requirements for communications have been described: re-programming the mission profile while the aircraft is airborne and returning sensor data to home base.

[8] Digital technology is rapidly displacing photographic techniques for data capture and storage. Using TV cameras and digital tape recorders allows the number of digital images to greatly exceed photographic techniques. For example, a TV camera including control equipment weights a kilogram or so, and the digital tape recorder a couple of kilograms, but several thousand high quality images can be collected on a tape the size of an audio cassette. A special advantage of digital images over photographic methods is that the digital image may be recovered, in full cover, without chemical processing. In addition, the images can be digitally processed to enhance features or seek special shapes using computer processes that are much faster than human interpretation.

If on-board senor data processing and data compression is used, then use of communications links would be reduced. A HF transmitter, notwithstanding its limited bandwidth, could provide the required transmission range and data rate for missions where the data rate is less demanding.

For more data intensive applications such as ‘real-time’ battlefield surveillance, a shorter range - higher bandwidth link would be needed. For high frequency (eg microwave) communications, antennae can be made small and highly directional, reducing the risk of detection. The skin of a composite aircraft is transparent at these frequencies, so a steerable dish could be employed inside the SPSA to provide a point-to-point communications link. Since the aircraft knows precisely where it is at all times, a dish antenna could be continuously directed towards the communication base, or be directed to switch from one base to another. The latter capability would allow sensor data to be continuously down-loaded (say) initially to a shore base, then to ships at sea.

Satellite communications are another possibility for an up-link. Again, a steerable dish could point to a communication satellite since the SPSA would know both its own location and that of the satellite. The satellite would provide the down-link to the ground station. Using a satellite as the intermediary link would allow reliable, continuous long range, high bandwidth communications. Commercial satellites presently in orbit would provide the required capability, unless there is a requirement for many simultaneous SPSA missions.

Modulated lasers provide another opportunity for short range, line-of-sight communications. Modulating a laser provides a very high bandwidth capability and the opportunity to transmit along a narrow communication beam. Again, the SPSA knows its position, and if it can track the position of a receiver, it can direct the beam with precision. Information on SPSA and the receiver movement could be encoded in the data stream, allowing each system to track the other and maintain a very narrow beam, high bandwidth communication system. A particular advantage of laser communications is the absence of conductive antennae which could be detected by radar and absence of side-lobes that can be detected away from the direction of the main beam.

There is a range of options for communication with SPSA, with the best choice being determined by the mission tasks and environment. Some development would be needed, especially for highly directional communications systems designed to restrict the broadcast beam to a small angle to reduce the probability of detection.

Inexpensive and Fuel Efficient Engines

The ultralight aircraft industry has spawned the development of reliable, lightweight and inexpensive aircraft engines. Typical examples are engines manufactured in Austria. Intended for the harsh environment of snow-mobiles, the engines have been adapted for the equally harsh aircraft engine environment. There are several types. Of special interest to SPSA use are the 618UL and the 912UL models. The 618UL is a 58 kg, twin ignition, two cylinder two stroke engine which produces 55 kW. The retail cost is approximately $AUD6,000 and the operational life between overhaul would be about 300 hours. The 912UL is a 65kg twin ignition, four cylinder four stoke producing 59 kW. Its cost is about $AUD12,000 and its operating life between overhaul is currently 1200 hours. Neither of these engines is certified for aircraft use by the Australian Civil Aviation Authority, but they are approved types for ultralight aircraft. The range versus payload of a SPSA using these engines is discussed later in the paper.

Although Australia produced complete aircraft engines during WW II, the production of piston aircraft engines ceased soon after the war ended, and components for the jet engines for military aircraft such as the Sabre and the Mirage were manufactured under licence. Recently, the ultralight aircraft industry has produced sufficient demand, and aircraft engines are now produced in Australia, albeit on a small scale and using some car engine components. One Melbourne based manufacturer produces 100 - 150 kW aircraft engines by fitting Subaru engines with reduction gearing which makes the propeller more efficient.

Another interesting development is the Jabiru engine produced by a Queensland Company. The Jabiru is a small Cessna 150 like aircraft produced entirely in Australia. Initially it used an Italian engine, but, after the Italian company ceased production, the Australian company took the courageous decision to produce a certified aircraft engine entirely in Australia. This four cylinder, four stroke engine produces about 41 kW and has a time between overhaul of about 600 hours, a purchase cost of about $AUD10,500 and a guaranteed overhaul cost of $AUD2,500. This is the first certified aircraft engine to be completely designed and built in Australia. The company is currently developing a 55 kW engine which would suite higher performance piston engined SPSAs. They intend to offer these power plants to the USA Tier II UAV manufacturers.

Annex A provides data sheets for the Jabiru, Rotax 912UL and Rotax 618UL engines respectively.

The foregoing indicates that suitable Australian produced aircraft engines are available for an Australian produced SPSA. In comparison with military jet engines, the cost is very low. These engines are sufficiently reliable for SPSA use, and could be maintained at low cost. The engines, especially the four stroke variants, are fuel efficient and provide a long range, long endurance capability as shall be seen later.

Advanced Aerodynamic Designs

Conventional aircraft with a forward main wing and aft tail are inefficient. To remain stable, the tail has a down force to counter the forward pitching moment of the lifting wing. As a result, the tail fights the wing. There are a number of alternative designs that are more efficient. Two designs are considered here.

The first is the tandem wing design. These aircraft have a wing at the front of the aircraft to counter the pitching moment, and in this case, the front wing provides lift. This configuration is naturally more efficient. There are additional advantages of this aerodynamic configuration. If both wings are relatively equal in area, the aircraft can remain stable over a wide range of centre of gravity.

Surprisingly, few commercial aircraft with this configuration are produced. The Beech Starship is one example. There are several types produced from the experimental and home-built aircraft market, with Burt Rutan being the best known designer. His aircraft include the Long-Eze, the Quickie and the record breaking Voyager which completed a non-stop around the world flight.[9]

To illustrate the efficiencies which can be achieved, the Quickie Q-200 airframe-engine combination produces a fuel economy of about 12 km/litre flying at 300 km/hr when powered by a 140 kW Continental O-200. Aircraft engines such as the O-200 are not as fuel efficient as modern car engines, so producing the same fuel economy as (say) an average Australian family car at three times the speed is a testament to the efficiency of the Q-200 airframe.

A tandem wing configuration has other benefits. To make the aircraft stable, the front wing must be more highly loaded than the rear wing. This means that the front wing stalls before the rear wing. As the aircraft slows, the front wing loses lift, and the nose drops while the aircraft remains under control with ailerons on the rear wing which cannot stall (provided the aircraft has been designed and loaded correctly).

There is another feature of tandem wing aircraft that, to the author’s knowledge has not been exploited, but which has been known and patented for several decades. The patent dates now place this knowledge in the public domain which allows aircraft designers free use of the idea. Flaps are used on conventional aircraft to increase the camber of a wing, hence its lifting capability. This allows aircraft to take off and land at a slower speed, while retaining thin wings that give low drag at cruise speeds. Tandem wing aircraft can employ flaps on both wings to improve the slow speed characteristics of an aircraft. This configuration allows a SPSA with a tandem wing design to use flaps for slow speed take-off and landing, while retaining a low drag, thin wing for efficient cruise performance.

The twin wing layout also allows a compact structure, which can be important when the SPSA has to be transported to the operating site. If both wings are made removable, the aircraft could be crated in a box about 5 metres by 1.5 metres by 1.5 metres. Assembly would involve two wing mounting bolts and connecting two control linkages per wing. Given this modular structure, a SPSA could be readied for flight ‘out of the box’ in less than an hour.

Annex B-1 shows a picture of the tandem wing Q-200 and Annex B-2 a drawing of a simple SPSA employing these aerodynamic concepts.

The second design suggested for consideration is a lifting body/flying wing, similar in appearance to the B-2 stealth bomber. Annex B-3 shows a line drawing of a possible design.

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[9] These aircraft were considered radical at the time of their design, because they broke with tradition both in the aerodynamics and the materials used. The shape of these aircraft is quite unconventional with wings, often called ‘canards’ at the front and no tail. Composite materials allowed complex shapes to be produced, even by inexperienced home builders. The Voyager was specially constructed to carry an extraordinary fuel load in comparison to its weight, and needed composite materials to produce the necessary strength-to-weight ratio.

In this structure, the drag is reduced by having a melded body-wing structure. As can be seen from the drawing, this layout is very compact, although it is not as easy to disassemble into a small package for transportation. The design could allow the wingtips to be removed in which case the crated size would be about 3.5 metres by 2.5 metres by 2 metres.

This design does not allow as wide a range of centre of gravity as the tandem wing, so fuel position and payload need to be managed more carefully.

Notwithstanding these limitations, the lifting body aircraft has the potential for higher speed flight than the tandem wing design. Since range and endurance are directly related to drag, this design could be superior to the tandem wing layout.

OPERATING CHARACTERISTICS

The foregoing allows the operating characteristics of a SPSA to be described.

Detectability and Vulnerability

The SPSA would be virtually undetectable. Radar cross section would be very small, with only the engine, control hinges and rods, electrical wiring and payload being reflecting surfaces. Care with design would minimise reflection from these sources. A piston engine emits little heat, and if the exhaust is muffled and dispersed internally, there would be a very low infra-red and audio signature.

Visually, the small size would make it difficult to see. A person with unaided perfect vision on a clear day can see objects that subtend an angle of about a second of arc. Looking directly onto the three axes of the aircraft would give detection distances of about 10 km looking at the wing plan-form; about 5 km from the side; and about 3 km from head on. Camouflage and hazy conditions would reduce these distances substantially.

There is some anecdotal data on the detectability and vulnerability of UAVs. The US Army has been experimenting with UAVs for some time, and these experiments have included attempts to destroy the aircraft with weapons such as the Vulcan machine gun, infrared surface to air missiles, small arms fire etc. Even when no special measures have been taken to use a ‘stealth’ design or operational profile, the low level of emissions and small size makes a UAV a difficult target. Most are made of composite materials which reduces the radar cross section, and gives some tolerance to small calibre hits.

Range and Endurance

Using the Quickie Q-200 for comparison, a smaller but equally efficient airframe powered by an engine in the 55-60 kW range, should be able to produce a top speed of about 400 km/hr, but the operating speed would be generally much lower when long range and/or long endurance are required. The range and endurance an be calculated from the specific fuel consumption figures manufacturers supply for their engines. Assuming a 100 kg payload with 200 kg of fuel available, and with the SPSA operating without a high drag undercarriage (eg using a catapult or dolly launch), the maximum range and endurance based on the available figures would be would be as follows:

a. Range:

ENGINE	km @ 290 km/hr	km @ 390 km/hr
618UL	4100	3900
912UL	5200	4900

b. Endurance:

ENGINE	hours @ 290 km/hr	hours @ 390 km/hr
618UL	14.33	9.96
912UL	18.12	12.45

Graphs of the range versus cruise speed produced from the engine manufacturers data by an Excel mathematical model are included at Annex C. As a caveat, these figures need to be checked by a qualified aircraft designer. The author used simple 'square law' mathematical models to project the known Q-200 performance onto a theoretical SPSA of smaller size but assuming equivalent drag characteristics.

Launch and Recovery

The SPSA could be produced with or without an undercarriage. The advantages of an undercarriage are that the aircraft could be launched from airstrips and other prepared surfaces such as roads and fields. The take-off run cannot be estimated at this stage, but at maximum all-up weight of 600 kg, 1,000 metres might be required. Because of the high payload weight in comparison with an empty aircraft, a more lightly loaded aircraft would need about 300 metres.

If an undercarriage is not used, then there is the complication of the launch equipment. Dollies have been used for the Jindivik.[10] A catapult or rail and Jet Assisted Take Off (JATO) system could be used. The advantage of flying a SPSA without an undercarriage is that both weight and drag are substantially reduced, thereby increasing the payload and range. Fitting the aircraft with sacrificial skids and stopping the propeller horizontally would allow recovery without damage.

Auto-landing using GPS accuracy would require a landing strip about 100 metres wide and 300 metres long. A cable or net arresting system could be used to reduce the length of the landing run. For smaller SPSA designs, the aircraft could be captured in a net. If the SPSA were fitted with a video camera and a short distance data link, it

[10] The Jindivik is Australia's success story as far as UAVs are concerned. Conceived as a high speed, jet propelled target drone, it has been in operational use for several decades. The RAN make most use of the aircraft. Many have been exported. While the Jindivik still has operational uses, its metal construction and simple control and sensing systems would render it vulnerable in a hostile environment. Notwithstanding, it could provide considerable corporate knowledge in the development of the SPSA, especially in control systems.

could be manually landed in much the same way as a radio control aircraft or flying a computer simulation game. Ideally, the SPSA would have an auto-land capability to minimise dependence on external systems and on skilled personnel and to allow 24 hour, all-weather operations.

Payload Types

The size of the powerplant and airframe suggested above indicates that the maximum payload consisting of fuel and operational equipment would be 300 kg. There could be a trade-off between fuel and operational equipment. On short range missions for example, 200 kg of operational equipment could be carried with 100 kg of fuel. Range and endurance would be correspondingly reduced and care would have to be taken, as with all aircraft, not to exceed the maximum take-off weight.

Payload for the SPSA should be designed to be ‘modular’, with defined dimensions, typically 1 metre by 0.5 metre by 0.5 metre and weighing 250 kg. This pod could be placed to give the best location for sensors looking downwards, consistent with the aircraft’s centre of gravity requirements. For example for optical image collection, the sensors could be deployed below the fuselage and withdrawn on landing to prevent damage. In the case of electronic surveillance, the composite construction of the aircraft would allow the sensors to operate wholly from inside the airframe.

Operations in Civilian Airspace

The ‘stealth’ design would require visual and radar enhancement when operating in a civilian assistance mode, for example on drug crop or bushfire surveillance. The engines are fitted with alternators, and the electrical power could be used for strobe lights and radar transponders. The precise nature of the flight control system would allow the aircraft position to be known, alternatively, it could regularly transmit its position to the airspace control authority via a radio data link.[11] Conflicting air traffic could be advised either by a synthesised voice transmission or through the airspace authorities observing the position from a data link, then advising conflicting traffic.

CIVILIAN AND MILITARY USES

The SPSA design would have both military and civilian applications. The wider the range of uses for this type of craft, the more that could be produced and hence the lower the unit cost.

[11] The Future Air Navigation System (FANS) envisages that all aircraft will provide automatic position reporting. The location of the aircraft obtained from sources such as GPS or inertial navigation will be connected to transponders or other radio links. The airspace control system will then advise of conflicting traffic. Currently, aircraft operating in controlled airspace have barometric height coupled to the radar transponder to provide a three dimensional position of the aircraft while being ‘painted’ on radar. The position reporting system for a SPSA would be compatible with other civilian systems.

Civilian Uses

Most civilian uses could be expected to be based on surveillance. The SPSA could carry cameras and recording equipment. As described previously, digital recording would allow the images from an entire flight to be recorded for later analysis.

In civilian use, the communication links could remain open at all times as vulnerability of a radiating source is not an issue. Uses could include bushfire surveillance with continuous patrols over forests using visual and infra-red sensors to detect spot fires. Early detection and intervention can substantially reduce the damage caused by fires. Given the high cost of the recent fires in Australia, this application alone could justify the SPSA development, provided it could be demonstrated that an ‘eye in the sky’ would materially reduce the damage from bush fires.

Each year, Australia spends many millions of dollars on coastal surveillance. Some of this task could be undertaken at much lower cost using SPSA. Assuming a SPSA equipped for this mission costs $75,000, has an average operational life of 2000 hours, costs $20 per hour for maintenance and $10 per hour for fuel, then the cost per flying hour would be $67.50.

If the visual and infra-red cameras are panned and the optics set to cover (say) a strip 20 km wide, the surveillance speed is 200 km/hr and the time on station is 15 hours, then the SPSA could cover 75,000 sq km per mission. The cost of surveillance per sq km, using these figures would be $0.0169 per sq km. By contrast, a piloted and crewed aircraft costing (say) $500 per hour, covering a 50 km strip with radar (the detection range for wooden fishing boats can be quite low), at 320 km/hr, then the cost per sq km would be $0.0313, about twice as much. While piloted aircraft have more flexibility in being able to divert from a flight plan and closely inspect a target, ‘smart’ signal processing and/or continuous communication links via satellite (which would have to be costed), and re-programmable flight profiles would allow a mix of crewed and self piloted aircraft to reduce the cost and/or increase the effectiveness of this type of surveillance work.

A SPSA could undertake some mapping tasks, especially when rapid changes need to be stored for later analysis. Examples could be research into crop growth or changes to forest environments. While much of this type of data can be collected from satellite mapping, a SPSA could improve the detail and frequency by providing special mission profiles and carrying sensors at a lower altitude, hence providing greater detail in near ‘real time’.

From time to time, searches are conducted for survivors of crashed aircraft or boats lost at sea. A SPSA could be programmed to conduct a search over a specific location, looking with infra-red and visual sensors for survivors and wreckage, and listening on the survival frequencies for beacons. (The satellite monitoring emergency frequencies are only activated by beacons with a very stable frequency - a SPSA could be equipped with a receiver that detects signals operating on a less precise emergency frequency.) When such searches are conducted out over the sea or in bad weather by a SPSA, the risk of losing search aircraft and hence its crew is no longer an issue. Even in the worst weather, a SPSA could be dispatched to remain over the most probable areas in an attempt to locate survivors, since it is only equipment being risked - not lives.

Use by the Royal Australian Navy

One of the main tasks of the RAN is to protect sea lines of communication, often at considerable distance from the coast of Australia. Ships are heat generators which can be detected against a cool sea background. Thus, a ship-launched, airborne platform such as a SPSA equipped with a panning infra-red detector could provide extensive coverage for the protection of shipping, including protection of the fleet. With the appropriate payload a SPSA could also provide ELINT and decoy coverage.

Launch and recovery of aircraft at sea is always a difficult task. The relatively small size and weight of this style of SPSA would allow it to be launched on a rail, perhaps using JATO or a catapult. Some RPVs are recovered into a net, but recovery in this way by a conventional ship is difficult, especially at night and in high seas. If the SPSA were made of composite material as suggested, and the payload bay were sealed, then the craft could be recovered by ditching near a recovery ship and winching it aboard. Some water ingestion into the engine would result, but the modular nature of the SPSA would allow engines to be replaced and refurbished between flights at a reasonable cost.

If the RAN requires coverage from shore based aircraft, then the long range and endurance of the SPSA, and its low operating costs, would allow continuous coverage over the fleet. Assuming the SPSA has a safe still air range of 5,000 km, a transit speed of 250 km/hr and hence an endurance of 20 hrs, the time on station (TOS) overhead the fleet would be inversely proportional to the range of the fleet from the launch site. The following table shows the relationship between the fleet range from a launch site, the time on station and the number of aircraft required for 24 hr coverage:

Aircraft Required for Continuous Coverage

Distance from Launch to Fleet - km	500	1,000	1,500	2,000
Time on Station - Hours	16	12	8	4
SPSAs Required for 24 hr Coverage	1.5	2	3	6

An alternative to these proposals would be for an aircraft such as a C-130 to air launch the SPSA out to sea at the location required by the fleet commander. This option would greatly enhance the effective range and endurance of the SPSA. Recovery could be into the sea or at a pre-programmed land site.

A SPSA could provide some limited sonar buoy coverage by acting as a relay station. Given a design restriction of a payload of 100-200 Kg, few buoys could be dropped by a SPSA - probably too few to make the development worthwhile. However, if another aircraft such as a Long Range Maritime Patrol (LRMP) or a ship-borne aircraft positioned the buoys, a SPSA could remain in the region and relay data, while maintaining a visual and infra-red watch over the area. This role could free the crewed aircraft for other tasks, for example the ship borne aircraft could continue to place screening sonar buoys in front of the fleet while the SPSAs remained in the vicinity of the buoys to relay the sensor readings.

In times of hostilities, a SPSA could act as a harassment aircraft. Being virtually invisible to radar and infra-red detectors, and having a low visibility especially at night, it could be positioned over an opposing fleet and be ordered to dive on a selected ship. While the small payload would not sink a ship, it could disrupt other capabilities by attacking personnel and equipment exposed on deck. The mission capability of a ship could be compromised if ‘soft’ structures such as aircraft, antennae and superstructure were damaged.

The prime use of SPSA in a maritime environment is seen as a low cost, long range, long endurance sensor platform. Maritime SPSA could be sea or land based, or even air launched. Used in this role, the SPSA would be a force multiplier, adding value and survivability to other weapons systems, while reducing operating costs. Armed and programmed to attack, a SPSA could harass ships at sea and reduce the morale and operating effectiveness of the targeted fleet.

Army Use

RPVs and UAVs have been used to support ground forces in conflict for some time. Israel has developed a strong UAV industry and has tested the craft in battle. Some of the uses have been quite novel, for example to gather ELINT about Egyptian SA-6 movements during the 1973 war. The US Army tested UAVs in the Gulf War and gathered some useful operational insights into the future employment of UAVs. Surveillance in Bosnia is being conducted by UAVs.

The SPSA proposed in this paper suggests that advanced technology will extend the already proven value of these vehicles to support Army operations.

Stealth capability, miniaturised sensors and covert communications allow this design to remain over the battlefield for long periods to watch movements below. If the sensor results were ‘chirped’ back in compressed form, an opposing tracking missile (eg a surface-to-air anti-radiation missile) would be denied guidance information by the fact that the radiating vehicle would move between transmissions. The ability to make a random change of course immediately after a transmission could be part of the flight program to reduce vulnerability.

Longer range reconnaissance would assist planning for manoeuvres. A SPSA could map distant regions, report covertly or return with a recording of the sensor results. At longer distances, say, 500 km or more from the zone of conflict, such intelligence gathering could provide passive detection of troop movements and concentrations of critical stores and personnel. These could then be dealt with using air power for interdiction.

As in the RAN example, SPSAs could be used to harass and destroy soft targets, especially at long range. While any of these targets could be protected with hardened shelters, this ability to attack without detection or warning would require the enemy forces to divert combat forces to protecting vulnerable sites. A SPSA used in this mode would be relatively inexpensive, and could achieve a critical change in the ratios of forces in conflict.

Closer to the battle front, SPSAs could be used as long range artillery. At this shorter range, the SPSA could trade fuel for explosive payload. For some types of target, the aircraft's fuel supply could be fitted in the form of a fuel air explosive, so that maximum effect could be obtained from the payload - the shorter the flight, the larger the explosive.

While an expensive option in comparison with an artillery round, a SPSA could be inexpensive in a very hostile environment, eg where defensive missile and gun concentrations are high. Assume a $5 million ground attack aircraft will deliver 2 CBU-58 weapons at a cost of $10,000 per weapon at a vulnerability level of 0.1: the expected cost of the sortie is $520,000. Assume 4 SPSA aircraft will be required at a unit cost of $50,000 to achieve the same result - the cost of the SPSA option is $200,000. Added to this is the value (un-costed) of the attack aircraft aircrew being killed, injured or captured. The cost of training the additional aircrew required when high attrition rates are expected, and the propaganda cost of captured aircrew, makes a self piloted aircraft an attractive alternative in high risk environments.

These calculations depend on the levels of vulnerability and capability chosen, but the general principle is that as risk levels rise, then the value of the SPSA relative to the other options increases.

If a SPSA is equipped with a video camera and an image recognition processor, the SPSA fleet could undertake 'killer drone' counter-air operations, especially against the lower and slower battlefield helicopters. The Blackhawk for example has a never exceed velocity (Vne) of about 350 km/hr, a level flight top speed of 290 km/hr and a low altitude (less than 50 metres) operating speed of 200 - 250 km/hr. A SPSA with a top speed of 400 km/hr and a high 'G' manoeuvring capability could recognise and track a battlefield helicopter, then intercept and destroy the aircraft using 'kamikaze' tactics such as flying on a collision course. Even high speed military jets would be vulnerable at low level to front quarter attacks.

Owning a sizeable fleet of SPSAs would provide the Army with an organic capability to obtain long range reconnaissance, then use the resulting intelligence to conduct their own light harassment and interdiction missions. This capability would be most useful when conventional air power is unavailable due to higher priority missions. The most likely time for this to happen is early in a conflict when air power is being used to gain air superiority. At this time, a nation's constrained aircraft and aircrew resources simply do not generate enough sorties to meet all demands. However, a stock of SPSA aircraft could allow the Army to conduct their own parallel air campaign in support of their ground campaign. After expending the organic supply of SPSAs, the army could turn to other forms of air power as they are released from tasks such as winning air superiority.

A novel use for UAVs emerged in the Gulf War: aerial scouts. Anecdotal evidence describes a scenario where UAVs were directed by an airborne Forward Air Controller (FAC) over areas of enemy concentration. Attack helicopters such as the Apache were held in covert positions where they could not be detected and attacked.

When a target was detected, the FAC would direct the attack helicopter to fly direct to the target, attack, then retire to cover. These tactics were successful in increasing the kills by the attack helicopters while decreasing their vulnerability.

A novel use tested in the Gulf War was to 'pre-fly' missions. The UAV would be directed along an intended flight path for the attack helicopters and would sense and transmit threats such as surface-to-air missiles, radars and Anti-Aircraft Artillery (AAA). Using unmanned scouts to survey dangerous flight profiles would reduce risks for attack and transport aircraft such as the Blackhawk and the C130.

The Gulf War systems were effective, but somewhat 'patched together' because of the early state of development. In future it should be possible for a UAV to be controlled directly from the cockpit of an aircraft and transmit its sensor data directly back to the controller. This closed loop scout system could greatly enhance combat power while reducing the vulnerability of our aircraft. Ideally, such a system would be employed in multi-crewed aircraft where one person pilots the aircraft and another operates the UAV.

Anecdotal evidence describes another unexpected result. When manned aircraft pass over ground targets, troops on the ground resume their combat activities as soon as the aircraft has passed - people understand that it is difficult for the aircrew to detect ground targets under the aircraft. (As a pilot, I can confirm this view. The visibility from most cockpits of combat aircraft is very limited in regard to ground targets when they are below and behind the aircraft.) However, with UAVs such as the US Army Predator, which has a sensor dome under the aircraft, the ground troops were reluctant to move out of cover any time a UAV was in the area. This effect is both real and psychological. A UAV can have a 360 degree continuous sensing ability. The psychological effect comes from the knowledge that sensors often have a greater capability than humans to detect targets, and a computer based sensor system is alert 100% of the time. Thus, a UAV over a battlefield could constrain enemy ground operations.

Employing SPSAs by the army is a mix of strategy and tactics. A stealth aircraft with advanced navigation, sensor, communications and explosive payloads can confer a tactical battlefield advantage over an enemy not so equipped. Used for deep reconnaissance and interdiction of soft targets, SPSAs can force a shift of enemy resources from offence to defence, weakening front line combat forces. When high demands are being made on numerically limited air power resources, usual at the beginning of a conflict, SPSA assets would provide additional sources of offensive yet low cost air platforms that can be consumed early in the war . With astute setting of levels of SPSA stock-holdings, air power can cost-effectively swing from air superiority to close air support as the conflict matures towards victory.

The sum of these capabilities would enhance the Army's capability to conduct 'disengaged combat'. The concept is that a technologically superior force can engage the enemy outside the range of the enemy's weapons system, using engagement at a distance to reduce the enemy's fighting capability without the cost of friendly casualties. SPSA could use surveillance to find and track the enemy in real time, then direct deadly fire onto enemy forces though the use of stand-off precision guided weapons or SPSA equipped with a warhead. Winning a war without casualties is a very valuable characteristic where modern communications and intolerance of friendly losses are severe constraints on allied commanders.

Tactically, UAVs have been shown to confer special advantages, increasing combat power while reducing vulnerability. The psychological effect of ‘robot’ aircraft could also reduce enemy mobility.

RAAF Use of SPSA

Each of the armed Services has a special interest in intelligence obtained from surveillance. For the RAAF contemplating the task of gaining air superiority, the location and capability of threats such as aircraft, airfields, radar and missile sites are of prime importance. Low risk, real time reconnaissance at long range could be provided by the SPSA aircraft described in this paper.

If the force commander decides to attack in depth, SPSA aircraft can be pre-positioned to assist the strike force. ELINT capable aircraft can broadcast the location of hostile radar systems, EW craft could create decoys as described earlier and craft with terminal guidance could maintain station over critical radar stations, then destroy them once they begin to transmit.

For close air support, a combined strike from conventional and SPSA sources could dissipate defensive capabilities. Whether the Army or the RAAF would own and/or operate aircraft during such a combined strike would need to be defined.

SPSA could assist operations in dangerous airspace by acting as scouts as in the Army application, although with high speed jets, the SPSA would be quickly over-run by the jet during a mission if it is designed to pre-fly an ingress or egress corridor.

‘Real-time’ Bomb Damage Assessment (BDA) could enhance combat air power. Because of the vulnerability of aircraft during the ingress, attack and egress phases of a combat mission, the number of weapons planned for a target is set to generate a high probability of kill on a single mission, thereby maximising the ratio of kill probability to aircraft vulnerability.

The disadvantage of this approach is that it is expensive in terms of weapons use. For example, it could take (say) 2 bombs to achieve a 50% probability of kill, but 6 bombs to achieve a 95% probability of kill. Using a SPSA to transmit the results of an attack in real time could allow the attacking aircraft to restrict bomb drops to 2 per pass. If the target were destroyed on the first pass, the remaining bombs could be used on other targets. Alternatively, if the target was missed, repeat attack could be conducted until the mission is achieved. Optimising such a tactic requires an understanding of the risks associated with ingress, attack, probability of kill per pass and egress, but having ‘real-time’ assessments can be shown to increase the overall combat power from a given number of aircraft.

Another potential use of SPSA aircraft is laser designation. If stand-off precision guided weapons are available, it is preferable for the delivery aircraft not to have to overfly the target. A laser designator equipped SPSA could provide the required designation during an attack, and BDA afterwards.

Scouting, BDA and target designation require ‘real-time’, continuous cockpit to SPSA communication. However, the same system could be used from both Army and Air Force applications.

For SPSA aircraft to be most effective for Air Force use, they would have to be more highly developed than (say) Army use, with the ability to be controlled in a location over a target, to deploy a stabilised laser designator, and to collect and transmit BDA direct to a cockpit.

A more complex SPSA such as this could provide air power enhancement by replacing more expensive, piloted aircraft in the more vulnerable roles.

Joint Force Operations - the ‘Swing-Force’ Value of a SPSA Fleet

The use of SPSA in the land, sea and air environments, and for civilian uses has been described. In each case, a ‘generic’ SPSA carrying a mission specific payload has been described. The nature and tempo of armed conflict is difficult to predict, and force structures are often out of balance for a specific event. Because of the generic nature of the SPSA, each of the armed Services could own and operate SPSA to provide single Service force multipliers.

Once a conflict develops, the stocks of SPSA could be transferred between force elements as required to meet the needs of the campaign. Even civilian surveillance platforms could be pressed into military service, provided payload modularity is maintained across the fleet. Chief of the Defence Force and the Joint Force Commander would make decisions about the allocation of SPSA resources, since maintaining a common platform standard across the Australian Defence Force would permit such transfers to be made without loss of operational capability.

Since SPSA feature a ‘program, launch and leave’ mode of operation, large numbers could be airborne at one time, enhancing the concentration of force at critical times, while providing low cost access to air power.

AUSTRALIAN PRODUCTION OF A SPSA

A SPSA could be manufactured in Australia with a high Australian content. There are several locations where a SPSA could be manufactured using existing facilities. Interest in ultralight aircraft has led to a number of small companies being established with their own aircraft design and production facilities. Suitable certified engines of local design and manufacture are now available. Furthermore, the advent of the Collins class submarine project has led to the development of a local ability to manufacture complex designs, such as the submarine superstructure, using composite materials. On a larger scale, there are several companies with decades of experience in aviation design and manufacture that currently manufacture aircraft components. Any of these could design and build the SPSA design envisaged in this paper.

The materials for the airframe would be some form of composite structure: most probably fibreglass/epoxy resin over a form of foam, honeycomb or plywood. Aircraft grade fibreglass and epoxy resins are manufactured in Australia.

Development of the precision navigation and flight control system could build on extensive knowledge gained from the Jindivik program.

The Defence Science and Technology Organisation (DSTO) could assist with the development and integration of flight control and payload packages. DSTO has conducted extensive research into autopilots, sensors, radar reflectivity, communications etc, and could use this knowledge base to design payloads for specific missions. Once the design and testing is complete, the payload packages could be manufactured by DSTO or be developed by private companies tendering for the work.

The project development time could be reduced by developing the aircraft, flight control and payload systems in parallel. For example, the aircraft could be developed as a scale model, tested using model radio controls and in a wind tunnel. A full size version would then be built and a human pilot used for flight testing. At the same time, a locally produced aircraft could become the test bed for flight control systems installed in parallel with the manual controls. Once these have been developed to the degree where the SPSA could be flown unmanned, sensor packages could be tested. Finally, the SPSA would be fitted with the flight control and payload systems proven on the locally produced test bed. This strategy would provide a low risk, low cost, rapid development path. The current cost of a basic locally produced aircraft is about $AUD50,000.

Project management would be crucial to keeping the cost of development within reasonable limits. A commercial model could be used, with the Department of Defence requesting via tender one company to produce a SPSA to the pre-production stage. The winner of the tender could then manage the project by using a number of sub-contractors to supply components. Australian companies with this capability include ASTA, ADI and Hawker Pacific.

If a high Australian content could be maintained, then the SPSA would add capability to the ADF and employment to the Australian community while having minimal impact on the balance of trade. Australian manufacture of the SPSA would enhance defence self reliance.

EXPORT POTENTIAL

A SPSA aircraft with the capabilities described in this paper has general use wherever there are large areas to be surveyed and cost is a factor.

Examples in our region are Indonesia and Malaysia which have geographical territories covering large areas, but where the airfield infrastructure limits the use of crewed aircraft. For example, Indonesia’s territorial area exceeds that of the USA. SPSA fitted with the appropriate sensors and communications equipment could provide surveillance of territorial waters, and also complete other tasks, such as imaging for national development. As defence force equipment, SPSA would have the same uses as described previously, contributing to the cost effectiveness of the nation’s defences.

In other parts of the world, SPSA could contribute to special missions such as detection of illegal drug crops and the harvesting and movement of drug products. By providing this information, enforcement agencies could gather the intelligence they need to intercept shipments. A fleet of SPSA supplied to countries in (say) the Americas could undertake such a task.

United Nations peacekeeping is another environment where SPSA could contribute to the mission while reducing costs and vulnerability of forces on the ground. SPSA could monitor events from the air from low level, long endurance flights and transmit images to ground stations for assessment. The ability to re-program a SPSA while airborne would enable a SPSA to be positioned over a ‘hot spot’ to give commanders the information they need to react. Making these images available to the UN and to the media could assist in the settlement of conflict. People may be less inclined to commit atrocities if they know there is a good chance of detailed images of their actions being captured and recorded for later use.

As in Australia, civil use is a marketable function for SPSA. For example, in North America, SPSA could loiter over forests to monitor fires, and could conduct routine surveys of oil pipelines and electricity transmission lines to detect leakages. Assisting in natural disasters such as floods could be another role where SPSA could be launched and maintain station over the affected area.

SPSA produced from a high volume production line could compete on a cost and effectiveness basis with conventional ways of completing these missions. If Australia produces SPSA for its own use, production at the marginal cost would provide a very cost efficient and competitively priced platform for overseas purchasers. A target cost of a SPSA produced as a run of 100 aircraft with a basic autopilot system could be in the vicinity of $75,000.

CONCLUSIONS

A convergence of technologies allows low cost SPSA aircraft to be produced. Fitted with modular payloads, these aircraft would have civil and military use. Provided consistency is maintained in design, one type could be produced in large numbers, reducing the unit cost.

Operating without aircrew reduces aircraft complexity and weight, conferring a number of beneficial operating characteristics. The weight normally used by aircrew and their life support systems can be used for fuel and payload. Range and endurance are correspondingly increased.
A self piloted aircraft has special benefit in high risk environments. In civilian use this might mean searching for survivors at night and in bad weather. In military use, this characteristic would allow operation in areas where air superiority has not been established.

The inherent ‘stealth’ characteristics of a small, piston engine powered aircraft made from radar transparent composite materials further enhances the operational capability of the aircraft. If the aircraft is difficult to detect on radar or with infra-red sensors, is barely audible and can only be seen at short range, it can operate with near impunity in the most hostile environments.

The most common mission foreseen is imagery and electronic surveillance. Data obtained could be transmitted back to base via secure links or using burst transmissions. Alternatively, large volumes of data could be recorded and retained inside the SPSA for later analysis.

Fitted with explosives and a terminal guidance system, the SPSA could act as an offensive weapon. While the relatively small payload would limit the target set that could be usefully attacked, a harassment SPSA could have a disproportionate effect on operating systems considered invulnerable, and on enemy morale. This effect could be likened to the effect the Scud missiles had in the Gulf War, where the allied response was far in excess of that warranted by the potential military damage. The allied response diverted substantial resources from achieving the stated military objectives for the campaign, although in this particular case, the objectives were still achieved.

The size, structure and level of technological development required to produce a SPSA fleet are within the capability of Australian industry. Many of the raw materials are produced in-country, meaning that the project could have a high Australian content. Developed and manufactured in Australia, SPSA would add to the capability of civil and military powers, create employment while making minimal impact on the balance of trade. Once developed, a SPSA would have a substantial export potential.

Pilotless aircraft have been in production for fifty years. Technological developments now allow the capability to be substantially extended, and Australia has the capability to exploit the opportunity in the national interest.