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FUTURE ROLE OF AIR POWER IN THE DEFENCE OF AUSTRALIA

By

Group Captain Gary Waters

About the Author

Group Captain Gary Waters has been the Director of the Air Power Studies Centre since January 1993. He contributed to both editions of the AAP 1000, *The Air Power Manual*, is the author or editor of six books, has written extensively on defence and air power issues in national and international journals, and has previously contributed to the APSC Papers series.

INTRODUCTION

At a time when Australia, the ADF and the RAAF are faced with rapid, dynamic and continuing change, time needs to be taken to determine what the future is likely to hold. While there are many studies that focus on corporate or strategic planning and resource management (financial, personnel and facilities), little has been done, or at least published, in the way of future air power capabilities. This paper attempts to fill that void.

In analysing the future role of air power in the defence of Australia, it is necessary to start at the beginning and examine the nature of future contingencies and broad consequent requirements. With that as a foundation, future planning issues may be ascertained, which will be manifest as a need to carry out surveillance, a need for versatility, and a need to be self-reliant.

As well as these broad and specific planning issues certain warfighting capability requirements will also be necessary. While this paper covers many of the broad requirements, it also discusses some of the more pertinent in detail, such as platforms, weapons, avionics, mission support systems, simulation, anti-ballistic missile defence, and non-lethal technologies. This discussion then leads to an examination of what has been termed the Military Technical Revolution (MTR). The paper then concludes with comment on future force structure issues, based on what has been said so far, and a brief examination of the emerging technologies which can support that structure.

FUTURE CONTINGENCIES AND BROAD REQUIREMENTS

Future combat is unlikely to centre around large enemy lodgments as occurred in previous major wars, with the consequence that vast amounts of firepower are unlikely to be required. The Australian Defence Force (ADF) will more likely have to detect, identify and react to small numbers of targets in the air/sea gap. This then raises the question of the capabilities required. We certainly need to be able to look into the air/sea gap, and the best way to do that will be from the air and space environments. Hence, surveillance will be a primary role.

Should a response be required, whether in the air, at sea or on land, high technology will likely be part of the solution. It will avoid large numbers of personnel (which Australia does not have), and it will, therefore, reduce the number of likely casualties. Furthermore, it can avoid the tendency to generate a disproportionate response to any emerging threat.

Responsiveness and flexibility should be the key characteristics of our high-technology systems. If those systems are based in or deployed to the north, then security of bases becomes very important. From an ADF point of view, the security of northern bases (including air bases) will be enhanced by the expanded presence of ADF personnel in the north.

Future capabilities should allow the ADF to further exploit the night, allow all-weather operations, and offer improved precision capabilities in both defensive and offensive operations. We currently have an embryonic capability, which needs to be expanded.

Similarly, our ability to operate free from enemy interference, in terms of his electronic warfare capability, needs to be more sophisticated. Essentially, we need to be able to deny a potential enemy use of his sophisticated equipment while continuing to use ours: we also need to prevent him from denying us the ability to use our sophisticated equipment in the first instance.

Warfare of the future, as mentioned earlier, is unlikely to be characterised by massed armies. For the ADF, it would be prudent to use our surveillance capabilities, including surface forces, to detect and target enemy forces and then to use air-delivered weapons. Precision air support and infra-red reconnaissance[1] will be essential roles for the RAAF of the future, and our doctrine, planning concepts, force development, and capability and technology requirements should reflect that. Similarly, maritime patrol, airlift and airspace control (including air defence) will continue as necessary roles. Precision air support would apply across the full spectrum of traditional air-to-surface operations, encompassing maritime strike, Battlefield Air Interdiction (BAI), Close Air Support (CAIRS), interdiction, and deep strike.

It is likely that a joint force commander of the future would prefer to use air-delivered weapons with his ground scheme of manoeuvre to avoid heavy land force engagements. In this, the notion of precision air support would be vital. However, to improve effectiveness, the ADF must develop a data link capability (either voice or systems), with an ability for burst transmission.

RAAF doctrine argues that control of the air is a prime requirement in conflict.[2] In the future, this should be seen as sanitising airspace as far as necessary, and should include extensive coordination of all ADF systems, especially as technological developments may result in improvements in defensive systems against aircraft and air-delivered weapons.

In the unlikely event of a large scale defence of mainland Australia, the ADF would probably adopt a four phase plan. First, it would seek to halt the enemy lodgment. Second, it would aim to achieve a stalemate. Third, it would build-up forces, and fourth, it would wage decisive combat operations. The technologies and capabilities of the future should be able to support such a concept for operations.

Defence of Australian territory aside, the ADF may be asked to respond to a regional crisis, which could arise as a ‘peacetime engagement’. In other words, we may need to use military force, but in a normal peacetime environment for the remainder of the nation. Thus, we must be prepared for the contradiction of the ADF fighting while the nation formally remains at peace. This reinforces a point made in many contemporary writings that casualties represent our prime centre of gravity, especially if war has not been declared and sovereign territory is not under threat. This supports the argument for high-technology precision warfare in any conflict of the future.

[1] Precision air support and infra-red reconnaissance are described in Criss, GPCAPT P.J., *Employing Smart Technology in Low Intensity Conflict*, Air Power Studies Centre Working Paper Number 6, August 1992.
[2] *AAP1000 The Air Power Manual, Second Edition*, Air Power Studies Centre, Canberra, 1994, p 42.

Any future conflict for the ADF will almost certainly involve joint operations. Thus, the focus of activity can be expected to centre on joint doctrine, planning and operations. However, single Services must still remain adept within their own environments.

Joint operations are necessary for operational efficiency, but while efficiency may be a valid pursuit in deriving military effectiveness, it is not a substitute. That is, the efficiency of joint operations is not a substitute for effectiveness, nor for high levels of competence in a particular environment. Efficiencies are achieved through appropriate degrees of integration of highly developed and specialised single Service competencies. Effectiveness is derived from developing and honing these specialised environmental competencies.[3] This paper examines issues associated with exploiting the air environment to best effect.

Australia must have a capabilities-based force structure, not a specific threat-oriented one. This means we should not concentrate on any potential enemy in terms of threat, capabilities and intent, but rather, focus on broadly-based capabilities that provide more flexibility in contributing towards the achievement of our national goals. For example, the government's policy of regional engagement and involvement in peacekeeping operations will demand capabilities beyond those required in traditional defence roles. Yet, such activities are now seen as important contributions to the national interest.

Apart from defence of Australia issues, the latest strategic guidance (SR-93) states that the requirements for the ADF are also to increase defence engagement with regional nations, and maintain our alliance relationships and our commitment to international peace and security.[4] In meeting these broad requirements, the ADF must be capable of deterrence, crisis response, as well as war-fighting. Crisis response involves peacekeeping operations, humanitarian assistance, disaster relief missions, enforcement of UN trade sanctions, and evacuation of nationals. The only way for the ADF to provide the core competencies required to do this is through teamwork; as General Powell (then US Chairman Joint Chiefs of Staff) has said: 'joint warfare is team warfare'. This can be broadened for our purposes to: 'joint operations are all about teamwork'.

For the future, we must expect to be, as the US Navy's Admiral Paul Miller (C-in-C Atlantic Command) has said, in a 'dynamic equilibrium' - that is, a constant state of change. To keep up, we must learn to keep pace with that change. That must become part of our military ethos.

Requirement for the RAAF

One clear requirement of that change is for the RAAF to keep in mind that operating in the air is its focus, its whole reason for being, and that it must operate in an increasingly joint and combined setting.
The task for the RAAF is to act as one in an air force, joint force and combined force setting without losing individual specialised competencies. This is the challenge for the future - retain our specialised skills in an air force that needs generalists who understand

[3] Link, Major General Charles D., USAF 'The Role of the US Air Force in the Employment of Air Power', in Shultz and Pfaltzgraff, *The Future of Air Power in the Aftermath of the Gulf War,* Air University Press, Maxwell AFB, Alabama, 1992, p 85.
[4] *Strategic Review 1993,* Canberra, 1993, p 2.

the whole air force equation, joint operations and combined operations. Multi-skilling and career-broadening will be fundamental to our success in this.

While the extreme of jointness is one unified service, we must be careful not to confuse total jointness with military effectiveness. Jointness is about military efficiency - true military effectiveness will only come from a well-trained army, navy and air force. Specialised competency or professional mastery in the three environments of land, sea and air are fundamental to effective joint operations.[5]

The term 'synergy' has been used to describe joint operations. This means that the joint effort is greater than the sum of the single Service parts. However, true synergy only pertains if each of those parts is strong and competent in its own right.

When we package a joint force, it must be tailored around the objective, not around parochial interests. Thus, the objective is the most important issue - not which Service makes the largest contribution, or that each Service contributes equally. The linchpin, therefore, of the military's operational forces is the joint force commander (JFC). And we simply must do more in terms of improving our campaign planning ability - but that is the subject of another paper.

Maintaining the Qualitative Level

Exploitation of the air environment during the Gulf War was qualitatively different from that witnessed in the past. In January 1945, Berlin was in ruins but Hitler could still broadcast throughout Germany and communicate with his forces in the field; the army could still supply and move by rail; the Luftwaffe could still fly and fight; Berlin still had electricity, telephone services and water.

In January 1991 after 48 hours of bombing, Baghdad was virtually intact (as it remained for the 43 days of war) but Saddam could not broadcast throughout Iraq and could not communicate with his forces in the field; the army was about to be cut off from food, fuel and ammunition resupply; the air force was virtually grounded and air defences incapacitated; and Baghdad was deprived of electricity, telephone services and piped water.[6]

Australia must note these observations well and recognise the need to maintain its current qualitative level in exploiting the air environment so as to dominate any likely battlefield of the future. Underwriting any future success must be stand-off air-to-air and air-to-ground weapons. While our current qualitative level can be maintained for the life of type of our combat aircraft, we may be hard-pressed to do so post F/A-18 and F-111.

As potential enemies similarly realise the importance of the air environment they will, no doubt, improve their own capability to exploit that environment. Hence, the air environment is likely to become more lethal, and the capabilities of air-delivered weapons and survivability of platforms in our inventory will become even more fundamental to success in conflict. For example, work is underway in the US on the Advanced Missile Warning Program which will protect fighter aircraft from infra-red

[5] For further doctrinal comment on professional mastery, see *AAP1000*, pp 45, 58.
[6] Luttwak, Dr Edward N., 'Air Power in US Military Strategy', Shultz and Pfaltzgraff, p 19.

missiles. The program is likely to include a pilot warning mechanism and other technology to release a flare automatically so as to deflect any approaching missile.[7]

In terms of maintaining our qualitative level, it is important to keep pace with developments in the US so that the ADF can continue to work in concert with US forces. Furthermore, the ADF's level of technical sophistication and credibility in operations have much to contribute in terms of regional cooperation (or regional engagement).

However, maintaining this level of technical sophistication may depend on whether the American/Australian relationship will be as close as it is currently. We are so dependent on the US for air weapons and software, that it is difficult to imagine that changing, if we are to maintain a capable and credible force. However, there is a need to become more self-reliant in certain technologies and capabilities. Additionally, it would seem self-evident that it is in our national and regional interest to maintain the US's current level of involvement in the Asia/Pacific region.

FUTURE PLANNING

In our thinking for the future, the issue is not that we predict with unerring accuracy the nature of our next conflict but that our doctrine, force structure, operational tempo and campaign planning provide for rapid and skilful adaptability as the nature of conflict unfolds. Since our planning should revolve around credible threats, we need to identify the threats of the future. But just as importantly, those threats of the future must take cognisance of the capabilities of the future, both ours and any potential enemy's.

A RAND study[8] suggests that in analysing Western vulnerabilities, hostile states would consider four factors: warning time (especially the delays at the strategic level), internal subversion, terrorism, and Weapons of Mass Destruction (WMD).

Proliferation of WMD will be the dominant defence issue of the next decade. The likelihood that WMD would be used may inhibit the deployment of military forces as the threat of casualties is a centre of gravity; and the longer a war lasts, the greater is the risk. Because stand-off weapons will reduce the likelihood of casualties, exploitation of the air environment may be seen as the only political choice in circumstances where WMD feature. A similar case could be made in circumstances involving cruise missiles.

Cruise missiles were very effective in the Gulf. However, for the foreseeable future they will complement manned aircraft, not replace them. They are simply too expensive, relatively inflexible, require enormous data bases (for route guidance, etc) and can only carry small conventional warheads. The utility of cruise missiles will, however, be enhanced by the use of Global Positioning System (GPS) guidance.[9]

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[7] *Defense News*, 2-8 May 1994, pp 4, 29.
[8] The study, entitled 'Global Balance of Air Power' was conducted by Dr Chris Bowie in 1993. It has not been released publicly.
[9] This satellite system which involves some 24 satellites allows users to obtain full accuracy on position, velocity and time. Military systems provide accuracies of about 10 metres, while the overall system is deliberately degraded for civilian users, who can still achieve accuracies within 100 metres.

Cruise missiles may be an attractive proposition for the US, but in terms of maximising flexibility of air-delivered weapons, the man is still required in the loop. Nevertheless, the ADF does need to remain abreast of the latest missile technology, perhaps not so much in using it, but in countering it.

The issue of what the RAAF is able to offer the ADF in 20 years time needs to be examined. We probably need to maintain dedicated strike and air defence platforms, at least until weapons are ‘smart’ enough that a single platform-type may be sufficient. That does not appear to be the case for the foreseeable future. Planning issues should start at the broadest level by examining sovereignty, air space control and deterrence issues. In the latter, the focus would be on defensive deterrence (such as of denial), rather than offensive deterrence (such as of punishment).

Modern systems with their combinations of new weapons have provided new ways of winning wars. But there are drawbacks - huge investments, increasing demands on data collection sources (such as target and terrain information) and the need for rapid communications. Planning at all levels of war, but especially at the operational (or campaign) level, has become dependent on information and communications. Thus, the challenge for the RAAF for instance becomes one of planning an air campaign rapidly, and quickly transferring information into the cockpit as the campaign unfolds.

Surveillance

At a lower level of planning, where broad capability areas are determined, we should focus on the need to maintain modernisation of current capabilities, but with far greater emphasis on surveillance, including space-based systems. That said, there is an inherent danger in looking at the future simply as a series of iterations from today, rather than attempting a clean break and examining the future in its own right. Discussion on surveillance often leads to discussion on technology to support improved surveillance, but is rarely extended to the related requirement of improved identification.

Strategic guidance places priority on intelligence collection and surveillance.[10] Thus, we should concentrate on technologies associated with sophisticated reconnaissance and surveillance systems, including space-based systems. We also need technologies that deter aggressive behaviour by the credible threat of countervailing force.[11] This will necessitate a highly-sophisticated defence force.

Satellite surveillance and communications proved effective in the Gulf War, but once the requirement moved to ‘battlefield’ reconnaissance, Unmanned Aerial Vehicles (UAVs) were preferable. A mix of UAVs and small light satellites launched on demand may be the best way ahead. The Pentagon is examining a program that would provide multi-role, long-endurance unmanned aircraft capable of staying above 50,000 feet for up to 25 hours at a time (and which would effectively be invisible). Development contracts are expected to be let by October 1994.[12] Costs of launching satellites are escalating alarmingly, so the notion of launching on need only has some appeal. However, a major drawback of ‘launch-on-need’ is that operator practice can be afforded only by having

[10] *Strategic Review 1993*, pp 61-62.
[11] *ibid.*, pp 63, 65: where air defence and strategic strike are also listed as principal Defence roles.
[12] *Defense News*, 28 March – 3 April 1994, pp 4, 50.

the satellite in orbit. Warning time may not be sufficient to allow the necessary training to be effected.

Space-based systems provide an unprecedented force multiplier for C^3I and surveillance. Meteorological information, navigation, geosynchronous communications and early warning can all be provided by satellites, as can tracking and interception of missiles. Target designation and enemy air defence identification will also be improved through the use of space. In short, space power will develop and we should expect to see it evolve from ‘combat support to the full spectrum of military capabilities’.[13] In time, as other nations acquire space-based capabilities, it will be essential for any nation’s military credibility for it to be a member of the ‘space club’.

Versatility

Versatility is an important notion that gives rise to flexibility and adaptability. However, versatility does come at a high cost. Multi-role platforms are expensive, but more so as the number of roles increases. The cost of training in and conducting five or six roles is of orders of magnitude greater than doing so in two roles. In the future, we may be able to derive far more from simulation, perhaps even to the extent of gaining more from a simulated mission than from an actual mission. However, we must accept that at some time we may have to conduct the actual mission.

For the future, the ADF can be expected to operate small numbers of high technology systems that provide inherent flexibility. In an air force context, this gives rise to the multi-role/multi-mission concept which offers the following advantages:[14]

a. reduced number of aircraft types and hence:

    i. reduced support, deployment and initial training costs;

    ii. reduced maintenance and other logistics costs;

    iii. fewer procurement numbers of aircraft overall.

b. flexibility to adjust force balance to tactical and operational situations;

c. a degree of composite wing capability but still requiring force packaging; and

d. easier planning and subsequent execution of missions because of common performance of aircraft.

There are also some disadvantages associated with multi-role/multi-mission, such as additional training being required to provide crews with the ability for multi-role

[13] See Memorandum to all Air Force Major Commands on Air Force Space Policy, 2 December 1988, by Secretary of the Air Force Edward C. Aldridge Jr and Air Force Chief of Staff Gen Larry D. Welch.
[14] ‘Multi-role’ describes an aircraft which can perform a number of different roles, but not necessarily during the one mission, while ‘multi-mission’ describes an aircraft which can conduct a number of roles during one mission. These definitions are included in Alan Stephens, *Key Concepts in Air Power*, APSC Working Paper Number 11, 1993, p 15.

operations, and airframe and multi-role equipment costs exceeding those of single-role platforms.

Software developments will add considerably to versatility, which in the past required hardware solutions. Mission software is an important area on which the ADF should concentrate. The future could hold the promise of simpler platforms, more complex weapons and more complex software. As an example of the increasing importance of software, recent studies show that up to 80% of the functions of the F-22 would be controlled by software.[15]

Importantly, weapons of high cost cannot be confined to use in a single environment. The flexibility that has been argued traditionally for platforms, must extend to weapons.

Self Reliance and Self Sufficiency

The types of capabilities and technologies required for the future should be examined in a layered approach in terms of self-reliance. For example, at the first layer, would be capabilities and technologies that we can only acquire from overseas. Next, would be those for which we desire some measure of self-reliance. Third, would be those capabilities and technologies for which we want to be totally self-reliant.

Apart from self-reliance in as much as possible, we should also aim for self-sufficiency in weapon systems. This means that weapon systems should be deployable to isolated areas with as little support as possible. In other words, an F-111 should be able to deploy without a C-130 back-up. In the future, we should aim for aircraft to re-arm and refuel at a deployed site without major support infrastructure being in-situ or having to be deployed as well.

CAPABILITY REQUIREMENTS

In examining capability requirements of the future, we must be sure to argue for ‘application pull’, rather than ‘technology push’. This will require a far deeper understanding of the dynamic between national security objectives, likely threats, required response, military concepts of operation, mission types, weapon system requirements and applied technology. That is, we need to determine what we require of technology, not develop capability requirements that are determined as a result of technology. A structured approach, with a flexible methodology will be the order of the day.

Forces will have to be characterised by long range, high degrees of survivability and the ability to concentrate force when necessary. Yet, high-technology must be cost-effective. The increased costs of maintaining technological levels must not be allowed to outweigh the gains. Force structures of tomorrow will need to use technology qualitatively to improve their ability to engage in conflict, regardless of the level. In determining key areas of development for the future, we must bear in mind that many of the future technologies argued in contemporary literature exist already. Two areas mentioned

[15] *SIGNAL*, September 1993, p 48.

already that the RAAF must concentrate on are in acquiring self-protection systems and in reducing support infrastructure.

Future requirements in conflict will, more than ever, demand sound attrition management. Fundamental to this, for the RAAF, will be sophisticated self-protection systems, especially as the threat of low cost, effective man-portable air-to-air weapons increases. System survivability will be more important than ever.

The mobility and responsiveness which have been argued as prerequisites for defence systems lead to high levels of reliability and maintainability. Despite our aim to reduce support infrastructure at deployed sites, heavy and bulky items will still characterise military operations, and for the RAAF, this will mean a continuing requirement for ground handling capabilities at deployed locations for the foreseeable future.

In all acquisitions of the future, broad selection criteria should be applied, such as performance, design and applicability. That is, we should aim to enhance the performance of existing systems or provide new capabilities; we should, through quality design, improve availability and dependability or improve affordability of systems; and systems should have wide applicability across a range of capabilities or contribute to strengthening the Australian industrial base.

Platforms

As mentioned earlier, versatility of platforms will be essential. While maritime patrol, air defence and airlift will receive the focus of attention, the capability for strike should not be ignored. Thus, it would be prudent for the ADF to remain abreast of US developments in the Joint Advanced Strike Technology (JAST) program. From mid-March (1994) US companies have focused on USN and USAF future strike needs and are developing a range of options including space platforms, aircraft, missiles and UAVs.[16] Another development in the JAST program is the option of a short take-off and vertical landing (STOVL) strike fighter aircraft. The USMC is keen to see this type of aircraft in operation by 2010.[17]

Weapons

US programs are underway to equip dumb bombs with a guidance capability. Problems with Laser Guided Bombs (LGBs) in poor weather have led to renewed efforts in this regard. The Joint Direct Attack Munition (JDAM) will provide a weapon guided by an inertial navigation system aided by GPS, and should be operational by 1999. The Joint Stand-Off Weapon (JSOW) will provide a long-range glide bomb. Both programs will aim to offer large quantities at low cost.[18]

It is likely that no entirely new weapons will be developed. Efforts will focus on new sensors, propulsion systems, and computer processors - with the ultimate aim to improve autonomy of existing weapons, thus reducing the workload on the aircrews.

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[16] *Defense News*, 28 February – 6 March 1994, p 14.
[17] *Defense News*, 21-27 March 1994, p 28.
[18] *Defense News*, 7-13 February 1994, p 16.

Higher resolution, better imagery and better target discrimination will add to greater precision than ever before. New navigation and propulsion technologies will allow aircrew to fire a weapon from longer stand-off ranges, let it approach the target, and then guide it to target in the last 20 or so seconds.[19]

While American developments need to be followed, so should British ones. For example, the BAe Advanced Short Range Air-to-Air Missile (ASRAAM) will be in service by 1998. It will be compatible with any aircraft capable of launching AIM-9 Sidewinder or AMRAAM. ASRAAM will even be capable of defeating a hostile aircraft approaching from the rear hemisphere. There are also air-to-air missiles being developed by other nations that will offer high resolution, high probability of intercept and a virtual ‘no escape’ zone.

As technological advances continue, even greater improvement to stand-off ranges of air-to-surface weapons will be forthcoming. Furthermore, developments in weapons-carrying capabilities of transport aircraft will see the ability to maintain weapons on-station improve considerably.

Avionics

Technical advances in signal processing, software, fibre optics and sensors will underwrite future cost-effective success. One new sensor is Ladar (laser radar). Ladar should allow gunships, for instance, to get their first round on target accurately despite turbulence and wind.

Another sensor is Flaser (an active and passive sensor that combines FLIR and laser radar technologies). This could well be the next-generation targeting technology. Targeting, including identification through high-resolution air- and space-borne systems, on-station capability to monitor selective targets, and the ability to designate targets unambiguously will continue to improve. There is also the possibility of gaining access to mobile potential targets and ‘tagging’ them for subsequent action should it be necessary.[20]

Considerable work is being undertaken on EW systems - examining all-digital technology which would allow the EW suite to be incorporated into an aircraft’s digital avionics system. A lot of work is also being done in terms of data fusion in the cockpit - to provide more complete situational awareness.

Avionics systems will become more affordable, more reliable, more supportable, more adaptable and reconfigurable. Increased use of fibre optics will improve systems reliability and immunity to electro-magnetic interference.[21]

The night will become the preferred operating medium as it inspires awe, disadvantages the enemy and reduces civilian casualties due to the absence of civilians from the

[19] *ibid.*, p 14.
[20] For more detail on these latter comments on targeting, see Sullivan Jr, Leonard, *Meeting the Challenges of Regional Security*, Strategic Studies Institute, Carlisle Barracks, Pennsylvania, 1 February 1994, pp 24-29.
[21] For detailed comment on LADAR, FLASER and EW systems, see *SIGNAL*, September 1993, pp 45-48.

workplace at night.[22] So too, weapon systems, including the platforms, will need to operate in all weather conditions.

Mission Support Systems

Mission Support Systems (MSS) must be as sophisticated as the weapons employed and require great flexibility. For example, the same system should allow troop transport missions to be planned as the delivery of air-launched smart weapons. Mission planning systems need to contain maps, aerial photographs and satellite imagery as well as aircraft and weapon performance data to help aircrew plan their route, determine when missiles should be launched, and determine where they are likely to encounter enemy SAMs.

Just as important are mission rehearsal systems which feed satellite and aerial images into a computer to give a realistic picture of the battlefield and to allow aircrew to simulate operating over that battlefield.[23]

Simulation

The Americans are now suggesting that future US roles and missions could be shaped by advanced simulation technology as it is applied to large annual exercises.[24] The RAAF should be looking at which roles it thinks are important and determining how simulation can help in defining and conducting those roles. Effective training on operating platforms and firing missiles can be achieved already through simulation, and that will improve even further.

More specifically, US Atlantic Command is developing a Synthetic Theatre of War (STOW)-97 program that will form the foundation of its Joint Training, Analysis and Simulation Centre (JTASC). The JTASC and STOW-97 will allow Atlantic Command to 'develop plans for joint task force exercises, carry out exercises to test commanders and their staffs, support field training, aid in the development of joint doctrine and maintain a lessons-learned system to avoid past mistakes'.[25]

Anti-Ballistic Missile Defence and ERINT

Anti-ballistic missile defence has been discussed only in passing in Australia. NATO countries have been considering the establishment of ballistic missile air defence systems for some time. In a regional sense, we could look to a similar requirement. Thus, we would need to identify the kinds of technologies required, and their sources. We should strive for joint and collaborative programs that involve Australia and other regional partners, where possible.

The NATO Industrial Advisory Group has recommended that the highest priority capability for NATO Europe should be an extended air defence system; followed then by a comprehensive surveillance system. Within the air defence system are five priority sub-systems: early warning; area defence; ballistic missile and C3 (BM/C3); point defence; and new operational applications. Two examples of the latter are: the use of

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[22] Sullivan Jr, *Meeting the Challenges of Regional Security*, p 33.
[23] See *Defense News*, 7-13 February 1994, p 16.
[24] *Defense News*, 21-27 March 1994, p 26.
[25] *Defense News*, 6-12 June 1994, p 34.

forward-based radars with triangulated missile sites, and installation of defensive missile systems on-board ships.

An integrated BM/C^3 network for a geographic region would require information systems that incorporate artificial intelligence, virtual reality, and fast data algorithms. Similarly, new sensing equipment would be needed to differentiate between nuclear, chemical, biological, or conventional warheads and whether the warhead is a unitary or sub-munition type.

The US Army is keen to see in production a kinetic energy, hit-to-kill system. An Extended Range Interceptor (ERINT) missile is being offered by Loral Vought Systems as a strong competitor for Raytheon's improved Patriot. This is an exciting development as it focuses on lower-level defence, and more closely aligns itself to Australia's requirements. Australia would never be in a position of obtaining a Theatre High Altitude Area Defence (THAAD) system such as that proposed by the US.

The important point about the advantages of the hit-to-kill approach over say Patriot is that the kinetic energy solution is more effective for destroying ballistic and cruise missiles. It may be possible for ERINT to be integrated with Patriot's fire control radar and battle management systems. The ADF should remain abreast of these developments as the US Army hopes to deploy ERINT by the end of 1998.[26]

Non-Lethal Technologies

One of the problems for air forces of today is in enforcing no-fly zones without having to shoot down aircraft in violation of the no-fly rules. Non-lethal technologies include directed energy weapons that can temporarily blind pilots, chemical and biological agents that can degrade an aircraft's structure or fuel, and electro-magnetic energy that can disable the aircraft's computers.

The task would be to force a violating aircraft to abort its mission and leave the no-fly zone, without the aircraft being destroyed or the pilot killed. These new technologies would have to be compatible with current aircraft, sensors and C2 networks, and must comply with LOAC provisions. Three operational scenarios spring immediately to mind where non-lethal weapons would be appropriate:

a. stopping transport aircraft from violating air blockades;

b. preventing combat aircraft from conducting operational missions in a no-fly zone; and

c. preventing air strikes against friendly ground troops or naval forces.

Specifically, this technology could:

a. destroy an aircraft's weapon guidance system or the warheads on its weapons;

[26] For discussion on ERINT, see *Defense News*, (edition unknown - authored by Barbara Opall), pp 3, 58.

b. disable its engines, or degrade its airframe sufficient to force a mission-abort but still allow the aircraft to land safely;

c. degrade the aircraft's fuel;

d. degrade the aircraft's flight characteristics using low-speed, non-lethal warheads on existing missiles;

e. impair or permanently disable the aircraft's computers and avionics;

f. temporarily blind the pilot, using laser beams; and

g. affect the runway so as to make it unusable, eg with chemical agents that destroy tyres, or make the runway too slippery for traction.[27]

MILITARY TECHNICAL REVOLUTION

Since the future, as argued by this Paper, will be based around technology, it would be prudent to examine what has come to be known as the Military Technical Revolution (MTR). The RAND MTR model,[28] (Figure 1) which as a product of Project Air Force focuses on the promise of air power, provides a reasonable start-point:

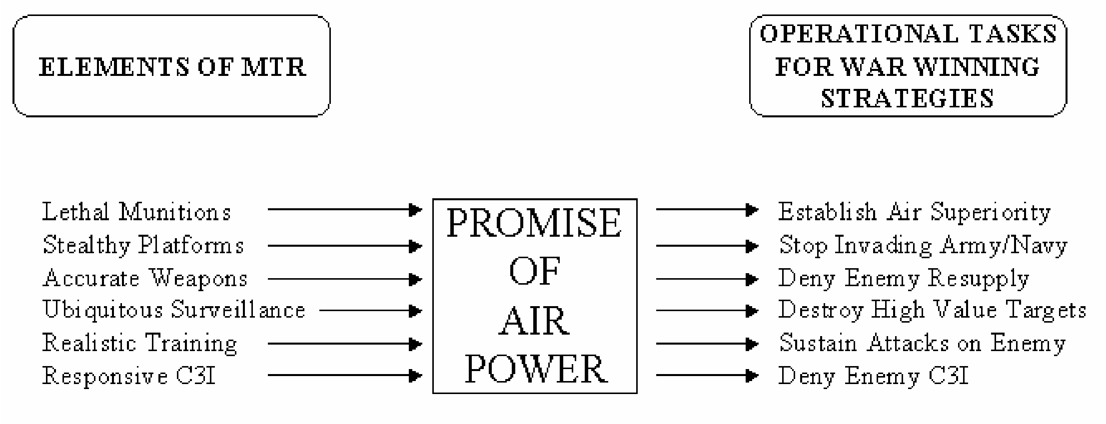

Figure 1 - RAND MTR Model

Further research into MTR has identified three distinct phases:[29]

a. The military engineering revolution which changed weapons, platforms and hardware - started during WWII and ended in the 1980s.

[27] Discussed in more detail in *Defense News*, 7-13 February 1994, pp 1, 45.
[28] Provided by Dr Russ Shaver, RAND Corp.
[29] Bodnar, Captain John W., US Naval Reserve, 'The Military Technical Revolution: From Hardware to Information', in *Naval War College Review*, Volume XLVI, Number 3, Summer 93, pp 7-21.

b. The military sensor revolution which started in the early 1970s with the advent of computerised sensors and weapon control systems. It may end in the late 1990s.

c. The military communications revolution which started in the late 1970s and focused on improved C3I capabilities, and may extend beyond 2000.

From this, we can argue that warfare will depend on hardware, sensors and communications. Since most nations of the future will achieve near-parity in these, the important issues will be those of knowledge, education, understanding and commitment that will tip the balance in one side's favour. We must be sure to be that side. To that end, we should be mindful of Mikhail Gorbachev's comment in 1989: 'We were nearly one of the last to realise that in the age of information science the most expensive asset is knowledge'.

FORCE STRUCTURE

Issues of the future which will impinge on force structure deliberations for Australia should include:[30]

a. survivable systems,

b. more precise, multi-purpose and interoperable weapons,

c. ability to see and guide weapons through cloud and in tropical conditions,

d. advanced EW to disrupt an enemy's C^3I,

e. advances in the ability to deploy,

f. improved ability to destroy enemy missiles (on the ground and in the air over enemy territory),

g. high-confidence, near real-time Bomb Damage Assessment (BDA),

h. comprehensive data base, including data fusion, and

i. continued quality and flexibility of personnel.

Force structure deliberations should lead to a breadth of capabilities to regenerate and reconstitute the force. Budget strictures limit the ability to do this more and more. Consequently, defence forces are being led to international interdependencies which will limit national options. This may lead to niche roles for some elements of the defence force. For the RAAF, however, it is likely to remain large enough to maintain capability across the breadth of roles, but it will turn increasingly to technology to continue to do so.

[30] Adapted from Rice, Donald, 'Air Power in the New Security Environment', Shultz and Pfaltzgraff, p 13.

Since the Gulf War, the focus has been on stealthy platforms. For the future, we should concentrate more broadly on survivable systems (including 'stealth'); and in this, systems are not limited to the platforms and weapons, but also include the Air Defence Ground Environment (ADGE), air bases, lines of communication, and so forth.
Finally, the following force structure determinants are suggested:

a. the capability to deter and control aggressive behaviour (in a denial sense),

b. versatility (which must address the inherent costs),

c. responsiveness and mobility (which must include self-reliance and self-sufficiency),

d. survivable C^3I and surveillance (preferably from space), and

e. the ability to build Australian influence.

EMERGING TECHNOLOGIES

Dr John Blair has argued that Research and Development (R&D) will be hampered by pressures to produce short-term results and that fewer vigorously trained scientists and engineers will be available to undertake the necessary innovation to ensure technology continues to develop.[31] Furthermore, the technologists will not only have to make the scientific discoveries, but they will have to apply and implement that technology as well.[32]

Those arguments aside, an air force of the future will have to support investment strategies which seek to:

a. maximise readiness,

b. maintain technological sophistication,

c. continually modernise existing systems, and

d. participate in the development of new systems.[33]

The United States Department of Defense (DOD) has identified 22 technologies which it argues are critical to maintaining a viable national defence program. They are as follows:[34]

a. Microelectronic circuits that can be integrated into high-speed computers, sensitive receivers, automatic control systems, etc. (Microelectronics).

[31] Blair, Dr John, 'Advanced Technology Challenges in the Defense Industry', in Shultz and Pfaltzgraff, p 329.
[32] *ibid.*, p 330.
[33] Adapted from those listed by Dr Blair for the US air forces.
[34] Blair, 'Advanced Technology Challenges in the Defense Industry', pp 336-337.

b. Preparation of high purity Gallium Arsenide (GaAs) and other compound semiconductor substrates and thin films for microelectronic substrates. (Substrates).

c. The generation of affordable and reliable software in timely fashion. (Software).

d. Ultra-high-speed computing by simultaneous use of all processing capabilities (Parallel Computer Architectures and Neural Networks).

e. Incorporation of artificial intelligence and robotics into mechanical devices. (Machine Intelligence/Robotics).

f. Testing of concepts and designs without building physical replicas through simulation and modelling. (Simulation and Modelling).

g. Integration of optical memories and optical signal and data processing. (Integrated Optics).

h. Ultra-low-loss fibres and optical components such as switches, couplers and multiplexers for communications, navigation, etc. (Fibre Optics).

i. Radar sensors capable of detecting low-observable targets and capable of non-cooperative target classification, recognition and identification. (Sensitive Radars).

j. Sensors that do not emit signals (hence passive) in detecting targets, monitoring the environment or determining the status or condition of equipment. (Passive Sensors).

k. Combination of computer architecture, algorithms and signal processing for near real-time automation of detection, classification and tracking of targets. (Automatic Target Recognition).

l. Formation of spatial beams by controlling the phase and amplitude of radio frequency signals at individual sensor elements distributed along an array (radar, underwater acoustic, or other) (Phased Arrays).

m. The machine integration and interpretation of data and its presentation in convenient form to the human operator. (Data Fusion and Ergonomics).

n. The ability to control the target signature (radar, optical, acoustic, or other) and thereby enhance the survivability of vehicles and weapon systems. (Signature Control).

o. The modelling of complex fluid flow to make dependable predictions by computing, thus saving time and money previously devoted to facilities and experiments. (Computational Fluid Dynamics).

p. Lightweight, fuel-efficient engines using atmospheric oxygen to support combustion. (Air-Breathing Propulsion).

q. Microwave radiation at high-power levels for weapon applications to disable sensors (temporarily or permanently) or to cause structural damage. (High-Power Microwaves).

r. The generation of power in the field with relatively lightweight, low-volume devices. (Pulsed Power).

s. The generation and use of hypervelocity projectiles to penetrate hardened targets and increase the weapon's effective range. (Hypervelocity Projectiles).

t. Materials possessing high-strength, low-weight and also able to withstand high temperatures for aerospace and other applications. (Advanced Composites).

u. The fabrication and exploitation of superconducting materials. (Superconductivity).

v. The systematic application of biology for an end use in military engineering or medicine. (Biotechnology Materials and Processing).

CONCLUSION

This paper has argued that future contingencies, whether in terms of broad surveillance or more specific combat capabilities, will rely upon high-technology solutions, which will involve exploitation of the air environment. This exploitation will necessitate precision, and an ability to operate at night and in all weather. We must be prepared to provide crisis response as well as war fighting effectiveness and to maintain our qualitative level throughout. Key planning issues should centre on sovereignty, air space control and defensive deterrence. During operations, the ability to gather and process information and the robustness of the communications network will be just as important as specific tactical capabilities. Surveillance (including space-based capabilities), versatility in the force structure (including software as well as hardware), self-reliance and self-sufficiency will be necessary for the key planning issues to be addressed satisfactorily.

These planning issues will lead to certain broad capability requirements which must focus on 'application pull', not 'technology push'. Long-range, high survivability levels, and the ability to concentrate force from small numbers will be the critical requirements. In this, performance, design and applicability should represent the key broad selection criteria of future acquisitions. Platforms, weapons, avionics, mission support systems, simulation, anti-ballistic missile defence and non-lethal technologies are all areas to which we should turn our attention.

Assessment of solutions to capability requirements needs to take cognisance of what has been termed the 'Military Technical Revolution'. In this, we should focus on hardware, sensors and communications for our technical solutions, but we cannot afford to ignore knowledge, education, understanding and commitment, which are essential companions, if we are to derive qualitative benefits.

The paper has also analysed the important force structure issues for the future and argued five force structure determinants - defensive deterrence, versatility, responsiveness (including mobility), surveillance (including C^3I), and the ability to build Australian influence. Emerging technologies are also examined in passing, with the caveat that technologies must seek to maximise readiness, maintain technological sophistication, assist in modernising existing systems, and contribute to the development of new systems.

In planning for the future, much of the attention in Australia has been directed towards corporate planning and resource planning. While that is as it should be, we must not lose sight of the fundamental mission of the RAAF, in this case, which is to conduct air operations in the defence of Australia. In this, certain capabilities will be required of Australia's air power, and it is to this important question that this paper has been addressed.