

**FROM PAST TO FUTURE:
THE AUSTRALIAN EXPERIENCE OF LAND/AIR OPERATIONS**

**A LAND FORCES' TECHNOLOGICAL PERSPECTIVE
FOR THE FUTURE**

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Introduction

As history has often shown, new technological development can have a profound influence on the course of a war, and on the future, as the Manhattan Project demonstrated at the end of the Second World War. At the same time, the innovative use of existing technologies can also achieve outstanding success. The Germans showed that the Blitzkrieg's innovative use of manoeuvre with existing armour and aircraft can also be decisive. In Australia we do not have the economy or demand to produce world leading technological developments consistently for our land forces, although some of Australia's defence industry developments are world class.¹ In Australia we are more likely to upgrade the proven technology in existing equipment, or buy high technology turn-key solutions from overseas manufacturers.

The Australian Defence Force needs technology to overcome the dual problems of Australia's enormous size and small population. The intelligent application of technology can help us to overcome the problems of defending with such a small population a land mass the size of continental USA. The size of the nation means that any enemy has a vast range of possible strategies, while we must plan for an equally vast number of options to counter him. The aim of the technology will be to increase the effective firepower, manoeuvre and morale of our forces on the battlefield, while minimising the cost of, and manpower involved in, combat operations.

Future innovations will enable commanders in a joint arena to enjoy greater accuracy when engaging targets; enhanced discrimination through identifications, friend, foe or neutral (IFFN), greater survivability through dispersed operations; and the ability to operate in all weather, day or night. The major new projects currently being staffed for the land force indicate that the focus is on communications, command and control, electronic warfare, surveillance and night observation, mobility, weapons and ammunition. While innovative technological developments may be incorporated in to some of these projects, it seems that the major technological multiplier in future systems will come through the application of micro-electronics and software based systems.

This paper seeks to describe the type of technologies that will influence the conduct of the land/air battle in short warning conflict in northern Australia and their influence on combat power, force structure and operational concepts.

The Collection, Processing and Dissemination of Knowledge

Knowledge

Key to the detection, protection and reaction phases of the land/air battle in northern Australia will be the winning of the knowledge war. This knowledge war will be fought with micro-processors and software and the rapid information collection, processing and dissemination of knowledge. Knowledge of enemy intentions will be collected through signals intelligence; knowledge of actual enemy activities will be collected by sophisticated ground, air and space-based sensors; the knowledge collected from these sources will then be automatically processed using computer-based expert systems and artificial intelligence; knowledge will then be distributed seamlessly, in text, visual and audio forms, to the various levels of command; and weapon systems will use the knowledge to target the enemy.

The collection, processing and dissemination of knowledge of one's own forces, the enemy and the environment (including weather) will be crucial in a land/air operations as commanders seek to gain an advantage over small groups of enemy who will often have the freedom of deciding the time and place of battle. Both commanders and subordinate force elements will operate in a common, knowledge-based environment,

Military Geographic Information

Given the vast distances, hostile terrain, variable weather and environment of northern Australia such knowledge is vital. Operations, particularly in the air, will be less dependent on weather and daylight than in the past due to advances in navigation systems, night vision equipment and weapon delivery systems. For both aircrew and troops, a thorough knowledge of the vagaries of the weather is essential in all forms of warfare, as history has often proved. Military geographic information systems will become increasingly important tools in achieving this aim. These systems, through the compilation of knowledge from a range of sources, will provide a commander with a high degree of awareness of the natural and artificial features in an operational area and the manoeuvre options of his command in that area. The collection of knowledge for these systems will increasingly be achieved through the use of remote sensors.

Knowledge Collection

Sensors will provide near real time warning of the actions of the enemy, reducing the relative advantages offered to the enemy by the size of the area of operations, darkness, small force size, camouflage, deception and stealth. Forces will rely extensively on the use of manned, or unmanned, remote or robotic sensors and other electronic means of detecting the enemy and automatically engaging him. Satellite, aerial and ground-based terrain and environmental sensors will offer a layered, highly capable, redundant detection system, with wider coverage, higher resolution and near real time responsiveness. Smart sensors combining passive optical and infra-red, radar, acoustic, seismic, and perhaps aromatic input, all sharing the same optics and processors, will be able to defeat stealth technologies which concentrate on masking a limited number of signatures. Integration of knowledge from sensors and the use of expert systems and artificial intelligence will allow sophisticated analysis of the enemy's intentions and the options to counter him.

Weapon systems will be integrated with the knowledge collection systems, thus allowing forces to engage targets once they have been located. Together with deployment of remote and autonomous robotic sensors, the trend will allow forces to be multi-roled. Forces tasked with detection (reconnaissance or surveillance) missions can quickly adapt to protection or reaction missions through the tasking of remote sensors and weapon systems, and the tailoring of munitions for particular target types. At the same time land forces will be freed from some of the demands of providing security for large headquarters, logistics areas, vital assets and the like as sensors become more efficient and field commanders gain more confidence in the systems.

Sensors will become more independent of human support, reflecting advances in robotic systems, such as in unmanned aerial vehicles (UAV). Improvement will be based on massively increased knowledge transmission, processing capacity, miniaturisation, low power consumption and new power delivery systems. Single spectrum data from multiple UAVs will be fused, providing multispectrum and multi-viewpoint imagery. Larger, high altitude, long endurance, multi-sensor UAVs will complement these small platforms and provide theatre coverage. Unattended Ground Vehicles (UGV) will also be widely used on the battlefield.

TI and II equipment will become common on the battlefield, as will systems designed to defeat such equipment. There will be increased opportunities to operate by night with such systems; however the requirement for rest will continue to be a major limiting factor on operations, particularly as the technological systems are more demanding on the human senses.

The wide use of electronic sensors will in many instances reduce, but not eliminate, the need for human confirmation of electronically collected and analysed knowledge. Incidents over the last few years, such as the accidental shooting down of the Iranian passenger jet by a US warship and the destruction of two Blackhawk helicopters by US jets, clearly demonstrate the consequences of relying solely on electronic forms of detection and identification.

Knowledge Processing

This knowledge will be integrated into battlefield decision support systems. Commanders and staff will be unable to sort and process manually the enormous amount of knowledge available to them. Increasingly the processing of knowledge will be achieved through automated decision support systems, such as expert systems and artificial intelligence. Decision support systems will allow a commander to 'what-if' various operational options, before compiling and disseminating orders to subordinates at the point of decision. Commanders will use expert systems to produce detailed operational options and orders.

Knowledge Dissemination

The conduct of the land/air battle will demand compatible communications in air and land combat systems. Communications networks will be 'adaptive', switching between communications nodes and links and use the most effective communications path. Expert systems will pre-sort knowledge and apply packet switching, data-compression or other techniques before transmission. Pre-processing of sensor knowledge in smart suites, transmission over wide-band secure communication links at terahertz speeds, and radically improved data-compression techniques and sophisticated, automated network management will have the dual effect of minimising the data to be sent and maximising the available bandwidth.

Distributed, automated processing of knowledge will overcome the need to centralise the production of knowledge in major headquarters. Knowledge will be collected and processed locally, and then disseminated down, laterally and upwards through the command support system. This will shorten the time to produce intelligence from raw data. Knowledge will be available in near real time as wide-band communications systems will provide for the rapid dissemination of intelligence in high quality secure voice, data and video form.

National Communications Infrastructure

The national communications infrastructure will underpin the land forces communications system. The capacity of the civilian communications system will provide highly redundant and secure communication, even in the face of concerted enemy action. New digital mobile phone technology provides secure and flexible means of communications in large parts of the country. This technology will be used extensively by land force elements, particularly in logistic areas where communications with civil contractors is necessary. Low earth orbit (LEO) satellites will complement more expensive, geo-synchronous systems, providing continental coverage wide high capacity, high redundancy bearers with theatre coverage. LEO will be common and cheap, their development being primarily driven by the civil communications market. LEO will provide high resolution multi-spectral knowledge, high bandwidth communications channels, high redundancy, and the capacity to vary on-board sensor at relatively low cost. Fibre optic cable offers ultra high bandwidth point to point bearers as well as providing back up to radio and microwave systems. Long range high frequency communications will only be required to back up vital tactical, operational or strategic communications systems. Civilian communications assets are vulnerable to direct attacks through precision munitions and other sophisticated threats, such as software viruses.

The dissemination of knowledge will be achieved in near real time as the communications systems become smarter and seamless to staff and the field soldier. The uncertainty facing the commanders, aircrew and ground troops will be reduced.

Knowledge Defeating Weapons

Unprotected C41 systems are vulnerable to the effect of electromagnetic pulse (EMP) weapons. Where our land forces will have EMP protected systems, they will use EMP weapons systems against unprotected systems, particularly where the enemy has shielded the equipment from attack by conventional weapons.

Lasers

Laser weapons will be deployed also to defeat optical systems used in sensors and range-finding and target designator equipment used by soldiers in soft skinned and armoured fighting vehicles, main battle tanks, helicopters and aircraft.² While the use of laser weapons to cause damage to the human eye is the centre of much controversy, Australian land and air forces will need to prepare for the possible use of this type of weapon against soldiers and knowledge collection systems. The possible threat of eye-damaging laser weapons is likely to cause a degree of reluctance in the use of items such as gun sights, binoculars and night vision devices. Soldiers on the battlefield will need to be trained in the use of countermeasures to such devices, such as the use of laser protection spectacles.

Viruses

Software driven electronic processing systems are vulnerable to viruses. The use of these devices against the enemy, and the protection of ones own equipment against such attack, need to be considered.

Outcomes

- The automation of knowledge collection, processing and dissemination will reduce the need for the manual processing of information, thereby reducing the staff required for these function.
- The integration of knowledge collection, processing and distribution systems will allow simpler, flatter command and control relationships. Coordination will occur in real time across flat structures rather than up and down command chains.
- High capacity cable systems will be used extensively to take advantage of the lower relative cost of such systems and the relative immunity of cable systems to enemy electronic warfare, while reducing the electronic radiation used by some modern weapons for target acquisition.
- The reconnaissance and surveillance by combat soldiers will increasingly be supplemented, and replaced by, the deployment of sensor assets controlled at the higher levels.
- Sensors will collect information around the clock and in adverse weather conditions.
- The delivery of knowledge collected by such systems will be rapid and demand equally timely reaction by combat soldiers.
- SIGINT will be vital for a commander on the battlefield. Increasingly, jamming will need to be more selective to avoid disruption to friendly systems.

Firepower

The effect of firepower depends on the responsiveness, accuracy and effect of a weapon system.

Responsiveness

With wide-band responsive communications links and the digitisation of knowledge, weapons will be integrated with knowledge collection assets to allow faster and more accurate engagement of the enemy. Deployability of weapon systems will be enhanced by the application of new materials, making systems lighter but more effective and lethal. Longer range air-to-ground and ground-to-ground missiles will provide accurate and flexible response to enemy action. At the same time, the range of conventional weapons will increase with incremental improvement in propellants and gun chamber mechanics.

Accuracy

During the Gulf War US pilots hit 50% of their targets with precision guided munitions. These PGM comprised only 8% of the total bomb tonnage dropped during the war.³ The use of clever, smart, and brilliant munitions will provide more reliable and effective engagement of target. While smart or brilliant munitions will be targeted primarily against key strategic enemy targets, they can also be used rapidly and effectively against small groups of unprotected enemy. The ability to fix the position of a weapon system, observer and the target using GPS, combined with the ability to target munitions precisely, will allow land and air weapons to be placed in support of a range of force elements. Weapons will be able to be redirected to alternative targets after being launched. Miniaturisation and lower cost will allow smart systems to be used across the existing range of calibres and types.

Weapon Effect

Lethality will improve, as weapons are developed to defeat specific targets. Weapons will either deliver greater kinetic energy, or tailor energy delivery to match the intended target. Rifles will be capable of firing armour piercing rounds to defeat the wider use of body armour. The accuracy and destructive power of new munitions may lead to a reduction in the use of armour and other forms of hardened protection and to the use of electronic countermeasures, such as laser detection and jamming systems, to warn of and defeat an enemy attack. Warhead technologies, such as thermobaric explosives and electro-magnetic pulse weapons, will allow more significant improvement of weapon effect.

Outcomes

- The responsiveness of systems through the automation of the target acquisition, delivery and tracking systems will reduce the numbers of combat personnel in the decision loop.
- Better weapons effect will lead to improved morale and confidence, and reduced numbers of combat personnel and fewer casualties. Combat units will be smaller, but more lethal.
- The enemy will be equipped with similar types of weapons. He will have access to similar technology and will deploy portable, autonomous, highly lethal systems to attack key targets from long range with great accuracy. Our land forces will need to be more dispersed and use more sophisticated methods of electronic camouflage to protect headquarters and key points from attack by precision munitions. Where possible line or cable systems will be used to reduce the probability of the intercept of radio traffic.
- Sophisticated radars and other sensors will be required to warn of the approach of terrain-following missiles and other brilliant munitions and the location of the firer. The use of dummy electronic signature devices may be used to confuse the enemy about the location and use of facilities.
- Modern weapons will be more expensive, and the decision to attack certain groups of enemy might be influenced by cost.
- The risk of collateral damage or injury to non-combatants is reduced.
- The utility of armour and other forms of protection will be reduced as the accuracy and effectiveness of weapons systems makes such protection less useful in some situations. More attention will be directed at camouflaging facilities and combat systems from enemy visual and electronic detection.

Ground and Air Mobility

Tactical mobility in the land/air battle will be provided by medium or short range fixed wing aircraft, helicopters and vehicles. Troops and their equipment can be inserted by air landing or parachute, but the cost and shortage of fixed and rotary wing aircraft will mean that vehicles will be the primary means of enhancing the mobility of ground troops. Ammunition, food and water will continue to constitute a major proportion of the combat loads of troops. Increasingly, the carriage of specialist soldier system technologies, such individual radios and night vision equipment will put heavier loads on troops and greater demands on the logistic system to move personnel and equipment within and between areas of operation. In short warning conflict in northern Australia the need to carry large quantities of water will restrict the mobility of ground troops once they have been inserted. Once inserted ground troops will continue to operate predominantly on foot, but they may have helicopters or vehicles in close support for more rapid movement or medical evacuation. The deployment of mortars or artillery with such forces will place further strain on the mobility of troops. Troops inserted by air will need eventually to be reinforced and resupplied by ground forces during protracted operations.

Advances in Vehicle Technology

Tactical mobility for vehicle mounted troops will be enhanced by improvements in vehicle propulsion, suspension and protection technologies. Land vehicles will have agile, rugged, reliable vehicles, with good endurance and protection. Improvements in vehicle technology are likely to be incremental. Propulsion systems will become smaller, lighter, more powerful and make use of computer based controllers to maximise efficiency. Improvements in engines and drive trains will allow vehicles to select power output and delivery to suit terrain and environmental conditions. Operators will need less training to drive future vehicles. Propulsion systems will remain based on improved internal combustion engine technologies, and hybrid combustion-electric propulsion systems may be applied to military applications in the future. Active suspension systems will allow significant improvement in absolute mobility (where vehicles can and cannot go) and relative mobility (how fast vehicles can traverse terrain). Predictive active suspensions will use forward looking high definition sensors to match suspension settings to predicted terrain, allowing vehicles to move faster across more rugged terrain. Wheeled vehicles will be able to traverse some terrains denied to present vehicles. Wheeled vehicles will move cross country at higher speeds. Tracked vehicles are expected to maintain superiority over wheeled systems in absolute mobility, provision of protection and stability for gun systems. Tracked vehicles will continue to be disadvantaged by their relatively higher fuel consumption, spare parts costs and vibration and noise.⁴

Vehicles will be smaller and lighter as crew functions are automated and propulsion and other systems miniaturised. All vehicles will continue to improve in reliability as sophisticated systems design and manufacturing using advanced materials matures. Overall, tactical mobility and sustainability will be enhanced significantly, thus increasing reaction time and decreasing the time taken to link supporting ground forces with airborne forces.

Protection

For vehicles, passive protection systems rely on armour to defeat warheads, and deception to defeat targeting. Composite, reactive and hybrid armour will allow incremental improvements in protection. Signature reduction by the application of stealth technologies will match improvements in sensor technologies. Reduction in total vehicle size, particularly for A vehicles, will reduce vulnerability. Active protection measures will become more crucial as targeting sensors improve. Active protection on A vehicles will allow the vehicle to detect and either intercept or divert relatively slower weapons reliant on on-board targeting. Weapons relying on remote targeting, using kinetic energy for target effect, will be more difficult to neutralise. Advanced materials may offer sufficiently improved armours. Improved protection

systems will reduce the likelihood of casualties in combat. Technologies to minimise the vulnerability of aircraft to shoulder fired missiles and vehicles to direct fire weapons and mines are advancing rapidly. For aircraft, pilots will continue to rely on tactical flying or electronic counter measures to defeat enemy ground based threats. Aircrew will be vulnerable to attack by laser weapons. Helicopter crews in low flying helicopter operations at night seem particularly vulnerable to such weapons.

Outcomes

- Most Australian ground troops will continue to use vehicles as the main enhancement to mobility because the cost of fixed and rotary wing aircraft will limit the availability to high priority tasks, such as the movement of rapid reaction forces or casualty evacuation.
- Advances in vehicle technology will provide little appreciable gains in overall mobility, but technology to enhance protection for these systems should decrease the likelihood of casualties by enemy attack and vehicle accidents.

Soldier Systems

The movement of troops by air will limit the amount of equipment that can be carried. Dismounted soldiers sustain 80% of all combat casualties.⁵ The soldier of the future is likely to be equipped with better clothing, equipment and weapons system, but the trend is that combat loads are getting heavier, not lighter. The soldier will use a range of devices, to enhance sight and hearing. Individual soldiers will have communications, navigation aids, and access to decision support tools through the command support system. Greater reliance on remote sensors and automated weapon systems will increase the chances of fratricidal engagements. Land forces will need to have an identification friend or foe system to reduce the likelihood of fratricidal engagements, as the FEBA becomes less discernible and all weather, around the clock operations become the norm.

Survivability

The protection of the individual soldier from death or injury will continue to be a major factor in the development of equipment and systems. Australian political leaders have continually demonstrated through history the importance of minimising the risk of injury or death to soldiers, at the expense at times of other objectives. Soldiers will continue to use the available cover, such as ground, vehicles or bunkers to protect themselves. Individual clothing and protection systems will reduce the possibility of injury. Advanced materials, perhaps genetically altered super strong natural substances such as spider's web, will allow high protection, lightweight body armours. This armour will be integrated into multi-function ensembles to protect against the natural and tactical environment, including CBW. The requirement to wear body armour will, to some extent, exacerbate the tendency to have soldiers carry heavier combat loads. Combat clothing will be cooled so that it is not detectable using heat sensitive surveillance equipment or weapons.

Global positioning systems and IFFN will increase effectiveness of operations and reduce confusion. New GPS systems can advise a soldier of his precise location within 16 metres. Confidence will be further increased by knowing in real time where friendly forces are and what they are doing, reducing the risk of fratricidal engagements. This knowledge will stem from automated position and status reporting by individual friendly soldiers and systems. Soldiers will carry computer packs that will provide them with access to the latest information on the terrain and tactical environment.

Outcomes

- Fixed and rotary wing aircraft will need to carry systems compatible with the electronic aids carried by ground troops, such as communications and IFFN.
- The soldier will carry heavier loads, notwithstanding the availability of fixed and rotary wing aircraft to carry troops to battle, resupply them, and the weight reductions achieved through lighter materials in weapons, caseless and plastic cased ammunition, and smaller calibres. Troops will carry a wide range of knowledge collection, processing and distribution equipment that will further burden the field soldier. Troops will need to be stronger, have more endurance and be better educated if they are to keep pace with the need to function with high technology equipment in a fast moving, 24 hour war.
- Soldier system technology will reduce the number of troops required to achieve combat missions. For example, once ground troops locate an enemy target, the troops may illuminate the target for an air bombardment or missile attack, thereby eliminating the need for ground troops to attack and destroy a target. With modern weapons systems, sensors and improved mobility, the force to space ratio will be maintained over a wider area.

Logistics

The logistics in the land/air battle concept depend heavily on the air situation. In short warning conflict Australian joint forces will enjoy air supremacy. Once deployed land forces will sometimes rely on air landed or air dropped stocks until ground forces are able to reach them and commence resupply. Air resupply will be particularly vulnerable to modern hand-held anti-aircraft systems in such operations, particularly as the enemy will have no doubt about whose aircraft are operating the area.

The need to sustain the ammunition, fuel, food, water, repair parts and medical supplies in the land/air battle will continue to challenge the joint commander. Increasingly, joint commanders will rely on the provision of supplies by civilian contractors. Modern weapon systems will need more resupply as the reduced number of high technology weapons on the battlefield are more dispersed and are used more often, so more complex and reliable logistic systems will need to be in place.

The cost of and complexity of maintaining modern combat systems will increasingly lead to more demand on base level repair support. Automation and integration will result in complexity and increased costs. This trend will be balanced by the adoption of sophisticated modelling, design and simulation tools to assist technology development and reliability. The cost of maintaining an operational technological advantage over the enemy will lead to the use of incremental platform improvement, a task which Australia's defence industry has adapted well to in past conflicts.

Ironically, more complex systems are likely to be more reliable than existing systems. New tools to manage complex design, tailor hybrid materials and simulate operational challenge before manufacture will result in ultra reliable systems. The trend to module replacement and miniaturisation will exacerbate the use of out-of-theatre repair.

The ability to anticipate the logistic requirements of the land force is a key factor for a land force commander. Computer modelling of logistics problems and the use of expert systems will enable a better appreciation of the logistics requirements of the land force.

Outcomes

- Overall, the logistic demands in the land/air battle will increase with the requirement to provide combat supplies for ground and air forces, and the need to move technical equipment to base repair facilities for repair and calibration.
- Logistic planning will be simplified as many of the routine planning functions are automated. Expert systems will be used to present options for the detailed resupply of the deployed force.

Conclusion

The collection, processing and dissemination of knowledge will be an underlying imperative of the future land/air battle in short warning conflict in northern Australia. The digitisation of this knowledge and the use of sophisticated processing and decision analysis tools will improve the ability of the joint commander to predict likely enemy intentions. In the detection phase of operations, real time knowledge of the objectives, enemy dispositions and activities, potential insertion points, and routes will contribute to more timely, less risky reactive missions. Major improvements in knowledge processing and storage will allow the integration of discrete surveillance, targeting, delivery and destructive systems into autonomous, highly lethal weapon systems with reduced risk of collateral damage, and multi-sensor platforms. Combat systems will be less prone to single spectrum stealth and deception countermeasures. Integration will lend to autonomous and improved range and lethality. Warheads will be smaller, lighter and more lethal and tailored to match targets. Integration of forces and automation of fire control systems will decrease weapon response time.

In the protection and reaction phases, the commander will have improved awareness of the situation and access to accurate real time information about possible objectives. The predominance of multi-role forces will improve response times, as will contraction in command layers and decision cycles. Accurate, more timely knowledge may improve the potential for pre-emptive deployment of reaction forces. Real time knowledge of the objective and enemy dispositions will improve the reaction to threat. Enemy forces deployed far from support will be at a significant disadvantage.

Improvements in coverage, deployability and lethality of weapons systems will provide greater combat power to relatively smaller and more mobile forces. Integration of force elements will mean that reaction forces might be drawn from a larger cross of the combat force, or that core reaction forces could be quickly augmented by multi-role forces. Multi-role forces and weapons will provide better protection for vital assets and respond more flexibly and lethally to unforeseen threats. Detection will be a function for all land forces.

The current trend to continuous, all weather operations will continue. Real time knowledge, the possession of highly lethal, wide coverage weapons and the integration of force elements to perform multiple roles will decrease decision and response cycles. Flatter command structures will help compress decision cycles in response to higher tempo operations and a fast moving, fast thinking enemy. Weather, lack of knowledge, lack of combat power, or lack of access to key decision makers will delay decisions less. The tempo of operations will be much higher.

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