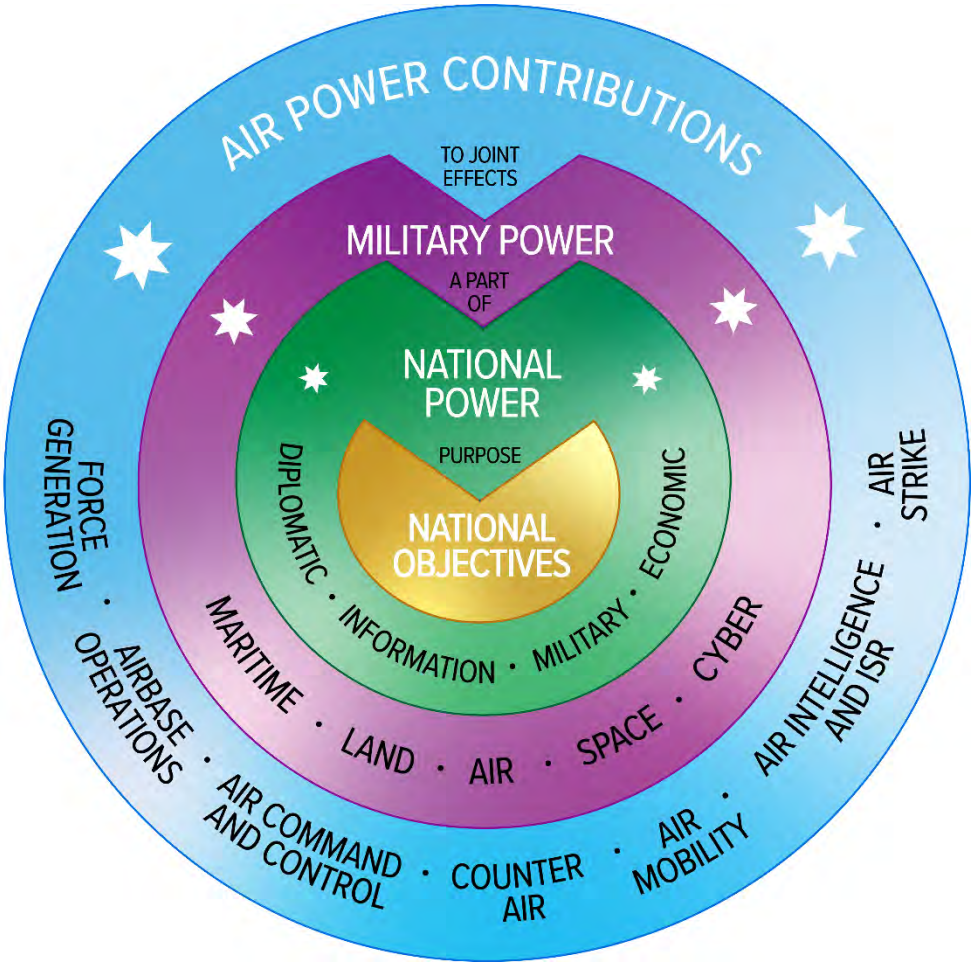
THE AIR POWER MANUAL

7th EDITION

AIR AND SPACE POWER SERIES

Air power contributes to joint effects as part of the military instrument of national power for the purpose of supporting whole-of-government efforts in pursuit of national objectives.



Acknowledgment of Country

Defence acknowledges the traditional custodians of the lands, air and seas in which we live, work and train. We pay our respects to their elders, past, present and emerging. We also pay our respects to the Aboriginal and Torres Strait Islander men and women who have contributed to the defence of Australia in times of peace and war.

Cultural Disclaimer

Aboriginal and Torres Strait Islander people are advised this manual may contain images or content referring to deceased persons. It may also contain words or descriptions that may be deemed culturally insensitive. The term *Australia's First Peoples* is used throughout this manual to refer to Aboriginal and Torres Strait Islander peoples.

AIR AND SPACE POWER SERIES

THE AIR POWER MANUAL

The Air Power Manual, 7th Edition, is issued for use by those with an interest in air power.

MEG Hupfeld AO DSC

Air Marshal
Chief of Air Force
Department of Defence
CANBERRA ACT 2600

March 2022

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FOREWORD

Welcome to the seventh edition of *The Air Power Manual.* This manual is intended to expand thinking about the future possibilities of air power in the Australian context and support the development of *airmindedness* within Defence. This manual complements all levels of Defence doctrine and supports the training and education of those who will generate and employ air power.

In previous editions of this manual, the employment of air power was framed in terms of the roles and missions of the Air Force. However, this construct could be interpreted to imply that air power—conflated with Air Force—had primacy, if not autonomy, in the delivery of those roles and their resulting military effects. These effects are now recognised to be inherently joint, with potential contributions from all of the operational domains.

This edition of *The Air Power Manual* builds on the foundational properties of the air environment, its ubiquity and the potential that holds for the application of military power, along with the human–technology relationship required to unlock that potential. This edition highlights the essentially human endeavour of air power and resists viewing it as simply as a collection of platforms.

While technologies and systems are important, they are only one part of what enables the delivery of air power. Without people intelligently wielding them, cutting edge technologies serve no real purpose. Air power practitioners need to not only be technically adept, they also must be strategically aware and understand their place in the joint force and their responsibilities to Government—they must strive for air power mastery and to maintain an intellectual edge.

It is this *airmindedness* which underpins the ability to integrate effectively with those less familiar with air power. Alongside mastery in all other operational domains, mastery in air power is an essential element for crafting optimal joint force contributions that best support whole-of-government efforts to achieve national objectives.

This manual aims to give readers the mindset they need to be creative and to encourage their curiosity—to best enable airminded practitioners to conceive and build the air power contributions we need to meet future challenges.

MEG Hupfeld AO DSC
Air Marshal
Chief of Air Force

ABOUT THIS MANUAL

This seventh edition of *The Air Power Manual* (APM) focuses on air power as distinct from Air Force. This manual serves as a foundational reference that complements and supports all levels of Australian Defence Force education and doctrine.

Aims

This manual has the following nested aims:

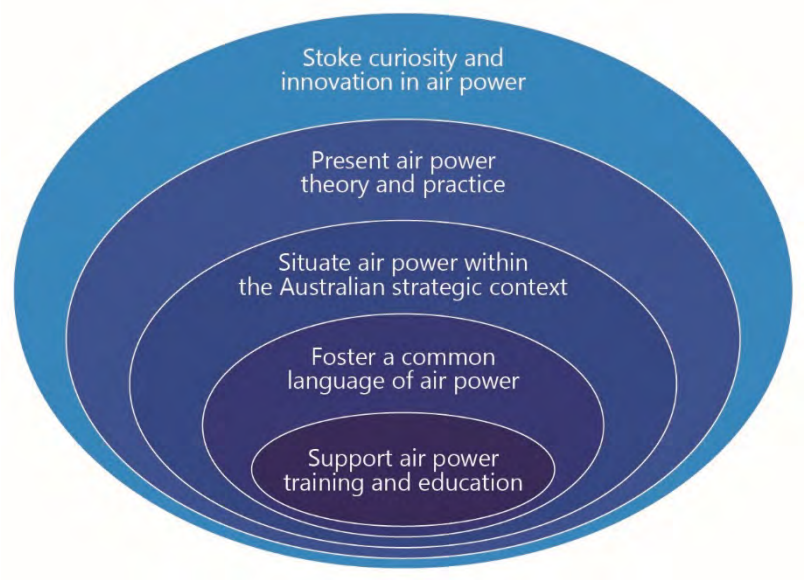
- **Support air power training and education.** First and foremost, this manual is written to support the training and education of those who will employ and enable air power. This is the core purpose of this manual as reflected in the diagram below.

- **Foster a common language of air power.** This manual will introduce terminology and definitions that describe air power and its employment.

- **Situate air power within the Australian strategic context.** The employment of air power is not an end in or of itself—its purpose is to achieve national objectives. This manual will overview this concept to correctly situate air power considerations.

- **Present air power theory and practice.** This manual presents the theory of air power, albeit at a high level, before introducing the air power model to explain the practical aspects of its employment.

- **Stoke curiosity and innovation in air power**. The highest aspiration of *The Air Power Manual* is to expand thinking about the future possibilities of air power. Innovation comes from learning, critical thinking, experimentation, and practice. This manual is written to give plenty of the *for what* and the *why* of air power, to explain some of the *how*, with a view to giving you, the reader, the widest possible aperture to figure out the *what next*.



Method

For some, this manual will be a first encounter with air power theory and practice. For others, it will be part of an ongoing journey. Regardless of experience, this manual has been designed to assist you on your air power journey using the following methods:

CHECKPOINTS – There is a lot of new information being presented in this manual for a first-time reader. The checkpoints, within these blue frames, are intended to provide natural pauses in the text so you can gather your thoughts, review what has been covered so far and then focus on the intent of the text to follow.

VIGNETTES – There are a number of vignettes placed throughout the manual within these sandy coloured frames. Each vignette has been selected with a view to expanding thinking about possible applications of a particular concept and to also highlight the relevance of wider societal considerations where relevant. Vignettes can be engaged with at your discretion. They can be skipped, skimmed, used to build your understanding or as a means of exploring relationships with various other concepts introduced throughout the manual. Questions are embedded within some vignettes to aid in such explorations.

TERMINOLOGY – Air power is complex and has developed a language of its own. Internally constructed terms and their definitions are embedded throughout every aspect of Defence and this manual is no exception. Where a term is essential for you to know, it will be highlighted using a green frame with clarifying notes included in italics where applicable. For other terms, they will be discussed in the text, or you can refer to the Australian Defence Glossary if you are not aware of the meaning. The index at the back of this manual will help you find where the term is discussed.

IMAGERY – Images are used throughout the publication to illustrate the topics being discussed. An acknowledgement, including source link and a full caption, is contained in the back of this manual.

Audience

This manual is primarily intended to be a reference for air power education throughout the early stages of a military career. However, this manual is also designed to be an accessible guide to the utility of air power for all professionals concerned with national security.

Scope

This manual distils ideas and principles pertinent to air power's contribution to national security. It is not intended to be the sole source of information on air power, but rather an introduction to encourage further study and discussion.

Each and every one of you is encouraged to become an active part of the discussion on air power. If you have thoughts on any concept presented within this manual, how it could be improved, what has been missed or a view you wish to share on any topic of relevance to air power, please visit the Air and Space Power Centre website using the link (https://qr1.be/6KFP) or QR code and be part of the conversation. Active participation is always the best way to learn.

AMENDMENTS

The Air Power Manual is a living document and therefore will be subject to amendment as air power discussions evolve. We welcome your input.

Hard copies of this publication will be correct at the time of printing however will not be subject to amendment and you need to check the electronic version for currency. The electronic version is held on the Air and Space Power Centre website (https://airpower.airforce.gov.au/) along with a full list of amendments.

Proposals for amendment of *The Air Power Manual* may be sent to:

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LE COMMANDANT COUTELLE
AU SIÈGE DE MAYENCE (1795)

COLLECTION 476 2ème Série (N°1) ROMANET & Cie IMP. EDIT. PARIS.

CHAPTER 1

AN INTRODUCTION TO AIR POWER

INTRODUCTION – This chapter provides the foundation for the manual by introducing you to air power and where it fits within the enterprise of a nation.

As you read through this chapter you should consider the following questions:

- What is air power and what is its purpose?
- Who delivers air power?
- What is the role of people in delivering air power?

Earth's atmosphere, the envelope of air that surrounds our planet, has long supported life and has enabled some of its inhabitants to fly. To humans, the air offered the potential to advance a wide range of endeavours, from ancient hunting and communication techniques through to the conduct of war. This potential, however, remained dormant until it was progressively unlocked through advances in technology. Boomerangs and woomeras enhanced the hunting effectiveness of Australia's First Peoples. Balloons, and then aircraft, allowed humans to further leverage the advantages of the air environment for a wide range of endeavours—including war.

AIR POWER – the total strength of a nation's capability to conduct and influence activities in, through and from the air to achieve its objectives.

Air power is often thought of in terms of the atmosphere's utility in warfare, but it goes well beyond that. It is the total strength of a nation's capability to conduct and influence activities in, through and from the air to achieve its objectives. This can range from building relationships between nations through enhancing tourism and trade, to enabling the rapid provision of support in a crisis—both domestically and internationally—all the way through to providing military capabilities during the conduct of war.

Air power is a complex concept, it can't be explicitly defined or artificially bound; rather, it requires a deeper understanding of its characteristics and potential. It also has distinctive characteristics that differ to varying degrees compared to other arms of military power. Air power is most effective when applied in concert with other instruments of national power, military or otherwise. Ultimately it is to be employed to achieve national objectives.

This manual is one of many you will need to engage with if you seek to master air power. What this manual will provide is a basic understanding and a framework for expanding your thinking on air power.

THE LIVING LANGUAGE OF DEFENCE

This manual presents ideas that range from the concrete to the abstract. At the more solid end are concepts such as the *air environment* and *military capabilities*; at the abstract end are *domain* and *power*. The aim of this manual is to present all these ideas in the clearest way possible in order to build your understanding of air power.

Abstract concepts have particular meanings based on Defence's perspective of the world and the unique language that has developed over time to describe it. This manual is designed to help create a

shared understanding of Defence's perspective, so we can speak the same language when talking about air power.

Where Defence's language is different from that of general Australian society—as represented in the Macquarie Dictionary—then we will define those terms in callout boxes or refer you to the Australian Defence Glossary. Over time these concepts, terms and definitions will become more familiar, but for those who are new to air power you need to learn them and the importance of their application.

National air power.

When new concepts or constructs solidify within the Australian Defence Force (ADF), they are often referred to in abbreviated forms, typically as an acronym. Acronyms are used extensively in Defence and can have unique meanings within different internal groups, this often presents a barrier to effective communication, both with and within the department. Where Defence concepts are introduced in this manual, we will also introduce their common use acronym—to best help you build an understanding of the living language of Defence and air power.

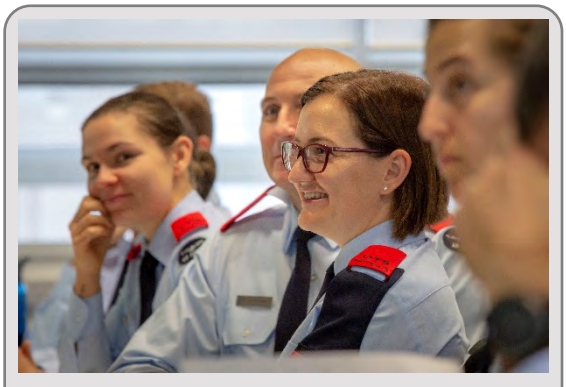
Air power versus Air Forces

We must understand that military air power is not exclusive to an Air Force. In Defence, each Service is assigned responsibility for generating and preparing agreed capabilities designed to meet Australia's national objectives. Air power is as much an integral part of Navy and Army capability as it is for the Air Force. In the national context, air power is also sourced through other government and commercial entities—for example, Australian Border Force and airlines. As such, this manual is not focused singularly on the Air Force, rather it takes a more holistic view of air power in the military.

While the air power contributions from each of the Services may differ, the environment, characteristics and practical considerations for the application of air power are common. We will explore this core message throughout the manual.

Air power practitioners

The ADF uses the terms *soldier*, *sailor* and *aviator* to describe personnel within each of the Services. As these terms are Service-specific, and we have already said that air power crosses Service boundaries, we will use *air power practitioner* as the collective term for those involved in the development and employment of air power.



Starting their air power journey.

This manual draws from the rich lessons of our history, offers guidance for today's practitioners and aims to set the foundations for

a dynamic future. However, it doesn't provide answers to current or future operational problems. That is the role of air power practitioners, drawing on all their knowledge and experience and applying it to the problem at hand.

This manual is not just for air power practitioners within the ADF. An appreciation of air power is also essential for civilian members of Defence and across all other Australian government agencies concerned with national security. Ultimately, this manual is designed to be a resource for anyone who has an interest in Australia's employment of air power.

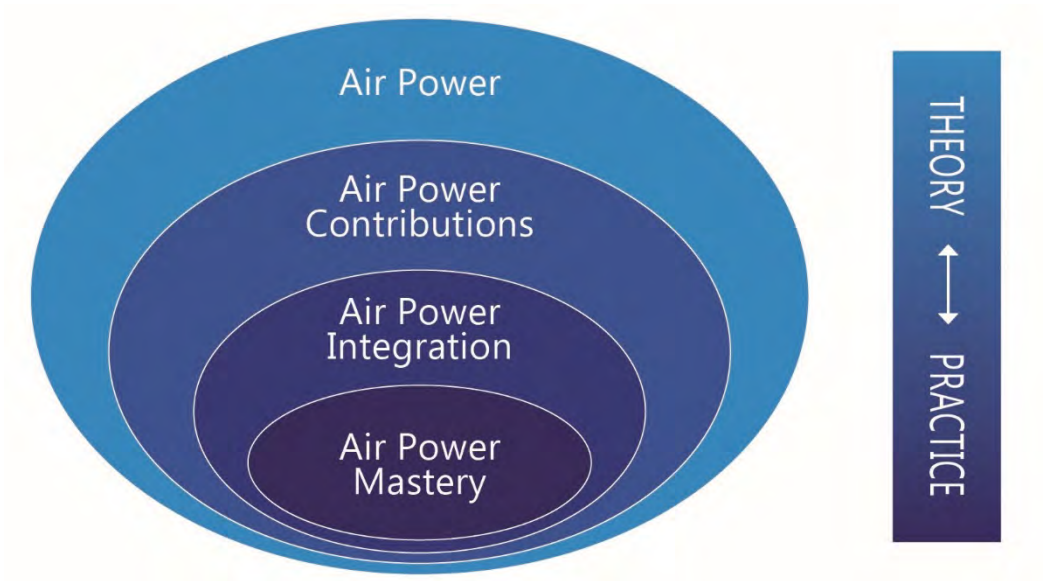
CHECKPOINT – A key part of the learning, for those new to air power, will be to understand its living language. New terms, abbreviations and acronyms will become part of your air power experience.

In the next section of this chapter, we will begin to look at the theory and practice of air power.

AIR POWER: FROM THEORY TO PRACTICE

Air power is not just about material things, such as aircraft. The ability to combine theory and practice to develop effective strategies lies with the air power practitioner. This was recognised by one of the earliest air power visionaries, Major General Billy Mitchell, United States Army Air Service, who defined air power as "... the ability to do something in the air."

Air power, in the Defence context, is the result of practitioners using their understanding of air power theory and doctrine, combined with their practical experience, to provide useful contributions from the air. The figure below depicts this relationship and provides a framework for the remainder of this manual.



The *theory* part of the model will look at the foundational aspects of air power including the strategic environment, air power theory and the role of doctrine. This is broadly the topic of the first three chapters of this manual.

The *practice* part of the model will focus on the contributions air power can make in support of national efforts, along with how they are integrated with other contributions. It will culminate with a look at how we then educate and train our air power practitioners on their journey to professional mastery. This is broadly the topic of the last three chapters of this manual.

Educating the wider audience on air power.

Air power theory

Theory is an understanding of the world that can be tested. Theory strives to appreciate the fundamentals—what is unchanging. Theory can be used by practitioners to develop concepts, strategies and plans. Theory is also useful in the ongoing education of those interested in deepening their understating of air power beyond the level discussed within this manual.

Theories of air power began to emerge not long after the advent of powered flight early in the 20th century. Among the first air power theorists were Douhet, Trenchard and Wrigley, with many others following in their footsteps.

It is important to acknowledge that many practitioners of air power generate their own theories for its optimal use, often subconsciously. These theories are influenced by many things and tend to evolve the longer the individual remains engaged with air power. Powerful influence often flows from personal engagement with the work of theorists, interactions with instructors and mentors and, for practitioners within the ADF, through engagement with doctrine. Arguably, however, the most powerful influence is simply one's own lived experience.

Air power doctrine

Doctrine is an articulation of the knowledge base of the ADF in any given field of endeavour. It represents a rich repository of knowledge that supports and guides those involved in the application of military power.

Air power practitioners use doctrine to inform their own theory and practice, to shape the development of their profession, through the education of current and future generations.

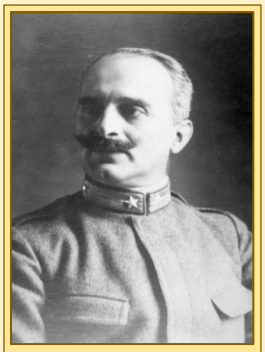
Learning from our past.

While *The Air Power Manual* is not ADF doctrine, it is inextricably linked to it. It draws from the *capstone* and *philosophical* levels of ADF doctrine and informs the *integration* and *application* levels. Links to key ADF doctrine publications are provided at the end of this manual.

While there are over 50 publications in the ADF doctrine hierarchy, the ideal start point is the two capstone publications—*Foundations of Australian Military Doctrine* and *Australian Military Power*.

EARLY AIR POWER THEORISTS

Former Italian Army General Giulio Douhet, Marshal of the Royal Air Force Hugh Trenchard, and Air Vice-Marshal Henry Wrigley, Royal Australian Air Force, are regarded as three early advocates and visionaries of air power.

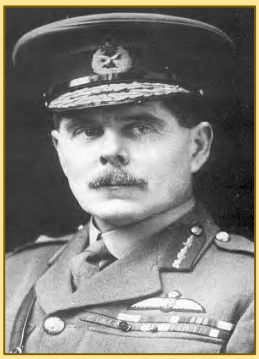


General Giulio Douhet.

GIULIO DOUHET, 1869–1930

Italian military officer and early advocate of air power, General Giulio Douhet, was an early supporter of strategic bombing and the military superiority of air forces. He served in the First World War, organising Italy's bombing campaign, but was court-martialled for criticising Italian high command by publicly declaiming Italy's aerial weakness. He was released when his theories were proven true with the defeat of Italian arms by the Austrian Air Force at Caporetta. He was later recalled and was promoted in 1921 to General. In 1922, he was appointed head of Italy's aviation programme by Benito Mussolini.

His 1921 book *Command of the Air* was very influential, especially in Great Britain and the United States, and was regarded as a classic by early air power theorists. He argued that command of an enemy's air space and subsequent bombing of industrialised centres would be so disruptive and destructive that the pressure for peace would be overwhelming. He maintained that *control of the air* could win a war regardless of land or sea power.



Marshal of the RAF Hugh Trenchard.

HUGH TRENCHARD, 1873–1956

Marshal of the Royal Air Force Hugh Montague Trenchard, 1st Viscount Trenchard GCB OM GCVO DSO was a British officer instrumental in establishing the Royal Air Force. He has been described as the 'Father of the Air Force'.

Trenchard was one of the first to grasp the radical impact aviation would have upon land warfare. The revelation came in September 1912, when he flew as an observer with Australian Arthur Longmore during Army manoeuvres. In less than an hour, Trenchard was able to locate the opposing force. He realised no army could manoeuvre in secret when there were airplanes to spot them. Trenchard's practical insights had made airpower a partner among the combined arms. A lesson that Trenchard took out of the First World War was that the air arm had to protect its own ability to operate—establish *air superiority*—before it could assist ground forces.

Air Vice-Marshal Henry Wrigley.

HENRY WRIGLEY, 1892–1987

Air Vice-Marshal Henry Wrigley CBE DFC AFC was a senior commander in the Royal Australian Air Force. A pioneering flyer and aviation scholar, he piloted the first trans-Australia flight from Melbourne to Darwin in 1919, and afterwards laid the groundwork for the RAAF's air power doctrine.

The concepts that he propagated included *air superiority* and *control of the air* as means of carrying out offensive strikes, and the substitution of aerial forces for ground troops. Wrigley's visionary advocacy of integrating naval, land and air elements in operations, including naval reconnaissance from the air, was well ahead of its time. His theory of advantage of 'long range firing' from aircraft has been realised by stand-off and beyond visual range aerial weapons.

Wrigley is credited with laying the foundations for modern air power doctrine within Australia—which would eventually be codified as the first edition of *The Air Power Manual* in 1990.

CHECKPOINT – Whether you are an air power practitioner or not, you will now be aware that air power is complex and that to successfully employ it a practitioner needs a deep understanding of its theory and practice.

In the next section of this chapter, we will begin to peel back the layers of our air power model and begin to understand the interrelationship between all the components.

STRATEGIC CONSIDERATIONS

Air power is realised through the ability of humans to use technology to unlock the latent advantages of the air environment for any given purpose. This can be quite simple, or incredibly complex, depending on the outcome sought. For the ADF, the outcome sought from air power is to *contribute to the military instrument of national power for the purpose of supporting whole-of-government efforts in pursuit of national objectives.*

National objectives

NATIONAL OBJECTIVES – the aims, derived from national interests, toward which a national policy or strategy is directed, and efforts and resources of the nation are applied.

To best explore the statement above, which is one of the core messages of this manual, we need to start at its ending—the pursuit of *national objectives*.

This then brings us to our next key definition, presented in the green box above. As with most definitions, this one comprises of several other concepts, such as *national interests* and *strategy*. Due to the importance of national objectives to understanding the *for what* of air power, we will begin with a broader discussion of these concepts, before moving to the *what*, *why* and *how* of air power in later chapters.

National interests and strategy

Our enduring national interests are pursued by advancing national objectives, such as the economic prosperity of Australia, preserving our independent decision-making, and ensuring the safety and freedom of all Australians. The central importance of national interests is neatly summed up in the Defence mission statement.

> To defend Australia and its national interests in order to advance Australia's security and prosperity.

Patrolling Australia's maritime approaches.

As an island nation, Australia is dependent on international trade for its continued economic stability and prosperity. As the vast majority of this trade is conducted through maritime routes in the Indian and Pacific Oceans, any disruption to Australia's maritime approaches could have immediate and dire consequences for the national economy and the nation's security. Australia's strategy, therefore, aims to

assure the security and stability of regional and global maritime commons and sea lines of communication upon which our nation is so dependent.

Capstone level doctrine is the best resource to build an understanding of Defence's perspective of, and role within, national strategy—see the recommended readings at the end of this manual.

National power

NATIONAL POWER – the total capability of a country to achieve its national objectives, devoid of external constraints and without being subject to coercion.

The Australian Government, like all Governments, uses *national power* to pursue national objectives. National power is generated through a complex set of interdependencies among departments, agencies and organisations.

National power can be described as having four principal instruments—Diplomatic, Information, Military and Economic—commonly referred to as DIME. The DIME model expresses the key instruments available for exercising national power. However, the four DIME instruments below are indicative, not exhaustive—there are always new means of exercising national power.

- **Diplomatic.** Diplomacy is the principal instrument for engaging with other states and foreign groups to advance national values, interests and objectives. Diplomacy is a principal means of organising coalitions and alliances, which may include state and non-state entities.

- **Information.** Information is the instrument of national power that is used to favourably shape and influence the perceptions and attitude of others. The information instrument of national power consists of all individuals, organisations and systems that collect, process, disseminate or action information.

- **Military.** Military power is the ability of a nation to use military capabilities in pursuit of national objectives. At its extreme, military power can be a coercive instrument used to compel an adversary to act in a manner consistent with one's own national interests. Military power has the potential for the lawful and ethical application of force—up to, and including, lethal force.

- **Economic.** The economic instrument of national power focuses both on building power through economic prosperity and using it to influence and achieve national objectives. A strong economy with free access to global markets and resources is a fundamental enabler of national security.

The Australian Government uses instruments of national power to positively influence the strategic environment, so it promotes Australia's national interests.

While each instrument can provide unique effects and influences, their unified purpose is to pursue national objectives as represented in the first two layers of the air power model as shown.

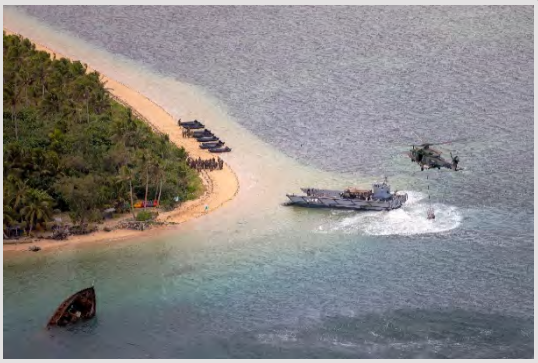
In the context of Defence, air power is focused mainly on contributions to the military instrument. However, it can also provide support to the other three. For example, Humanitarian Aid and Disaster Relief operations will use military force elements to support a nation affected by disaster while also helping shape Australia's diplomatic and economic interests.

Military strategy

Australia's military strategy, as a component of national strategy, describes the manner in which military power should be developed and applied to achieve national objectives. For the ADF, the Australian Government has outlined our military strategy through the three Strategic Defence Objectives of *shape*, *deter* and *respond*.

> Deploy military power to *shape* Australia's strategic environment, *deter* actions against our interests and, when required, *respond* with credible military force.

Pursuing these objectives requires more than simply providing a military response after the occurrence of an event that negatively impacts Australia's national interests. These three overlapping and concurrent objectives require the military instrument of national power to be postured to continuously contribute to shaping, deterring and responding through a range of military activities.



Military effects linked to national objectives.

Military effects

The concept of pursuing national objectives by creating outcomes through the employment of national power, including military power, is not new. War has long been considered the continuation of politics via other means.

The instruments of national power have always been used in efforts to change an adversary's beliefs and behaviour—referred to as *effects*. These effects concentrate on outcomes and how they may be achieved—*ends*—rather than the mechanisms and tools that enact them—*ways* and *means*.

The military effects that support the pursuit of national objectives can be delivered from tasks in support of civil authorities through to the application of lethal force. They also come from any mix of military capabilities from across all of the domains of the operating environment. In the living language of Defence, the term *joint* is used to capture this imperative.

Military power and the spectrum of competition

The *spectrum of competition* provides a theoretical model that helps to explain how the military instrument contributes to national power. Australia will rarely, if ever, apply the military instrument in isolation. All instruments of national power continually support each other

SPECTRUM OF COMPETITION – the framework used to describe the complex range of geostrategic interactions of national power that range dynamically between cooperation, competition and conflict.

in the pursuit of national objectives across the entire *spectrum of competition*, regardless of which instrument is leading a particular effort. It is important to note, however, that different relationships can be experienced simultaneously across this spectrum. For example, nations could be *cooperating* militarily, be in *competition* economically and in *conflict* diplomatically.

Fighting power.

Understanding these relationships assists with selecting the appropriate mix of capabilities from the instruments of national power for any context and situation. The focused aggregation and application of national power in pursuit of national interests, in the living language of Defence, is known as *campaigning*.

During conflict, the military may be tasked with fighting and winning the nation's wars. The fighting power of the ADF is the result of the integration of three interdependent components. The *intellectual* component—the knowledge to fight—is underpinned by the ideas, concepts, organisational lessons learned, and corporate knowledge captured within Defence doctrine. The *moral* component—the will to fight—embodies those intangible individual and organisational characteristics such as morale, integrity, values and legitimacy that are fundamental to success. The *physical* component—the means to fight—encompasses the capabilities that can create physical effects on the adversary and the operational environment. It is important to note at this juncture, to help you navigate the living language of Defence, that the term *theatre of operations* will be used throughout the manual to make the distinction between the *operational environment* and the geographical area in which a military operation takes place.

CAMPAIGNING – strategic application of power to achieve national interests.

OPERATIONAL ENVIRONMENT – all the elements, conditions and circumstances which may influence the employment of capabilities and the decisions of the commander during campaigns and operations.

THEATRE OF OPERATIONS – a sub-area within a theatre of war defined by the commander required to conduct or support specific combat operations.

Operational Domains

To organise effectively for the complex task of generating the military capabilities that deliver joint military effects, Defence has divided up the operational environment within which military power is applied. The name given to these sub-divisions is *domains*. They are maritime, land, air, space, and cyber—these are not hierarchical or necessarily aligned with any one Service or Group within Defence. This then leads us to the third layer of our air power model as shown here.

In all cases, military power is characterised by the ability to project power in, and from, the associated domain. While there are no exact boundaries between the domains, it is worth understanding the general scope of each.

- **Maritime domain.** The maritime domain corresponds to the oceans, seas, bays, estuaries, islands, coastal areas, including the littorals and their sub-surface features, and interfaces and interactions with the atmosphere.

- **Land domain.** The land domain is located at the Earth's surface and sub-surface ending at the high-water mark and overlapping with the maritime environment in the landward segment of the littorals.

- **Air domain.** The air domain is the envelope of air surrounding the Earth where density, pressure, temperature, natural obstacles and weather systems are the dominant environmental factors. This domain is the subject of the next chapter.

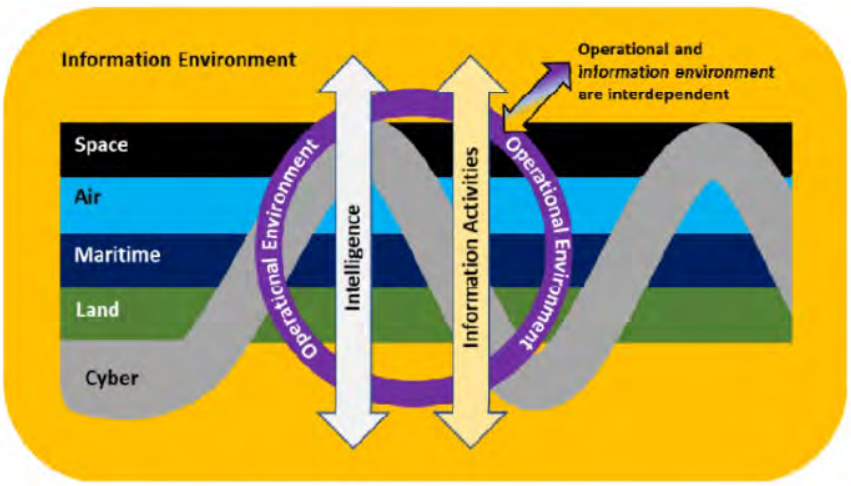
- **Space domain.** The space domain is that environment beyond the Earth's atmosphere, corresponding to space, where radiation, charged particles, electric and magnetic fields, vacuum, micro-meteoroids and orbital debris are the dominant environment factors.

- **Cyber domain.** A global domain, within the information environment, permeating the other four domains—maritime, land, air and space—consisting of cyberspace and the electromagnetic spectrum.

INFORMATION ENVIRONMENT – the aggregate of individuals, organisations or systems that collect, process or disseminate information. *Note that it includes the information itself.*

While Defence has divided up the operational environment into domains, it is important to keep in mind that military operations themselves are conducted within a singular unified environment—the real world. Our world is indivisible, complex and dynamic.

It follows then that every operational environment is comprised of all of the domains interwoven (see figure below) and is interdependent with the information environment. While boundaries are drawn to allow for the practicalities of resource apportionment and accountability, it must be recognised that these boundaries are self-defined and therefore both malleable and porous.



All of the domains must work together within the operational and information environments to best contribute to the whole-of-government pursuit of national objectives. Uncoordinated action within a single domain may create gaps and inadequacies that reduce the overall strength of military power.

Multi-domain operations.

The ADF embraces a *multi-domain* approach to harmonise the contributions from each of the domains into the joint force—emphasising the importance of thinking laterally about the full range of capabilities available. Wherever possible, the ideal is to incorporate agencies, departments and domains into a single cohesive network; this is referred to as joint *all-domain* operations in the living language of Defence.

What is crucial to the utility of the domain construct is that there are practitioners with expertise in each domain involved in designing and developing military capabilities, along with planning and conducting military operations. This manual aims to ensure these air power practitioners have the foundation on which to develop and grow to be effective within this construct.

CONCLUSION – This ends our overview of the military instrument of national power and the link between air power theory and practice. Importantly, you should now understand how military power contributes to national power—the *for what* of air power. You should also see that the environments and domains of military power are physically and conceptually interwoven and therefore must work together to achieve joint military effects.

The remainder of this manual will focus more specifically on air power, both in theory and practical application—the *what*, *why* and *how*. This is done through the following chapters:

- **Chapter 2** will begin our air power journey with an examination of the air environment and the properties that both enable and constrain operations in it.
- **Chapter 3** will introduce the characteristics of air power. While not unique, it is these distinctive characteristics that shape the viability of using air power to carry out particular tasks. In this chapter we will also examine the key considerations for the application of air power.
- **Chapter 4** then turns toward the practical application of air power—those contributions we can make to the joint force. This framework encapsulates the way in which air power is generated and prepared for military operations.
- **Chapter 5** then takes these individual contributions and describes the way in which they are integrated to form a viable joint force—tailored to best achieve national objectives.
- **Chapter 6** turns our focus back to the most important element of air power—the practitioner. In this chapter we will examine the journey towards achieving air power mastery.

CHAPTER 2

AIR DOMAIN

INTRODUCTION – This chapter explains the air domain through its physical, human, and cyber dimensions. By understanding the foundational aspects of the air environment, you will begin to appreciate its potential as an operational domain. This discussion looks at the air domain theoretically and is essentially about the *what* of air power.

As you read through this chapter you should consider the following questions.

- What is meant by the potential of air as an operational domain?
- What is the air domain? How and why does Defence uses this construct?
- How is the air domain shaped by the physical, human, and cyber dimensions?

Humans have devised many ways to use the air to do useful things and will continue to do so. The diversity of inventions and innovative ways to harness the potential of the air domain is immense, limited only by the range of available technologies and our imagination.

POTENTIAL OF THE AIR DOMAIN

This chapter introduces the theoretical foundations of the air domain—the first being ubiquity. The second is the essential relationship between humans and technology that allows the air environment to become an operational domain—the air domain.

Ubiquity—the state or capacity of being everywhere—is inherent within the air domain, as it always touches the entirety of the Earth's surface, the edge of space, and everywhere in-between.

It is this ever-changing relationship between humans and technology that enables the ubiquity of the air domain to be exploited for the purposes of military air power—unlocking its potential for *speed*, *range* and *altitude*.

Speed. The higher above the Earth's surface, the less the physical obstacles and atmospheric impacts—such as friction and drag—limit the achievement of very high speeds. New technologies are required, however, to enable increasingly faster speeds to be achieved.

Range. The air domain covers the entire surface of the Earth, making any point theoretically accessible from any other. New

Unlocking the potential of the air domain.

technologies are enabling greater endurance and thus the achievement of longer range without the need for replenishment.

Altitude. The air domain overlays both the land and maritime domains and offers those that operate within them the opportunity to exploit the vertical dimension, up to the limit of the atmosphere. Technology can enable air vehicles to operate up to the limit of the atmosphere—human endurance is often the limiting factor, however, due to the need for life support.

Technology enabling speed, range and altitude.

This potential for *speed*, *range* and *altitude* is limited only by the human–technology relationship within the air power system exploiting it—such as life-support requirements—along with human constructs within the domain itself, be they political, economic, legal or ethical.

FUNDAMENTALS OF THE AIR DOMAIN

AIR DOMAIN – the envelope of air surrounding the Earth, where density, pressure, temperature, natural obstacles and weather systems are the dominant environmental factors.

The *air domain* is an abstract idea generated by how Defence views the operational environment. It is a product of the dividing up of that environment, which has positive and negative consequences in theory and in practice—as described in Chapter 1. In a positive sense, this division provides a way to manage the complex enterprise of generating military power. In a negative sense, this division can unintentionally create boundaries in our thinking and practice.

Importantly, practitioners within each operational domain must consider the boundaries as being malleable and porous when they come together with the unified purpose to *shape*, *deter* and *respond* in support of national objectives.

While capstone doctrine defines the air domain along environmental lines—to expand thinking on the generation and employment of air capabilities—it is necessary to consider the aggregation of all elements of the physical, human and cyber dimensions that generate air power. To help understand the air domain construct, with a view to its utility for military operations, we will now explore these three underpinning dimensions.

THE PHYSICAL DIMENSION OF THE AIR DOMAIN

The air environment, otherwise known as the atmosphere, is the physical medium that forms the foundation for the air domain and the activities within it. Air is scientifically categorised as a fluid and has physical properties—such as density, temperature and pressure—that can be measured and exploited. The air can be used for propulsion (via a sail or through combustion), buoyancy (as used, for example, by a balloon or an airship), to generate aerodynamic lift (as used by a rotary or fixed-wing aircraft) or to send and reflect electromagnetic signals (as used, for example, by radar and communication systems).

TECHNOLOGY, THE KEY TO UNLOCKING THE AIR DOMAIN

The air environment has long held the potential for flight. However, it wasn't until humans developed the necessary technology, that flight was achieved. While the earliest origins of flight are thought to have dated back several hundreds of years BCE—kite flying in China—Australia's First Nations Peoples had effectively been utilising the boomerang—the first human made object heavier than air to fly. The boomerang—designed to utilise aerodynamics—was invented more than 25,000 years ago.

The next step in the leveraging of the air environment came in the form of balloons—lighter-than-air vehicles—filled with hot air or other gases, that rose off the ground and flew using buoyancy. These craft allowed humans to now exploit altitude albeit speed was limited to that of the prevailing winds, thus achieving a limited range. Throughout the mid-19th century, several balloon flights were made in Australia. In 1858, balloonist William Dean, in his gas-filled balloon, *The Australasian*, travelled 30 kilometres with two people on board.

Wright Flyer at Kitty Hawk, 1903.

Then, on 17 December 1903, Wilbur and Orville Wright made four brief flights with a powered, controllable aircraft at Kitty Hawk, North Carolina in the United States. The Wright brothers had invented the first successful airplane. These vehicles primarily use aerodynamic lift, that requires the lateral movement of at least some part of the aircraft through the surrounding air mass.

The first Australian to make a 'heavier than air' flight was George A. Taylor who made a series of glider flights at Narrabeen on 5 December 1909. Later that month, Colin Defries made several attempts to become airborne at Victoria Park Racecourse, using an imported Wright Biplane, with varying degrees of success. Humans had overcome the forces of the air environment and now the development turned toward going faster, higher, and further. Aircraft became more aerodynamic—engines had become more powerful—air-to-air refuelling had also been successfully achieved by 1923 but was not widely adopted until after the Second World War.

Speed. Technology has unlocked speeds well in excess of the speed of sound, however it is not always useful to travel fast. When, for example, the aircraft is needed to remain in close proximity of an objective, then a hovering helicopter or even a balloon could be far more useful than supersonic flight. Conversely, when the aircraft must be able to move quickly between objectives, then higher speed is a definite advantage.

Altitude. Like speed, the altitude an aircraft can achieve is a direct result of its design—including its ability to sustain human occupants. However, like speed, high altitude is not always required and must be matched to the task. For example, balloons were effectively used in the First World War to support artillery bombardments as they provided a wider view of the battlefield. However, equally, there was an altitude beyond which the occupants could no longer see the ground in sufficient detail to be useful, or communication was lost. As technology has advanced, so has the usefulness of higher altitudes.

Range. A factor of speed and endurance, range is limited by aircraft design and constrained by the endurance of the human occupants. If the human is removed from the airborne system, then this constraint is removed. The use of uncrewed aerial vehicles has vastly increased the potential design range of an aircraft given that significant endurance increases can now be included in the design.

Virgin's 'Global Flyer' holds the record of 67 hours for a crewed, unrefuelled flight.

Technology has unlocked the available range, altitude, and speed of modern aircraft however each must be matched to the range of tasks for which an aircraft is expected to be employed. To finish, consider how aircraft design factors—speed, altitude and range—have changed now that uncrewed options are being more widely employed.

The atmosphere also has a vertical dimension which, notionally at 100 kilometres above sea level—the Kármán line—transitions into the space environment. The atmosphere also has an inherent nature that generates effects beyond human influence—collectively known as weather. These natural phenomena can be obstacles to human activities or, at their worst, catastrophic for life.

Physical properties

The primary physical properties of the air environment, introduced below, shape the potential for the projection of military power and underpin the characteristics of air power presented in the next chapter.

Overcoming Earth's gravity.

Gravity. The Earth generates a gravitational force commensurate with its mass. Gravity is a constant force which pulls all the particles and elements that constitute the atmosphere—primarily a gaseous mix of nitrogen and oxygen—towards the centre of the earth. Within the air environment, gravity must be overcome to create flight or maintain an altitude.

Pressure. Air pressure is a function of the weight of the column of air above a particular point in the atmosphere. Air is less dense at higher altitudes as there are weaker forces pushing on it. When we breathe in air at sea level, the atmospheric pressure causes oxygen to easily pass through the lung membranes into the blood. At high altitudes, while the percentage of oxygen in the air remains constant, the lower air pressure makes it more difficult for oxygen to pass into our blood. As oxygen deprivation results in a loss of consciousness and eventually death, air power systems designed to operate at high altitudes must include oxygen support for any human crew required. This adds considerable complexity.

Temperature. Air temperature across the Earth changes according to season, location, and altitude—with temperature typically dropping one degree per 100 metres above sea level. Temperature at high altitudes, typically 10 kilometres or more above sea level, is so low that human life is not sustainable without artificial heating—another complicating factor for the design of some air power systems.

Runway clearance in extreme temperatures.

Air density. The density of the gaseous mixture that makes up the atmosphere is directly proportional to pressure and temperature—air is less dense at higher altitudes and temperatures—and this has significant impacts on aerodynamics. What this means in practice is the effective lift of an aerofoil—such as an aircraft wing or helicopter rotor blade—will reduce with increases in temperature or altitude until reaching the point where it can no longer overcome gravity.

Natural obstacles

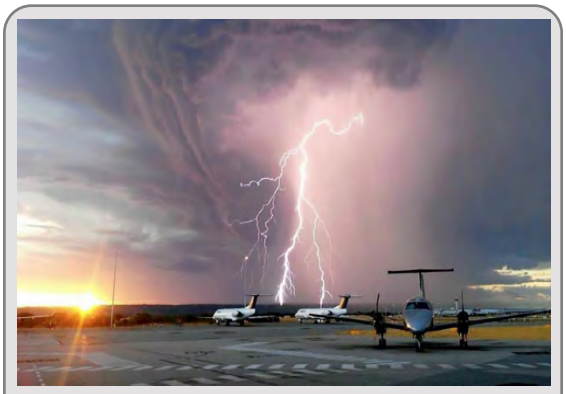
The ubiquity of the air environment means it is theoretically possible to travel from any point on the Earth's surface to any other point on the Earth's surface via a path through the air. That said, there are some natural obstacles that can impede flight operations.

Ground. The air environment is not bounded by the Earth's surface and can extend into areas that may not be readily accessible to air power systems—such as inside buildings or caves. Additionally, mountains can create natural barriers to flight when the technological limitations of an air power system may not allow it to go over the top. The ground will also impact on the effectiveness of sensors, with terrain often used to avoid detection from the air. Finally, flight low to the ground can also lead to spatial disorientation—for example, through dust (brown outs) or snow (white outs) that can create risks to operations.

"Brown out".

Sea. Like the ground, the sea forms a natural barrier that impedes flight and the ability for airborne sensors to detect objects below the surface. This can be overcome, to some extent, by employing sensors specifically designed to penetrate the medium.

Weather. Weather can dramatically change the atmospheric conditions necessary to sustain safe flight and to operate sensors effectively. Low cloud, fog and rain may impede visibility while thunderstorms, and the rapidly rising or falling air currents which usually accompany them, can affect the control or even structural integrity of an aircraft. Lightning, hail and icing can also have a catastrophic impact on aircraft frames, electronic systems and aerodynamics. Weather can also, however, have some positive impacts on air power in certain circumstances, such as using it to avoid detection or to increase operational performance.



Lightning strikes near an aerodrome.

Smoke and pollution. Smoke or other pollutants, natural or created, can linger for extended periods in the air and may interrupt aircraft operations or sensor effectiveness. At the extreme, volcanic ash is a natural substance that can create a thick cloud that remains in the atmosphere for extended periods of time. Flight through volcanic ash presents significant dangers to aircraft, including damage to airframes and engines.

Fauna. Flying fauna, typically birds, can also be a hazard to flying operations. Birds can impact airframes and be ingested into engines. In extreme cases, bird-strikes can bring down an aircraft or cause serious injury.

CHECKPOINT – An understanding of the physical properties of the air environment begins to give shape to the air domain and its potential for military operations. Projection of military power through the air always needs to take its physical properties into consideration.

In the next section we will examine the human dimension that focuses on those human constructs and influences that shape the employment of air power.

THE HUMAN DIMENSION OF THE AIR DOMAIN

While the air domain is shaped by the physical properties of the air environment, the ability to use it for the projection of military power is significantly influenced, in theory at least, by human constructs—such as law, politics, economics and ethics. For the human dimension as it encompasses the attitude and mindset that are necessary for the effective use of air power—see the discussion on airmindedness in Chapter 6.

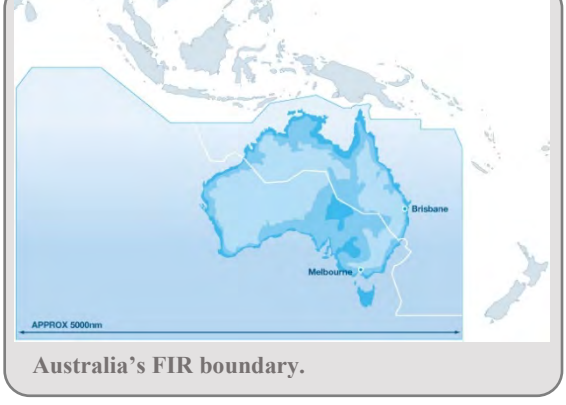
Legal considerations

The rules-based international order is a shared commitment by most nations to conduct their activities in accordance with agreed rules that have evolved over time—such as international law, regional pacts, trade agreements, immigration protocols and cultural norms. The rules-based international order includes the laws that seek to define how nations can use the sea and the air.

Transiting sovereign airspace with clearance.

Air sovereignty. International law recognises the legal status of sovereign airspace directly above a state's territory including its territorial sea, archipelagic and internal waters. Civilian aircraft are permitted to enter another state's airspace without diplomatic clearance if they have followed International Civil Aviation Organisation (ICAO) procedures. Military aircraft, however, are expected to seek permission to enter another state's airspace—except during a conflict or an in-flight emergency; this may be via a specific diplomatic clearance or general permission granted by a standing agreement between nations.

International airspace. Military and civilian aircraft are free to operate in international airspace without interference. However, there are a number of human constructs that can impact freedom of navigation.

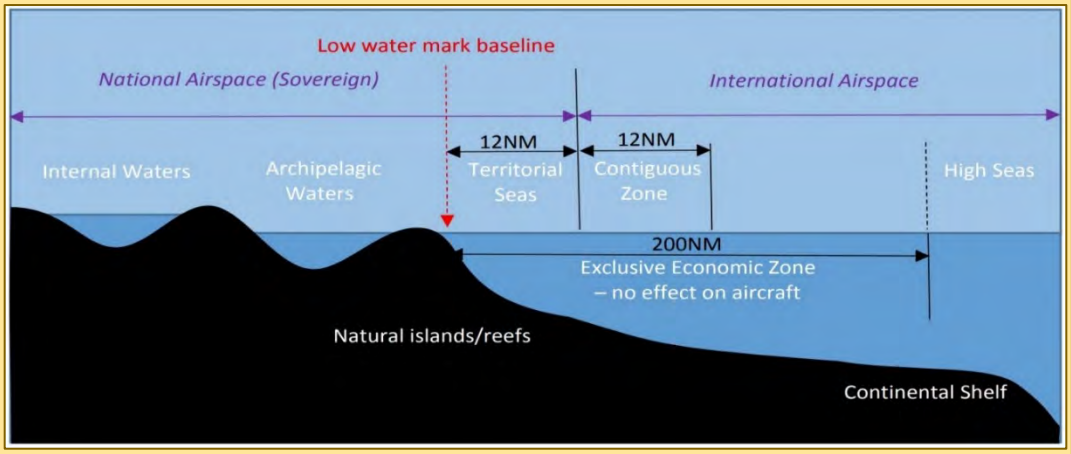


Australia's FIR boundary.

- **Flight Information Region (FIR).** These are defined areas within which flight information and alerting services are provided. FIRs are established by ICAO for

MARITIME AND AIRSPACE BOUNDARIES

A state's maritime and airspace boundaries are established through a combination of the *United Nations Convention on the Law of the Sea* (UNCLOS) and the *Convention on International Civil Aviation* (Chicago Convention).



Australia's maritime zones.

Low water mark baseline. The low water mark baseline is normally measured from the lowest astronomical tide along the coast and includes the coasts of islands. Also known as the territorial sea baseline.

Internal waters. All waters within the territory of a state such as harbours, rivers, and lakes; together with all other waters to landward of the baseline from which the state's territorial sea is measured.

Archipelagic waters. Those waters enclosed by archipelagic baselines drawn in accordance with UNCLOS; that is, a baseline joining the outermost points of the outmost islands and drying reefs of an archipelago providing such a baseline does not exceed 100 (or 125) nautical miles.

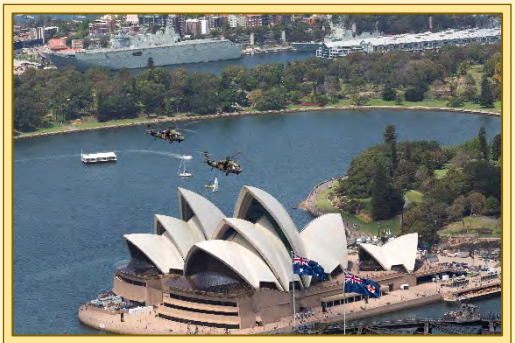
Territorial seas. A belt of water not exceeding 12 nautical miles in width measured from the low water mark baseline. A state's sovereignty extends to include the territorial sea.

Contiguous zone. A belt of water contiguous to the territorial sea, the outer limit of which does not exceed 24 nautical miles from the low water mark baseline. In this zone, a state may exercise its customs, fiscal, immigration or sanitary laws and regulations.

Exclusive economic zone. An area beyond and adjacent to the territorial sea. The outer limit of an exclusive economic zone cannot exceed 200 nautical miles from the low water mark baseline. Within this zone, a state has sovereign rights for the purposes of exploring and exploiting, conserving, and managing all natural resources.

High seas. All parts of the sea which are not included in the territorial sea or internal waters of states.

National airspace. All airspace above all those waters to landwards of the outer limit of a nation's territorial sea, including internal waters, territorial sea and archipelagic waters. Territory is national airspace and subject to the territorial sovereignty of individual nations.



Flying in national airspace.

International airspace. Airspace not within any country's territorial limit is considered international, analogous to the *high seas* in maritime law.

the safety of civilian aviation and encompass both national and international airspace. Acceptance by a state's government of responsibility for an FIR does not grant that government sovereignty over that international airspace.

Air patrol of the Air Defence Identification Zone established for the 2006 Commonwealth Games.

- **Air Defence Identification Zone (ADIZ).** An ADIZ is a special designated airspace of defined dimensions within which aircraft are required to comply with identification and reporting procedures additional to those related to the provision of air traffic services. These zones are established above the high seas adjacent to the coast, and over the territorial sea and territory. Under the Chicago Convention, state aircraft (including military aircraft) are not required to notify the state imposing the ADIZ if they are merely transiting through it and do not intend to enter the sovereign airspace of that state. This is important for freedom of navigation and international airspace usage and forms an important international norm. Further, the establishment of an ADIZ does not confer on the imposing state any sovereignty with regards to airspace. Once within such an ADIZ, a state aircraft can expect to be challenged or intercepted by the imposing state, and they should ensure they respond professionally and courteously to any challenge or intercept in order to ensure the situation does not escalate. A temporary ADIZ may be declared for military purposes.

- **Exclusion Zone (EZ).** In situations of international conflict and times of tension, a state is entitled, under the United Nations Charter, to exercise measures of individual or collective self-defence against an imminent threat of armed attack or an actual armed attack. On many occasions in modern history, states have declared an EZ in areas adjacent to national territory, invoking the principle of individual or collective self-defence.

Operations law. ADF activity, and therefore the application of air power, is significantly shaped by the legal framework for military operations to which Australia and most other nations adhere. If, for example, the Attorney Generals Department advises the Government that an armed conflict (whether international or non-international) is occurring in a particular area where the ADF will deploy, then the law of armed conflict (LOAC) must be complied with. Although the ADF is required to always comply with LOAC (or other applicable legal framework), the ability to act may be further restricted by national policy. This is reflected in relevant operational documents such as rules of engagement (ROE) and targeting directives which limit and influence ADF command decision-making. There are accepted limits of action in armed conflict—the means of warfare are not unlimited—and the concept of legitimacy must prevail.

ADF command decision-making.

Political considerations

Any nation which relies upon international air travel, civilian or military, use routes that cross foreign national borders and are therefore open to difficulties generated by friction in international relations. The air domain can be politicised by targeting international carriers with the aim of pressuring their governments in international disputes—a form of political warfare. It could also be simply in the national interest to restrict air travel for altruistic reasons, such as public health during a pandemic.

- **International border closures.** On 20 March 2020, the Australian government took the unprecedented step of closing international borders to all non-citizens and non-residents. This action was considered necessary as around 80 per cent of all coronavirus cases in Australia had originated from people who were infected overseas before entering Australia. This political act was in support of Australia's national interests—protecting its people.

International border closure.

- **Civil aviation and the One-China policy.** In May 2018, the Civil Aviation Administration of China called on 44 international airlines to modify the way they refer to Taiwan, Hong Kong, and Macau as separate countries. This was part of a broader policy of pressuring large multi-national companies to conform to mainland China's policies regarding its territorial claims.

Economic considerations

Aviation provides a worldwide transportation network that is essential for global business and tourism. The air domain, therefore, plays a vital role in facilitating economic growth, particularly in developing countries. Air transport may provide the only transportation means in remote areas, thus promoting social inclusion and contributing to sustainable development.

The international movement of air freight and passengers relies on the rights for freedom of navigation previously described. Revoking such freedoms, or endangering aircraft when transiting a state's airspace, interrupts the movement of cargo and passengers and can have serious impacts upon the economic and social prosperity of a nation.


Commercial aviation.

The ADF, through its capability development processes, also provides economic support to the nation under a reciprocal relationship with industry. Defence aims to provide opportunities for Australian companies to compete for Defence work and thereby encourage investment in Australian industry. A strong sovereign aviation capability underpins national security and offers direct economic benefits to the Australian economy.

Ethical considerations

The members of the ADF are part of the *profession of arms*. A key characteristic of members of this profession is that they regulate their conduct within the legislative and policy framework created by government, which defines what is right and wrong in the pursuit of the ADF's professional duties. In return for such regulation, the ADF is trusted to do things otherwise restricted in society.

The use of the air domain for the application of lethal force requires air power practitioners to have a clear understanding of their ethical and legal obligations. Decisions must be in line with our Defence values. They must be lawful and just—based upon the right intention for action. On operations, such decision-making will influence the legitimacy and credibility of ADF actions. If decisions are not lawful or just, or perceived not to be, this can undermine the ADF's legitimacy and related strategic narrative. In extreme cases, this could lead to campaign failure.

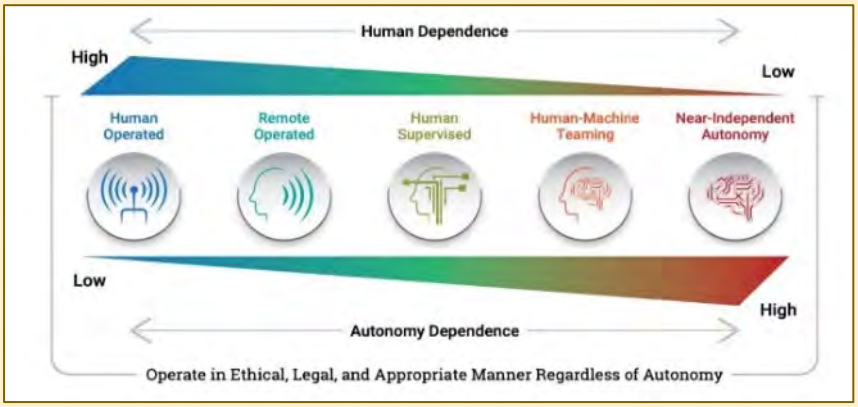
The ADF's ethical framework and decision-making model is shown above and explained in the ADF ethics doctrine. While each individual ADF member is accountable for their own actions in seeking to uphold ethical decision-making, the burden of responsibility falls to commanders to ensure this is implemented by exercising leadership through example and direction. Ethical considerations are further explored as part of air power mastery in Chapter 6.

ETHICAL AUTONOMY

With technology has come a level of information flows well beyond the capacity of a human. As a result, our reliance on technology to collect, analyse and present information has increased to the point that we have become more reliant on intelligent and autonomous systems. The question is, what is the right balance between human and autonomy dependence?

In March 2020, it is alleged a drone operated autonomously in attacking a human target in Libya. Fitted with facial recognition, an attack drone is theoretically capable of autonomously identifying, selecting and coordinating an attack on a human being. Allegedly, this was the first time an autonomous system, with lethal weaponry had been used to attack humans. This example opens up a range of ethical questions.

Where would such an operation sit within the ADF's ethical decision-making model? How could artificial intelligence act 'lawfully and justly, based upon the right intention for action'? How would an autonomous 'attack' reflect our expectations for human accountability and moral responsibility?



CHECKPOINT – Human constructs create very real obstacles to the use of the air domain. Using a combination of legal, political, and economic leverage, a nation can control the use of the air domain over their sovereign territory and, to a lesser degree, the approaches to its territory. International expectations may also limit how and where air power can be projected. As a strong proponent of a rules-based international order, Australia always strives to operate lawfully and ethically.

In the next section we will examine the cyber dimension of the air domain. While the air environment can be exploited for a wide range of information and cyber effects, our consideration will be limited to cyberspace and electromagnetic radiation, both enabling technologies for many air power systems.

THE CYBER DIMENSION OF THE AIR DOMAIN

The cyber dimension of the air domain recognises the criticality of information to air power and the use of the air domain as a medium for the transmission of information. For air power, this includes the use of cyberspace and the electromagnetic spectrum.

Cyberspace

CYBERSPACE –all interconnected communication, information technology and other electronic systems, networks and their data, including those which are separated or independent.

Cyberspace is the global digital environment of partitioned and interdependent logical and hardware infrastructures, networks, systems, information, and services. Air power both delivers effects in, and through, cyberspace and is often critically reliant upon the secure transmission of information through the air domain.

Electromagnetic spectrum

The physical properties of the atmosphere influence the transmission of electromagnetic radiation, be it naturally occurring or of human origin. This radiation is collectively referred to as the electromagnetic spectrum.

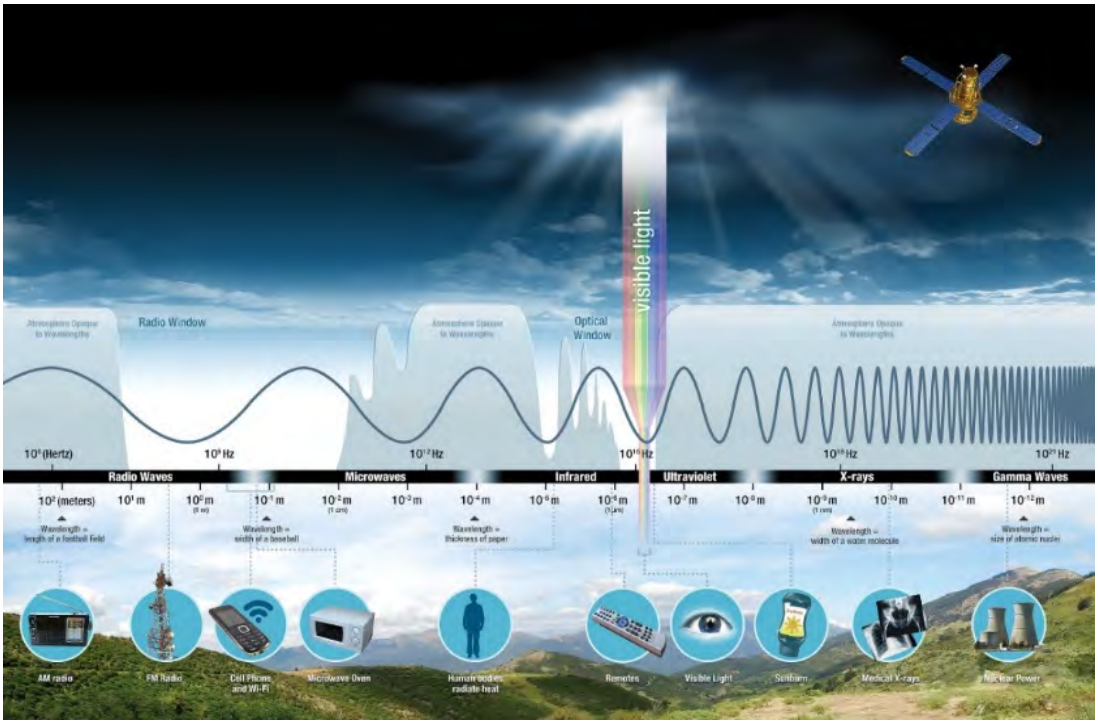
It is comprised of waves of radiated energy from electrical and magnetic fields. This radiated energy ranges from long waves, such as radio waves and microwaves, to short waves, such as X-rays and gamma rays.

Visible light falls in a very narrow wave band near the middle of this spectrum. This spectrum is depicted graphically on the next page.

Electromagnetic radiation in the atmosphere can be exploited through space, airborne or surface-based systems, typically in the form of radio waves for communication, microwave radiation for radars and the infra-red and visible spectrum for electro-optic sensors.

The air environment is a permissive medium for the transmission of data between network nodes—such as between aircraft and command and control elements.

Defence use of the electromagnetic spectrum.



Electromagnetic noise

Technological developments have changed the electromagnetic environment around the Earth. As technology has advanced and propagated, so has the level of electromagnetic fields generated from artificial sources—this is referred to as electromagnetic noise.

The electromagnetic spectrum is finite and competition for its use, both military and civilian, is fierce. Modern military technologies require increased access to the electromagnetic spectrum to enable the flow of critical information, without which the success of operations may be at risk. Likewise, the commercial demands on the spectrum are immense and growing, focused on an increased range of services such as telecommunications and satellite broadcasting. Nevertheless, there are some key provisions in international regulations enabling protected spectrum usage for military purposes.

As military technology becomes increasingly dependent on advanced sensors, computing power and enormous communication demands, so the level of electromagnetic radiation has increased within the air domain.

Higher levels of noise typically demand higher power outputs from electromagnetic systems to remain effective, further perpetuating the level of electromagnetic noise. The impact of this noise can also be mitigated using modern signal reception and processing techniques.

Shared use of the electromagnetic spectrum.

Military operations could have significant impacts on civilian services provided through the electromagnetic spectrum over a wide area. Defence is a responsible user of the electromagnetic spectrum and complies with domestic and international law. Domestic and international authorities regulate frequency allocations and power outputs. As a result, the use of some air power systems may be limited, if considered necessary by a commander, when operating in or near populated areas, to minimise unintended impacts on the civilian population.

CONCLUSION – This ends the first of the two theoretical chapters. We have examined the foundational aspects of the air environment, the *what* of air power.

We looked at the physical properties and discussed how they can shape air power, including the influence of electromagnetic considerations. We also looked at the human dimension where legal, political, economic and ethical considerations can constrain how we use the air domain for the employment of military power.

By understanding the fundamentals of air environment, natural or human, we are best placed to leverage its potential as an operational domain.

In the next chapter, we will take the second theoretical step in our journey and look at the characteristics of air power and some of the key operational considerations for its employment.

CHAPTER 3

AIR POWER

INTRODUCTION – As the second chapter focused on the theoretical aspects of air power, this chapter begins by taking our understanding of the air domain and deriving the three *air power characteristics*.

The human–technology relationship at the heart of air power will then be used, along with these characteristics, to explain several key *operational considerations* for the employment of air power. These characteristics and considerations are the *why* of air power.

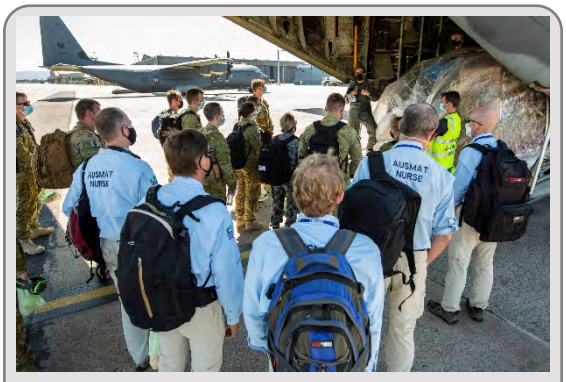
As you read through this chapter you should consider the following questions:

- How are the three air power characteristics derived from the nature of the air domain?
- How does the human–technology relationship shape operational considerations for the employment of air power?
- What do you see as the resulting advantages and disadvantages of air power?

In the last chapter we identified speed, range and altitude as being representative of the potential of the air domain. This potential is a product of the ubiquity of the air environment and limited only by technical and human constraints. In this chapter we will further explore that potential by, firstly examining the characteristics of air power derived from the nature of the air domain. Secondly, we will focus on the human relationship with technology, both in its design and configuration—that results in a number of considerations for the operational employment of air power.

AIR POWER CHARACTERISTICS

The characteristics of air power shape the contributions it can make to whole-of-government efforts and are derived from the nature of the air domain. Like the potential for speed, range and altitude inherent in the air domain, these characteristics can be exploited for military advantage through the human–technology relationship that lies at the very heart of air power.



ADF supporting whole-of-government efforts.

The characteristics of air power are *reach*, *perspective* and *responsiveness*. These characteristics are not necessarily unique to air power, nor do they stand alone. They are often complementary and overlapping, both with each other and with the characteristics of the other operational domains. They are derived from the inherent speed, range and altitude achievable through the air domain. Their value is in providing air power practitioners with a construct through which to readily assess and appreciate the relative advantage air power could provide in any specific operational context.

Reach

REACH, *as an air power characteristic* – the distance over which a military capability or system can contribute to desired effects.

Reach, in the context of military power, is the distance over which a military capability can contribute to desired effects—inclusive of platforms, sensors, communications and weapons. Reach is

not unique to air power, however, leveraging the potential for range and altitude in the air domain can provide notable advantages for achieving desired effects over relatively large distances.

The reach of air power is primarily influenced by the range and position of the air power systems employed.

Range. The reach of an air power system is typically the sum of the range of associated platforms, sensors, communication networks, and weapons. An airborne platform will be limited by its design—the product of its speed and endurance. The endurance, and therefore reach, of an air power system can be impacted by the limits of the operating crew, such as life-support requirements and fatigue.

Positioning. The physical positioning of an air power system, relative to an objective, is another key factor with respect to reach. This positioning is in three dimensions, as altitude will be a factor for the range of airborne systems, particularly where line of sight is a design constraint. Where the positioning of an air power system does not provide the required reach to achieve a desired effect, then forward positioning within the theatre of operations becomes a key consideration. While forward positioning can be relatively simple for small, lightweight, and self-contained systems—such as those carried by individual soldiers—it is a complex undertaking for air power systems that require basing with significant support services; often this will require access to a major airbase or specialised maritime platforms.

The reach of air power can support other operational domains, expanding options to deploy, employ, and sustain a wide range of capabilities. Likewise, capabilities in other domains can extend the reach of air power.

MOUNT SINJAR

In early August 2014, after months of conflict across Iraq, the Islamic State had turned their attention to the Yazidis—a Kurdish-speaking religious minority living in northern Iraq. Facing capture and death, 30,000 Yazidis fled the Islamic State onslaught, becoming trapped on Mount Sinjar without food, water, or shelter. In addressing the growing humanitarian crisis, and potential genocide, the US-led coalition had to rely upon air power to respond with air strikes against Islamic State forces and air mobility to deliver critically needed supplies to the embattled Yazidis. This operation brought together air power from across the coalition.

On the first night of the mission, air mobility aircraft were escorted to Sinjar by strike aircraft, where the air former then dropped 28,224 packaged meals and 5,800 litre of fresh drinking water. During the subsequent six nights of intensive operations, the allied air effort managed to deliver a further 100,000 packaged meals and 130,000 litres of fresh water.

Significantly, these supplies were sufficient to sustain the trapped people while the air strikes enabled Kurdish Peshmerga troops to help the Yazidis leave Mount Sinjar.

In subsequent missions in November, Australian transport aircraft undertook four airdrops to deliver more than 32 tonnes of aid including water, food and shelters—essential with the oncoming harsh winter conditions.

The Islamic State threat meant air supply was the only viable option for providing relief to the Yazidis—only air power contributions could *reach* them in this environment and in the timeframe required.

Preparing for airdrop of humanitarian supplies.

Perspective

PERSPECTIVE, *as an air power characteristic* – the greater field of view and extended horizon for generating situational awareness attainable through the altitude, speed and range inherent within the air domain.

Perspective, in the context of military power, describes the way a force views the operational environment and is normally linked to the range of visual and sensor horizons. A greater perspective enables a broader understanding of seemingly separate events on the surface, thereby increasing situational awareness of the operating environment. This, in turn, supports more informed decision-making.

Perspective is enhanced by the increased field of view made possible through altitude. Put simply, it enables systems to see further. As many sensors rely on their line of sight, as altitude increases, so does their range. Therefore, the potential for speed, range and altitude within the air domain can be exploited by air power systems to enhance the available perspectives of an operating environment.

The perspective from the air can be restricted by terrain, weather and human obstacles—such as structures and smoke—and might not always be the ideal view of the operational environment. Perspective from the air may also be impacted by deception techniques like camouflage or spoofing of electronic signals.

There will be circumstances where the perspective available through other domains, or in combination with them, will be more useful for a particular operational situation. For example, situational awareness in a dense urban environment will typically be better informed by being close to and within its structures, rather than from high altitudes.

PERSEVERANCE & INGENUITY

On 19 April 2021, NASA successfully completed the first controlled, powered flight by an aircraft on another planet—Mars.

Mars has an atmosphere that is much thinner than Earth's made up of 95 percent carbon dioxide. The resulting air density is only one percent that of Earth. Hence, generating adequate lift is much more of a challenge even if Mars' gravity is but one third of that of the Earth.

A solar powered, dual rotor craft, *Ingenuity* was originally designed to fly up to five metres above the ground and for up to 90 seconds per flight. However, it proved it could achieve far greater performance during initial tests. With solar power, the flight endurance of the aircraft is not limited by available power, rather by the heating of the motors which increases by 1°C every second.

Deployed in company with the Mars *Perseverance* Rover, the aircraft exploits altitude to provide an increased perspective of the Martian surface to ensure that rover can avoid hazardous obstacles that may permanently impede its mission.

Ingenuity carried a piece of fabric from the wing of the 1903 Wright Flyer.

***Perseverance* rover and *Ingenuity* helicopter on the surface of Mars.**

Responsiveness

RESPONSIVENESS, *as an air power characteristic* – the synergy of speed, range and altitude that enables contributions to desired effects relatively quickly.

Responsiveness, in the context of military power, is the ability of a military capability to contribute to desired effects, when and where required. Air power is able, technology depending, to leverage the relative speed and range advantages inherent in the air domain to respond at great distances relatively quickly. Altitude can also play an important role in responsiveness, especially for systems designed to loiter safely above, or near, an operational objective so as to be best positioned to act if required.

The responsiveness of air power can also provide significant advantage when in direct support of other military forces. This may include the deployment of military capabilities from one part of a theatre of operations to another, or in-between theatres, thus enabling timely responses to changing situations. When time is of the essence, especially for effects needed over a significant distance, air power often provides the most viable options due to its responsiveness.

The potential for responsiveness in an air power system, as for perspective and reach, is a product of its design and configuration. The ability to move quickly from one location to another is influenced by its speed, range and, to a lesser degree, its altitude. All of which are determined by the system design.

While the ability to shift between different tasks is constrained by the system's configuration, the range of available configurations is limited by design.

AIR TASK GROUP DEPLOYMENT – OPERATION OKRA

Operation *Okra* is a contemporary illustration of air power's inherent responsiveness and the need for interoperability and the value of its people. *Okra* was the ADF's contribution to coalition operations against the Islamic State in Iraq and Syria.

The air component was formed in early September 2014, with the decision to deploy an Air Task Group (ATG) comprising some 400 personnel, six F/A-18F Super Hornets, one E-7A Wedgetail, and one KC-30A Multi Role Tanker Transport aircraft. With only two weeks of pre-deployment preparation to bring together disparate capabilities for service in a complex operating environment, the ATG departed Australia on 21 September—arriving at Al Minhad Air Base, United Arab Emirates two days later.

Remarkably, at the time of the commitment, the E-7A and KC-30A were still only at initial operational capability—the Super Hornets had only achieved full operational capability in December 2012. The ATG rapidly integrated into the coalition force structure and commenced its first air operations just two weeks after arrival. This was a remarkable achievement, which was acknowledged by the then CAF, Air Marshal Brown, who observed that 'to deploy such a potent and capable force in a relatively short time is testament to the professionalism and skill of our Air Force.'

Air Task Group deployment to Iraq.

Over six rotations, the ATG conducted 2,700 strike sorties, transferred more than 45,000,000 litres of fuel to our own and allied air assets, and the Wedgetail became a highly sought-after control asset. This deployment reflected the professional mastery of air and ground crews honed from years of training and multinational engagement. It also clearly demonstrated air power *responsiveness*—the ability to move people and assets into theatre at very short notice.

How does this deployment illustrate other air power characteristics or considerations?

CHECKPOINT – The three air power characteristics of *reach*, *perspective* and *responsiveness* are derived directly from the foundational aspects of the air domain. You should now be able to see the theoretical building blocks that describe air power and how they are inter-related.

You should also be beginning to appreciate the importance of evaluating the context in which air power may be employed and using its theoretical underpinnings to understand how it can best contribute.

In this next section we will focus on the key *operational considerations* that flow from the human–technology relationship at the heart of air power.

As each operational consideration is discussed, you should be thinking about air power's relative advantages and disadvantages to the employment of military power.

CONSIDERATIONS FOR THE EMPLOYMENT OF AIR POWER

Our ability to leverage the advantages inherent in air power's characteristics is fundamentally dependent on the technological system being employed, and the human limitations within that system. This is why the human-technology relationship is so fundamental to air power. This relationship also leads to several key operational considerations for the employment of air power—these are *dependency, persistence, fragility, precision, payload* and *agility*.

These operational considerations evolve over time, in line with advances in technology and our ability to harness the potential this offers. The considerations below are designed to provide a framework from which air power can be evaluated against other military options within any operational context.

Dependency

DEPENDENCY, *as an air power consideration* – the reliance on other capability and support systems to enable the generation, employment, and sustainment of military power.

Air power systems are typically quite complex and maybe reliant on a substantial base from which to operate. This support base is often inclusive of an aerodrome, access to technical servicing and replenishment services. All of which are dependent on people. For example, an aircraft, or squadron thereof, would typically need access to a suitable operating surface, fuel and payload replenishment—potentially including weapons—and a complex set of crew and aircraft systems support. This level of dependency typically requires an established airbase or specialised naval assets.

Airbases are, however, often isolated facilities which rely on a complex supply chain typically using elements of the national support base—be it our own or that of a host nation. This forms a dependency on civilian organisations as a part of that supply chain.

Supply chain dependencies.

While the airbase may be afforded a relatively high level of security, a similar level of security for the civilian elements can be difficult to achieve.

Reduced support dependencies for relatively simple and portable systems may allow for more independent operations. For example, a small aerial vehicle may be able to be

supported organically from the naval asset or land unit that is employing it to leverage the advantages of the air domain.

For more complex air power systems, airbases, including specialised naval assets, are the springboards from which air operations are launched, sustained, controlled and recovered. An airbase is an operational entity consisting of the combat elements, support systems and the highly specialised personnel that enable employment of air power. Air power's dependency on basing can be mitigated, however, by creating redundancy through the development of a network of airbases, and by ensuring sufficient resilience to defend and recover from damaging events—caused by both human and natural sources.

As discussed in Chapter 2, modern air power systems are also highly dependent on the information environment and the cyber domain. Artificial intelligence, often associated with autonomous systems and decision support tools, also creates an increased dependency on information, both timely and accurate. Without effective information flow, critical systems could be rendered ineffective, particularly where they require mission-specific data.

Additionally, the connectivity and networking possible with modern systems can result in massive amounts of data being available to inform decision-making. While computers greatly assist, humans can still find this extremely challenging due to information overload, thereby exacerbating other human fragilities, like decision-making biases and the potential of feeling detached from military effects being generated at great distance from the human operators or decision makers involved. Human limitations within air power systems will remain a key factor for the foreseeable future, beyond just dependency.

OPERATION BUSHFIRE ASSIST

The Australian summer of 2019–20 brought with it one of the most devastating bushfire seasons on record. Affecting over 46 million acres, 3,500 homes and thousands of people, it represented a major humanitarian crisis that lasted almost nine months.

While not trained, equipped, or certified to undertake ground-based or aerial bush firefighting, the role of the ADF expanded with land, sea and air services providing support to the state emergency services

State-chartered water bombing aircraft became dependent upon the operational and logistics support of local ADF bases, thus increasing the reach and responsiveness of the aircraft.

HMAS *Adelaide* anchored off the coast of Eden, and HMAS *Choules* anchored off the coast of Mallacoota, provided essential basing support to both air and maritime assets in the evacuation of residents cut off by the fires. ADF air assets were also used for fire spotting and to increase the perspective of commanders who flew over the affected areas.

As you continue your journey through this chapter, turn your mind to how this example also illustrates other considerations that follow such as persistence, precision, payload and agility?

Water tanker dependency on ADF airbasing.

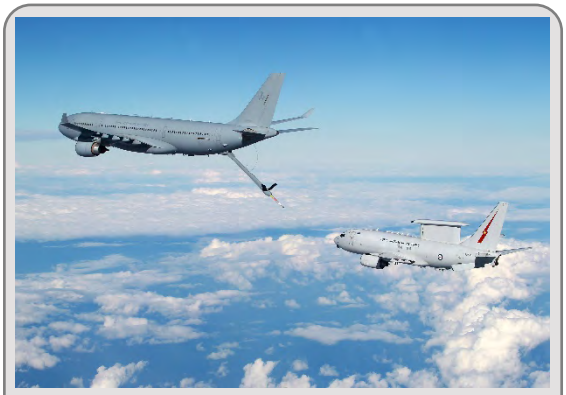
HMAS *Adelaide* anchored off the NSW coast.

Persistence

PERSISTENCE, *as an air power consideration* – the ability of Defence elements to visit and revisit objectives to create effects without occupying terrain or remaining in close proximity to the objective.

Current technology, through design and configuration, limits the time air power systems can contribute persistent effects, often exacerbated by the endurance limitations of the human operators involved.

The effect an air power system creates may be transient. However, through rotation or by repeating missions as required, a posture of relative permanence can be maintained. This has the potential advantage of creating a persistent effect without the need for the protracted physical presence and support requirements associated with a deployed force.



Increasing endurance, thus potential persistence.

Technological developments are increasingly providing the ability to mitigate the impermanence of airborne systems, through increased endurance and advances in air-to-air refuelling. Surface-based systems that generate effects in, or leverage the advantages of, the air domain are also increasing the range over which they can provide persistent effects as technology advances.

OPERATION SOVEREIGN BORDERS

In 2013, the Australian Government established Operation *Sovereign Borders* to detect and intercept illegal maritime arrivals primarily transiting our northern approaches. Headed by a Joint Agency Task Force, the operation committed air, maritime, and land-based resources from the Australian Border Force (ABF), Australian Defence Force (ADF), and the Australian Federal Police.

Operation *Resolute* is the ADF contribution to *Sovereign Borders* primarily encompassing Navy ships, AF aircraft, Army patrols, and additional surveillance and response assets when required.

Patrolling Australia's northern maritime approaches.

With the Government's 'zero tolerance' policy for illegal maritime arrivals, the operational aim is to create a single, persistent effect—the detection and interception of all illegal vessels. Yet, such an effect does not require a constant surveillance presence across the whole theatre of operations.

Maritime Border Command sequences both ABF and ADF maritime and air patrol areas to ensure the surveillance coverage matches the patrol asset speed and reach against the speed and reach of a potential illegal vessel. This allows aircraft to be tasked to revisit surveillance areas, with particular focus on threat corridors and arrival risks, thus ensuring a high level of integrity of search—the effect is persistent.

Sovereign Borders represents a complex, multi-departmental operation based on the defence of Australia's national interests, yet it also represents the successful integration of air, maritime and land assets in the pursuit of a persistent effect. What other operational examples can you identify with similar outcomes?

Fragility

FRAGILITY, *as an air power consideration* – a measure of the potential vulnerability of a capability system, including personnel, facilities, materiel and information, to any threat from an adversary or operating environment.

The interdependency between humans and technology within an air power system presents many areas of potential fragility. This should not be confused with the system's survivability or durability, as mitigation of fragilities associated with components of an air power system may serve to greatly enhance its overall operational resilience. There is a link between considerations of dependency and fragility within an air power system. It is the human limitations within a system that are the more dynamic source of fragility. The consistent need for high levels of technical expertise, coupled with often stressful and harsh operating environments, serve to increase the risk of human error—within an operating environment often hostile to human life.

Across all Services in the ADF, human error within air power systems has resulted in undesirable operational effects, unnecessary loss of military capability and, tragically, the loss of life. This has been true in both training and operational contexts. As air power systems are critically dependent on humans, it is imperative to consider their welfare and support needs to ensure system resilience.

Technologically speaking, air power systems are typically very complex and designed with clear and specific engineering requirements. Airborne platforms are usually built to be as light as practicable, carrying little or no armour protection. Consequently, it usually does not take much in the way of internal technical issues, or damage from external sources, to seriously compromise the operational effectiveness of an air power system.

Ability to sustain a level of serious damage.

By exploiting speed and altitude, for example, the airborne systems can remain outside the reach of an adversary's anti-aircraft weapons. Additionally, the use of low observable technologies can reduce detection, while tactics and self-defence systems can also contribute to aircraft survivability. Redundant systems, such as hydraulics and electric systems, can ensure a level of damage can be sustained without becoming immediately catastrophic to the platform aircraft, crew or mission.

The need to mitigate potential fragilities creates specific and highly specialised demands on the maintenance and support of air power systems. Planning for air operations must ensure personnel and vital support systems are not unnecessarily vulnerable to adversary action and sufficient redundancy for alternative options is an imperative for mission critical air power effects.

The level of fragility of the technical elements of an air power system are inherently part of its design. Humans, however, can enhance their resilience through training, education and conditioning. Maintaining adequate rest and sustenance is also a key consideration for mitigating human fragilities within air power systems.

HUMAN FRAGILITY

Since the earliest days of aviation, highly skilled people have always represented the greatest strength of air power, yet they have also been a significant source of system fragility. Human fragility must therefore be considered an integral part of air power system design.

As combat aircraft became more capable of operating from higher altitudes, operators found themselves dependent on life-support systems and increasingly dislocated from the reality of their targets. Advances in precision-guided munitions have compounded this dislocation even further, with operators able to strike their targets without ever seeing them.

Remote operations.

This dislocation is but one aspect of human fragility that can impact operations, primarily through the potential for unconscious bias. Additionally, increasingly vast amounts of information need to be considered within very short timeframes, demanding quick decisions, and further exacerbating the risk to effective decision-making.

A powerful contemporary example of these risks is evident in the growing use of uncrewed aerial vehicles (UAV). Remote UAV operations allows for lethal combat effects to be decided upon from well outside a theatre of operations—even at a home base—where operators and decision-makers are able to return to their families after their shift in an active operational theatre is temporally at an end.

This split reality can be very confronting, requiring practitioners to immerse themselves in the reality and pressures of military operations while at work, then adjust to normal family life immediately after and in-between. The fragility of our people needs to be understood and carefully managed within such environments.

How might remote operations impact on the generation of air power practitioners into the future?

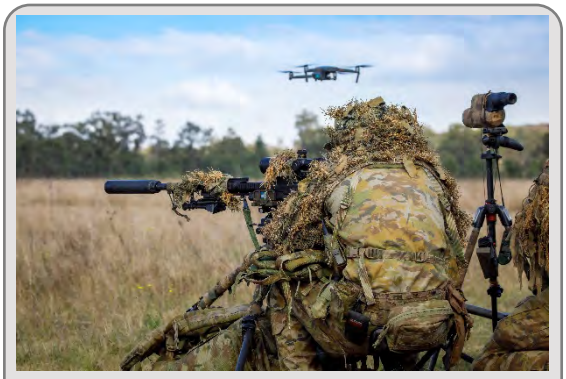
How could we change our training and education to meet these challenges?

Precision

PRECISION, *as an air power consideration* – the ability to employ lethal or non-lethal force and achieve effects accurately, with discrimination and proportionality.

Precision involves the ability to create a desired effect while avoiding undesired effects—such as collateral damage. This is particularly important in operating environments where there is a strategic or ethical imperative to discriminate between legitimate targets and what surrounds them. Precision is equally important across the information environment especially regarding decision support.

Although the precise application of force is achievable through all domains, the combination of air power's perspective, reach and responsiveness enables it to contribute discriminate effects rapidly and, if required, simultaneously over relatively large distances. The degree of precision able to be achieved for the pursuit of effects through the air domain is governed by the technological and human limitations of the systems being employed. Precision is also influenced by the system design and configuration. The design of platforms, sensors and weapons may limit



Achieving precision effects.

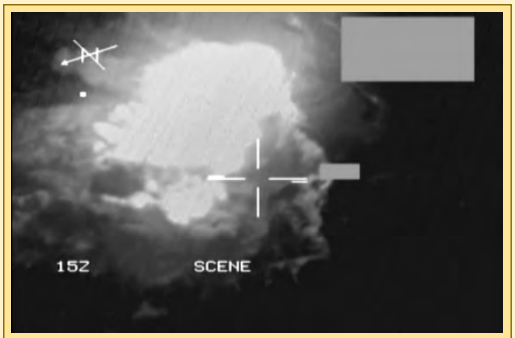
accuracy, while a specific configuration may be required to achieve desired effects against a particular target.

There is an important distinction, however, between precise effects and the accuracy achievable by an air power system. For example, a precision-guided munition (PGM) can reliably hit a designated point target with well-defined accuracy. However, achieving the desired effect is the result of a thorough targeting process, involving activities—often across multiple domains—such as target identification and weapon matching to ensure discrimination and proportionality.

Precision in the employment of air power does not always involve the use of PGMs or the application of force. For example, accuracy in the delivery of personnel or equipment via airdrop from aircraft can equally contribute to precise effects. Furthermore, airborne systems can provide precise and timely information on targets of interest to maintain situational awareness and provide decision support for a range of possible actions.

TARGETING FOR PRECISION EFFECT

Targeting is inextricably linked to joint precision effects. While it has always been an important feature of military power, it has become more so as air power has become increasingly defined in terms of precision and collateral damage considerations. The acquisition of precision-guided air-launched weapons demands a high-level of targeting support to be fully effective—especially in identifying appropriate targets.



Targeting, inextricably linked to the precision effect.

Targeting is underpinned by a recognition that targets typically form nodes within a system. Target Systems Analysis is a specialised discipline that has evolved significantly since the Second World War. Complex systems theory and adaptive systems have made this analysis much more of a science.

Recent military campaigns have underscored the central importance of targeting. Deliberate targeting, where target folders are developed in advance, was a key feature of air operations in the Middle East. These operations demonstrated the effectiveness of air power to systematically disable an adversary's known capabilities—such as air defence systems—by targeting the vulnerable nodes in the system, rather than the whole system. Deliberate targeting, however, has been increasingly complemented by time sensitive targeting, whereby intelligence cycle can provide time-critical target identification and cueing.

Targeting has a strong relationship to the intelligence cycle and is a vital component of the command-and-control framework. This relationship between intelligence and command is critical to the effective targeting process and the achievement of precision effects.

What if the targeting process results in the misidentification of a target? What if the wrong target is struck? Can you think of any examples of targeting failure and what the ramifications were?

Payload

PAYLOAD, *as an air power consideration* – the total weight, volume or capacity of passenger, cargo, sensors, weapons or electronic capabilities that can be delivered by an air power system.

The employment of air power is typically all about the payload being delivered. It is primarily the payloads delivered from, through or operated in the air domain that can generate desired effects. The presence of an air power system within an operating environment is rarely an end unto itself—posturing or positioning being exceptions. Such presence may contribute to a shaping or deterrence effect.

Considerations of payload, however, are not limited to what can be transported from one point to another. They also encompass the sensors, weapons or electronic capabilities carried by an air power system to achieve an effect. These are part of the design and configuration of a system.

Configurable payloads.

The payloads that can be carried by aircraft are limited in comparison with ships or land vehicles. However, air power trades load-carrying capability against responsiveness and reach. In some operational contexts, a smaller payload delivered responsively may better contribute to desired effects than a larger one deployed much later. Air power may also be the preferred means of delivering personnel or equipment to an objective area that is difficult or dangerous to reach via land or sea. Payload limitations can also, in part, be mitigated by high sortie rates conferred by air power's responsiveness and reach.

SEAHAWK

The Seahawk is a sea-going helicopter that has been in service with the Royal Australian Navy for more than three decades. The all-weather helicopter is primarily configured to conduct anti-submarine and anti-surface warfare, however, it can also be reconfigured for search and rescue, logistics support, personnel transport, and aeromedical evacuation.

The latest variant, the MH-60R uses advanced sensors such as radar, infra-red and sonobuoys, as well as its electronic warfare suite. It employs advanced weapons, such as the Hellfire air-to-surface missiles and the Mark 54 anti-submarine torpedo.

The Seahawk forms an integral part of the ship's weapons and sensor systems. It can extend the combat radius of its parent ship by exploiting range and altitude to reach beyond the ship's sensor range, locating and attacking surface or sub-surface targets if required.

Indicative of the Seahawk's agility and versatility was its performance in support of operations in the Middle East Area of Operations. When first deployed, the Seahawks were involved in a variety of missions, including protection of US aircraft carrier task groups from air and missile attacks.

Post the Iraq War, helicopters were involved with supporting the multinational Maritime Interception Force, enforcing UN sanctions on Iraqi trade through the Persian Gulf. These activities were further heightened during the Second Gulf War as part of Australia's contribution to the Global War on Terror.

Reconfiguring the payload.

The Seahawk, over its multiple variants, has demonstrated the platform's inherent design and configuration flexibility, with the ability to adapt payloads for maritime patrol, search and rescue, personnel transfers and fast-rope insertion of boarding teams.

Agility

AGILITY, *as an air power consideration* – the ability to transition between tasks rapidly.

The reach and responsiveness of air power gives it the potential to shift relatively quickly from contributing to one desired effect to another, with some systems able to prosecute different objectives at the same time. This agility, typically a factor of technology and training, can allow a small force to carry out a range of tasks that may otherwise need a number of different dedicated systems.

The agility of any given air power system is reliant upon its design, the configuration of the payloads able to be fitted to it and the ability of those who operate it. As air power systems have become more technologically advanced, their ability to be configured to contribute to different efforts concurrently or during a single mission has not always been enhanced. While some systems have been designed for just such agility, others have become so specialised that significant effort is required to prepare them for different contributions.

Agility of human decision-making.

Agility is also dependent upon the skill sets of human operators within any given air power system. The planning process, decision-making and information distribution all benefit from the agility of the humans involved. A faster and more accurate decision-making process than that of the adversary, will enhance the chance of success of any given mission or campaign. This concept is most famously represented as the 'OODA loop' by Colonel John Boyd, United States Air Force.

AGILE DECISION-MAKING

The OODA loop is the cycle of *observe–orient–decide–act*, developed by military strategist and United States Air Force Colonel John Boyd. The four steps in the OODA loop guide the way decision-making can be understood and applied.

Observe. Step one is to observe the situation with the aim of building the most accurate and comprehensive picture as possible. Information alone is insufficient. The observation stage requires converting information into an overall picture with overarching meaning that places it in context. A particularly vital skill is the capacity to identify which information is just noise and irrelevant for the current decision.

Orient. Orientation means connecting yourself with reality and seeing the world as it really is, as free as possible from the influence of cognitive biases and shortcuts. You can give yourself an edge over the competition by making sure you always orient yourself before making a decision, rather than just jumping in.

Colonel John Boyd, USAF.

Decide. In this step, the decision-maker must use understanding from the first two steps. However, the decision-maker must strive to avoid bias as continued use of the same decision will not be effective.

Act. There is a difference between making a decision and acting upon it. By taking action, you test the decision; the evaluation of that action comes from re-entering the loop at observe.

FROM THEORY TO PRACTICE

Theory describes how we understand things, what they are and what they might do. Theory needs to be constantly tested and updated to ensure it remains relevant. What has been present up until this point is a contemporary review of the theory of air power, *what* it is and *why* it presents potential advantages for the application of military power. Consideration of these advantages as well as possible drawbacks, is equally important for professional air power practitioners.

From here we will shift the discussion to *how* air power may be employed—the practice of air power. Emphasis will remain on the essential role humans have in this endeavour, along with how considerations of air power must always be part of the collective whole of military power.

Finally, it is imperative that, at all times, we keep the *for what* of air power front of mind; that is, to support whole-of-government efforts in pursuit of national objectives.

CONCLUSION – In this chapter we derived the characteristics of air power from foundational aspects of the air domain, particularly its ubiquity and its potential for speed, range and altitude.

We then drew key operational considerations from both the characteristics of air power and the human–technology relationship that underpins it.

These characteristics and considerations provided a theoretical framework for evaluating the utility of air power within any given situation. It is imperative for professional air power practitioners to understand the factors that influence the advantages and disadvantages that air power could provide in any given operational context.

This manual now moves from the theoretical *what* and *why* of air power, to the practical *how*; beginning with examining *how* air power contributes to military power.


AIR FORCE

CHAPTER 4

AIR POWER CONTRIBUTIONS

INTRODUCTION – Having covered air power in theory, it is now time to turn our focus to practice. In this chapter we will explore *how* air power contributes to the joint force in support of national objectives.

Thinking in terms of how air power can best contribute to whole-of-government efforts helps practitioners consider the many ways it can add value; beyond airborne platforms but acknowledging they will remain a critical element in many operational contexts.

As you read through this chapter you should consider this central question: how can each air power contribution to the joint force support the strategic defence objectives of *shape*, *deter* and *respond*?

The answer you must extend yourselves beyond is: what platform can be used for that?

The military instrument of national power will always be used as part of whole-of-government efforts. It follows that air power must be thought of in terms of how it can contribute to the joint force for the purpose of attaining national objectives. Additionally, air power's contribution to whole-of-government efforts must be thought of as being continuous, rather than something that comes into play only when arbitrary conflict thresholds are crossed.

Meeting this challenge requires innovative and creative thinking on the generation and employment of air power; this is the role of air power practitioners. Novel concepts need to be explored and tested against existing structures and assumptions to ensure air power is best prepared to contribute to the joint effects required to meet emerging and future strategic challenges across the entire spectrum of competition. In this chapter, we discuss how air power contributes to joint effects as an integral part of the military instrument of national power.

AIR POWER CONTRIBUTIONS FRAMEWORK

The air power contributions framework is designed to expand thinking on the possible application and utility of air power. It aims to ensure that air power, as a part of military power, is continually enhanced to best support national objectives. You are encouraged to reflect on how each contribution presented could be applied to *shape* and *deter* and *respond* in support of whole-of-government efforts.

The air power contribution framework is neither intended to create arbitrary divisions nor an implied hierarchy; rather it is designed to promote the integration of air power capabilities. Air power contributes to joint effects in support of whole-government-efforts through *force generation*, *airbase operations, air command and control*, *counter air, air mobility*, *air intelligence and ISR* and *air strike*.

These contributions form the outer ring of our air power model as shown here.

AIR POWER CONTRIBUTIONS – FORCE GENERATION

The joint force conducts Australian Defence Force (ADF) operations by bringing together the best array of available capability options, across all of the operational domains. The Service Chiefs, through the authority granted to them by the Chief of the Defence Force, are accountable for the force generation of capabilities and for preparing them to contribute to the joint force. Generating and preparing forces will always be the cornerstone of military power, with the central element being people. Air power is but one component that contributes to this whole of Defence enterprise.

Community engagement

Australians have always had an affinity with air power. Australia's First Peoples effectively leveraged the advantages of the air domain for many thousands of years to enhance their hunting and communication effectiveness. The advent of powered flight increasingly served as a way to overcome the vast distances that separated many Australians from a culturally rich array of ancestral ties.

Engaging with the community.

Our national drive for enterprise and innovation has seen us significantly contribute to advancing the possibilities of air power. This affinity continues be to a strong calling for our youth as they come of age and seek out a profession. This lies at the very heart of Australian air power and is a core element in fostering the generation of military power.

The ADF's connection with the Australian population is the primary mechanism through which people enter into voluntary military or civilian service. Meaningful engagement, based on shared values, across the Australian community is therefore a fundamental imperative. This connection is enhanced through being sensitive to cultural norms, constructively supporting equality and fostering meaningful connections with Australia's First Peoples.

The conduct of community engagement and outreach through interactions with air power—such as flypasts, air shows and airbase open days—is an important aspect of strategic communications and public affairs within Defence.

International engagement

In a similar vein to community engagement, meaningful military-to-military relationships throughout our region and with our international partners will always be fundamental to generating military options beyond our shores.

Access to allied technology.

As many of our partners do not organise for joint effect in the same manner as the ADF,

each Service and Group has a key role in fostering the relationships required across each operational domain to best enable our joint force for contingencies abroad.

For air power, the intrinsic benefit of international engagement includes access to leading edge technology, interoperability, and support on operations, along with basing and overflight options. These benefits flow both ways in a productive partnership and positively affect how air power can contribute to whole-of-government efforts across the spectrum of competition.

Force preparation, education and training

Central to all of the air power contributions within this chapter are the air power practitioners, inclusive of their training, education and force preparation.

Preparing forces is the role of the Service Chiefs and is underpinned by Defence's training and education systems. Through training and education—discussed further in Chapter 6—air power practitioners develop the skills and experience necessary to prepare them for operations.

Collective training.

Force preparation includes the understanding of, and conditioning for, the operating environment and does not stop once force elements are deployed. Force preparation is a continuous process, accessed via reach back as necessary. It is tailored to the operating environment and can include ongoing collective training, mission rehearsal and the ability to rotate or augment forces.

Collective training follows from individual training and involves creating, replicating or simulating the workplace and operational conditions under which tasks are performed to achieve group outcomes.

Mission rehearsal is a more specific type of collective training and allows for force elements to practice a mission, across a range of simulated threat scenarios, so as best to prepare for actual execution.

Live, virtual and constructive training.

Advances in technology have also increased the capabilities of modern simulation systems, whether local or distributed across many sites. These systems allow for the preparation and rehearsal of missions to advance the proficiency of the joint force while reducing inherent risk.

These capabilities are also enhanced through the use of sophisticated training ranges that enable a combination of live and virtually constructed environments.

Air power technical support

Scientific studies underpinning air power.

Building on the human aspects of force generation discussed above, air power systems are often complex and require extensive training for practitioners and a range of support services for their development and employment.

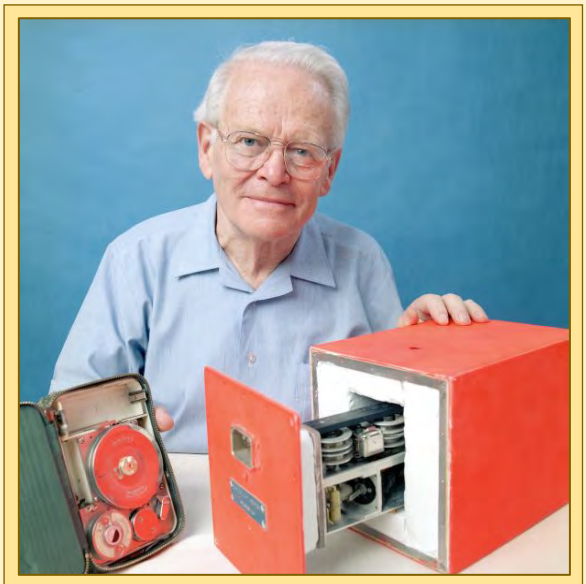
The ADF's ability to provide organic operational support requires expertise in the areas such as airworthiness, simulation and experimentation, test and evaluation, specialised payloads, range management and Defence Science and Technology Group support studies.

A number of air power support activities provide the basis to analyse emergent threats, design responses and integrate new systems—often through reach-back support during the conduct of operations. Whereas many of these activities may be seen as single-Service rather than joint force activities, they all directly contribute to the force generation, preparedness and employment of the joint force.

BLACK BOX FLIGHT RECORDER

Dr David Warren AO, of the then Defence Science and Technology Organisation's Aeronautical Research Laboratory in Fisherman's Bend, invented the world's first black box flight recorder in 1953.

He had seen the world's first miniature tape recorder, the 'Minifon', at a trade fair at about the same time the world's first jet airliner, the de Havilland Comet, had suffered a mysterious series of fatal crashes.



Black box flight recorder.

It occurred to David that if a recorder was carried in the cockpit of an aircraft, there could be a record of everything that was said up until the very moment of the accident.

A demonstration model of the black box was produced in 1957 and, while not approved by the Australian aviation authorities, was received enthusiastically in Britain.

Subsequently, the British Ministry of Aviation announced that the recorder should be carried on all planes, at least for recording instrument readings at that time.

Following the unexplained crash of a Fokker Friendship in Mackay in 1960, the judge at the court of inquiry ordered recorders be fitted to all future Australian aircraft. Thus, Australia became the first country in the world to make cockpit voice-recording mandatory.

Since that time, the black box flight recorder has been universally adopted as a means to investigate accidents and to prevent their recurrence—a significant contribution to international airline safety.

CHECKPOINT – Force generation encompasses a wide range of activities that support the joint force.

You should now understand that the joint force is not just those elements deployed to a theatre of operations. It includes all efforts to generate and prepare forces, and to support them during the conduct of operations.

Next, we will look at *airbase operations*.

AIR POWER CONTRIBUTIONS – AIRBASE OPERATIONS

The contribution of air power across the spectrum of competition is normally dependent upon effective airbase operations. This requires secure airbases in the right locations with adequate base utilities, essential support personnel and services. While airbases are typically land based, a naval vessel offers similar services within the maritime domain.

The effort required to establish, maintain and secure an airbase often makes them ideal choices for concentrating command and control elements, preparing joint and partnered forces for operations and for hosting a wide range of critical support functions.

This reciprocal contribution to both air power and joint functions scales with the size and complexity of the airbase—from large strategic hubs outside the theatre of operations, through to staging points closer to, or within, the theatre of operations.

Airbasing at sea.

Airbase roles

An airbase is an air power system—including those organic to a naval vessel—that has the inherent capability for a number of roles. These include, but are not limited to, the following.

- **Main operating base**. A main operating base (MOB) is an airbase, aerodrome or seaport located within the theatre of operations that has a mature support organisation, stores of war reserve materiel, and is capable of receiving and operating augmentation equipment, supporting organisations and non-unit materiel during contingency or wartime operations. An MOB provides the infrastructure and services for hosted units to conduct training, operations and maintenance support.

- **Forward operating base**. A forward operating base (FOB) provides an airbase from which air operations missions are launched in support of the joint force. An FOB will be in, or contiguous to, a theatre of operations.

Main operating base.

- **Force mounting base.** Planners may decide to use an airbase as the point from which personnel and supporting materiel concentrate into joint force elements prior to deployment into a theatre of operations. The airbase may also facilitate mission rehearsal and force preparation activities.

- **Air point of embarkation or disembarkation.** An air point of embarkation (APOE) or disembarkation (APOD) supports the embarkation and disembarkation of personnel to, from and within, a theatre of operations.

- **Intermediate staging base**. An intermediate staging base (ISB) supports the functions required for the staging of personnel from air points of embarkation to air points of disembarkation or to another staging location.


Landing zone.

- **Landing zone.** Typically, a landing zone (LZ) is a point of insertion for the joint force by fixed or rotary wing aircraft within a theatre of operations. Many naval vessels have landing zones incorporated into their design, often to support organic air power systems.

Airbase functions

The level of support provided to an airbase will differ depending on the type and location. The contribution to joint effects provided by airbase operations will be made up of one or more of the following airbase functions.

- **Command and control.** The exercise of authority and direction by a designated airbase commander over assigned and attached forces.

- **Airbase protection.** Airbase protection involves measures taken to protect airbase personnel, information and infrastructure against acts that may degrade effective air operations. The provision of a secure airbase from which to conduct air operations is a fundamental requirement for the projection and sustainment of air power—this is equally as important for air operations conducted from naval vessels.

- **Airbase operations support.** The conduct of air operations requires a range of support activities and services. Many of these are directly related to the air power system, nature of the operations, airbase assets and functions.


Deployed catering capability.

- **Airbase logistics support.** The provision of airbase logistics support is critical to the generation and sustainment of air and ground operations. Agencies that provide airbase logistics support (ADF or civil contractors) will be responsible for the delivery or coordination of goods and services that directly support air

operations. They may also be responsible for the sustainment of the airbase through the delivery or coordination of essential services such as warehousing and distribution, supply chain operations, transport, catering (including in-flight catering), working and domestic accommodation and the repair and management of aviation support and general equipment.

AERODROME – a defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of fixed wing and rotary wing aircraft.
NOTE: For the purposes of this manual, aerodrome includes the flight deck of a naval vessel.

- **Aerodrome engineering.** Airbases require utilities and environmental management commensurate with the number of personnel on site and the scope of its operations. ADF airbases must conform to national and host nation environmental laws and regulations. Aerodrome engineers can provide or oversee minor work through to major construction. Engineers on a naval vessel provide the support necessary to maintain the facilities and equipment required for organic air operations.

- **Health support.** An airbase contributes aerospace health capabilities to facilitate the conduct of operations and in support of aeromedical evacuation (AME). AME encompasses the movement of injured or ill personnel, requiring the supervision or care of qualified aeromedical evacuation medical personnel, to and between medical treatment facilities by *air mobility*.

Aeromedical evacuation training.

- **Airbase safety.** A safe operating environment on an airbase is achieved through the management and coordination of aviation and ground safety. Whether in Australia or on deployed airbases, compliance with all standard workplace health and safety regulations and management protocols is essential.

- **Emergency response and aerodrome recovery.** Emergency response and aerodrome recovery is an essential requirement of airbase operations whether that be, for example, immediate response to an aircraft crash or incident, provision of explosive ordnance disposal or provision of battle damage assessment and aerodrome recovery services.

- **Network operations.** Network operations is focused on the provision and assurance of cyberspace infrastructure to meet operational objectives without direct action against an adversary.

For more detail on the airbase employment functions, refer to the ADF doctrine publication ADF-I-3 *Airbase Operations*.

Joint personnel recovery

Joint personnel recovery is the culmination of all forms of recovery for ADF personnel, in all environments, to preserve capability and meet the Government's responsibility to reduce the risk to the lives and welfare of personnel. Effective joint personnel recovery requires contributions from

across all operational domains and is normally in support of, or in concert with, whole-of-government and our allies depending on the specific context of each mission.

When air power systems are required as part of a joint personnel recovery mission, the various elements involved will typically be mounted through the most applicable airbase—which includes specialised naval assets—with effective airbase operations fundamentally important to success. These operations include the following.

Rescue operation.

- **Search and rescue operations.** Search and rescue operations encompass the recovery of isolated personnel, involving military or civilian search and rescue in permissive environments.

- **Recovery operations.** Recovery operations encompass the recovery of isolated personnel during and after combat, conducted in all threat environments; this includes *combat recovery*, *combat search and rescue* and *special recovery operations*.

CHECKPOINT – Basing is critical for air power, whether that be a home base or an operating base, including naval vessels, enroute to, near or in a theatre of operations. The level of support required will differ depending upon the systems that need to be supported.

Airbases are often ideal for hosting functions outside of flying operations. This may include headquarters, force preparation and training, medical support, or simply respite locations. Airbase operations provide a wide range of critical contributions to the joint force.

To highlight integration between air power contributions, where our forces are hosted on a base owned or controlled by another nation, the critical importance of international engagement to force generation increases.

This integration will be just as apparent when we look at *air command and control*.

AIR POWER CONTRIBUTIONS – AIR COMMAND AND CONTROL

Command and control is the means for the exercise of authority over, and lawful direction of, assigned forces. It unites the people, systems and processes used to make policy, develop capability, enact operational decisions, and prepare forces for operations to achieve national objectives.

In the 20th century, centralised command and decentralised control was seen as the pinnacle of excellence, but this is evolving. The pace of operations has caused relations between leaders at each level to intensify and deepen. This is the domain of neither centralisation nor decentralisation, but of genuinely collaborative, networked command.

Types of air command and control

Air command and control is specially designed to contribute to the overall command and control of operations by ensuring air power elements are effectively synchronised with efforts across all domains.

Air battle management. Air battle management encompasses the processes of planning, directing, coordinating, and controlling air assets in operations. It does not include the command or tasking of air assets.

Airspace management.

Airspace management. Airspace management encompasses the safe, effective, and flexible use of airspace for legitimate military and civilian operations. This activity continues in peace, and in times of tension or conflict and requires a high level of coordination between the military and the civilian agencies responsible for air traffic management. For peacetime operation, this is strongly focused on Air Traffic Control services however, during conflict, this can include direction of air power in support of friendly forces.

Electronic battle management. Effective protection of air power relies on the use of the electromagnetic spectrum. When non-kinetic weapons are employed to exploit the adversary's use of the electromagnetic spectrum, a high level of coordination is required to ensure friendly activities are not adversely affected.

Targeting. Targeting is the process of identifying targets for possible engagement and determining the attack system to capture, destroy, degrade or neutralise them. Targeting takes into account international and Australian law, national and strategic objectives, operational requirements and capabilities, and ethical imperatives. Effective targeting is dependent on timely and precise intelligence—although commanders are often required to make decisions with incomplete or imperfect information—is guided by desired effects and provides significant advantage to the joint force. Conversely, errors in targeting have the potential to create unfavourable effects, with potential for outcomes detrimental to national objectives. The complex web of air command and control systems are designed to contribute directly to this enduring joint force imperative.

Theatre air control system

Air command and control utilises a complex system that involves personnel, platforms, information management technology, communications networks and decision support and operational environment awareness tools. Due to the dynamic nature of air operations across large areas, air command and control systems need to be flexible and responsive to effectively control and manage activities throughout and beyond operational theatres.

A Theatre Air Control System (TACS) is used by a Joint Force Air Component Commander (JFACC) to control air operations. An effective TACS is based upon a structure of information exchange and prioritisation between different levels of command, that allows for the planning, control, and execution of all joint air operations.

Air and Space Operations Centre (AOC). The AOC is the core of a TACS and in the Australian context is permanently assigned within Joint Operations Command (JOC) to plan and execute air power contributions to the joint force.

Air Support Operations Centre (ASOC). The ASOC is the primary element within a TACS responsible for the execution of air and space power in direct support of joint force land component operations. It is directly subordinate to the AOC and is responsible for coordinating and directing air support for land forces at the tactical level.

Member of a Tactical Air Control Party.

Tactical Air Control Party (TACP). The TACP is usually attached to a tactical level headquarters and ensures the use of all assigned airspace and air capabilities effectively meets the tactical commander's requirements.

Airspace Control Element (ACE). The ACE is a TACP element that provides air support control in assigned airspace within a specified area. The ACE directly supports the joint force by controlling and coordinating surface and air assets, integrating joint fires, and coordinating air movement with adjoining civilian and military agencies.

THEATRE COMMAND OF AIR POWER

Air power is inherently agile and responsive, and therefore able to adjust to various demands across a theatre of operation, and even between multiple theatres. For this reason, the command and control of air must be carefully managed at the level best placed to ensure optimum outcomes from this inherent agility and responsiveness.

Deployed air mobility control element.

For named operations, *Theatre Command* of force assigned assets is normally delegated to the Chief of Joint Operations (CJOPS) who, in turn, may delegate elements of command and control to subordinate commanders. In the ADF, CJOPS typically assigns *Operational Command* to an air component commander—nominally Director General-Air (DG-AIR) within Headquarters Joint Operations Command.

Whereas some force elements will only operate within a single theatre of operations, under the command of a single Joint Task Force Commander (JTFCDR), some air elements have the capability to be focused on the right place at the right time to meet a range of joint objectives across multiple theatres. Therefore, for all but the most tactical of air assets, theatre command of air will be centralised under DG-AIR. In turn, DG-AIR will be tasked to support the tactical level commanders. This allows an air asset to be used flexibly to meet one or more JTFCDR's objectives either concurrently or through agile tasking—potentially inflight when priorities change.

As an example, off the north-east coast of Queensland, the theatre of operations for Operation *Resolute* (Australia's maritime interests) and Operation *Solania* (maritime surveillance in the pacific region) overlap despite different mission objectives. However, a single maritime patrol aircraft operating in this area can concurrently contribute to both operations. By holding the command of the air asset at the theatre level, mission tasking can be shaped to include both operations while also holding a contingency capability for meeting Australia's search and rescue obligations.

How might air power agility and responsiveness be impacted if the command of air assets was always delegated to the tactical level?

CHECKPOINT – A theatre of operations is complex and dynamic and effective air command and control is critical for directing and synchronising missions. Air command and control is required equally across the spectrum of competition as it underpins safe operations in the air environment.

It is also important to note that integration must occur across all the operational domains. Effective air command and control is equally important to naval and land elements as it is to the airborne assets they operate with as part of the joint force.

This should become highly evident as we look at *counter air*.

AIR POWER CONTRIBUTIONS – COUNTER AIR

Counter air involves targeting and engaging air power elements of an adversary's force. Through delivering counter air effects, the joint force aims to suppress the adversary's military air power—such as air strike or air defence systems—allowing friendly forces to operate across all operational domains unhindered from the air. Counter air also includes defensive measures to achieve the protection of territory, personnel and materiel against the adversary's air power, thereby preventing the adversary from achieving *control of the air*. Counter air contributions from air power need to be considered alongside those from all other operational domains.

Offensive counter air

Offensive counter air (OCA) is an activity conducted proactively to destroy, degrade, neutralise or disrupt adversary air power, or to contain it as close to its source as possible. OCA utilises all operational domains to target an adversary's air power. This may include, but is not limited to, disabling, or destroying parked aircraft, runways, fuel facilities, hangars, air traffic control facilities, air defence systems and other aviation infrastructure.

Air power can contribute to OCA through the employment of counter air capabilities to clear a specified section of airspace of adversary aircraft and through the suppression of enemy air defences. Offensive counter air can also be delivered through non-kinetic effects such as electronic attack.

Defensive counter air

Defensive counter air (DCA) encompasses active and passive measures to detect, identify, intercept, destroy or neutralise the effectiveness of adversary air activity. These measures include both kinetic and non-kinetic means to achieve the effect.

Active DCA aims to suppress an adversary's military air power through direct defensive action taken to destroy, nullify, or reduce the effectiveness of hostile air and missile threats against friendly forces and assets. It includes the use of aircraft, air defence weapons, electronic warfare and other available weapon systems.

These actions are normally conducted over or close to friendly territory so as to avoid or minimise the damage to friendly forces.

Air defence radar system.

Passive DCA aims to minimise the effectiveness of adversary air activity by enhancing the survivability of friendly forces and installations. These measures include camouflage, concealment, deception, dispersion, reconstitution, redundancy, detection and warning systems, and the use of protective construction.

A holistic extension to DCA which aims to ensure the stability and security of airspace by coordinating, controlling and exploiting the air domain is referred to as integrated air and missile defence (IAMD).

CHECKPOINT – Counter air focuses on denying an adversary the effective use of the air domain. However, it doesn't need to be absolute nor continuous. Counter air needs to be established where it is needed and for as long as it is needed—typically to allow freedom of manoeuvre of our own forces, or to protect our bases and lines of supply. The aim is simply to stop the adversary from using air power against us.

Air control has always been a key air power contribution to the joint force, and will remain so, but it is important to be clear on *where*, *when*, *how much* and, most especially, *for what*?

Next, we will look at *air mobility*.

AIR POWER CONTRIBUTIONS – AIR MOBILITY

Air mobility is the ability to deploy, sustain and redeploy personnel, materiel or forces to, from or within a theatre of operations by air. Air mobility also encompasses airborne activities in which combat forces and their equipment manoeuvre about the battlefield under the control of a ground force commander

Inter-theatre air mobility.

Air mobility enables the conduct of military and whole-of-government operations and has utility across the full spectrum of conflict. Notably, air mobility provides considerable advantages with respect to responsiveness and when surface obstacles or threats need to be avoided.

Inter-theatre air mobility capability enables the ADF to conduct or contribute to operations in support of Australian national security objectives in the broader geo-strategic environment. Intra-theatre air mobility facilitates rapid air movement of forces and supplies within a theatre of operations—this can enable a small force to be effective over a large geographical area.

PERMISSIVE ENVIRONMENT – an environment in which host country military and law enforcement agencies have control and the intent and capability to assist friendly operations.

UNCERTAIN ENVIRONMENT – an environment in which the reactions of local authorities and/or the population cannot be predicted despite host nation government willingness to support ADF operations.

HOSTILE ENVIRONMENT – an environment where ADF operations are likely to be opposed by local forces and/or the local population.

Air logistics support

Air logistics support (ALS) is an air activity to deploy, distribute or recover personnel,

CONTROL OF THE AIR

Control of the air has been a central focus for air power theory from its inception and can generally be defined as the ability to conduct operations in the air, land and maritime domains without effective interference from adversary air power and air defence capabilities.

Shipborne air defence system.

As a theoretical ideal, control of the air provides freedom from attack, freedom to attack and freedom of manoeuvre. It is important to understand when considering control of the air that it is not an end in itself—it is a key enabler for joint effects within an operational context, bounded by area and time.

Where the air domain is contested, achievement of military objectives will normally require the joint force to achieve adequate control of the air to mitigate risks from an adversary from the air domain.

Typically, the level of control required needs only be sufficient to enable the manoeuvre of friendly forces and the engagement of adversary forces. The common levels of control of the air are described as follows:

- **Air supremacy** exists when the adversary's air power and air defence capabilities are incapable of effective interference, unbounded by time and location.
- **Air superiority** exists when operations can be conducted at a given location for the desired duration without effective interference by adversary air power and air defence capabilities.
- **Air parity** exists when *control of the air* is actively contested in a particular location over any period of time and no actor is able to obtain an operationally significant air power advantage and air defence dominance over another.
- **Unfavourable air situation** exists when operations can expect to encounter prohibitive interference from adversary air power and air defence capabilities.

Mobile ground-based air defence weapon system.

Modern conflicts have demonstrated that the *control of the air* experienced within a theatre of operations can differ at any given time or place. Additionally, the ways an adversary may seek to contest the air domain can now originate from across all of the domains of the operational environment.

An example of this would be where some air power elements are experiencing *air supremacy* at high flight levels while, at the same time, other air power elements may be experiencing air parity or an unfavourable situation at lower levels—with their self-defence systems challenged by portable air defence systems.

How could control of the air be achieved in the future?

How might cyber effects be included? How could control of the air be impacted by space systems which are able to deliver kinetic or non-kinetic effects?

Finally, what impact might drones, such as swarming drones, have on the future control of the air?

Airborne air defence.

materiel or forces in a permissive environment. Air logistics support would normally be conducted through internal carriage of personnel and cargo but also by airdrop or external lift.

Special purpose missions. Special purpose missions provide safe, reliable, connected, and protected air transportation for national leadership in direct support of national security objectives. Special purpose missions are dedicated to transporting members of government as well as other approved senior officials and foreign dignitaries and require a high level of mission assurance.

Airborne operations

Airborne operations.

Airborne operations are an air mobility activity conducted within an active theatre of operations to deliver or extract combat ready forces and their logistic support.

Airborne operations can be via internal carriage in fixed and rotary wing aircraft (*airland*), dropped out of an aircraft (*airdrop*), or helicopter underslung load carriage (*external lift*). Airborne operations often require specialised systems, tactics, techniques and procedures to enable success in uncertain or hostile environments.

Air assault. An air assault is the landing of combat forces on, over or within range of an objective. Air assault may include a deliberately contested landing or an operation in which assault forces manoeuvre, typically using rotary wing mobility, to engage adversary forces to seize and hold key terrain.

Air-to-air refuelling

Air-to-air refuelling.

Air-to-air refuelling (AAR) is the replenishment of an aircraft by another, while both are in flight. The contribution of AAR is always highly valued on operations and is a keenly sought-after contribution across the joint force and among allies and partners. This is due to it improving the reach, responsiveness, and persistence of many other air power contributions.

Examples of the force-multiplying contribution of AAR include extending the range of deploying combat and combat support aircraft, enhancing air bridges by allowing suitably equipped transport aircraft to refuel enroute, extending the reach of air strikes beyond normal operating ranges and increasing counter air coverage for the joint force.

CHECKPOINT – Air mobility contributes to and enhances many capabilities across the joint force, along with often supporting national objectives in its own right. The responsiveness and reach of air mobility make it a valuable resource in most operational contexts.

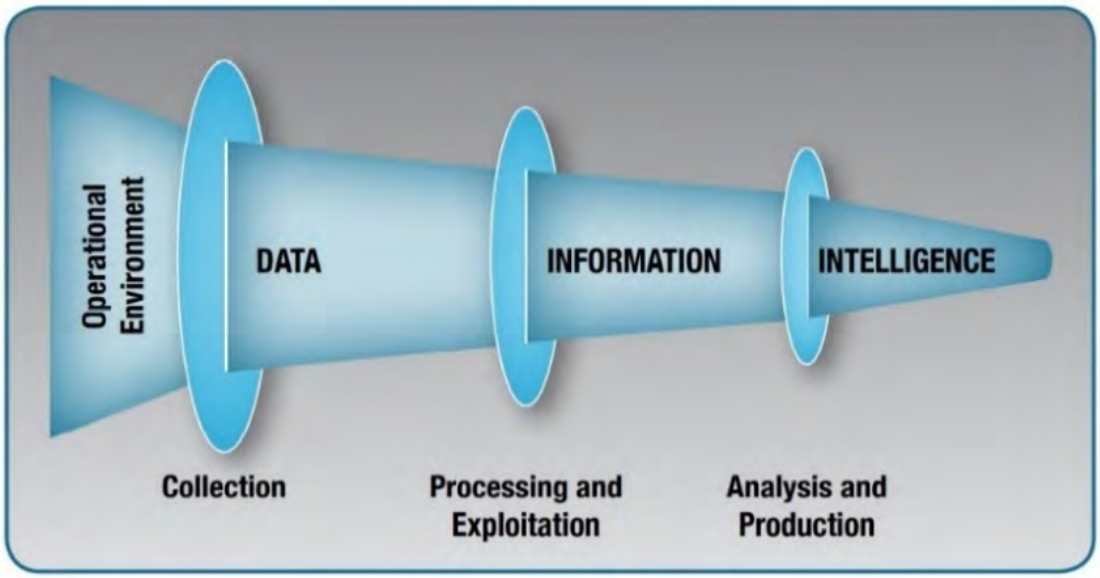
The statement above is evidenced by air mobility contributions being constantly in demand and often in short supply. Hence, the employment of air mobility should always be considered in relation to the specific effect required, not requested by aircraft type. Air mobility specialists inside air command and control systems are best placed to prioritise and identify the most effective assets for tasks.

Next, we will look at *air intelligence and ISR*.

AIR POWER CONTRIBUTIONS – AIR INTELLIGENCE AND ISR

Intelligence is an enduring function carried out through constant activity across all domains as part of a whole-of-government enterprise. The Defence Intelligence Enterprise (DIE) comprises all activities conducted by collection elements and by intelligence organisations that process and exploit data to produce fused intelligence products.

There is a link between intelligence, and Intelligence, Surveillance and Reconnaissance (ISR) activities. ISR is not part of the intelligence cycle but supports the collection phase of that cycle. The figure on the following page shows the relationship between data, information and intelligence.



Air intelligence

INTELLIGENCE – the activities, processes and outputs that relate to the directed acquisition, processing and dissemination of information about threats, opportunities and operating environments.

Air intelligence is an integral part of the DIE. It contributes to strategic level situational awareness and decision making and enables operational and tactical level activities in the air domain.

Air intelligence draws from strategic, whole-of-government, intelligence collection and fuses this with tactical level intelligence, data and ISR information to understand threats, opportunities and the

operating environment. Air intelligence is essential to effectively employ air power assets, sensors and systems in joint operations.

While air intelligence is particularly important for military operations during a conflict, it should be viewed as a continuous activity across the spectrum of competition.

Air intelligence activities during peacetime are equally as vital as they build the foundations for effective decision making for shaping, deterrence and response. This is achieved by monitoring the region, maintaining situational awareness of the air domain, guiding tactics development, assisting capability development and providing indicators and warnings analysis.

During periods of escalating tension, air intelligence enables the joint intelligence preparation of the operating environment, mission planning, threat warning and broader situational understanding.

Air intelligence analysts.

Air ISR

ISR – an activity that synchronises and integrates the direction, planning and operation of collection capabilities and actions and of processing, exploitation and dissemination systems.

ISR is an activity that synchronises and integrates the direction, planning and operation of collection capabilities and processing, exploitation, and dissemination systems. ISR activity links to the collection phase of the intelligence cycle. Through common use over an extended period, ISR has become widely accepted as a single term, rather than simply the acronym of Intelligence, Surveillance and Reconnaissance.

The fundamental difference between intelligence and ISR is the direct link to the sensor. Intelligence is a process and an output that is not tied to specific types of collection capability. By contrast, ISR tasks are inherently linked to specific capabilities. ISR does not exclusively support intelligence it also directly informs other operational activities such as targeting and strike.

Air ISR contributions to the joint force can come from air or ground based systems and can include visual and electronic observation. The broad perspective attainable through the air domain provides a field of view for ISR systems that cannot be matched in the other physical domains, other than space. This advantage in perspective is further enhanced by exploiting other characteristics of the air domain like reach and responsiveness.

It is important to recognise that the contributions of many modern air capabilities have expanded beyond what was envisioned in

Exploiting the greater perspective from the air.

their initial concept of employment to include a variety of innovative functions. For example, it is not unusual to find a strike asset employed for ISR or an ISR asset employed for strike.

Processing, exploitation and dissemination

Processing, exploitation and dissemination (PED) is a term commonly used across the intelligence community and is being more broadly used within Defence as new technologies are introduced. PED is not part of the intelligence cycle but is an ISR activity and is the mechanism that enables timely processing, exploitation and dissemination of ISR data, information and intelligence.

Headquarters enabled by PED.

PED refers to the process and systems by which collected information and raw data is processed into a useable format, exploited, and disseminated to systems or people that will take action. The key distinction between PED and intelligence analysis and assessment is that PED has a direct link to the collection capability, either during collection or immediately afterwards. Intelligence analysis and assessment have no such direct link with the collection activity.

CHECKPOINT – Intelligence underpins operations. Without it, commanders cannot make informed decisions on how best to employ the military capabilities assigned to them. However, that intelligence must be timely and accurate. Air power is both critically reliant on, and an important contributor to, effective intelligence and ISR.

Lastly, we will look at the contribution of *air strike*.

AIR POWER CONTRIBUTIONS – AIR STRIKE

The demonstrated capability to strike an adversary allows the application of a range of strategies, such as a diplomatic warning or show of force, through to the actual use of that force.

Air strike.

Air strike may be used to deter or coerce an adversary, degrade, neutralise or destroy their war-making capabilities, or disrupt or deny their courses of action. Air strike can employ lethal or non-lethal, kinetic or non-kinetic, means to create the desired effect on an adversary.

Air strike can be either deliberate or dynamic. Deliberate air strikes are planned, in advance, to achieve desired strategic, operational or tactical objectives. The reach of air power can provide advantages here. In contrast, dynamic air strikes are conducted in short-term anticipation of, or in reaction to, emerging targets. Air power's responsiveness is of value here.

INFORMATION OPERATIONS – the operational-level planning and execution of integrated, coordinated and synchronised kinetic and non-kinetic actions against the capability, will and understanding of target systems and/or target audiences, particularly decision-making, while protecting our own.

It is important to note that air strike can also create unintended effects—as is the case for any type of strike. Although both kinetic and non-kinetic weapons have become increasingly precise, technical challenges or targeting errors can result in collateral damage that may have undesired political, diplomatic and military repercussions. This is why decision making with respect to air strike is critical and must be made at the appropriate level, from the tactical level through to the national Government, depending on the type of strike being applied.

Strategic attack

Strategic attack is an offensive activity designed to create specific strategic effects that damage, degrade, or destroy an adversary's will, war-making capabilities or disrupt or deny courses of action—this includes contributions to *information operations*.

Understanding information warfare challenges.

Close air support

Close air support (CAS) is an air activity conducted against hostile targets that are in close proximity to friendly forces. The aim of CAS is to neutralise or disrupt an adversary who is engaged with, or about to engage with, friendly ground or amphibious forces.

A high degree of coordination with friendly forces is required for effective close air support—elements of embedded *air command and control* are typically required to achieve this.

Air interdiction

Air interdiction is conducted to disrupt, degrade or destroy an adversary's capability on its way to be used against friendly forces. Although air interdiction is an integrated process, it is normally conducted at such distance from friendly forces that detailed coordination is not essential.

Electronic attack

Electronic attack involves the use of electromagnetic energy, directed energy, or anti-radiation weapons to degrade, neutralise or destroy an adversary's operational capabilities. Electronic attack can include electromagnetic jamming and electromagnetic deception—such as false target or duplicate target generation.

Electronic attack.

Anti-surface and anti-submarine warfare

Anti-surface warfare (ASuW) is conducted with the intention of denying the adversary effective use of their surface vessels in the maritime domain. Anti-submarine warfare (ASW) is conducted with the intention of denying the adversary the effective use of their subsurface capabilities.

Air power contributions to ASuW and ASW are normally integrated with the operations of friendly naval forces.

Anti-submarine warfare.

CHECKPOINT – The potential advantages to strike on offer through the air domain make it a key air power contribution. Exploiting reach and responsiveness, air power can conduct long range strikes against planned or emerging targets with precision.

Importantly, it is not always necessary to conduct a strike in order to create a powerful effect. The demonstrated capacity to strike contributes toward efforts to *shape* and *deter*.

RELATIONSHIP BETWEEN THE AIR POWER CONTRIBUTIONS

While we have presented the air power contributions as different entities, they should never be viewed as standing alone. The air power contributions framework is not intended to create arbitrary divisions that result in capability stovepipes or an implied hierarchy. To be most effective, each air power contribution must be integrated with the others across all of the operational domains.

The air power contributions framework is designed to expand thinking on the possible employment of air power in support of national objectives. You are encouraged to reflect on how each contribution presented could be applied to *shape*, *deter* and *respond* as part of the joint force and in support of whole-of-government efforts.

CONCLUSION – In practice, air power prepares and provides contributions to the joint force. They provide planners and commanders with options from which to draw the most effective force for achieving national objectives.

Now that you have an understanding of *what* and *how* air power can contribute, in the next chapter we will look at *how* they are integrated into the joint force.

CHAPTER 5

AIR POWER INTEGRATION

'… you have to fight comprehensively across all the domains, you cannot prioritise one and cherry-pick benefits from the others, except at some cost.'

AVM Edward Stringer CB CBE RAF
2018 Lord Trenchard Memorial Lecture

INTRODUCTION – The last chapter introduced the air power contributions framework. These contributions will always be to joint effects and usually as part of whole-of-government efforts.

As part of the next step of examining air power in practice, this chapter will discuss *how* air power integrates as part of the joint force.

As you read through this chapter you should consider the following questions:

- Why is interoperability important and how is it different from integration?
- What level of interoperability is needed for success?
- How does this change with operational context?

A constant theme throughout this manual is that air power's contribution to military power must be considered in concert with all other operational domains, along with partner agencies and nations. The central importance of this concept, and how it is orchestrated within Defence, is the topic of this chapter.

The ability of forces to integrate, whether they be within a nation's own military or between partner nations, does not come easily. Integration begins with interoperability, so we will start our discussion there.

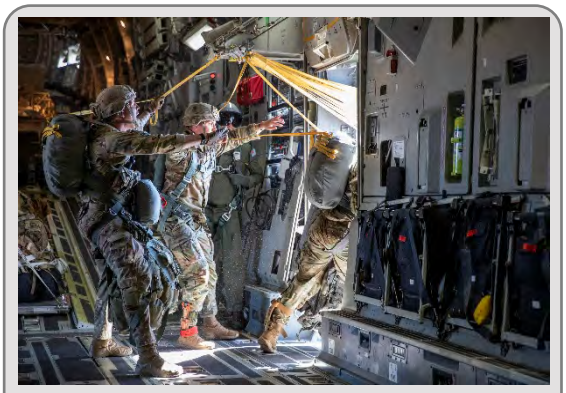
DEFENCE INTEROPERABILITY FRAMEWORK

Air power systems need to be able to operate safely and effectively together with other military force elements and non-Defence entities as part of a joint force or in partnered operations. However, there will always be barriers, both technical and human, to achieving perfect integration.

Effective interoperability is often all that is needed for mission success; this is recognised within Defence's interoperability framework.

This section will focus on explaining Defence's approach, or language, with respect to interoperability—*layers*, *dimensions* and *levels*.

As you read through this section, remember we need to focus on the technology and the human dimensions, as both generate limitations and create opportunities with respect to interoperability.



Advantages of interoperability.

Interoperability layers

The ADF - joint by design.

In an ideal world, we would be interoperable with our allies and partners—but for many real-world considerations this is not easy to achieve. In an effort to attain this ideal, it is necessary to first identify with *who* we need to have interoperability. Within the Defence framework, the *who* is identified through the following *interoperability layers*.

Joint. The joint force is the Australian Defence Force's (ADF) default operating construct. It brings together the necessary elements of military power to respond to an operational scenario. While the ADF definition of joint encompasses the involvement of two or more Services or Group force elements, the ADF can also conduct joint operations using a force element from a single Service, under the command, planning and execution of Headquarters Joint Operations Command. The ADF is a joint force by design, regardless of how many elements are employed on a given operation.

Whole-of-Government. Whole-of-government operations will typically bring together multiple elements across the national power model in response to peacetime scenarios such as a response to a natural disaster or security operations for a high-profile event. Defence is not typically the lead agency for such an operation. The ADF is expected to be able to operate with all relevant government departments and agencies, at both the federal and state level, to support national objectives.

Military in support of state emergency response.

Multinational. Multinational operations may be conducted across the spectrum of competition, from peacetime—such as humanitarian aid and disaster relief—through to war-like operations. At the multinational level, the ADF will be expected to operate with, or at least alongside, forces from one or more other nations. Multinational operations are typically very complex, due in part to the different interoperability baselines of each of the nations involved and differences in rules of engagement and policy.

Interoperability dimensions

Now that we can identify the *who* in our interoperability challenge, the next step is considering in *what way* we need to be interoperable. Known as *interoperability dimensions*, they reflect the fact that

interoperability extends beyond just technically compatible equipment. They describe the dimensions through which the ADF can achieve interoperability with other entities.

Technical. The technical dimension encompasses the ability of equipment to connect and share information. This dimension can include common operating systems, ground support equipment or shared role equipment and payloads. In many cases, the level of achievable interoperability will be enabled, but not defined, by the level of technical compatibility.

Procedural. The procedural dimension encompasses the compatibility of processes, procedures and doctrine between force elements and other entities. Compatible procedures can sometimes overcome the limits of technical compatibility—for example, the ability to use foreign ground support personnel to assist in aircraft handling through the cross certification of their skillsets and qualifications.

Human interoperability.

Human. The human dimension encompasses the professional mastery of the force and its compatibility with other entities based upon experience and perspective. Collective training, such as international exercises, is a key enabler of this dimension of interoperability.

Interoperability levels

The last step in Defence's framework looks at the question of *how much* interoperability do we need? The *interoperability levels* indicate how closely the ADF will be able to operate with other entities. Interoperability is a key consideration in force design for the ADF. The level achievable is often variable and directly dependent upon the projected operating context and is inextricably linked to the interoperability layers and dimensions.

Integrated. At the integrated level, the ADF will be able to merge, and potentially interchange, capabilities with other entities. This level represents the highest level of information sharing and compatibility across the technical, procedural and human dimensions. Common equipment may well form the foundation for an integrated force. For example, the C-17 Globemaster III Integrated Sustainment Program provides a network of allied parts and repairs around the world utilising interoperability as its basis.

Integrated level of platform maintenance.

Compatible. At the compatible level, the ADF and other entities will have the potential to interact and complement each other. At this level, the operating systems are able to operate together, however, the support required to achieve this may be much larger due to unique requirements or interfaces. Interoperability at the compatible level may be enhanced through common procedures and processes.

The intent, at this level, is to work alongside rather than merging capabilities. For example, while Australia and the United States may operate the same aircraft types, the certification of technical staff may be different. This, therefore, could impede mutual support activities but may be mitigated by established procedures for verifying each other's qualifications and endorsements.

ADF interoperability.

Deconflicted. At the deconflicted level, the ADF and other entities can co-exist but do not interact with each other. Separation may be achieved at both the physical and virtual levels, including separation by time or location, separation of allocated bandwidth for electronic operations, or even separation of command networks due to security limitations. See the Operation *Southern Indian Ocean* vignette below.

OPERATION SOUTHERN INDIAN OCEAN

The disappearance on 8 March 2014 of Malaysia Airlines MH-370 sparked one of the most comprehensive search and rescue operations in aviation history. Commencing in the South China Sea, the search area soon shifted to off the coast of Western Australia as analysts aggregated all sources of information and reassessed the flight path of the aircraft. The resulting search area was in excess of 25,000km^2, however this iteratively grew as additional theories were added to the search algorithms.

The resulting Australian-led operation, Operation *Southern Indian Ocean*, coordinated the search and rescue efforts of ships and aircraft from nine nations—Australia, China, India, Japan, Malaysia, New Zealand, South Korea, the United Kingdom and the United States.

Communication between all of the participants soon proved a key challenge. Fixed wing operations were coordinated through an Air Task Group operating out of RAAF Pearce and hence were able to be deconflicted in time and space. However, organic air assets embarked on the ships were not coordinated by the Air Task Group. Some participants were relying on communication channels back through their national agencies. At best, air operations were at the deconflicted level.

In some cases, aviation safety was established by having air riders from No 2 Flying Training School accompanying the foreign crews on each mission. Safety altitude blocks were also established to ensure vertical clearance between aircraft operating in the same or adjacent areas.

At one point, HMAS *Success* took copies of the air orders to participating ships to ensure they were received and understood.

Supporting foreign crews during the search.

CHECKPOINT – Defence's interoperability framework provides a logic and structure to the very complex concept of interoperability. It is made even more complex by the fact we may be able to achieve differing amounts of interoperability across this framework, depending on the *who*, *what* and *how much*.

In the next section we will begin looking at the integration of air power with the other elements of military power. This begins simply with one-on-one analysis; the first step in understanding our *joint layer* of interoperability.

INTEGRATION ACROSS THE DOMAINS

Before we look more holistically at the operational integration of military power in the joint force, we need to look at how the domains interact and what opportunities and challenges they offer to interoperability. The air domain presents some unique considerations here, due to it being adjacent to every other physical domain and being a key medium for activity in the cyber domain. While we will start by looking at pairings of domains, hold foremost in your mind the end aim for the ADF of having a *joint* force that achieves the highest achievable *level* of integrated interoperability across all operational domains; that is, to be *integrated*.

Air–land integration

Since the inception of air power, air and land power—along with maritime power, which we look at next—have worked together to achieve military objectives. As we know from Chapter 2, the air domain overlays the terrestrial surface of the Earth, and all parts of that surface are theoretically accessible from the air. Natural obstacles that may significantly impede land power may be of little consequence to air capabilities. That said, complex terrain—such as caves and urban areas—may impact significantly on the effectiveness of air power.

Land power is also subject to some of the natural properties of the air environment, like weather. Similarly, air power can be adversely affected by land-based phenomenon—such as smoke when used to mask ground movement. Land and air power can also find themselves in reciprocal relationships—where one is in direct support of the other—in achieving military objectives.

Coordinated air–land training.

Air power, through intelligence, surveillance and reconnaissance (ISR), can be the eyes and ears for land power components providing a perspective well beyond their own horizons. Air can enable land power, for example, by assisting freedom of manoeuvre and enhancing mobility; this allows the application of force in the land domain by suppressing adversary forces. In some cases, this may be with adversary forces in direct proximity to our land forces—this is where clear and effective air command and control becomes especially critical.

Similarly land power can provide critical capabilities for air power; for example, enhancing the security of airbases and providing target designation for air strike in complex urban areas. Air power is also highly reliant on the use of the land domain. Terrestrial airbases, ground-based segments and over-land supply routes all rely on a level of land control. Land power can also contribute directly to the suppression of enemy air power through land strike, thus being a contributor to air control.

Air–land integration maximises the military power created by coordinating and synchronising complementary capabilities from the air and land domains. It encompasses all the processes that plan, coordinate, control and de-conflict the activities of the air and land elements within a given theatre of operations. Air power is enabled and enhanced by the relative advantages of land power. Through effective integration, the contributions to joint effects through both domains are greatly strengthened.

JOINT FIRES

As technology has shaped modern air power, it has also shaped the other operational domains. This can create potential adverse interaction if not effectively coordinated. Joint fires is the employment of forces from two or more components, in a coordinated action, to produce desired effects in support of objectives.

Air-to-surface attack dramatically increases the amount of joint fires available to a commander. Air power possesses great reach, responsiveness, and precision, but must be planned and coordinated. Once on task, payloads are fixed, but air capabilities can be rapidly shifted from deliberate to dynamic targets with minimal delay.

Where an air action against hostile targets is in close proximity to those friendly forces, the commander determines the level of integration required based on the proximity to friendly forces, fire or movement. Where air action is focused on the adversary before contact with friendly forces, less integration and coordination is required.

Where increased control is required, specialist Joint Terminal Attack Controllers (JTAC) will deploy with ground forces to coordinate or direct combat aircraft engagement.

Deconflicting air and land fires.

How might cyber operations impact on this relationship into the future?

Air–maritime integration

The air and maritime domains have several important similarities, such as the characteristic of the human–technology relationship, noting that, in the maritime domain, this relationship has a far longer history. Sea power, like air power, provides an essential contribution to the freedom of manoeuvre in most operational contexts.

The air domain overlays the maritime domain, and this generates some similarities to the air domain's relationship with the land domain. One key difference is that sea surface forces are typically unable to mask their position from the air due to the lack of natural obstacles. However, as they do to all other operational domains, sub-surface elements present a significant challenge to detection from the air.

Like land power, maritime and air power can have a supported or a supporting relationship, depending on the desired effects and objectives.

Air and sub-surface elements working together.

Air power can significantly increase the perspective of maritime forces, offering them a situational awareness well beyond their reach.

Air power can also directly contribute to sea control by suppressing adversary sea power, either on the surface below. Organic air power on board a naval asset could also provide kinetic and non-kinetic strike, and reach back to land facilities for provisioning or, for example, evacuation of injured or ill sailors.

Maritime air control asset.

Maritime forces can significantly contribute to air control, particularly through the capabilities of specialised naval assets, like air warfare destroyers and aircraft carriers. Maritime forces also provide a critical supply capability, able to bring equipment and personnel well beyond the capacity of air assets, into a theatre of operation.

Maritime forces can also provide basing for air power assets from remotely crewed air power systems and organic helicopters to significant airbase operations provided on specialised assets such as helicopter landing docks and aircraft carriers.

Like air and land power, air and maritime power will often work in close proximity to each other. Communication and effective command and control is critical to ensure separation of potentially lethal military effects. Air–maritime integration maximises the military power created by coordinating and synchronising complementary capabilities from the air and maritime domains.

ANTI-SURFACE AND ANTI-SUBMARINE WARFARE

Operating in the maritime domain—with few or no obstacles for protection—naval vessels can be vulnerable to attack by an adversary's surface and sub-surface forces. Anti-surface and anti-submarine warfare, therefore, are crucial capabilities that can contribute to the survivability of maritime assets.

While modern naval vessels are fitted with highly specialised and capable sensors, their range can often be limited by their location—such as a radar antenna's height above sea level. Similarly, weapon engagement ranges may be relatively short, which could enable an adversary to come close enough to attack.

Air power, whether organic to the ship or tasked in direct support, can provide significant increases in the effective reach and combat capability of a ship. For anti-surface warfare, an aircraft can exploit its altitude advantage to immediately increase the perspective of a ship and the effective patrol area many times beyond the inherent range of the ship's sensors. This extended reach—potentially layered between fixed and rotary wing aircraft—can be used to detect and engage adversary surface forces well before they can threaten friendly maritime forces.

For anti-submarine warfare, aircraft can similarly search, detect, and localise adversary sub-surface threats well outside surface vessel engagement zones. This can pose dilemmas for a submarine degrading its operational effect.

The integration of air and maritime forces in such scenarios is critical particularly when operating in close proximity to each other. For non-organic air, tactical control of the aircraft will typically be passed to the ship so that fires can be coordinated.

How might artificial intelligence impact such integration into the future?

Airborne anti-surface warfare capability.

Air–space integration

Rocket launch through the air domain.

The air domain sits in between the space domain and the land and maritime domains, and therefore between space, user and ground segments and is a critical environment for the link segment. Space activities are directly reliant on the air domain for the launch or recovery of space vehicles. Air capabilities can also contribute to space control through the application of air power against adversarial terrestrial-based space assets, such as ground stations. While the transmission of communication and sensor data is also through the air using the electromagnetic spectrum this is normally considered to be part of the cyber domain.

Air capabilities are similarly reliant on the space domain where sensors or communications are used to overcome line-of-sight limitations. Space-based Global Navigation Satellite Systems (GNSS) are also critical to the successful navigation of airborne systems and some guided weapons. The GNSS also provides precision timing for secure communications.

Effective air–space integration at the operational planning level can also provide opportunities to make use of complementary capabilities. For example, both the air and space domains offer significant ISR capabilities, which, if coordinated during an operation, can complement one another by ensuring there are no gaps in coverage. Space-based capabilities provide vital information for all of the operating domains and air–space integration is critical to the successful employment of air power.

THE GROWING RELIANCE ON SPACE

The militarisation of space has long been a significant feature of contemporary warfare. Space systems enable global communications for command and control, provide positioning, navigation, and timing information to support precision effects, and provide unique overhead access for situational awareness.

The First Gulf War is broadly acknowledged as the first space war, in which the American Global Positioning System (GPS) played a key role in the provision of highly accurate navigational information. This information proved invaluable in enhancing air power effects by allowing aircraft to operate accurately over terrain that was literally uncharted.

AGM-154C Joint Stand-off Weapon.

A decade later, half of the precision-guided munitions dropped during the Second Gulf War were GPS-guided weapons. Since then, satellite-guided munitions have come to account for a growing proportion of the airborne weapons, including joint stand-off weapons. Enabled by satellite guidance, a single aircraft can now precisely navigate to, and engage multiple targets in a single mission.

Indicative of the growing importance of space, Australia has recently established the Defence Space Command within the ADF. The formation of Defence Space Command recognises space as a unique operational domain and that assured space services and products becoming increasingly critical to the ADF.

However, with the increased dependence on space, how fragile is this relationship? What would the impacts of counter-space technologies have on operations in the air domain?

Air–cyber integration

Cyber operations.

As the cyber domain is not a physical domain, any activity relies upon the exploitation of mediums within the other physical domains. This includes the transmission and reception of data through the air.

The cyber domain is essential to air operations as it provides the infrastructure and services that connect many air activities to other airborne, land, maritime or space-based users. Cyber security is also critical to air power systems. Secure cyber networks are key to addressing risks to air power from adversary cyber threats.

Air–cyber integration aims to create desired military effects in the physical or virtual battlespace. Air–cyber integration can involve cyber operations in support of air operations, or air operations in support of cyber operations. Air operations in support of cyber operations can include kinetic or non-kinetic attacks on selected computer nodes to deny an adversary a critical capability or force them to use networks that can be attacked or exploited using cyber capabilities. Such activities must be coordinated through a full spectrum targeting process to ensure unintended consequences are avoided or managed. Air power can also contribute to cyber operations through the provision of intelligence, data and information.

CYBERSPACE OPERATIONS

The emergence of cyberspace has altered the character of war in ways unimaginable a generation ago. This is particularly pertinent in an era of operations where many deliberate military cyber actions fall short of warfare, reflecting that, in an information age, cyber effects are ubiquitous across society. As such, cyber operations have the potential of generating effects within all the operational environments, including the cyber domain.

In general terms, cyber contributes to air power effects in three distinct ways. Firstly, the conduct of defensive cyber activities to protect friendly air power capabilities from adversary cyber attacks. Secondly, the conduct of offensive cyber activities to deny, degrade, disrupt, destroy, and manipulate adversary systems as a part of a joint effect. Thirdly, the conduct of cyber exploitation activities to inform the commander's situational awareness and decision superiority. Each of these cyber activities directly support, and are increasingly important to, applying air power in uncertain and hostile environments.

Recognising the importance of cyber to operations, the ADF has established cyberspace capabilities to provide cyber security and cyber protection effects. To ensure freedom of manoeuvre across all of the domains, cyber security must be maintained through governance, protection, detection, response, and recovery efforts on key cyber terrain.

Having hardened and defended networks allows the ADF to counter the cyber threat to operations. This has included the establishment of a new Cyberspace Warfare workforce to provide the specialist skills required to contribute to joint military objectives.

Cyberspace operator.

CHECKPOINT – All the operational domains are inherently linked within the real world of any given operating environment. Air power is needed by, and in turn needs, the other elements of military power to be optimally effective. But how do we bring this all seamlessly together?

In the next section we will examine the integrated functions of the joint force—the basic building blocks of ADF operations.

JOINT FORCE INTEGRATION

Joint operations are most effective when the various contributions across all the operational domains are brought together to complement each other's strengths and mitigate any inherent limitations. The backbone of an ADF joint force will, therefore, be the ability to *integrate* contributions from across all domains for the job at hand.

Integrated Campaigning is the focused aggregation and application of national power in pursuit of national interests, achieved by realising the potential of the ADF's people, ideas, and materiel, combined with those of allies and partners. The ADF conducts and contributes to integrated campaigning by embracing and exploiting integration persistently across all levels, domains, settings and all forms. Through integration of the ADF with others, the military most effectively contributes to the defence of national interests.

The actions of the joint force—the core contributions of the military instrument of national power in support of national objectives—are built upon a number of basic integrated functions. It is important to understand these functions, as they are the *why* of joint force integration at the operational level. The close relationship between these functions and air power contributions should be apparent.

Mixed reality – the future?

- **Force generation and sustainment.** Force generation is primarily undertaken by the ADF Services and primarily relates to personnel and equipment. Each Service chief has their own responsibility, assigned by the Chief of the Defence Force (CDF), to ensure the air power contributions resident within their Service are raised, trained, and sustained in line with CDF's preparedness requirements. Sustainment while on operations, beyond prescribed periods, is predominately a joint logistics function.

- **Command.** Including control, command is exercised across all levels and represents the distribution of responsibilities for planning and directing resources allocated to the management of the operational environment. Within the ADF, *Full Command* is exercised by CDF, who delegates *Theatre Command* to the Chief of Joint Operations for most, but not all, ADF operations. Air command and control is an essential enabler of this function.

- **Situational understanding.** Situational understanding plays an important role in alerting Defence planners to the nature and scale of existing or emerging security threats to Australia and its interests and is an essential prerequisite for the conduct of campaigns and operations. Situational

understanding is equally important during the execution of operations. Air intelligence and ISR is an essential contributor to situational understanding.

- **Force projection.** Movement and manoeuvre (force projection) allow friendly forces to exploit the operational environment while denying the same freedom to an adversary. Force projection of military elements within the air domain is largely contingent on the basing requirements of those elements. Air power plays a key role in force projection for all the physical operating domains.

- **Force protection.** Force protection is defined as all measures and means to minimise the vulnerability of personnel, facilities, equipment, and operations to any threat and in all situations, to preserve freedom of action and the operational effectiveness of the force. Force protection encompasses all measures—except those covered under force application—taken to protect the capability of a force from operational, environmental, and occupational threats. Protection of elements within the air domain is partly a function of counter air and airbase operations and has key dependences across all other operational domains. Likewise, air power plays a key role in providing force protection to all other operational domains.

Force protection.

- **Force application.** Force application is the single function that is unique to the military instrument of national power. At its core is the potential for the legitimate application of lethal force on external actors. Clear authorities and careful planning are essential to achieving strategic, operational, and tactical objectives through force application. The air domain offers notable advantages for this function in certain operational contexts due to the characteristics of air power as described in Chapter 3.

The optimal achievement of joint functions requires the best possible interoperability between all force elements within Defence, or as described by the living language of Defence, at the *joint layer* we need to ensure the highest achievable *integrated level* of interoperability across all *dimensions*. Of course, as we keep on highlighting, it is never just about Defence.

CHECKPOINT – Air power is part of the joint force, and the backbone of the joint force in integration. Achieving integration can be difficult and, therefore, lower levels of interoperability are often sufficient to effectively carry out joint functions in some operational contexts.

We now move into the second and third *layers* of the interoperability framework; whole-of-government and multinational.

WHOLE-OF-GOVERNMENT INTEGRATION

The military is but one instrument of national power. For most strategic problems, military power will be integrated within a whole-of-government framework to provide a set of options for achieving national objectives.

ADF support to national emergencies.

While military systems are generally structured for armed conflict, due to the uncompromising demands of that particular operational context, they can equally provide the government with options for dealing with domestic or international situations across the spectrum of competition.

Whereas the joint force is the default construct for dealing with military objectives and the application of military power, there is no default construct for a task force that involves a number of government departments. Close cooperation and understanding of what each department can contribute to a whole-of-government effort is critical.

At the whole-of-government level we can still aim for a level of integration, however, the systems between departments are often, and necessarily, different. That said, we can still aim for a high level of interoperability through compatibility, if not integration. By sharing doctrine, process and procedures, our aim is to educate our partners on what and how the military can contribute to national objectives.

Communication and planning are clearly critical and yet, herein lies one of the key obstacles—the living language of Defence. Our approach is often abrupt and reliant upon brevity. Other government departments will also have a language of their own. Again, the more we educate, train and most importantly, communicate, the more we overcome these difficulties of language.

MULTINATIONAL INTEROPERABILITY

Multinational interoperability.

From the outset you will note we use the heading of *multinational interoperability* and not *multinational integration*. Why? Because the multinational layer is the most complex and often the one in which the most obstacles will be found.

Operations at the multinational level usually bring together a complex set of capabilities, culture, procedures, and rules often unique to the supporting nation. While close interoperability, up to integration, may be possible between some allied nations, for other partner nations deconfliction can sometimes be the only option. This can be driven by incompatibilities in technology, differing national interests or even simply by language.

We should never constrain ourselves to the lowest level of interoperability that can be collectively achieved in multinational operations. We must integrate where we can with other nations. We should

only strive for compatibility where integration is not feasible and resort to deconfliction only when absolutely necessary.

Understanding our potential multinational partners—engaging with them in peacetime, exchange programmes, collective training and sharing of doctrine, processes and procedures—can help to alleviate some of the interoperability obstacles.

CHECKPOINT – Interoperability is a complex but essential part of any military operation. The Defence interoperability framework is useful for understanding, and working through, the challenges of interoperability.

Lastly, we will turn our focus back to the integration of air power contributions, particularly people.

INTEGRATION OF AIR POWER CONTRIBUTIONS

The contributions of air power to joint effects must be designed, generated, and prepared with the imperatives of integration and interoperability front of mind. Air power is not an end unto itself; it is part of a complex suite of elements that all need to work together as part of whole-of-government efforts to support national objectives, often in partnership with other nations.

The air power contributions framework acknowledges the key role of joint force planners in selecting the correct mix of joint force contributions to meet the unique challenges of specific operating environments and objectives—the aim being to combine the best contributions, from all of the domains, to deliver desired effects.

Viewed through a lens of horizontal integration, the utility of a low-observable air strike capability can be enhanced through leveraging its potential as a survivable ISR platform. Similarly, a transport aircraft's utility is potentially much broader than a traditional air mobility role. As an example, the airborne insertion of a Special Forces team to neutralise an adversary's capability may provide the same operational effect as striking it with air-launched kinetic weapons but may have benefits at the national strategic level.

Embracing horizontal integration requires capability mangers to meaningfully consider—with the core purpose of supporting national objectives front of mind—how to best generate and prepare force elements (platforms, materiel and personnel) to contribute to joint effects. These contributions frame the orchestration of effects in the air domain and represent the operational art of air power.

Air power contributions require air power practitioners to understand the theory of air power and value effects over aircraft, thereby resisting platform-centric thought. They also require air power practitioners to be comfortable operating within Defence's operational domain construct and with our partners, to be true military professionals. In other words, they require air power mastery.

CONCLUSION – Air power will not work alone. It will form part of a joint, whole-of-government, or even multinational, task force during operations. Interoperability is complex, Defence has developed a framework of *layers*, *levels* and *dimensions* as a way of making sense of that complexity. Understanding this and putting it into practice alongside partners who are unfamiliar with it, requires considerable expertise, experience. and professionalism.

In the next chapter we will take a closer look at the role of people in air power and the pathway to air power mastery.


DANGER
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CHAPTER 6

AIR POWER MASTERY

INTRODUCTION – In this final chapter, we will turn our focus fully towards the most important element of air power—the air power practitioner. We have used the term air power practitioner throughout the manual, and we will now examine the training, education and professional mindset that underpins that collective term, along with what it takes to attain air power mastery.

As you read through this chapter you should consider the following questions:

- What is the role of air power practitioners in the delivery of air power?
- How can training and education opportunities be used to best achieve professional mastery?
- What are the next steps in my learning journey?
- How can I use my knowledge and experience to help mentor the next generation of air power practitioners?

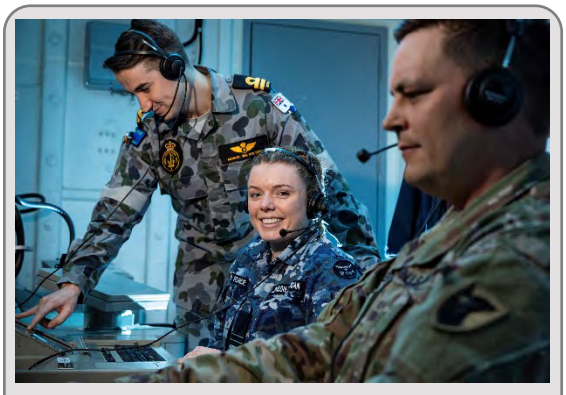
War is a human endeavour. It requires human engagement cognitively, physically, and socially within and across each operational domain. It is the humans within any given air power system that ensure it is developed, managed and employed professionally and that it adds value to the military instrument of national power in pursuit of national objectives. In this chapter, we will look at air power mastery and why it underpins air power's ability to achieve military advantage—this is the core of the *how* of air power.

AIRMINDEDNESS

AIRMINDEDNESS – the sum of an individual's depth and breadth of knowledge and understanding of the characteristics and employment of air power.

People are the foundation upon which air power is built. It is people who decide how all aspects of technology and force structure are developed, employed, sustained, and maintained. *Airmindedness* encapsulates how air power practitioners apply their non-materiel resources—such as intellect, emotions, motivation, and leadership to achieve national objectives.

Airmindedness is both a collective and individual phenomenon; both are mutually reinforcing. In terms of the collective, airmindedness represents everything from a national awareness of the broad benefits of aviation through to how air power specifically enhances organisational capabilities and outcomes. At the individual level, airmindedness can simply be a passion for flight through to the development and application of specialist aviation skills and knowledge.



Air power practitioners.

History has shown us that air power practitioners, through their various experiences employing air power, develop distinct perspectives regarding the concept, characteristics and conduct of military operations. Through experience, practitioners

progressively develop nuanced understanding of the fundamental properties of the air environment and the characteristics and considerations of air power.

We achieve airmindedness through education, personal development, culture, organisational values, and experience gained across a range of air power related activities. Airmindedness presents as the instinctive ability to understand how air power can effectively contribute to joint effects that support whole-of-government efforts to deliver national objectives.

THE PROFESSION OF ARMS

Members of the Australian Defence Force (ADF) belong to the profession of arms—one of the four 'classical' professions in society.[1] This profession involves, among a great many other things, employing organised violence in the national interest. It carries responsibilities that no other individual, agent or organisation within a nation can either legally or morally undertake. The military is the only profession that has the legal capacity and obligation to plan for and deliberately apply lethal force. ADF personnel base their professional focus on service to the nation. The Defence focus leads to intellectual discussions on tactics and operations, the best ways to deliver military outcomes, and extends to strategic considerations that examine the nature and ever-changing character of war.

The increasing focus on integrated operations is generating communities of practice which broadly specialise in maritime, land, air, space and cyber power.

With the central importance of multi-domain integration to optimising military power, it is imperative to understand how specialty areas contribute as part of the collective to achieve joint effects.

Understanding the Profession of Arms.

Capability managers challenge their people to solve the issues related to shifts in the strategic environment, technology and the human attributes required to best deliver military effects. This challenge requires air power practitioners to continually seek to expand their skills, knowledge and experience—to achieve an *intellectual edge*.

CHECKPOINT – There is no doubt that an understanding of air power comes through an inherent appreciation of the theory and practice of air power—what air power can contribute and when it is best employed.

It is this airmindedness that provides common ground when working alongside fellow air power practitioners, but also underpins the ability to integrate effectively with those less familiar with air power—both outside and within the profession of arms. Airmindedness is an essential element, alongside an equally deep appreciation within others across all the domains, to crafting optimal joint force contributions in support of whole-of-government efforts to deliver national objectives.

In the next section we will make the case for air power practitioners to go beyond airmindedness—we will look at the need for an intellectual edge.

[1] The other three classic professions are the *Profession of Medicine*, *Profession of Divinity* and *Profession of Law*.

INTELLECTUAL EDGE

Air power practitioners are often faced with unstructured challenges where the solutions will never include just one option. Preconceived solutions of the past do not guarantee success against current and emerging problems.

Air power practitioners must appreciate that their understanding of a problem, or its solution, will always be imperfect. The future is uncertain, geopolitics is in a constant state of flux and technological advancement will continue at pace—with surprises at every turn. Air power practitioners need to continually strive for an intellectual edge to remain effective in uncertainty.

An intellectual edge demands imagination, innovation, and analysis. It is often thought of as a personal endeavour, however, air power practitioners develop and maintain an intellectual edge through engagement with wider professional communities—thinking around and through challenges in new and novel ways.

Maintaining an intellectual edge.

Air power practitioners need to consume information and be prepared to contest ideas. They need to be able to rapidly adapt to change and be comfortable in testing limits—accepting failure and learning fast—this is how an intellectual edge is achieved and maintained.

The most successful professionals are those who take on this challenge with humility and a thirst for knowledge. High performing professionals choose to learn from the expertise of others every day—to fill the gaps in their own knowledge and experience. This professional mastery is achieved through hard-won experience and an active pursuit of an intellectual edge.

CHECKPOINT – An intellectual edge is the pathway to professional mastery. Being able to analyse and solve emerging problems, drawing upon skills, knowledge and experience, faster than an opponent, enables military advantage—in any operating domain.

In the next section we will examine the ADF's professional mastery framework.

PROFESSIONAL MASTERY

The most important factor in the successful application of military power is the professional mastery of its practitioners. The effective exercise of military power must be tailored to integrate with all other instruments of national power for the purpose of achieving national objectives.

PROFESSIONAL MASTERY – the measure of the ability of Defence members to execute their duties, encompassing: their ability to perform these duties in a range of circumstances; their self-confidence to act autonomously despite risk and ambiguity; and their understanding of the purpose and consequences of their actions.

Professional mastery makes the difference between the judicious application of military power towards desired ends, and the ineffective dissipation of precious and finite national resources.

There is no set mould or specific pathway to mastery. It is through the unique experiences of each air power practitioner that diversity of thought and pathways for further development are generated.

Professional mastery is a career-long journey. The closest to absolute attainment any individual can achieve is a function of how long they actively pursue a genuine desire for continuous learning. Once the active pursuit of mastery wanes, so does the level of attainment.

Defence employs a professional mastery framework consisting of *technical mastery*, *Defence mastery* and *social mastery*. This framework acknowledges and encourages learning beyond the classroom.

Balance within this framework is essential. Defence and technical mastery form the knowledge and skills elements of this balance. Too much focus on knowledge risks perspectives becoming too theoretical, while too much focus on technical skills risks a lack of strategic awareness. Social mastery then balances the gaps and potential for over reliance on either technical or Defence mastery.

Technical mastery

Defence air power practitioners commence their careers with a technical focus. It is commonly the chosen vocation of the individual and it delivers necessary tactical outcomes for the military instrument of national power. Technical mastery in the military differs somewhat to technical mastery in society. Air power practitioners in Defence are often expected to master multiple technical functions throughout their career and, in some cases, outside of their chosen initial employment streams.

Establishing technical mastery.

Technical mastery is the combination of an individual's training, knowledge and experience; integrated with the skills that deliver a specific employment function.

Defence mastery

Defence mastery is often reflected in theoretical concepts and discussions. The skills and knowledge acquired through Defence mastery provides integration opportunities across all operational domains and focuses practitioners beyond just air power concepts.

Defence mastery through air power concepts.

Defence mastery relies on individuals to consume information, engage in a contest of ideas, challenge assertions and seek evidence for absolute claims. Defence mastery can even create the potential to recognise when a military solution to a military problem may not achieve the best outcome for the nation.

Social mastery reflected in social engagement.

Social mastery

The ability to work well with others is critical to achieving objectives. Social mastery is not just being professional, it is about being approachable, creating formal and informal networks and being able to generate influence through constructive engagements. Air power practitioners in the ADF need to not only be effective as team members within the joint force, but also with colleagues across Defence and whole-of-government.

Social mastery can be as simple as a welcoming nod or wearing business attire over uniform to a whole-of-government planning group, along with ensuring that the living language of Defence does not present a barrier in such settings. It can be as difficult as working without ego to accept a concept that may challenge personal feelings or ideas while assessing the merits of an argument.

Often, social mastery is the intangible or understated relationship that is shared from our commonality and our differences. It is through our common core values that we can harness the strength from diversity and break down social and professional barriers.

CHECKPOINT – The three components of the framework above are all interrelated and support each other in the pursuit of professional mastery.

Critically, all three must evolve together through a structured programme of personal development, training, and education. This will be discussed in the next section, along with leadership and societal expectations of air power practitioners in ADF.

MILITARY TRAINING, EDUCATION AND PERSONAL DEVELOPMENT

On induction into the military, a person brings with them their own life and cultural experiences. Very few come into the military with a clear understanding of their chosen vocation. For this reason, the professional mastery framework, introduced above, includes an outer layer comprised of training, education and personal development—all of which serve to progressively unlock the individual's technical, Defence and social mastery.


Core military training.

Military training. Military training underpins technical mastery and prepares individuals to

act with certainty in an uncertain environment by instilling instinctive procedures, processes and knowledge. Military training can be used to validate, verify and certify the preparedness of an individual, unit or task group.

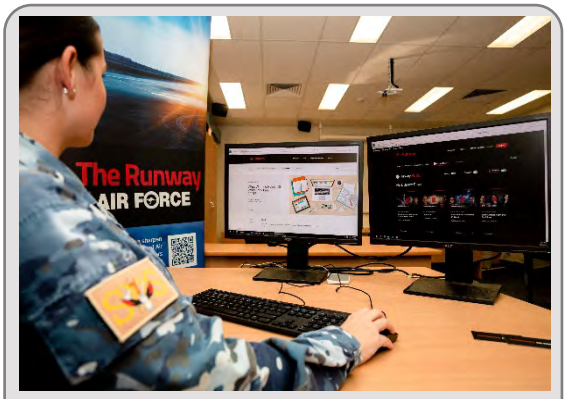
Military education. Military education prepares individuals for uncertainty and complexity by further developing knowledge, adaptability, judgement and creativity. For the ADF, military education is intended to generate a thinking force. While introduced at an early level of career progression, it tends to be developed more thoroughly once the individual has a significant level of military and operational experience to draw upon.

Personal development. Whereas military training and education are part of a formal structure, personal development focuses on the individual's desire to improve themselves through self-motivated means such as post-graduate study, expanding their breadth of reading and being an active part of the ongoing conversation on military power.

Education and training continuum

The ADF education and training continuum integrates opportunities across an individual's career. At each level, expectations of leadership, Defence mastery and social mastery increase. Technical mastery, however, focuses on the proficiency and individual skillsets required of a particular position or job.

Firstly, the tactical is mastered. Then operational integration become the focus before progression through joint development to strategic integration. This journey develops professionals who are ultimately able to function within the joint, whole-of-government and multinational environments. This continuum, at its peak, is designed to generate strategic thinkers who are able to lead, advise and follow as part of the national approach to any activity.



Gateway to military education.

You cannot rely on just what the system provides. Professional currency cannot be achieved from formal courses alone. While relevant, such courses are limited to strict learning criteria and limit diversity of thought across the profession. Currency ensures the appropriate knowledge, skills, and ethical foundations are maintained and, where appropriate, challenged to drive improvement within a profession.

Each practitioner is responsible for their own development. A personal commitment to lifelong learning not only leads to mastery, but also maintains currency in your chosen field.

VALUES, CULTURE, ETHOS AND BEHAVIOUR

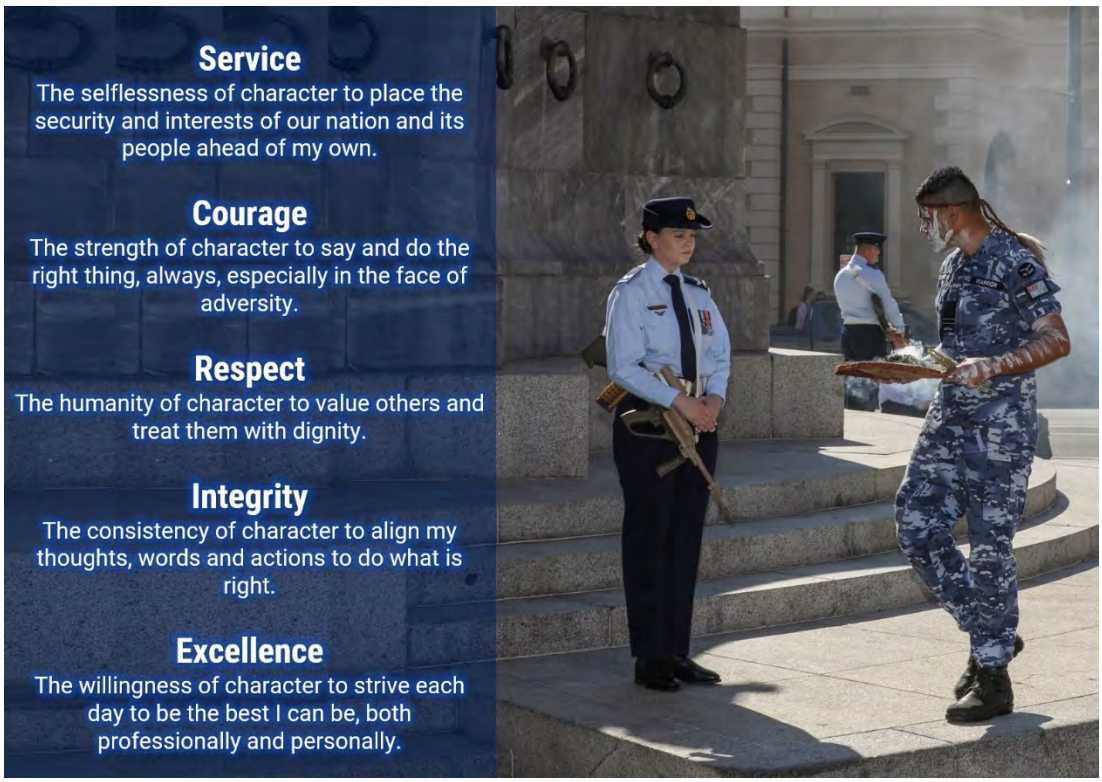
The traditions and customs that contribute to the ADF's identity are reflected in the values and ethos it promotes and the manner in which its people adhere to, and embody, those qualities. The values demonstrated by the ADF are an indicator of the Australian national identity and our societal expectations.

The ADF is held to account by the Australian people and is expected to operate within the national bounds of legality, morality, and ethics. The ADF's values guide the way the people act, individually and collectively, and demonstrates its commitment to Australia's societal norms. Of all the enduring characteristics of the ADF, effective leadership is at the heart and inspires, underpins and enables all the other qualities and capabilities of the ADF.

Embracing social diversity.

Defence values social diversity within the team. This means different life experiences, different cultural understanding, and different beliefs. These differences strengthen the delivery of airpower through diversity of experience and thought. Only by valuing each individual's perspectives on, and experiences with, air power, can a professional community best work as a team to achieve national objectives.

Professional masters realise inclusion and acceptance of diversity generates an environment where all individuals are empowered to meet and act upon the ADF values. The Chief of the Defence Force (CDF), as commander of the ADF, has high expectations and standards for every serving member. While diversity is embraced, conformance to expected behavioural standards is not conditional. The ADF doctrine publications on *ADF Leadership*, *Military Ethics* and *Military Character* codify CDF's expectations and are fundamental readings for every air power practitioner in the ADF.



CHECKPOINT – Through training, education, and professional development, an individual will be given the opportunity to enhance their professional mastery of air power.

For air power practitioners in the ADF, part of this journey will be mandated through programmed training and education however, a critical part must be developed through individual motivation—a desire to be part of the profession of arms.

Additionally, military professionals are required to live by Defence's values, to uphold society's expectations and act in a manner that embraces the culture of the ADF. You must understand what it is to work morally and ethically, and how that will impact on your decisions and actions in employing air power, regardless of your role.

The concluding section of this manual turns its eyes skyward, towards the future, and lays forth an enduring challenge to air power practitioners as they strive for mastery—a challenge for you!

THE FUTURE CHALLENGE FOR AIR POWER PRACTITIONERS

> 'If there is one attitude more dangerous than to assume that a future war will be just like the last one, it is to imagine that it will be so utterly different that we can afford to ignore all the lessons of the last.'
>
> **JC Slessor**
> **Air Power and Armies, 1936**

The profession of arms requires, among many other things, airminded professionals that have a holistic understanding of the theory and practice of air power and how it contributes to the joint force as part of the military instrument of national power. This includes learning relevant lessons from the past and seeking to apply them to emerging and novel trends. They must seek to leverage every opportunity to gain military advantage, be it through the emergence and confluence of technologies, or changes in the natural and strategic environment.

While the environment in which the Defence will operate tomorrow may look familiar to those who wish it so, it will also provide novel and unforeseen opportunities to gain military advantage for those who search for it.

The key for us into the future is to look forward, anticipate change and adapt accordingly, while also seeking to apply the lessons of the past where they remain applicable; in other words, exploit our professional mastery.

Embracing our past, but focusing on our future.

As air power practitioners you will be faced with unstructured challenges where the solutions will never include only one option. Any preconceived solutions from the past will not solve these challenges.

It will always be important to appreciate that your understanding of a problem, or its solution, will always be imperfect. The future is uncertain. Therefore, you must continually strive for an intellectual edge to remain effective in that uncertainty.

What changes?

While the future is unknowable, it can be assumed some aspects and trends within today's operating environments will continue to have some relevance. Also, as reputedly articulated by Mark Twain, 'History doesn't repeat itself, but it often rhymes.' In your ongoing pursuit for an intellectual edge, you must look for possible military advantage in the glimpses of what could be and the echoes of what has been.

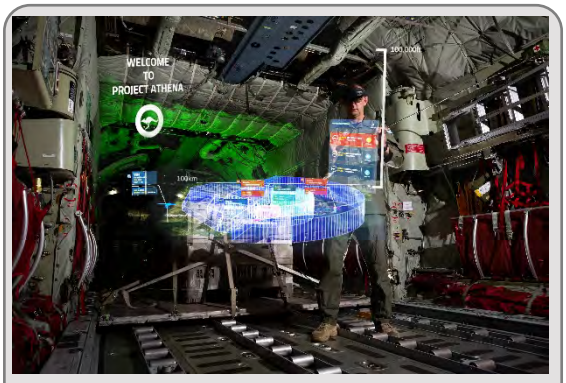
It is commonly assumed the era of constant competition is here to stay for the foreseeable future. We now live in a much more competitive world, and the complex nature of the global system has created the conditions in which states are able to compete in new ways short of what we would have defined as war in the past, exploiting the seams between cooperation and conflict.

Unlocking cutting edge technology.

Our competitors will also leverage the limits of our logic and our theories—such as those presented within this manual—and will most certainly seek to operate outside any logic we are seen to slavishly adhere to. No logic can ever be flawless; we must acknowledge its strengths and limitations and constantly seek to improve. The imperative is to continually ask ourselves why we are doing what we are doing, what happens when we do it and what are the limits and constraints that could be leveraged by an adversary.

Technology will continue to evolve and, occasionally, transform. Perceiving the impact of future technologies on the character of air power will remain an inherent challenge to all air power practitioners. The very nature of the human–technology relationship that is so central to air power has shifted through history—and will continue to do so.

The future battlespace is expected to be far more complex, contested and congested; one where time-sensitive decisions will need to be made that cannot rely on the time taken for human consideration and decision-making. The application of future air power will need data gathering, information processing, and decision-making at performance speeds beyond the limits of human capacity.



Virtual operations room.

One of the future challenges for air power, and all elements of military power, will be to meet the increased implementation of artificial intelligence and autonomous systems while retaining the ethical place of the human in the decision cycle. While laws and community standards may change over time, the linkage to military application of the legal, ethical and moral framework will remain constant.

UNCREWED AERIAL VEHICLES – BACK TO THE FUTURE

While modern uncrewed aerial vehicles are increasing in both number and capability, the use of uncrewed aircraft began as early as 1896. In May of that year, Dr Samuel Langley proved that mechanical flight was possible with his *Aerodrome No. 5*, an uncrewed aircraft.

In 1918, Orville Wright co-designed an uncrewed biplane, the *Liberty Eagle*—nicknamed the *Bug*. Launched using a trolley and rails, in much the same way as the *Wright Flyer*, this aircraft could carry a payload of 90 kilograms of explosives and was guided by a gyroscopic stabiliser. It was the first attempt at a guided missile.

1918 Liberty Eagle.

In 1918, the US Army became interested in unmanned flight and ordered 25 *Liberty Eagle* aircraft. The intent was for the aircraft to be used as an aerial torpedo.

Just over two decades later in 1941, the *OQ-2 Radioplane* became the first mass-produced uncrewed aerial vehicle. By 1945, only a few years later, radioplane factories had produced around 15,000 aircraft for use as target drones.

Since achieving the first sustained controlled flight, the idea of uncrewed flight has grown to be one of the most useful aircraft technology systems in modern history.

Today, uncrewed aircraft have transformed from a basic tool into high-technology machines—providing assistance during both humanitarian and war time scenarios.

What do you see as the future of uncrewed aerial vehicles? What are the opportunities for the ADF?

What endures?

While the future geo-strategic environment will continue to be much more complex, one thing will remain constant for us. We can no longer just focus on our ability to *respond* to conflict. We must continue to focus on how to best contribute to *shaping* and *deterrence* in all that we do.

Shaping Australia's strategic environment.

This will require us to develop novel connections and collaborations within government to ensure we remain effective across this broader spectrum of requirements.

One constant in a dynamic and uncertain future, is that the most essential element to effective air power will remain the mastery of its practitioners. The key to success in any possible future will be you, your experience, and your professional mastery, even if you are only just starting your journey and this manual is your first exposure to the complexities of air power and our operating environment.

Don't assume anything you have read so far is the answer! While history will continue to provide valuable insights, it should be seen as a springboard from which you open your mind to new ideas and ways of thinking.

THE FINAL CHECKPOINT – People are the heart of air power and its contributions to the joint force—which are part of whole-of-government efforts in support of national objectives.

Through military training and education, we create the core experiences of air power practitioners. By encouraging their personal development, we help them on their journey towards professional mastery. Air power mastery embodies the desire to contest ideas and best prepare air power for future challenges.

PARTING THOUGHTS …

Air power has always challenged human imagination, long before powered flight. The theories developed for air power's optimal use evolved over time and have driven and guided us to our current conceptions. It is now, as always, time to look forward and develop the next generation of air power theory, and air power practitioners. That's you by the way, so here are some questions you should be thinking about:

How can future air power best support and integrate with whole-of-government efforts to deliver national objectives?

What happens when no one contests the ideas that are driving air power into the future?

What else should be in this manual … and how can you make it better?

This ends your journey through *The Air Power Manual.* Hopefully it has opened your mind to the near boundless possibilities of air power.

As a final comment, this manual was never meant to be the one and only discussion you engage with on air power. Consider it as a primer for a career-long journey.

Be proud of your role as an air power practitioner. Know your profession and represent it well. You are the key to air power's future.

Good luck on your journey!

Consume

…

Contest

…

Contribute

…

Collaborate

LIST OF VIGNETTES

RECOMMENDED READINGS

Your future air power education will rely upon you reading far more widely than just this manual. What follows is a list of publications that should start you upon that journey.

ADF policy, concepts, plans and guidance

The Australian Defence Force (ADF) is underpinned by a dynamic set of policy, concept, plans and guidance documents used in the management of the joint force. What follows are the principal documents that will assist you in your ongoing learning, particularly in understanding the ADF's strategic environment. Note, however, that some of these publications may be withdrawn during the life of this manual whereas others will be regularly updated.

- ***Defence White Paper*** sets out a comprehensive, responsible long-term plan for Australia's defence. The Government is investing in defence to ensure we have the armed forces we need to protect Australia and to secure our interests in the coming decades.

- ***Defence Strategic Update*** sets out the challenges in Australia's strategic environment and their implications for Defence planning. It provides a new strategic policy framework to ensure Australia is able, and is understood as willing, to deploy military power to shape our environment, deter actions against our interests and, when required, respond with military force.

- ***Force Structure Plan*** details the Government's intentions for new and adjusted ADF capability investments to implement the new strategic objectives contained within the Defence Strategic Update.

- ***Defence Interoperability Guidance*** is Defence's approach to optimising interoperability of the Joint Force at the whole of force level. Its purpose is to ensure the Joint Force is sufficiently interoperable to meet strategic guidance set by government.

- ***Air Force Strategy*** informs how Air Force will posture itself to achieve air and space effects across the operational spectrum and meet Defence strategic objectives to *shape*, *deter* and *respond*.

ADF doctrine

Doctrine draws upon our rich history and shapes the knowledge and beliefs that underpin the way the ADF achieves national objectives. The ADF has a single knowledge base of doctrine—the ADF Doctrine Hierarchy. All of the ADF doctrine publications are available on the Defence Protected Environment at http://drnet/vcdf/ADF-Doctrine/Pages/ADF-Doctrine-Library.aspx, however, these are not available on the internet.

Of the 50-plus publications within the ADF doctrine hierarchy, the following four are fundamental next steps in learning. The first two are capstone publications which will provide a deeper level of understanding of the concepts we have presented in this manual. Whereas the *Military Ethics* and *ADF Leadership* publications are core to Chief of the Defence Force's (CDF) expectations of you as military professionals.

- **ADF-C-0 *Foundations of Australian Military Doctrine*** is a capstone document in a hierarchy of publications from which all ADF doctrine is derived. This publication provides overarching guidance for the employment of the ADF in support of Australian Government objectives.

- **ADF-C-0** ***Australian Military Power*** is a capstone document that describes how the ADF employs the unique attributes of the physical and non-physical domains to deliver military strategic effects in support of national objectives.

- **ADF-P-0** ***Military Ethics*** provides a philosophical-level reference for the ADF on military ethics. It aims to reflect, complement and reinforce the ADF warfighting philosophy, as well as inform it.

- **ADF-P-0** ***Military Character*** codifies an ADF approach to character and character development at the philosophical level.

- **ADF-P-0** ***ADF Leadership*** provides a foundation for understanding leadership and serves as a guide for leader training and development across the ADF. It distils ideas and principles pertinent to leadership in the military that have endured through history.

Air and Space Power Series

The Air and Space Power series is a collection of publications that compliment ADF doctrine and are intended to provide learning and invoke thought. These publications are not doctrine, but are closely aligned.

- ***The Space Power Manual*** is a professional guide to assist Defence personnel and our partners in national security to gain the understanding necessary to generate, apply, project, and sustain space power, including space power's contribution to decision support.

- ***Australian Experience of Air Power*** is a concise history of the Royal Australian Air Force from its beginnings to its role as a vital part of the Australia Defence Force of the 21st century.

INDEX OF KEY TERMS

Throughout this manual we have introduced you to a number of new terms—the living language of Defence. Some have been formally defined in green text boxes, while others have been discussed within the text. This index will assist you in finding the place in the publication where each term is primarily discussed. The list is not exhaustive, nor is it intended to be.

ABBREVIATIONS

Abbreviations are very much a part of the living language of Defence and are often used to achieve brevity. The ones listed here include those used through this manual and not an exhaustive list of abbreviations you will encounter during your career.

AAP	Australian Air Publication
AAR	Air-to-Air Refuelling
ABF	Australian Border Force
ACE	Airspace Control Element
ADF	Australian Defence Force
ADG	Australian Defence Glossary
ADIZ	Air Defence Identification Zone
AFP	Australian Federal Police
AFSTRAT	Air Force Strategy
ALS	Air Logistics Support
AME	Aeromedical Evacuation
AMP	Australian Military Power (ADF doctrine publication)
APM	*The Air Power Manual* (Air and Space Power series publication)
AOC	Air and Space Operations Centre
APOD	Air Point of Disembarkation
APOE	Air Point of Embarkation
ASOC	Air Support Operations Centre
ASuW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATG	Air Task Group
CAS	Close Air Support
CDF	Chief of the Defence Force
CJOPS	Chief of Joint Operations
DCA	Defensive Counter Air
DG-AIR	Director General-Air
DIE	Defence Intelligence Enterprise
DIME	Diplomatic, Information, Military, Economic
DSTG	Defence Science and Technology Group
EW	Electronic Warfare
EZ	Exclusion Zone
FASOC	Future Air and Space Operating Concept
FIR	Flight Information Region
FoAMD	Foundations of Australian Military Doctrine (ADF doctrine publication)
FOB	Forward Operating Base
GNSS	Global Navigation Satellite Navigation
GPS	Global Positioning System

HQJOC	Headquarters Joint Operations Command
IAMD	Integrated Air and Missile Defence
ICAO	International Civil Aviation Organisation
IS	Islamic State
ISB	Intermediate Staging Base
ISR	Intelligence, Surveillance and Reconnaissance
JFACC	Joint Force Air Component Commander
JOC	Joint Operations Command
JORN	Jindalee Operational Radar Network
JSF	Joint Strike Fighter
JTAC	Joint Terminal Air Controller
JTFCDR	Joint Task Force Commander
LOAC	Law of Armed Conflict
LZ	Landing Zone
MOB	Main Operating Base
OCA	Offensive Counter Air
PED	Processing, Exploitation, and Dissemination
PGM	Precision Guided Munition
RAAF	Royal Australian Air Force
ROE	Rules of Engagement
SPM	*The Space Power Manual* (Air and Space Power series publication)
TACP	Tactical Air Control Party
TACS	Theatre Air Control System
UAV	Uncrewed Aerial Vehicle
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea

ACKNOWLEDGEMENTS

This manual is drawn from both the knowledge and experiences of the ADF as well as from allied and other foreign sources. While this manual is not for commercial sale, a list of acknowledgments will not only serve to properly attribute content to source but can also provide you additional references for further reading. All of the acknowledgements contained here were correct at the time of publishing.

Front Matter

a. **Front cover, Indigenous Artwork:** *'Caina Putut, Ilya, Wartanganha'*
Artist: Ms Chern'ee Sutton
Source: https://www.cherneesutton.com.au (reproduced on approval through the Directorate of Indigenous Affairs, Department of Defence)
Story: The painting is titled *'Caina Putut, Ilya, Wartanganha'* meaning *'Long ago, Today, Tomorrow'*. The artwork was presented to Defence by Ms. Sutton at the 2017 Conference and is currently displayed in Deputy Secretary Defence People's office with the custodianship of the artwork residing with the Directorate of Indigenous Affairs, Department of Defence.
Reproduction: The indigenous artwork, *'Caina Putut, Ilya, Wartanganha'*, reproduced on the front cover of this publication cannot be reproduced, copied, or shared without the specific approval of the artist. Applications for use can be made through the custodian of the artwork: the Directorate of Indigenous Affairs, Department of Defence.

b. **Front Cover, Photograph:** *E-7A Wedgetail crew,* Defence imagery
Source: http://images.defence.gov.au/20200818adf8567820_061_1.jpg
Caption: Surveillance and Control Officers man their terminals on a Royal Australian Air Force E-7A Wedgetail aircraft in the Middle East region.

c. **Inner Sleeve, Image:** *Air power model*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

d. **p. i, Image:** *CAF Badge*, Defence artwork

e. **p. i, Photograph:** *CAF Portrait*, Defence imagery

f. **p. ii, Image:** *Air and Space Power Centre Logo*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

g. **p. iv, Image:** *Aims of the air power manual*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

h. **p. v, Image:** *Air and Space Power Centre QR-code*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

Chapter 1

a. **Chapter cover, Drawing:** *Historical air power*, Released under Creative Commons v4.0
Source: https://commons.wikimedia.org/wiki/File:Early_flight_02561u_(1).jpg
Caption: Part of a series of collecting cards with pictures of events in ballooning history from 1795 to 1846.

b. **p. 1–2, Photograph:** *National air power*, Defence imagery
Source: http://images.defence.gov.au/20110305raaf8160650_0161.jpg
Caption: A birds eye view of the 2011 Australian International Airshow and Aerospace & Defence Exposition, held at Avalon in Victoria from 1-6 March.

c. **p. 1–2, Photograph:** *Starting their air power journey*, Defence imagery
Source: http://images.defence.gov.au/20190723raaf8185068_0152.jpg
Caption: Officer Cadets receive theory lessons on leadership during classroom instruction at Officers' Training School in East Sale, Victoria.

d. **p. 1–3, Image:** *Air power theory to practice*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

e. **p. 1–4, Photograph:** *Educating the wider audience on air power*, Defence imagery
Source: http://images.defence.gov.au/20190729raaf8198167_013.jpg
Caption: Australian Air Force Cadets from No 8 Wing in the Northern Territory inspect the flight deck of a No 37 Squadron C-130J Hercules aircraft during a flight over Darwin.

f. **p. 1–4, Photograph:** *Learning for our past*, Defence imagery
Source: http://images.defence.gov.au/20200204ran8061448_023.jpg
Caption: Former naval aviators hold their book '*Wings of Gold*' in a UH-1 Iroquois helicopter at the Fleet Air Arm Museum, HMAS Albatross.

g. **p. 1–5, Vignette Photograph:** *General Giulio Douhet*, Public domain, copyright expired
Source: https://commons.wikimedia.org/wiki/File:Giulio_Douhet.jpg
Caption: General Giulio Douhet, Italian Army (30 May 1869 – 15 February 1930).

h. **p. 1–5, Vignette Photograph:** *Marshal of the RAF Hugh Trenchard*, Public domain, copyright expired
Source: https://commons.wikimedia.org/wiki/File:Hugh_Trenchard,_1st_Viscount_Trenchard.jpg
Caption: Marshal of the Royal Air Force Hugh Montague Trenchard, 1st Viscount Trenchard GCB OM GCVO DSO (3 February 1873 – 10 February 1956).

i. **p. 1–5, Vignette Photograph:** *Air Vice-Marshal Henry Wrigley*, Public domain, copyright expired
Source: https://en.wikipedia.org/wiki/File:UK2063Wrigley1944.jpg
Caption: Air Vice-Marshal Henry Wrigley CBE DFC AFC (21 April 1892 – 14 September 1987).

j. **p. 1–6, Photograph:** *Patrolling Australians maritime approaches*, Defence imagery
Source: http://images.defence.gov.au/20180908adf8160650_021.jpg
Caption: Low level rigging run in a C-27J Spartan to observe a small vessel on the Great Barrier Reef during Operation *Resolute* in Townsville.

k. **p. 1–7, Image:** *First two layers of the air power model*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

l. **p. 1–8, Photograph:** *Military effects linked to national objectives*, Defence imagery
Source: http://images.defence.gov.au/20191119ran8562953_296.jpg
Caption: His Majesty's Armed Forces of Tonga and the ADF during a Humanitarian Aid and Disaster Relief amphibious demonstration in Nuku`alofa, Tonga.

m. **p. 1–8, Image:** *Spectrum of conflict*, Defence artwork
Source: ADF-C-0 *Australian Military Power*, Lessons and Doctrine Directorate, Vice Chief of the Defence Force Group

n. **p. 1–9, Photograph**: *Fighting power*, Defence imagery
Source: http://images.defence.gov.au/20200818adf8567820_061_1.jpg
Caption: Surveillance and Control Officers man their terminals on a Royal Australian Air Force E-7A Wedgetail aircraft in the Middle East region.

o. **p. 1–9, Image:** *First three layers of the air power model*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

p. **p. 1–10, Image:** *Domains of the operational and information environments*, Defence artwork
Source: ADF-C-0 *Australian Military Power*, Lessons and Doctrine Directorate, Vice Chief of the Defence Force Group

q. **p. 1–11, Photograph:** *Multi-domain operations*, Defence imagery
Source: http://images.defence.gov.au/20200724raaf8208022_273.jpg
Caption: A formation from the Royal Australian Air Force of an E-7A Wedgetail from No 2 Squadron, three F/A-18A Hornets from No 77 Squadron and an EA-18G Growler from No 6 Squadron fly over a Royal Australian Navy task group of HMA Ships *Canberra, Hobart, Stuart, Arunta* and *Sirius* during the Regional Presence Deployment in July 2020.

Chapter 2

a. **Chapter cover, Photograph:** *Earth's atmosphere from space*, ADF licenced Shutterstock image
Source: https://www.shutterstock.com/image-illustration/fragment-earth-high-relief-detailed-surface-91705817
Caption: A fragment of the Earth with high relief, detailed surface, translucent ocean, and atmosphere, illuminated by sunlight.

b. **p. 2–1, Photograph:** *Unlocking the potential of the air domain*, Defence imagery
Source: http://images.defence.gov.au/20150505adf8500210_001.jpg
Caption: 6th Battalion soldier holds the PD-100 Black Hornet Nano air vehicle at Gallipoli Barracks, Enoggera.

c. **p. 2–1, Photograph:** *Unlocking the potential of high-altitude balloons*, Defence imagery
Source: http://images.defence.gov.au/Jasper Square Screenshot.jpg
Caption: Plan Jericho is undertaking a number of advanced sensing activities, including high altitude balloon launches and sub-orbital rocket launches. Air Force's Jasper hitched a ride on this launch to accompany the high-altitude balloon into the stratosphere.

d. **p. 2–2, Photograph:** *Technology enabling speed, range and elevation*, Defence imagery
Source: http://images.defence.gov.au/20210526raaf8207245_507.jpg
Caption: F/A-18F Super Hornet, departs RAAF Base Darwin, into a Super Moon as the commencement of the Lunar Eclipse during Exercise *Arnhem Thunder* 21.

e. **p. 2–3, Vignette Photograph:** *Wright Flyer at Kitty Hawk, 1903*, Public domain, copyright expired
Source: https://www.wright-brothers.org/Information_Desk/Just_the_Facts/Airplanes/Wright_Airplane_images/1903_Flyer_I/1903_First_Flight_Complete.jpg
Caption: 1903 Flyer I – The Wright brothers first powered aircraft, and the first in which anyone made a sustained, controlled flight.

f. **p. 2–3, Vignette Photograph:** *Virgin's 'Global Flyer' holds the record of 67 hours for a crewed, unrefuelled flight*, NASA imagery – free to use for non-commercial reasons
Source: https://commons.wikimedia.org/wiki/File:Globalflyer_landing_cropped.jpg
Caption: The Virgin Atlantic Airways Global Flyer aircraft approaches NASA Kennedy Space Center's Shuttle Landing Facility for a landing.

g. **p. 2–4, Photograph:** *Overcoming Earth's gravity*, Defence imagery
Source: http://images.defence.gov.au/20210603adf8609651_0741.jpg
Caption: An Australian Army Tiger Armed Reconnaissance Helicopter conducting deck landings on HMAS Canberra, during Exercise *Sea Explorer*.

h. **p. 2–4, Photograph:** *Runway clearance in extreme temperatures*, Defence imagery
Source: http://images.defence.gov.au/20120123adf8266070_068.jpg
Caption: Soldiers and civilians from across Multi-National Base - Tarin Kot, Afghanistan provided the manpower to clear the runway of snow and ice after recent falls.

i. **p. 2–5, Photograph:** *Brown out,* Defence imagery
Source: http://images.defence.gov.au/20091011adf8239716_134.jpg
Caption: Chinook helicopter from C Squadron, 5th Aviation Regiment, stirs up the dust as it lands at Patrol Base Buman, Afghanistan.

j. **p. 2–5, Photograph:** *Lightning strikes near an aerodrome*, Australian Commonwealth copyright
Source: https://www.atsb.gov.au/media/5772419/ao-2014-185-final.pdf
Caption: Lightning strike at Perth airport.

k. **p. 2–6, Photograph:** *Transiting sovereign airspace with clearance*, Defence imagery
Source: http://images.defence.gov.au/20210810adf0000000_002.jpg
Caption: The latest four Royal Australian Air Force F-35A Lightning II aircraft to roll off the Lockheed Martin production line in Texas, have headed straight to Alaska to participate in Exercise *Red Flag* 21-3.

l. **p. 2–6, Image:** *Australia's Flight Information Region boundary*, Public domain
Source: https://www.airservicesaustralia.com/about-us/about-our-operations/facilities/air-traffic-management-services/

m. **p. 2–7, Vignette Image:** *Australia's maritime zones*, Public domain
Source: Adapted from ICAO as at https://www.icao.int/APAC/Meetings/2018%20ATMSG6/Flimsy%206%20International%20Airspace%20and%20Civil-Military%20Cooperation.pdf

n. **p. 2–7, Vignette Photograph:** *Flying in national airspace*, Defence imagery
Source: http://images.defence.gov.au/20181018raaf8195382_025.jpg
Caption: A formation of Black Hawk helicopters from 6th Aviation Regiment fly over Sydney Harbour to commemorate 50 years of the Australian Army Aviation Corps.

o. **p. 2–8, Photograph:** *Air patrol of the Air Defence Identification Zone established for the 2006 Commonwealth Games,* Defence imagery
Source: http://images.defence.gov.au/20060312adf8176659_002.jpg
Caption: Two No 77 Squadron F/A-18 Hornets fly training combat air patrols over Melbourne during the lead up to the 2006 Commonwealth Games.

p. **p. 2–8, Photograph:** *ADF command decision-making*, Defence imagery
Source: http://images.defence.gov.au/20200213raaf8540638_0065.jpg
Caption: RAAF, United States Air Force and Japanese Air Self-Defense Force personnel conduct a humanitarian assistance and disaster relief brief at Andersen Air Force Base during Exercise *Cope North* 20 in Guam.

q. **p. 2–9, Photograph:** *International border closure*, Australian Federal Police imagery
Source: https://www.straitstimes.com/asia/australianz/australia-largely-free-of-covid-19-in-no-hurry-to-reopen-borders-prime-minister
Caption: Australia closed its international borders to all non-citizens and non-residents in March 2020.

r. **p. 2–9, Photograph:** *Commercial aviation*, Released under Creative Commons v4.0
Source: https://commons.wikimedia.org/wiki/File:Sydney_Airport_(7373562108)_(cropped).jpg
Caption: Sydney Airport photo taken from the window of a Garuda A330 on the way out of Sydney to Bali.

s. **p. 2–10, Image:** *Ethical decision-making framework*, Defence artwork
Source: Drawn from the ADF's Joint Professional Military Education continuum v2.0

t. **p. 2–10, Vignette Image:** *Human vs autonomy dependence*, Public domain, US military imagery
Source: Adapted from a US military image used in multi-national briefing

u. **p. 2–11, Photograph:** *Defence use of the electromagnetic spectrum*, Defence imagery
Source: http://images.defence.gov.au/20210728raaf8657697_004.jpg
Caption: Combat and Network Electronics Technicians from No 3 Control and Reporting Unit, perform fault finding on a Hawkeye Satellite Communication Terminal at their deployed site at Mt Wolvi, Queensland in support of Exercise *Talisman Sabre* 2021.

v. **p. 2–12, Image:** *Electromagnetic spectrum*, Public domain, cited as NASA imagery
Source: https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/thumbnails/image/EMS-Introduction.jpeg

w. **p. 2–12, Photograph:** *Shared use of the electromagnetic spectrum*, Defence imagery
Source: http://images.defence.gov.au/20190325raaf8200818_070.jpg
Caption: Defence Science and Technology's High Frequency Line of Sight Radar Receiver Array near Coondambo, captures signals reflected from overhead satellites, during *SpaceFest* 2019 at the Woomera Test Range in South Australia.

Chapter 3

a. **Chapter cover, Photograph:** *OP BUSHFIRE ASSIST*, Defence imagery
Source: http://images.defence.gov.au/20200106ran8578298_137.jpg
Caption: Royal Australian Navy Aircrewman checks the surroundings below as they prepare to land their Navy MRH-90 Helicopter at Towamba, NSW during Operation *Bushfire Assist* 2020.

b. **p. 3–1, Photograph:** *ADF supporting whole-of-government efforts*, Defence imagery
Source: http://images.defence.gov.au/20211027raaf8179088_058.jpg
Caption: ADF and Department of Foreign Affairs and Trade personnel receive a brief from a No 37 Squadron Loadmaster before boarding a C-130J Hercules bound for Papua New Guinea during Operation *PNG Assist*.

c. **p. 3–2, Vignette Photograph:** *Preparing the airdrop of humanitarian supplies*, Defence imagery
Source: http://images.defence.gov.au/20140814adf8270845_008.jpg
Caption: Loadmaster examines paperwork while in the background stand ten airdrop pallets of humanitarian aid lashed to the deck of the Royal Australian Air Force C-130J Hercules transport aircraft during the flight to Mount Sinjar in northern Iraq.

d. **p. 3–3, Vignette Photograph:** *Perseverance rover and Ingenuity helicopter on the surface of Mars*, Public domain, NASA imagery
Source (1): https://mars.nasa.gov/resources/25778/ingenuity-helicopter-is-ready-to-drop/
Caption (1): Ingenuity helicopter is ready to drop. NASA's *Ingenuity* helicopter can be seen here with all four of its legs deployed before dropping from the belly of the *Perseverance* rover on 30 March 2021, the 39th Martian day of the mission.
Source (2): https://mars.nasa.gov/mars2020/multimedia/raw-images/NLF_0111_0676792771_816EBY_N0040922NCAM03111_03_0LLJ#.YMWXQR6v23E.mailto
Caption (2): A view of NASA's *Ingenuity* helicopter acquired from the *Perseverance* rover using its onboard navigation camera, on 12 June 2021, the 111th Martian day of the mission.

e. **p. 3–4, Vignette Photograph:** *Air Task Group deployment to Iraq*, Defence imagery
Source: http://images.defence.gov.au/20171012raaf8485160_023.jpg
Caption: Australian Defence Force personnel based at Australia's main air operating base in the Middle East Region with a range of Australian aircraft, 2017.

f. **p. 3–5, Photograph:** *Supply chain dependencies*, Defence imagery
Source: https://images.defence.gov.au/20161124adf8443968_156.jpg
Caption: Australian Army soldier prepares a collapsible fuel drum to be filled during a defuelling/refuelling trial of a Royal Australian Air Force C-17 Globemaster aircraft at RAAF Base Amberley in Queensland on 24 November 2016.

g. **p. 3–6, Vignette Photograph:** *Water tanker dependency on ADF airbasing*, Defence imagery
Source: http://images.defence.gov.au/20200108raaf8161446_023.jpg
Caption: A New South Wales Rural Fire Service (NSW RFS) RJ85 'Boomer' Large Air Tanker taxies along the flight line at RAAF Base Edinburgh.

h. **p. 3–6, Vignette Photograph:** *HMAS Adelaide anchored off the NSW coast*, Defence imagery
Source: http://images.defence.gov.au/20200105ran8578298_340.jpg
Caption: A Royal Australian Navy MH-60R Seahawk 'Romeo' Helicopter departs HMAS *Adelaide* during Operation *Bushfire Assist* 2020.

i. **p. 3–7, Photograph:** *Increasing endurance, thus potential persistence*, Defence imagery
Source: http://images.defence.gov.au/20150610raaf8437718_0187.jpg
Caption: KC-30A MRTT and E-7A Wedgetail conduct air-to-air refuelling testing in the airspace near RAAF Williamtown.

j. **p. 3–7, Vignette Photograph:** *Patrolling Australia's northern maritime approaches*, Defence imagery
Source: http://images.defence.gov.au/20180905raaf8185068_0241.jpg
Caption: A Royal Australian Air Force No 11 Squadron P-8A Poseidon pilot, conducts a rigging run to visually identify a vessel during a mission on Operation *Resolute*.

k. **p. 3–8, Photograph:** *Ability to sustain a level of serious damage,* Defence imagery used by third party website.
Source: http://www.adf-messageboard.com.au/invboard/index.php?showtopic=989
Caption: An F-111C was damaged by a pelican on 19 April 2008. The jet was flying at 900 metres on a test bombing raid at Evans Head, northern NSW, when a pelican struck the fibreglass nose and was sucked into an engine. With a significant damage, the aircraft recovered to, and landed safely at, RAAF Amberley.

l. **p. 3–9, Vignette Photograph:** *Remote operations*, Defence imagery
Source: http://images.defence.gov.au/20201019ran8061448_019.jpg
Caption: A Royal Australian Navy Remote Pilot Warfare Officer, remotely controls a ScanEagle Uncrewed Aircraft during a training sortie at Jervis Bay Airfield.

m. **p. 3–9, Photograph:** *Achieving precision effects*, Defence imagery
Source: http://images.defence.gov.au/20210512raaf8185068_0098.jpg
Caption: A Precision Engagement Team small uncrewed aerial vehicle is deployed during a live fire airbase protection scenario at the Singleton Military Training Area during Exercise *Gathering Storm* 21.

n. **p. 3–10, Vignette Photograph:** *Targeting, inextricably linked to the precision effect*, Defence imagery
Source: http://images.defence.gov.au/20160211raaf8178707_002.jpg
Caption: An infrared picture from a camera on a RAAF F/A-18A Hornet fighter aircraft shows the entrance to a Daesh underground tunnel complex in northern Syria being struck by a 2000lb GPS guided, ground-penetrating bomb dropped from the aircraft.

o. **p. 3–11, Photograph:** *Configurable payloads*, Defence imagery
Source: http://images.defence.gov.au/20200721raaf8208022_040.jpg
Caption: Royal Australian Air Force pilot from No 6 Squadron inspects the EA-18G Growler prior to an air-sea integration mission at Andersen Air Force Base, Guam, during the Regional Presence Deployment.

p. **p. 3–11, Vignette Photograph:** *Reconfiguring the payload*, Defence imagery
Source (1): http://images.defence.gov.au/20140725ran8117631_011.jpg
Caption (1): Members from NUSQN 725 stand alongside Aircraft 902 which fired the first 'Hellfire' missile from an Australian MH-60R Seahawk in Florida, United States of America.
Source (2): http://images.defence.gov.au/20201020ran8061448_060.jpg
Caption (2): Aviation Technician Avionics from No 816 Squadron conducting checks on an Advance Precision Kill Weapons System laser guided rocket at HMAS Albatross, Nowra, New South Wales.

q. **p. 3–12, Photograph:** *Agility of human decision-making*, Defence imagery
Source: http://images.defence.gov.au/20190213raaf8540618_0035.jpg
Caption: Royal Australian Air Force Intelligence Officer and Air Battle Manager monitor screens inside the Control and Reporting Centre at the Nevada Test and Training Range facility during Exercise *Red Flag* 19-1 held at Nellis Air Force Base, Nevada, USA.

r. **p. 3–12, Vignette Photograph:** *COL John Boyd, USAF*, Released under Creative Commons v4.0
Source: https://thestrategybridge.org/the-bridge/2015/11/16/uploading-john-boyd
Caption: Colonel John Boyd, USAF developed the OODA loop to explain how to direct one's energy to defeat an adversary and survive.

Chapter 4

a. **Chapter cover, Photograph:** *Nightime marshaller*, Defence imagery
Source: http://images.defence.gov.au/20210817adf8298528_0160.jpg
Caption: Royal Australian Air Force member of the Mobile Air Load Team marshals in the KC-30A Multi-role Tanker Transport aircraft as it arrives in the Middle East region, to support the evacuation mission in Afghanistan.

b. **p. 4–1, Image:** *Air power model*, Defence artwork
Source: Air and Space Power Centre, Royal Australian Air Force

c. **p. 4–2, Photograph:** *Engaging with the community*, Defence imagery
Source: http://images.defence.gov.au/20171018ran8095516_036.jpg
Caption: Survival Equipment Maintainer with students from the Rockingham Beach Primary School in the demonstration life raft at the Survival Equipment Workshop during their visit to HMAS *Stirling*, Western Australia.

d. **p. 4–2, Photograph:** *Access to allied technology*, Defence imagery
Source: http://images.defence.gov.au/210715-A-GG328-398.jpg
Caption: Soldiers from 1-1 Air Defense Artillery Battalion fires a Patriot missile during Exercise *Talisman Sabre* 2021 on 16 July 2021, at Camp Growl in Queensland, Australia.

e. **p. 4–3, Photograph:** *Collective training*, Defence imagery
Source: http://images.defence.gov.au/20210727ran8562933_0288.jpg
Caption: Navy Aircrewman watches a replenishment at sea between HMAS *Ballarat* and USS *America* off the coast of Queensland, during Exercise *Talisman Sabre* 2021.

f. **p. 4–3, Photograph:** *Live, virtual and constructed training*, Defence imagery
Source: https://images.defence.gov.au/20160817raaf8165233_013.jpg
Caption: A CAE Australia contractor and the Commanding Officer No 285 Squadron, watch progress of the training in the C-130J Simulator during Exercise *Coalition Virtual Flag* 16.

g. **p. 4–4, Photograph:** *Scientific studies underpinning air power*, Defence imagery
Source: http://images.defence.gov.au/20210714DSTG8026732-040.jpg
Caption: Transonic Wind Tunnel Test Lead at Defence Science and Technology Group's site in Melbourne.

h. **p. 4–4, Vignette Photograph:** *Black Box flight recorder*, Defence imagery
Source: https://www.dst.defence.gov.au/news/2015/04/29/vale-david-warren-ao-1925-2010
Caption: Dr David Warren of Aeronautical Research Laboratory in Fisherman's Bend invented the world's first black box flight recorder in 1953.

i. **p. 4–5, Photograph:** *Airbasing at sea*, Defence imagery
Source: http://images.defence.gov.au/20210427ran8562933_0074.jpg
Caption: HMAS *Ballarat's* MH-60R helicopter winches personnel onto the flight deck of HMAS *Sirius* during a replenishment-at-sea in the Karimata Strait.

j. **p. 4–5, Photograph:** *Main operating base*, Defence imagery
Source: http://images.defence.gov.au/20210517raaf8636447_246.jpg
Caption: Two F-35A Lightning II, fully loaded with inert GBU-12 laser guided ordnance for the very first time, enroute to the Delamere Air Weapons Range in the Northern Territory during Exercise *Arnhem Thunder* 21.

k. **p. 4–6, Photograph:** *Landing zone*, Defence imagery
Source: http://images.defence.gov.au/20170714ran8100087_011.jpg
Caption: An aircrewman from HMAS *Canberra* exits an MRH-90 at a landing zone during Exercise *Talisman Sabre*.

l. **p. 4–6, Photograph:** *Deployable catering capability*, Defence imagery
Source: http://images.defence.gov.au/202001126army8270357_1078.jpg
Caption: An aircraftman watches over the food point as some of the over 300 soldiers get their first meal from the Royal Australian Air Force's, Combat Support Group Deployed Catering Capability during Operation *Bushfire Assist* 19–20.

m. **p. 4–7, Photograph:** *Aeromedical evacuation training*, Defence imagery
Source: http://images.defence.gov.au/20211003ran8562933_0050.jpg
Caption: Personnel aboard HMAS *Ballarat* conduct aeromedical evacuation training using the ship's embarked MH-60R helicopter during a Regional Presence Deployment to the Indo-Pacific.

n. **p. 4–8, Photograph:** *Rescue operation*, Defence imagery
Source: http://images.defence.gov.au/20190408ran8234993_029.jpg
Caption: A Royal Australian Navy sailor is winched from a MRH-90 maritime support helicopter during a personnel transfer with HMAS *Collins* in the Bay of Bengal during *Ausindex* 2019.

o. **p. 4–9, Photograph:** *Joint battlefield airspace control*, Defence imagery
Source: http://images.defence.gov.au/20150918ran8100087_102.jpg
Caption: A Joint Battlefield Airspace Control officer works with Leading Seaman Combat Systems Operator in the Air Traffic Control room onboard HMAS *Canberra*.

p. **p. 4–10, Photograph:** *Tactical Air Control Party*, Defence imagery
Source: http://images.defence.gov.au/20210728army8615249_0079.CR3.jpg
Caption: Member from No 1 Security Forces Squadron, as part of the Tactical Air Control Party supporting the 3rd Brigade, at the Townsville Field Training Area, Queensland, during Exercise *Talisman Sabre* 2021.

q. **p. 4–9, Vignette Photograph:** *Deployed air mobility control element*, Defence imagery
Source: http://images.defence.gov.au/000178923_0006.jpg
Caption: Personnel of Headquarters Air Command at RAAF Base Richmond running a deployable air mobility control element for the East Coast Air Defence Exercise (ECADEX).

r. **p. 4–11, Vignette Photograph:** *Shipborne air defence system*, Defence imagery
Source: http://images.defence.gov.au/20200310ran8112562_176.jpg
Caption: HMAS *Arunta* fires an Evolved Sea Sparrow Missile off the coast of Western Australia to test its missile systems after undergoing the ANZAC Midlife Capability Assurance Program upgrade.

s. **p. 4–11, Vignette Photograph:** *Mobile ground-based air defence weapon system*, Defence imagery
Source: http://images.defence.gov.au/20190708adf8178707_103.jpg
Caption: Members of 16th Regiment armed with their RBS-70 watch over the battlefield as two US Army Apache Attack helicopters demonstrate their capability at Shoalwater Bay Training Area in Central Queensland.

t. **p. 4–11, Vignette Photograph:** *Airborne air defence*, Defence imagery
Source: http://images.defence.gov.au/20181114raaf8298528_0301.jpg
Caption: A Royal Australian Air Force No 1 Squadron F/A-18F Super Hornet patrolling the skies above Port Moresby in support of APEC.

u. **p. 4–12, Photograph:** *Air defence radar system*, Defence imagery
Source: http://images.defence.gov.au/20170522raaf8227810_0073.jpg
Caption: An Air Force Communications Electronic Fitter from No 3 Control and Reporting Unit, conducts daily serviceability checks on the guy wires during Exercise *Diamond Spear*.

v. **p. 4–13, Photograph:** *Inter-theatre air mobility*, Defence imagery
Source: http://images.defence.gov.au/20210822adf8298528_0943.jpg
Caption: Australian citizens and visa holders prepare to board the Royal Australian Air Force C-17A Globemaster III aircraft, as Australian Army infantry personnel provide security and assist with cargo at Hamid Karzai International Airport, Kabul.

w. **p. 4–13, Photograph:** *Airborne operations*, Defence imagery
Source: http://images.defence.gov.au/20200826army8583067_371.jpg
Caption: Australian Army soldiers from 6th Battalion, Royal Australian Regiment, prepare to board a CH-47 Chinook at Kokoda Barracks, Queensland, during Exercise *Brahman Stride*.

x. **p. 4–14, Photograph:** *Air-to-air refuelling*, Defence imagery
Source: http://images.defence.gov.au/F35_002.jpg
Caption: An Air Refuelling Operator controls the transfer of fuel from a Royal Australian Air Force KC-30A Multi-Role Tanker Transport to a United States Air Force F-35A Lightning II during Exercise *Cope North* 2021 in Guam.

y. **p. 4–15, Image:** *Relationship between data, information, and intelligence*, Defence imagery
Source: Drawn from the ADF-P-2 *Intelligence*, Lessons and Doctrine Directorate, Vice Chief of Defence Force Group.

z. **p. 4–15, Photograph:** *Air intelligence analysts*, Defence imagery
Source: http://images.defence.gov.au/20200610raaf8609651_091.jpg
Caption: Air Intelligence Analysts brief fellow members in the operations floor at the distributed ground station - Australia, RAAF Base Edinburgh.

aa. **p. 4–16, Photograph:** *Exploiting the greater perspective from the air*, Defence imagery
Source: http://images.defence.gov.au/20210325adf0000000_06.jpg
Caption: Commander JTG 629.1 and Commissioner Resilience NSW on an Army Blackhawk conducting a tour of flood affected areas on the mid NSW coast today to inform recovery planning.

bb. **p. 4–16, Photograph:** *Headquarters informed by PED*, Defence imagery
Source: http://images.defence.gov.au/20210809raaf8658961_0062.jpg
Caption: The Combined Air Operations Centre provides the command and control of airpower throughout the United States Central Command area of responsibility, which covers 20 nations from Northeast Africa across the Middle East to Central and South Asia.

cc. **p. 4–17, Photograph:** *Air strike*, Defence imagery
Source: http://images.defence.gov.au/20151015raaf8185068_0160.jpg
Caption: Two MK 84 2000lbs Bombs hit their mark during Exercise *Black Dagger*.

dd. **p. 4–17, Photograph:** *Understanding information warfare challenges*, Defence imagery
Source: http://images.defence.gov.au/20191029adf8630742_3406.jpg
Caption: The *iWar* forum 2019 was held on October 29 at Parliament House, Canberra. The forum brought together members of Defence, the militaries from Australia, Canada, New Zealand, United Kingdom and United States government departments and industry to examine emerging information warfare threats.

ee. **p. 4–18, Photograph:** *Electronic attack*, Defence imagery
Source: http://images.defence.gov.au/20201208raaf8194170_0014.jpg
Caption: The EA-18G Growler electronic attack aircraft is the Australian Defence Force's joint electronic warfare capability lead. Growlers work with other Air Force, Army and Navy platforms to enhance Defence's ability to control the electronic environment; and where necessary, deny or degrade the electronic systems of adversaries.

ff. **p. 4–18, Photograph:** *Anti-submarine warfare*, Defence imagery
Source: http://images.defence.gov.au/20201208ran8555536_0322.jpg
Caption: A Royal Australian Navy MH-60R Seahawk helicopter from No 816 Squadron launches a sonobuoy during an anti-submarine warfare training serial off the coast of Jervis Bay, New South Wales.

Chapter 5

a. **Chapter cover, Photograph:** *Vertical replenishment training*, Defence imagery
Source: http://images.defence.gov.au/20201020ran8611078_0107.jpg
Caption: An MRH-90 helicopter conducts vertical replenishment training on-board HMAS Adelaide in preparation for Exercise *Sea Wader* 2020.

b. **p. 5–1, Photograph:** *Advantages of interoperability* Defence imagery
Source: http://images.defence.gov.au/20210728raaf8659008_0389.jpg
Caption: Alaskan based United States Army paratroopers from 3rd Battalion, 509th Parachute Infantry Regiment, 4th Infantry Brigade Combat Team (Airborne), 25th Infantry Division 'Spartan Brigade', parachute drop from a Royal Australian Air Force C-17A Globemaster III aircraft, during Exercise *Talisman Sabre* 2021.

c. **p. 5–2, Photograph:** *The ADF – joint by design*, Defence imagery
Source: http://images.defence.gov.au/20210730ran8611078_0029.jpg
Caption: ADF members stand together onboard HMAS *Canberra*, during Exercise *Talisman Sabre* 2021.

d. **p. 5–2, Photograph:** *Military support of state emergency*, Defence imagery
Source: http://images.defence.gov.au/20200201adf8267338_076.jpg
Caption: A gunner from the 20th Regiment Royal Australian Artillery, performs post-flight checks of a Wasp III Small Uncrewed Aircraft System (SUAV). The aircraft are being used to monitor spot fires in the Tharwa area in the early morning hours when helicopters are not operating.

e. **p. 5–3, Photograph:** *Human interoperability*, Defence imagery
Source: http://images.defence.gov.au/20170718adf8439709_099.jpg
Caption: A Joint Fires and Effects Coordination Centre Legal Officer and a Department of Foreign Affairs and Trade Gender and Policy Advisor exchange views on International Laws and dynamic targeting at the Shoalwater Bay Training Area during Exercise *Talisman Saber*.

f. **p. 5–4, Photograph:** *Integrated level of platform maintenance*, Defence imagery
Source: http://images.defence.gov.au/20170510raaf8485160_0058.jpg
Caption: Lock wiring a fuel filter during the Enhanced Air Cooperation third phase as part of Exercise *Pacific Agility* focusing on the maintenance of the C-17 as a common platform between the USAF and RAAF.

g. **p. 5–4, Photograph:** *ADF interoperability*, Defence imagery
Source: https://images.defence.gov.au/20170201raaf8185068_0069.jpg
Caption: A RAAF P-8A Poseidon supports sea trials for the then NUSHIP (now HMAS) *Hobart* in the Gulf St Vincent off the coast of Adelaide.

h. **p. 5–4, Photograph:** *Supporting foreign crews during the search*, Defence imagery
Source: http://images.defence.gov.au/20140328adf8558864_006.jpg
Caption: Royal Australian Air Force and Republic of Korea Navy pilots plan their next sortie at RAAF Base Pearce, Western Australia.

i. **p. 5–5, Photograph:** *Coordinated air-land training*, US military imagery
Source: https://upload.wikimedia.org/wikipedia/commons/1/1b/16_AD_Regt2.jpg
Caption: Members of 16th Air Defence Regiment conducting coordinated training.

j. **p. 5–6, Vignette Photographs:** *Deconflicting air and land fires*, Defence imagery
Source (1): http://images.defence.gov.au/20210718adf8443968_326.jpg
Caption (1): An Australian Army Tiger Armed Reconnaissance Helicopter flies past an M777 Howitzer, during a firepower demonstration at Shoalwater Bay Training Area in Queensland, during *Talisman Sabre* 2021.
Source (2): http://images.defence.gov.au/20180320raaf8207218_0169.jpg
Caption (2): Joint Terminal Attack Controller (JTAC) student out in the field during Exercise *Black Dagger*.

k. **p. 5–6, Photograph:** *Supporting maritime forces*, Defence imagery
Source: http://images.defence.gov.au/20210212ran8108462_0099.jpg
Caption: HMAS *Rankin* conducts helicopter transfers in Cockburn Sound, Western Australia, as part of *Rankin's* training assessments to ensure the boat is ready to deploy.

l. **p. 5–7, Photograph:** *Maritime air control contributions*, Defence imagery
Source: https://images.defence.gov.au/20170201raaf8185068_0335.jpg
Caption: NUSHIP *Hobart* conducts sea trials in the Gulf St Vincent off the coast of Adelaide South Australia, 2017.

m. **p. 5–7, Vignette Photograph:** *Airborne anti-surface warfare capability*, Defence imagery
Source: http://images.defence.gov.au/20180712raaf8227810_126.jpg
Caption: Officer Commanding, No 92 Wing, Royal Australian Air Force, alongside the ATM-84J Harpoon loaded on the P-8A Poseidon at Marine Corps Base Hawaii, during Exercise *RIMPAC* 2018.

n. **p. 5–8, Photograph:** *Rocket launch through the air domain*, Defence imagery
Source: http://images.defence.gov.au/20160300unk0000000_010.jpg
Caption: Launch of rocket to test hypersonic speed at more than five times the speed of sound, Woomera, May 2016.

o. **p. 5–8, Vignette Photograph:** *AGM-154C Joint Stand-off Weapon*, Defence imagery
Source: http://images.defence.gov.au/20100908raaf8184174_0001.jpg
Caption: Super Hornet carrying AGM-154C Joint Standoff Weapon on transit to Woomera Test Range, South Australia.

p. **p. 5–9, Photograph:** *Cyber operations*, Defence imagery
Source: http://images.defence.gov.au/20191017raaf8485160_002.jpg
Caption: Members of No 462 Squadron and the Joint Cyber Unit conducted defensive cyberspace operations and incident response activities during Exercise *Pink Pill*.

q. **p. 5–9, Vignette Photograph:** *Cyberspace operator*, Defence imagery
Source: http://images.defence.gov.au/20180706raaf8540618_0002.jpg
Caption: Personnel at work inside the No 462 Squadron Cyberspace Simulator at the Defence Science and Technology site in the Edinburgh Defence Precinct, South Australia.

r. **p. 5–10, Photograph:** *Mixed reality – the future?*, Defence imagery
Source: http://images.defence.gov.au/AIR_C-17-20200722-Amberley-8063 .jpg
Caption: Avionics Technician from No 36 Squadron utilises the Hololens mixed reality device during maintenance of a C-17A Globemaster III aircraft. ***Digitally Altered Image.***

s. **p. 5–11, Photograph:** *Force protection*, Defence imagery
Source: http://images.defence.gov.au/20190710adf8561311_056.jpg
Caption: No 1 Security Forces Squadron member and her Military Working Dog patrol around Rockhampton Airport during Exercise *Talisman Sabre* 2019.

t. **p. 5–12, Photograph:** *ADF support to national emergencies*, Defence imagery
Source: http://images.defence.gov.au/20200629adf8615648_0363.jpg
Caption: Royal Australian Air Force Medical Assistant from No 1 Expeditionary Health Squadron takes a sample nose swab from a member of the public at the Melbourne Showgrounds.

u. **p. 5–12, Photograph:** *Multinational operability*, Defence imagery
Source: http://images.defence.gov.au/HA_DRインタビュー MSgt Masumi Suehara.jpg
Caption: Royal Australian Air Force Linguist from No 23 Squadron and United States Air Force Public Affairs Reporter interview a member of the Japan Air Self-Defense Force during Exercise *Cope North* 2021 in Guam.

Chapter 6

a. **Chapter cover, Photograph:** *F-35A pilot and ground crew*, Defence imagery
Source: http://images.defence.gov.au/20210825raaf8161479_017.jpg
Caption: Royal Australian Air Force No 3 Squadron F-35A Lightning II pilot chats to a ground crew member on the flightline.

b. **p. 6–1, Photograph:** *Air power practitioners*, Defence imagery
Source: http://images.defence.gov.au/20210719ran8620187_0169.jpg
Caption: Air Defence Artillery Fire Control Officer of the United States Army, Royal Australian Air Force Air Battle Manager, and Royal Australian Navy Fighter Controller in HMAS *Brisbane's* operations room, during Exercise *Talisman Sabre* 21.

c. **p. 6–2, Photograph:** *Understanding the Profession of Arms*, Defence imagery
Source: http://images.defence.gov.au/20180517adf8513881_9.jpg
Caption: Commander, Australian Defence College presents to the Profession of Arms Seminar held at the Centre for Defence and Strategic Studies, Australian Defence College Weston Creek, Canberra.

d. **p. 6–3, Photograph:** *Maintaining an intellectual edge*, Defence imagery
Source: http://images.defence.gov.au/20190215adf8630742_1145.jpg
Caption: The opening of the new War College and Australian Defence Force Training Centre at the Australian Defence College, Western Creek, Canberra.

e. **p. 6–4, Image:** *Professional mastery model*, Defence imagery
Source: Adapted from the Joint Professional Military Education continuum v2.0

f. **p. 6–4, Photograph:** *Establishing technical mastery*, Defence imagery
Source: http://images.defence.gov.au/20160529ran8100279_108.jpg
Caption: Australian Army soldier from 5th Aviation Regiment conducts maintenance inspections on an MRH90 helicopter onboard HMAS *Adelaide* during Exercise *Sea Explorer* 2016.

g. **p. 6–4, Photograph:** *Defence mastery through air power concepts*, Defence imagery
Source: http://images.defence.gov.au/20180320raaf8494074_024.jpg
Caption: Uncle Harry Allie delivers part of the Welcome to Country speech at the 2018 Air Power Conference in Canberra.

h. **p. 6–5, Photograph:** *Social mastery reflected in social engagement*, Defence imagery
Source: http://images.defence.gov.au/20190424ran8494670_307.jpg
Caption: Australian Defence Force members take a weaving class during a visit to the Meh Mari Cultural Village in Malaysia during *Indo-Pacific Endeavour* 2019.

i. **p. 6–5, Photograph:** *Core military training*, Defence imagery
Source: http://images.defence.gov.au/20200222adfa3529183_14254.jpg
Caption: ADFA midshipmen and officer cadets during the 2020 ADFA CDF Parade.

j. **p. 6–6, Photograph:** *Gateway to military education*, Defence imagery
Source: http://images.defence.gov.au/20210413raaf8658961_0046.jpg
Caption: The Runway, website for information on Air Force's professional military education at RAAF Base Wagga.

k. **p. 6–7, Photograph:** *Embracing social diversity*, Defence imagery
Source: http://images.defence.gov.au/20210306ran8555536_0624.jpg
Caption: Australian Defence Force and Defence Civilians participate in the Sydney Gay and Lesbian Mardi Gras Parade 2021.

l. **p. 6–7, Image:** *ADF values*, Defence imagery
Source: Adapted from http://images.defence.gov.au/20210331raaf8485160_053.jpg
Caption: Indigenous Liaison Officer conducts a smoking ceremony and Welcome to Country during the Air Force Centenary Commemorative Service in Adelaide.

m. **p. 6–8, Photograph:** *Embracing our past, but focusing on our future*, Defence imagery
Source: http://images.defence.gov.au/20110915raaf8227810_0096.jpg
Caption: Senior Australian Defence Force Officer - Edinburgh with the wife of the only known surviving, Australian-born Battle of Britain veteran, invited to the unveiling ceremony of the Battle of Britain honours board at the Officers Mess, RAAF Base Edinburgh.

n. **p. 6–9, Photograph:** *Unlocking cutting edge technology*, Defence imagery
Source: http://images.defence.gov.au/20210722ran8562933_0010.jpg
Caption: HMAS *Ballarat's* embarked MH-60R helicopter and S-100 Schiebel Camcopter on the flight deck, while sailing off the coast of Queensland during Exercise *Talisman Sabre* 2021.

o. **p. 6–19, Photograph:** *Virtual operations room*, Defence imagery
Source: http://images.defence.gov.au/204706-Hololens-overlay_02_CON1.jpg
Caption: Jericho Disruptive Innovation is piloting virtual operations rooms on air bases across the country using Microsoft Hololens 2 headsets to project a hologram of the battlespace in front of the user.

p. **p. 6–10, Vignette Photograph:** *1918 Liberty Eagle*, Public domain, copyright expired
Source: 1918-Liberty-Eagle-side-view.jpg (800×479) (wright-brothers.org)
Caption: The Liberty Eagle – nicknamed the Bug – carried 200lbs (91kg) of explosives and was guided by a gyroscopic stabilizer. It was the first attempt at a guided missile.

q. **p. 6–10, Photograph:** *Shaping Australia's strategic environment*, Defence imagery
Source: http://images.defence.gov.au/20160413adf8494074_021.jpg
Caption: An Australian Army Taipan MRH-90 helicopter interrupted classes when it landed at the Rakiraki Muslim Primary School.

Back Matter

a. **Chapter cover, Photograph:** *Next generation balloon*, Defence imagery
Source: http://images.defence.gov.au/20160420raaf8440875_201.jpg
Caption: The Next Generation Air Force Balloon soars at sunrise over Lake Burley Griffin, Canberra.

b. **Back Cover, Indigenous Artwork:** *Maliyan Eagle – 'Our Place, Our Skies'*
Artist: Lisa Jackson Pulver
Source: The artist
Story (as told by the artist's cousin, Wendy Brady): The Maliyan eagle, is important. We know what it means to us in Air Force. But for my family, it is one of our special creatures that speaks of our story. My cousin told me the story of the Maliyan, and how he stays up high, watching carefully, coming to earth when needs be. Maliyan is resourceful, efficient, precise, adaptable. He can see clearly, he listens carefully and acts when needs be. The southern cross in the night sky is where, a long time ago, the Maliyan rested for a moment on a big flight across the stars. He stayed there for a little while.
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