Elements of Air and Space Power Theory for Developing Air Forces

Col Carlos Eduardo Valle Rosa,
Brazilian Air Force (Reserve)

Introduction

Within the context of academic or military media in Brazil (or even in Portuguese), there is not a cultural focus for discussing airpower theory. Attempts to develop this debate were made by authors such as Lysias Rodrigues[1], Nelson Freire Lavenère-Wanderley,[2] and Arp Procópio de Carvalho.[3] They, despite dealing with broader topics such as "geopolitics," "deterrence," and "air transport," highlighted some essential elements which were derived from the ideas of Giulio Douhet, Alexander Seversky, Hugh Trenchard, and William Mitchell.

The last book published containing elements for the formulation of a more consistent theory of airpower was the work of Murillo Santos in 1989.[4] His distinguished contribution is the explanation of airpower theory elements from a Brazilian perspective. He identifies flexibility and mobility, aerospace technology development, the importance of deterrence, and demand for professional military education as critical factors for an air force.

Since the 1990s, however, there have not been any published works in Brazil that formulate airpower theory or suggest ways to debate it. Because of this insufficiency, basic doctrine has become the source for theoretical debate—which is inappropriate.

Theory and doctrine are different concepts. Doctrine is a guide to the best airpower practices and serves as a reference without being directive. It is derived from the experiences accumulated by an institution (or observation of other nations' accumulated expertise), which identifies the best practices over time.[5] Indeed, social, scientific, technological, or economic changes will drive the evolution of these practices and revisions of doctrine. On the other hand, theory consists of formulations derived from specific perceptions of reality. From the empirical observation that indicates certain tendencies, theory prescribes behaviors, elaborates ideas, and formulates concepts. In theory, systematizations are used to explain, elucidate, or interpret phenomena.[6] Thus, we can say that doctrine directs *how to do*, while theory provides the justifications for *why do*.

This article addresses the interdependent relationships between theory and doctrine, despite its predominant theoretical focus. It acknowledges the demand

for a discussion on airpower theory in an environment that has been more concerned with practical and technological issues. It does not focus on Brazil, despite context being a limiting factor, just as it was for the original theorists.[7] The alternatives presented here are intended to encourage discussion in countries seeking to overcome obstacles in the development of airpower. Therefore, its scope encompasses the challenges and roles nations face when structuring air forces to guarantee aerospace sovereignty.

Classical air power thinking, which sought to ensure independence from surface forces, sought to identify distinctive features and functions. Air dominance, deep attack, interdiction of communication lines, mobility, battlefield situational awareness, and close air support have guided theoretical thinking to this day. This article's purpose is to highlight evolving elements of air and space power theory. It is structured in two parts. The first will establish the scope of the discussion, identifying scenarios in which the theory is applied. The second will address proposed essential theory elements—which either stand by themselves or are grouped—and takes into consideration economic or structural organizational limits.

Although such limits influence effective performance, theoretical thinking cannot be hindered by such restrictions. As Giulio Douhet stated, "that victory is reserved for those who anticipate new developments in the nature of war and not for those who adapt to these developments after they occur."[8] Henry Arnold agreed with this thought process and warned about the need to absorb "new ideas and techniques."[9]

Scenarios Considered

A methodical description of scenarios is needed. Every theory has a delimitation observed in the problems it addresses. Therefore, it is not possible to achieve a universal, or holistic theory for air and space power. Many theorists have developed quite specific approaches. John Slessor's ideas revolved around the concept of interdiction.[10] Wolfram Freiherr Von Richtofen,[11] along with Arthur Tedder and Arthur Coningham,[12] were devoted to idea of the interaction of the air force with the army, in what he called close air support. John Boyd promoted the OODA Loop decision cycle and focused on command and control.[13]

The ideas developed herein will be relevant in two primary contexts: conventional and unconventional warfare, and do not apply to conflicts involving weapons of mass destruction (generally associated with chemical, biological, radiological, or nuclear weapons [CBRN]).[14] They also do not include the use of air and space power in humanitarian actions or peacebuilding.[15] Furthermore, they are not ideas to be used for secondary actions of an air force. Thus, they do not address

the spectrum of support for government agencies or civilian agencies (air transport, fire services, meteorological studies, aerial photography, among others).

Conventional warfare is defined as "armed conflict carried out within classical patterns and use of conventional weapons, which may be total or limited, either because of the size of the conflict area, or the extent of the effects to be obtained."[16] Within the context of conventional warfare, we delineate our scenarios into two situations. First, conventional warfare against a peer equal and second, conventional warfare against an inferior combat force.

In the conventional warfare scenario against a peer, action is characterized by the confrontation between regular military forces, using similar equipment (technological differences in related categories of weapons systems do not exclude that scenario), and of a non-CBRN nature.

In conventional warfare against an inferior force, the scenario is characterized by one side having a potentially greater combat value over the opponent. This can translate into quantity and quality of weapons systems, command, control, computers, communications, intelligence, surveillance, and reconnaissance (C4ISR) capabilities, combat experience, and consolidated doctrine, among other factors.

On the other hand, unconventional warfare—can be defined as, "military activities conducted by or with the use of hidden, auxiliary or guerrilla forces, to allow resistance or insurgency movements whose objective is to coerce, destroy, or occupy a government or an invading force."[17] As seen in the Table, the spectrum of applications may also incorporate police or counterterrorism actions, although the traditional definition of war must be broadened for conflicts or crises.

Scenarios		**Characteristics**	**Examples**
Conventional warfare	Against a peer	- There is a similarity in combat capabilities - No CBRN weapons -Could be a total or simulated conflict - Use of regular military forces	First World War, Korean War, Six Days, Yom Kippur, and Falkland Islands/Malvinas.
	Against an inferior power	- Same as before except for when there is symmetry in the capabilities	Vietnam, Gulf War, Bosnia, and Kosovo
Unconventional warfare		- Use of stealth forces or guerrilla forces - Asymmetry in capabilities - No CBRN weapons - Could include police or antiterrorism operations	Algerian War, fight against *Fuerzas Armadas Revolucionarias de Colombia* (FARC - Revolutionary Armed Forces of Colombia), or Afghanistan

Table – Scenarios considered
Source: Author, 2018

Undoubtedly, categorizations such as those presented may raise questions. The distinction between the scenarios presented above must not neglect Carl von Clausewitz's warning about complexity, uncertainty, and chance when it comes to the phenomenon of war.[18]

Mary Kaldor also highlighted this complication when she coined the term "new wars," whose concept of hybridism, taken from Frank Hoffman, gives the war a "public and private, state and non-state, formal and informal character . . . including mixing different types of war (conventional, counterinsurgency, and civil war, for example)".[19]

These new wars present possibilities that escape specific categorizations. Qiao Liang and Wang Xiangsui have similar views. They highlight "unrestricted war," or war that "transcends all borders and boundaries."[20] Borders and limits not in the geographical sense but the general understanding of tactics, techniques, dimensions of strategy, and actors.

Elements of Theory

With the scenario perspective defined, it is necessary to focus on the words "air" and "space" within the application of military power.

There is no continuity between the physical characteristics of the Earth's atmosphere and outer space. The aerodynamic constraints that allow aircraft to fly are different from those that guide the flight of space objects. From the highest point in the atmosphere where conventional flight is possible, astrodynamics establishes the rules of physics. This limit point, however, is controversial. According to Jerry Sellers et al., "the line where the atmosphere ends and space begins is by no means clear."[21]

Lack of clarity regarding the boundaries of each domain usually creates concepts, such as "aerospace power," "air and space power," and "military aerospace power." The conceptual problem expands when cyberspace is added to outer space.[22] A definition that we consider appropriate for this article was adopted in 2001 by the European Conference of Air Force Chiefs. They reached a consensus on defining airpower: it is "the ability to protect and employ military forces in the air and in space, or a platform or missile operating on the surface of the".[23] With it in mind, a discussion of the elements that could compose a theory of air and space power can occur. UAVs, missile air defense, ballistic missiles, and antisatellite weapons will be examined in the following text as part of a theoretical debate on air and space power.

Unmanned Aerial Vehicles (UAVs)

Unmanned aerial vehicles[24] have increased visibility by fighting insurgencies. Martin van Creveld believes that "UAVs are better than high-performance aircraft in counterinsurgency operations."[25] The history of this vehicle can be traced back to when aerostats (a lighter than air aircraft that gains its lift through the use of a buoyant gas) carried bombs. For example, in 1849, Austrians used this aircraft to drop grenades in the city of Venice.[26]

The wide variety of types, sizes, and functions of UAVs that have increased in recent years requires their incorporation into a new theoretical framework for use of air and space power. For example, one type of UAV, drones, can provide situational awareness and reduce the limitations of impermanence on the battlefield—which is also case with the use of C4ISR. Highlighting the value of drones for intelligence, Stephen Budiansky cites the criticality of drones in the battlefield. He cites that in Iraq, in 2003, data from a target connected to a drone connected via satellite was transmitted to a command and control center and within 20 minutes data was available.[27] UAVs can also carry out patrols of maritime areas, with the use of sensors and tele-transmitted visual observation. They can also serve as decoys.[28] Precision couplings with laser-guided weapons, GPS, or optics can provide UAVs a distinctive advantage. In addition to precision, it can help prevent risks to pilots and reduce the likelihood of collateral damage.

Small drones, up to 40 kg, have already become mandatory equipment in many surface forces. They can provide some of the capabilities mentioned above. As Pablo Chovil points out, this type of device "predicts the democratization of technology on the battlefield, which will modify how nations will fight with their adversaries."[29]

Today, there is not a consistent technological limit that prevents the use of UAVs in different contexts. From small drones to the RQ-4 Global Hawk, a UAV that can reach close to 14 tons,[30] scenarios like those described in this article allow for use of drones.

In conventional warfare, peers can use the MQ-1B Predator for intelligence gathering or against fixed or mobile targets. Even smaller UAVs can patrol over air bases or strategic facilities in search of deficiencies. UAV teams can transport ordinary or infrared cameras and collect important reconnaissance. They can also launch small explosives that cause damage to aircraft, command and control systems, or radar antennas. Recently, it was reported that a South American political leader suffered an attempt on his life by a small drone carrying explosives.[31]

In an unconventional war, such as the one taking place in Afghanistan since 2001, drones may have been used by the Taliban to conduct suicide attacks against

the forces of the North Atlantic Treaty Organization (NATO). This is already happening in Syria and Iraq.[32]

Not widely taken into consideration in the theory of airpower is a wave of drones, valuing the principle of mass, and jointly programmed to fly over targets using small explosive devices. The International Civil Aviation Organization (ICAO), in its concepts of operation, foresaw that possibility when it identified "operations (of multiple simultaneous drones) with remote control."[33]

In the same scenario, UAVs may use jammers to interfere or block radio frequency communications or electromagnetic wave signals. The threat from UAVs will demand using devices that neutralize the performance of these aircraft. Blockers, known as drone killers, force the drone to descend or return to its point of origin. For example, the Dronekiller model from IXI Technologies creates an electronic barrier that prevents the drone from completing its mission.[34]

To what extent UAVs will completely replace piloted aircraft is still unknown. Drones increasing influence on the most diverse types of battle spaces can no longer be ignored in the theoretical debate. UAVs reduce costs and save lives. Additionally, their systems can perform missions with the same degree of efficiency as their manned peers. These factors urgently demand a revision in airpower doctrine. The result of these empirical experiences must guide a new theoretical reality for the use of airpower.

Antiaircraft Defense with Missiles

The history of the use of surface-to-air missile (SAM) is also a pertinent to a discussion of the second element of conventional warfare theory presented. The conflict in Vietnam was testimony to the intense use of SAMs by the North Vietnam as a response to attacks by the United States. As Larry Addington points out, throughout Operation Rolling Thunder, US forces lost more than 900 aircraft, about 95 percent from antiaircraft weapons.[35] In Operation Linebacker II, B-52 bombers also paid a high price because of the North Vietnamese SAM SA-2. As Marshall Michel III mentions, in the 11 days of operation, "15 B-52s were struck, three seriously damaged, and six had minor damage . . . with a loss rate of 1.89 percent, 28 crew members died, and 34 were captured."[36]

In 1988, the Union of Soviet Socialist Republics (USSR) invaded Afghanistan to fight the Mujahideen. Portable SAMs, also known as Man-portable air-defense systems (MANPADS), played a significant role when used by insurgents opposing the Soviet invasion. The appearance of the Blowpipe and Stinger missiles changed the course of the war in Afghanistan.[37] These portable systems severely restricted the ability of Soviet aviation to provide support to ground forces, one of the factors that contributed to the end of the war.

Invisibility to radar is such a disruptive feature for airpower because it allows for immune penetration. Since 1999, however, it seems to have been somewhat neutralized by antiaircraft defense. The first loss of the American stealth plane, the F-117, in the conflict in Kosovo, was due to a SA-3 Goa SAM, belonging to the Yugoslav army.[38]

The relevance of SAMs in conventional and unconventional warfare scenarios must be considered, an approach Giulio Douhet did not take regarding antiaircraft artillery.[39] Any current airpower theory must somehow include the capability of SAMs.

A robust antiaircraft defense capability must incorporate detection systems. Since the Battle of England, that has been a reality. Defense in layers[40], is a concept that the USSR incorporated into its doctrine in 1967, and revealed in 1973, in opposition to Israeli aviation. The SAM system caused severe damage, surprising the Israeli Air Force. SA-6 Gainful missiles, guided by radar, and ZSU-23-4 Shilka guns were responsible for the destruction of 40 Israeli aircraft in the first 48 hours of that war.[41]

Autonomous capabilities, in the form of MANPADs, established themselves as outstanding in the battlefield. The acquisition of portable missiles by the infantry, capable of being directed by the heat generated by aircraft's turbines, significantly reduced the vulnerability of troops and expanded the threat against the aircraft.

Because of their low cost and ease of operation, storage, stealth, and lethality, SAMs are elements to be included in a new theory of airpower. However, the full replacement of the concept of air defense with intercepting aircraft is not yet anticipated. Regardless, the value of SAMs is increasing, either in a system structured in layers or one with autonomous MANPADs.

Ballistic Missiles

During World War II, the German V-2 rocket was used against targets in Great Britain. Powered by a mixture of ethanol, water, and liquid oxygen, a gyroscopic targeting system, and amatol payload (TNT and ammonia nitrate), the weapon was the forerunner of ballistic missiles. Its original name, *Vergeltungswaffe* (weapon of revenge or retaliation), carries the theme that the Cold War period would give to that type of weapon.

From the end of World War II to 1991, ballistic missiles, when linked to nuclear warheads, existed to prevent war from happening.[42] Even without nuclear warheads, ballistic missiles are weapons with great deterrent potential and political influence.

The Cuban Missile Crisis—one of the most stressful incidents of the Cold War—was the result of focusing on the characteristic that this type of weapon

possesses. The installation of Soviet missiles in Cuba constituted a threat to US national security. The crisis almost escalated to an armed conflict between the two powers.

Another significant example of the psychological power associated with the threat of ballistic missiles is illustrated by the 1991 Gulf War. The famous "Scud hunt" occurred because of the possibility of splitting the Coalition in the event Israel retaliated against Iraq. The ballistic missiles also demonstrated a characteristic that speaks to the theory of airpower. As noted in the *Gulf War Air Power Survey*, only 15 percent of attacks against the Iraqi Scud missile system were against mobile launchers. That system "proved to be elusive and surviving."[43] This quality of discretion and survival in a battlespace dominated by air superiority of the adversary merits consideration.

In a conventional setting, whether peer-to-peer, or against a lesser power, the existence of a missile launch capability imposes a great deterrent. When that capability is a consequence of the conjugation of mobile launchers and ranges capable of reaching enemy centers of gravity, ballistic missiles must be considered as a component of a renewed theory of air and space power.

Without a doubt, financial considerations, mainly budgetary limits in developing countries, will emerge as obstacles to the acquisition of this capability. However, it is interesting to note the comparison made by Squad Leader R. Clarke, "North Korean Scud C missiles were sold to Syria for $3 million each. Scud Bs were purchased by Iraq for less than $1 million a unit, including operating and support costs for a few years. In contrast, an attack aircraft today costs about $40 million."[44]

The proliferation of this type of weapon, even considering conventional warheads, is a phenomenon that has already registered. The Arms Control Association identified missiles of various kinds that exist in 31 countries.[45] According to the 2018 *Military Balance*, countries such as North Korea and Iran seek the continuous development[46] of ballistic missiles, which may represent a trend for forces with inadequate fighting power.

Other evidence supporting the relevance of ballistic missiles to air and space power theory is the development of interception or protection systems. The Patriot system, despite criticism of actual effectiveness[47] and cases of fratricide,[48] has been used in various situations. One of the most recent was in the deployment of units to Japan facing North Korean threats.

There certainly are concerns regarding ballistic missiles. According to Michael Sheehan, "the Reagan government initiative (called the Strategic Defense Initiative) was an ambitious scheme to protect the entire American population against attacks by ballistic missiles with nuclear warheads, through a layered system that would intercept the missiles at different points of its flight path".[49]

The latest concept developed is known as theater missile defense. The United States uses the High-Altitude Area Defense Terminal (THAAD). THAAD is a mobile system that can intercept medium and short-range ballistic missiles, inside or outside the atmosphere.[50] Russia, with the S-500[51], is developing a similar capability, and China has conducted tests with a similar system.[52]

Antisatellite Weapons

Authors like Everett Dolman and Michael Sheehan contest the idea of space as a universal commodity or that space will be explored for the benefit of all humanity. Additionally, space is without borders or sovereignty. Space has already been transformed to project military power. This militarization "is not only a fact but an ongoing process,"[53] Based on that, nations must prepare to conduct military operations in outer space.[54]

The perception that this had become a reality came with the 1991 Gulf War. Satellite systems enabled geographic precision positioning, reliable telecommunications, quality images from space sensors, and real-time weather information, among other capabilities. Coalition forces were beneficiaries of those systems. These benefits were evident in quotes attributed to Arthur C. Clarke, the science fiction writer, who designated that war as the "First World War of Satellites".[55]

In 2007, this scenario would take a step forward when the Chinese Antisatellite Weapon Test (ASAT) was revealed. It was launched from a surface missile and hit a deactivated satellite at a height of about 800 kilometers.[56] The United States also conducted experiments of the same nature. According to Michael Sheehan, "a heat-oriented missile was launched from an F-15 Eagle aircraft and was able to hit orbiting satellites."[57] David Ziegler states that the Russians also had ASAT weapons programs.[58]

The extent to which ASAT projects continue to develop in those nations and others remains a contentious issue. The undisputed fact is that capabilities derived from space, like satellite communications, weather information, or geographical referencing, will be present in any battlespace, be it conventional or unconventional.[59]

Any force that becomes dependent on some factor for the effectiveness of its application, such as command and control, ability to obtain situational awareness, or ability to obtain data about the adversary to create intelligence products, automatically creates centers of gravity that, if neutralized, can create a great advantage in conflict resolution.[60]

Today, this is a reality for space. The C4ISR is a vital knot for conducting military operations. Naturally, this condition transforms satellites into high-value targets, as telecommunication is essential in modern warfare. Even in the case of unconventional warfare, insurgents use the ability to communicate and organize.

Indeed, the doctrine of military operations in space has already been discussed for some time. Michael Sheehan notes that, in the United States, this doctrine incorporates four functions, "supporting space operations, expanding force, applying force, and space control."[61]

The terrestrial components of the telecommunications system or the apparatus necessary to put a satellite into orbit, such as data link stations, antennas, launch centers, among others, will surely be included in a list of targets. The goal of the adversary is to eliminate the functionalities provided. Thus, exploration of this area in conventional theory is needed.

Disabling satellites can be accomplished via physical, electromagnetic, or cybernetic attacks. George and Meredith Friedman argue that efforts to disable satellites can be conducted, "by attack on ground stations, by the use of solid projectiles against satellites, by the use of high-energy beams against satellites or by disturbance, corruption, or impersonation of data flows between space and surface, using electronic warfare techniques."[62]

Therefore, the importance of satellites can no longer be ignored. ASATs or even actions against the capabilities derived from space systems of military interest, being in space or on the Earth's surface, are a new theoretical element.

Conclusion

Phillip Meilinger warned us that "war has changed dramatically, as some episodes demonstrate, indicating that traditional methods, weapons, forces, tactics, and strategies will no longer be successful."[63] What would these "traditional" factors be? How, then, to conduct war, particularly in air and space, with incomplete theories, which ignore the importance of the elements discussed herein?

Initially, analysis revealed the lack of theoretical debate on air and space power in the Portuguese language. By understanding the essential differences between doctrine and theory, we corroborate that diagnosis as essential. Since we tend to take doctrine as theory, and formulate doctrine without a theoretical or experimental framework, we consider this dangerous!

The article's focus was not concerned with formulating a new theory of air and space power. Since all approaches require a methodological delimitation, observed through the scenarios, the purpose was to present some elements that must be incorporated into the theoretical debate on air and space power.

This is especially true in the case of air forces facing significant budgetary limits, which restrict their capabilities, both in quantitative and qualitative terms. Those forces, more than any other, cannot fall into the trap of judging that just one type modern equipment is better than others as a solution for a lack of resources.

An analogy would be enlightening to support this argument. A house can be built by a bricklayer, a plumber, and an experienced electrician. They, with modern tools, will feel well-prepared for construction by laying bricks and installing plumbing and wiring. With the presence of a master builder, who organizes the project, work can be completed quickly, and material saved. Some would think that the house would be ready soon. Some will believe that the house would be cheaper to build this way. However, a home will only be properly built when the architect and engineer are present. They represent the intellectual work, adherence to standards and theories that govern civil construction. The same is true with an air force, it cannot be built without "engineers and architects of airpower," who study, investigate, evaluate, and in short, theorize. Without them, doctrine will only be experiments with stone, pipes, and wires.

UAVs, missile air defense, ballistic missiles, and antisatellite weapons can no longer be ignored in the theoretical debate on air and space power. These elements, according to the general ideas discussed in this article, are not a recipe for quick theory development. To the current theorist, especially in the scenarios and the air forces considered, the observation of these elements in isolation or conjugated constitutes an approach to the "engineering and architecture" of a theory of air and space power. ❑

Notes

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Col Carlos Eduardo Valle Rosa,
Brazilian Air Force (Reserve)

Valle Ross earned a bachelor of history, a master's in aerospace sciences from the Air Force University (UNIFA), and is currently a PhD candidate in geopolitics from the Universidad Federal de Río Grande del Norte. He is an Instructor for airpower and air strategy. Valle Rosa has written articles on aerospace doctrine and war simulations. He is the author of the book *Poder Aéreo: Guía de Estudios (*Airpower: Study Guide) and the chapter "Brazilian Air Power" in The Routledge Handbook of Air Power.