Airpower Rhapsody: Final Act?

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Introduction

This is certainly not a traditional article, as the reader will find it is a combination of traditional modeling, essay and, at times, prose and its subtle informality. However, the main objective is to debate and present the nuances about the eventual end of airpower, at least as it's traditionally thought as, where the role, in the past, was played exclusively by pilots and their aircraft.

Narrative-analysis theories, outside of the natural evolution of airpower throughout past geopolitical events, were sought to support differing points of view and conclusions, from the evolution of vacuum tube technology to the current modern cybernetic domain. Additionally, multidomain theory was considered as the true theater of operations in the future, which will make the synergy between air, space, and networks indispensable. Next, a broad review was conducted on the specific capabilities expected of new platforms versus their mere acquisition, i.e. the objects of desire of every aviator. Finally, this article explores innovation as the art of fusing means, machine, and man, while still enabling sustainable defense budgets that meet institutional objectives, all while taking into consideration today's omnidirectional threat environment.

The End?

At the end of the 1980s, author Francis Fukuyama dared to publish an article on the theoretical "End of History"[1] when witnessing the end of a long cycle of polarization between the US and the former Union of Soviet Socialist Republics (USSR), in which reform movements in Eastern Europe and the USSR, as well as the spread of Western culture, would mark the final victory of capitalism. However, what the famous scholar may not have fully considered is the fungibility of today's environment, even though it appeared to have been frozen in time since US President Harry Truman's famous speech in 1947, in which he asked Congress for financial resources to contain the advance of communism in Europe.[2]

However, paradoxically, while non-western capitalist reformist vigor in Russia would not be successful, China, another country that did not adopt the western capitalist democratic economic model, emerged as a military and economic world rival. History seems to follow a cycle of perpetually starting over, versus just simply ending. From this succinct historical background, a spectator should infer to not forget that the three ingredients of this historical rhapsody—medium, ma-

chine, and mankind—never tire of challenging our collective imagination by reinventing themselves over time. The route is long, the sky is not always deep blue, and the landing will always be a repositioning for the next take-off.

Taking a bold new look, through the exclusive geopolitical doctrinal prism of international relations, one can see how today's airpower rhapsody evolved from US Admiral Alfred Mahan's theory that naval power should be a country's main quest, according to his work *The Influence of Seapower on History 1660–1783*,[3] published in 1890; and English geographer Halford Mackinder's theory, "The Geographical Pivot of History,"[4] published in 1904, which proclaimed that the control of territory was essential to provide economic power and military support to the State—that is, power would be exerted by dominating lands; theories which are further advanced by the Father of Aviation, author Alberto Santos Dumont's *Dans L'Air* (My Airships),[5] from 1904, and *O Que Eu Vi, O Que Nós Veremos* (What I Saw, What We Will See), from 1918.[6]

Santos Dumont's works outlined not only numerous developments from studies of aeronautical sciences, whether in the fields of engineering, air transport, cooperation, or aerodynamics, but also the potential military use of airpower in antisubmarine missions, reconnaissance, and guiding artillery firing solutions. Thus, the evolution of geopolitics began to incorporate the pillars of the doctrinal use of aerospace, a third dimension, to influence actors and alter the course of events. Diagnosis prior to execution, considered fundamental and pioneering, was promoted by Italian General Giulio Douhet, *Il dominio dell'aria* (The Command of the Air),[7] published in 1920 and then revised in 1927.

Today, however, this airpower rhapsody and its audience are presented with domains in which neither sea, land, nor air remain fundamental to guarantee the State's interest, as the future most likely lies somewhere in a vacuum, and between the two simplest existing numbers: 0 and 1. For airpower, specifically, while change is always challenging, it is at the same time at the heart of its flexibility and versatility. After all, in space, you do not fly, but orbit, something still quite three-dimensional, to the comfort of all aviators. This three dimensional scenario, of course, does not touch upon the challenging eleven dimensions of String Theory,[8] whose mathematical principles aided Albert Einstein's Theory of Relativity,[9] and, on the contrary to comfort, causes motion sickness (vertigo resulting from movement, travel, etc.)[10] min most aeronauts, when faced with three spatial dimensions, one temporal dimension, and seven other curved dimensions; enough "G" force for any pilot. Back on earth, "zeros and ones" are not exclusive to aeronautical sciences, quite the contrary, they are on the fingertips of every person connected to cyberspace. Faced with this reality, be it modern reconnaissance balloons, fifth-generation fighters, giant transport aircraft, remotely piloted air vehicles,

autonomous urban mobility vehicles, satellites, or space stations, on Earth, in orbit, and/or other planets, the future of the third dimension is viscerally connected to a trail of zeros and ones, arranged in the ethereal and diffuse cyberspace.

With space and air having similar doctrinal foundations, albeit never strictly equal, and with the understanding that it is practically impossible to imagine the future of airpower without cyber, new analysis curtains open in this rhapsody, in its final act, to present new actors in this endless cycle. At a first glance, the new actors look the same as the old ones, but they have been reinvented, as the multidomain environment comes to the fore-replacing the medium, capabilities (versus simple machines), and mankind, as the evolution and innovation of the combatant/inventor.

It is necessary to clarify that, evolution, as used in this context, represents neither revolution, which destroys to rebuild, nor replacement, which exchanges one concept for another, but something akin to the levels and stages of human moral evolution, proposed by the North American psychologist Lawrence Kohlberg.[11] In human moral evolution, only 5 percent of people humans reach stages 5 (moral discernment leading to actions in the name of the social contract) and 6 (universal principles), the highest stages of the evolutionary process. This evolution does not prevent human action in stages 1 to 4, in which humans advance from mere obedience from fear of punishment (stage 1) to the recognition of authority for the maintenance of social order (stage 4). Like the moral formation of human beings, this article proposes for airpower to evolve through the aggregation of new domains, capabilities, and postures, but without abandoning the doctrinal bases of using airpower to influence actors and alter the course of events.

The Multidomain

The journey of airpower evolution continues with advancements in the environment in which airpower tends to be employed (to include the "green" environmental movement in which aircraft also now need to operate). Ever since the conquest of the third dimension, States have come to regard airpower as a deterrent, as well as a national strategy tool, in an ever-changing international environment.[12] Today and in the future, airpower professionals will need to face not only the 11 conceptual physical dimensions of String Theory,[13] but the practical reality of what is called "network dimension" as well, which will permeate the use of digitized aerospace power, at least in the coming decades.[14]

The depth of the link between air, space and cyberspace can be observed by the simple US mission definition of military airpower: to fly, fight and win in air, space, and cyberspace.[15] However, the preponderance of global, planetary and interplanetary geopolitics, and the resulting increase in the military use of space, has

ended in conferring doctrinal autonomy to space independent from air, as in the past air achieved doctrinal autonomy, independent to sea and land.

Thus, when the US activated, on 20 December 2019, a fifth armed service, the US Space Force (USSF)—born from an organizational structure formerly part of the US Air Force (USAF) Space Command (AFSC)—there is a practically irreversible tendency to consider space as a legitimate theater of operations in armed conflicts.[16] Of note, after the 11 September 2001 terrorist attacks, the US Congressional Space Commission criticized the USAF for institutionalizing the primacy of aircraft pilots over former AFSC space professionals.[17] Even the most skeptical could claim that, with the creation of the USSF, the doctrinal fusional relationship between atmosphere and the vacuum of space would be doomed to an end; further reinforced when the USAF changed its mission in April 2021 to "to fly, fight and win . . . airpower anytime, anywhere,"[18] removing any mention of space and cyberspace. However, instead of weakening the concept of the use of airpower in a multidomain environment, this change ends up strengthening it, since, in addition to making "airpower" explicit in the organizational mission of the world's most powerful Air Force, it expanded airpower employment *omnidirectionally. Furthermore, "anytime" can lend itself to a* poetic and futuristic interpretation that includes Einstein's unexplored fourth temporal dimension.

Brazilian Perspective

From a Brazilian aeronautical perspective, three fundamental components distinguish the two national multidomain realities between the US and Brazil. The first is the US military use of outer space, whether for offensive or defensive operations; while Brazil engages in the peaceful dual employment of space for 1) secure communications combined with the guarantee of internet access for isolated communities, and 2) reconnaissance and intelligence capabilities combined with public policies to protect the environment (reviewed further later in this article). The second distinction between the US and Brazil is, of course, the budget. While the contribution of US taxpayers to the US Department of Defense (DoD) is in the hundreds of billions of dollars, the Brazilian Ministry of Defense' financial resources is only in the tens of billions, the former accounting for 3.4 percent of GDP for defense spending, the latter for 1.5 percent.[19] These first two distinctions between the US are related to the third, which is the scope and area of responsibility established for each country's aerospace power projection. The US projects its aerospace power all the way up to the interplanetary level, especially with its recent successful landings and take-offs on Mars,[20] while Brazilian projects its aerospace power, just as most other nation-states, at the national and

sometimes regional levels. It is because of these three major distinctions that air and space remain symbiotically connected in Brazilian military airpower doctrine.

With regards to the cyberspace domain, the term is intrinsically connected to network operations, as coined in the pioneering doctrine of the USSF, which states "The network dimension of space operations allows users to command, control, and exploit space capabilities through a physical and logical architecture that collects, transmits, and processes data around the world and across the domain."[21] It goes on to clarify that because of these dependencies, cyberspace operations within this network dimension are a crucial and inescapable component of military space operations and represent the main link with the other domains of warfare. Now, if air and space remain symbiotically connected in Brazilian military airpower doctrine, it would be even less likely that cyberspace would be distinct.

The multidomain environment, as discussed so far, has focused in the use of aerospace power in a military environment, but how can it be integrated with the needs of the citizenry (as in the case of Brazil's dual employment of space for peaceful purposes)? How do airpower leaders develop solutions to harmoniously merge interests and capabilities to influence "actors and the course of events?"[22] One example is in the protection of the environment, where armed forces have tied sustainability with energy resilience in an innovative strategy that has been well received by societies.[23] This strategy encourages armed forces to gradually diversify their energy sources, replacing those considered unsustainable with autonomous energy solutions, such as solar, wind, and biofuels-with the aim is to ensure that, in the event of an abrupt interruption in a logistical energy supply chain, another can be allocated to guarantee continuity of military operations.

Energy Resilience

A good part of the energy supply chain depends on the network domain, which is subject to the inherent weaknesses of military information technology systems, such as command and control systems, among others. Additionally, physical energy production and distribution networks, in most cases, are managed by supervision and data acquisition systems, such as SCADA.[24] Additionally, resilient energy solutions which harness power from the sun, wind, or tides, do not have the inherent vulnerabilities of aviation logistical systems.

What's more, aerospace power, whether military or civil, provides countless possibilities to enhance energy resilience through the reduction of carbon footprint (emissions). These range from the design of energy self-sufficient air bases, airport facilities, and air or space traffic control systems; to the redesign of more efficient airways and landing/take-off procedures. This culminates in the use alternative sources of propulsion such as biofuels or electricity, which strike at the

heart of one of the biggest problems faced by large cities as well and has the potential to change the entire aerospace multidomain landscape.

Future Capabilities

Providing an uninterrupted supply of energy to sensitive infrastructures, reducing carbon emissions, and ensuring sustainable agility in urban mobility are capabilities needed in all future aerospace multidomain environments. However, the basic premise of Capabilities-Based Planning (CBP)[25] does not depend on specific pieces of equipment nor individual requirements. Therefore, we attempt to close this rhapsody with a series of examples, quotes, and doctrines, adopting Albert Einstein's methodology to clarify and refute theories.

Leonardo da Vinci's illustrations of man with wings,[26] Father Bartolomeu de Gusmão's *Passarola*,[27] Santos Dumont's balloons[28] and planes,[29] space shuttles and international orbital stations—although different equipment using different technologies, all sought to make mankind fly, whether into the skies or space. Nonetheless, they are distinguished from each other mainly by their intrinsic capabilities, which end up adding to each other: from the simple pleasant observation of the city of Paris, seen from above, to providing real-time communications to all corners of planet Earth. Regardless, it is essential to identify and prioritize those capabilities needed to support a country's aerospace power-certainly, a space station's capabilities is quite distinct from a simple reconnaissance balloon, but their prices and maintenance costs are also quite distinct as well. Just like determining which home computer to buy, based in terms of value and capabilities required.

When dealing with defense budgets, the first realization revolves around the finite budgetary resources a country has available to dedicate to airpower. Next comes the decision-making process on how to boost the use of those finite financial resources and exploitation of existing capacities. One example is the use of artificial intelligence (AI) to exploit open data sources, such as the collaborative partnership between the USAF and the Massachusetts Institute of Technology (MIT) and its USAF-MIT AI Accelerator,[30] as a defense policy tool, with the aim of making fundamental advances in Artificial Intelligence (AI) to improve Department of the Air Force operations, while meeting other broader social needs as well. Such interdisciplinary collaboration between AI experts from military and academia created new algorithms, technologies, and solutions. To tackle such high value-added collaboration efforts, a new type of human resource is required: the innovators.

The Innovators

The first thing that needs to be debunked about innovation is that the concept is all about technology. Instead, for our rhapsody, technology takes a supporting role to human creativity and new ways of thinking about problems. This is where the binary nature of networks most often becomes a tool, versus the goal itself.

First, we use Freud's concept of human behavior to classify personnel who work in the digitalized aerospace multidomain as innovators,[31] using two current theories: The theory of behavioral economics of systems by Daniel Kahneman,[32] and the human mindset by Carol Dweck.[33] Second, we use examples of how recent applications of innovation have contributed to the success of aerospace power around the world.

From the Nobel Prize-winning theory of economics 2002 by the certainly innovative mind of Daniel Kahneman, his "Thinking, Fast and Slow"[34] explains why sometimes, it feels like hard work to do something in a different way from norm. A simple reconnaissance flight to understand such a theory does not need to be either time-consuming or even conducted at high altitudes, just a single pass to detail the future sorties needed to fully understand binary decision systems, originally named by psychologists Keith Stanovich and Richard West.[35] Kahneman defends the existence of two methodologies of human thought in decision making. The first is called System 1, in which decisions are made quickly, intuitively, automatically, with little or no effort and without awareness of voluntary control; and in the second, System 2, choices occur in a more laborious, deliberative, and logical way, including complex calculations, and mental operations involve subjective experiences, choice, and concentration.[36]

Experienced aviators, by nature, decide fluidly, quickly, and naturally, and thus, should be uniquely qualified as innovators. Kahneman's theory, in line with the doctrines of the Father of Aviation, Alberto Santos Dumont, and the USAF, which promote innovation at the institutional level,[37] states that innovation is not synonymous with improvisation or the absence of phases and of processes.

At first glance, it would seem that System 2's methodology would be rejected outright, as the adoption of existing procedures and doctrine would be more instinctive, since even the analysis of a new procedure or incorporation of a simple change in either an administrative or operational routine would require a conscious effort to break inertia-innovation tends to generate a certain psychological discomfort for first-time airmen. Yet, innovation occurs not by the mere insight of experienced aviators, but from solutions that originate from all members of the institution, regardless of their rank or function. Either way, innovation requires a methodology, with clear and successive phases:

Phase 1 - Identify problems, prioritize them, and build a conceptual solution, properly aligned with the institutional mission.

Phase 2 – Start tactically, that is, focus on small high value targets.

Phase 3 – Find the right solution and spread the success.

Phase 4 – Adapt solution for larger targets.[38]

Completing an orbital cycle around Kahneman's Systems 1 and 2, Alberto Santos Dumont, based on his vast successful practical experience, synthesized the above by stating: "There is a saying that genius is great patience without pretending to be a genius, I insisted on having great patience."[39]

Innovating is human, methodological, and brilliant

Moving on, a certain mental posture is required for military airpower innovation. Stanford University psychology professor Carol S. Dweck, trying to understand how people deal with failure, uses practical examples in a clear, direct, and rich manner, provides practical examples that divide human mentality into Fixed and Growth Mindsets.[40] In this new dual classification, the Fixed Mindset is characterized as one in which the individual adopts a posture of immutable characteristics, which creates the constant need to prove to his self-worth; whereas the Growth Mindset is based on the belief that individuals can cultivate their basic qualities through their own efforts.[41] The latter was perfectly in line with the lessons of Santos Dumont, who even when failing or experiencing an accident with some of his inventions, never abandoned growing via trial and error, leading humankind in heavier-than-air flight.

In a broad sense, the most pertinent among the conclusions of this theory, especially when referring to military or civilian airpower, is that institutions also have a corporate Mindset.[42] That is, work environments that embrace the Fixed Mindset firmly believe that a team member either "has" or "does not have" a certain talent. In contrast, corporations that believe that people can grow and improve through toil, good choices, and proper coaching commit themselves to the "culture of growth."[43] Airpower leaders are protagonists choosing which Mindset will prevail in their organizations, as they are responsible for institutional growth and are the facilitators of the professional growth of their staff. It's clear, from everything discussed so far, that innovation and failure will always walk together, side by side, but it is the Mindset that will determine this union as incompetence or as a step forward.

At this point, even the most skeptical reader would be asking what does innovation have to do with war? Is it possible to evolve to the Innovation Mindset without abandoning the core principles of military airpower? Well, with regards to budgeting, since August 2019 the US DoD has embraced innovation, at the

highest decision-making levels, through its Defense-Wide Review (DWR),[44] which revisited decision-making processes in the search for new budgetary efficiencies. This effort examined $99 billion of resources allocated to some 50 DoD organizations and identified aggressive reform opportunities, resulting in more than $7.8 billion in resources saved or redirected in FY21 alone.[45] Among the actions adopted, DWR sought to abandon grandfathered projects, not because the forerunners were incompetent or careless, but simply because that inherited projects were no longer of benefit, nor met current defense priorities.[46]

Unfortunately, defense budgets tend to be analyzed as a whole, which strengthens a Mindset to benefit the effectiveness of the whole, versus individual, because, in war, everything happens everywhere at the same time, i.e. War = Multipart + Multitemporal + Multidomain.

Thus, we now return precisely to the topic of multidomain, in which the internal competition for primacy between USAF Airmen and USSF Guardians took place in the early 2000s[47], and recognize that this sort of competitive mind set no longer suits modern defense scenarios. Instead, a collaborative mind set must be stimulated and developed, competition should be leveraged against an enemy, and not compete against each other within a State's multidomain environment.

In support of this mind set, in 2017, the USAF launched the AFWERX program,[48] with the objective of stimulating an innovation culture (Mindset), with reduced bureaucracy within the institution. AFWERX focuses on the need for providing airpower with necessary capabilities, quickly and at low cost. This mind set was further encouraged by Gen. Charles Q. Brown, Jr., who took over as the USAF's new Chief of Staff of the USAF in August 2020, and adopted the motto: "Accelerate Change or Lose . . . what is good enough today will fail in the future."[49]

Final Considerations

This analysis concludes with another lesson bequeathed by one of the pioneers of airpower, Italian General Giulio Douhet, who provided the following thought for future generations: "Victory smiles for those who anticipate the changes in the character of war, not for those who wait to adapt after the changes take place."[50] These changes occur in the world, in wars, in societies, in aerospace power, in technologies, in defense budgets, in family structures, in the social construct of the military, in our way of thinking, in the values of each generation, and so forth, innovations are perennial and omnidirectional.[51]

Close the curtains, but do not end the rhapsody, as the airpower rhapsody is timeless, always extolling the air forces' mission-it unites past, present and future via generations of leaders in an intriguing cycle of the past always influencing the future.[52] ❑

Notes

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