Opportunities and challenges of emerging technologies

The importance of the aerospace industry for Brazil

Peterson Ferreira da Silva, PhD

A series of innovations and technologies are transforming business, the economy, and life on a global scale. New technologies bring opportunities and vulnerabilities to the more-developed countries and simultaneously contribute to increasing technological progress in developing countries, especially in the fields of security and national defense. At present, among the so-called emerging or disruptive technologies are, for example, advanced robotics, the Internet of Things, 3-D printing, autonomous vehicles, augmented and virtual reality, and artificial intelligence (AI).[1]

These technologies are bringing opportunities for the security and defense of several countries. New possibilities are available to the most-modern armed forces in the world. Training environments for live, virtual, and constructive simulation, for example, offer high-fidelity virtual scenarios with intensive use of commercial off-the-shelf (COTS) software, reducing costs and increasing effectiveness of pilot training.[2] Tools based on big data and AI offer more-detailed analysis of various issues, which vary from the management of aircraft life cycle to the planning of entire military campaigns.[3] The research and development of small unmanned aerial vehicles (UAV), including drone swarms, are evolving rapidly; in fact, in the near future, they may even be employed in urban environments under the command of land forces.[4] The development of 3-D printing already indicates interesting logistical initiatives in terms of deadlines, production scales, and costs.[5]

When taken together, we can see that these new technologies reinforce each other. For example, in 2018 the US Office of Naval Research signed a contract with Lockheed Martin to explore how machine learning and AI can make 3-D printing more reliable, saving hours of inspection after production.[6] In the United Kingdom, initiatives such as the Defense and Security Accelerator are financing innovations with potential repercussions for national security and defense, such as investigations in the area of behavioral analysis, using the ample amount of data generated by the advance of information and communication technologies, being explored through the advances obtained in big data and AI.[7]

On the other hand, these same disruptive technologies open a new range of vulnerabilities and threats. The proliferation of advanced missile technologies, the rapid development of electronic warfare and, especially, the growth of the cyber field are challenges of which the major powers are already aware. The problem is that the increase in emerging technologies such as AI and quantum computing promises to catalyze the threat environment. Thus, the use of AI for the improvement of missiles brings changes even in the field of nuclear deterrence.[8] In short, radars and satellites based on quantum radar can become a great threat to the most-modern aircraft that have stealth technologies.[9]

It is in this context that major powers have invested heavily in these new technologies to try to keep up with the avalanche of transformations. France, for example, intends to invest USD 1.85 billion in AI by 2022.[10] In the United Kingdom, it is estimated that close to USD 1.4 billion will be allocated in that same period as a result of an association involving Japanese and Canadian investors.[11] The United States launched the National Quantum Initiative Act in September 2018, with the objective of accelerating research in that sector, taking into account its importance for the future of the economy and national security.[12] Germany has already announced the creation of a federal organization similar to the Defense Advanced Research Projects Agency in the United States to explore advanced defense technologies, such as cybernetics.[13] In Russia, Vladimir Putin even asserted that whoever dominates AI "will govern the world," while Moscow's investments in that segment equate to around USD 12.5 million per year.[14] However, of special emphasis is China's ambition to become a world leader in AI by 2030, seeking to develop an entire industrial sector dedicated to that field, estimated at USD 145 billion.[15]

Brazil and the Issue with a Growing Technological Gap

If accompanying these profound changes in the fields of national security and defense is a great challenge for the world's major military powers, what are the armed forces of countries like Brazil doing in the face of these complex technological transformations? Brazilian efforts to more systematically address the steps taken in science, technology, and innovation in the military and civilian sectors gained new breath after the creation in 1999 of the Ministry of Defense. In 2003, for example, the *"Strategic Conception: Science, Technology and Innovation of Interest to the National Defense"* document was published. One of the contributions of this work was to define 23 technologies classified as "of interest to the national defense": (1) data fusion; (2) microelectronics; (3) information systems; (4) high-sensitivity radars; (5) weapon-systems environment; (6) high-energy density materials; (7) hypervelocity; (8) pulsed power; (9) precision automatic navigation;

(10) composite materials; (11) computational fluids dynamics; (12) active and passive sensors; (13) photonics; (14) machine intelligence and robotics; (15) signature control; (16) nuclear reactors; (17) space systems; (18) propulsion with suctioned air; (19) materials and processes in biotechnology; (20) chemical, biological, and nuclear defense; (21) systems integration; (22) superconductivity; and (23) renewable energy sources.[16]

Despite the definition of these 23 technologies, during the following four years (2004–2007), the armed forces made few significant technological requests in those areas. Even after the launch in 2005 of the National Defense Policy[17] and the National Policy of the Defense Industry,[18] few practical reflections are observed in Brazilian defense acquisitions. In the Brazilian Air Force (FAB), for example, the process of buying new fighters that began in 1995 was put on hold at the beginning of the Lula administration in 2003 and resumed in 2006, and only in 2013 was the choice of Swedish Gripen fighters established.[19]

Brazilian National Defense Strategy 2008: The Cyber, Space and Nuclear Priority Areas

In 2008, the area of science, technology, and innovation for national defense can be considered one of the highlights of the National Defense Strategy (END). This document highlighted the importance of national planning for the development of products with high technological content, with the support of coordinated efforts between civil and military scientific and technological institutions, industry, and universities. In the END of 2008, three structural axioms were defined: (1) the reorganization of the armed forces, (2) the restructuring of the defense industry, and (3) the redefinition of the regular forces personnel.[20]

The END of 2008 attempted to establish the resources of a regular budget for development and production, among others, for (1) combat and transport aircraft; (2) conventional submarines and nuclear propulsion; (3) surface naval means; (4) intelligent weapons, such as missiles, bombs and torpedoes, among others; (5) UAVs; (6) command-and-control and information-security systems; (7) radars; (8) electronic warfare equipment and platforms; (9) individual equipment and communication systems for the future fighter; (10) armored vehicles; (11) troop transport helicopters to increase tactical mobility, and reconnaissance and attack helicopters; (12) ammunition; and (13) optical and electro-optical sensors.

The forward-looking 2008 END allowed for the emergence of several Brazilian military projects in the Navy, Army, and Air Force. A first draft of the portfolio of the projects was released in 2012 as the first *White Paper on National*

Defense (*LBDN*)[21] In the field of aerospace, for example, in 2008, a contract was signed for the subsidiary of Airbus Helicopters in Brazil, Helibras, for the manufacture of 50 EC725/H225M helicopters.[22] In the same year 12 Mi-35M helicopters were purchased from Russia,[23] but negotiations regarding the purchase of the Pantsir-S1 air defense system did not materialize.[24] The domestic development of UAVs also resumed with new impetus. One of them was the "Falcão" (800-kilo class), manufactured by a joint venture formed in 2011 by the Brazilian companies Embraer and Avibras, as well as by AEL Systems (a subsidiary of the Israeli company Elbit Systems in Brazil).[25] In 2009, Embraer, the leading company in the Brazilian aerospace segment, launched the KC-390 aircraft project seeking to conquer the global segment previously occupied by the C-130 aircraft manufactured by Lockheed Martin.[26] At the same time, the Ministry of Defense, the Funding Authority for Studies and Projects (*Financiadora de Estudos e Projetos* FINEP), the Brazilian Space Agency, and the Brazilian Development Bank (BNDES) launched the *Inova Aerodefesa* Joint Support Plan in 2013, with the objective of supporting innovation in products, processes, and services in industrial aerospace, national defense, and public security, with an initial budget of R$2.9 billion.[27] Finally, it is worth highlighting the conclusion of the process choosing the Gripen aircraft, manufactured by the Swedish company Saab, as the new fighter of the FAB.

However, as of 2013, a political and economic crisis began to settle in Brazil,[28] culminating in Pres. Dilma Rousseff's impeachment in 2016.[29] The impact of these crisis on Brazilian military spending was immediate.[30] Several contracts involving military projects encountered problems and were renegotiated. For example, in 2015, Helibras launched a program of voluntary layoffs to adjust its cadre of officials to the fall in sales in the civil aviation market and the budget cuts suffered by the armed forces.[31] In 2016, the budget restrictions and the lack of specific orders for UAVs led to the end of the joint venture formed by the companies Embraer, Avibras, and AEL Systems.[32] The development of the KC-390 aircraft also suffered delays in its schedule as a result of an incident with its prototype and overdue transfers close to R$500 million from the government to Embraer.[33]

However, despite these negative effects, it is possible to affirm that the political and economic crisis is only one part of the problems faced in Brazilian defense management. This is because that crisis catalyzed at least three broader factors that can also be considered decisive to understand the dynamics of the Brazilian military budget.

The first factor is the traditional allocation of resources to the armed forces. Despite that Brazil is the eighth-largest world economy[34] and in 2017 was eleventh-highest spender in terms of military expenditure worldwide (29,300 million/1.4 percent of GDP),[35] close to 74.5 percent of the entire budget of the Ministry of Defense is allocated to personnel, especially inactive and retirees, and only 7.5 percent goes toward equipment.[36] In practice, this means there are fewer resources to keep Brazil's 347,000 personnel (Navy: 76,530, Army: 222,764, Air Force: 65.060) technically up to date.[37]

The second factor is the relatively high autonomy that the Navy, the Army, and the Air Force have in relation to the Ministry of Defense, even after the 2008 END.[38] Historically, each of the services has had, for example, ample freedom in terms of defense acquisitions, despite the creation in 2011 of the Secretariat of Defense Products (SEPROD) in the Ministry of Defense.[39] Thus, it is possible to affirm that in Brazil there is not a "centralized model" of defense acquisitions but rather three procurement systems that the Ministry of Defense tries to coordinate with approximately 1,385 civilians and military personnel.[40]

Finally, a third factor that can be considered decisive for understanding the dynamics of the Brazilian military budget is the irregularity of resources available throughout the fiscal year, which also occurs not only in the Ministry of Defense but also in practically all the ministries.[41] Added to this is a diversity of political pressures for the Brazilian military, especially the Army, to exercise increasingly greater roles in public security, as illustrated in the case of the state of Rio de Janeiro,[42] which ends up influencing, in a certain way, the allocation of budgetary resources for the armed forces in the long term, given the importance conferred to subsidiary missions.

The result is a set of obstacles preventing, since the ministry's inception, the creation of reasonable, adequate, and articulated planning between the Navy, the Army, and the Air Force, for diverse military projects. This is further hampered by the high instability of defense resources.

Gripen Acquisition: An Opportunity to Explore Emerging Technologies

The decision in 2013 to acquire 36 Saab Gripen fighters (28 single-seater and 8 tandem) presented a valuable opportunity for the FAB and the Ministry of Defense to explore new technologies in the aerospace field. Deliveries are scheduled to be completed before 2024. However, the total number of aircraft to be acquired may reach, in the long term, approximately 108 units.

This is taking into account the planned deactivation of the F-5 and AMX aircraft in the FAB and the eventual replacement of the Navy's A-4 Skyhawks with a naval version of the Gripen (even before the deactivation in 2017 of the Brazilian aircraft carrier *São Paulo*),[43] even though Embraer modernized all these legacy aircraft in the 2000s.[44]

The aeronautical sector has shown that it has been a key technology leader in Brazil over the last few decades, mainly from the development, in the 1980s, of the AMX aircraft in partnership with Italy. The new Gripen program will only serve to further benefit Brazilian military aviation. First, due to Brazil obtaining for its arsenal a multirole aircraft equipped with modern sensors and the active electronic scanning radar, as well as the possibility of the use of fifth-generation missiles beyond the visual range such as the Meteor or short-range missiles such as the A-Darter, manufactured for 12 years in a partnership between Brazil and South Africa. [45]

Second, the acquisition of the Gripen represents an opportunity for pilots and Brazilian companies to seek not only present emerging technologies but also organizational and process innovations. Brazilian pilots in training in Stockholm are in contact, for example, with advanced simulation centers, such as the *Flygvapnets Luftstrids Simulerings Centrum* (Swedish Air Force Combat Simulation Center).[46] These same pilots will be exposed to modern logistical management practices, since the *Försvarets materielverk* (Swedish Defense Materiel Administration) is recognized for its experience in implementing performance-based logistics,[47] something relatively new in the FAB.

In addition, the assembly of parts for the Gripen orders at the Embraer Defense and Security factory and the transfer of technologies foreseen in the contract of acquisition of the first 36 aircraft will train companies and personnel in the Brazilian aerospace segment. The Swedish–Brazilian Research and Innovation Center was created in 2011 in Brazil with the objective of projecting and supporting initiatives aimed at advanced technologies among universities, governments, and companies—not only in the aeronautical sector but also in the areas of security and defense, urban development, sustainable energy, and transportation and logistics.[48] One of the recent fruits of the Gripen program was the choice of wide-area display produced by AEL Systems to equip not only the fighters acquired by Brazil but also the 60 Gripen and those ordered in Sweden.[49]

In this regard, the current negotiations involving Boeing and Embraer in the commercial sector will undoubtedly define the future of the FAB and Brazil's national security and defense industrial base. In the end, Embraer's commercial aircraft sector has laid the foundation for the company's success

in the military sector, especially when taking into consideration the instability of orders from the Brazilian military.[50]

Conclusion

Accelerated technological progress is accompanied by a great challenge for companies and governments. In the military field, even major military powers have faced dilemmas defining military capabilities. Meanwhile, new technologies not only bring opportunities but also vulnerabilities. Faced with this scenario, the technological gap between developed and developing countries tends to increase, with clear consequences in national security and defense fields.

The impact of technologies known as emerging and disruptive can already be observed. It is no coincidence that the major military powers have invested significant resources in research and incentives in these cutting-edge technologies. For countries like Brazil, this means the need to reconsider old practices, organizational structures, and processes, with the aim of trying to minimize the threat of technological developments underway. Thus, the definition of priorities becomes fundamental.

As noted, the Brazilian participation in the Gripen program, with Saab and Embraer Defense and Security at its center, is one of the examples of opportunities open to the country, even in the face of the political, economic, and organizational difficulties that have occurred in recent years. Thus, the aeronautical sector, with several of its projects led by Embraer, has been a more specific key technological driver than the various lists of documents produced by the Ministry of Defense, with technologies defined as priority only on paper.

The central issue facing Brazil is how to guarantee good long-term results in the framework of the partnerships with Gripen, while at the same time cultivating associations between the North American company Boeing and Embraer in the commercial sector. At the center of the debate is the Embraer group, considered the most-important Brazilian conglomerate in the aeronautical segment and the national security and defense industrial base. Furthermore, based on the above, it is possible to affirm that the armed forces in Brazil will hardly have the conditions to keep up to date in the coming years if they do not face the issue of high personnel costs and the low resources assigned to equipment. For this, measures for greater coordination in defense acquisitions, including the definition of common priorities between the Navy, the Army, and the Air Force, should be presented as better options to exploit the potential brought by emerging technologies such as autonomous vehicles, augmented and virtual reality, AI, and cybernetics—especially when taking into account so many other Brazilian economic and social priorities. ❑

Notes

1. PWC, "The Essential Eight," *PWC*, 4 September 2018, https://www.pwc.com/gx/en/issues/technology/essential-eight-technologies.html; and *Foro Mundial de Economía*, "Top 10 Emerging Technologies 2018," September 2018, http://www3.weforum.org/docs/Top10_Emerging_Technologies_report_2018.pdf.

2. J. R. Wilson, "The increasing role of COTS in high-fidelity simulation," *Military & Aerospace Electronics*, 1 September 2018, https://www.militaryaerospace.com/articles/print/volume-29/issue-9/special-report/the-increasing-role-of-cots-in-high-fidelity-simulation.html.

3. Corrie Poland, "NATO focuses on big data and artificial intelligence," *Air Combat Command,* 12 June 2018, https://www.acc.af.mil/News/Article-Display/Article/1549099/nato-focuses-on-big-data-and-artificial-intelligence/; and Valerie Insinna, "US Air Force turns to data analytics to solve B-1, C-5 maintenance challenges," *Defense News*, 25 September 2018, https://www.defensenews.com/digital-show-dailies/air-force-association/2018/09/25/air-force-looks-to-data-analytics-to-help-solve-b-1-c-5-maintenance-challenges/.

4. Kyle Rempfer, "DARPA hopes to swarm drones out of C-130s in 2019 test," *Air Force Times*, 18 December 2017, https://www.airforcetimes.com/newsletters/daily-news-roundup/2017/12/18/darpa-hopes-to-swarm-drones-out-of-c-130s-in-2019-test/; and Todd South, "Drone swarm tactics get tryout for infantry to use in urban battlespace," *Army Times*, 8 January 2018, https://www.armytimes.com/news/your-army/2018/01/08/drone-swarm-tactics-get-tryout-for-infantry-to-use-in-urban-battlespace/.

5. Daniel Cebul, "Marines 3-D print replacement parts for F-35, unmanned ground vehicle," *Defense News*, 25 April 2018, https://www.defensenews.com/industry/techwatch/2018/04/25/marines-3-d-print-replacement-parts-for-f-35-unmanned-ground-vehicle/.

6. Daniel Cebul, "How the Office of Naval Research hopes to revolutionize manufacturing," *CISRNET*, 15 October 2018, https://www.c4isrnet.com/industry/2018/10/15/how-the-office-of-naval-research-hopes-to-revolutionize-manufacturing/.

7. United Kingdom, Defence and Security Accelerator (DASA), "Behavioural Analytics for Defence and Security," 11 October 2018, https://www.gov.uk/government/publications/competition-behavioural-analytics-for-defence-and-security/behavioural-analytics-for-defence-and-security.

8. Dom Galeon, "Russia is building an AI-powered missile that can think for itself," Business *Insider*, 26 July 2017, https://www.businessinsider.com/russia-artificial-intelligence-missile-2017-7 ; "How Artificial Intelligence Could Increase the Risk of Nuclear War," RAND Corporation, 24 April 2018, https://www.rand.org/blog/articles/2018/04/how-artificial-intelligence-could-increase-the-risk.html.8

9. Zhao Lei, "Quantum radar tech to counter stealth," *China Daily*, 25 September 2018, http://www.chinadaily.com.cn/a/201809/25/WS5ba96f86a310c4cc775e7d08.html ; and Mary-Ann Russon, "Canada developing quantum radar to detect stealth aircraft," *BBC News*, 25 April 2018, https://www.bbc.com/news/technology-43877682; Stephen Chen, "Could ghost imaging spy satellite be a game changer for Chinese military?", *South China Morning Post*, 26 November 2017, https://www.scmp.com/news/china/society/article/2121479/could-ghost-imaging-spy-satellite-be-game-changer-chinese.

10. Mathieu Rosemain and Michel Rose, "France to spend $1.8 billion on AI to compete with U.S., China," 29 March 2018, https://www.reuters.com/article/us-france-tech/france-to-spend-1-8-billion-on-ai-to-compete-with-u-s-china-idUSKBN1H51XP.

11. Ryan Browne, "Global tech industry backs UK with $1.4 billion artificial intelligence deal," CNBC, 26 April 2018, https://www.cnbc.com/2018/04/26/uk-ai-industry-gets-1-point-4-billion-investment-from-global-tech-industry.html.

12. United States of America, "National Quantum Initiative Act," *Congress.gov*, 17 September 2018, https://www.congress.gov/bill/115th-congress/house-bill/6227/text

13. Lewis Sanders IV, "Germany creates DARPA-like cybersecurity agency," *Deutsche Welle* (DW), 29 August 2018, https://www.dw.com/en/germany-creates-darpa-like-cybersecurity-agency/a-45266458.

14. Samuel Bendett, "In AI, Russia Is Hustling to Catch Up," *Defense One*, 4 April 2018, https://www.defenseone.com/ideas/2018/04/russia-races-forward-ai-development/147178/.

15. "China's core AI industry to exceed US$145 billion by 2030: report," *Xinhuanet*, 8 December 2018, http://www.xinhuanet.com/english/2018-12/09/c_137660142.htm.

16. Brazil, Ministry of Defense, Ministry of Science and Technology, "*Concepção Estratégica e Inovação de Interesse da Defesa Nacional*" (Strategic Conception and Innovation of Interest to National Defense), Brasilia, 2003, p. 42-43.

17. Brazil, *Decreto nº 5.484, de 30 de junho de 2005. Política de Defesa Nacional* (PDN) (Decree No. 5.484, 30 June, National Defense Policy, http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Decreto/D5484.htm.

18. Brazil, Portaria Normativa nº 899/MD, de 19 de julho de 2005, Política Nacional da Indústria de Defesa (Naval Regulation No. 899 / MD, 19 July 2005, National Policy of the Defense Industry-(PNID), https://www.defesa.gov.br/arquivos/File/legislacao/emcfa/publicacoes/pnid_politica_nacional_da_industria_de_defesa.pdf.

19. State of S. Paulo, "*Cronologia: a compra dos caças, uma negociação de 18 anos*" (Chronolgy: The purchase of fighter jets, an 18-year negotiation), 18 December 2013, https://politica.estadao.com.br/noticias/geral,cronologia-a-compra-dos-cacas-uma-negociacao-de-18-anos,1110136.

20. Brazil, *National Defense Strategy*, 2008, https://www2.gwu.edu/~clai/recent_events/2010/Brazil_Defense/National_Strategy_of_Defense.pdf.

21. Brazil, Defense White Paper, Brasília, 2012, https://www.defesa.gov.br/arquivos/estado_e_defesa/livro_branco/lbdn_2013_ing_net.pdf.

22. *Airbus Helicopters*, "Airbus Helicopters delivers the first EC725 manufactured in Brazil," 17 de junio de 2014, http://www.helicopters.airbus.com/website/en/press/Airbus%20Helicopters%20delivers%20the%20first%20EC725%20produced%20in%20Brazil_1524.html.

23. *Defense Industry Daily*, "Fighter helicopters Mi-35M / AH-2 *Sabre*), 15 December 2014, https://www.defenseindustrydaily.com/mi-35m-wins-brazilian-attack-helicopter-competition-05180/.

24. *Defense Industry Daily*, "Rio 2016: Brazil Looks to Russia for Air Defense Systems," 8 February 2017, https://www.defenseindustrydaily.com/rio-2016-brazil-buys-russian-air-defense-systems-018297/.

25. Diálogo *Digital Military Magazine*, "Brazil's UAV Falcão to Make Inaugural Flight Before July," 3 May 2012, https://dialogo-americas.com/en/articles/brazils-uav-falcao-make-inaugural-flight-july ; and Rodrigo de Oliveira Andrade, "*The flight of the Falcon*," September 2013, http://revistapesquisa.fapesp.br/en/2013/10/23/the-flight-of-the-falcon/.

26. *Flight Global*, "Brazilian Air Force signs deal launching Embraer KC-390 tanker-transport," 14 April 2009, https://www.flightglobal.com/news/articles/brazilian-air-force-signs-deal-launching-embraer-kc-325113/.

27. Brazil, Financiadora de Estudos e Projetos, "*Inova Aerodefesa*," http://www.finep.gov.br/apoio-e-financiamento-externa/programas-e-linhas/programas-inova/inovacao-aerodefesa.

28. *The Economist*, "Has Brazil blown it?" 27 September 2013, https://www.economist.com/leaders/2013/09/27/has-brazil-blown-it.

29. Daniel Gallas, "Dilma Rousseff impeachment: How did it go wrong for her?" 12 May 2016, https://www.bbc.com/news/world-latin-america-36028247.

30. Diego Lopes da Silva, "How Brazil's political and economic crisis affects its military spending", 22 June 2017, https://www.sipri.org/commentary/blog/2017/how-brazils-political-and-economic-crisis-affects-its-military-spending.

31. Vírginia Silveira, "*Helibras abre programa de demissão*" (Helibras opens program for layoffs), Valor Econômico, 16 January 2015, https://www.valor.com.br/empresas/3862662/helibras-abre-programa-de-demissao.

32. Ivan Plavetz, "*Embraer comunica encerramento das atividades da Harpia*" (Embraer announces closing of activities at Harpia), Tecnodefesa, 7 January 2016, http://tecnodefesa.com.br/embraer-comunica-encerramento-das-atividades-da-harpia/.

33. Xandu Alves, "*Ministro admite um atraso de R$ 500 milhões em repasses do governo ao projeto do KC-390*" (Ministry admits delay of R$500 million in government losses for the KC-390 project), O Vale, 29 April 2015, http://www2.ovale.com.br/ministro-admite-um-atraso-de-r-500-milh-es-em-repasses-do-governo-ao-projeto-do-kc-390-1.582478 ; and Ernesto Klotzel, "*Embraer registra perdas de US$ 100 milhões com KC-390*" (Embraer reports losses of US$100 million with KC-390), *USAero Magazine*, 2 August 2018, https://aeromagazine.uol.com.br/artigo/embraer-registra-perdas-de-us-100-milhoes-com-kc-390_3962.html.

34. *World Development Indicators database*," World Bank, 21 September 2018, http://databank.worldbank.org/data/download/GDP.pdf.

35. Nan Tian, Aude Fleurant, Alexandra Kuimova, Pieter D. Wezeman and Siemon T. Wezeman, "Trends in World Military Expenditure, 2017. SIPRI Fact Sheet, May 2018, https://www.sipri.org/sites/default/files/2018-05/sipri_fs_1805_milex_2017.pdf.

36. Edna Simão, Fabio Graner and Ribamar Oliveira, "*Pessoal consome 75% das verbas dos militares*" (Personnel uses 75% of military budget), Valor Econômico, 12 November 2018, https://www.valor.com.br/politica/5979571/pessoal-consome-75-das-verbas-dos-militares.

37. Audiência Pública com o ministro da Defesa Joaquim Silva e Luna, Câmara dos Deputados. (Public audience with the Minister of Defense Joaquim Silva e Luna, Chamber of Deputies), Comissão de Relações Exteriores e Defesa Nacional (CREDN) (Foreign Affairs and National Defense Commission), 4 July 2018, http://www2.camara.leg.br/atividade-legislativa/comissoes/comissoes-permanentes/credn/audiencias-publicas/2018-arquivos/07-04-debater-temas-de-defesa-nacional-com-o-ministro-da-defesa-general-de-exercito-joaquim-silva-e-luna.

38. Érica Winand and Héctor Luis Saint-Pierre, "The fragility in the Brazil's defense policy," History Vol 29 No. 2, France, December 2010, http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0101-90742010000200002.

39. Peterson Ferreira da Silva, "*Para além da mera discussão sobre a fixação de percentagens do PIB para a defesa: a necessidade de reforma do arcabouço brasileiro de aquisições militares*" (Besides de mere discussion of setting NDP percentages for defense: The need to reform the Brazilian legal framework for military acquisitions). IX Encontro Nacional da Associação Brasileira de Estudos de Defesa (IX National Meeting of the Brazilian Association of Defense Studies), 06-08 July 2016,

http://www.enabed2016.abedef.org/resources/anais/3/1472152129_ARQUIVO_PETERSON_ARTIGO_ENABED16_revisado_AGO2016.pdf.

40. Brasil, *Livro Branco de Defesa Nacional 2016 (versão sob apreciação do Congresso Nacional*), (2016 National Defense White Papers), Brasília, p. 154, https://www.defesa.gov.br/arquivos/2017/mes03/livro-branco-de-defesa-nacional-consulta-publica-12122017.pdf.

41. Eliane Oliveira, Geralda Doca and Manoel Ventura, "Com cortes nos orçamentos, mais ministérios têm dificuldades de manter atividades" (Budgetary cuts, but ministries have difficulty maintaining their activities), O Globo, 11 July 2017, https://oglobo.globo.com/economia/com-cortes-nos-orcamentos-mais-ministerios-tem-dificuldades-de-manter-atividades-21575482.

42. Andres Schipani, "*Brazilian military to take control of security in Rio de Janeiro*," Financial Times, 16 February 2018, https://www.ft.com/content/a4e31d0c-1374-11e8-8cb6-b9ccc4c4dbbb.

43. Thiago Vinholes, "*Mesmo sem porta-aviões, Marinha do Brasil segue interessada no Gripen naval*" (Even without aircraft carrriers, Brazilian Navy is still interested in Gripen), 21 July 2017, https://airway.uol.com.br/mesmo-sem-porta-avioes-marinha-do-brasil-segue-interessada-no-gripen-naval/.

44. "*Brasil deve comprar 108 Gripen NG*" (Brazil should purchase 108 *Gripen NG*), Aero Magazine, 19 November 2014, https://aeromagazine.uol.com.br/artigo/brasil-deve-comprar-108-gripen-ng_1836.html.

45. *Agência Força Aérea, "Míssil A-Darter conclui testes na* África *do Sul"* (Air Force Agency, *A-Darter* Missile finishes testing in South Africa), 28 September 2018, http://www.fab.mil.br/noticias/mostra/32836/PODER%20AEROESPACIAL%20-%20M%C3%ADssil%20A-Darter%20conclui%20testes%20na%20%C3%81frica%20do%20Sul.

46. Saab, "Brazilian pilots prepares for flying," 3 December 2018, https://saabgroup.com/media/stories/stories-listing/2018-12/brazilian-pilots-prepares-for-flying/.

47. Saab, "Saab receives order from FMV for Gripen support and maintenance," 3 July 2013, https://saabgroup.com/media/news-press/news/2013-07/saab-receives-order-from-fmv-for-gripen-support-and-maintenance/.

48. *Swedish-Brazilian Research and Innovation Centre* (CISB), http://www.cisb.org.br/.

49. "AEL Sistemas passa a integrar a cadeia global de produção do Gripen" (AEL Systems joins Gripen's global assembly line), 26 November 2018, https://www.aereo.jor.br/2018/11/26/ael-sistemas-passa-a-integrar-a-cadeia-global-de-producao-do-gripen/.

50. Yuri Vasconcelos, "A deal in the air," Pesquisa FAPESP, June 2018, http://revistapesquisa.fapesp.br/en/2018/06/20/a-deal-in-the-air/..

Peterson Ferreira Da Silva, PhD

PhD in International Relations (University of Sao Paulo, 2015). Master's Degree in International Relations, (San Tiago Dantas - Unesp, Unicamp and Puc/SP – 2011). Invited-member of the Defense Industry Department (COMDEFESA) in the Sao Paulo Federation of Industries (2005–2018). Associate researcher in the Aerospace and Defense Studies Laboratory (LabA&D/UNICAMP) and in the Center for Strategic Studies of the Brazilian Army (CEEEx/EME – 2016-2018). Professor at the Brazilian War College (ESG). Research Interests: international security , National Security and Public Policy, Intelligence, Innovation & Defense, defense policies/white papers; defense industrial policies, civil-military cooperation projects...