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IS THE 21ST CENTURY THE END OF THE AIRCRAFT CARRIER ERA?

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Abstract

The paper discusses the relationship between aircraft carrier's significance for world's nations and its existential threats by excessive costs and new technologies available in this century. It examines this issue using the methodology of an applied research essentially based on a literature review, establishing an explanatory research through a mixed methods approach as a mode of enquiry. It concludes a new less costly generation of carriers will be able to preserve the majority of nations' interests. Whilst, the US will continue to project power with its supercarriers until the end of this century, in a transition for the robotic age, as well as the same "cheaper" carriers as other nations for further operations.

Introduction

Some technologies have provided significant changes in the navies across the globe, since the beginning of the 20th century, such as the conventional and wireless telegraph, steam engines, and big guns, reshaped the naval strategy, and even tactics. The Battle of Tsushima (1905), during the Russo-Japanese War (1904 – 1905), was emblematic and illustrates how those technologies were deployed in the naval warfare. Subsequently, those advances combined with the armoured hull, which was used on ships since the mid-1800s, turned the battleship into the principal ship of the fleets.[1]

During the interwar period, the continuous development of the naval warfare, mostly the battleships, led to its limitations established at the Washington Conference in 1922. The Treaty defined limits on the capital ship and aircraft carriers displacements and armament. Despite the clear separation on those definitions, the simple distinction between carriers and any other regular surface ships demonstrated the increasing importance of those peculiar ships.[2]

From the early-1900s onwards, the perception of space has definitively changed. Distances have become "shorter" due to the development of aircraft. During WWII, this perception was more evident and geography had an obvious relevance.[3] In Mediterranean Theatre, the distances involved were relatively short and land-based aircraft developed an important role for both Axis and Allies.[4] From this same premise, the German Air force (*Luftwaffe*), which had become increasingly successful in its short-range continental war, has envisaged the condition for an ultimate air strike over the British territory by the late 1930s. However, the Battle of Britain in 1940, proved that air defence can defeat an air offensive and became an important milestone in Air Power history.[5] Nevertheless, the European Theatre was not the most appropriate scenario for carriers due to the threat of land-based aircraft, except for the successful air strike carried out from the United Kingdom (UK) carrier HMS "Illustrious" during the Battle of Taranto (1940).[6]

On the other hand, in the Pacific Theatre, the extension of the Japanese Empire reached more than 5,000 miles between its north-south extremities and its perimeter slightly more than 14,000

[1] Michael A. Palmer, *Command at Sea: Naval Command and Control since the sixteenth century* (Cambridge: Harvand Press, 2007): 227-230.
[2] United Kingdom. HM Stationery Office. "Conference on Limitation of Armament: Washington 1921-22, Cmd. 1627," (London: HM Stationary Office, 1922): 17. http://treaties.fco.gov.uk/docs/pdf/1922/TS0001-1.pdf (accessed April 16, 2016).
[3] George T. Renner, *Human Geography in the Air Age* (New York: The Macmillan Company, 1942), 122-125.
[4] Palmer, Command at Sea, 257.
[5] Colin S. Gray, *Airpower for Strategic Effect* (Alabama: Air University Press, 2012), 107-109.
[6] Edwin P. Hoyt. *Carriers Wars: Naval Aviation from World War II to the Persian Gulf* (London: Robert Hale, 1990), 17-18.

miles, demanding shipborne aircrafts as well as long-range bombers.[7] The Japanese efforts in Central Pacific stretched for approximately 1,500 miles to force a "decisive battle" with the American Fleet.[8] In that context, the Battle of the Coral Sea (1942) became the first in naval history when adversary fleets were never in sight of one another.[9] Subsequently, the carrier began to overtake the battleship, which has gradually becoming obsolete for distant engagements between belligerents' forces at sea. Therefore, the aircraft carrier could no longer be a mere escort ship. Its fundamental role in the most significant navies, has been demonstrating valuable offensive and defensive capabilities, made it their capital ship.[10]

The deployment of carriers has been challenged by the nuclear threat during the Cold War (1947 – 1991), when the nuclear deterrent seemed to effectively, in that bipolar world stage, maintain the *status quo* of the global powers. Fortunately, during the Falklands/Malvinas War (1982), carriers were back as a breath of change in the nuclear age.[11] Nonetheless, the British nuclear-powered submarine (SSN) "Conqueror" sunk the Argentine cruiser "Belgrano", sending the entire Argentinian fleet, including the carrier "25 de Mayo", back to their homeport after a single attack.[12]

By the late 1980s, a new world order had come. The collapse of the former Soviet Union in 1991 led to the end of the bipolar world and superpowers rivalry, proclaiming a series of political crisis across the globe.[13] In that unstable and uncertain environment, the necessity of alliances had become more prominent for power projection. Notwithstanding, it usually demands friendly airfields close to the action, which might not be available due to political, operational or even climatic limitations. In this sense, carries have represented a viable alternative to solve this problem, providing relative independence from the host nations. Thus, the First Gulf War (FWG) in 1991 firstly witnessed this enormous transformation in conflicts for the twentieth-first century. This was only achieved due to new capabilities aboard, such as Command, Control, Communications, Computer, and Intelligence (C4I), which has enabled better integration and interoperability with all forces involved.[14]

Therefore, this paper will examine the past and present importance of aircraft carriers in order to establish a prospective view for the applicability of these platforms until the end of the 21st century and perhaps support the decision for new investments in such ships. The carriers' vital importance,

[7] D. Clayton James. "American and Japanese Strategies in the Pacific War," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (New York: Oxford University Press, 2010), 717.
[8] Palmer. Command at Sea, 259.
[9] David MacIssac. "Voices from Central Blue: The Air Power Theorists," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (New York: Oxford Press, 2010), 637-38.
[10] Geoffrey Till, *Air Power and the Royal Navy 1914-1945: A Historical Survey* (London: Jane's Publishing, 1979), 81.
[11] Gordon A. Craig and Felix Gilbert. "Reflections on Strategy in the Present and Future" in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (New York: Oxford Press, 2010), 868.
[12] Sandy Woodward and Patrick Robinson, *One Hundred Days: The Memoirs of the Falklands Battle Group Commander* (London: Harper Press, 2012), 228.
[13] Andrew Heywood, *Global Politics* (Basingstoke: Palgrave Macmillan, 2014), 44-45.
[14] Geoffrey Till, *Seapower: A guide for the twenty-first century* (London: Routledge, 2009), 246.

as well as its excessive cost in acquisition, maintenance, and operation, represents a real dilemma for the future of the world's most representative armed forces. Accordingly, "carriers" are usually a topic of discussion, especially in times of austerity, when it becomes more frequent and controversial. In broad terms, an aircraft carrier is a large platform over the sea, able to carry and deploy a variety of technologies.

Thus, from the viewpoint of the application of this research, the paper will show the various aspects involved in the current carriers deployment, through the collection of information fundamentally based on a literature review of the subject to provide a theoretical background to the study. Hence, it will also establish an explanatory research in order to meet its objective, which is to discuss the relationship between carrier's significance for the world's navies and its existential threat by enormous cost and new technologies available in this century.

To achieve this objective, the paper will assess the topic through a mixed methods approach of both qualitative and quantitative research to establish a mode of enquiry. The former will be developed in the first two sections, describing the principal characteristics of the carriers as a capital ship in the navies, and their relevance for tactical and operational level; as well as the strategic role of the carriers for the nations and the contribution to their maritime attributes, contrasting different maritime strategies and its deployment in the United States (US) and China, as a case study. The latter will be established in the last three sections, discussing the balance between the opportunity of new technologies applied in carriers to enhance its capabilities and issues, such as overall costs, inherent constraints and continuous development of revolutionary technologies, which ultimately might substitute the current ones.

Carrier: The Capital Ship and its relevance to Naval Power

This section will discuss the role of the carriers as a capital ship and its relation to the naval power. For this, it will use the lenses of different acknowledged naval strategists to assess the carriers' tactical and operational importance, as well as strategic principles, as the basis for the next section. Moreover, it will analyse a brief case study in the American carrier-centered fleet model deployed in the US Navy (USN), the most prominent carrier power.

The continuous development of technology, especially concerning aircraft, deeply affected the carrier-borne naval aviation. In 1921, William "Billy" Mitchel successfully demonstrated an experiment with an aircraft sinking a battleship (former German *Ostfriesland*), despite some critiques saying that the ship was not able to provide any reaction. In spite of that controversy, the US naval authorities realised the carrier-based aircraft would be useful to escort the main battle

fleet.[15] In 1922, the Washington Conference on armament limitations anticipated the increasing importance of carriers, distinguishing capital ship and aircraft carriers as vessels of war exceeding 10,000 tons of displacement, but only the former would carry guns exceeding 8 inches caliber.[16] Subsequently, the emergence of carriers during WWII was noticeable and the battleship would no longer be admitted as a capital ship.

A rough explanation of a capital ship is that kind of ship able to defeat any other sort of ship. During days of sail ships, the capital ship was the one with the most guns. Likewise, the dreadnoughts thereafter had the biggest guns. It must be highlighted the impact of each of those ships, affecting the entire fleet doctrine and architecture. From a different perspective, the capital ship might be also defined as that ship whose greater power, expense, and prestige, becomes a realisation of a nation's naval power, which is the military component of the seapower.[17]

At this point, it is fundamental to understand the concept of seapower. In essence, seapower embraces the contribution of the national power to events at sea. It also involves all non-military activities related to sea use, such as merchant shipping, fishing, shipbuilding and so on, contributing to naval power and influencing the behaviour of other people on the land. For this paper, seapower and maritime power will be considered synonyms. [18]

Alfred Thayer Mahan (1840 – 1914) used extensively the concept of the "decisive battle", inspired in the Second Punic War and the infamous Roman defeat in the Battle of Cannae (216 B.C.) by Hannibal.[19] The mahanian perspective of "the decisive battle" is that great victory against the adversary's organized force in order to definitely solve any dispute, deploying a battle fleet with a line of battleships, rather than establishing a demonstration of force in several places. For him, a nation should have an organised force able to pursue its policies and hence to strike the enemy's force afloat.[20] In other words, a navy must be composed essentially by capital ships to be decisive at war.[21]

In 1921, Admiral Herbert William Richmond (1871 – 1946), also known as the "British Mahan", summarized the "decisive battle" as that one for the "destruction of the enemy's capital ship."[22] To

[15] MacIssac, Voices from Central Blue, 632.
[16] UK, Conference on Limitation of Armament, 17.
[17] Robert C. Rubel, "The Future Of Aircraft Carriers," *Naval War College Review* 64, No. 4 (2011): 15-18. https://www.usnwc.edu/getattachment/87bcd2ff-c7b6-4715-b2ed-05df6e416b3b/The-Future-of-Aircraft-Carriers (accessed April 16, 2016).
[18] Till, Seapower, 22.
[19] Alfred T. Mahan, *The influence of the Sea Power upon History, 1660-1783* (Boston: Little Brown and Company, 1918), 9. Kindle version.
[20] Ibid., 708-709.
[21] Philip A. Crowl, "Alfred Thayer Mahan: The Naval Historian," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (Oxford: Oxford University Press, 2010), 458.
[22] Till, Seapower, 158.

a certain extent he was right, the vulnerability of the carriers as a capital ship was ratified by the reports of Admiral Sandy Woodward after the Falklands/Malvinas War in 1982, when any mishap with them could be fatal to the entire campaign.[23] The Battle of Midway (1942) is a good example to illustrate Richmond's affirmative of a decisive battle, as a tipping point in the Pacific Campaign, where the Japanese carriers losses affected the balance of power until the end of the war in the Pacific, due to Japan's incapacity to rebuild its Carrier Strike Force.[24]

Furthermore, Mahan envisaged the military "command of sea", a concept inspired in the Peloponnesian war narrated by the Greek historian Thucydides,[25] establishing a prolonged control of the sea lines of communication (SLOC) in order to ensure the use of the sea for the nation's interests or to deny it for the enemy.[26] Notwithstanding, he had limited resources to impose that "command of the sea" and therefore the "decisive battle" would establish it with less resources and time. In other words, a decisive victory may provide an effective "command of the sea" to the victorious nation, and simultaneously prevent its opponent from achieving this condition.[27]

From this premise, at least two important principles were necessary to establish that "command of the sea": the availability of good SLOC and the concentration of force, in order to achieve the decisive battle and ensure the use of the SLOCs. Julian Stafford Corbett (1854 – 1922) clarified the mahanian concept of concentration of forces, which does not necessarily mean keeping them as one mass, but disposing them in a timely manner at a decisive point.[28] This is highlighted in the famous Mahan's aphorism: "Never divide the fleet!"[29]

In fact, Mahan knew that the absolute control of the sea might be a "utopia". An adversary's small fraction of naval forces or its single ships would be able to strike unprotected points, especially in long coast-lines, and evasions of weaker opponents could always occur. [30] It could be seen in modern warfare, the introduction of the submarine and the aircraft in the world wars challenged the idea of the command of the sea.[31] In this sense, Mahan established some conditions, which could affect the sea power of the nations, such as geographical position, physical conformation and the extent of the territory. The geographical position, for instance, might provide a strategic advantage against the enemies, with a central position for a good base, favouring the concentration of

[23] Woodward and Robinson, One Hundred Days, xx.
[24] Hoyt, Carriers Wars, 96.
[25] Lawrence Freedman. *Strategy: A History* (New York: Oxford University, 2013): 115.
[26] Mahan, The influence of the Sea Power upon History, 914.
[27] Till, Seapower, 158.
[28] Julian S. Corbett. *Some Principles of Maritime Strategy* (London: Longmans, 1911), 452-453. Kindle Version.
[29] Crowl, Alfred Thayer Mahan, 458.
[30] Mahan, The influence of the Sea Power upon History, 67.
[31] Robert C. Rubel, "Command of the sea: An old concept resurfaces in a new form." *Naval War College Review* 65, No. 4 (2012): 22. https://www.usnwc.edu/getattachment/e7dabb3b-333d-4af1-8eb3-b98d311c470d/Command-of-the-Sea--An-Old-Concept-Surfaces-in-a-N (accessed April 30, 2016).

forces.[32] From a mahanian view, the geography was fundamental for the Naval Strategy in order to combine the geographic elements involved with the deployment of the available forces, posing a most basic economic problem, which is established by limited resources for increasing demands.

Grenfell highlighted that the use of the SLOCs should be ensured by a so-called control fleet, consisting of all ships engaged in that work, such as destroyers and other small crafts, to provide focal areas and terminal patrolling or shipping escorting. The control fleet could be scattered to achieve this effective control in single ships or small groups. However, due to the lack of protection against a large body of the opponent in each area, those ships would need a battle fleet composed of battleships at its core, to bring an action to any opponent before it could be harmful.[33] That dual role of the Naval Forces represents a necessity of a balanced fleet, which should be able to develop both functions, as a control fleet and a battle fleet.

The American Admiral Elmo Zumwalt (1920 – 2000), former US Chief of Naval Operations (CNO), had also envisaged this dichotomy in the early 1970s. Notwithstanding, the disparity between a battle fleet with sophisticated and costly ships and an inexpensive control fleet, which the latter would be restricted to lower-risk zones, had been commonly accepted in the modern navies. Therefore, Zumwalt's ideas were strongly neglected. Nevertheless, due to the world oil crisis in 1973, the financial constraints implied the acceptance of the so-called “high-low mix” fleets in the USN. It was later designated Cruiser-Destroyer Groups (CRUDESGRU), combining these two kinds of ships. Subsequently, the Destroyers “Spruance” Class (DD) and Frigates “Oliver Hazard Perry” Class (FFG) Construction Programmes was undertaken.[34]

Julian Stafford Corbett (1854 – 1922) agreed that the concept of Mahan’s decisive battle should be desirable especially for a superior force. However, his approach to the focus on the control of the SLOCs would lead Mahan’s “command of the sea” concept to become a fallacy. According to Corbett’s perspective, the non-line ships, such as cruisers, should not only be part of a control fleet, but should be the eyes of the battle fleet, as scouts of the battleships. He stressed Admiral Nelson’s view that if the object of naval warfare was to control the SLOCs, despite there were no sufficient non-line ships to provide an effective control fleet, the only way to exercise the control of the sea would be through a battle fleet integrated with those ships, which should be its eyes.[35] This view inspired the current configuration of the modern navies and the concept of the Carrier Strike Group (CSG), where the carrier has a central role as “the eyes of the fleet” and simultaneously its striking power.

[32] Mahan, The influence of the Sea Power upon History, 93-95.
[33] Russell Grenfell. *Seapower in the next war* (London: Geoffrey Bles, 1938), 8-9
[34] Hervé Coutau-Bégarie. *Traité de Strategie* (Paris: Economica, 2011): 738.
[35] Corbett. Some Principles of Maritime Strategy, 137-138.

The Corbettian perspective probably anticipated the decline of the battleships a few decades later. The superior firepower of the battleships put carriers as escort ships after the WWI. However, the increasing capabilities provided by the aircraft during the early years of WWII, established a clear shift of the carriers' role in the navies. The deployment of carriers to escort the fleet is illustrated by a Winston Churchill statement, before the Norwegian Campaign in early-1940, "that the role of the armoured carriers in 1940 and 1941 must be the defence of the Fleet when at sea or at Scapa against shore-based aircraft", totally influenced by the European Theatre perspective. Whilst, by late-1941, when the Mediterranean and Atlantic wars had increased in intensity, the British Naval Staff had argued that there is a "(…) striking evidence of the value of carrier-borne aircraft in finding and fixing the enemy and in providing air protection for our forces operating in narrow waters," which added the power projection as another role for the carriers.[36] Therefore, carriers has no longer to be only the "eyes of the fleet", but also a fundamental role in defending the fleet whilst projecting force.

However, some echoes of interwar controversies have been continuing around the carriers, even after the Battle of Midway, whereby military authorities were still not confident with the success of the carriers. In 1942, Sir Archibald Sinclair, the British Secretary of State for Air, argued its efficiency asking: "aircraft carriers have been proved successful, particularly when operating within range of enemy land-based aircraft, as at Midway?"[37] In fact, that is still a key question, due to the fact that the carriers will always be limited to their airwings and consequently will be an overburdened projecting force or striking whilst defending the fleet, when facing land-based air forces the same size or greater than itself. This limitation forced the carriers to carry out "hit and run" raids, as seen during the famous Doolittle raids in early 1942, using its speed to attack Japanese bases, disrupt the enemy's essential land lines of communications, and escape from the range of land-based aircraft. Therefore, the high risk involved meant the carriers could not engage with the enemy's aircraft decisively, which Rubel called "cavalry" due to the similarity to the US Civil War Cavalry, who carried out risky engagements in a dismounted fight with the infantry.[38]

From this premise, carriers need some essential characteristics to develop their current roles in strategic deployments. As seen previously, those characteristics are "the capital ship", "the eyes of the fleet", and "the cavalry". However, there are two other important characteristics that have also to be highlighted, the "the airfield at sea" and "geopolitical chess piece", which the latter will be expanded in the next section.[39]

Concerning "the airfield at sea", the aircraft carrier did not emerge as a fully developed weapon

[36] Till, Air Power and the Royal Navy, 80-81.
[37] Ibid., 82.
[38] Rubel, The Future Of Aircraft Carriers, 15.
[39] Ibid., 15-18.

system until the beginning of WWII, when shipborne aircraft were still very limited in performance and capabilities.[40] However, after the discovery of radar in 1935, there was a high potential of its applicability in air defense systems for land air bases, which was successfully confirmed during the Battle of Britain (1940). Therefore, similar deployments of carriers, as "airfields at sea", was just a matter of time.[41]

In late 1930, the same command formation model previously adopted on battleships was deployed in carriers, and accordingly the first Carrier Divisions (CARDIV) in the USN was established. After the commissioning of the "Essex" and "Independence" Carrier Classes in the USN in late 1942, the CARDIVs were reassigned as Carrier Groups (CARGRU) with up to four carriers in each one.[42] Subsequently, after WWII, the USN had to downsize their naval forces to adapt them to the constraints of the post-war budget.[43] By mid-1970s, the American single carrier-centered model had been established for the first time in their naval history, organising groups called Carrier Vessel Battle Group (CVBG), when the CRUDESGRU was also implemented, according to Zumwalt ideas.

The primacy of the carrier-centered model definitely prevailed over the battleship, which had an unviable cost due to its intensive labour manning and the modern cruisers and destroyers, equally powerful in terms of firepower. Hence, the last battleship in the USN was decommissioned in 1992.[44] Finally, after the Second Gulf War (2003), the CARGRUs and CRUDESGRUs had merged and designated as CSG, placing them under fleet commands for both operational and administrative control.[45] This new organization was closely aligned to the global power projection strategy established by the US Government after the collapse of the Soviet Union. Furthermore, it could be argued that 21st century carrier-centered organisation has ultimately proclaimed the distinction between the classic land organisation, such as battle groups and divisions, and the organisation in modern and more independent strike groups.

This particular organisation of the US Fleets is a clear result from the influence of the mahanian concepts, which led to the current American policies towards a global force. The other carrier powers, particularly those that signed the Treaty of Washington in 1922, have lost the capability to build carriers. The Europeans nations were clearly affected by WWII, when their shipyards were at

[40] Palmer. Command at Sea, 257.
[41] Gray, Airpower for Strategic Effect, 105-106.
[42] Global Security. The Carrier Group One. http://www.globalsecurity.org/military/agency/navy/cargru1.htm (accessed April 30, 2016).
[43] US Government Spending. "20th Century Defence Spending." http://www.usgovernmentspending.com/spending_chart_ 1900_2020USp_XXs2li111mcn_30f_20th_Century_Defense_Spending (accessed April 30, 2016).
[44] US. Department of the Navy. "Battleship History." http://www.navy.mil/navydata/ships/battleships/bbhistory.asp (accessed April 31, 2016).
[45] Curtis A. Utz, Mark L. Evans, and Dale J. Gordon, "The Year in Review 2004," *The Naval Aviation News* 87 no. 5 (2005): 22. http://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=21332418&site=ehost-live (accessed April 16,2016).

full stretch and the industrial capabilities were restricted due to the axis attacks, as well as the financial constraints after the war. Likewise, the Japanese aftermath of WWII resulted in serious defence industry restrictions. Concerning the strategic importance of the forces organisation, Mahan argued: "Even for a peaceful solution, that nation will have the strongest arguments which has the strongest organized force."[46]

The current US doctrine for the CSG establishes its elements on a "symbiotic" relation, not allowing the carriers to operate independently by their own. Therefore, whilst the carriers provide air defence to the fleet with its aircraft, its escort ships provide anti-air and anti-submarine (ASW) protection. Hence, the CSG structure consists of one nuclear-powered aircraft carrier (CVN) with an embarked airwing; up to five surface combatant ships, such as cruisers (CG) and destroyers (DDG); and at least one cruise missile land attack (SSBN) or SSN.[47]

Moreover, for long-distance operations, the CSG might have replenishment ships to provide logistic support. The Carrier airwing is equipped with various types of aircraft, such as shipborne fighter jets, Airborne Early Warning (AEW) aircraft, and transport planes. The escort ships are cruisers able to carry out long-distance strikes with the Tomahawk Land Attack Missile (TLAM) and destroyers equipped with the Aegis guided-missile system, the world's most sophisticated air defence system; and also provide air defense and ASW for the entire group. The SSN is responsible for eliminating the submarine threat to the group.[48]

This impressive defence umbrella can extend over a 200 nautical miles (NM) radius around the CSG. In 2002, for instance, US carriers established an armed airborne presence over Afghanistan more than 400 miles away from its operating stations in the Northern Arabia Sea.[49] That protection area is almost as large as a country like France, where a single opponent would have few chances to penetrate that protection, enhanced by the AEW planes, fighters, ship's air defence, ASW aircrafts and helicopters, among others.[50] Therefore, only a massive attack able to saturate the defences would have some likelihood of success, but would come with excessive high costs. The Argentine Air Force had that experience in 1982.[51] Accordingly, in times of crisis, multiple CSGs will be able to form, alongside other forces as necessary, an Expeditionary Strike Group (ESG) in

[46] Mahan, The influence of the Sea Power upon History, 566.
[47] US Navy. US Department of the Navy Issuances (DONI). "OPNAVINST 3501.316B: Policy for a baseline composition and basic mission capabilities of major afloat navy and naval groups" (Washington: US Navy, 2010): 2-4 https://doni.daps.dla.mil/Directives/03000%20Naval%20Operations%20and%20Readiness/03-500%20Training%20and%20 Readiness%20Services/3501.316B.pdf (accessed April 31, 2016)
[48] Zhang Tao. China Military online. "Expert: China should develop omnipotent carrier strike group." http://english.chinamil.com.cn/news-channels/pla-daily-commentary/2016-01/22/content_6865378.htm (accessed April 31, 2016).
[49] Benjamin S. Lambeth. National Defence Research Institute (RAND). American Carrier Air Power at the Dawn of a New Century (Santa Monica: RAND Corporation, 2005), 34. http://www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG404.pdf (accessed May 13, 2016).
[50] Coutau-Bégarie, Traité de Strategie, 630.
[51] Ibid., 735.

order to project significant power at sea and ashore.[52]

The ESG concept is the realisation of the liberal interventionism in defence of the status quo maintenance, which will secure the interests of the nations, mainly in Europe and in the US, addressing their threats or responding to the crisis rapidly, before they affect the stability of those nations.[53]

The Strategic Importance of the Carriers

The increasing relevance of the navies in its diplomatic role had culminated with the rise of carriers by mid-1900s. Some strategists envisaged the unique capability of the carriers as an opportunity to exploit it for diplomacy. The navies' attributes applied to the carriers led them to develop a decisive role in global events. To illustrate this, it will be used as a study case for this chapter, the carriers' relevance in the South East Asia territorial controversy and to demonstrate the importance of this capital ship in the Chinese Defence Strategy.

Despite the evidences of the strategic importance of the carriers in the Pacific Campaign during WWII, the Royal Navy (RN) insisted in the equally important balanced fleet, especially after the war. For the British, the aircraft carriers are not the centerpiece of their chessboard and obviously because of the limitation on their shipbuilding industry; Britain could not focus on carrier construction in favour of the efforts on other fleet units. The New Construction Programme (NCP) of 1942, for instance, established the need for 16 carriers with 48 aircrafts for the Fleet by 1946, when in fact it had only four new carriers and three old ones. The same situation has happened successively in other programmes due to Economic contraints, resulting in changes or projects projects being abandoned.[54]

Conversely, the US has overtaken the UK, which was considered the world's major industrial power in manufactured products by 1885. Afterwards, the continuous growth of the American industry led to the establishment of the famous President Theodore Roosevelt (1858 – 1919) foreign policy, the "big stick diplomacy". Roosevelt developed his policy on Mahan theories, using it for his own interpretation of the Monroe Doctrine (1823), which led to the American expansionism and interventionism in the rest of the Continent. One of those interventions was to help the insurgents in Panama for their independence from Colombia, in order to ensure the American control of the Panama Canal after its construction, which was a Mahan vision to connect the Atlantic and Pacific Oceans as part of their global strategy. Mahan also influenced the

[52] US. Department of the Navy. "Naval Operations Concept 2010: Implementing the Maritime Strategy" (Washington, 2010): 83. https://www.uscg.mil/history/docs/2010NOC.pdf (accessed April 31, 2016).
[53] Till, Seapower, 8-9.
[54] Till, Air Power and the RN, 81.

development of the USN, which was smaller than Chilean, Argentine or Brazilian Navies by late-1880s.[55] Mahan stressed the importance of naval strategy, which "has indeed for its end to found, support, and increase, as well in peace as in war, the sea power of a country."[56]

However, the achievement of the naval strategy aims involves the exercise of the maritime power, which is also expressed by its military assets, through its naval forces. For this, those forces need some key attributes, which are fundamental to operate them on, under or over the sea, and even ashore.[57] The British Maritime Doctrine established some of those attributes, which most of them are primarily provided by the aircraft carriers.

Access is a very important attribute, which differently than over land, at sea is mostly available due to the fact that the majority of the nations have a coastline. Additionally, on the land, there might exist physical obstacles or boundaries between the objective and the nation's forces. Therefore, the neutrality of the sea provides an opportunity to the naval forces to exercise the nation's interests and if necessary to project power, whose carrier might be a key element as previously seen.[58] A famous speech by the US President Bill Clinton expresses exactly this idea: "When word of a crisis breaks out in Washington, it's no accident that the first question that comes to everyone's lips is: 'Where's the nearest carrier?'"[59]

Mobility is a particular characteristic of the naval component and crucial for long-distance deployments, where the ability to maintain the readiness and respond immediately to any crisis is vital. This attribute, which is enabled by access to the sea, distinguishes the naval power from the land and air powers through the geographic opposition imposed by the sea, which is represented in almost 70 percent of the planet. Notwithstanding, the naval component might exploit the maritime environment, enabling its maximum mobility and providing the capacity to project power from the sea, potentially using carriers. Accordingly, the warships and mainly the carriers might be the only available instruments to provide options for governments to address critical situations.[60]

The Lift capacity is also an important need, especially for major operations, provided by maritime support. In this sense, airpower is the most efficient way to develop this support. However, the long-distances involved as well as the operational environment configuration might not enable this support directly from land bases, when the carrier is again a key element for this significant

[55] Henry Kissinger. *Diplomacy* (New York: Simon and Schuster, 1994): 34-40.
[56] Mahan, The influence of the Sea Power upon History, 81
[57] UK. Development, Concepts and Doctrine Centre (DCDC). *British Maritime Doctrine*. Joint Doctrine Publication (JDP) 0-10 (Shrivenham: DCDC, 2011): 2-1. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/33699/20110816JDP0_10_BMD.pdf (accessed April 31, 2016).
[58] Ibid., 2-1.
[59] National Broadcasting Company (NBC). "Big deck super-carriers rule the seas: Nimitz-class and others key to U.S. 'force projection'. http://www.nbcnews.com/id/3070317/ns/world_news/t/big-deck-super-carriers-rule-seas/#.VycqC2MfRh8 (accessed April 31, 2016).
[60] UK, British Maritime Doctrine, 2-2.

attribute, providing logistic support at and from the sea.[61]

Sustained reach is a singular capacity of the maritime forces, allowing them to operate in a large variety of missions in the same battlespace for an extended period, provided by medical facilities aboard the ships and logistic support from tankers and supply ships. As the largest platform in the fleet, carriers might provide most of those supports to enable this attribute.[62]

Versatility is a significant attribute of the warships, especially carriers. Due to the diversity of aircraft in its airwing, carriers are able to provide a full-spectrum response to address threats or tackle any crisis, from the tactical to the political level. Additionally, the C4I structure aboard establishes essential elements, such as flexibility, adaptability, and jointery characteristics.[63]

Poise or endurance is another key attribute required for any force, which only the naval component has the ability to remain on station for long periods in order to provide effects with its presence or even projecting power. The relevance of the political decision to resolve the appropriate use of force in deterrence or coercion will be discussed later. However, the recognised importance of warships, especially carriers, as instruments of diplomacy has some undesirable effects due to its presence, which may lead to different perceptions by others, maybe hostility. Therefore, the poise attribute exploits all others previously mentioned, which the carrier impressively develops.[64]

Resilience is a peculiar characteristic of naval forces afloat due to the necessity to sustain their operations at sea. The capacity for this had to be developed for their roles in the maritime environment, where no further support is available, except those provided by own forces. Thus, the internal facilities and structure, such as medical support and damage control, as well as logistic ships to provide repair assets, have become essential to fleets. Otherwise, they will easily become non-operational if they lose losing their capabilities after an opponent's attack.[65]

The combination of all attributes presented above results in another attribute, the so-called leverage. This last attribute is a critical element to leverage events ashore, with consequent political and military effects. The carrier's immense power exerts an especial influence in those events. It provides the ability to change the course of a crisis, working on both operational and strategic levels. A nation or a coalition may shape and exploit the operational environment to achieve their national interests. Moreover, joint or combined forces may involve the enemy in a condition to disrupt the enemy's forces.[66]

[61] Ibid., 2-2.
[62] Ibid., 2-3.
[63] Ibid.
[64] Ibid., 2-5.
[65] Ibid.
[66] Ibid., 2-6.

Thus, the navies are currently designed to develop some essential functions to ensure the use of the sea. From this premise, Ken Booth established a trinity, which underpins the use of the sea in the majority of the modern navies and its nation's foreign policy. For him, the navies have three basic roles, which are inter-related and have to be continuously balanced: the diplomatic, the military, and the policing role.[67]

First, the diplomatic role is responsible to ensure the nation's interest and is developed according to its foreign policy. The British Maritime Doctrine also designates it as International Engagement due to its relevant influence in external events. This role might be expressed by influence, conflict prevention, and presence. One of its aims is to achieve the political objectives through the so-called negotiation from strength or coercion, using the nations' prestige or simply manipulation.

This is a traditional function of the navies and the superpowers are skilful in doing it, establishing a prudent naval presence of their warships, particularly the aircraft carrier, to ensure the persuasion of other states to act in favour to the national interests without using force. Likewise, its persuasion could be used in cooperation with friendly nations against a third party.[68] The presence is represented with one of those traditional activities of "showing flag" in order to exploit the visibility of the fleet, visiting friendly seaports or simply "poised" in a maritime area close to a certain crisis region, where the carrier would be its best instrument. In the early-1900s, US President Theodore Roosevelt sent his recently built "great white fleet" on a "world tour" as a sign of the rising American global power.[69]

Second, the policing role or maritime security exploits the seapower under the international, national, and co-operating partners states law, tackling activities, such as piracy, people and arms smuggling, and many other international crimes. The United Nations Convention on the Law of the Sea (1982) (UNCLOS) is the most accepted international law concerning the use of the sea, and until 2015 almost 170 nations had ratified it.[70] Accordingly, the nation's navies, coast guards or both may provide the necessary resources to preserve those rights, as well as to tackle maritime and transnational crimes at sea, by themselves or in co-operation with other nations.

This role might be also applied during Humanitarian Assistance and Disaster Response (HADR). For instance, in 2007, the hospital-ship USS "Comfort" and the Landing Helicopter Assault (LHA)

[67] Ken Booth. *Navies and Foreign Policy* (New York: Routledge, 2014): 15-18.
[68] Ibid., 19.
[69] Joseph S. Nye. *The Future of Power* (New York: Public Affairs, 2011), 45. Kindle Version.
[70] United Nations. Division for Ocean Affair and Law at Sea. "Chronological lists of ratifications of accessions and successions to the Convention and the related Agreements as at 02 January 2015." http://www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm#The%20United%20Nations%20Convention%20on%20the%20Law%20of%20the%20Sea (accessed May 6, 2016).

ship USS “Peleliu” visited tens of nations across the African continent, providing medical assistance to several needy communities.[71] From this premise, Elleman stressed the influence of the national power and prestige as increasingly more represented by “soft power” in this century. His analysis on the American Operation UNIFIED ASSISTANCE in 2004, when a devastating tsunami killed more than 150,000 people from Indonesia to South Africa, demonstrated that aircraft carriers, which are typical representations of “hard power”, might also provide significant “soft power”.[72] Joseph Nye coined this term in late 1980s, defining it as “the ability to affect others through the co-optive means of framing the agenda, persuading, and eliciting positive attraction in order to obtain preferred outcomes.” In this sense, “soft power” is able to provide legitimacy of policies and influence in global events. According to him, the disaster relief provided by the USN to Indonesia in 2004 exerted a strong influence on its people’s attraction to the American values and culture.[73] In broad terms, carriers are the realisation of his concept of “smart power”, which is the combination of “hard power” by the mere use of force, and “soft power” by influence, using coercion and persuasion. There is a tendency for this particular role to be exploited more in the next few years due to the increasing rate of global climate change effects, and therefore armed and security forces are more likely to be deployed in response to those risks for the people in general.[74]

Third, the military role is the pure ability on warfighting, enabling the other two roles. This use of force is based on principles, such as “command of the sea”, “decisive battle” or concentration of force”, currently applied through sea control and sea denial. Sea control is the condition to establish a freedom of movement for one’s certain purpose, through a “decisive battle” for the annihilation of the opponent or a “blockade” for his containment. However, that sea control can not be permanent and has to be established in time and space. Hence, it has to be achieved by the control above, below, and on the surface environments, which does not necessarily need a specific threat.[75] Sea denial is exactly the opposite and its purpose is to prevent the adversary’s sea control in a certain maritime area, during specific times. Carriers may develop the sea control with a good performance, due to the intrinsic attributes of poise and versatility. Conversely, the submarine may develop the sea denial more properly, due to its stealth capacity below the surface, demanding an immense effort of its opponent to establish the control of the sea.[76] The deployment of the nuclear-powered submarines for the British Exclusion Zone around the Malvinas/Falkland Islands in 1982

[71] Till, Seapower, 251-263.
[72] Bruce A. Elleman. “Waves of Hope: The U.S. Navy's Response to the Tsunami in Northern Indonesia.” (Newport Papers 28, Naval War College, 2007), 117. https://www.usnwc.edu/getattachment/a498aa21-6d0f-4938-9d16-14060466165d/Waves-of-Hope.aspx (accessed May 6, 2016).
[73] Nye, The Future of Power, 20-21.
[74] UK. DCDC. Global Strategic Trends: Out to 2045. 5th ed. (Shrivenham: DCDC, 2015), xxii. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348164/20140821_DCDC_GST_5_Web_Secured.pdf (accessed May 13, 2016).
[75] UK, British Maritime Doctrine, 2-10.
[76] Coutau-Bégarie, Traité de Strategie, 733.

demonstrated its total efficiency in order to provide the sea denial against the Argentinians.[77]

However, the most controversial expression of this role is the deterrence. The strategic deterrence currently offers the threat of nuclear weapons by some nations; who might deploy those weapons using the SSBN.[78] Likewise, the conventional deterrence has to persuade the opponent with a credible force, for instance, moving a CSG to a crisis area. The former US President Ronald Reagan illustrated the American policy on deterrence in one of his speeches stating: "We maintain the peace through our strength; weakness only invites aggression" [79] and not coincidentally the official motto of the nuclear-powered carrier, USS "Ronald Reagan" (CVN-76), is "Peace Through Strength" to express exactly that idea of deterrence.[80] However, deterrence depends on its credibility, which is a matter of perception on each adversary and has to be effective before any other action, otherwise it is totally useless.[81]

For some Realists, the security dilemma, which is a condition of the state behaviour translated in actions or capabilities that are often misinterpreted as aggressive by others, led to a singular dynamic to explain conflicts, and ultimately war.[82] From this premise, it could be argued that China is suffering by this security dilemma. The imbalance of power caused in Southeast Asia by its increasing economic growth resulted in a rising military power. The perception of this condition could be seen as defensive or offensive, depending on different perspectives. However, the American hegemon is perceived as threatening by the persistent Chinese effort to preserve the survival of its own nation, even if the Americans view China to have benign intentions.[83] China has moved on from its "near-coast defence" naval strategy between the 1950s and 1980s, for the containment of Taiwan's Government and against a possible Soviet invasion from the sea, to a "near seas active defence" since the late-1980s onwards, against potential "China's seas" threats and to secure its EEZ and territorial claims, in addition to the enhanced "anti-access/area-denial" (A2/AD) to prevent Taiwan's independence.[84]

That operational space expansion required aircraft carriers.[85] In addition to the territorial controversies in the South Asia Sea, China's economic development has become more dependent

[77] Lawrence Freedman. *The Official History of the Falklands Campaign: War and Diplomacy* (London: Routledge, 2007), 88.
[78] Coutau-Bégarie, Traité de Strategie, 733.
[79] Jordan Adams. The Daily Signal. Reagan's Inspiring Words on Defense: "Peace through Strength." http://dailysignal.com/2013/04/01/reagans-inspiring-words-on-defense-peace-through-strength/ (accessed May 2, 2016)
[80] US. Department of the Navy. USS Ronald Reagan. http://www.reagan.navy.mil (accessed May 2, 2016).
[81] UK, British Maritime Doctrine, 2-23.
[82] Andrew Heywood. *Global Politics* (Basingstoke: Palgrave Macmillan, 2014), 19.
[83] Colin Elman and Michael A. Jensen, "Realisms," *in Security Studies: An Introduction*, ed. Paul D. Williams (Oxon: Routledge, 2013), 27-30.
[84] Andrew S. Erickson, Abraham M. Denmark, and Gabriel Collins. "Beijing's 'Starter Carrier' and Future Steps Alternatives and Implications." Naval War College Review 65, no.1 (2012): 38. https://www.usnwc.edu/getattachment/647f61ae-c554-4475-b344-6e3b8c3d551f/Beijing-s--Starter-Carrier--and-Future-Steps--Alte (accessed May 11, 2016).
[85] Nan Li and Christopher Weuve, "China's Aircraft Carrier Ambitions: An Update," Naval War College Review 63, no.1 (2010): 17. https://www.usnwc.edu/getattachment/99679d4b-cbc1-4291-933e-a520ea231565/China-s-Aircraft-Carrier-

on foreign raw products, mainly oil and gas.[86] Hence, the importance of the Strait of Malacca has become increasingly relevant, where more than 80 percent of Chinese crude oil flows through the South Asia Sea. The oil shipped through the Malacca Strait towards the South China Sea represents three times the flow through the Suez Canal and fifteen times the amount that is transported through the Panama Canal, corresponding to more than one-third of the World's seaborne oil trade.[87] In 2013, China has become the world's largest net importer of crude oil and other liquid fuels, exceeding the US, and accordingly Saudi Arabia, as its largest supplier, provides almost one-fifth of that supply.[88]

Mao Zedong envisaged the relevance of the SLOCs at South Asia Sea in 1958, when he proposed the Communist Party to build "railways on the high seas" for the maritime trade, supported by carriers' protection. However, the Chinese Carrier Program was established only in early-1970 and due to financial constraints, the program was postponed. Therefore, during the 1990s, when the Chinese Defence Budget was continuously rising, the program could be undertaken more seriously.[89] Actually, that decision was a consequence of the overwhelming success of the American Campaign in FGW and the failure of the Chinese in deterring the American intervention on the Taiwan Strait Crisis (1995-96). The Chinese leaders noted that a military modernisation plan should be urged, mainly for the People's Liberation Army Navy (PLAN), where a carrier programme should definitely be included.[90] Nonetheless, as seen in the previous chapter, carriers are not able to operate independently due to their inherent vulnerability, demanding escort ships with ASW and air defence capabilities, as well as a versatile airwing and afloat logistic support.[91]

Admiral Liu Huaqing, also known as "the father of the modern China" or the "China's Alfred Thayer Mahan", was the visionary of "near seas defence" strategy and the Chinese carrier. The realisation of his vision was started after the purchase of the former Soviet Kiev Class carrier from Ukraine in 2000. Alongside the refurbishment of that carrier, the Chinese have developed new shipborne aircrafts, such as the Z-8 AEW and the jet fighter J-15, supposedly an unlicensed Su-33 copy.[92] Even though, the conventionally powered Chinese carrier "Liaoning" might have around 30 aircrafts on its airwing, whilst an US nuclear powered carrier, which has a greater cruising enduring, might accommodate more than 60 aircrafts aboard.[93] Furthermore, China has also been

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Ambitions--An-Update (accessed May 10, 2016).
[86] Erica Strecker Downs. China's Quest for Energy Security (Monograph Report, RAND Corporation, 2000): 3. https://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1244/MR1244.ch2.pdf (accessed May 10, 2016).
[87] Business Insider UK. "The South China Sea Will be the battleground of the future." http://uk.businessinsider.com/why-the-south-china-sea-is-so-crucial-2015-2?r=US&IR=T (accessed May 10, 2016).
[88] US. Energy Information Administration (EIA). China is now the world's largest net importer of petroleum and other liquid fuels. http://www.eia.gov/todayinenergy/detail.cfm?id=15531# (accessed May 10, 2016).
[89] Li and Weuve, China's Aircraft Carrier Ambitions, 15-16.
[90] Felix K. Chang. Foreign Policy Research Institute. "China's Naval Rise and the South China Sea: An Operational Assessment," Orbis 56, no. 1 (2012), 22. doi: 10.1016/j.orbis.2011.10.002
[91] Li and Weuve, China's Aircraft Carrier Ambitions, 25.
[92] Erickson, Denmark, and Collins, Beijing's 'Starter Carrier,' 16-19.
[93] Ronald O'Rourke. "China Naval Modernization: Implications for US Navy Capabilities - Background and issues for

developing its submarine modernisation effort, especially the SSBN and SSN due to its importance to provide a critical deterrence in the South China Sea, whilst the carrier programme is still undertaken.[94] However, a single aircraft carrier implies in a necessity of a long maintenance period, demanding time and resources, whilst depriving the navy of its airpower projection capability.[95]

Thus, even after the commissioning of the first Chinese aircraft carrier in 2012, the strategic carrier programme for the South China Sea has been in a transition towards the multiple indigenous carriers for the next fifteen years.[96] Whilst this transition is not achieved, China is proceeding with the establishment of the control of the "strategic triangle" within Paracel Islands, Scarborough Shoal, and the Spratly Islands. The Islands serve as military air bases with missile batteries and military radars installed, working as "unsinkable carriers" at sea. Notwithstanding, China accused the US of the "militarisation" of the region, sending warships to enforce the "freedom of navigation."[97]

Hence, the new modern military forces would ensure China's status as a leading regional power and an active global player, displacing the US influence and asserting its territorial claims in the region.[98] Despite the classic military deployment of the carriers, China might also use them for HADR, NEO, or maritime security operations, such as anti-piracy. The Chinese has still resented the gap established during the 2004 Indian Ocean tsunami and 2011 Japan's earthquake, when it would be able to attend with a diplomatic support deploying a carrier, whilst the Americans successfully used these opportunities.[99]

This situation in South China Sea is very similar to the Japanese Empire expansion before WWII and the dispute of the Pacific Islands with the Americans during the war to secure its maritime area. That dispute resulted ultimately in air and naval bases establishments for the control of that vast area and in a confrontation of the carriers at sea to ensure this control. Therefore, these two branches of the "control of the sea" occur exactly in the same condition where there is an imbalance of power. The perception of threat affects the strategic relationship between nations,

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Congress" (US Congressional Research Service, 2014): 16. https://www.fas.org/sgp/crs/row/RL33153.pdf (accessed May 11, 2016).

[94] Ibid., 8-9.

[95] Erickson, Denmark, and Collins, Beijing's 'Starter Carrier,' 35.

[96] Bloomberg. "China Aircraft Carrier Launch by End- 2015 Plausible, Experts Say." http://www.bloomberg.com/news/articles/2015-09-30/china-aircraft-carrier-launch-by-end-2015-credible-experts-say (accessed May 11, 2016).

[97] The Economist. "China v the rest: As the sea becomes more militarised, the risks of conflict grow." March, 26 (2016) http://www.economist.com/news/asia/21695565-sea-becomes-more-militarised-risks-conflict-grow-china-v-rest (accessed May 10, 2016).

[98] O'Rourke, China Naval Modernization, 4.

[99] Erickson, Denmark, and Collins, Beijing's 'Starter Carrier,' 37-38.

great or small powers, which means that the relative rise of a state's power led to a relevant shift in the balance of power.[100]

Carriers Weaknesses

Even at the tactical or strategic levels as seen in the previous sections, carriers are not invulnerable and the balance between their weaknesses and strengths is still a challenge for the modern navies. In this section, it will show the extent of this challenge and the approach that some nations have taken to address this critical problem.

The most evident carrier's weakness is the lack of its own ASW assets, which is provided by its airwing and escort ships. This characteristic is very present on carriers because they are large targets and its ASW protection is still not fully effective against submarine threats, which cannot easily be detected. Submarines might attack a CSG with torpedoes, sea mines or missiles.[101] However, this threat is not new and the German Navy extensively used submarines during WWI, rather than its expensive battleships, which ultimately had the same carriers' intrinsic problems as large targets.[102] The German submarines also established a total dominance over the Atlantic in the early years of WWII, when they started to be defeated only after the deployment of a disproportional number of defensive units, including ships and aircrafts, for each submarine.[103]

There was a controversy in the USN about Mahan's aversion to *la guerre de course,* which should be directed to peaceful merchant ships and was totally opposite to his ideas of the "battle fleet" and "decisive battle"*,* influenced the Americans to neglect the study of submarine warfare, even after the overwhelming success of the Germans in WWI. His fixation on the capital ship in which the aircraft carriers assumed the principal participation in the Pacific war during WWII reflected in the climactic battle between opposing fleets in that Theatre. However, the defeat of the American's opponent came only after a combination of arms provided by the prolonged naval gunfire against the Japanese fortifications ashore, the strategic bombing by the US Army Air Forces (USAAF), and the paradoxically well-succeeded *guerre de course* provided by the American submarines against Japanese merchant ships.[104] Nevertheless, the submarine is no longer "the weapon of the weak", deployed manly in *guerre de course* against the maritime traffic, and currently represents a source of deterrence and great powers' status. Moreover, the nuclear-powered submarines are also

[100] Athanassios G. Platias and Constantinos Koliopoulos. *Thucydides on Strategy: Grand Strategies in the Peloponnesian War and their Relevance Today* (London: Hurst and Company, 2010): 87.
[101] Andrew S. Erickson and Andrew R. Wilson. "China's Aircraft Carrier Dilemma." *Naval War College Review* 59, No.4 (2006): 14. https://www.usnwc.edu/getattachment/095c6b68-6707-4030-a142-8f07e9aeb524/China-s-Aircraft-Carrier-Dilemma---Erickson,-Andre (accessed May 12, 2016).
[102] Platias and Koliopoulos, Thucydides on Strategy, 9.
[103] Coutau-Bégarie, Traité de Strategie, 979.
[104] Crowl, Alfred Thayer Mahan, 475-76.

almost independent on the surface of the sea and its constraints are basically food supply and the endurance of the crew.[105]

In addition, carriers' logistic support at sea is a critical vulnerability. There is no doubt that the operational mobility successfully achieved by the US naval forces in 1944 through the use of the underway refuelling and Replenishment At Sea (RAS) changed entirely the carrier's deployment. However, the enormous apparatus established to replenish carriers afloat with fuel, weapons, and other supplies involves not only a logistics ship, but also an escort ships screen to protect the carrier while doing RAS. Furthermore, during that period, the carrier is unable to launch or recovery aircraft and the CSG must sail to a "safe zone" to accomplish this complex procedure, otherwise it would be an easy target for enemy's aircrafts or submarines. Even though, there is no demand of fuel for the nuclear-powered carriers, air operations demand thousands of litres of aviation fuel for the aircraft, which can only be received during the RAS.[106]

Another technical vulnerability is the launching system. The most common systems for conventional aircrafts are the "ski jump", which is a bow ramp that helps aircraft to takeoff; and the steam catapult, roughly a hydraulic piston is fitted along a slotted cylinder where a hook is attached to a shuttle connected to that piston. There are pros and cons for each system, but the limitations the "ski jump" in terms of capabilities are enormous and the advantages are mainly lower cost and more space available aboard for other purposes. The combination of the launching system and the arrested recovery system forms the types of carriers, such as the Catapult-Assisted Takeoff but Arrested Recovery (CATOBAR) and Short Takeoff but Arrested Recovery (STOBAR). The former, for instance, was created by the UK and perfected by the US. It is broadly considered that a catapult is essential for heavy aircraft with long-range capability or high payloads, common conditions for ground strikes, intelligence collection, and midair refueling. Whilst, the rolling takeoff assisted by a "ski jump" found in STOBAR carriers is better suited for air defence and light-loaded short-range strikes.[107]

However, despite the steam catapult has better ability to exploit the capabilities of the carriers, it has to be designed specifically with accuracy in order to work effectively. A safe and precise launch is a combination of a calibrated catapult, carrier's speed, and local wind. Therefore, carriers need a powerful source of energy to generate enough steam to the catapult, whilst increasing the speed into the wind for the air operations. It could be argued that for nuclear-powered carriers there are no further problems concerning the energy for steam. However, the catapult system is

[105] Coutau-Bégarie, Traité de Strategie, 733.
[106] Thomas C. Hone, Norman Friedman, and Mark D. Mandeles. "Innovation in Carrier Aviation" (Newport Papers 37, Naval War College, 2011), 27-28. https://www.usnwc.edu/getattachment/313c5780-cfa3-4ed4-8716-5543d78e8d31/37.pdf (accessed May 13, 2016).
[107] Erickson, Denmark, and Collins, Beijing's 'Starter Carrier,' 30-31.

designed to accelerate an aircraft on the flight deck to achieve the takeoff speed for each fixed-wing model. Hence, the calibration of the appropriate steam pressure for each kind of aircraft, which its payload depends on several variables, such as fuel, weapons, or people on board, demands precise information. The personnel working on the flight deck and hangars provide all information for the catapult; therefore any failure of the system or information provided may cause a fatal accident.[108]

Therefore, the modern CATOBAR carrier requires at least two catapults available, to provide continuous air operations during an air strike, for instance. Notwithstanding, the limited space available on the flight deck for taxiing and parking aircrafts awaiting takeoff, whilst the catapult is prepared for the next launch, demands time as well as intense and permanent training to achieve a high-level of readiness for air operations aboard. Thus, time is a critical factor for launching and recovery aircrafts on carriers. Likewise, the STOBAR carrier demands equally high training, however it does not need to place great reliance on an entire system for the launching procedure.[109]

The complexity of systems aboard the carriers, as well as the demanding training, results in very high costs. The carrier expenses are considerable for any nation and involve, acquisition, operation, maintenance, and training. For instance, the acquisition cost of each 90,000 tonnes-US "Nimitz" Class carrier is around US$ 4.5 billion. Whilst, the first new 100,000-US "Ford" Class carriers will reach at least US$ 14 billion, including Research and Development (R&D) costs for the entire class. The next ones are about US$ 10 billion each, the most expensive warship ever built. It will take seven years to be finished and the entire airwing required for both CATOBAR type classes is around 60 aircrafts, for US$ 3.5 billion.[110] Nowadays, no nation is able to build carriers like the Americans, who want to spend more than US$ 81 billion to build 38 warships in the next five years, including carriers and submarines, achieving a total of 308 battle force ships.[111] The British, for example, adopted the STOBAR model for their new 65,000 tonnes-British carrier HMS "Queen Elizabeth." It is due to finished by 2017 and has an overall cost of US$ 10.5 billion, more than twice the amount when its contract was signed in 2007, with 10,000 workers permanently deployed in this project.[112] Interestingly, the French has chosen the CATOBAR model for their new 38,000 tonnes nuclear powered carrier "Charles de Gaulle," which took 13 years to make at a cost of US$

[108] Ibid.
[109] Hone, Friedman, and Mandeles, Innovation in Carrier Aviation, 101.
[110] Strategy Page. "Naval Air: Replacing Carriers With Cruise Missiles." https://www.strategypage.com/htmw/htnavai/20130519.aspx (accessed May 12, 2016).
[111] Cable News Network (CNN). Politics. "Supercarrier Ford to join Navy fleet in September." http://edition.cnn.com/2016/04/07/politics/us-navy-aircraft-carrier-shipbuilding-plan/ (accessed May 13, 2016).
[112] British Broadcasting Corporation (BBC). "Does anybody still need aircraft carriers?" http://www.bbc.co.uk/news/magazine-18237029 (accessed May 13, 2016).

3.5 billion and it is the only one in the country.[113]

Accordingly, the interest in less costly carriers, such as the Short Take-off and Vertical Landing (STOVL), has become more frequent. The 17,188 tonnes-Spanish carrier "Principe das Asturias", which was commissioned in 1988; as well as the 11,485 tonnes-Thailand's Spanish built carrier "Chakri Nareubet," only commissioned in 1997, had the relative cost of US$ 0.3 billion.[114] However, it seems likely the 27,780 tonnes-Landing Helicopter Dock (LHD) "Rey Juan Carlos I" will replace the "Principe das Asturias"; likewise the 27,000 tonnes-Italian carrier "Cavour", which was commissioned in 2008 for around US$ 1.5 billion, will replace the 13,800 tonnes Italian carrier "Giuseppe Garibaldi," commissioned in 1985.[115]

Although those "cheaper" carriers are dependent on STOVL aircrafts, such as AV-8B Seaharrier or F-35 Joint Strike Fighter (JSF), this tendency interestingly reflects not only the concerns about the carriers' acquisition cost, but also its operation and maintenance. According to the US General Accounting Office (GAO), the estimated annualized cost for a regular American CSG in 2000, including acquisition, operation and support, was around US$ 1.6 billion per year and only for the carrier itself; its airwing was more than a half of this cost.[116] Moreover, the overall annual cost just for operating and support a CVN is almost US$ 300 million, considering its 50-year life-cycle.[117]

Meanwhile, the daily cost assessed for "Cavour" operations during the Humanitarian Assistance response after the Haiti's earthquake in 2010 was something roughly equivalent to US$ 80 million per year.[118] In 2004, Thailand's carrier was also deployed in HADR Operations after the Indian Ocean tsunami, as well as in Thailand's flooding of 2010 and 2011.[119] Thus, it could be argued that even regular carriers, due to their inherent flexibility, have been pressed recently into service more frequently in Intervention Operations, such as HADR, and involved in a multi-agency or multi-national environment rather than in typical inter-estate conflicts.[120] Therefore, it has become suitable to provide the required response with these "low-cost" carriers in order to achieve the same desired diplomatic effect of the conventional carriers.

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[113] BBC. "Islamic State group: Charles de Gaulle carrier triples French firepower." http://www.bbc.co.uk/news/world-europe-35518636 (accessed May 13, 2016).
[114] Till, Seapower, 129.
[115] Eric Grove, "Carrier waves: programmes speak of an enduring appeal," Jane's Navy International. October, 26 (2007) https://janes.ihs.com/Janes/ Display/1202616 (accessed May 13, 2016).
[116] US. General Accounting Office (GAO). *Navy Carrier Battle Groups*: *The Structure and Affordability of the Future Force* (Washington: US Congress, 1993): 94. http://www.gao.gov/assets/160/152948.pdf (accessed May 13, 2016).
[117] US. GAO. *Navy Aircraft Carriers*: *Cost-effectiveness of conventionally and nuclear-powered carriers* (Washington: US Congress, 1998): 80. http://www.gao.gov/assets/160/156278.pdf (accessed May 13, 2016).
[118] Luca Peruzzi, "Cavour aids Haiti disaster relief efforts," International Defence Review. February, 15 (2010) https://janes.ihs.com/Janes/ Display/1106968 (accessed May 13, 2016).
[119] Business Insider UK. "Thailand has an aircraft carrier with no aircraft." http://uk.businessinsider.com/ thailands-aircraft-carrier-has-no-aircraft-2015-2?r=US&IR=T (accessed May 13, 2016).
[120] Rubel, The Future Of Aircraft Carriers, 19.

Part of the operating and support costs are attributed to carrier personnel, which represent almost 3,500 people and around US$ 104 million per year plus US$ 20 million for their annual training.[121] The overall number of personnel aboard a US CVN "Nimitz" Class, including the airwing and the flag officer's staff embarked, can reach more than 5,000 people.[122] Carrasco highlighted that particularly the CVN manpower takes 46 percent of the total personnel afloat in the USN.[123]

The nuclear power plant of a "Ford" Class carrier will be able to generate almost three times as much as a "Nimitz" Class with a smaller crew of around 4,500 people.[124] However, regardless the same demand for aircraft fuel, the enormous CVN's crew still have the same needs of a small town, such as food and other basic products, where logistic support is necessarily continuous. The combined diesel and gas turbine (CODAG) for the new HMS "Queen Elizabeth" carrier, which will be able to generate enough power for a town the size of Swindon in the UK or 5,500 family homes and as much as a "Nimitz" Class carrier,[125] would be less expensive for a crew of 1,600 when fully operational.[126] However, the same energy is generated for a UK nuclear-powered "Trafalgar" Class submarine, but only for a 130-crew, demanding lower costs to provide equally deterrence, albeit doubtfully perceived.[127]

The high cost of the new ships facing the shrinking of the defence budget in the majority of world's navies led the naval authorities to prioritise the submarines, also able to launch cruise missiles. The long-range missiles, as well as the long-range Unmanned Aerial Systems (UAS), such as the RQ-4 Global Hawk, combined with satellites, provided the same feature for long distance power projection like carriers present. The American SSBNs can deliver more than 500 cruise missiles.[128] Likewise, the USN has recently developed an ASW Continuous Trail Unmanned Vessel (ACTUV), which will be able to operate in an anti-submarine role and cover an area of 10,000 nautical miles with no crew.[129] These new systems, including the Unmanned Underwater Vehicles (UUV), are a step in the path towards the robotics age.[130]

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[121] US. GAO. Navy Aircraft Carriers, 81.
[122] BBC. Does anybody still need aircraft carrier?
[123] Juan L. Carrasco. "A Manpower Comparison Of Three US Navies: The Current Fleet, A Projected 313 Ship Fleet, and a more distributed bimodal alternative" (Operation Research Paper, Naval Postgraduate School, 2009), 16. http://www.dtic.mil/dtic/tr/fulltext/u2/a509152.pdf (accessed May 14, 2016).
[124] World Nuclear Association. "Nuclear-powered ships." www.world-nuclear.org /information-library/non-power-nuclear-applications/transport/nuclear-powered- ships.aspx (accessed May 14, 2016).
[125] UK. RN. "Power To Queen Elizabeth: Mighty Engines Are Installed On Future Carrier." http://www.royalnavy.mod.uk/news-and-latest-activity/news/2013/january/29/130129-power-to-queen-elizabeth (accessed May 14, 2016).
[126] UK. Aircraft Carrier Alliance. "The Queen Elizabeth Class." http://www.aircraftcarrieralliance.co.uk/the-ships/the-queen-elizabeth-class.aspx (accessed May 15, 2016).
[127] UK. RN. "Trafalgar Class." http://www.royalnavy.mod.uk/the-equipment/submarines/fleet-submarines/trafalgar-class (accessed May 16, 2016).
[128] Strategy Page. Naval Air
[129] Fortune. "Inside the Navy's New Autonomous Sub-Hunting Warship." http://fortune.com/2016/ 04/08/navy-autonomous-sub-hunting-warship/ (accessed May 18, 2016).
[130] Phillip E. Pournelle. "The Rise of the Missile Carriers." *Proceedings Magazine* 139, no.5 (2013). http://www.usni.org/magazines/proceedings/2013-05/rise-missile-carriers (accessed May 18, 2016).

Another indirect cost is the risk involved in air operations aboard carriers. In spite of the intense training and extremely methodical procedures, accidents are still highly likely, representing a costly business. Rubel highlighted that between 1949 and 1988, almost 12,000 aircraft and 8,500 aircrew were lost in the American naval services (USN and USMC). Likewise, the carrier-based losses were equally higher rather than in the entire naval services in 1954, when the fatal accidents began to drop after the angled-deck implementation.[131] Beyond the aviation risk, the nuclear reactor in carriers demand specialized personnel and high-level training, which represents for a "Nimitz" Class an increment of 6 percent in its crew in comparison to a conventional US carrier.[132]

There are some critiques against the enormous carrier apparatus and its extreme cost, which led to an alternative of the so-called "arsenal ships" that would be able to provide an extensive sea-launched missiles. Concerning the size, a "Nimitz" Class carrier would be able to carry around 4,000 cruise missiles.[133]

By the early-2000s, carrier-based operations have been established far beyond littoral reaches. Operations ENDURING FREEDOM (Afghanistan, 2001-2002) and IRAQI FREEDOM (2003) were the witnesses of a significant shift on carrier airpower from analog to digital network-centric operations. The USN's carrier forces, exploiting carriers as a command and control (C2) platform, have become increasingly integrated and highly connected. In this new post-cold war world, the instability in the International System combined with the phenomenon of the globalisation have provided the suitable condition for the validation of the current maturation of US carrier airpower after decades of improvements, ratified by those conflicts previously mentioned.[134]

According to RAND Corporation, around 80 percent of the carrier-based air strikes achieved targets, which were unknown to the aircrew before the aircraft launch during the those operations between 2001 and 2003. By that time, 84 percent of the USN sorties hit at least one target and 93 percent of all USN munitions dropped were either satellite-aided or laser-guided.[135]

Nevertheless, electronic and digital systems are subject to failures or simply human errors. Moreover, electronic sensors are also affected by the enemy's deception in the operational environment. The USN experienced this unfortunate situation during operations at sea in 1988, when USS "Vincennes" mistakenly hit an Iranian civilian airliner resulting in the death of the 290

[131] Robert C. Rubel, "The U.S. Navy's Transition to Jets," *Naval War College Review* 63, no. 2 (2010), 51-52. https://www.usnwc.edu/getattachment/76679e75-3a49-4bf5-854a-b0696e575e0a/The-U-S--Navy-s-Transition-to-Jets.aspx (accessed May 16, 2016).
[132] US. GAO. Navy Aircraft Carriers, 82.
[133] Till, Seapower, 129.
[134] Lambeth. American Carrier Air Power, 8.
[135] Ibid., 99-100.

people on board after a supposedly AEGIS system failure. Therefore, despite some relevant advances, the new technologies cannot provide solutions to all the problems of C2.[136]

The high connectivity currently available in naval forces is strongly dependent on communication, which is also subject to the enemy's interferences. However, the continuous advance of satellite communications during the last decades has also provided higher echelons interferences, even in the political level, undermining the "initiative of the subordinate."[137]

Carrier: A source of Innovation and Revolutionary Technology

Technology has provided several possibilities for carriers in the last hundred years. However, to understand how carriers broke the hegemony of the battleships it is fundamental to look back to its infancy in WWI, as well as its emergence in WWII. Thus, this chapter will discuss the importance of the revolutionary technologies and the opportunity that they provided to the carriers, developing innovative and creative solutions to the air operations at sea.

During the early years of WWI, the first seaplanes had been deployed primarily for reconnaissance and gunfire spotting. Consequently, they have become more suitable for naval operations rather than dirigibles, still vulnerable to attack. Likewise, land-based airplanes did not have enough range for missions over sea. The British dominated the naval aviation during the entire WWI, using only cruiser-converted carriers. Notwithstanding, in 1918 the RN completed the world's first flush-deck carrier HMS Argus, albeit late for the war. It was very similar to modern aircraft carriers, except for the lack of an island superstructure on the side of the flight deck, which was introduced in 1920 on HMS Eagle.[138] However, the creation of the Royal Air Force (RAF), the first independent military air service in the world, implied in significant naval aviators losses for the RN, making the Fleet Air Arm suffer from a clear neglect during the entire interwar period. Consequently, the shipborne aircrafts became sooner obsolete.[139]

The USN commissioned its first carrier the USS Langley in 1922. This collier-converted carrier was more alike HMS Argus.[140] By that time, aircrafts had been very limited and air operations aboard also incipient. However, despite the increasingly development of the aircraft, carriers were not equally enhanced. This was likely as a consequence of the particularity of the European Theatre

[136] Palmer, Command at Sea, 302.
[137] Ibid., 303.
[138] Max Boot. *War Made New: Weapons, Warriors, and the Making of the Modern World* (New York: Gotham books, 2006), 248.
[139] Ibid., 248-49.
[140] US. Department of the Navy. "A brief History of US Navy Aircraft Carriers: Part 1 - The Early Years." http://www.navy.mil/navydata/nav_legacy.asp?id=1 (accessed May 17, 2016).

and the Washington Treaty in 1922, even after the controversial experiments of "Billy" Mitchell. [141] Accordingly, the USN had only five first-line carriers in 1939. Nonetheless, due to US campaign in the Pacific against Japan, the Americans had seventeen large new carriers, eight light carriers, and seventy-seven escort carriers by the war's end.[142] Meanwhile, British naval architects helped Japanese engineers to build their first aircraft carriers in 1922. The Imperial Japanese Navy (IJN) had thereafter built its first aircraft by the early-1930s.[143]

Thus, neither the USN nor the Japanese Navy had fully deployed their carrier-based aircrafts until 1940, when the Grumman F4F-3 Wildcat and the Mitsubishi A6M2 Zeke Type 0, the infamous "Zero", had become respectively their primary fighters.[144] However, by the end of WWII, the continuous development of the aircraft, mainly jet fighters, required modifications in carriers. First, jets landed in higher speed than piston-engine aircrafts, demanding visual aids to guide the pilot onto the flight deck. Second, jets accelerated slower than piston-engine aircrafts for take-off, requiring a catapult to provide a safe take-off independent of the ship's speed or wind intensity. Third, the possibility of missing landings with a deck permanently free of restrictions for a "touch-and-go" brought the idea of a new flight-deck design. Therefore, after the first years of 1950s, the steam catapult, optical landing system, and flight-angled deck, were combined and deployed aboard the USS Forrestal in 1955.[145] Those new modifications would also provide the development of new carrier-based bombers that could carry very heavy bomb loads. There is a clear distinction between the RN and the USN for carriers operations in the recent postwar years, when the former adapted its carriers for jet fighter deployments in protection of the maritime trade from air attacks, and the latter for long-range strikes, mainly nuclear attacks.[146] Admiral Chester Nimitz had envisaged this situation still during WWII, when he stated "[the] characteristics of aircraft may have a serious adverse effect on the utility of existing carriers and even on the overall importance of carrier aviation in the future."[147]

Innovations, such as the angled flight-deck, have significantly decreased Class-A mishap rates (aircraft destroyed and/or fatality) since its implementation. Moreover, it has represented a relevant milestone in accident prevention for the US naval services after WWII, according to the Naval Safety Center.[148] Furthermore, those innovations also provided an opportunity to broadly exploit the full-spectrum of the aircraft's capacity. The diversity of the airwing demonstrates the versatility

[141] Boot. War Made New, 249.
[142] Hone, Friedman, and Mandeles, Innovation in Carrier Aviation, 2.
[143] Boot. War Made New, 254-55.
[144] Palmer, Command at Sea, 257.
[145] Thomas C. Hone, Norman Friedman, and Mark D. Mandeles. "The Development Of The Angled-Deck Aircraft Carrier: Innovation and Adaptation." *Naval War College Review* 64, No. 2 (2011). https://www.usnwc.edu/getattachment/afe51317-dabb-4379-b802-79eb1d9815fc/The-Development-of-the-Angled-Deck-Aircraft-Carrie (accessed May 17, 2016).
[146] Hone, Friedman, and Mandeles, Innovation in Carrier Aviation, 138.
[147] Ibid., 9.
[148] US. Naval Safety Center. "Annual Mishap Overview: FY14 (Norfolk: Naval Safety Center, 2015)," 5. http://www.public.navy.mil/navsafecen/ Documents/media/FY14_Annual_Report.pdf (accessed May 17, 2016).

of the carriers, from AEW to ASW, including air logistics support. However, the air strikes had a particular improvement in the late-1980s. The Global Positioning System (GPS) improved the naval air power capabilities, in addition to being the first major system in the post-Cold War era with a high potential for civilian applications.[149]

The accuracy provided by the GPS during Operation DESERT STORM in 1991 was between 7.5 and 13.0 metres. By that time, an aircraft could estimate its groundspeed within 0.2 kilometres per hour (kmh) or 0.1 miles per hour (mph) using a GPS.[150] Thus, the need for "surgical" strikes since the challenge of the strategic bombing over Japan by the end of WWII was finally supplied. The GPS was not only restricted to navigation, but it has been widely deployed in imagery for mission planning ashore or aboard the carriers. This innovation was fully exploited to support nighttime precision bombing missions around Baghdad in 1991 by the land-based US Air Force (USAF) F-117 Nighthawk stealth fighter-bombers.[151] These world's first stealth aircrafts combined with the GPS technology brought an enormous advantage to the Americans during the strikes over strategic targets at the very beginning of the FGW. The same stealth technology was used in the B-2 Spirit long-range bomber during the Second Gulf War (SGW) in 2003, when the rapid dominance was achieved by the overwhelming American military superiority, producing a psychological effect in the adversary's will through the so-called "Shock and Awe" doctrine.[152] The F-117s destroyed 40 percent of all strategic targets During DESERT STORM in only 2 percent of the overall sorties. Likewise, the same efficiency was achieved by the B-52 Superfortress bombers using GPS, which could attack seven targets for each target the Vulcans could attack during the Falklands War in 1982.[153]

That new high technology weaponry brought hope to the American people, who have been concerned about the number of casualties since the Vietnam War. However, they finally achieved the "zero casualities" dream during the FGW, when there were only 148 fatalities and 458 wounded of 500,000 troops, which represented a negligible 0.03 percent during the entire DESERT STORM. It was not only a motivating factor for the American Armed Forces, but also an important victory to get its list of weapons for the future wars approved by the US Congress.[154]

Beyond all of those new improvements, the new US "Ford" Class carrier will be equipped with an Electromagnetic Aircraft Launching System (EMALS). The overall idea is to reduce costs and

[149] Michael Russell Rip and James M. Hasik. *The Precision Revolution: GPS and the Future of Aerial Warfare* (Annapolis: Naval Institute Press, 2002), 10.
[150] Ibid., 88-89.
[151] Ibid., 142.
[152] Harlan K. Ullman and James P. Wade. *Shock and Awe: Achieving Rapid Dominance* (Washington: National Defence University, 1996), 20. http://www.dodccrp.org/files/Ullman_Shock.pdf (accessed May 17, 2016).
[153] Rip and Hasik, The Precision Revolution, 201-202.
[154] Qiao Liang and Wang Xiangsui. *Unrestricted Warfare* (Beijing: PLA Literature and Arts Publishing House, 1999), 93-96. http://www.c4i.org/unrestricted.pdf (accessed May 18, 2016).

personnel with more efficiency in air operations afloat. The new nuclear reactors will have the capacity to provide almost three times of the energy generated in a "Nimitz" Class carrier. Furthermore, the new system will improve by 15 percent the number of sorties per day on the new carrier. In addition, it will reduce the requirements of personnel to operate it by up to 1,000 people, in comparison with the former class. The entire project involves the construction of four new "Ford" Class carriers until 2050, with a life-cycle of 50 years each. Moreover, it is not viable to install this system in the "Nimitz" class carriers, which means that if everything works as planned, the "Ford" class carrier will be the dominant capital ship in the USN by the end of this century.[155]

The advent of the variant of the Lockheed Martin's F-35B STOVL JSF will enhance the air operations aboard smaller air-capable ships, due the fact that it has a lift fan instead of the AV-8 Harrier's four vectored nozzles to deliver launch thrust, which demands the ski-jump for a take-off with greater payloads. Thus, the new aircraft will provide an increment in range and load carrying capability. [156] This is a new perspective for amphibious operations using LHD or LHA ships, such as the Spanish "Rey Juan Carlos I" or the Italian "Cavour", as well as the 24,000-tonnes Japanese "Izumo" recently commissioned in 2015.

However, there are some critiques of the JSF programme, which is considered as the last manned sea-based fixed-wing aircraft. First, the cost of the aircrafts rose around 7 percent per year during the 1990s. For instance, the UK's initial order for 14 F-35Bs, as part of the future "Queen Elizabeth" carrier airwing, will cost about £2.5bn with additional support costs added.[157] Second, the high sensitivity to loss when operating in high-risk operational environment has an increasing influence during the air campaigns. Third, the high potential of the Unmanned Aerial Vehicles (UAV), also known as Remotely Piloted Air Systems (RPAS) or simply drones, has become more evident in the last years. Forth, the improved Information Technology (IT) aboard the modern aircraft will continuously reduce the need for a human, which currently is a limitation to the high performance aircraft due to physiological constraints. [158]

Undoubtedly, the deployment of the RPAS has become more frequent for military purposes. Current systems, such as the US Air Force (USAF) MQ-1B Predator[159] or the RAF MQ-9A Reaper, which were previously used only for Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR), have been armed with air-to-ground missiles for precision air strikes

[155] Bill Sweetman, "Carrier renaissance: new-wave designs to maximise innovation," IHS International Defence Review. September, 7 (2006), 56-62. https://janes.ihs.com/Janes/Display/1097824 (accessed May 21, 2016).
[156] Rubel, The Future of Aircraft Carriers, 21.
[157] BBC. "UK to spend £2.5bn on F-35 fighters." http://www.bbc.co.uk/news/uk-26124894 (accessed May 18, 2016).
[158] Till, Seapower, 127.
[159] US. USAF. "MQ-1B Predator." http://www.af.mil/DesktopModules/ArticleCS/Print.aspx?PortalId=1&ModuleId=854&Article=104469 (accessed May 18, 2016).

since 2007 and 2008 respectively.[160] Conversely, the challenges to deploy RPAS afloat, particularly on carriers, are far more complex. Nevertheless, the X-47 Unmanned Combat Air System (UCAS) with a modern stealth design was successfully launched by a steam catapult, requiring less energy than a F/A-18 Superhornet fully loaded; and recovered by the arresting gear, equally releasing less energy than a conventional aircraft, aboard the carrier USS "George W. Bush" (CVN-77) in 2013. The UCAS demonstrated that an autonomous aircraft might fully operate afloat, developing the same missions of a conventional aircraft, including air-to-air refueling.[161] This successful experiment led the USN to conduct the Unmanned Carrier-Launched Airborne Surveillance and Strike System (UCLASS) programme to build a UAV similar to MQ-9 Reaper to operate aboard carriers.[162]

Therefore, the current world of warfare is a combination of a diversity of technologies and respective methods. The addition of each new element is likely to cause new changes in certain types of warfare until the outbreak of a military revolution.[163] According to Moore's law, which implies in doubling the microprocessor's capacity in less than 2 years, technology develops rapidly and continuously.[164] The development of military technology is constantly establishing a new stage for further expansion of the battlespace, which maybe became global, if considered the cyberspace.[165] Hence, it could be argued that some nations are involved in the "weapons' trap", increasingly draining their resources to produce the ideal weapon, which will never be achieved due to the inherent technology's characteristic of continuously changing.

Carrier's "New Threats"

This section will discuss the main threats to the "survivability" of carriers, imposing challenges to its continuity. Most of them are also resultants from the same military revolution that provided the innovation on carriers. The Revolution in military thought is, ultimately, a revolution in warfare forms and methods. The revolution of military technology is basically the reform of the formulated system, but still focused on changes in the same forms and methods. The entire process of change will imply in the maturation of the military revolution. [166]

Thus, the first carrier's vulnerability exploited by the new technologies is the submarine threat. Due to persistent ASW unreliability, not only the submarine itself is an existential threat to the carriers,

[160] UK. RAF. "Reaper MQ-9A RPAS." http://www.raf.mod.uk/equipment/reaper.cfm (accessed May 19, 2016).
[161] Shishir Upadhyaya, "Projecting power ... and politics? Carriers in the Indian Ocean," Jane's Navy International. February, 11 (2015). https://janes.ihs.com/Janes/Display/1735961 (accessed May 16, 2016).
[162] O'Rourke, China Naval Modernization, 62.
[163] Liang and Xiangsui, Unrestricted Warfare, 140.
[164] Gordon E. Moore. "Moore's Law At 40" in *Understanding Moore's Law: Four Decades Of Innovation*, Ed. David C. Brock (Philadelphia: Chemical Heritage Press, 2006), 73-74. http://www.chemheritage.org/Downloads/Publications/Books/Understanding-Moores-Law/Understanding-Moores-Law_Front-Matter.pdf (accessed May 20, 2016).
[165] Liang and Xiangsui. Unrestricted Warfare, 40.
[166] Ibid., 115.

but also innovations, such as the Russian "Shkval" supercavitating rocked-propelled torpedo, which was developed primarily as rapid-reaction defence against undetected US submarines. This new weapon is an autopiloted torpedo rather than a regular homing guidance torpedo. Its speed can reach 230 mph (or 386 kmh), four to five times faster than a conventional torpedo. The efficient range with 80 percent of success probability is about 7,655 yards (or 7,000 metres). Iran has also a variant of this same weapon.[167] The USN is developing a Surface Ship Torpedo Defence (SSTD) programme to protect its high value units at sea against that threat.[168]

Likewise, the Americans are working on a UUV Master Plan, which involves small robotic lobster using artificial intelligence and other systems using active sonar to map the underwater environment or to detect objects of interest, such as sea mines, as well as sophisticated Autonomous Undersea Vehicles (AUV) using internal guidance systems and passive sonars for ASW missions, which alternatively might launch weapons. Some countries, including China, have developed this new technology and there is tendency for it to be extensively exploited in the next coming decades, which might be also a threat to carriers, especially in maritime environments like South East Asia Sea with several small islands and shoals that make the ASW more complex.[169] To illustrate this real threat, a South Korean frigate was supposedly sunk in 2010 by a torpedo launched by a North Korean "midget submarine," small enough to hide in shallow waters. This kind of submarine might also be supplied to Iran.[170]

The second vulnerability is against the air threat, mostly provided by cruise missiles. The Chinese DF-21D anti-ship ballistic missile is currently the greatest risk for US carrier operations in China's near seas. This Chinese weapon is designed to attack mainly naval targets at sea at a range of 1,700 km with high accuracy, using inertial guidance and the Chinese "Beidou" satellite navigation system.[171] To counter this threat, the Americans are developing new technologies to be used aboard ships and particularly carriers with the new high-energy nuclear reactors, which are able to generate greater electrical power. This power will supply energy for an electromagnetic rail gun (EMRG), as well as for high-power free electron lasers (FELs) and solid state lasers (SSLs), whose potential will be deployed not only against missiles, but also UAVs and air defence, in broad

[167] Military Periscope. "A-111 Shkval torpedo." https://www.militaryperiscope.com/mdb-smpl/weapons/minetorp/torpedo/w0004768.shtml (accessed May 18, 2016).
[168] US Naval Institute. "Navy Develops Torpedo Killing Torpedo." http://news.usni.org/2013/06/20/navy-develops-torpedo-killing-torpedo (accessed May 18, 2016).
[169] Robert W. Button et al. "A Survey of Missions for Unmanned Undersea Vehicles." (Monograph Research, RAND Corporation, 2009), 51-57. http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG808.pdf (accessed May 21, 2016).
[170] The Economist. "Missile technology: Peril on the sea." June, 10 (2010). http://www.economist.com/node/16295552 (accessed May 21, 2016).
[171] Ron Christman. "China's Second Artillery Force Capabilities and Missions for the Near Seas" in China's Near Seas Combat Capabilities, eds. Peter Dutton, Andrew S. Erickson, and Ryan Martinson (China Maritime Studies 11, Naval War College, 2014), 35-39. https://www.usnwc.edu/Research---Gaming/China-Maritime-Studies-Institute/Publications/documents/Web-CMS11-(1)-(1).aspx (accessed May 21, 2016).

terms.[172] Actually, it could be argued that UAV is not a great direct threat to carriers, but it might threaten its "survivability", in terms of power projection.

The recent advances are pointing to a variety of deployments for autonomous aircraft. For instance, Facebook has just announced an audacious Strategic Plan for the next 10 years. It is building a Boeing 737-wingspan and solar-powered drone to provide broadband Internet while staying in the air for three months to rural and hard-to-reach areas.[173] The solar-powered airplane "Solar Impulse" demonstrated this new capability in 2015, flying more than 7,000 km across the Pacific with no fuel.[174] The electrical flight has several advantages over the conventional ones. It offers quiet, clean, and reliable propulsion, preserving the engine parts. Moreover, for military purposes, it also reduces drastically the thermal signature, avoiding infrared detection.[175]

The third vulnerability is provided by the asymmetric or unconventional threat. It could be, for instance, from a small Special Forces team that would be able to establish the control of a container ship in a restricted waterway at the Persian Gulf, where that ship might be veered into the path of a CSG. This maneuver could cause a collision to carriers or simply limit its air operations. This threat also comes from extremists groups, which could launch an attack with waterborne Improvised Explosive Devices (IEDs), after identifying less protected logistics group providing carrier support.[176] In 2001, the awareness level against this threat was heightened after the USS "Cole" suicidal bombing attack in Yemen. However, even after the mitigation of this risk with the so-called force protection, the threat imposed by small high-speed boats at restricted waterways is still persistent.[177] Iran, for instance, has around 1,000 fast patrol boats, which would be able to offer this threat.[178]

Cyber-attacks have an uncertain feature, due to its real effects and possibilities, as well as if it is provided by state, non-state actors, or even non-professional warriors. However, only in 1994, there were 230,000 security-related intrusions into US Department of Defence (DoD) networks. By that time onwards, this kind of incident has increased significantly.[179] The high connectivity found in the US CSG provides the perfect environment for cyber threats. According to the Pentagon, there

[172] O'Rourke, China Naval Modernization, 37.
[173] CNN. Money. "Facebook just built a gigantic solar-powered drone that will stay in the stratosphere for months at a time, beaming broadband Internet to rural and hard-to-reach areas." http://money.cnn.com/2015/07/30/technology/facebook-drone-aquila/index.html?iid=EL (accessed May 18, 2016).
[174] BBC. "Solar Impulse completes epic flight to Hawaii." http://www.bbc.co.uk/news/science-environment-33383521 (accessed May 21, 2016).
[175] The Economist. "Future aircraft: Electrifying flight." September, 19 (2015). http://www.economist.com/news/science-and-technology/21664944-using-electric-and-hybrid-forms-propulsion-very-different-looking-aircraft (accessed May 21, 2016).
[176] John Patch. "Fortress at Sea? The Carrier Invulnerability Myth." *Proceedings Magazine* 136, no.1 (2010). http://www.usni.org/magazines/proceedings/2010-01/fortress-sea-carrier-invulnerability-myth (accessed May 21, 2016).
[177] Till, Seapower, 228.
[178] BBC. Does anybody still need aircraft carrier?
[179] Liang and Xiangsui. Unrestricted Warfare, 46.

is a Chinese hackers' army that has prepared a devastating cyber attack against the Americans CSG.[180] Likewise, China is developing electromagnetic pulse weapons against US carriers, which is similarly aggravated with the advent of the new "electric" Ford Class, where all systems might be neutralised, including those used to support the air operations. [181]

Conclusion

The aircraft achieved rapid technological advances that led to the emergence of the carriers during WWII. Its increasing capabilities has been used in the tactical, operational, and strategic level to achieve the nations' political aims. The carrier's centrality and unique significance has motivated the discussion of its deployment in the naval strategy as a capital ship of the navies. Likewise, its relevance to establish the US carrier-centered model fleet or simply CSG.

The Carrier has provided an opportunity to exploit it for diplomacy. However, it has unique attributes, such as poise, mobility, and versatility, which make it able to develop a decisive role in global events. China has also envisaged the carriers' relevance, especially due to the vital importance of South East Asia seas to its increasing Economy. Therefore, the Chinese Defence Strategy involves the development of the PLAN whilst it does not have a reliable CSG to protect its interests.

Despite the enormous capacity for power projection, carriers are not invulnerable. Beyond all technical discussion of carrier's efficiency, the high cost that involves its acquisition, maintenance, and operation, is still a challenge for any nation. The increase in intra-state conflicts, as well as HADR and NEO operations, rather than regular inter-state conflicts resulted in the emergence of "low-cost" non-nuclear carrier. This new "cheaper" carrier, like LHD or LHA, demand less personnel and costs, providing a new perspective for its future deployments. Thus, the risk for any nation to invest in building carriers is very high due to their long life-cycle, demaning extreme costs, as well as numerous personnel and demanding training, unless other national objectives should be achieved with its investment, such as the development of the defence industrial base and the Economy at large. Furthermore, new technologies have been developed rapidly and other alternatives to project power, such as cruise missiles in submarines or "arsenal ships", might provide less costly possibilities. Additionally, all sort of unmanned vehicles have been increasingly developed and maybe are pointing out to a robotic age.

[180] Tim Reid. "China's cyber army is preparing to march on America, says Pentagon." September, 08 (2007). The Times. http://find.galegroup.com/ttda/infomark.do?&source=gale&prodId=TTDA&userGroupName=jscscoll&tabID=T003&docPage=article&searchType=&docId=IF503704866&type=multipage&contentSet=LTO&version=1.0 (accessed May 21, 2016).
[181] O'Rourke, China Naval Modernization, 37.

Nevertheless, new technologies have continuously provided new opportunities for the carriers in the last hundred years. Revolutionary Technologies has been developed for carriers, such as EMALS and UCAS, which will change entirely the way that carriers have been deployed.

Submarine threats, such as supercavitating torpedoes, as well as air threats like anti-ship ballistic missiles, alongside cyberthreats and other expressions of non-conventional attacks might put carriers in risk.

Finally, it could be argued that carriers are an emblematic realization of the naval power, as the battleship was in the past. However, it is supposedly changing to achieve the current expectation of the current nation's interests and global demands. That changing process is probably reaching an inflexion point due to defence budget cuts in the majority of nations, reflecting directly in carrier's "Achilles heel", cost and personnel, like the battleship suffered with its intensive and costly labour manning during its last days of service.

Thus, until the end of this century, there is a tendency for the US to move towards the robotic age still as a global and most prominent military power. By that time, when the life-cycle of the new "Ford" Class ends, the Americans might develop an "unmanned carrier" or other similar to project power and protect their naval forces. Whilst, its LPH and LHA carrier-like will continuous to provide amphibious operations, as well as HADR and NEO. This form of carrier is also likely to be used by other nations due to its lower costs. In this sense, China will continue in its path to achieve by itself the indigenous CSG capability and is more likely to be in the halfway of those two forms by the end of the 21st century.

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