Naval Action in the 21st Century, or the Fifth Age of Combat at Sea

By Thibault Lavernhe

Abstract

Based on an examination of the determinants of naval action in the 21st century, this article assesses the extent to which war at sea is entering a new era, that of the age of robotics. Yet, in this "fifth age of naval combat", the aims of naval action and the principles that govern it remain fundamentally unchanged. Reconciling the novelty of processes and the permanence of principles is the challenge facing the actors of naval combat in the new century.

Résumé

Examinant les déterminants de l'action navale au 21e siècle, cet article montre dans quelle mesure la conflictualité sur mer entre dans une nouvelle ère, celle de l'âge de la robotique. Pour autant, dans ce "cinquième âge du combat naval", les finalités de l'action navale et les principes qui la régissent n'ont pas fondamentalement évolué. Concilier nouveauté des procédés et permanence des principes, tel est l'enjeu des acteurs du combat naval dans le siècle qui s'ouvre.

Mots-clés : Cinquième âge du combat naval ; robotique ; stratégie et tactique navales ; évolutions et permanence ; principes de la guerre.

Keywords : *Fifth age of naval combat ; robotics ; naval strategy and tactics ; permanence and change ; principles of war.*

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Full Text

In 2022, characterizing the challenges that a new century already well underway holds in store for us is an exercise that requires examining all the facets of power. The military field is no exception: from strategic reviews to white papers, all nations regularly analyze present and future power relationships and try to deduce the best way to adapt their military apparatus – among other levers – to face them. In the symphony of power, naval forces are once again, as they often are in history, one of the main yardsticks of state power, for which the air-sea space is a privileged place of expression. It is therefore useful to look at the major determinants of naval action today and in the future. Identifying them, understanding their dynamics means placing oneself in a position to seize the opportunities that will inevitably arise, while avoiding certain dead ends.

For the sake of clarity, it is best to start by addressing two issues about naval action. First, can it be reduced to naval combat? Of course not. Naval action will be considered here through the extensive prism of naval operations: not only at the four levels of warfare (political, strategic, operational, tactical), but also in its three modes of expression, whether it be deterrence (a form of action), coercion, or intervention. However, characterizing naval action mainly means focusing on naval combat, the ultimate form of exercising naval power. Therefore, without claiming to reduce it to naval combat alone, the latter will be given a central place in what follows. Secondly, at a time when environments[1] and fields of conflict[2] are increasingly intertwined, is the term "naval" not too restrictive – should it not be replaced by a more comprehensive reference to "maritime" or "military" action? No, because naval action as discussed here has its own unique traits. It is not the same as maritime action, which strategically subsumes it,[3] nor should it be diluted in military action in the broad sense.

As will be seen on examination, naval action has crossed the threshold of what can be termed the "fifth age of naval combat". This new age succeeds, without totally erasing them, its four ancestors : those of the sail, the naval gun, the airplane and the missile. And we will see that despite a rapidly changing physical and immaterial context which justifies the identification of such a new naval age, the purpose of naval action and the principles that govern it shine through their stability.

After placing the purposes of naval action into perspective, the present study will examine the machinery of modern naval combat, before looking at some principles that seem likely to endure in the new era.

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[1] A conventional distinction applied today lists them as land, sea, air, exo-atmosphere and cyberspace.

[2] In France, the 2020 force employment concept distinguishes, beyond material fields, informational and electromagnetic activity among immaterial fields. However, the perimeter of these fields of conflict varies from one source or author to another.

[3] *Cf.* Corbett, 1911. Julian Corbett (1854-1922) is the great theorist of the relationship between naval and maritime action.

What Place and Purpose for Naval Action in the 21st Century?

Since the end of the Second World War, a quantitative and qualitative peak of naval action,[4] and even more so since the end of the Cold War, the changing context of naval operations has raised the issue of whether their purpose is evolving as a result. Yet, an examination of the potential conditions of use of naval forces at the dawn of the 21st century suggests that their use cases have not fundamentally changed.

Changes in the Context of Naval Action

The context of naval action is first and foremost the sea – the point of departure or application of the action of naval forces. However, it is clear that the maritime environment of the 21st century is not identical to that of the 20th. For half a century, the sea has been "shrinking" as a result of the extension of the range and number of land-, sea- and especially space-based detection assets and the extended reach of land- and sea-based weapons systems. While the volume of the global sea mass has not changed,[5] the size of the littoral zone[6] has expanded to the point where certain areas such as the Baltic, the Eastern Mediterranean and the South China Sea can now be considered 'dead ends', at least from an operational point of view. Yet, only a few decades ago, these last two areas were still spaces where one could manoeuvre without being overshadowed by the land mass. Other 'cul-de-sacs' will certainly appear tomorrow, which are all potential "disputed zones". Let us note in passing that the Black Sea, much talked about today, has always been such a cul-de-sac, in the true sense of the word : it is therefore not indicative of this trend, even if it concentrates its manifestations.

As a fluid environment, the aero-maritime space is also less and less smooth, due to the constant proliferation of man-made installations such as oil platforms, artificial islands and, increasingly, wind turbines. In addition, a strong trend towards territorialisation has become manifest, as part of a more general dynamic of questioning the law of the sea, which has been widely commented on for two decades.[7]

The marine environment is also apparently less opaque, due to real progress – deep-sea exploration (whatever "deep" may mean), detection by quantum gravimetry – in the field of underwater detection.[8] The sea is also a place for naval action and its contours are changing as a result of climate change, both at high latitudes – where the ice pack is shrinking – and at lower latitudes – where some atolls are expected to be submerged.

Finally, although the sea has always been a space where a wide variety of players coexist and intermingle, the 21st century is characterized by a democratization of access to

[4] Symonds, 2020.

[5] Fully 70% of the world's surface is covered by oceans.

[6] There is no strict definition of the littoral zone concept. However, it can be considered to be the area comprising the maritime band under the direct influence of the land mass (particularly in terms of detection and engagement) and necessary to support operations on land, as well as the strip of land that can be attacked, supported and defended directly from the sea.

[7] See, for example, Prazuck, 2021.

[8] Morel, 2017.

the high seas, which has resulted, among other things, in a significant extension of criminal activities on the ocean.[9] On this last point, a change in scale rather than in nature has been noted. Piracy and drug trafficking are emblematic examples : these two historical maritime activities went through a major revival at the turn of the century, while at the same time global maritime traffic has rocketed up and the size of Western navies decreased.

The other change in the context of naval operations concerns the framework in which they are carried out. Firstly, the major trend characterizing modern conflict is that of the disappearance of purely naval operations as a factor in conflict resolution. It is true that naval forces have been involved in the vast majority of Western military operations since 1945, but apart from the 1982 Falklands episode, where the Royal Navy was involved, or, more anecdotally, the cod war between Iceland and the United Kingdom in the 1970s,[10] naval operations are now almost systematically embedded in a joint framework from the moment they are conceived at strategic level. This trend towards joint operations, which has affected all Western militaries after 1990, is a framing element of naval action that has become even more pronounced in the 21st century as a result of interlocking fields of conflict. Only the two extremes of confrontation at sea remain partly outside this trend : oceanic deterrence at the top, sea policing missions[11] at the bottom of the spectrum. For the rest, naval action, though sometimes a dominant factor, is in the main only one actor among others, hardly ever alone in deciding the issue at stake. In short, naval action is becoming more *dependent* on the joint framework in which it takes place. This may seem obvious to the contemporary sailor, but on a long-term scale, it constituted a turning point.

In addition to this first trend, naval action more often takes place in coastal areas. This is the result of the extension of the influence of land over sea, as already mentioned, but also of the concentration of power along the coastline,[12] and finally of the determined orientation of naval forces towards land since the end of the Cold War. At the same time, a growing share of the world's naval forces – in the sense of their contribution to naval action – is now land-based. This is certainly not new : shore batteries, marines, maritime patrol aviation have been or still are important parts of navies. But under the combined effect of a growing influence of sensors and land-based weapons on maritime space, the remote control capabilities offered by digitalization, and the greater and more effective role of drones or space-based sensors, actions that were previously carried out by ships, submarines or aircraft based at sea are and will increasingly be carried out by land-based means. This is the case with surveillance of maritime areas, whether near or far, by semaphores, drones or satellites controlled from land, or with strikes at sea carried out by

[9] Manet, 2018.

[10] The cod war (or rather wars) between the UK and Iceland between 1952 and 1976 centred on the issue of Iceland's unilateral extension of its fishing zones, which triggered a military response from London to protect British fishermen. Several violent interactions took place.

[11] For instance, *Operation Atalanta* to combat piracy in the Indian Ocean, or *Operation Agenor* to protect maritime traffic in the Strait of Hormuz.

[12] Commission des Affaires étrangères, de la Défense et des Forces armées du Sénat, 2012.

batteries of missiles – ballistic or otherwise – or by assault aircraft deployed from land. China is a typical example of this trend.[13] This does not, of course, prevent these means from being organically linked to maritime commands. But more than ever, naval battle actors, especially if the action takes place in an increasingly extensive coastal environment, will be largely land-based : anti-warship strikes by coastal missile batteries, from the Falklands (1982) to the Russian cruiser *Moskva* (2022) and the Israeli corvette *Hanit* (2006), are illustrations of this phenomenon. This is compounded by the inexorable decline in the size of Western combat fleets since the end of the Cold War,[14] both a consequence and a contextual factor.

Finally, the framework of maritime operations, in addition to being marked by increasingly interwoven fields of conflict, to which we will return, is affected by a shift in conflict types. This is typically the case with what is now referred to as hybridity and grey zones, on which the literature has been abounding since 2005.[15] Regardless of the debate on the relevance of these terms, this shift in the centre of gravity of power relations below the dual threshold of aggression and attribution has a lasting effect on the framework of naval operations. This is particularly the case with the flowering of so-called contested spaces, in which certain actors play on the "cul-de-sac" effect mentioned above to slow down, or even prohibit, an approach by sea : by imposing new interpretation grids now superimposed on more traditional schemes – without erasing them. In this context, the usual factors of superiority, without evaporating, become apparently less decisive when the irregular is mixed with the regular, communication with ambiguity and cooperation with dispute..

What Consequences on the Purpose of Naval Action?

Combined, all these factors of change seem to call into question the purpose of naval action. A cursory examination might suggest that some of its historical aspects are now secondary or even obsolete. Despite the resurgence of naval powers, control of the sea through decisive battle would seem an unrealistic hypothesis in the era of "sub-threshold" confrontations and nuclear deterrence. Commerce raiding to disrupt the opposing side's trade flows would be counterproductive in an era of interlocking economic interests between States. Maritime blockade, to be effective, would demand naval means and political resolve beyond our reach. As three decades of unopposed action close in, force projection would be too risky and politically unacceptable, as evidenced by the Western reluctance to put troops ashore in recent engagements,[16] humanitarian interventions aside. Power projection? Why not, but in the age of long-range air action, going by sea would be an expensive luxury. Territorial protection would be done primarily on land, with naval

[13] McDevitt, 2020.

[14] In 1987, the US Navy had 525 combat ships, including 15 aircraft carriers and 36 SSBNs. In 2020, the total comes to 296 combat ships, including 10 aircraft carriers and 14 SSBNs. France had 144 combat ships in 1987, compared to 72 in 2020.

[15] The phrase "hybrid wars" was first given currency by Lt. Gen. James Mattis in : Mattis & Hoffman, 2005.

[16] Notably Libya, Syria and Iraq.

action limited, once again, to oceanic deterrence or to police tasks such as the fight against illegal trafficking. As for aero-maritime surveillance, it is important, certainly, but can't drones and satellites see to it ? In the end, isn't it the case that the purpose of naval action in the 21st century may well be circumscribed to a few well-defined uses : power projection from the high seas within an air campaign or on the occasion of a cruise missile raid, oceanic deterrence, and above all, the vast field of "order at sea", i.e., broadly defined, maritime policing, where we no longer deal with *enemies*, but with mere *threats*? To these limited purposes of naval action would be added, from time to time, maritime transport – *par excellence* the kind of servitude Admiral Castex aptly described in his day[17] – and a little naval diplomacy. In his attempt to model contemporary seapower, British historian Geoffrey Till has even theorized the notion of a *post-modern navy*, i.e. a navy "*at the heart of the globalization process*", whose action would consist in a cooperative approach to secure global commons.[18] This model would tend to replace the state-centric navy model in the West. Moreover, could we not go even further and note the decline of military force as a factor in the resolution of contemporary conflicts ? At a time of "comprehensive approaches" and "grey zone" confrontations, is it not clear that the military will rarely provide a solution, or even be downright counter-productive ? These issues have been raised by commentators on the setbacks suffered in Iraq, Syria, Afghanistan and Mali.

Yet, closer inspection shows that despite these contextual shifts, the purposes of naval action in the 21st century remain broadly unchanged : the range of use cases for naval operations, whatever their setting or context, remains as wide as ever, and in some cases has actually widened.

Despite the evolution that has affected it, air-sea space is and will in all likelihood remain an environment to be controlled and exploited. Its control – i.e., the ability to operate freely in it and to deny its use to an adversary if necessary – and its exploitation – namely, its use to achieve an objective at sea or in another field of conflict – are two ever-present goals of naval action. The lack of effort required to conquer air-sea space since the fall of the USSR might have led one to believe that it was a freely available option with no price tag attached to it, but everything indicates that this is no longer the case. Similarly, hybridity and "below the threshold" conflict, despite the indirect responses they seem to call for, do not downgrade the action of naval forces. On the contrary, such threats pose a renewed challenge to them in their efforts to (even temporarily or locally) secure command of the sea (to use a somewhat outdated phrase), even in the absence of an overt exchange of blows. They place naval forces, as the French Chief of Naval Staff put it, in a situation of "*little or no choice*" when facing them.[19] Much of a naval force's activity today is thus about carving out space to operate freely without being under the sway of opposition forces, particularly in contested littoral areas such as the eastern Mediterranean, the Persian

[17] In his *Strategic Theories* (1929-1935), Admiral Castex uses the term "servitudes" to describe the requirements of external strategies that impose missions other than those of combat on naval forces.
[18] Till, 2013, p.35.
[19] Admiral Vandier's speech at the French Institute of International Relations (IFRI, Paris) on 17 June 2021.

Gulf or the South China Sea.[20] And to do so, it must make full use of the tools that accompany the entry into a new age of naval combat, which will be further examined below.

Securing and maintaining control of a portion of air-sea space thus remains an important goal of modern naval action. How can such an advantage be exploited? In this regard, the three historical poles of exploitation remain relevant: acting towards the land, exploiting the water mass (and associated bottoms), and moving freely. These three poles, which traditionally refer to the respective figures of the navy man, the fisherman and the merchant, continue to structure naval action in the present century.

Action towards the land, because the access options offered by the sea to the crisis zones of today and tomorrow remain decisive, despite the greater viscosity of maritime space. One only has to look at the vastness of the Indo-Pacific area to be convinced of the "tyranny of distance"[21] and the leverage that sea basing provides to deal with it. And action towards land should not be understood solely in terms of power or force projection : it begins with intelligence actions, as illustrated, for example, by the permanent presence for several years of a French frigate[22] in the Syrian canal to observe the dynamics of the Syrian conflict from the sea.

Exploitation of the water mass, because it will most probably remain the place where nuclear-powered ballistic missile submarines stealthily move, but above all because the exploitation of resources of the sea and the seabed will increasingly demand the action of naval forces because of the appetite for power that they arouse. The collusion between the actions of naval forces and civilian exploiters of maritime space bears witness to this : in the Eastern Mediterranean, where the Turkish Navy devotes a large part of its activity to securing the action of exploration and drilling vessels, or in the South China Sea, where militias and coastguards combine their efforts to monopolize the water column's resources. More generally, the actions of the vast majority of navies to monitor their sovereign spaces are also part of this framework. As the 21st century promises to find at sea many of the solutions to its resource problems,[23] this use case will remain a strong marker of the purpose of naval action.

Free circulation, finally, because the dynamics of "maritimization", which has characterized all the cycles of globalization since the Geographical Discoveries of the 15th

[20] This was typically the challenge faced by the French naval air group during its latest *Clemenceau 22* deployment in the Mediterranean, when it had to operate in a constrained space marked by a high density of Russian naval units. From February to April 2022, the French naval air group formed around the Charles-de-Gaulle aircraft carrier operated from the central and eastern Mediterranean in support of several air-land operations (*Chammal* in the Levant, EUFOR *Althea* in the Balkans, and *Enhanced Vigilance Activities* in Eastern Europe), in a context of heavy naval and air presence of the Russian Federation's armed forces.

[21] Vandier, *ibid.* New Caledonia is 20,000 km away, or 36 days at sea and 19 hours by air. Tahiti is 16,000 km and 28 days by sea, 18 hours by air via the United States. From Tahiti, Singapore is 12,000 km and 12 hours away by air, Guam 6 hours.

[22] *Cf.* "En Méditerranée orientale, à bord d'une frégate française aux aguets", Agence France Presse, 30 October 2020.

[23] For an overview of the energy component of maritime space resources, see CESM, 2019.

and 16th centuries, is not about to end in the century to come. This obvious fact was brought home to us by the blocking of the Suez Canal by the container ship *Ever Given* in March 2021[24] or, more recently, by the consequences of the war in Ukraine on maritime traffic and, indirectly, on the economies of the region.[25] Naval action will continue to find a framework for its use on that score, whether it is to make free movement possible or, on the contrary, to impede it, as illustrated by the Russian Navy's action in the Black Sea since the beginning of the conflict in Ukraine. One reason why this purpose of naval action has, to a degree, been lost sight of is that, apart from pirates, regarded as endemic threats and not adversaries, naval action in this area remains diffuse. The last significant naval action – that is to say, one that mobilized significant resources against an identified adversary – in this respect was the tanker war of the 1980s. However, the resurgence of hybrid conflict suggests that commerce raiding is not just a figment of the imagination,[26] as evidenced by the incidents that have marked maritime traffic around the Strait of Hormuz and in the Eastern Mediterranean since the summer of 2019, but also by the repeated attacks on merchant ships in the Black Sea since February 2022,[27] which are not just collateral damage. Lastly, it should be noted that the Freedom of Navigation Operations (FONOPS) regularly organized by the US Navy in several areas of the globe (Taiwan Strait, Black Sea or approaches to Venezuela)[28] constitute a basic though strategic use of naval action in support of free movement which is bound to expand due to the growth of grey areas.

So much for the three historical facets of exploitation. But the cases of exploitation of the control of air-sea space do not stop there. Three other use cases are definitely emerging.

Firstly, naval action to protect the land mass. To be sure, the maritime defence of coastlines is not new : it goes through history, from the British squadrons guarding the Channel against the Napoleonic threat to the torpedo boats of Admiral Aube guarding the French coast against the British hegemon in the late 19th century. But the rise of sea-based ballistic missile defence added a new dimension to naval action in its shielding role, to such an extent that part of the American, Japanese and Dutch fleets now specialize in this function,[29] whether to protect territories and their populations or, on the contrary, to shield fixed military installations, such as in Guam or in the Persian Gulf states. Progress in this

[24] Kumar & Mercogliano, 2021.

[25] Fully 97% of Ukraine's exports pass through its ports. Bulk cereals play an important role : in 2020, its wheat exports alone represented 11% of the world total (figures issued by the International Maritime Organization – March 2022). Arab countries, especially Egypt, are very dependent on Ukrainian exports.

[26] Cancian & Schwartz, 2020.

[27] In less than three months into the conflict in Ukraine, 19 civilian ships were hit in the Black Sea and the Sea of Azov by mines, missiles or artillery (figures quoted by the Maritime Information Cooperation & Awareness Center – MICA Center and the Coast Guard Operational Centre – COFGC).

[28] The US Navy conducted 10 FONOPS in 2019 and as many in 2020. These operations often consist of a simple transit through areas of the high seas whose use is contested by some littoral powers because of claims that go beyond the framework set by the law of the sea.

[29] See the March and May 2022 editions of *Proceedings* for a review of the US Navy and world navies, respectively.

area is constant : on 16 November 2020, *USS John Finn* achieved the first ever interception of a target simulating an intercontinental ballistic missile profile with one of its SM-3 Block II-A interceptors.

Second, naval action aiming at space. The effect of space on naval action is often discussed, but the reverse is overlooked. Not only are naval forces now (and will remain) able to see what is happening in space,[30] but they can also be actors in "star wars" by destroying satellites from the sea, as shown by the firing of an SM-3 missile from USS *Lake Erie* at a US spy satellite in February 2008.

Thirdly, naval action geared towards the deep sea. Again, the theme of undersea cables is not new, as a quick review of the history of the two world wars and the Cold War suggests.[31] But seabed warfare promises to become an important purpose of naval action in the coming era, as evidenced, for example, by Russian capabilities[32] and Western announcements in that domain.[33] Rescuing submarines in distress also contributes to positioning the actors through capability demonstrations, in the form of soft power. Search operations for the Indonesian submarine *KRI Nanggala-402*, lost on 21 April 2021 at a depth of 800 metres, saw China arrive with great fanfare to help Jakarta (after it pushed the US out of the operation), but fail in its recovery attempts.[34]

Finally, mention must be made of the political, or rather diplomatic, uses of naval forces. Following on from British ambassador James Cable, French strategist Hervé Coutau-Bégarie drew up a very complete picture in a book published in 2011,[35] showing the wide variety of options in this practice. What about the rest of this century? Such uses do not seem likely to weaken : it is enough to observe, among other things, the metronomic coupling between American diplomatic action and the deployments of its naval air groups or, recently, the first deployment of the British aircraft carrier *HMS Queen Elizabeth* for several months, with a schedule of visits to several dozen countries,[36] against the backdrop of the "Global Britain" strategy. Another illustration on a regional scale is that of Turkish power, which also uses the language of naval diplomacy in the Mediterranean. More than ever, naval action at the strategic level is part of the great game. And within the typology of naval diplomacy advanced by Hervé Coutau-Bégarie, it seems as if its dissuasive variety is destined to occupy a predominant place, as it often does in the history of international relations.

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[30] A long-range air surveillance radar such as the SMART-L ER (Extended Range), which is fitted to some Western frigates, can detect low-orbiting satellites.

[31] Sheldon-Duplaix & Huchthausen, 2009.

[32] See : Sutton, 2021.

[33] The French Armed Forces Ministry published its seabed control strategy in February 2022, which includes a whole range of capabilities (see : https://www.defense.gouv.fr/actualites/armees-se-dotent-dune-strategie-ministerielle-maitrise-fonds-marins). The Royal Navy recently announced that it will commission a Multi-Role Ocean Surveillance Ship (MROSS) dedicated to the defence of submarine cables by 2024 (see, for example : https://www.navaltoday.com/2021/03/25/royal-navy-to-get-new-multi-role-ocean-surveillance-ship/).

[34] See, for instance : https://www.lepoint.fr/monde/l-indonesie-renonce-a-recuperer-son-sous-marin-coule-02-06-2021-2429306_24.php.

[35] Coutau-Bégarie, 2010.

[36] Ho & He, 2021.

It is clear from this overview that past and future changes in the environment of naval action do not fundamentally affect its aims. On the contrary, they strengthen and, in some cases, expand them. The same cannot be said for the modalities of naval combat.

The Modes of Naval Action in the Fifth Age of Naval Combat

In naval action, processes, i.e. its tools and the way they are handled, have always been very volatile. This stems from the sensitivity of the naval domain to technological innovation – a double-edged sword, for while some navies have gained dazzling advantages from it in history, others have reaped bitter rewards : innovation – the new name for progress – is a major challenge for navies, as a recent book explained.[37] Having said that, how can one attempt to characterize the state of progress in today's naval action processes ? It is best to start by placing it in historical perspective.

A Brief Genealogy of Naval Combat

Any prospective effort must indeed begin with a retrospective look : let us therefore draw up, in broad strokes, the genealogy of naval combat. The chronological division offered is obviously open to debate, but its purpose is to characterize the dynamics of naval combat rather than to establish precise boundaries between historical eras that in reality interpenetrate. Moreover, no era totally erases the other : what counts are the novelties brought by each age and the way they affect naval action.

The first era is the age of sail, which extends from the 16th century, with the birth in Europe of the first combat fleets worthy of the name, to the middle of the 19th century, which saw steam definitively replace the use of wind as a means of propulsion. The means of naval combat were then ships, guns and optical signals. The factors of success in battle were the winds, the number of vessels, and crews' boarding ability as well as resilience. Battle is geometric, casualties are high, and ships are often captured to serve under the enemy flag.

The second age is that of the cannon, which runs from the last quarter of the 19th century until the interwar period. Its golden age came during the 1900-1916 period, which was particularly rich in innovations and advances in doctrinal thought. The means of naval combat were then guns, torpedoes, armour, radio, and searchlights. The submarine, "*a subversive asset*", made its first appearance. Factors of success in battle included numbers, manoeuvre, concentration of forces, the range of weapons, and the ability to engage first. Combat was still very geometric. Casualties remain high, and ships are increasingly sunk.

The third era is the age of the aeroplane. It is a fleetingly transitional age that stretches from the interwar period to the end of the 1960s. The means of naval combat are aircraft (bombers or fighters) operated from land or from aircraft carriers, bombs, radar, fire control guns, submarines, sonar and, above all, cryptology. Factors of effectiveness in the confrontation are in-depth surveillance and reconnaissance, firepower (both offensive and defensive), speed in the concentration of forces, the ability to break through enemy

[37] Corman, 2020.

codes and first engagement. As duels between forces move beyond the horizon, naval combat gradually loses its geometric form. The vectors of naval combat (submarines, ships, aircraft) are destroyed at a rapid pace.

The fourth age is the missile age, which began in the 1960s[38] and continues to the present day. The means of naval combat are missiles – whether conventional, nuclear, cruise or ballistic –, nuclear submarines, (now often multirole) aircraft, combat systems that combine arms, sensors and, above all, their ability to communicate with each other via tactical data links. The factors of success in battle are the concentration of fire (no longer necessarily the forces' own), the quality (range, precision) of the tactical and long-range image, and still, the effective ability to engage first. In the missile age, the geometry of combat has disappeared in favour of a greater dispersion of means, linked together by modern command and control (C2) tools. At the same time, the navies' focus is more on avoiding hits than on taking them, relying on self-defence systems (hard or soft kill) for survivability. Compared to previous ages, combat becomes essentially destructive for machines, less so for men.

The fifth age, which we are now entering, is that of robotics. While they are not its only manifestation, robots crystallize the characteristics of this new age made possible by an acceleration of the digitalization trend apparent since the previous age. In addition to the assets of the missile age, the new naval combat resources are drones,[39] artificial intelligence (AI), remote effectors, and the networks that link them to other naval combatants. In this new era, we are moving from the fast-paced development of hardware and software capabilities characteristic of the previous era to their use in many applications. The success factors that seem to be emerging in naval combat are information capability (understood in its broadest sense, i.e. beyond the mere surveillance and reconnaissance central to the cannon and aircraft ages and the tactical situation of the missile age) and concentration of effects (not just fire). It is an age in which one seeks above all to avoid hits, either by disrupting the enemy's information as far upstream as possible, or by engaging deported and uninhabited means when a risk of engagement exists. It is this age that we should now analyze further.

The Fifth Age of Naval Combat – Characteristics and Manifestations

In the age of robotics, the three classical pillars of naval action – surveillance and reconnaissance, fire application and command and control (C2) – are worth exploring again.

Surveillance and Reconnaissance in the Fifth Age of Naval Combat

More than illumination, the fifth naval age is really about information. This term may seem vague, but it should be clear that we are talking about tactical information, i.e. information "for naval action". In this field, the nascent new age is in line with the

[38] It can be symbolically traced back to the naval battles of the 1967 Six-Day War.

[39] The first drones appeared in the 1960s, but their development really began in the late 1990s with advances in remote control and autonomy. The *Predator* family is emblematic of this impulse.

previous ones, by seeking a simultaneous improvement in performance on the three axes of range, permanence and precision. In these three directions, the new tools of naval combat allow significant progress, if not breakthroughs.

First of all, drones, whether aerial,[40] surface[41] or underwater,[42] combine range and endurance. On the scale of a system of drones capable of taking turns, such endurance borders on permanence when automation makes it possible to free oneself completely from the limitations associated with the human factor : while the vast majority of them, particularly aerial ones, still require remote human piloting, a growing proportion now carry out their mission in total autonomy – just like robots. For example, on 7 June 2021, the unmanned vessel *Nomad* completed a long-distance crossing of 4,421 nautical miles from the Gulf of Mexico to the Pacific Ocean : this vessel remained autonomous for 98% of its journey, except for the crossing of the Panama Canal. This test is part of the US Navy's process of developing a fleet of unmanned surface ships, with the ultimate goal of having at least 140 unmanned combat ships.[43]

Secondly, space-based sensors are gradually becoming established as tactical surveillance and reconnaissance capabilities. Formerly reserved for strategic intelligence, surveillance and reconnaissance (ISR),[44] they are now entering the field of naval action thanks to the simultaneous increase in their resolution, the complementarity of their detection modes[45] and their frequency of passage.[46] In the French case, the examples of the *Trimaran III* maritime surveillance programme[47] and the rise of the *Unseenlabs*[48] start-up are part of this dynamic. All in all, the entry of satellites into the tactical layer of naval action leads to a major leap forward in the three areas mentioned above.

Finally, in the age of robotics, the networking of sensors has led to an unprecedented expansion of the range of surveillance and reconnaissance for naval action. This sharing is not new : it has existed since the missile era *via* tactical data links, which have been a condition of successful naval action for decades. The coupling of these data links to digital and satellite-based information has made it possible for several years to share tactical images at very great distances between fleets and headquarters. But in the fitfh naval age, this networking is now done without loss of precision, by directly merging the

[40] A Northrop Grumman MQ-4C *Triton* medium altitude, long endurance (MALE) maritime surveillance drone can operate for 36 hours at a distance of more than 3,700 km from its starting point.

[41] Developed by the US Defense Advanced Research Projects Agency (DARPA), the *Sea Hunter* surface drone (40 m, 145 t) can operate autonomously for about 60 days and cover 10,000 nautical miles.

[42] Thus, underwater "gliders", depending on their type, can cover transoceanic distances with an autonomy of several tens of days depending on their battery recharging system.

[43] *Cf.* the Battle Force 2045 strategic plan presented by the US Navy in October 2020.

[44] Intelligence, Surveillance and Reconnaissance.

[45] Optics, infra-red, synthetic aperture radar, passive electromagnetic listening, etc.

[46] The periods of "revisit" of the same area by certain constellations are now of the order of a few hours, as opposed to several tens of hours in the case of strategic systems.

[47] *Trimaran III* will provide permanent surveillance of French maritime space with more than 300 satellites.

[48] Unseenlabs, a start-up based in Rennes, specializes in satellite-based radio frequency (RF) geolocation of ships at sea.

raw information from combatants at sea: in addition to extending the global informational scope of a fleet, such a merger allows undifferentiated engagement by different platforms. The French collaborative naval surveillance programme (VCN)[49] is part of this framework, far behind the American Cooperative Engagement Capability (CEC) programme, which has been operational for several years. An illustration of the potential resulting from the convergence of these different advances was provided on 25 April 2021. On that day, the destroyer *USS John Finn* fired an SM-6 *ERAM* anti-aircraft missile at a distance of more than 200 nautical miles at a target detected by a network of passive sensors carried by air and surface drones and other surface ships.[50] The target was hit far off and in all discretion. In the fifth naval age, this networking dynamics completes the shift from the ship-centric to the network-centric navy model, which the US Navy has theorized in terms of two concepts: Distributed Maritime Operations and Distributed Lethality.[51]

Lastly, it should be noted that a common requirement runs through advances driven by drones, satellites and data fusion : that of being able not only to convey a large mass of information – which raises the question of throughput –, but also to exploit it – which raises that of processing capacity. This is where specialized AI – that which solves a given problem, as opposed to generalist AI – acts as a catalyst for all these robotics age advances, by producing elaborate data after processing a larger amount of data more quickly. Naturally, by virtue of the principle of reciprocity of actions, naval combatants will seek to erode the adversary's performance along the three axes discussed above. This will of course be done by physical means, such as jamming sensors or stealth, but also and above all by action in immaterial fields : this is the whole purpose of Information Warfare, to which we shall return.

Engaging the Enemy in the Fifth Age of Naval Combat

As far as application of fire is concerned, the emerging naval age, though lacking any clear breaks with its predecessor, offers certain salient characteristics. Here again, we find a continuity of effort under the triple headings of range, precision, and velocity. The race for range mainly affects the (anti-ship,[52] cruise[53] or ballistic[54]) missile segment, but torpedoes and guns (electromagnetic or otherwise) are not left out. It is interesting to note that in this transition phase, the range of detection means tends to follow the range of weapons. The networking of sensors mentioned above should make it possible to adjust both, at least on the scale of a naval force. Matching the range of weapons and sensors (including space-based sensors) on the scale of an entire theatre will be the next frontier :

[49] See for instance : https://www.meretmarine.com/fr/defense/fremm-la-veille-cooperative-prevue-en-2021.
[50] See for instance : https://news.usni.org/2021/04/26/unmanned-systems-passive-sensors-help-uss-john-finn-bullseye-target-with-sm-6.
[51] Rowden, 2015.
[52] While since the 1980s their range had remained around 100 km, anti-ship (cruise) missiles now have standard ranges of several hundred kilometres. For example, the future anti-ship missile (FMAN), a Franco-British programme, announces a range of 300 km.
[53] Naval cruise missiles (the French *MdCN* or the US *Tomahawk*) have ranges of around 1000 km.
[54] China's DF-21 and DF-26 anti-ship ballistic missiles have ranges of between 2000 and 3000 km.

this issue is embodied in the problem of the anti-ship ballistic missile with accelerated glider,[55] whose kill chain[56] issue will no doubt continue to add to the literature and feed heated debates on the vulnerability of aircraft carriers.[57]

As regards weapons velocity, the beginning of the 21st century is marked by the emergence of hypervelocity,[58] a new attempt by the sword to pierce the shield, which challenges advances in detection and interception by raising anew the issue of instant kills and destructions. Many navies already equipped with supersonic weapons[59] have launched hypersonic weapons programmes.[60] As for the third vertex of the triangle, the accuracy of weapons remains a constant concern and must be reconciled with the conflicting requirements of range (as illustrated by the example of precision ammunition for electromagnetic guns) and velocity (as illustrated by the issue of terminal guidance for anti-ship ballistic missiles).

Another strong trend in the coming era is the displacing of effectors, i.e. the generalization of drones operating *alongside* platforms (aircraft or combat ships) to facilitate the accomplishment of their mission.[61] In addition to the general trend, already mentioned above, towards greater autonomy of which drones are emblematic, the dynamic here consists of developing more numerous, less expensive, more difficult to detect and, above all, coordinated autonomous strike means. This inflection, typical of the robotics era, is embodied in the concepts of *swarming* on the one hand, and *autonomous* or *loyal* wingman[62] on the other. Examples of such programmes are the European SCAF,[63] the Australian Air Power Teaming System, the American XQ-58 *Valkyrie* and X-61 *Gremlins*, or the Russian S-70 *Okhotnik*-B. In terms of coordinated munitions, the American *Golden Horde* system is a good illustration.[64]

For the naval tactician, this development has several implications. First, it increases the capacity of manned platforms to occupy air-sea space with numbers unchanged. Secondly, the dual effect of numbers and stealth increases the tactical options available to the naval tactician in his offensive design. In particular, the tactical superiority factor conferred by numbers – i.e., 'mass' – is potentially coming back in force after having failed Western navies. On the other hand, when it comes to defence, the tactician is faced

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[55] This term refers to a missile that is initially propelled by a booster (like a ballistic missile), but after separation adopts a non-ballistic trajectory by "gliding". The Chinese DF-26 missile is an example.

[56] This term refers to all the conditions to be met from the detection, tracking and targeting of a ship, to the weapon's path and its terminal guidance to the target.

[57] On this topic, see the very useful review by Slaars & Henry, 2020.

[58] Hypervelocity refers to speed ranges above Mach 5 (i.e. 5 times the speed of sound). Between Mach 1 and Mach 5, armaments are merely supersonic.

[59] For example : Russia with its SS-N-26 et SS-N-27 missiles, India with its *BrahMos* model.

[60] For instance : India's *BrahMos II*, Russia's *Tsirkon* and *Avangard*, and the US *Conventional Prompt Strike* (CPS).

[61] Henrotin, 2021.

[62] *Loyal Wingman* is the name given to the drone developed by Boeing Australia to accompany the F-35.

[63] This French acronym stands for *Système de combat aérien du futur* : Future Air Combat System.

[64] Henrotin, *ibid*.

with a new challenge, similar to that faced by the US Navy in 1944 when confronting kamikazes.[65] In particular, the movement of swarms, which is based on AI, will be difficult to anticipate. This development will also accentuate the overall trend towards a lower share of casualties relative to material losses in naval combat. We can also foresee the increased demands on commanders to prepare, control and maintain these remote effectors that will become part of naval air forces' orders of battle. As with illumination, specialized AI is the catalyst for these developments in application of fire, for both attack and defence. Not only because of the need for synchronization between a multitude of vectors that can change targets at the last moment, but also because of their velocity : defending against a hypervelocity missile requires a reaction time that exceeds human reaction capabilities. Of course, this challenge is not new, and it was integrated very early on into the automation of naval combat systems (the American *Phalanx* autonomous system is the best-known example), but by moving from subsonic or light supersonic to hypervelocity, this challenge changes in nature.

Finally, the list would be incomplete if one failed to mention the emergence of so-called directed energy weapons, which include laser and microwave weapons.[66] Until now, these weapons have been mainly confined to the status of demonstrators, but they should probably become the preferred tools for naval action in the 21st century. For the tactician, they hold numerous advantages : multiple engagements in short sequences on very fast targets, high precision (in the case of the laser weapon), no limitations as regards ammunition, and gradation in effects. This last advantage is particularly relevant in a hybrid context. Although they are not intended to revolutionize the modalities of naval combat, they should, however, have a significant influence on the economic model of fleets, as their cost per "shot" is much lower than that of a self-defence missile. The technological challenges surrounding their development remain numerous, however.[67]

Command in the Fifth Age of Naval Combat

Finally, let us turn to C2, the intelligence – artificial or otherwise – that links tactical information to the application of force. In this area, the goal in the fifth age of naval combat will not change : to maximize the performance of one's own C2, erode that of the opposing C2, and guard against its attempts to degrade ours. What do we see when we look at C2 processes ?

Firstly, a burgeoning doctrinal field, that of Information Warfare (IW) : if the gun was the driving force behind naval doctrinal thinking at the beginning of the 20th century, it seems as if IW has replaced it in this role in the 21st. A field still in its structuring phase, IW does not have a strictly defined perimeter, but it can be regarded as the set of actions intended to influence the adversary's decision-making process by affecting its information

[65] In this respect, it can be noted that, like kamikazes, swarms of drones will have a strong psychological effect on their targets.

[66] This term refers to weapons systems capable of directing a beam of electromagnetic waves (laser or microwave) at a target. By definition, these weapons operate at the speed of light.

[67] Energy to be produced, cooling, safety.

as well as information management processes, and, reciprocally, the actions intended to prevent him from hindering our action in these same areas. IW is obviously not new : for naval action, it can be considered to have begun in the age of the cannon, with the radio and aerial surveillance and reconnaissance. It was refined to the extreme during WW II and then during the Cold War. But what is renewing this field in the fifth naval age is, as mentioned above, the effective move from the *development* of certain material and immaterial capabilities – often under the impetus of the private sector – to their *operational use* in naval action. Let us cite a few examples. In the underwater acoustic world, massive data processing makes it possible to find a useful signal, sometimes an extremely weak one, drowned in a mass of noise. Geospatial Intelligence (GEOINT) applications also use this lever to superimpose independent layers of data in order to bring out key elements of the situation and thus facilitate decision-making. Specialized AI, still in its infancy, makes it possible to detect abnormal behaviour among the stream of normal commercial flows that cross the aero-maritime space, making clues accessible almost immediately at the tactical level that would otherwise be perceived *a posteriori*, sometimes long afterwards. Also worth mentioning are social network monitoring tools used in order to detect the perceptions of action in progress, and assess their impact in terms of influence or operational security (as when monitoring ship movements).[68] In addition to the emergence of these applications, there are all the potentialities of the cyber field that supports them, to which we shall return. And for all these applications, the practitioner will have to assume that the adversary has the same tools and think about the best way to protect himself from their effects and degrade the opponent's performance.

Contemporary naval C2 is also becoming more complex as a result of the increasing interweaving of environments and domains. While the 1990s and 2000s had seen the rise of interservice symbiosis, the coming decades will see interdomain symbiosis,[69] beyond the military field alone. In this context, the command of a naval operation must, from the design stage, take into account a growing number of lines of operation and ensure that the effects produced by naval action are synchronized not only with the action of air and land components, but also with space, cyber and information action. This last area, for convenience referred to as "influence", will play an increasing role in the synchronization efforts required of naval force headquarters,[70] especially as its C2 model is naturally highly centralized. More generally, this increase in complexity is reflected in the multiplication of transversal command and coordination structures within a naval force: to the traditional "component commanders" have been added chains dedicated to cyber defence, space, IW, etc. Two practical consequences follow. Firstly, an inflation of the areas of responsibility (and therefore *a fortiori* of the size) of naval force command staffs. Secondly, an evolution of the physical structure of the combat information centre

[68] Saunois, 2021.
[69] This concept has been stabilized in the US under the term Multi-Domain Operations (MDO). The US Air Force calls it Multi-Domain C2 (MDC2), the US Army MDO, and the US Navy Distributed Maritime Operations (DMO). The rationale behind the different names is broadly the same in each case.
[70] Saunois, 2021.

(CIC) of combat ships, which will have to be tailored to manage a growing mass of information and integrate their action into a wider range of effects. At the tactical level, the main challenge will undoubtedly be to maintain a level of complexity compatible with combat action, i.e. ultimately, have sufficient information to act. The Americans took a step in that direction when they introduced the first CICs half-way through the Second World War in the Pacific, which allowed them to merge the information from early radar and sonar systems into a picture that allowed them to use their weapons effectively.[71] Sailors in the 21st century will have to make this switch by integrating the new tools of naval warfare into their command-and-control centres. Finally, it is safe to prophesy that, with the increasing centralization of a great deal of tactical information at all levels of decision-making, there will be voices against the so-called "compression of the levels of war". But this concern of the tactical echelons, recurring with every historical progress in C2 assets, will probably be quickly dispelled, as each level quickly finds its feet in its "swim lane".

Finally, these current or foreseeable developments in naval action raise the question of the relationship to time in the fluid space that is aero-maritime space. As one analyst notes, fluid spaces are marked by "*a predominance* (*or a tendency to predominate*) *of space-time over matter, and even a very clear predominance of time over space* (*whereas time and space tend to be equivalent in solid spaces*)".[72] In the fifth age of naval combat, as we have seen, the compression of time continues under the effect of the increasing velocity of armaments, but above all under the impact of the increasing pace at which an enormous mass of information is made available. There is no doubt that in the age of robotics, 'machines' will adapt to process ever more information, ever faster. However, as Admiral Richardson, US Chief of Naval Operations, pointed out in 2018,[73] the challenge of naval competition is less about gaining information superiority than about gaining decision-making superiority. More than speed, it is therefore a matter of tempo. In this area, two points should be borne in mind. Firstly, each level of war has its own tempo, and the Western fascination with the speed of combat actions should not lead us to forget that although the tactical tempo is by far the fastest, it cannot impose its mark on the other, inherently slower levels of war. In 21st century naval action, there is therefore a strong challenge to maintain the coherence of the tempos between the levels of warfare, despite a permanent quest to fight at information speed.[74] Secondly, it is important not to lose sight of the fact that man, with all his limitations, will remain the central link in this decision-making competition for a long time to come, in the absence of a general-purpose AI, which is still a long way off.

Let us close this section devoted to naval action processes in the 21st century by emphasizing that in the absence of 'major battles' at sea for several decades (the last major

[71] Hone, 2019.
[72] Henninger, 2012.
[73] "Preface", in Hughes & Girrier, 2018, p.xix.
[74] Kollars, 2021.

such 'battle' was *Operation Corporate* conducted by the Royal Navy to recapture the Falklands in 1982), the potential for "technological surprise" is significant. It is therefore advisable to remain cautious about predictions made in this current time of permanent crisis "*below the threshold of war*", and carefully observe regular outbursts of naval violence such as in the Black Sea since the Russian invasion of Ukraine.

Twenty-First Century Principles of Naval Action Remain Unchanged

Stable aims, evolving processes, certainly – but what about the 'principles' of naval action in such a context ? A quick overview, offering an opportunity to look at some of the constants of naval combat through the prism of the new era, will convince us that they have not aged a bit.

The Triad of Naval Warfare Principles Is Here to Stay

History suggests that naval combat is fast, destructive and decisive.

Fast : ever since the first naval age, combat actions at sea, where forces are concentrated quickly and 'machines' are quickly destroyed, have been marked by brevity. Now, under the effect of the increase in the velocity and range of weapons (speed of light for directed energy weapons), and the compression of information processing time, this brevity can only increase.

Destructive : "*annihilate the enemy*" was Admiral Nelson's credo. Nothing has changed : then as now, naval combat is won by attrition, never by manoeuvre alone. The growing lethality of weapons in the age of robotics is part of this continuity. Soft action in cyberspace will not replace it : it will at best be a facilitator when it comes to neutralizing an opponent, not a substitute for kinetic action. What we can hope for is that this destructive character will increasingly spare humans.

Decisive : "*On the sea, when the scales start tipping, they will tip all the way*", said Lieutenant Baudry[75] in 1912 to describe the fragile balance that exists between two forces whose confrontation at sea can quickly tip over under the effect of an advantage, however modest, gained by one party to it. And given the difficulty of quickly replacing inherently expensive naval assets, the sea is then permanently available to the victor. The characteristics of the fifth age of naval combat exacerbate this decisive aspect of naval confrontation, both in its conduct and in its consequences, as the increasing cost of the tools of naval combat will make them more difficult to replace, despite the moderating effect of a low-cost mass provided by displaced effectors.

The recent loss of the Russian cruiser *Moskva*, hit without warning in the Black Sea on 13 April 2022 by two *Neptun* anti-ship missiles and sunk a few hours later with an uncertain but probably significant human toll, sheds a harsh light on the current relevance of this trinity.[76]

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[75] Baudry, 1912, p.140.
[76] Zimm, 2022.

Engage First : A Great Maxim That Will Endure

As developed in another article by this writer,[77] the great maxim of naval combat is to manoeuvre in such a way as to be able to deliver the decisive blow first. This imperative was imposed from the earliest hours of the gun age, ran through the aircraft age and again permeated the missile age. In each of these ages, naval thinkers attempted to model the mutual attrition between two fleets subjected to continuous fire (gun age), deck fire (aircraft age), or salvo fire (missile age), concluding that the premium for attacking first was sufficiently strong to either allow the stronger side to win without casualties or to allow the weaker party to redress the balance in its favour. The age of robotics will be no different, with a mix of missile-age bursts and the "deck cargo" of remote effector swarms.

The need to engage first will be all the greater as the capacity of platforms to take hits will not tend to increase. However, in the gun and aircraft ages, such capacity to take hits acted as a powerful moderator to compensate for tactical errors. Without this moderation, the tactician of the fifth naval age will be prompted to go for quick tactical successes... and thus to first engagements, especially if he does not benefit from the comparative advantage of the "mass" brought by remote effectors. The only difference with previous ages, already visible in the missile age, is that engagement will require less and less physical massing of forces. In the missile age, engaging first from dispersed positions was possible ; with the extension of weapons range and the spread of collaborative engagement that characterize the robotic age, this trend towards dispersion will increase.

The Superiority of the Offensive as a Compass

US Admiral Mahan famously noted that "*to employ a navy as an instrument of pure passive defence is found faulty*", whichever way you look at it, since "*the distinguishing feature of a naval force is mobility while that of passive defence is immobility*".[78] Formulated a century ago, this observation is still relevant in the 21st century because naval warfare remains fundamentally a war of movement and attrition where the attacker is favoured. In addition to this natural *bonus* to the offensive, there is a *malus* to the defensive when the only possible stronghold for a fleet that wants to defend itself is on land : at sea, to withdraw is to no longer exist. French Admiral Daveluy thus considers that "*maritime defence, from whatever point of view one considers it, offers only disadvantages. It can be imposed ; but it must never be adopted voluntarily. On both sides we are led to choose the offensive to seek out the enemy in order to fight him. But the two sides will not do this in the same way*".[79] Despite the sustained focus on addressing threats in the new age, these broad equilibria are not likely to change. This search for responses to new threats is really a matter of security, and must be approached not as an end in itself but as a condition of the naval war leader's freedom of action in the service of a positive objective, in an offensive

[77] Lavernhe, 2019.
[78] Mahan (Alfred), 1911, p.132.
[79] Cited in Vego, 2020, p.33.

dynamic that is appropriate to naval action. Cyberspace, another fluid and opaque environment, also predisposes to the offensive[80]: the coupling of this field of conflict with operations at sea should therefore reinforce the need for an offensive approach to naval action.

However, it is necessary not to blind ourselves to the offensive advantage provided by the "new weapons" mentioned above (hypervelocity armaments, swarming effectors, directed energy weapons, etc.), particularly those that use the leverage of greater speed. When used by the defensive party, especially in a littoral context, these weapons can indeed pose defensive challenges that the offensive party will not always be able to solve.[81] This does not detract from the conceptual superiority of the offensive in naval combat, but it does temper the tactician's temptation to believe that speed of decision, coupled with speed of weaponry, is a magic solution to achieve victory.

Movement as a Comparative Advantage

Certainly, the trends described at the beginning of this article point to an erosion of the traditional advantage of mobility conferred on naval action over land mass. The time is long gone when naval power could bypass a land-based defence system with impunity, although the advent of the aircraft may for a time have restored the advantage to the sea party by allowing it to 'break' the mobility of rail on land. Repeats of the Incheon amphibious landing of September 1950 in Korea are unlikely. However, mobility remains a characteristic of naval action which should continue to offer four main advantages : surprise, concentration capability, evasive action and counter-designation.

These four advantages vary in intensity depending on the location of the confrontation and the forces involved, but each can be exploited by the naval warfare commander as opportunities arise. Today, as in the past, this manoeuvre mentality is embodied in the US Marine Corps component at the operational level : yesterday, in the 1990s, with the concept of *Operational Maneuver From The Sea* (OMFTS), today with that of *Expeditionary Advanced Base Operations* (EABO),[82] thus suggesting that manoeuvre from the sea remains and will remain a source of freedom of action and inspiration. At the tactical level, an exercise such as *Polaris 21*, carried out in the western Mediterranean in December 2021,[83] highlighted the relevance of the advantage provided by the mobility of a naval air force in order to free itself from the apparent brake constituted by the red circle of a "contested zone" : well used, movement enables it to "*beat its land-based adversary to*

[80] Boyer, 2014.

[81] Brister, 2021.

[82] The concept is based on the use of small units capable of conducting amphibious operations to carry out surveillance, forward basing, jamming and even anti-ship missile site installations, and then re-embark to move to another location in a short period of time. On this topic, see the USMC's official website : https://www.marines.mil/News/News-Display/Article/2708120/expeditionary-advanced-base-operations-eabo.

[83] Bringing together several dozen French and foreign warships off the French coast for a fortnight, this high-intensity operational preparation exercise saw two naval forces confront each other in a coastal environment with a high degree of realism. See : https://www.defense.gouv.fr/marine/polaris-21-exercice-grandeur-nature.

the punch" so that the latter may, on arrival, be a little late or "too short" of a missile volley. And it often doesn't take much more to win.

The same is true for counter-designation: a naval force travelling at 25 knots covers a distance of about 5 nautical miles in 12 minutes, the time it takes for an anti-ship ballistic missile to cover a distance of just over 1,000 kilometres ; such uncertainty will remain a challenge when it comes to hitting the right target at the right time.[84] In the fifth naval age, as in the past, anything that is fixed is vulnerable, and anything that moves, even at a few dozen knots, is less vulnerable. Only a breakthrough in the field of space-based laser weapons could challenge this constant. On this last point, it should be noted that during the interwar period, some analysts were already predicting the end of surface ships in the face of the rise of air weapons,[85] before repeating their prophecy with the appearance of nuclear arms. But surface ships still exist, evolving at speeds that have not drastically changed in the last century.

Note that in the Black Sea, the Russians have made extensive use of this advantage of movement to concentrate their own and circumvent opposing forces.[86] On the other hand, the loss of the *Moskva* indicates that it was not sufficiently used for counter-designation : the result was not long in coming.

Surprise: Still Key to Naval Action

The new age that is dawning might suggest that surprise has given way to safety. Not only has deception – whether strategic, operational or tactical – become less important in an age of skinny fleets, shrinking distances and persistent space surveillance, but advances in cryptology and cyber protection have also made communications secure, ending the dialectics of encryption-decryption that played a key role in the naval confrontations of the Second World War. In reality, the ability to surprise one's opponent in the 21st century has not diminished – one could even consider that it rather increased. In addition to the fact that maritime environments still supply ample room for concealment (underwater volume, archipelagic waters, etc.), three elements of modern combat favour surprise: cyberspace, AI and drones.

Cyberspace, first of all, because the information (or cognitive) field it supports is an infinite – and inexpensive – source of distortion and falsification of the opponent's information that can induce him to act against his interests. The spoofing of the *Automatic Identification System* (AIS) used by surface ships is a now commonplace example. In its physical and logical layers, cyberspace is also a source of sabotage and obstruction to a naval force. It is also a potential source of tactical intelligence : in the decades to come, it is safe to imagine a naval force managing to integrate itself into the enemy combat system and get hold of its tactical image. All these elements contribute to the risk of surprise in

[84] Slaars & Henry, 2020.
[85] Lavernhe, 2020.
[86] Sheldon-Duplaix, 2022.

naval operations, and the security effort to be developed to prevent it is sometimes disproportionate, as it requires the consideration of a multiplicity of scenarios.

AI, secondly, because the algorithms that make it up are nothing without the data that feed it. However, in a context of conflict between States, it is likely that data will be the first target of deception. Using the example of AIS mentioned above, it is easy to imagine that a massive alteration of AIS data in a maritime theatre could lead to the emergence of totally fanciful assessments by AI systems trained to process data supposed to be valid in normal times. Beyond algorithms, the challenge of protecting against this type of deception will therefore revolve around the quality of sensors capable of providing the tactician with true information.[87]

Finally, drones, because of their small size and their potentially unpredictable evolutionary logic when based on AI, are likely to create a tactical surprise. The incursion of a small underwater drone piloted from land into a large military port for intelligence or sabotage purposes, for example, is a credible threat. All in all, the tactician of the fifth naval age will have more opportunity than ever to design his modes of action to include deception and surprise provided he or she has the necessary levers to act in all milieux and fields of conflict. This is one of the challenges of the multi-milieu and multi-field approach under discussion today.

The Centre of Naval Action: Man

Let us listen to Foch: "*Thus, these theories, which were thought to be correct by basing them solely on certain and mathematical data, had the misfortune of being radically false because they left out the most important element of the problem, whether it was a matter of command or execution, the element that animates the subject, makes him live: man with his moral, intellectual and physical faculties; because they tended to make war an exact science, ignoring its very nature as a 'frightening and passionate drama'* (*Jomini*)".[88]

This discussion could have gone over many more principles (linking of arms, concentration of effort, freedom of action, etc.) to show their permanence. But since it is coming to a close, the human factor, which has constituted the great source of continuity in naval action ever since the age of sail, seems a fit concluding topic. It would take a whole article to deal with it. Let us limit ourselves here to underlining three salient points.

Firstly, sailors will not vanish from naval forces tomorrow. With the advent of drone technology, they will in part be distanced from the cauldron of combat, continuing an age-old trend that began with jet weapons. But specialized AI is still far from erasing the role of humans in decision-making, particularly in the context of uncertainty.[89] More generally, it is in the teaming of human and machine that naval forces will optimize their performance.[90]

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[87] Tangredi, 2021.
[88] Foch, 1903.
[89] Naulet, 2019.
[90] CNO Strategic Studies Group 35, 2016.

Secondly, in the absence of effective naval combat practice for several decades,[91] the potential for "technological surprise" mentioned above is coupled with the potential for "human surprise" : in spite of the indispensable training of crews and for all the lessons learnt from history, one cannot accurately predict the capacity of sailors, on the appointed day, to extricate themselves from the stupefaction that will be theirs when faced with the "novelty" that combat action will then represent. To know this is to free oneself from a prejudicial overconfidence.

Thirdly, while the skills of sailors will continue to evolve with technology, there is a growing need for tactical leaders to secure a high level of general naval combat knowledge. Such general savvy alone will allow them to dominate the technology and get the most out of it by being creative. The naval history of the two world wars amply illustrates this.[92]

Should We Positively Conclude?

The exercise in foresight on naval action that has been ventured here must not in any way lead us to forget that history remains a graveyard of prophecies: it is impossible to predict exactly what a future battle at sea will be like in the 21st century. Between 1885 and 1935, only seven major naval battles took place,[93] leaving the navies of the Second World War with no absolute certainty about the nature of the fighting they were to engage in. In a short time, they learned about radar, assault carriers, cryptology, modern submarines, etc. Since 1945, naval battles have been few and far between, providing only a narrow, fleeting a glimpse of maritime conflict in the missile age. It is therefore to be expected that, despite the anticipation efforts of modern navies in 2021, many calculations will be thwarted. Let us therefore leave the only certain conclusion, in the form of a joke, to a man from the sail age – Maurepas (1701-1781), Secretary of the Navy under Louis XV from 1723 to 1749: "*Do you know what a battle at sea is, gentlemen ? We meet, we cannon, we separate, and the sea is no less salty for it*".

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[91] Apart from the destruction of the Libyan fleet at dockside during *Operation Harmattan* in 2011 by an air assault, the last French naval victory dates back to 1941 during the Battle of Koh-Chang, which pitted the French Navy against the Siamese Navy.

[92] Hone, 2019.

[93] Yalu (1894), Port-Arthur (1904), Tsushima (1905), Coronel (1914), Falkland (1914), Dogger Bank (1915) and Jutland (1916).

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