Evolution of warships in the digital age

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Abstract

In the context of historical developments in maritime conflicts, warships have always been the central pillars of naval power, determining the course of empires and influencing the outcomes of wars. From ancient Greek triremes and Roman galleys to modern aircraft carriers, these vessels have been essential in both national defence and the exploration and colonization of new territories. In contemporary times, the role of warships has further expanded to include humanitarian and peacekeeping missions while maintaining their fundamental functions of protecting maritime communication routes, controlling maritime spaces, and projecting force. As technology continues to advance, the digital age redefines naval capabilities, propelling warships into a new era of innovation and strategic complexity. This article provides a brief history of warships, highlighting the essential elements that have contributed to their development and ongoing relevance, and explores the future impact of the digital age on these crucial platforms for global security.

Keywords:

This article explores the main historical milestones that have defined the functions and importance of warships over time, highlighting the way in which they have retained their essential missions despite the transformations brought by technological progress. It also analyzes the implications of modernization and digitalization on contemporary naval operations, underscoring emerging challenges and opportunities within global maritime security. This critical analysis aims to provide a comprehensive understanding of the historical and technological dynamics of warships, highlighting their ongoing relevance in the current geopolitical context. Through this historical and contemporary lens, the study of warships reveals not only a tale of adaptation and innovation but also a continuous manifestation of their lasting influence on geopolitics and international security.

In an ever-changing world, naval forces will continue to play a central role, adapting to new technological and strategic realities.

The research methodology for this article includes:

- a chronological approach to examine key transitions in the design and function of warships, identifying the technological and geopolitical factors that have driven these changes;

- the selection and analysis of case studies of nations that have made significant contributions to naval innovations, such as England in the early modern period or the United States in the contemporary era, to understand variations in strategies and technologies;

- an analysis of how these technological and historical developments influence national and international defense strategies, using strategic models and scenarios from current conflicts.

The research limitations are represented by the lack of access to classified information about the latest technologies implemented by naval forces belonging to states with highly developed defence industries, in which military institutions have research and innovation institutes. In most states today, armed forces no longer innovate; they focus on selecting and developing civilian technologies that have military relevance. The article is structured into four parts: the first part presents some historical milestones relevant to the evolution of warships; the second part outlines a possible model for building naval capabilities to understand mainly the limitations of naval platforms; and in the third and fourth parts, the main characteristics of the digital age and its impact on warships are presented.

A brief history of warships

Throughout history, warships have been essential instruments of maritime power, influencing the course of conflicts and the formation of empires. In the modern era, the missions of warships are primarily those consolidated over the centuries, playing a crucial role in global maritime security, protecting communication lines, and projecting force in regional and international conflicts.

To highlight the fact that the missions of warships have not fundamentally changed and to construct a pattern of their evolution and relevance, I will present the main historical milestones that have defined warships and their importance.

The first warships, such as Greek triremes and Roman galleys, were powered by oars and used in maritime confrontations. These ships were built for rapid manoeuvrability and their purpose was to inflict damage through boarding, utilizing archers and catapults on board (Strauss 2004).

In the Middle Ages, the Vikings developed long, fast, and manoeuvrable ships used for raiding and trade (Magnusson 1980). These ships influenced the later design of warships in Europe.

Advancements in shipbuilding led to the emergence of line ships, large heavily armed vessels that dominated the seas. These ships had multiple decks equipped with cannons, used in major naval battles, such as those during the Napoleonic Wars.

Warships facilitated the exploration and colonization of new territories. During the Age of Discovery, nations such as Portugal, Spain, the Netherlands, and England used warships to explore unknown lands, establish colonies, and claim new territories. This expansion contributed to the creation of global empires and the spread of cultural and economic influences.

Control of the seas and oceans was essential for the economic prosperity of empires. Warships protected trade routes against piracy and enemy attacks, ensuring the free flow of goods and resources. For example, as the British Empire expanded, the Royal Navy protected global trade routes, contributing to Britain's economic dominance in the 17th to 19th centuries.

The Industrial Revolution marked the transition from sailing ships to steam propulsion. This era introduced armoured warships, such as the famous HMS Warrior.

The two World Wars led to rapid developments in warships. Battleships like the HMS Dreadnought redefined naval warfare in the early 20th century (Edwards 2024). After World War II, aircraft carriers became essential due to their capacity to launch aircraft and project power over great distances.

The presence of a strong fleet can act as a deterrent against rivals and can be used to project a nation's power on an international scale. Warships enable the rapid and strategic deployment of military forces, providing nations with the ability to intervene in conflicts far from their borders. These capabilities are evident in modern examples of aircraft carriers and maritime strike groups employed by the world's great powers.

Famous naval battles, such as the Battle of Midway, demonstrated that naval superiority can determine the fate of wars and change the international balance of power (history.com 2024). Victory in these confrontations granted maritime powers control over the seas, undermining the ability of enemies to defend or expand territories.

In the contemporary era, warships are not only instruments of war, but also platforms for humanitarian missions, peacekeeping, and international cooperation. Participation in international maritime exercises and joint missions helps strengthen relationships between nations, promoting global stability and security.

Moving forward, I believe that detailing how naval capabilities are constructed is necessary, considering their diversity and specificity depending on the factors that are determinants of the main characteristics of a naval platform.

Factors that influence the shipbuilding – types of ships

To understand the elements that contribute to building the capabilities of naval forces, I believe that the elements derived from the study I conducted regarding coastal warfare can serve as a simplistic model upon which naval platforms are built to suit various strategic situations.

Thus, the main conclusion of the study, based on the analysis of historical cases of military actions conducted in the coastal area, is that the characteristics of the environment influence the way in which the naval platform is constructed, which, in turn, affects the weapons and technology installed on the platform, all of them having direct implications on the tactics used in combat (Cucinschi 2020).
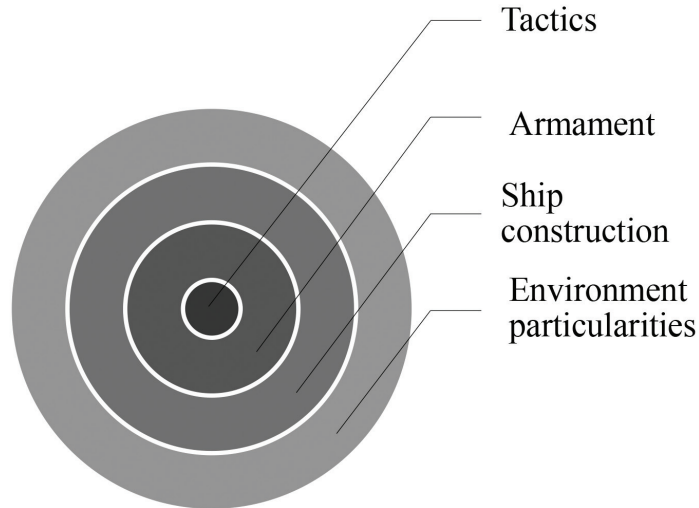
Figure 1   The interdependence between the main elements of littoral warfare (Cucinschi 2020)

Subsequently, through case studies focused on states that have developed effective capabilities for coastal warfare, I have concluded that, in addition to the previously mentioned factors, consideration must also be given to the adversary, the form of action (offensive or defensive, and less so in the case of stability operations), and experience in building naval platforms (Cucinschi 2020).

Building on this study, one can understand how naval capabilities are currently constructed based on the physical environment—this

may allow for the construction of large platforms (for oceans and large seas) or small ones, for smaller, enclosed, or semi-enclosed seas. Subsequently, the platforms, depending on their sizes, can be equipped with different types of armaments. Given that naval forces address combat in environments such as surface, anti-submarine, and air defence (more recently, seabed warfare), the weaponry is grouped within these three categories.

Typically, relatively small ships, such as corvettes, allow for the equipping of weaponry and sensors for combat in a single environment, while being limited in the others. Frigates, which are medium-sized ships, allow for the equipping of sensors and weaponry for combat in two environments, with limitations in the third. Destroyers, being large ships, allow for the installation of equipment and sensors capable of fighting in all three environments.

In addition to specific missions only for naval forces, military vessels can also carry out actions in support of ground forces, air forces, and special operations forces, usually with large ships (destroyers, cruisers, aircraft carriers) or specialized vessels (assault ships).

Up to now, seabed warfare has not been associated with a specific type of ship, as there are no concrete elements about how to approach this new environment.

I believe it is important to understand how the main types of warships are constructed because, in many cases, the expectations of other force categories or the commanders of combined forces exceed the realm of possibility for naval platforms.

Additionally, to understand how the digital age impacts the transformation of military vessels, it is necessary to understand the benchmarks that underlie the specificity of the types of ships used in current conflicts, which is why I have conducted this brief analysis.

Next, I will carry out an analysis concerning the transition into the digital age and the fact that it can lead to transformations regarding the building of capabilities for naval force platforms.

Digital age – defining characteristics

The digital age, often referred to as the information age, is a period in human history characterized by major technological revolutions and the transition from a resource-based economy to one based on information and knowledge. This era features several defining characteristics that have profoundly transformed society, economy, culture, and the way we interact with one another.

> 1. *Digital Technology and Information Accessibility:* One of the most emblematic traits of the digital age is the abundance and accessibility of information through technology. The internet, personal computers, smartphones, and other digital devices enable us to access and distribute information on a global scale in a fast and efficient manner. This unlimited

access to information has democratized knowledge, allowing individuals to learn and grow autonomously (Katz and Ronald 2002).

2. Global Communications: The digital age has radically transformed the way we communicate. Social networks, emails, instant messaging, and video conferencing platforms allow us to stay connected with others, regardless of geographical distances. This globalization of communication has facilitated cultural and economic exchanges but has also led to phenomena such as technology dependence and the rapid spread of misinformation (Castells 1996).

3. Digital Economy: Technological innovations have led to the emergence of a digital economy, where goods and services are created, managed, and traded online. E-commerce platforms, digital assets, and cryptocurrencies are manifestations of this transition. The digital economy has created new business opportunities and changed employment paradigms, enabling remote work and the development of careers in emerging fields (Brynjolfsson and McAfee 2014).

4. Automation and Artificial Intelligence: Advances in artificial intelligence and automation have had a profound impact on jobs and industrial efficiency. While these technologies have improved productivity and reduced costs, they have also raised concerns regarding job loss and ethics in the use of AI (Tapscott 1995).

5. Social and Cultural Impact: The digital age has deeply shaped the social and cultural aspects of our lives. Individuals build hybrid identities, both physical and virtual, with the ability to express themselves and organize into digital communities. However, this environment has also contributed to social isolation and raised questions regarding privacy and the security of personal data (Turkle 2012).

6. Security Challenges: With the benefits of digital connectivity come challenges related to cybersecurity. Threats such as hacking, online fraud, and cyberattacks are on the rise, necessitating the need for sophisticated security solutions and education in data protection (Van Dijk 2012).

In conclusion, the digital age is characterized by increased interconnectedness, economic and technological innovations, and social and ethical challenges. These transformations have led to a reconfiguration of global society, providing numerous opportunities while simultaneously demanding responsibility in managing the technological impacts on humanity.

The impact of the digital age on naval platforms

The digital age has brought significant transformations across multiple fields, including maritime conflict. Warships, considered essential in the defence strategies of any maritime nation, have not remained unaffected by these changes.

First of all, digital technology has revolutionized the equipment and onboard systems

of warships. The information management systems aboard ships have become more advanced and interconnected. The integration of digital technologies has led to the development of more efficient sensor systems, secure communication systems, and improved rapid response capabilities. For instance, the use of artificial intelligence has enabled the automation of complex processes, allowing many routine operations to be managed with minimal impact from the human crew, thereby reducing errors and increasing operational efficiency.

Secondly, the digital age has opened new horizons regarding naval strategies. The concept of cyber warfare has become a crucial component of modern conflicts. Warships must now be prepared for cyber threats, developing both defensive and offensive digital capabilities. This entails implementing advanced cybersecurity systems and training personnel in cyber warfare, ensuring the protection of critical information and communication infrastructure.

Furthermore, computer-aided design and virtual simulations have revolutionized how warships are conceived and tested. These technologies allow engineers to create highly detailed 3D models and simulate various operational scenarios before actual construction begins. As a result, design errors are minimized, and the ship's performance is optimized for different combat conditions, saving significant time and resources.

Additionally, modern weapon systems integrated with digital technology represent a significant advancement in both defence and offence. Digitally guided technologies, such as smart torpedoes and guided missiles, offer superior precision and firepower. Anti-aircraft and anti-ship defence systems have also been greatly optimized through advanced sensors and radars, allowing threats to be detected and neutralized well before they become critical.
Moreover, digital technology has led to improvements in the durability and sustainability of warships. Modern designs focus on reducing radar and acoustic signatures, using advanced materials and innovative designs that make them harder to detect by enemies and more energy-efficient.

Furthermore, the digital age has fostered integration and interoperability between different types of armed forces and nations. Warships are now capable of participating in multinational exercises and peacekeeping operations due to standardized communication and information-sharing systems. These capabilities are crucial for international cooperation and for rapidly updating strategic information in crisis situations.
In addition to the technical and strategic advantages, the transformations of the digital age have also posed some ethical and social dilemmas. Automation and the use of artificial intelligence in combat decisions raise issues of accountability and morality, especially concerning lethal actions. Additionally, the growing reliance on digital systems exposes warships to risks of manipulation or malfunctions caused by cyberattacks.

Thus, it can be asserted that the digital age has profoundly influenced the evolution of warships, radically redefining the way they operate. Technological innovations have led to improvements in the efficiency and operational capabilities of vessels, while new strategic and ethical challenges have emerged in the context of digital integration. It is essential for naval forces to continue adapting to these changes, developing innovative solutions to meet modern defence and security requirements.

Conclusions

Throughout history, warships have remained essential in projecting maritime power and protecting international security. Although the fundamental missions of these vessels have evolved, their essence has remained the same: ensuring control of maritime space and protecting sea lines of communication.

From the era of triremes and galleys to modern ships equipped with advanced technologies, the evolution of warships reflects the progress in shipbuilding and armament. These vessels have been instrumental not only in wars but also in exploration and colonization, defining the outlines of great historical empires.

The Industrial Revolution and the digital age, more recently, have fundamentally transformed naval platforms. Modern propulsion, sophisticated armament, and automation have increased efficiency but have also introduced new challenges, such as the need for cybersecurity and the ethical management of artificial intelligence.

The digital age has facilitated the promotion of international maritime cooperation. Modern warships are equipped for interoperability, allowing participation in multinational exercises and missions, which strengthens diplomatic relations and contributes to global security.

In the context of the digital age, naval forces must continue to adapt, developing innovative solutions to address contemporary challenges. The integration of new technologies must be balanced with ethical responsibilities and protection against cyber threats.

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