SHAPING A BETTER MARITIME WORLD

MATTHIEU **DE TUGNY**

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BUREAU VERITAS

We share your drive to protect our blue planet and leave the maritime world in a better place than we found it.

It's what unites us, our passion for the oceans and our desire to not just protect our seas, but to shape a better maritime world for future generations.

MATTHIEU **DE TUGNY**

PRESIDENT,
BUREAU VERITAS MARINE & OFFSHORE

THE IMPORTANCE OF MARITIME

Shipping plays an essential role in today's world. The goods it transports help build cities, feed the global population and keep industry moving.

11
billion tons of goods
transported include food, consumer goods and fuel

4.7bn tons
container cargo

3.2bn tons
bulk cargo

3.2bn tons
tanker trade

98,140
commercial ships

90%
of goods
are transported by sea

Shipping is the cheapest form
of commercial transport contributing just $5 to the $100 cost of a pair of trainers!

+150%
fleet capacity
Seaborne trade volumes have increased by nearly 90% in the past 20 years: over the same period, fleet capacity has grown 150%

29%
of the global order book
by tonnage was capable of using alternative fuels at the start of 2020

1M
people of all nationalities
are directly employed in the maritime industry

3%
of global CO_2
Shipping is the most efficient form of commercial transport

7
ports of the world's top 10
are in China

1800 1850

Industrial revolution and trade

Mechanization, steam power and increased use of iron in construction led to a boom in commodities trading. Metal-hulled cargo ships able to carry dry commodities in bulk were born.

1860

Oil fuels the modern economy

The first oil well was dug in the United States in 1859. Yards competed to design effective tankers. In 1886, Bureau Veritas classed the first steam-driven ocean-going tanker, in which oil could be pumped directly into the hull.

1900

The sea as tourism

Advances in ship design cut journey times across the Atlantic, enabling the first passenger cruise ships to set sail. High-profile accidents led to the first International Convention for the Safety of Life at Sea – and a growing role for classification societies.

1950s

Globalization begins with a box

The invention of the humble shipping container enabled more goods to be loaded onto ships – and much faster. Supported by the risk calculations of classification societies, yards designed larger ships able to carry thousands of containers.

1990s

Emergence of offshore wind

The first offshore wind farm was built in 1991 but it was not until the mid-2000s that a sizeable project pipeline emerged. Demand for vessels able to transport and service turbines grew, and classification societies developed dedicated Rules.

2000 2020

Innovation in LNG

The early 21st century saw multiple innovations in the LNG value chain. Bureau Veritas classed the first ever LNG carrier with a dual-fuel propulsion system. Today, 30% of new vessels run on LNG.

2020 2030

Decade of transformation

Intensive research and development will enable the industry to meet society's need for decarbonized shipping. New orders from the mid-2020s will feature new fuel systems and greater use of electrification.

MEETING SOCIETY'S CHANGING NEEDS FOR

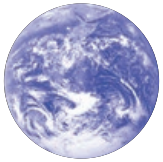
OVER 200 YEARS

With every societal and economic shift, shipping has rapidly evolved to meet new challenges, supported by classification.

Over half a century ago, US astronaut Bill Anders took a photograph that would change our relationship with the world forever. Earthrise, snapped from the Apollo 8 spacecraft as it rounded the dark side of the moon, shows a planet that is overwhelmingly blue.

OUR BLUE PLANET

This single image brings home the fact that over two thirds of the world's surface is covered by water. Life on earth – our life – depends on the ocean, and the crucial role it plays in regulating our climate and atmosphere.



Humanity's relationship with the ocean goes back to its beginnings. For thousands of years, the sea has played a central role in human and economic development by enabling the movement of people, goods and ideas. It mitigates climate change by acting as a heat and carbon sink. But its relationship with humanity is fraught. The sea is a dangerous place, claiming an estimated three million vessels since humans first set sail. It is also fragile, its marine fauna and flora easily damaged by human activity.

As such, the evolution of the modern maritime industry has been closely linked to the development of standards to improve safety and protect the marine environment. This has been the work of classification societies such as Bureau Veritas. Thanks to the rules put in place by classification societies, shipping today is far safer than at the beginning of the industrial revolution, with proportionally fewer lives lost at sea. We have also made strides in reducing marine pollution from the majority of vessels.

These advances are no longer enough. Today the world faces its biggest challenge. To avoid the catastrophic impacts of climate change we must limit global warming to the 1.5° set out in the Paris Agreement by decarbonizing our industrialized economy. Shipping plays a central role: if world trade volumes have increased by a factor of 40 since the middle of the last century[2], it is because shipping has evolved to meet society's demand for goods from around the world. Ships are the lynchpin of global trade's upstream supply chain. As society demands that commodities groups, brands and retailers act responsibly, addressing shipping's environmental impacts will form an increasingly important part of these economic players' sustainability strategies.

1/ Source : UNESCO
2/ Source : WTO

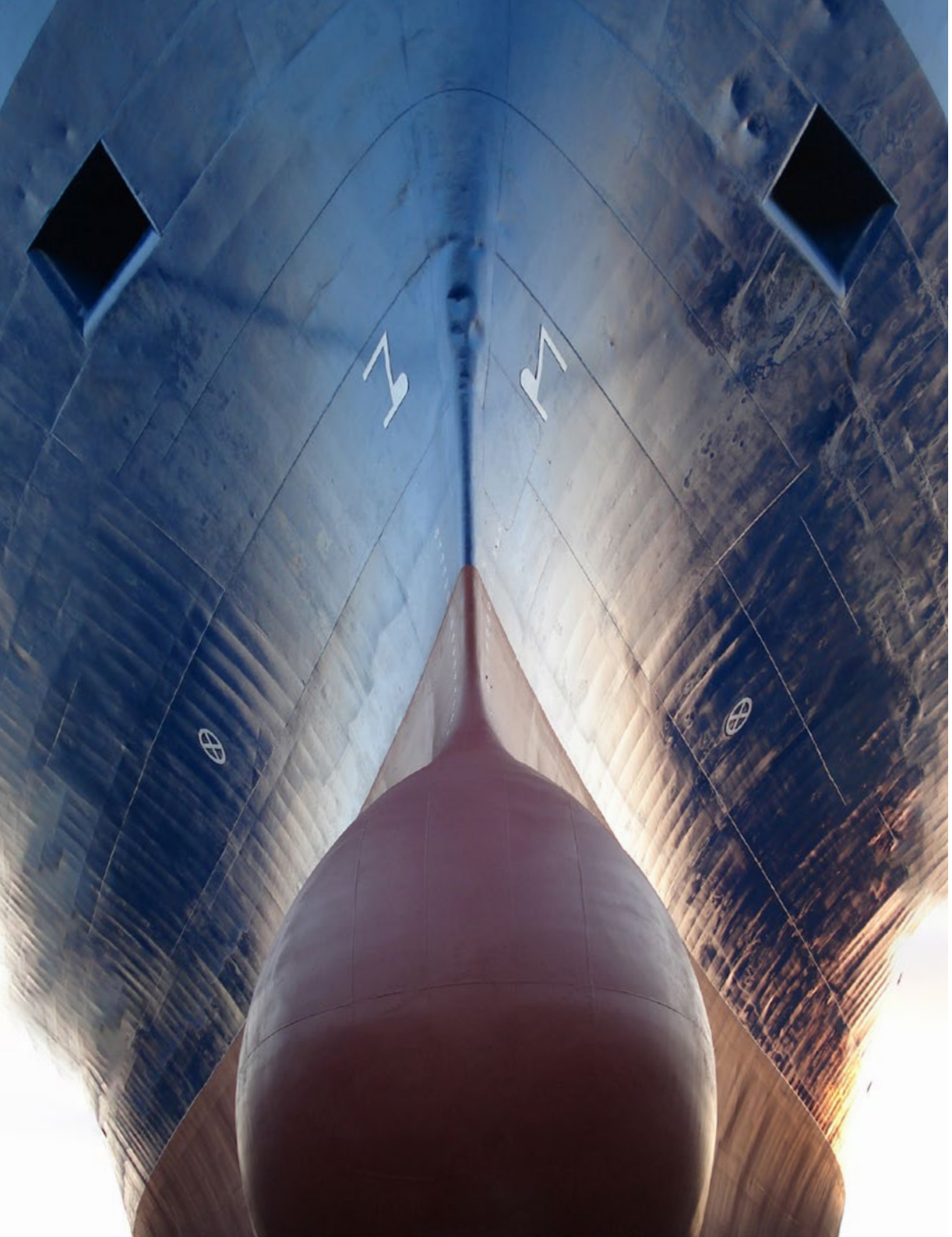
Wide-ranging transformation of the shipping industry has already begun and will significantly accelerate over the next decade and beyond. Decarbonizing shipping will require innovation and development of safe new fuel and propulsion technologies as well as new designs. It will demand the adoption of a circular approach both to sourcing and end-of-life. The important decisions need to be taken now. With assets typically lasting over 25 years, the vessels being designed today will be in use well into the 2040s.

While GHG emissions may be top of mind, shipping's end-customers are looking to improve sustainability in a wider sense. The sea is now recognized as a stakeholder in its own right. Marine biodiversity and the need to protect oceans has become a mainstream news topic. Social issues are also rising up the agenda: the shipping industry employs over one million people directly, and several million more indirectly. This makes seafarer wellbeing and social conditions in maritime supply chains a rising concern, one which was brought to the forefront during the COVID pandemic.

What will be the role of classification in the shipping industry's transformation? It will be more vital than ever before. Thanks to their unique role in bringing maritime actors together and the expertise they bring to bear in developing the standards that make safe innovation possible, classification societies will help shape a better future for the shipping industry, and the wider world.

IT IS OUR ROLE

TO PRESERVE OUR BLUE PLANET FOR FUTURE GENERATIONS



THE ROLE OF CLASSIFICATION SOCIETIES

— To understand what makes classification societies essential to the maritime world, it is useful to imagine what that world would be like if they did not exist.

Imagine the following scenario. A shipowner offers a commodities trader the opportunity to charter a ship that has just left the yard after two years of construction. They reassure the trader that their millions of dollars of cargo will be safe, saying that the ship's design is brand new and state of the art.

Should the trader trust the owner? The answer is probably, "not without better information." That, at least, is the conclusion of most insurance companies, who demand a classification certificate as a condition of insurance.

Classification societies set technical standards used in the construction and operation of ships. Their purpose is to protect life and assets, and to prevent marine pollution. They do this by setting requirements relating largely to the structural strength and integrity of the ship's hull and its appendages, but also to essential systems such as propulsion and steering. Compliance is checked via regular surveys throughout a ship's life.

Classification societies publish their standards as Rules, which all vessels who are classed with that society must follow. They also fulfill their purpose by acting on behalf of Flag Administrations – the countries owners choose to register with – to implement international safety and pollution prevention regulations. Their approval comes in the form of certificates, a currency of trust used between owner, charterer and insurer.

This role as guardian of the sea puts classification societies in a unique position. By way of example, Bureau Veritas classes over 11,000 vessels and represents 140 out of the 150 Flag Administrations. Taken together, classification societies represent around 30,000 highly qualified professionals who bring their knowledge and experience to bear in ship design, construction and operation. They share their knowledge via their Rules, but also in the direct relationships they build with owners and yards. Rules are also enhanced thanks to the experience gained when tackling specific challenges in the design of a new ocean-going vessel.

This collaboration between classification society, owner and yard comes naturally, but sharing of knowledge is also formalized at an industry level via IACS, the International Association of Classification Societies. This non-governmental association is made up of the 12 leading classification societies, including Bureau Veritas as one of its founders. Over 90% of the world's fleet complies with its members' Rules. Its working groups pool knowledge and resources to tackle a wide range of maritime safety issues, ranging from fires onboard containerships to cybersecurity. IACS is the principal technical advisor to the International Maritime Organization and makes contributions at a regional level, for example to the European Union. Pooling the knowledge and expertise of its members, it answers regulators' bold ambitions with technical, practical recommendations that can be put into action on thousands of ships worldwide.

200 YEARS OF TRUST IN MARITIME DEVELOPMENT

The story of classification goes hand in hand with modern economic development. The first classification register was established in the second half of the 18th century. This started the formalization of a system to enable underwriters to understand the risks they were taking when they chose to insure a vessel (see page 20). As the industrial revolution gathered steam and trade flourished around the world, the number and reach of classification societies increased to meet demand for safe, ocean-going ships.

This is no small feat. The past 200 years have witnessed huge economic and societal changes. Shipping has evolved at every step to meet those needs. In the early 1800s, ocean-going vessels were built of wood, powered by wind and took nearly a month to cross the Atlantic. By the end of the century, the wood had been replaced by steel, the sails by a steam engine, and Atlantic crossings had been cut to two weeks. Wealthy people in the United States and Europe were suddenly able to hop between the two continents in relative comfort. Unprecedented quantities of merchandise, from manufactured goods to primary foodstuffs and oil, were crisscrossing the world's seas.

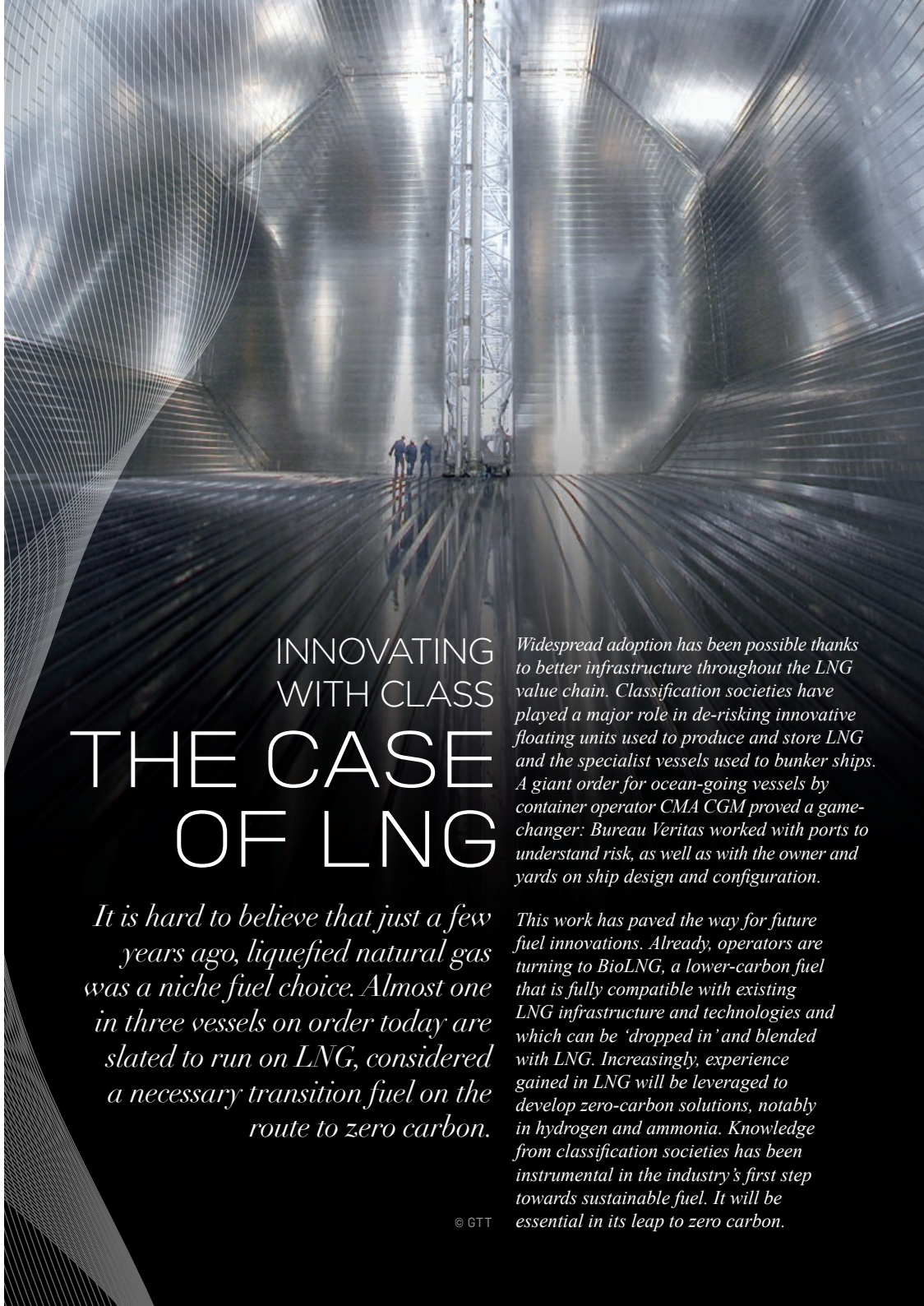
Classification societies supported each societal evolution, energy transition, and shipping innovation with new Rules. In 1886, Bureau Veritas classed the Glückauf, the first ocean-going, steam-powered oil tanker in the world. It was also the first vessel in which oil could be pumped directly into the vessel's hull instead of being loaded in drums. Just under 80 years later, we classed the first ship for the transport of natural gas. Today, as economies transition from fossil fuels to renewable energies, our Rules are used to build the technically advanced service vessels that keep wind farms running efficiently.

Classification also supported the single most important invention that underpins globalization: the container. Before the 1950s, goods were loaded onto ships in sacks, barrels and crates, a process that could take up to three weeks. The idea of transporting goods in standardized boxes enabled each ship to carry more goods, and unload them in under 24 hours. The cost of shipping plummeted and ships grew in size to accommodate thousands of containers. This evolution was made possible by classification societies, who calculated the risks associated with container arrangements and developed dedicated Rules to address them. (Bureau Veritas, in addition, certifies the containers themselves to ensure standardization: around half of new containers manufactured today carry our stamp).

To be credible and trusted in this role, classification societies need to act with ethics, and independence. Whether developing rules applicable to an entire category of vessels, such as container ships, or assessing the designs of breakthrough innovations such as marine renewable energy technologies, our reputation is founded on impartiality.

THE ULTIMATE ROLE OF A CLASSIFICATION SOCIETY IS TO PROVIDE TRUST BETWEEN MARINE STAKEHOLDERS

The ultimate role of a classification society is to provide trust between marine stakeholders. At Bureau Veritas, we shape trust via specific attributes we bring to the table, shown in our logo created nearly 200 years ago (see page 21). Those attributes have never been more relevant than they are today.



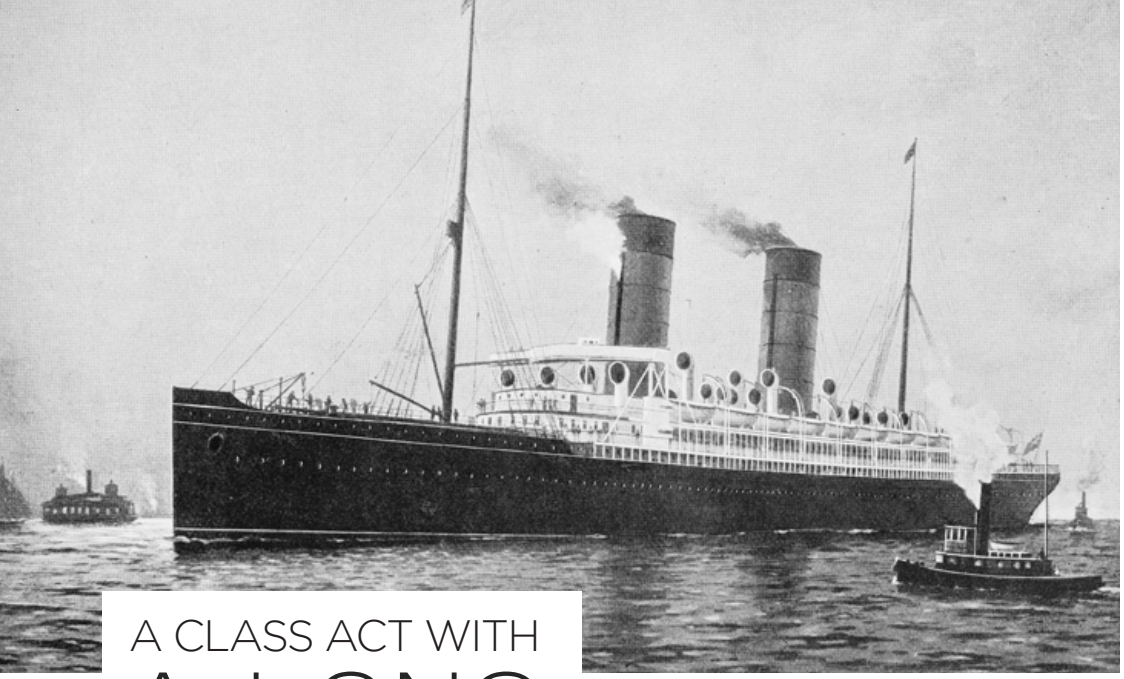
INNOVATING WITH CLASS

THE CASE OF LNG

It is hard to believe that just a few years ago, liquefied natural gas was a niche fuel choice. Almost one in three vessels on order today are slated to run on LNG, considered a necessary transition fuel on the route to zero carbon.

Widespread adoption has been possible thanks to better infrastructure throughout the LNG value chain. Classification societies have played a major role in de-risking innovative floating units used to produce and store LNG and the specialist vessels used to bunker ships. A giant order for ocean-going vessels by container operator CMA CGM proved a game-changer: Bureau Veritas worked with ports to understand risk, as well as with the owner and yards on ship design and configuration.

This work has paved the way for future fuel innovations. Already, operators are turning to BioLNG, a lower-carbon fuel that is fully compatible with existing LNG infrastructure and technologies and which can be 'dropped in' and blended with LNG. Increasingly, experience gained in LNG will be leveraged to develop zero-carbon solutions, notably in hydrogen and ammonia. Knowledge from classification societies has been instrumental in the industry's first step towards sustainable fuel. It will be essential in its leap to zero carbon.



A CLASS ACT WITH A LONG HISTORY

In the second half of the 18th century, merchants, owners and sea captains would gather to swap information, and make deals to share rewards and losses on specific voyages. The issue was that they had no way of knowing the quality or condition of the ships concerned.

The solution was a register that attempted to classify the condition of the hull and equipment. Bureau Veritas was among the first societies to establish a register, in 1828. Initially, ships were graded according to the quality of their construction and current state. Today, this system no longer exists: ships are either in or out of class according to whether they comply with a society's Rules.

Cooperation between the various classification societies began in the early 1930s culminating in the creation of the International Association of Classification Societies (IACS) in 1968. IACS works closely with the International Maritime Organization (IMO), the principal body governing maritime safety and pollution prevention regulations. It provides technical support and guidance, and interprets regulations, which are then applied by classification society members.

Today, the remit of classification societies is far wider than safety and structure. Following the introduction of various IMO regulations, it now includes prevention of pollution – and, increasingly, protection of the planet's fragile biosphere.

THE TRUTH

WITHOUT FEAR OR FAVOR

Bureau Veritas shares something in common with the New York Times: our original motto. Nearly 70 years before the venerable publisher set the standard for newsrooms worldwide, an information bureau for maritime insurers declared its aim "to seek out the truth and tell it without fear or favor".

TODAY

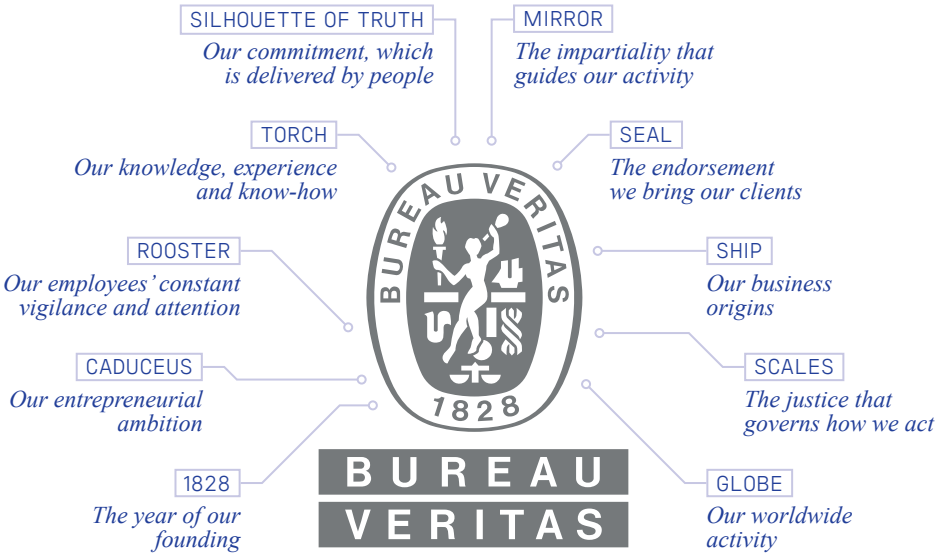
We employ over **80,000 people** worldwide.

We class more than **11,500 ships.**

We are present in **140 countries**

OUR LOGO

continues to reflect our business and values



HOW CLASSIFICATION IS SUPPORTING THE SHIFT TOWARD SUSTAINABILITY

— Classification societies, then, have played and continue to play a central role in safe shipping innovation. Nowhere is this innovation more in demand currently than in the field of sustainability.

Sustainability is often described as a journey, but it might better be characterized as a mountain climb. International organizations set ambitious, science-based, broad-based goals – the summit – which companies and governments commit to reach. They must then work out a detailed route, specific to their own assets, challenges and capabilities, to get there.

When it comes to shipping, owners and operators have their sights set on the UN Sustainable Development Goals. Those relating to Climate Action and Life Below Water are particularly relevant, but IMO has identified links between its work and all the individual SDGs.

IMO's goal-based standards represent most owners' Everest. Current headline targets include slashing annual greenhouse gas (GHG) emissions from international shipping by at least half by 2050[3] and cutting the carbon intensity of all ships by at least 40% by 2030 and 70% by 2050. Net zero is likely to be the next move. This is less of a pleasant stroll uphill, more an ascent of a sheer rock face. It will involve phasing out GHG emissions from shipping entirely as soon as possible. This will demand a rapid acceleration in innovation to replace the diesel fuel propulsion that has dominated marine transport for the past 100 years with a carbon-free alternative. It is the role of Class to provide owners and yards with Rules that translate objectives into concrete ways they can be delivered.

Major advances have been made in identifying and developing the potential of zero-carbon fuels, with ammonia and hydrogen considered leading contenders. The issue is that both come with major safety risks. Hydrogen is both explosive and flammable. Ammonia is highly toxic and caustic, and no safe combustion technology exists as yet. Both fuels also present logistical challenges. They are much larger by volume for each unit of energy than heavy fuel oil meaning that far more space is needed for storage. And as a liquid, hydrogen must be stored using cryogenic technology at temperatures of -253° C.

Technology providers are working hard to find solutions. In the case of hydrogen, they are modifying existing tank designs to improve insulation performance. Fuel cell power systems, which are already common on land, are being reworked for use onboard ships. Meanwhile, engine manufacturers are in the initial stages of developing internal combustion engines that use hydrogen as fuel, with some companies having already built prototypes. In the case of ammonia, the second half of 2021 saw an important step reached with the design of a carrier that uses its own cargo as fuel. Batteries charged from a carbon-free electricity source such as wind or nuclear power can be used for short journeys – but their weight and volume currently make them impractical for long voyages.

3/ Compared to their level in 2008. Source: IMO

ONBOARDING HYDROGEN FOR ZERO-CARBON SHIPPING

As a potentially zero-carbon fuel[4], hydrogen could be the trump card the shipping industry needs to halve greenhouse gas emissions by 2050.

With technology under development, classification and engineering expertise will be key to ensuring green hydrogen-fueled ships can safely grace our seas.

For hydrogen to become an alternative fuel of choice, the industry needs to overcome issues relating to safety and storage design. Hydrogen is highly flammable. It also has a relatively low volumetric density, thus requiring significant onboard storage capacity.

Efforts to upgrade existing technology and develop new capabilities are now at prototype stage. In France, for example, Sogestran is developing hydrogen fuel cells for a passenger ship and cargo vessel, whilst Piriou is testing a hydrogen-fueled dredger.

Before we can harness hydrogen to power shipping at scale, we must first establish regulations and industry standards to guide design, manage risk and secure supply chains. The clock is ticking down to 2050. The work we do now will ensure the safe use of clean fuels for many years to come and forge a greener future for our blue planet.

4/ When sourced from renewable electricity via electrolysis.

TURNING DOWN THE VOLUME IN OUR OCEANS

The ocean was once Jacques Cousteau's "silent world", but for the past 60 years marine noise pollution levels have doubled decade on decade[5]. Responsibility for this increase in underwater radiated noise (URN) lies largely with commercial shipping. The respective high and low frequency sounds of a ship's engine and propellor perturbs marine mammals and fish, interfering with their ability to echolocate, hunt, navigate and detect threats.

5/ Source: European Commission

For the past 60 years, marine noise pollution levels have doubled decade on decade.

The good news for sea creatures is that there are many paths to reducing noise pollution from retrofitted and new vessels. Solutions open to ship owners range from adding acoustic enclosures and widening engine stiffeners to optimizing propeller blade design. Classification societies such as Bureau Veritas play an important role in encouraging uptake of these solutions by recognizing owners' actions via a voluntary URN notation

Classification societies play a critical role in de-risking new projects. They use their expertise in risk and marine engineering to assess new designs, identify issues and provide an independent opinion on the design's soundness. This is known as an Approval in Principal (AiP). In addition to the recent AiP for the ammonia carrier, Bureau Veritas has issued AiPs relating to gas containment systems, bunker barges, floating wind turbines and various promising marine renewable energy technologies.

These types of certificates are often the precursor to technology entering the mainstream. They demonstrate confidence from a respected third party that a technology is safe. In doing so, they can open access to further funding and commercialization.

Classification societies also contribute to innovation in sustainability through their involvement in industry groups that bring together shipyards, engine designers, energy majors and more. This way of working is highly valuable as many of the projects developed are years away from becoming commercially viable. Recent or ongoing joint industrial projects involving Bureau Veritas include a project to design, build and test a zero-carbon engine room. Another focuses on ship-based carbon capture. Future projects could explore the use of nuclear power – already used onboard some naval vessels – in commercial shipping.

The decarbonization challenge also demonstrates the need for agility. For a century, the world used heavy fuel oil. In the past decade, this has started to be replaced by LNG. Now, new fuels offering lower-carbon options and zero carbon alternatives are being considered. Innovation has never been so rapid. De-risking these solutions requires experienced classification societies, able to apply expertise gained in shipping, energy or other industries to an entirely new area, and bring the agile solutions the industry needs.

SUSTAINABILITY: THIS TIME IT'S DIFFERENT

Shipping has been through many evolutions. What is different this time is that its operations are under scrutiny by powerful downstream economic actors. They themselves are under pressure from regulators and consumers, who consider ships part of their supply chain.

This new dynamic forces action on topics that do not make immediate economic sense for ship owners, even if they can be beneficial in the long run. Circular economy considerations, for example, can feel somewhat abstract when assets have a 30-year lifespan. Yet owners today are starting to think about sustainable materials sourcing and planning for end of life. This includes a social dimension, as current conditions for workers dismantling ships are often abysmal.

Operational excellence is no longer just a synonym for cost-cutting: instead, operators are targeting just-in-time models that cut asset downtime and improve fuel efficiency. They are talking proactively about how to protect marine fauna and biodiversity by eliminating the plastic pollution caused by ghost nets, or taking voluntary measures to reduce noise pollution. Finally, a real conversation on the social and living conditions of crew – a topic which came to the fore during the pandemic as seafarers were stranded around the world – has begun.

Bureau Veritas is supporting owners and yards on all these topics. The baseline is environmental compliance – ensuring that ships classed with us follow international regulations relating to pollution (MARPOL) and data collection and monitoring on emissions (EEDI, EEXI, CII). Beyond this, we offer voluntary notations. These are standards vessels can choose to adopt to improve their environmental or social performance. Our Sustainable Ship notations recognize efforts to prevent pollution, reduce emissions, protect marine ecosystems, prepare for ship recycling and enhance wellbeing onboard. Our ultra-low emission vessels notation demonstrates that owners have gone the extra mile in cutting air pollution by fitting advanced air emission control technology onboard. And our Underwater Radiated Noise (URN) notation tackles noise pollution that hinders sea mammals' ability to communicate, hunt, migrate and echolocate (see pg 26).

One area on which classification societies have been relatively quiet until now is social sustainability. This is not to minimize our role – the Marine Labour Convention audits we carry out play an important role in protecting seafarers' working and living conditions, and many owners also request health and safety certification for their vessels. But the uncomfortable truth is that working conditions in the marine industry sometimes fall woefully short. If unclassed fishing vessels and unregulated shipyards are the worst offenders, the conditions onboard some classed vessels have room for improvement.

It was not the role of a classification society to demand that the industry tackle topics that are not directly related to its core mission of safety and environmental protection. We are trusted partners, there to inform and support, not sanction. However, the unique expertise and experience of classification societies make us well placed to help owners address new demands imposed by its downstream customers. The scope of classification is not set in stone. It is less than half a century ago that environmental protection became part of our core activity. Perhaps it is now time to add a much-needed social dimension to our work. In doing so, we can provide a concrete, tried-and-trusted approach to helping owners reach their new goals.

THE FUTURE OF SHIPPING IS DIGITAL

— At the dawn of the shipping era, technology was synonymous with nature. To navigate the seas, sailors followed constellations and planets from port to port. To predict the weather, they interpreted the colors of the sunrise and sunset.

Today, technology is synonymous with data. The rapid development of onboard digital systems has hugely increased the amount of ship data available. Modern vessels generate over 20 GB of data daily – the equivalent of streaming 16 feature films or 4,000 songs. Meanwhile, the ongoing work of classification societies has produced a vast corpus of shipping information. This knowledge is now going digital, with naval engineers and marine experts feeding their hard-earned expertise into databases.

Thanks to technological advances, the marine industry can now combine data from onboard systems and classification societies. Shipowners are already using this aggregated data to improve operational performance, address regulatory requirements and minimize environmental impact. And the applications for marine digitalization go well beyond this.

For classification societies, digitalization provides an opportunity to enhance valuable services. Classification societies have a long history of adapting to industry needs, developing new technical and safety requirements for changing times. By leveraging digitalization, classification experts today can continue this legacy, quickly developing safer, more relevant Rules. This flexibility and responsiveness will be crucial to those looking to support the next wave of marine innovation.

Advances in software are also reshaping how marine industry players manage the ship lifecycle, starting at the design phase. Using innovative modeling technologies, shipyards can develop fully digital, three-dimensional models of vessels. For classification societies, this means increased efficiency. Instead of mailing 2D plans back and forth, experts can perform digital classification assessing the 3D version of a ship via a collaborative, virtual platform. Thanks to our state-of-the-art in-house software, Bureau Veritas can already offer digital classification for 3D models of all kinds.

Moving into the operational phase, digitalization is making it easier for shipowners to monitor their fleets. A wave of web and mobile applications is enabling ship managers to digitally plan surveys, manage assets and access documentation. The same software that monitors a person's heartrate during a morning run or locates the nearest Italian restaurant is now available for ships. Want to track your vessel's fuel consumption? There's an app for that. Looking for a port for your next survey? There's an app for that as well.

Of course, these applications do not exist simply for technology's sake. At Bureau Veritas, we approach application development where there is a clear client need. Digital tools like Optimum Survey Planning and Veristar Project Management were designed to address everyday ship management challenges. And when we build new applications, our goal is to respond to evolving client needs. For example, our latest application, Veristar Green, is a direct answer to recent legislation surrounding emissions monitoring.[6]

ENTER THE ROBOTS – AND THE HACKERS

Beyond digital applications, in-service ships are reaping the benefits of Remote Inspection Techniques (RIT). Marine surveyors are putting robots – including underwater drones, remotely operated vehicles and crawlers – to work during surveys. Contrary to the vision of science fiction writers, the robots behind remote inspection are both safe and indispensable. By taking difficult-to-capture measurements and retrieving close-up photos, they can improve efficiency and limit survey costs. By entering high, narrow and water-filled spaces onboard, they protect marine surveyors. While such techniques are currently limited to specific regulatory contexts, the industry is looking to expand their use.

The marine surveyor experience will further transform with the development of augmented and predictive surveys. This approach combines big data, Artificial Intelligence (AI) and pattern-recognition software to detect problems in advance. First, software collects data from a ship, creating a complete asset history and evaluating current vessel condition. This data is then compared against a 3D model and databases containing information about ship condition. Based on this, AI will be able to flag problems like corrosion and plate weakening before they occur. And surveyors will be able to board ships safely, armed with a targeted inspection plan.

6/ EEXI and CII regulations, adopted by IMO in June 2021.

Protecting surveyors, however, is only one element of securing the shipping sector. As ships have become more connected, the risk of cyberattacks has grown. Hackers are now targeting in-service vessels with ransomware, malware and phishing attacks. When successful, these incidents cost shipowners time and money.

To help shipowners manage these threats, classification societies are building expertise in data and systems security. As of 2021, cyber security has become a mandatory aspect of ship safety for both existing and new ships. Classification societies have been working steadily with shipowners and shipyards to help them meet this new requirement. Bureau Veritas has notably developed a comprehensive approach to cyber security that enables shipowners to identify and secure vulnerable systems.

SHIPPING GETS SMART

This will become an increasing industry focus as the maritime industry trends toward heavier reliance on connected systems. The next major leap in connectivity that shipowners are eyeing is the development of smart and autonomous ships. These vessels can perform some or all tasks without onboard human intervention. Think of them as the floating version of self-driving cars or trains.

Classification societies are already playing a vital role in the development of these vessels. First, compliance experts are developing guidelines for the digital systems that regulate ship speed and routing, ensuring they arrive at port on time. Second, risk management specialists are building a comprehensive approach to limiting risk for smart and autonomous vessels. Their goal is to improve onboard safety and prevent accidents in risky environments.

NEW ROLES WILL BE CREATED IN SMART SHIPPING AND CYBER SECURITY, INCREASING DIVERSITY IN THE MARINE INDUSTRY

Autonomous vessels will need to interact with smart ports. These digitally-equipped harbors will use big data, AI and IoT systems to safely and efficiently maneuver ships in and out of port.

Still, just as digitalization cannot replace classification services, smart ports and autonomous vessels are no substitute for experienced crewmembers. Personnel will work onboard for the foreseeable future, guiding and improving fledgling technologies for smart and autonomous ships. When ships eventually reach full autonomy, crew will move to performing valuable roles onshore, ensuring vessels function properly.

While some roles in shipping will be transformed, others will be created. Both smart shipping and cybersecurity broaden the professional purview of the marine industry. Classification societies will always prize naval engineers and architects, but cybersecurity specialists, AI developers and robotics experts will soon become invaluable. This will swell the ranks of classification societies and bring more diverse profiles to the marine industry.

Finally, digitalization will help improve marine sustainability. New technologies, digital systems and production processes can all help minimize ships' environmental impact. Additive manufacturing – the process of creating 3D objects through layering materials – is a good example of this (see page 36). This production method enables ship parts to be 3D printed locally and as needed. For shipyards and shipowners, this means reducing waste from construction and maintenance, and limiting emissions-heavy logistics activities.

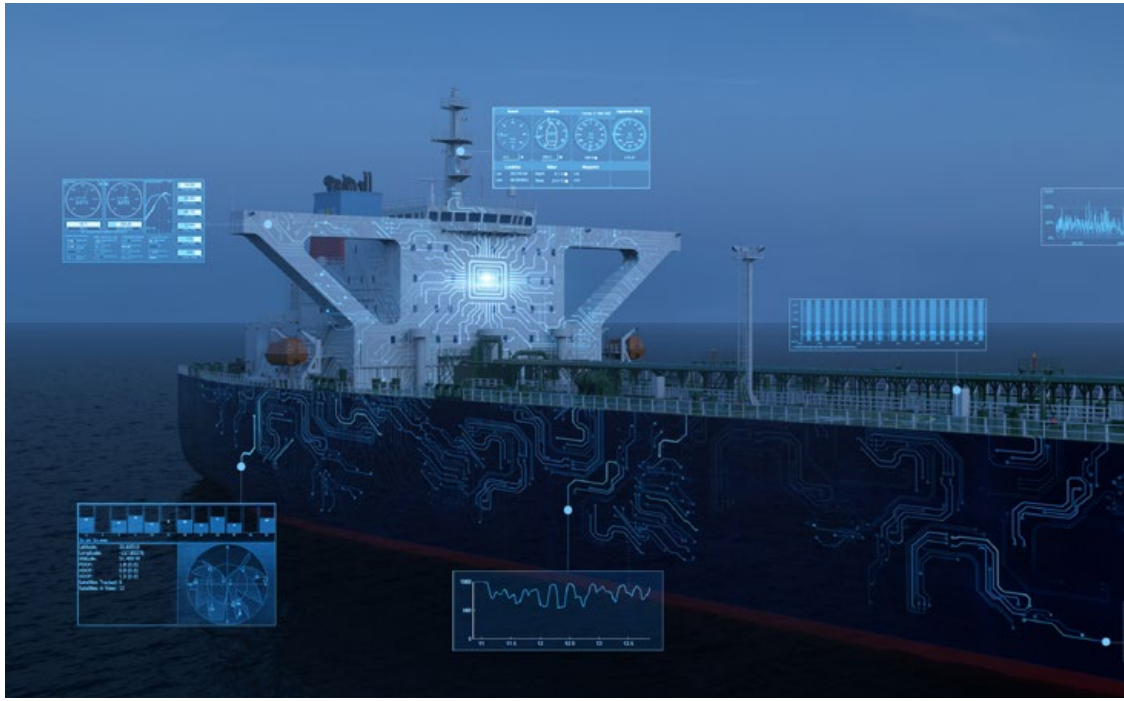
HOW NEW TECHNOLOGIES WILL REVOLUTIONIZE THE SHIPPING INDUSTRY

THE SECOND PRINTING REVOLUTION

Although a eureka moment makes for a good story, most breakthroughs are not so fleetingly accomplished. If additive manufacturing is making inroads into shipping manufacture, widespread acceptance requires trust in the technology.

Additive manufacturing – commonly known as 3D printing – significantly cuts material usage and energy consumption compared to traditional methods. An Approval in Principle from a trusted third party can further boost its appeal to manufacturers. Bureau Veritas supported French defense contractor Naval Group from design to completion in producing a new generation of 3D printed propeller. It is the first to be produced to military quality, requiring rigorous development, inspection and testing throughout.

Elsewhere, additive manufacturing is being used to make spare parts inventory more efficient, as suitable components can be printed onboard as needed. In this case, third party experts can help to select and test the parts to be printed, and thus charge the way vessels are built and maintained.



MAKING SENSE OF DATA

Artificial intelligence in shipping is not new. For several years now, machine learning algorithms have enabled owners to analyze data and predict the need for maintenance, thereby avoiding unacceptable risk – or unnecessary downtime.

But today, AI is coming into its own. The demands of the energy transition are focusing owners' and operators' attention on energy efficiency. AI algorithms spot patterns in consumption data collected by sensors, and help operators visualize data, run simulations and help optimize energy use onboard. Thanks to advanced simulations that take into account parameters such as the weather, operators can choose alternative routes that burn less fuel. Looking ahead, AI models will act as the eyes onboard autonomous vessels, used to detect other vessels or objects in the water and avoid collision.

AI is only as good as the data that feeds it. It needs to be trained, tested and evaluated by human experts – then trained again, once more data is available. All this means that experts will continue to work hand-in-hand with AI. The future is efficient – and human.

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THE FUTURE OF MARITIME

— Our industry is facing systemic transformation. This is no longer just about ships. A fair transition to a more sustainable maritime world encompasses the energy and port infrastructure that support them, the economy they serve, the people who sail them – and the sea itself.

Shipping is increasingly visible to its end customers, who are seeking greater transparency on its environmental impact. Shipping represents a largely irreplaceable step in complex supply chains. All impacts, from air and water pollution through to working conditions onboard ships, the materials used in ship construction, and how vessels are dismantled at end of life, are increasingly scrutinized and, potentially, regulated.

Wider trends in society are mirrored in shipping companies' boardrooms. Owners are talking about designing flexibly and for the long-term. They need new, more diverse talent – and are starting to hire it. The sea itself is increasingly seen as a stakeholder, to be protected for future generations.

Already, things are changing more rapidly than almost any of us could have anticipated. Owners and operators face important questions.

QUESTIONS

FOR A SAFE LOW-CARBON FUTURE

The future will be characterized by multiple fuel and propulsion options. Both the industry and individual owners need to consider some key questions to enable informed choices.

HOW CAN I...

Scale up my efforts?

Demonstrate my sustainability efforts?

Design my vessel flexibly to accommodate a future zero-carbon fuel?

Build a hull that will last more than 25 years and be retrofit-optimized?

WHAT WILL **MY SHIPS TRANSPORT?**

What will be my customers' expectations?

WHAT **NEW PORT INFRASTRUCTURE** IS REQUIRED?

WHAT CAN I DO NOW?

What are my options today to improve performance?

How far am I ready to commit?

What are the pros and cons of options available today? Will they remain suitable in 5, 10 or 15 years?

HOW SAFE ARE FUTURE FUEL SUPPLY CHAINS AND OPERATIONS?

What are their characteristics, safety issues and associated risks?

How will different fuels perform?

What are their environmental impacts?

What are the alternatives to fuel? Should I consider wind-assisted propulsion? What about electric-hybrid?

WHAT CAN I EXPECT FROM **POLICY MAKERS** OVER THE COMING YEARS?

WHAT DOES IT MEAN FOR **MY PEOPLE?**

What talent do I need to hire?

DECARBONIZATION: TOMORROW STARTS NOW

Propulsion is a case in point. For nearly five thousand years, ships harnessed the power of the wind. History began to speed up in the 19th century with the introduction of the steamship. Massive growth in demand for seaborne trade in the second half of the 20th century was dominated by the diesel engine. In the early years of the 21st century, LNG was adopted as a new clean fuel, and is increasingly considered mainstream. Now owners are exploring new options.

The role of class has mirrored this trajectory. During most of the past two centuries, class has been heavily focused on the structural safety of ships. In the middle of the 20th century, that role expanded to include pollution. When the challenge of addressing harmful local air emissions such as sulfur and nitrogen oxides and particulates rose to the forefront, the scope of classification societies further evolved. Class has played a major role in transferring knowledge accumulated in addressing the risks in the carriage of LNG to gas-fueled shipping. That knowledge will be vital now as the industry responds to the challenge of global warming, exploring new solutions in the quest to reach zero-carbon fuels.

But a safe zero-carbon future will be about much, much more than fuels and propulsion. We will see new cargoes, new trade routes, and a greater focus on systems. This will be combined with demand for new skills and multiple propulsion technologies.

This represents a radical change from the past. And we must be ready to be surprised by where technology and societal changes may take us.

In a safe zero-carbon future, the maritime world will gain in prominence. The shipping industry will increasingly need to be the guardian of the ocean. At the same time, shipping will form the backbone of low carbon transportation. One of the biggest consequences of putting a price on carbon will be to highlight the efficiency of shipping for cargo transportation. When looking at net environmental benefits in agriculture, energy or manufacturing, shipping will play an ever more important role in connecting low-carbon centers of production with markets. Carbon-conscious end-users may actively choose shipping over aviation where practical.

CLASSIFICATION WILL BRIDGE THE REGULATORY GAP WITH GUIDELINES, AND BUILD CONFIDENCE WHERE THERE IS UNCERTAINTY

But the stakes for owners, designers and yards are high. Reaching the ‘right’ decarbonization solutions for maritime activity, trade and transportation means betting on new technology, and understanding its performance, risks, and operational constraints. This new future also has profound implications for energy providers and ports. It has taken 15 years to build the value chain necessary to supply just one fuel, LNG. The reliable and safe supply of multiple fuels and power solutions, to multiple types of vessels in ports worldwide will now need to be designed and constructed even faster than this.

To reach the answers, we need to ask the right questions (see pg 40-41). The optimum solution for each owner, operator, shipyard, port or cargo company will depend on multiple factors, ranging from vessel size and type to anticipated routes, sea conditions and client demands in terms of speed, flexibility and sustainability ambitions. It will be used in combination with digital, AI-driven solutions to achieve maximum efficiency. Some questions – such as how to create reliable infrastructure in the right locations – can only be tackled at industry level.

We will also need to develop new multi-party contractual relationships to ensure that reducing the carbon intensity of shipping becomes a shared adventure with mutual or positive sum benefits.

It is here that classification societies will come into their own. In addition to leveraging our expertise to support agile, safe development of zero-carbon maritime, we will be providing the pathway and confidence necessary to answer the key questions emerging – as well as bringing forward new solutions based on our experience in supporting value chains and in advancing smart solutions.

SHAPING A BETTER MARITIME WORLD

The smart, low-carbon, low-impact ships of the future may be radically different from the vessels in operation today. What does this mean for class? Ultimately a safe low-carbon world will mean fewer big ships carrying fossil fuels and more new ships carrying clean fuels. Meanwhile, ever-more sophisticated ships will become a new normal supporting new trades and new requirements.

Classification in the future will be even more important than it is today. We have solid foundations, we have the expertise and we know and understand the shipping eco-system. We act as a catalyst for innovation, helping the industry make the right decisions by assessing risks. This is how we will continue to bring value to the maritime world.

Classification has a crucial role to play as the maritime world enters a new era in which sustainability concerns have moved firmly center stage. At their most basic level, sustainability and safety are really about the same thing: protecting resources and people. As IMO further develops the requirements of MARPOL, the leading class societies, via IACS, will work to find pragmatic solutions on how to implement the new standards and harmonize them across the industry.

Classification can also support the industry's environmental ambitions and help it move faster by de-risking new innovations. We cannot expect stakeholders to slow down now: customers and governments are driving change and are moving at different speeds. This inevitably challenges the ideal of a globally regulated landscape – global regulation will be playing catch-up for now. But class will provide the confidence in this time of transition and multi-track development.

The role for Bureau Veritas is even wider: as the only classification society with a strong presence and expertise throughout the value chain of world trade. We test, inspect and certify commodities and manufactured goods, process and systems from the farm gate to your dinner plate, or from the mine to the factory gate and into retail.

As such, we are uniquely placed to measure progress and bring trust to entire supply chains. We bring a holistic view to our classification clients thanks to our knowledge and understanding from both upstream (in the form of commodities, energy and infrastructure) and downstream (in the form of consumer goods). Thanks to our commitment at group level, we are able to support clients to achieve all their environmental, social and governance (ESG) objectives. We are able to help our clients adopt an approach to sustainability that considers the entire life and impact of each vessel.

Our role has evolved since our inception, but its essence remains the same: to bring our years of experience and expertise to ask and answer searching questions, working with the industry to find solutions that work today and are ready for the future. We are proud of the role we have played for almost 200 years. We are looking forward to the contribution we will make for decades to come.

CLASS HAS ACTED AS A CATALYST FOR CHANGE IN THE PAST
IT HAS THE CAPACITY TO DO SO AGAIN

AN INDUSTRY IN TRANSITION

AN INDUSTRY IN TRANSITION

A. Power generated from renewables is expected to significantly increase, with wind power forecast to more than double in the decade to 2030.[7] Here, we see floating wind turbines with over 15MW capacity installed at depths of up to 60 meters serviced by electric wind farm vessels 1.

B. Carbon capture contributes to efforts by process industries to reach net zero, by removing emissions that are challenging to avoid. Here, CO_2 from an internal combustion plant is captured using filters and stored in liquid form in tanks 2. It is then transported 3 to a CO_2 terminal located on a repurposed rig 4, now used to inject CO_2 into disused oil and gas wells.

C. Natural gas is expected to be a fuel of choice during the transition, with synthetic methane and BioLNG increasingly dropped in and blended with LNG. Here, LNG produced at an FLNG 5 is transported to the LNG terminal, where it is stored in tanks.

D. Industry experts anticipate that an ageing population and growing middle class will continue to boost cruise industry growth. Here we see an LNG-powered mega-cruise ship 6 designed to reduce underwater radiated noise; onboard, zero-plastic and waste reuse programs limit its environmental impact.

E. The ship at this container terminal 7 is 40% larger than those in use today, reflecting a continuation of the trend for ever-larger ships. Shore power from a decarbonized electricity source cuts emissions while in port.

F. Decommissioning of oil and gas platforms is expected to ramp up with nearly 3,000 platforms worldwide decommissioned in the decade to 2030. Non-harmful structures can be left on the seabed to become an artificial reef colonized by marine life 8.

7/ Source: IEA

G. Hydrogen is key to manage wind intermittency, by combining renewable energy with energy storage. When the wind is active, turbines produce electricity that is delivered directly to the consumer. Excess power is used to create hydrogen from seawater via a process of electrolysis 9. The hydrogen is stored in pressured tanks on the seabed 10, then converted back into electricity during periods of low wind to satisfy demand.

H. Responsible tourism features electric boats and submarines 11 to observe replenished marine life.

I. Wind-assisted technology 12 significantly lowers emissions from smart vessels running on LNG and increases the cost efficiency of ammonia-fueled ships. Route optimization software enables vessels to use the most energy-efficient route.

J. Next to the port, a renewables yard fabricates wind turbines, which are lifted onto a heavy transport ship by electric harbor cranes 13.

K. Retrofitting at this yard enables owners to improve existing assets. This bulk carrier 14 is being fitted with better living quarters, improved climatization, wind-assisted technology and a bulbous bow to improve energy efficiency.

L. An additive manufacturing facility minimizes the cost and emissions of bespoke retrofit parts. It generates its own energy from solar panels on the roof 15.

M. Shallow waters with fast tidal streams are ideal for generating marine renewable energy 16.

N. Vessels such as this autonomous electric-powered gobbler boat 17 help clean the oceans of plastic waste, which in 2021 accounts for 85% of total marine waste.

O. Bottom-based geodesic domes 18 support sustainable fish farming. Fish are fed, looked after and harvested by robotic shepherd submarines.

P. The world of low-carbon energy is supported by new infrastructure, including an LNG export mega-pipeline and an electricity super-connector 19.

THERE IS A REAL URGENCY AROUND DECARBONIZATION.

Ships have a lifespan of 20 years or more: vessels ordered in 2030 need to be 2050-proof. That means we need to carry out the analysis required to make the right fuel choices in the next few years. A cross-sectoral, lifecycle approach involving both the maritime and power sectors will be critical. We are not expecting to see one single solution, but multiple.

Decarbonization is also an economic question. Since the birth of capitalism, the environment has not been taken into account. That is changing with the introduction of market-based mechanisms, and it will have a fundamental impact on how we consider ships.

HING **CHAO**

CHAIRMAN,
WAH KWONG MARITIME
TRANSPORT HOLDINGS

THE COHESIVENESS OF THE MARITIME INDUSTRY WILL GROW IN STRENGTH AND ENABLE US TO BUILD A STRONG FUTURE ECONOMY.

Despite disrupting global supply chains via seaborne trade, the pandemic has catalyzed transformation, namely through digitalization and decarbonization. Port authorities have a major role to play in these areas. Broad-based restructuring must be enabled to create a seamless cross-border digital network, and cohesive partnerships such as the Global Centre for Maritime Decarbonisation will be key in driving the decarbonization of international shipping. The maritime industry's versatility and resilience will continue to see us through any challenges in the future as we remain on course to establish Singapore as a Global Maritime Hub.

LEY HOON **QUAH**

CHIEF EXECUTIVE,
MARITIME & PORT
AUTHORITY OF SINGAPORE

“AS AN INDUSTRY, WE ARE MOVING RAPIDLY INTO A DIFFERENT MODUS OPERANDI.

Technological advances and digitalization of operations are undoubtedly key to reducing our environmental footprint. Most importantly though, reaching viable carbon zero emitting vessels requires brave decisions and collaboration.

The entire maritime supply chain – including but not limited to shipping, cargo, finance, ports, fuel producers /suppliers, engine manufacturers, shipyards and infrastructure – has to work together to ensure the equitable decarbonization of our industry. In doing so we will set a level playing field and pave acompetitive and sustainable way ahead for all involved. It is part of a new way of working, one that is necessary to bring about rapid transformation.

SEMIRAMIS **PALIOU**

CHIEF EXECUTIVE OFFICER,
DIANA SHIPPING INC.

CLIMATE CHANGE WILL DRIVE NEW BUSINESS MODELS, COLLABORATION – AND FAR GREATER TRANSPARENCY.

The start of this decade was a tipping point, when shipping realized decarbonization was for real. As regulators tightened scrutiny, the carbon reduction interests of the industry's customers, financiers and investors started to converge around a clean and transparent industry.

The energy transition will combine with today's digital age to change far more than just fuel. It will trigger an era-defining shift in strategy and business models, with collaborative relationships at its heart. Only in that way can shipping solve the looming conundrum of high priced zero carbon fuel and efficient zero-carbon shipping.”

JULIAN **BRAY**

EDITOR-IN-CHIEF
AT TRADEWINDS

With all my thanks to the people at Bureau Veritas and our clients, who inspired and contributed to this book.

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