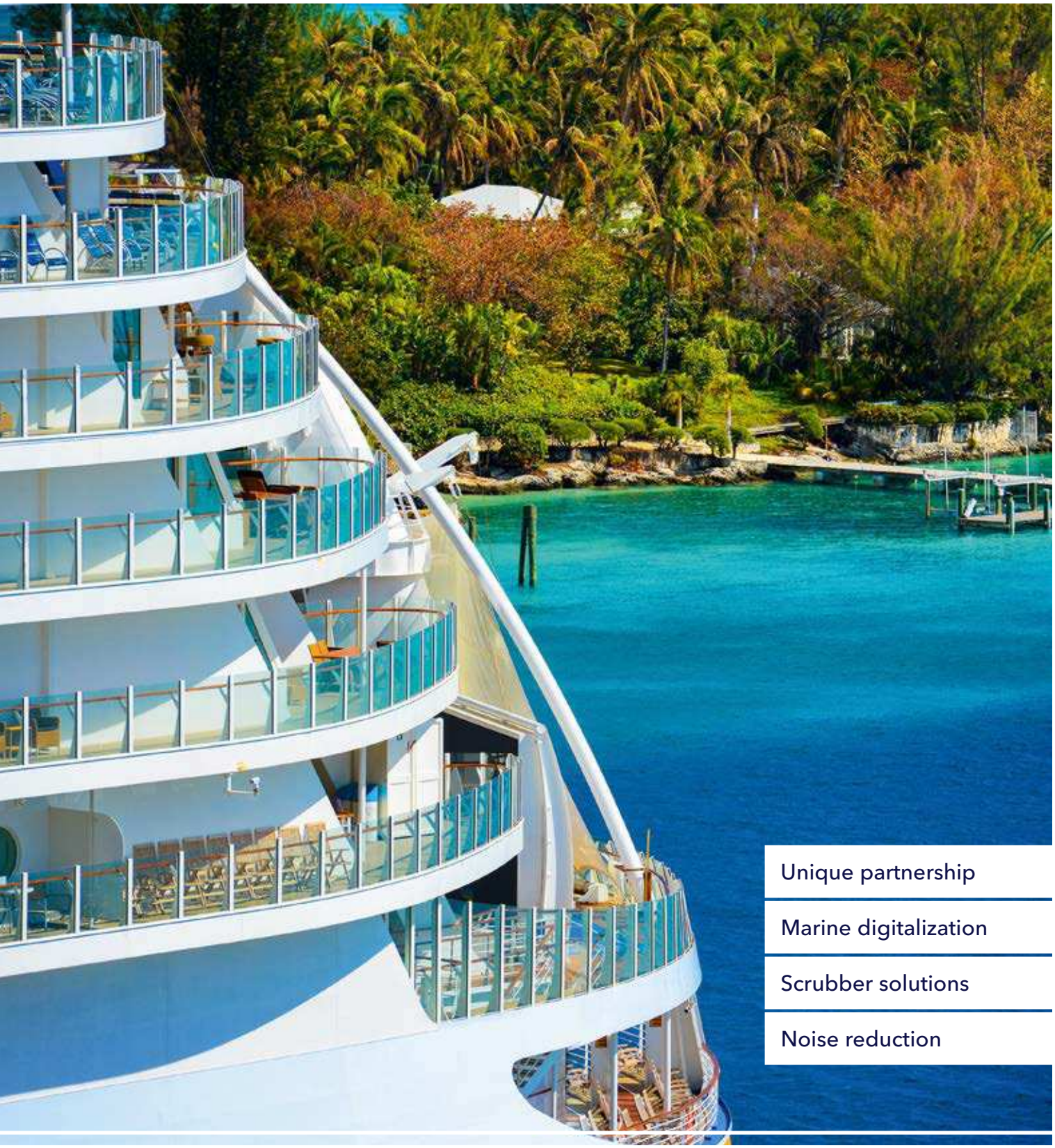
DNV·GL

CRUISE UPDATE

2017



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Cover photo: Costin79/Dreamstime.com

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DEAR READER,

The cruise industry promises to set new records once again this year, growing at an unprecedented rate, with many new vessels being commissioned or planned. Cruise operators around the world are successful because they offer unique holiday experiences and good value for money. This is driven by innovative on-board technology and services and cruise concepts.

The maritime industry is cyclical in nature. Some analysts argue that the cruise segment cannot possibly continue growing at this rate. We disagree: the cruise business does not follow the same logic as the traditional commodity segments. It is a very small part of the leisure market; the key to future growth, potentially at even higher rates, is its ability to grow its share in this market. DNV GL sees good reason to be optimistic.

Over the past year we have seen a revitalization driven by the expedition cruises segment. New vessels are being ordered, and there are some fantastic new designs which are likely to change the market dramatically.

As we see it, three factors will determine the future success of our industry: innovation, safety and environmental performance. As a leading classification society for the cruise industry, DNV GL remains committed to supporting this sector by encouraging innovation, driving safety, and accounting for future environmental requirements, whether they are driven by regulations or the market.

Bill Gates once said: "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction."

Of course this statement originally referred to the IT sector, but we believe it is equally indicative of our own industry: while we are able to anticipate the next round of innovations, our segment is sure to undergo major changes over the next decade which are much harder to predict – new ideas and concepts developed by suppliers, yards or classification. We are continuously challenged to rethink our ways of working and find new and better solutions. The only thing we can be certain about is that today's performance will not be good enough in tomorrow's business environment.

Enjoy the read!

CRUISE UPDATE

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Four Wärtsilä diesel engines power *AIDAaura* and generate electricity for the on-board grid.

COMMON GROUND

In a unique strategic partnership, Carnival Corporation, the world's largest cruise operator, has teamed up with the world's largest cruise ship life cycle solution and equipment provider, Wärtsilä, to enhance engine reliability and efficiency as well as cut maintenance costs.

They came from opposite ends: retired Vice Admiral Bill Burke, now Chief Maritime Officer (CMO) for Carnival Corporation, spent most of his life in the U.S. Navy in charge of submarines; and Scotsman Fraser Scott, Head of 4 Stroke Sales AMER at Wärtsilä, was an aviation engineer for many years. They literally met in the middle – in surface shipping. Their respective employers, Carnival Corporation and ship life cycle solution and equipment provider Wärtsilä, were locked in legal litigation because of maintenance matters. When Burke, and Scott first met a few years ago to help find a way out of their companies' disagreements, they quickly discovered there was more common ground than anyone had anticipated. "Both sides were motivated to change their behaviour," says Burke, who brought up performance-based logistics (PBL) as a basis for a new approach. When Fraser contributed several concepts from aviation, both parties began to think of the situation as a mutually beneficial strategic opportunity.

Today, after 20 months of negotiations, Burke and Scott have become a strong team. Their innovative 12-year strategic agreement for performance-based engine maintenance will take effect on 1 April 2017. "I am so emotionally invested in this deal with Carnival," says Scott. The complex agreement, comprising 100 pages plus several hundred more of schedules and attachments, breaks new ground in the shipping industry, establishing an innovative form of collaboration between ship operators and equipment manufacturers that may eventually revolutionize the maritime sector as a whole.

A fresh approach

"Carnival used to have a transaction-based relationship with Wärtsilä," explains CMO Burke. When an engine or component failed, Wärtsilä sold them the parts and services required for repairing the damage. "In a sense this arrangement worked in favour of the engine supplier: every time there was an engine problem the OEM was able to make another sale. This was the wrong kind of incentive, and it was not in Carnival's best interest." Burke had become acquainted with the PBL maintenance delivery model

Photos: AIDA Cruises, Carnival Corporation & plc, DNV GL, Wärtsilä

"Our potential savings in fuel costs are counted in tens of millions of dollars per year. In addition, the deal with Wärtsilä increases reliability and safety – these are very critical factors in the competitive, fast-growing cruise market."

Bill Burke, Chief Maritime Officer, Carnival Corporation

Medium-speed engines from Wärtsilä are the workhorses on board many cruise ships.

during his time in the U.S. Navy. Scott, on the other hand, was familiar with similar arrangements in the aviation industry. The gist of the new cooperation between the parties is the concept of sharing both the burden and the benefits of keeping ship machinery operational through condition monitoring and dynamic, proactive maintenance.

The agreement lowers the long-term maintenance costs for Carnival, while incentivizing Wärtsilä to address potential technical issues proactively by making appropriate changes to its engineering, manufacturing or stock-keeping practices. Wärtsilä's investment costs are offset by Carnival sharing the fuel cost savings with the engine manufacturer. "Our arrangement essentially aligns both parties' capital expenditures," says Scott, "and both sides will be more satisfied with the outcome."

Big data reveals optimization potential

All engine maintenance and monitoring work for roughly 400 engines on board 79 of Carnival's vessels will be handled by Wärtsilä. The company will provide its dynamic maintenance planning (DMP) and condition-based maintenance (CBM) services to Carnival's ships. The key element enabling performance-based logistics is Wärtsilä's advanced data collection and >

BILL BURKE

Vice Admiral (ret). Burke joined Carnival Corporation & plc in December 2013 as Chief Maritime Officer of Corporate Maritime Operations. He is responsible for leading the company's commitment to health, environment, safety, security and sustainability.

He served on five U.S. Navy submarines. During that time, Burke acted as commander of the *USS Toledo* (SSN 769) and head the Submarine Squadron II.

FRASER SCOTT

Fraser Scott, Head of 4 Stroke Sales AMER at Wärtsilä Services, is an engineer with extensive experience in the design, service and management of complex engineering solutions in the aviation, marine and offshore industries.

In recent years, he has concentrated on marine propulsion and power generation operations and maintenance with a focus on innovative optimization strategies.

Fraser Scott (Wärtsilä Services, left) and Bill Burke (Carnival Corporation) sealed the cooperation.

Carnival Corporation's portfolio of cruise line brands.

> processing capability, which was further enhanced recently by the acquisition of Eniram, a provider of energy management, analytics and performance optimization solutions. Wärtsilä remotely collects and analyses engine performance data, which is picked up by on-board sensors and transmitted via satellite. "We already have thousands of vessels connected to our system and are collecting large amounts of data," Scott explains. "We are able to focus specifically on the Carnival engines to see how they are operating and how the crews are using them. This feedback loop allows us to discover additional potential for efficiency enhancements. We can see trends, follow degradation and predict points of failure so we can take proactive steps before failure occurs. We also receive data on operational procedures so we can tell the crews what they can do to improve performance and fuel efficiency."

Maintaining and upgrading hardware

On-board maintenance is typically carried out by Carnival crew members. They are trained and supervised by Wärtsilä technicians, who will also certify the skills acquired by the Carnival mechanics up to a certain level. "The Carnival team thus builds up expertise continuously, while the workload for the Wärtsilä technicians gradually decreases," says Burke.

Based on its big data-derived insight into operational performance and improvement potential, Wärtsilä plans its dynamic maintenance and determines when the next overhaul should occur. Furthermore, Wärtsilä will progressively optimize and upgrade the on-board equipment. "Based on the estimated service life of each ship, there are various efficiency-enhancing technology packages we can install when periodical overhauls are performed," explains Scott. "These packages' effectiveness has

Photos: Carnival Corporation & plc, DNV GL, Wärtsilä

ABOUT CARNIVAL CORPORATION

The company's portfolio of global cruise line brands includes Carnival Cruise Line, Fathom, Holland America Line, Princess Cruises and Seabourn in North America; P&O Cruises (UK) and Cunard in England; AIDA Cruises in Germany; Costa Cruises in Italy; and P&O Cruises in Australia.

Together, these brands comprise the world's largest cruise company with a fleet of 101 ships visiting more than 700 ports around the world. Between 2016 and 2020, 15 new ships are scheduled to be delivered to Carnival Corporation.

Carnival Corporation employs over 120,000 people worldwide and its ten cruise line brands attract nearly 11 million guests annually, which is about 50 per cent of the global cruise market. Combining more than 200,000 daily cruise guests and 77,000 shipboard employees, more than 277,000 people are sailing aboard the Carnival Corporation fleet every single day.

ABOUT WÄRTSILÄ CORPORATION

Wärtsilä is a global leader in advanced technologies and complete life cycle solutions for the marine and energy markets. By emphasizing sustainable innovation and total efficiency, Wärtsilä maximizes the environmental and economic performance of the vessels and power plants of its customers.

In 2016, Wärtsilä's net sales totalled 4.8 billion euros with approximately 18,000 employees. The company has operations in over 200 locations in more than 70 countries around the world.

The Services division is a major driver of growth for Wärtsilä. A highly innovative company, Wärtsilä, which is listed on the Helsinki Nasdaq stock exchange, invests 2.6 per cent of its net revenue in R&D.

"I see potential to extend the concept to other equipment as well, always with the ultimate goal of enhancing efficiency and reliability and saving money."

Fraser Scott, Head of 4 Stroke Sales AMER, Wärtsilä Services

Maximizing equipment uptime is key to successful operation in the highly competitive cruise industry.

been demonstrated, and since Wärtsilä shares in the fuel savings achieved over time through installing them, we can recoup our investment."

This arrangement encourages Wärtsilä to improve efficiency, not only by upgrading hardware but also by providing advice and recommendations on ship operation and maintenance. "We expect that condition-based maintenance will safely extend the interval between overhauls," says Burke. "It will give confidence to leadership afloat and ashore that engine maintenance is being conducted at a high level of quality. Because maintenance is performed based on the number of running hours, we know our costs are predictable and stable regardless of overhaul timing." Maintenance planning will be done by both companies on a collaborative basis.

A mutually beneficial arrangement

From enhanced fuel efficiency and equipment life to real-time visibility of engine performance and better medium-term maintenance planning, the value of the agreement to Carnival is considerable. The sheer number of Wärtsilä engines covered under the agreement means that even the smallest improvements in vessel fuel consumption add up to significant savings in fleet operational costs. "Our potential savings in fuel costs are counted in tens of millions of dollars per year," says Burke, "and in addition, the deal with Wärtsilä increases reliability and safety – these are very critical factors in the competitive, fast-growing cruise market."

"The value of the long-term agreement is approximately 900 million euros. While similar, less complex arrangements have existed in the aviation industry for some time, this is a revolutionary change for Wärtsilä," says Scott. "I see potential to extend the concept to other equipment as well, always with the ultimate goal of enhancing efficiency and reliability and saving money." The current deal is structured to address existing heavy-fuel-burning engines, Burke points out: "But it would definitely be possible to include future engines and technologies." He views the agreement as a starting point which will require adjustments going forward. Once enough data has been collected, he hopes, Carnival should be able to quantify the financial benefits.

Carnival's classification societies, which were consulted during the initial stages of the agreement and gave their approval, may also play a role as the two companies gather experience with this collaboration model that spreads both the risk and the profits of engine operation and maintenance between the parties. "Some questions or situations may emerge in the process that require input from or assessment by a qualified, independent third party," says Burke. "We are confident class will be supportive in helping us address any such issues."

Both Burke and Scott admit that the past 20 months of negotiations had been a challenge because of the complexity of the deal. But they are both very satisfied with the result: "For one of the world's biggest ship engine manufacturers and the world's biggest cruise company it doesn't make sense to be in a transaction-based business relationship," says Burke. "Rather, they should form a strategic partnership. This deal will establish that." **AK/NIS**

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EMBARKING ON THE DIGITAL JOURNEY

The digital revolution is gripping the maritime world. The cruise industry can reap enormous benefits, says Capt. Patrik Dahlgren, Vice President at Celebrity Cruises and Head of Global Fleet Optimization at Royal Caribbean Cruises (RCL), in his interview with CRUISE UPDATE.

It has often been said that the maritime industry is lagging behind other industries when it comes to digitalization. You are now in the middle of this disruptive transformation at RCL. Do you share this view from your practical standpoint?
Patrik Dahlgren: Yes, the maritime industry's thinking is pretty old-fashioned in comparison to the automotive or aviation industry. We have been kind of immune to disruptive technologies in shipping. But with younger generations coming in, the approach is now changing. We see this every day at RCL.

The cruise sector seems to be ahead of other shipping segments.
Dahlgren: No doubt! Our operational schemes are much more complex than in traditional cargo shipping and our ships consume much more energy. I think this is the reason why the cruise industry was the first to begin exploring new ways of reducing complexity by leveraging data insights and reaping energy and operational efficiency benefits.

How did you at RCL prepare for this exciting journey?
Dahlgren: First of all, we tried to gather as much information as possible and learn from other companies. For example, we have a strong partnership with Scandinavian Airlines and Finnair and looked how they are running their command and control centres. Within shipping, we are working closely with Maersk Line. It is always interesting to see what the market leader is doing. We frequently meet and exchange ideas with these partners. And to really push this topic internally we recently established the Global Marine Group within RCL to roll out our digitalization strategy fleet-wide across all brands.

How far along are you in your drive to digitalize your fleet operations?
Dahlgren: We started by installing the Eniram system on board our vessels in 2009. Back then, only the trim tool existed. Over the years more and more features were added, such as weather data,

The largest vessel of the Solstice class, *Celebrity Reflection* was launched in 2012. She can accommodate more than 3,600 passengers.

route planning, full energy consumption, etc. Today, instead of taking a reactive approach and just collecting data, we are venturing into real-time predictive analytics jointly with Eniram. Since the end of 2015 we have been collaborating closely on developing an entirely new, next-generation operations management system. This is nothing you can buy off the shelf, and I am proud to say we have come further than we expected.

What are the next steps?
Dahlgren: We have been monitoring and capturing data, and the next stage is to enable data-driven decisions. Unlike other ship operators we take a decentralized approach. Instead of having one single monitoring centre, we want to split the data into manageable volumes and distribute it to the right people – the bridge, the chief engineers and, of course, the fleet captain ashore. To this end we are establishing our Mobile Operations Centre. So far, crew members on three pilot vessels are using iWatches, iPads and other mobile devices to receive all relevant data about their ship. Of course they can still access the same data from their computers. But the idea is to distribute the data in real time to the right people. We trust our staff and want them to use their knowledge to extract pertinent information from the data so they can use it to drive the right behaviour. The pilot phase, which we launched this January, is already showing some very good results.

Are you still using paper reports?
Dahlgren: Not really. They're being replaced by the app over time.

How does this new approach change the decision-making process? Is it still the captain who has the last word?
Dahlgren: Of course, the captain still makes the final decision, together with his team on the bridge. When we introduced the Mobile Operations Centre, the first thing we made clear was: This is not about "Big Brother is watching you". And not about us driving the ships from the shore. The captains and the chief engineers are accountable and responsible. But the app is there to help them operate the vessels better.

> "We distribute the right data to the right people to take right decisions at the right time."
>
> **Patrik Dahlgren,** Vice President at Celebrity Cruises

You were a shipmaster in the past and are obviously embracing this change. But what about crew members who are, say, 20 years older?
Dahlgren: Of course, the younger generation embraces technology more readily, whereas older people often view it with some scepticism. But ultimately the feedback has been unequivocally positive even from the most senior captains. They said: We've been waiting for this.

What are the advantages from the bridge perspective?
Dahlgren: For example, when there is an incident, the data is available in real time to both the crew and the shore-side fleet management. It is no longer necessary for the bridge officer to take a screenshot of the electronic chart display and >

Photos: Celebrity Cruises, Eniram

Crew members receive relevant alerts and notifications on their mobile devices in real time. The same data is available to the company's shore-based staff.

> information system (ECDIS), or to explain the incident in a lengthy phone call with shore. All data is collected at one point and accessible instantly. Of course, even in a traditional nautical operation scenario data is everywhere, but in a different form.

So many things are easier for the crew?
Dahlgren: Yes, the system reduces the communication effort significantly. We recently had a case where a vessel headed into eight-metre waves due to an abrupt weather change. As a Celebrity shoreside team, we received the notification about the wave heights. A few minutes later, we were notified again by the app telling us that the route had been changed and the vessel was heading towards waters with waves of only three metres. There was no reason for us to interfere because the information reached us in real time.

Aren't you sometimes overwhelmed by the amount of information?
Dahlgren: There is certainly a risk of information overflow. Everyday our RCL fleet of 45 vessels generates approximately one billion data points. When we introduced the app, I was constantly being notified with unfiltered data and my watch was constantly vibrating. You can imagine that weekend family life was impossible under these circumstances. So we started to filter the information and now I only get notified when data meets certain parameters that we feel that I need to be aware such as weather and sea conditions etc.

You said in the beginning that the initial focus of the Eniram system was on improving energy efficiency. How much energy are you saving by utilizing big data?
Dahlgren: We have achieved a 15 to 20 per cent reduction of propulsion power by improving hull performance alone. In the past, the choice of antifouling coatings was mostly based on intuition and supplier information. Now we base that decision purely on data. We have incorporated the new ISO 19030 standard, which allows us to accurately capture the hull fouling effect, into our fleet performance software and can compare the hull performance of all vessels in our fleet. This has been very helpful in selecting the most suitable coating and hull surface preparation.

CAPTAIN PATRIK DAHLGREN

Dahlgren began his career as Second Officer aboard *Grandeur of the Seas*. Working his way up the ladder to Captain, he served on several cruise ships, amongst others *Oasis of the Seas*, then oversaw the Quantum-class newbuilding programme as Director of Newbuilds. He completed a Master of Nautical Science programme in Sweden and a Business Economics degree at Edinburgh Business School. Today he serves as Head of Global Fleet Optimization for all RCL brands and is also Vice President Marine Operations at Celebrity Cruises.

Another important measure is route optimization. When the crew uploads the designated route during the departure briefing, the system provides them with an alternative, more energy-efficient route, provided that the weather is acceptable. It even shows us how many tonnes of fuel we will save and what that means in terms of dollar savings based on current bunker spot prices. In total we have saved almost one million US dollars on fuel oil over the past nine months. The fascinating aspect is: as the system accumulates data, the alternative routes get better and better. Take for example the route between Sydney and Hobart: our ships have made this trip several hundred times – that is a lot of data!

What other parameters are you looking to optimize?
Dahlgren: There are many more areas we are looking into, such as deployment optimization, port turnaround times, enhanced HVAC, installation of air lubrication systems, etc. We really care about the environment, and to reach our goal of reducing our carbon footprint by 35 per cent by 2020 compared to 2005 levels as agreed with the World Wide Fund for Nature, we need to change our way of thinking.

And will you reach this goal?
Dahlgren: Yes, absolutely.

Have you reached it already?
Dahlgren: No, but we are closing the gap and there are still three years to go. All these disruptive technologies have helped us a lot. We can quantify the impact of every single measure now, and the data is telling a compelling story.

ABOUT ROYAL CARIBBEAN CRUISES

Incorporated in 1985, Royal Caribbean Cruises Ltd. is the parent company of Royal Caribbean International, Celebrity Cruises, Pullmantur, Azamara Club Cruises, and CDF Croisieres de France and owns joint venture interest in TUI Cruises. Together these brands operate approximately 45 ships in the cruise holiday industry with an aggregate capacity of roughly 110,900 berths. The company's ships operate on selected itineraries, calling at approximately 480 destinations on all continents.

Celebrity Cruises, a premium cruise line founded in 1988, has been a member of Royal Caribbean since 1997. The Miami-based company currently operates 12 vessels.

> "Our aim is to maintain the safest, most effective and most efficient cruise fleet in the world and therefore we challenge established norms by further developing disruptive technologies."
>
> **Patrik Dahlgren,** Vice President at Celebrity Cruises

You might face a scenario where the safest route is much more expensive in terms of energy consumption. How would you handle this?

Dahlgren: The answer is simple: safety is always our first priority, passenger comfort comes second, and energy efficiency thereafter. This principle is also embedded into our fleet performance system, which will never suggest a route through rough seas. And we definitely do not want our captains to be overly eager to save dollars while our guests become sea sick.

Speaking about safety, what are your plans for your fleet performance system?

Dahlgren: We are currently integrating more and more safety aspects into the Eniram system. We already know a lot about weather, wind and waves, but correlating this information with past incidents will enable us to improve safety further. Big data can also help us spot deviations caused by irrational crew behaviour, and many other things. All key information we need for major, fleet-wide safety initiatives is now being made available in a format that allows us to identify specific issues that need our attention. The engine fire safety charrette we recently conducted is a perfect example. We increasingly noticed fuel leak issues in our analyses, so we performed a survey and drilled down to discover the reasons.

What is more, we are digitalizing everything that is check-list or audit-related to make this information available on mobile devices. Our new iAuditor application enables us to execute audits on the fly and analyse the results with ease. This tool will eventually replace the old-fashioned check lists. We have also integrated the DNV GL Port State Control guidance into the iAuditor, and are already seeing positive results in the PSC statistics since this information is now available to everybody on a mobile device. What really makes the difference is the behaviour of our people: when they use a tool they know is visible and transparent they will consciously go to the next level.

Information captured by the Eniram software enables fast crew decisions.

You have also started an initiative to reduce technical downtime. Can you tell us about this?

Dahlgren: We have been looking into predictive analytics for quite a while because the daily costs of downtime are horrendous. In addition, we want to increase reliability and, thereby, safety. Jointly with SpecTec we are currently developing an app that will monitor the inventory of all ships in real time. *Celebrity Equinox* is our first test ship and more vessels will follow soon.

To give an example: huge numbers of pumps are installed on board our ships. Instead of having our technicians take them all apart at regular intervals, operational data can give us a good indication when it is time to exchange parts. But to do this, we first need to know every single piece of equipment and the manufacturer's maintenance recommendations. Is condition-based maintenance supported? Does it make sense? We have realized that in some cases there are no technical or financial benefits.

Then we have to define critical spare parts from both the safety and the technical reliability perspective, and determine where each spare part should be stored – on board, on board another ship that operates in the same area, in a specific warehouse, etc. We need to establish whether the spare part is connected to logistics, what agreements have been made with the supplier, and whether the part can be delivered within a certain timeframe.

This doesn't sound like an easy task...

Dahlgren: Absolutely not! This is why we partner with the consulting branch of Porsche, one of the most efficient car manufacturers in the world. The marine industry is light years behind the automotive industry when it comes to logistics – so why not learn from them?

When we started this, we found large numbers of spare parts on board our vessels that didn't really need to be there. Take for example a spare electrical motor: it doesn't make sense to have it on board a ship that was delivered maybe 15 years ago. Rather, it should be at the manufacturer's facility where it can be maintained and delivered when it is actually needed. >

Photos: Celebrity Cruises, DNV GL, Eniram

Celebrity Equinox is the test ship for Celebrity's new predictive analytics application that aims to avoid downtime.

> What we are developing now is a Plan for Every Part (PFEP) on board, which will lead to a specific plan for each partner. Our aim is to have access to their warehouses and order spare parts directly.

Won't this change your relationships with suppliers significantly?
Dahlgren: Yes, it will. In the future we will consider during the design phase for a vessel whether suppliers can catch up with these requirements or not.

How did your crews react? A chief engineer probably likes to have everything stored on board.
Dahlgren: The first reaction was: "Are you going to take spare parts away from us?" But gradually the crew understood the benefits of the process. We are actually carrying extra stocks of some parts on board while reducing others after performing a risk and financial analysis. As a positive side effect, we have more space available to make sure the right part with the right quality is always available at the right time.

Another new tool is your maintenance dashboard. What's the idea behind it?
Dahlgren: For a very long time we used manual maintenance reports that had to be sent to the ship manager once a month, copying the fleet director. There was a little field at the bottom of the form where you would write: "Need assistance from shore-side." In addition we had many, many phone calls and e-mails. If the crew wanted to escalate an issue they rarely could get as quick a response as today with live transparency of data transfer.

The newly developed maintenance dashboard has changed all that. It went live recently. Maintenance teams on board our ships now fill in every single item into this collaborative, fleet-wide data tool, indicating the affected system, the issue, the owner of the topic, the level of severity and so forth. The status can then be tracked neatly by both the crew and the onshore staff. You cannot imagine the enormous gains in communication efficiency we have achieved!

But the aggregated data does more: it shows us when there are multiple instances of an issue occurring on different ships. Our technical experts on shore can then look into this and solve the problem before it causes downtime. In the past, ship managers may have taken different approaches to resolve a specific issue without even communicating with each other. With more and more data accumulating, we drive focus and achieve better decisions.

What is your vision ahead on this digital journey?
Dahlgren: What we are really trying to implement is a company-wide asset performance management system that eliminates data silos and creates a holistic data ecosystem for our vessels. We just need to take the next steps which will eventually bring us to machine learning for better predictability. We will also consolidate the individual energy, safety and maintenance dashboards into a single one. This future is not far away, we are almost there!

This all sounds great. But how do you make sure you can trust your data?
Dahlgren: First of all you have to collect data from many different sources and put them into a unified format and a common system. Of course you also need to be able to trust the hardware which produces the data, and the platform where the data is aggregated. And you need to make sure that the analytical algorithms are accurate. We developed the Eniram system and our other applications jointly with partners and spent hundreds of hours cross-checking the results. Any time we embark on a new initiative we have subject-matter experts come in and check if the data makes sense.

Looking into the future, we see more opportunities than risks or challenges in marine digital transformation. Our aim is to maintain the safest, most effective and most efficient cruise fleet in the world and therefore we challenge established norms by further developing disruptive technologies. It's going to be an interesting journey for sure. ▮ **NIS**

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THE SCIENCE OF SAFETY

The Maritime Safety Research Centre (MSRC) is an industry-university partnership involving the Department of Naval Architecture, Ocean & Marine Engineering at the University of Strathclyde, Royal Caribbean Cruises (RCL), and DNV GL.

The University of Strathclyde accommodates the newly established Maritime Safety Research Centre.

The Maritime Safety Research Centre, the world's first centre of its kind, was established to improve safety at sea through close collaboration between the industry and academia. It focuses on interdisciplinary research and development projects. Opened by IMO Secretary-General Kitak Lim in November 2016, it seeks to support the shift of maritime safety from empirical to risk-informed legislation and goal-based standards.

"The world of shipping is undergoing a major transformation," said Knut Ørbeck-Nilssen, CEO of DNV GL – Maritime, at the inaugural ceremony. "Moving forward, our industry will still be at the heart of global trade, bringing people together and keeping the world's economy growing. But the industry itself, the vessels, the infrastructure, and the systems that connect them are likely to change substantially – as will regulatory and societal pressure with regard to maritime safety."

Addressing increasing complexity

On its mission to contribute to safer waterborne operations, the centre will develop a life cycle risk management approach that accounts for all cost-effective measures of risk reduction, both active and passive. These efforts will enable significant safety improvements for new and existing ships and offshore units while promoting a state-of-the-art safety culture and continuous development of the regulatory framework. Providing enhanced capabilities for medium- and long-term research, the MSRC will account for the increasing complexity of modern technology and operations as well as the societal expectations for human safety and environmental protection. As a partnership between leaders in academia, ship classification and ship operation, it is ideally positioned to pursue its long-term objective of mitigating safety risks for crews on board European-built vessels by 90 per cent by the year 2050.

Key research areas for the period until 2025 include safety and security of complex systems on board ships, dynamic barrier management, ship stability, intact and damage stability of cruise ships, safety culture, fire protection and prevention, and blackout prevention.

"The time is ripe for adopting a new model by reconstituting a centre of excellence for maritime safety," said the Director of the MSRC and Professor of Maritime Safety, Dracos Vassalos. "The vision and the long- and short-term goals are set, shared and served through close collaboration between industry and academia in a truly interdisciplinary, common-threaded R&D. Our research activities are strategically focused, ensuring that academic excellence is combined with strong industrial engagement." **SA**

For further information please visit:
www.strath.ac.uk/research/maritimesafetyresearchcentre

IMO Secretary-General Kitak Lim (ctr.) was joined at the opening ceremony by Knut Ørbeck-Nilssen, CEO of DNV GL – Maritime, Professor Sir Jim McDonald, Principal and Vice-Chancellor, University of Strathclyde, Professor Dracos Vassalos, Professor of Maritime Safety and acting director at the Maritime Safety Research Centre, and Harri Kulovaara, Executive VP of Maritime and Newbuilding RCL (f.l.).

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Photos: DNV GL, University of Strathclyde

EXPLORING THE ARCTIC

Shipbuilder Kleven renews ties with the booming passenger segment, winning contracts for several new, state-of-the-art Hurtigruten vessels that set a new benchmark for sustainability, reach and customer comfort. At the same time these projects are a boost to Norwegian shipbuilding.

It is hard not to admire Kleven Maritime's position in today's difficult shipbuilding market. Kleven's order books are full, and in order to achieve that, this northwestern Norwegian innovator has moved successfully from dependence on the offshore market to diversification into other segments – including cruise. Winning contracts for complex newbuilds in diamond exploration, fisheries, cable laying, hybrid ferries and luxury yachts has helped Kleven find their way back to the passenger segment, where they made their first entry in 1996 with the Hurtigruten coastal ro-pax liner *Nordkapp*.

Opening a new chapter

Now Kleven will build two new Explorer-class passenger ships for Hurtigruten, with an option for two more, capturing the contracts in the face of fierce international competition, and signalling the start of what they believe can be a new era for Norwegian shipbuilding. "Like everybody else, Kleven has to follow markets," says Kleven CEO Ståle Rasmussen. "Cruise is active now, so all the big yards are booked. That leaves an opening for yards that can build the smaller ships, which are increasingly in demand."

The new Hurtigruten ships will be classed for ice-infested waters, allowing them to serve the expanding explorer cruise market. "A growing number of seasoned cruise customers are demanding more exotic destinations," Rasmussen observes. "Satisfying this demand requires ships that are able to cruise

ROALD AMUNDSEN AND *FRIDTJOF NANSEN*

- The first of Hurtigruten's new Explorer-class vessels
- Also suited to Norwegian coastal routes
- Rolls-Royce design together with Espen Øino and Hurtigruten
- To be built at Kleven Verft
- Passenger capacity: 530
- Cabins: 265
- Crew: 151
- Dimensions: length 140 metres, beam 23.6 metres, height 29 metres
- Draught: 5.3 metres
- New hybrid technology
- 20 per cent reduction in fuel consumption and CO_2 emissions
- Enabling fully electric propulsion for the first time on a cruise ship, up to 30 min.
- Classed by DNV GL
- Notation: PC(6) / Polar Code B
- Deliveries in 2018 and 2019, respectively

The new Hurtigruten Explorer-class ships can travel to any destination and ensure an excellent passenger experience.

Photo: Rolls-Royce

virtually anywhere in the world, and these ships must provide a higher standard on board."

Kleven has built three Hurtigruten ships to date, definitely a factor in the landing of this latest contract for their new vessels. But another major step along the way was the delivery of Kleven's first two luxury yachts, built for New Zealand's wealthiest businessman. "Building these yachts was a great learning experience. Once we proved we could deliver to that demanding standard of finish, a key barrier to the high-end cruise ship market was removed," says Rasmussen. As an added bonus, the offshore-influenced, ice-class yachts generated not just massive local interest, but attention from the international media, helping to establish Kleven's reputation in this exclusive segment.

Trustworthy contractor

Good relationships have always been at the foundation of Kleven's business, going back to their origins at Myklebust Verft on Gurskøy in 1915, and the establishment of Kleven Verft in Ulsteinvik in 1944. Originally the yards served the local fishing and merchant fleets, providing repairs, harpoons, deck machinery – whatever was needed. Their first newbuild, a fishing vessel, was delivered in 1961. Today Kleven Maritime operates both the Myklebust and Kleven yards, just down the fjord from each other.

Kleven's culture of cooperation has its practical roots in the close-knit regional community of maritime designers, >

Diversification and high-tech manufacturing technology spell the success of Norwegian shipbuilding. The new cable-laying vessel for an ABB partner demonstrates how flexibility attracts new business.

> suppliers and owners. "For us, it's an extremely collaborative business. We don't have our own design department, so we have to be nimble enough to accommodate many different designs," Rasmussen relates. Being a family operation also influences their approach to business: "As a family-owned company, Kleven has a long-term strategy, and success in the long run is a matter of give and take. We depend on working together with others. Kleven has a long-standing company culture of fostering these relationships."

Collaboration with class

Relationships with classification societies are among the most important for Kleven. "Our way of working with DNV GL and the other societies is extremely collaborative. The class business is obligated to be objective, but there is no doubt that close cooperation between the yard and class societies contributes to the efficiency and quality of a project." Rasmussen cites the strong local presence of DNV GL in Ulsteinvik as a good example of combining accessibility with a wide global reach.

This close collaboration will figure prominently in the construction of the new Hurtigruten ships. Classed by DNV GL to Polar Class 6, they will be capable of sailing in waters with seasonal ice. With a length of 140 metres and 265 cabins accommodating 530 passengers, they will also be the biggest vessels ever to be constructed at Kleven.

A new hybrid technology will also make them the first cruise ships with fully electric propulsion, contributing to a 20 per cent reduction in fuel consumption and CO_2 emissions during normal operation. Selective catalytic reduction (SCR) to remove NO_x, together with heat recycling, will enhance the ships' green profile

> "The class business is obligated to be objective, but there is no doubt that close cooperation between the yard and class societies contributes to the efficiency and quality of a project."
>
> **Ståle Rasmussen,** CEO Kleven

while adding to the list of technical and design challenges to be met jointly by Kleven and DNV GL.

Ståle Rasmussen is confident that the long-standing relationship between the two partners will serve them well on these flagship projects: "In the end it's about working together effectively to find the best solutions for all stakeholders."

The future is here

More than just keeping them busy, the Hurtigruten contracts seem destined to define Kleven's future, and perhaps the future of Norwegian shipbuilding.

"The yacht and cruise segments have the potential to be solid contributors to Kleven's business," Ståle Rasmussen believes. But competition is formidable for newbuilds. Twelve international shipyards had vied for the new Hurtigruten contracts.

Working in Kleven's favour are the many different ship types on their resumé, making them attractive for a broader range of projects. But Kleven's real advantage, Ståle Rasmussen believes, is their approach to building ships:

U116, the second luxury yacht delivered by Kleven Verft.

"We are not consultants. We are hands-on. We work close to the steel, and that is the core of our business philosophy." As proof of their commitment to this philosophy, Kleven will complete even more work on the Hurtigruten ships than on previous newbuilds, including the most complex hull modules and the entire length of all three uppermost decks.

And the company will continue to invest. "Kleven is in for the long haul. We believe in the future of shipbuilding in Norway." Rasmussen cites productivity as the key success factor for building ships in high-cost countries like Norway: "Our decision some years back to invest in automation and robotification has helped us compete on productivity in international markets. While a lot of production went to Asia, we believed we could find ways to produce efficiently here. A robot costs the same in Norway as anywhere, so why not figure out smarter ways to use it here?"

Keen minds, busy hands

But it takes people to run the machines, and there is no substitute for skill and commitment. "We have a local advantage," Rasmussen acknowledges. "There is a strong local maritime community in this region, and we share a very keen interest in everything to do with the sea. We have always behaved as a cluster, long before cluster thinking became popular."

Fortunately for Kleven, and for the industry, this local interest in things maritime is shared by the younger generations. "We can offer young people jobs locally, and that is the real future of the industry in Norway," says Rasmussen.

Ståle Rasmussen's forecast for Norwegian shipbuilding in the next five to ten years? "Offshore should make a comeback, but it's hard to know when, or how strong it will be. There will be more automation and smarter use of robots, but flexibility and diversification will continue to be the keys to survival." **KG**

Photos: Berge Myrene, Kleven, Multi Maritime AS, Olav Thokle, Salt Ship Design

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The advanced fishing vessel *Gitte Henning* represents Kleven's traditional commitment to the fishing industry.

Kleven will build two hybrid ferries for FosenNamsos Sjø.

TRAINING MAKES THE DIFFERENCE

Captain Luigi Razeto, SVP Marine Operations at Norwegian Cruise Line Holdings (NCL), spoke with us about the importance of a strong team, an exemplary safety concept, cooperation with class, and the Chinese cruise market.

Mr Razeto, what exactly is your role at Norwegian Cruise Line?
Luigi Razeto: I head the Marine Operations department, which is in charge of marine safety and compliance, environmental protection, public health, medical care, global security, nautical and port operations, and global fuel procurement. I am also involved in newbuilding, dry-docking, and everything else that has to do with compliance. You cannot keep track of all this without a strong team. I am lucky enough to have a young, dynamic, motivated, knowledgeable team in my department. But my main concern is the ships. I am the direct point of access and always need to be available to the shipmasters and crews, whatever they may need. If an urgent decision is required where the captains feel they need our support, they call me.

How do you accomplish this with a relatively small team?
Razeto: We have modern ships which are well built and easy to maintain. We put a lot of effort into training our crews to fill all the knowledge gaps. In today's business environment and across the industry, officers move up the ladder very fast so we have to make sure everyone gets the right kind of qualification, from the crew in general to the technicians we send on board for repair and maintenance activities. One of the great advantages about this company is that we are truly all working together as one cohesive team with a common goal, and the fact that the three operational teams – Marine, Technical and Hotel – are all located on the same floor in our building is incredibly helpful in supporting communications and the decision-making process.

Safety is naturally the top priority of every cruise line. What is your approach at NCL?
Razeto: NCL has always had a safety culture that was well ahead of the competition and this is deeply incorporated in our company's roots. But we strive to make things even better, and currently we have two focus areas: the first is being open to suitable technology that supports safety, the other is to translate the complex safety requirements into easy-to-grasp lessons for our training

Commissioned in 2014, *Norwegian Getaway* accommodates 4,028 guests. Safety on board is the top priority for owner NCL.

Norwegian Joy, built to the North American standard, was designed to provide a tailor-made cruise experience to Chinese passengers.

CAPTAIN LUIGI RAZETO

Having graduated from the Camogli (Genoa) nautical school in 1984, Luigi Razeto spent the majority of his sea career at Costa Cruise Line, where he was eventually put in charge of establishing the safety division. In 2002 he joined Carnival Cruise Lines with the task of rewriting all policies and procedures related to ISM and ISO 9000/14001. From 2008 Razeto headed the Nautical Operations and Compliance department at Prestige Cruise Holdings (Oceania Cruises and Regent Seven Seas Cruises). Following the acquisition of Prestige Cruise Holdings by Norwegian Cruise Line in 2014 he was put in charge of Marine Operations for the three brands.

programmes so every crew member understands and remembers what to do. Furthermore, we are in the planning phase of a campaign based on the motto: "Safety starts with me!" where each crew member becomes a safety representative – or, more aptly put, a safety ambassador – and embraces safety as part of their lifestyle. The ultimate goal is that every daily activity must be integrated into the safety culture.

Where do you train people?

Razeto: Most of the training happens on board, but we have also developed training and exercise programmes which are delivered by our partners in certain ports. In addition to this, experts will come on board to conduct regular assessments exposing our crew to different challenges relating to safety and other topics. They then deliver a report that we use to fine-tune our policies and procedures as well as our training programmes.

How do you address environmental compliance?

Razeto: We are implementing many upgrades on ships, such as trim optimization systems, to reduce fuel consumption and emissions to air. The benefits are visible, especially when comparing fuel consumption before and after implementation. We will install scrubbers on a number of vessels (see page 20) and are working on a vessel deployment concept to determine which ships are best suited to operate in specific areas, such as ECAs. This is a learning process – we are acquiring knowledge about where to tweak performance and what changes to make on a day-to-day basis.

What is the role of class in your overall safety and environmental approach?

Razeto: Any owner should be smart enough to establish a level of partnership with class that goes beyond mere adherence to classification rules. We are in continuous cooperation with DNV GL in many areas to jointly learn and to improve. It would be narrow-minded to think we can do it all alone. Sometimes it is not even about new ideas for the future, but rather about changing how we do certain things to get better. We have started a new, comprehensive crew training programme with a stronger focus on avoiding incidents and enhancing the safety of using rescue boats and life-saving appliances in general. This is an area where we need cooperation with class. We need DNV GL to review our new concept, update it, modify it, and ensure its compliance. Then we will present it to the flag states and explain the rationale behind it to get their approval.

Another example: the Arctic and Antarctic are becoming potential "exotic destinations". We are studying these areas and the requirements of operating there. As you can imagine, there aren't many people in the cruise industry who are familiar with these regions. Since DNV GL is a classification society for many different ship types and has enormous expertise in many fields and geographical regions, we thought it would be a good idea to take advantage of what DNV GL may have to offer and study the matter together. Cooperation with class on innovative projects is invaluable. The secret is looking at class not as a mere vendor but as a partner. Decades ago class was basically an extension of flag states in charge of strictly imposing rules. That has changed fundamentally since the mid-eighties when classification societies internationalized and became essential, global partners for shipowners. We need to fully embrace this new concept.

You are entering the Chinese cruise market. How are you adapting to local needs?

Razeto: Unlike other cruise companies we took a bold step, and not necessarily a cheap one: we designed *Norwegian Joy* as a vessel that will cater exclusively to Chinese taste. We want our guests to have fun. *Norwegian Joy* is the first cruise ship featuring a go-kart track where guests can go racing with their friends. In addition to the usual water parks we will have a laser gun battlefield and a virtual reality room with lots of adrenalin-packed adventures, etc.

Chinese guests typically only have time for four-to-five-day getaways. On such a trip the ship itself is a destination they want to explore, and by offering a unique, tailor-made experience we hope to attract plenty of business. China is definitely an interesting venture for us. ▮ **AK/NIS**

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Photos: DNV GL, Norwegian Cruise Line

When delivered in 2015 by Meyer Werft, *Norwegian Escape* was equipped with one of the world's biggest scrubber systems.

CLOSING THE LOOP

With the IMO global sulphur cap coming into force on 1 January 2020, operators are taking steps to comply. In the cruise industry, many are favouring scrubbers as the most economical solution. Norwegian Cruise Line Holdings (NCL) shares some experiences from its scrubber installation projects.

With up to 70,000 vessels affected by the upcoming IMO regulations, operators face the choice between switching to LNG-powered engines, running their vessels on distillate fuel such as marine gas oil (MGO) or installing an exhaust gas cleaning system consisting of one or several scrubbers. The best option very much depends on the given vessel type, operational pattern and the short and long-term availability of appropriate fuel.

One of the largest players in the cruise industry, the Miami-based Norwegian Cruise Line is in the process of installing scrubbers on several of its 14 vessels. The first projects have been completed successfully, explains Paolo Mele, SVP Technical Operations at NCL: *Pride of America* was equipped with scrubbers in 2013 and *Norwegian Escape* was delivered in 2015 with one of the world's biggest scrubber systems installed at the time.

Scrubbers spray alkaline water into the exhaust gas stream to neutralize sulphur oxides (SO_x). An open-loop system neutralizes the SO_x by taking advantage of the natural alkalinity of seawater, which is subsequently cleaned and discharged back into the ocean. A typical closed-loop system uses freshwater mixed with sodium hydroxide; the washwater is then purified and recirculated, and the resulting residual sludge is stored in tanks and disposed of at the next port that offers appropriate facilities. Closed-loop systems can be used independent of the composition of the water the vessel is operating in, including estuaries and freshwater bodies such as the Great Lakes.

Since there are heavy restrictions on the use of open-loop systems within the three-nautical-mile zones along the US coastlines as well as in some European ports, NCL decided to add a closed-loop system to *Norwegian Escape's* open-loop system,

PAOLO MELE

As Senior Vice President (SVP), Technical Operations, Paolo Mele is overseeing repair, maintenance and dry-docking activities for all three brands of Norwegian Cruise Line Holdings. He collaborates closely with newbuilding teams in Germany and Italy. Born and trained in Genoa, he began his career with Costa Line, then worked at Chandris. He subsequently spent 22 years at Carnival Cruise Line, both shoreside and as a shipboard officer, and has been with Prestige Cruise Holdings (now a part of Norwegian Cruise Line's parent company) for the past decade.

> "Hybrid systems give us the flexibility to adapt to any sea region and the applicable emission regulations so we can deploy our ships wherever we want."
>
> **Paolo Mele,** SVP Technical Operations at NCL

with support from DNV GL. Its sister vessel *Norwegian Joy*, which is currently under construction, will be equipped with an open/closed-loop hybrid system which will be fully compliant in all ports around the world. "Hybrid systems give us the flexibility to adapt to any sea region and the applicable emission regulations so we can deploy our ships wherever we want, without switching to expensive distillate fuel oil," says Mele. "In the long run, there won't be many regions left where our ships can operate freely without a closed-loop scrubber."

Therefore, NCL will continue retrofitting scrubbers on existing ships. But even vessels using closed-loop scrubbers must carefully choose their itineraries to include ports offering sludge disposal facilities. "We are still studying all these matters to see how much sludge is generated and how often it needs to be discharged and where," says Mele. "It is all quite new to us."

Many variables

Retrofitting ships in operation with a scrubber system is not an easy task, Mele points out, especially when installing a closed-loop system. A wide array of pumps, pipes and tanks need to be added to the machine room, and one of the key questions is where to place the sizeable tanks required to store the residual sludge. "On *Pride of America* we had to install an open-loop system because we were unable to find a suitable place for the sludge tank," Mele explains. "On *Norwegian Escape* we are still trying to find a way to install sludge tanks for conversion to closed-loop."

Since NCL's cruise vessels are booked practically year-round, most of the retrofitting work has to be performed while the ship is operating, which can complicate matters. "We try to install the towers during dry-docking, but the rest has to be done while the ship is in transit," Mele emphasizes. "We have to take cabins out of revenue to accommodate the technicians. When the ship is in severe weather, all installation work has to stop. We also need special permission for welding and, depending on the port of call, we must make sure to get special visas for the technicians."

Tricky logistics

Component logistics is another challenge. The installation phases must be carefully coordinated, because it is impossible to store all components on board at once, so shipments of parts have to be directed to specific ports in a timely manner. "Many factors can interfere with the planned process," says Mele. "You may have the contractor on board but no parts, or all the parts but not the contractors. There may be a strike somewhere, and your parts will be a week late so the work cannot proceed as scheduled." He emphasizes: "Logistics and scheduling alone are extremely complicated processes. And we haven't even begun to discuss the complexity of the retrofitting work itself – with passengers on board!"

Keys to success

What has really helped move the retrofit projects along against all odds – and with a technical coordination team of only three on the NCL side – was the excellent team spirit that developed between the NCL staff and the contractors, says Paolo Mele. "This generated enthusiasm about the common goal and a positive mind-set – they all collaborated extremely well to get the job done."

To ensure safe and trouble-free operation of its scrubber systems, NCL has partnered with DNV GL, which provides crucial hardware-in-the-loop (HIL) testing services. Such tests also reduce the systems' on-board commissioning time.

NCL is planning to retrofit five more ships with closed-loop scrubber systems. "The next generation of our cruise ships will be designed with exhaust gas cleaning systems in mind, so the retrofitting challenge is only temporary," says Paolo Mele. **AK/NIS**

Photos: courtesy of Yara Marine Technologies AS/Meyer Werft/Ingrid Fiebak-Kremer, DNV GL

GLOBAL SULPHUR CAP 2020

On 27 October 2016, the IMO MEPC meeting agreed on a 0.5 per cent global fuel sulphur limit which will take effect in 2020. Affecting up to 70,000 vessels, it will apply in addition to the 0.1 per cent sulphur limit in Emission Control Areas (ECAs). The DNV GL Global Sulphur Cap 2020 guidance document explains all the details, choices and challenges.

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ASIA'S NEW STAR

Who is the newest shining light among cruise vessels? The answer: *Genting Dream*. Delivered on 12 October 2016 from Meyer Werft in Papenburg, Germany, she took her maiden voyage on 13 November 2016.

A NEW YARDSTICK

Genting Dream is designed to cater to the rapidly developing Asian cruise market and is the first dedicated premium cruise liner based in Asia. The vessel is the largest ordered by owner Genting Hong Kong for Dream Cruises to date.

This picture shows one of her most eye-catching features: a state-of-the-art LED lighting system which can be individually controlled to provide colour, movement and video effects. Developed by Project International Lighting Designers the system was engineered and installed by Wärtsilä Funa.

GENTING DREAM KEY FIGURES

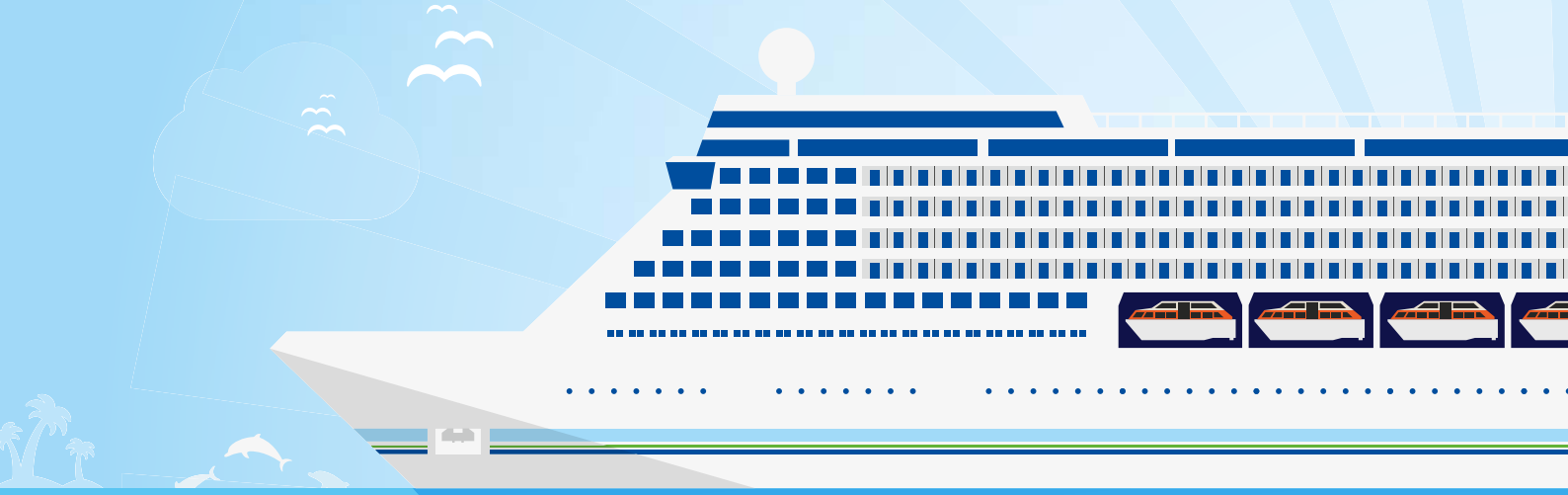
- Shipyard: Meyer Werft, Germany
- Length: 335.35 m
- Beam: 39.7 m
- Draught: max. 8.3 m
- Gross tonnage: 151,300 GT
- Engine power: 76,800 kW
- Top speed: 23.4 kn
- Passenger capacity: 3,348 (lower berths)
- Pax cabins: 1,674
- Two *C-Explorer 5* submersibles (see page 32)
- Class: DNV GL

Genting Dream's environmentally friendly marine engines, diesel-electric pod drives, and improved hydrodynamics contribute to an ecological cruise experience and considerably reduced operating costs.

Photo: Meyer Werft/Ingrid Fiebak-Kremer

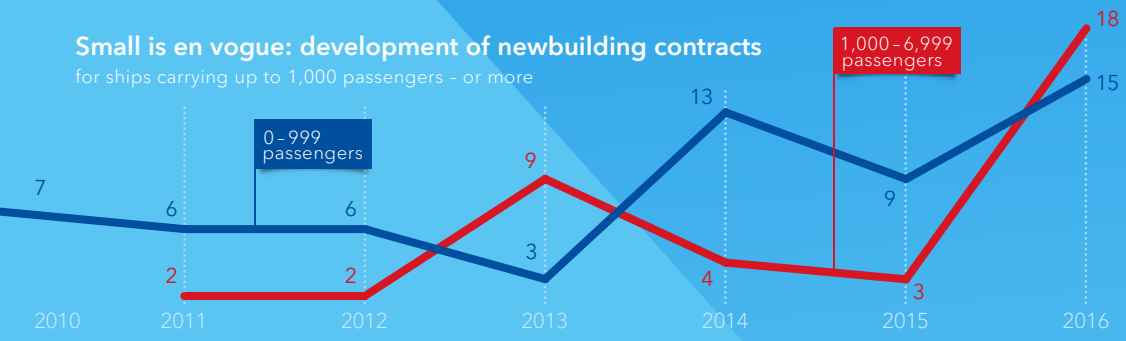
CRUISE SHIPS: A GROWTH MARKET

Close to 360 cruise vessels are navigating the seas, and more than 70 are in shipyards' order books. While smaller, expedition-type ships are currently especially popular, the average number of beds on board is increasing. An overview of key facts and figures, including DNV GL's position in the cruise market. **AJO**



Small is en vogue: development of newbuilding contracts

for ships carrying up to 1,000 passengers – or more

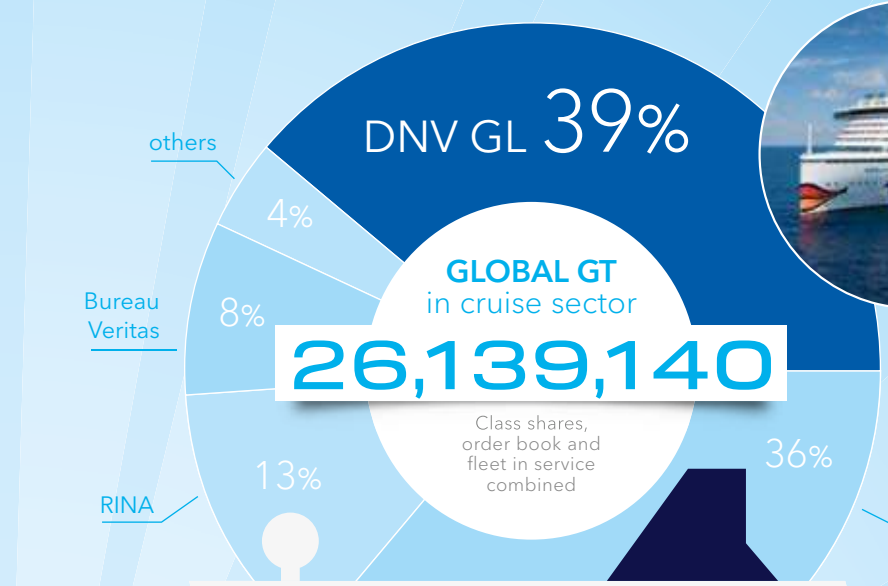


Expedition yachts like the *Endeavour* series, built by MV Werften, are in demand. Delivery of the first vessel is planned for 2019.

357 CRUISE SHIPS

Size of the current active global fleet

AIDAprima, built by Mitsubishi in Japan, is one of the most spectacular additions to the DNV GL-classed fleet.



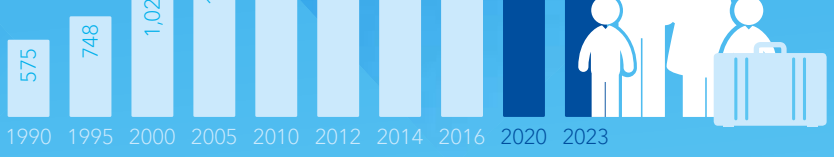
MORE THAN 70 ORDERS

are in the global order book, to be delivered by 2023. More than half of these vessels will be built by yards in Italy and Germany.

Approved for up to 6,400 passengers, *Harmony of the Seas* is currently the world's biggest cruise vessel.

Development of average size

in pax numbers, existing cruise fleet



19 YEARS

is the average age of the world's cruise fleet. A luxury sailing liner launched in 1931 is the fleet's Methuselah.

Sources: Clarksons Research, IHS Fairplay

Photos/illustrations: AIDA Cruises, denisdubrovin - Fotolia, icons by Madebyoliver/ Freepik from www.flaticon.com, MV Werften, Royal Caribbean International

Celebrity Eclipse passed the DNV GL SILENT-E assessment with flying colours. She is the first cruise vessel to receive this class notation.

Yanran Wang, DNV GL, presents the SILENT-E certificate for *Celebrity Eclipse* to Captain Zissis Koskinas, Celebrity Cruises.

SILENCE IS GOLDEN

Marine mammals, such as whales and dolphins, are impacted by underwater noise. The Vancouver Fraser Port Authority is taking the lead in promoting quieter ships – with an innovative incentive programme.

Vancouver is a beautiful port city in a spectacular natural setting between majestic mountains and the Strait of Georgia. The Port of Vancouver is not only Canada's largest cargo gateway but it also serves as home port for cruise lines operating in the northern Pacific. What is more, British Columbia's coastal waters are inhabited by countless marine mammal species, such as orcas, fin, blue, grey and humpback whales, dolphins and seals. With its rich marine wildlife the region is a favourite among marine biologists, and every year thousands of nature enthusiasts flock the region during whale-watching season from May to October.

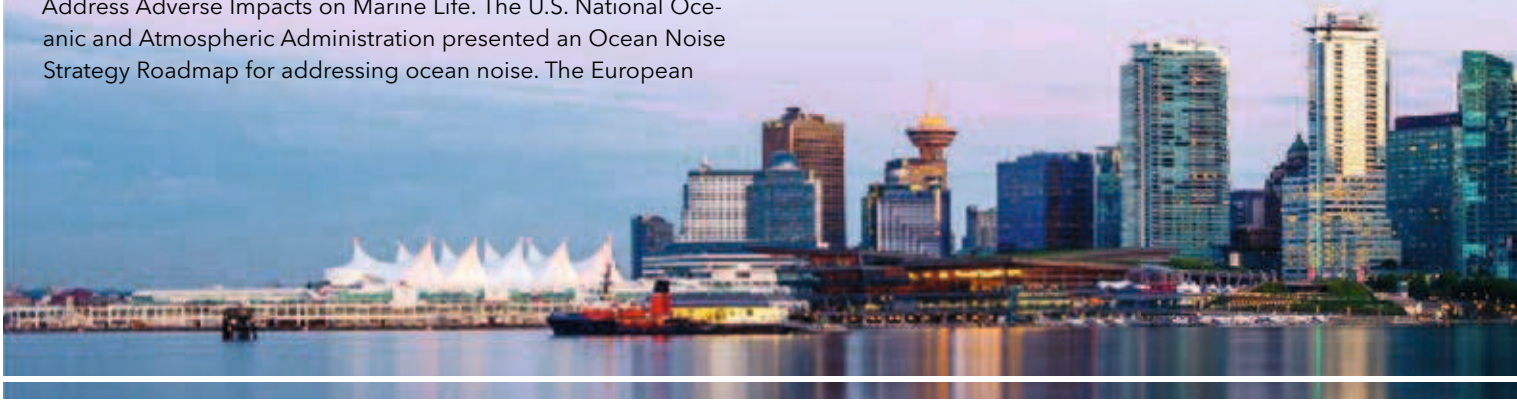
Protecting this precious natural habitat, and in particular those marine mammals designated as "at-risk" under Canada's Species at Risk Act, is a core objective of the Vancouver Fraser Port Authority, whose Enhancing Cetacean Habitat and Observation (ECHO) programme aims to strike a healthy balance between preserving wildlife and accounting for the needs of tourism and cargo shipping. Lowering underwater noise from ships is one of the measures that can be taken to reduce the impact of shipping on marine mammals in the area. Ship noise can interfere with the ability of marine mammals to navigate, communicate and identify prey.

An innovative incentive programme

Shipping-induced underwater noise has been given a lot of attention during the past decade. The International Maritime Organization adopted its MEPC.1/Circ.833 Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life. The U.S. National Oceanic and Atmospheric Administration presented an Ocean Noise Strategy Roadmap for addressing ocean noise. The European Union has completed two large projects looking into the effects of underwater noise in European waters, called "Suppression of Underwater Noise Induced by Cavitation" and "Achieve Quieter Oceans by Shipping Noise Footprint Reduction", respectively.

The Vancouver Fraser Port Authority has been among the pioneers investigating the impact of shipping noise on at-risk marine mammals. Launched in 2014, the port authority-led ECHO programme is a collaborative research initiative involving marine transportation industries, conservation and environmental groups, First Nations individuals, government and scientists. In 2016, the port authority turned to DNV GL for advice on underwater noise criteria to support this programme. DNV GL recommended using its SILENT class notation developed by the DNV GL underwater noise expert group. Published in 2010, this notation defines various underwater noise limitation categories, including the SILENT-E class notation specifying "Environmental" criteria. "These limits include sound frequencies marine mammals are known to use for communication or are sensitive to," says Yanran Wang, Project Engineer – DNV GL Maritime Advisory, Miami. "The DNV GL rules provide a realistic framework for what is technically achievable and feasible." The DNV GL expert group was able to share key expertise which allowed the port authority's ECHO

The Vancouver skyline as it greets cruise ships approaching the Canada Place cruise ship terminal, located in the tent-like structures on the left.



programme to include "quiet vessel" notations in its underwater noise reduction incentive programme.

What makes the ECHO programme so innovative is the inclusion of some new underwater noise criteria to the port authority's existing EcoAction incentive programme. Since 2007, EcoAction has recognized a variety of fuel, technology and environmental management options that make ship operators eligible to receive discounted harbour due rates. On 1 January 2017, the port authority added new incentive criteria to the programme to include harbour due rate discounts for quieter ships. Depending on the environmental protection measures taken, ships may qualify for one of three EcoAction Award levels, rewarding vessels with up to a 47 per cent reduction in harbour dues. This makes Canada the first country in the world with a marine noise reduction incentive.

"Adding underwater noise reduction criteria to our EcoAction programme is an exciting next step towards our long-term goal of reducing the impacts of shipping activities on at-risk whales," says Duncan Wilson, Vice President of Corporate Social Responsibility at the Vancouver Fraser Port Authority.

Rewards beyond discounted fees

Ships bearing the DNV GL SILENT-E class notation qualify for the highest EcoAction discount when calling at the Port of Vancouver. When Captain Zissis Koskinas, Associate Vice President in charge of Nautical Operations and Fleet Captain at Celebrity Cruises, learned about the soon-to-be-introduced incentive programme last October, he called DNV GL to inquire what needed to be done for a ship to qualify. DNV GL scheduled a measurement campaign within in a few days to evaluate the underwater noise level of the cruise vessel *Celebrity Eclipse* against the DNV GL SILENT-E notation. The vessel calls at Vancouver on certain routes. Captain Koskinas says he expected having to make some modifications on board but DNV GL, after taking the measurements, found that the vessel was already fully compliant.

"*Celebrity Eclipse* was the first cruise vessel ever to receive the SILENT-E notation," says project manager Yanran Wang. "Our experience with this vessel shows that it is not difficult for modern cruise ships to meet the low-noise criteria. In spite of their huge power demand, they are quieter by design than many other commercial ship types, from the propeller to the machinery installation."

For Celebrity Cruises, the port fee discount is not the only reason to welcome the EcoAction programme, says Captain Koskinas. "Passengers are often environmentally aware and ask us what we do to protect the environment. Being able to demonstrate that our cruise ship is kind to marine life makes our brand look good and is consistent with the concept of sustainable tourism. Celebrity Cruises has always had a culture of going beyond regulations in terms of safety and the environment. Signing up for EcoAction makes us a pioneer in whale-friendly cruise shipping."

DNV GL has already received enquiries from other owners regarding the SILENT-E notation, and *Celebrity Eclipse* can serve as a reference ship for the Vancouver Fraser Port Authority's industry-leading EcoAction incentive programme. "When assessing a vessel, DNV GL can accommodate the ship itinerary for necessary measurements. The underwater noise measurements on *Eclipse* were carried out with passengers on board and without requiring any deviation from the cruise schedule. Drawing on extensive experience in noise and vibration evaluations from the past 60 years, the DNV GL noise experts are also able to give practical advice on underwater noise reduction measures," explains Wang. Considering the increasing environmental awareness among ports worldwide, DNV GL is confident other ports will follow in Vancouver's footsteps. ■ **AK/NIS**

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Photos: DNV GL, heyengel - Fotolia, Celebrity Cruises

NEVER STOP INNOVATING

Success is a wonderful thing, but to keep it going it is essential to explore new horizons and grow the customer base. Helge Hermundsgård, Business Development Manager at DNV GL, shares some thoughts about the current state of the sector and how to propel it into an equally successful future.

The optimism in the booming cruise industry is pervasive. Few segments of the shipping industry can come close to the successes the cruise business has been celebrating. The only factor limiting further growth is yard capacity – the order books have a longer horizon than ever, stock prices are close to an all-time high, the US market is expected to hit 16 million passengers in 2020, and China is growing fast. People not familiar with this industry tell us that this must be the peak and a downturn is inevitable in the near future. But that is not what we see happening.

According to CBRE, the world's largest real estate investment management firm, there are 187,000 hotels with more than ten rooms in the world totalling 17.5 million guest rooms, Airbnb not included. This figure contains both leisure and business facilities. WTTC, the World Travel & Tourism Council, suggests that 76 per cent of these facilities are leisure hotels. These numbers make the cruise industry appear like a midget in the leisure industry. Claiming a larger share of the holiday market is the challenge, say the leaders of the cruise sector. If the cruise industry succeeds in growing its market share, the current growth rates could be maintained or even exceeded, provided that yard capacities can keep up.

Our core competencies and experience at DNV GL are in the technical and marine disciplines, and we believe that one of the key enablers of future success is innovation. Focal points for innovation should be safety, energy technology, operational efficiency and passenger experience.

Safety

Safety will always be a top item on the industry's agenda. Over the years numerous safety-related initiatives have contributed significantly to improved ship design and operational practices, and new standards are constantly raising the bar.

Using data systematically to identify hidden optimization potential will benefit fleet management and translate to competitive advantage.

We all know that the primary cause of accidents is human error. This is being addressed through training, initiatives to raise awareness, and other measures, and while safety performance is improving across the shipping industry, the challenge remains that making errors is simply human nature. The best approach is therefore to minimize opportunities for erroneous reactions and decisions by designing and integrating more robust systems which eliminate potential negative consequences of human miscalculation or misconception. New technologies developed by other industries can serve as an inspiration for the cruise industry.

For example, if Google can deploy a self-driven car in Mountain View, California, why shouldn't a cruise ship be able to use automated navigation? While it would seem reckless to advocate unmanned cruise ship bridges, new technology can certainly help reduce the likelihood of human errors and the resulting casualties.

The aviation industry – a good example is Rolls-Royce's new jet engine technology – demonstrates how to rethink safety, reliability and efficiency, and the same approach could be taken with ship engines. The announcement by Wärtsilä and Carnival Corporation of their new, performance-based strategic partnership is an encouraging step, and similar partnerships which endeavour to rethink the way the industry works are likely to follow suit.

Energy technology

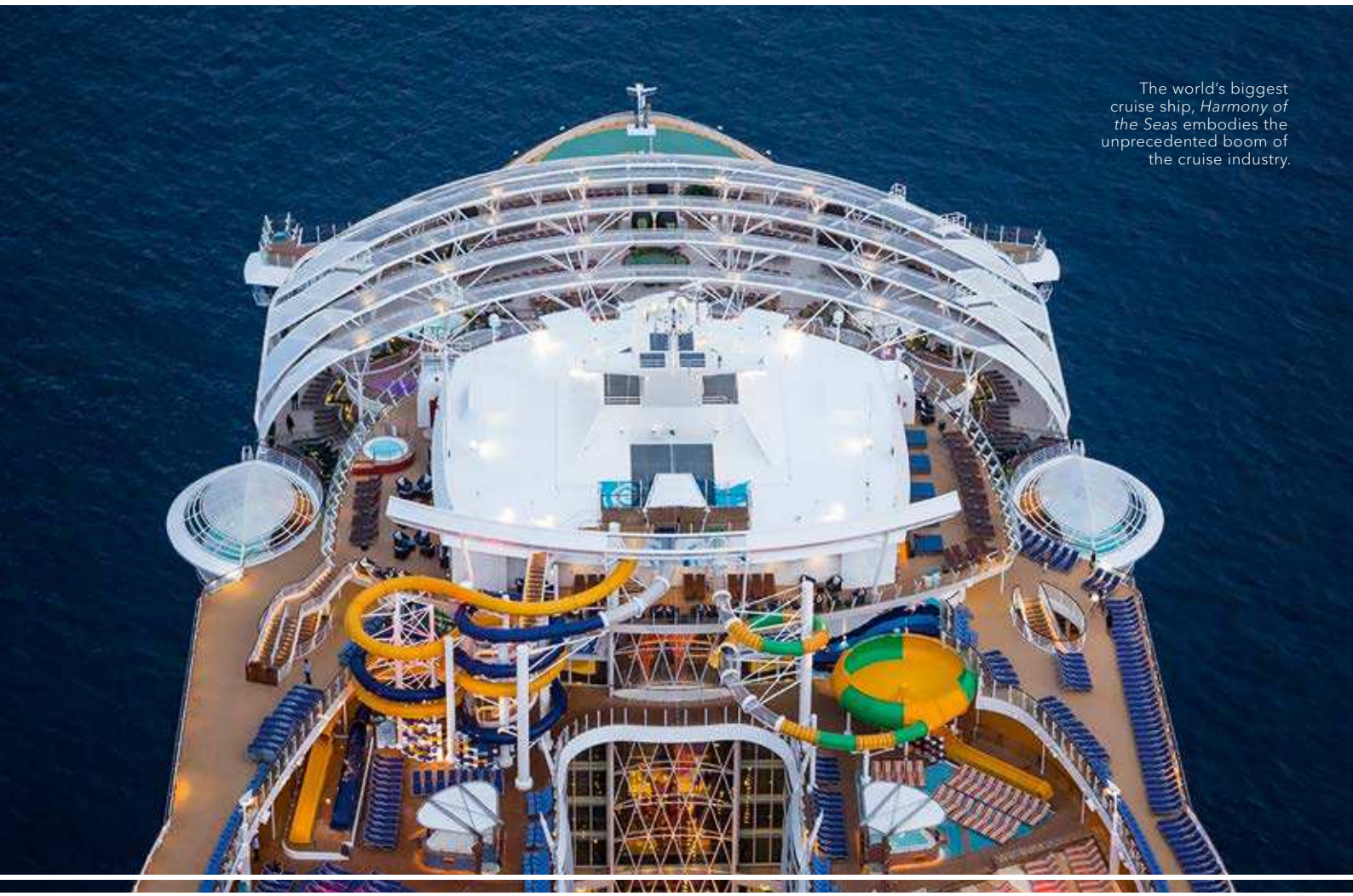
To date, nearly all cruise ships have been using conventional fuels. However, the first LNG-fuelled vessels are awaiting completion, and natural gas appears to be a favourite for newbuilding projects over the next decades. On a lesser scale, fuel cell technology is steadily improving and will play an increasing role as well.

The cruise segment is still in the early days of the energy shift, and Carnival's and RCL's LNG projects and RCL's fuel cell plans are promising indications of an emerging transition that could produce fascinating results.

The energy challenge comes with two key questions: what will be the dominant, i.e. the most cost-efficient and sustainable, fuel in future as we strive to find an affordable, carbon-neutral propulsion technology? And secondly, how can we optimize on-board energy efficiency and lower the energy demand?

Efficiency

Cost-efficient operation is a core objective for any profit-oriented business, even in good times. There is still much room for



The world's biggest cruise ship, *Harmony of the Seas* embodies the unprecedented boom of the cruise industry.

improvement in the way we operate and how we manage vessels. True cost-efficiency is not necessarily achieved by selecting the cheapest solution for a given purpose; rather, the focus should be on finding the best way to minimize the total cost base over time. Here again, the courage to innovate can make a big difference.

A key enabler in improving efficiency, optimizing fleet management and ensuring well-informed decisions is advanced business intelligence. Today's vessels are highly connected but much of the data is simply stored somewhere without unlocking the insight hidden therein. The challenge is to learn how to capture the data, organize it and extract meaningful information. This requires bringing new capabilities to the operation of ships, whether through data scientists or other expertise. We believe that the winners in the cruise business will be those who succeed in forming interdisciplinary teams combining traditional maritime competence with new capabilities.

Passenger experience

The passenger experience in the early days of cruise shipping was dramatically different from what it is today. Innovation will doubtlessly continue; in fact, it is a key differentiator and a critical growth factor in the market. To attract new customer groups, operators are offering entirely new routes, such as expeditions to the Antarctic, while on-board entertainment and leisure facilities are getting ever more sophisticated.

Enabling innovation

At DNV GL, we believe the innovation challenge is a key factor for our clients' and our own future business success. We are constantly building expertise and developing our services to enable innovation that adds value to our clients' fleets while making ships safer and more efficient. DNV GL adapts its approach to our individual clients' strategic and business needs to support their growth and ensure the best holiday experience for their guests. **HH**

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Photos: DNV GL, Royal Caribbean International

MOOD MATTERS

The cruise industry is booming and with vessels growing in size and complexity, so does their interior. DNV GL met with Finnish design office dSign Vertti Kivi & Co. to discuss some of their stand-out projects, the relationship with class and which trends will shape the future of cruise ship interior design.

The mood of a room is one of the things Vertti Kivi thinks about most when he and his team develop their proposal for what a cruise ship should look like from the inside. As Head of Design, CEO, and co-owner, Kivi heads dSign Vertti Kivi & Co., one of the newest additions to the interior design field in the cruise market. The design office is based in Helsinki, Finland, and has completed more than 1,000 projects since being founded in 1993. "Our previous work included Michelin-starred restaurants and boutique hotels, office and retail spaces and airplane interiors," Kivi says. But despite being a relative newcomer in the maritime industry, dSign has already realized several impressive projects. "I think being new means we can offer a fresh approach to finding ways to attract and impress the guests on board," he adds.

The first maritime project dSign worked on was the complete interior design of the *Viking Grace*, which sails between Finland and Sweden. One of the main attractions on the route between Turku and Stockholm are many small islands which make up one of the most extensive archipelagic complexes in the world. "Our aim was to create restaurant spaces with strong ambiances and changing moods, which don't necessarily compete with the views of the archipelago, but add something to the overall experience and entertain the passengers, especially when it's dark," says Kivi.

Everyone pulls together

With the contract to design twelve public areas on board TUI Cruises' *Mein Schiff 3* and *Mein Schiff 4*, both classed by DNV GL and delivered by the Meyer Turku shipyard in 2013 and 2014 respectively, Kivi's team moved into deeper waters. The successful completion led to orders for the interior design of two more sister ships, *Mein Schiff 5* and *Mein Schiff 6*, which included all shopping areas, the large Meerleben maritime museum, cafeterias, bars, the casino, a night club, as well as the executive lounge

The Meerleben Maritime Museum space on board *Mein Schiff 3*, also provided on board *Mein Schiff 4*, *5* and *6*, has many features that get the passengers involved, including an interactive globe and video projection.

A computer rendering of the Cigar Lounge on *Mein Schiff 4*

> "I think our strength lies in that we can approach the tasks set with a fresh look at things, putting creativity first in the beginning of the process."
>
> **Vertti Kivi**, Head of Design, CEO and partner of dSign Vertti Kivi & Co

and the teens only area. dSign's most recent interior design project is on board another Meyer Turku construction: Tallink's new 2,800-passenger *Megastar* ferry.

"One thing that strikes me about the maritime industry is how everyone on board the vessel under construction pulls together to work towards getting the job done in time and as specified. As a designer, I really appreciate suppliers and the project partners asking about the idea and purpose of a particular space," says Samuli Hintikka, Head of Design at dSign. "This was not common in land-based projects. In the design process for ship spaces new ideas are also brought to the table without hesitation. This emphasizes the strength provided by so many people engaged in and working on the same project, resulting in spaces one person could not achieve alone," explains Kivi.

Accounting for regulations

The interior design for a new ship starts some two years before the vessel is completed. "In a series of vessels the owner often specifies reference areas on board existing vessels, which are to provide the baseline for the cost level of the area to be designed," says Kivi. When the main idea of a space is fixed, Kivi and his team start with the technical drawings, including the arrangements and wall projections. Designing passenger ship spaces comes with a long list of regulations that are uncommon in land-based projects. "We at DNV GL work closely with designers and the yard to ensure all design ideas can be realized in compliance with our class rules as well as international and national requirements, if applicable," explains Andreas Ullrich, Senior Principle Engineer International Rules at DNV GL. For example, an interior architect has to understand what materials can be used on board and account for their rigidity and strength, their fire class, weight, cost, availability, and repairability. All systems, machinery, lighting, furniture and materials on board have to be IMO-certified. "Close collaboration with class is essential every step of the way, especially in aspects related to fire safety. All areas have to be able to resist specified fire loads, and the fabrics and furniture have to be fire- and flame-retardant," Kivi says. To ensure passenger safety in a worst-case scenario, DNV GL also provides fire simulation and evacuation process analyses.

Once compliance with class and IMO rules is ensured, "one of the most important aspects to consider for the interior design of bigger cruise ships is to create a smooth customer flow between areas and ensure the room layouts allow for different functions and mood designs. We always pay extra attention to lighting design. It is a vital part of mood design, and no interior looks good in bad lighting, especially when it's dark," says Kivi.

Morphing spaces

One trademark of dSign is the SpaceAlive concept, which modifies the mood and visual elements of a space according to the changing needs throughout the day. Various areas on board *Viking Grace* transform in appearance and functionality depending on the time of day or night. For example, a ship lounge may transform from a daytime meeting room or cafeteria to a bar at night, with chairs and tables that rise automatically, removable walls and changeable lighting. "When we designed the interior of Tallink's vessel *Megastar*, we managed to design a new kind of layout for the lobby and got rid of the long, frustrating corridors, which are so common on ships," Kivi explains.

In the future, Kivi expects to see a greater number of multi-functional spaces on board cruise vessels. "Passenger expectations towards the sheer variety of available experiences on board are growing constantly. And because the overall space is limited, I think we will see more and more space designs that can be adapted to the guests' varying needs during the day," he explains.

DNV GL's Andreas Ullrich welcomes new ideas and innovative concepts on board. "Designs are becoming more complex with every new project and some introduce new materials on board cruise vessels. Our role as class is to make sure these ideas and materials can withstand daily operational stresses and emergency situations," says Ullrich. "Testing the feasibility of new ideas and finding ways to help designers realize their concepts safely is one of the most exciting aspects about classification in the cruise industry, a sector that is bursting with fresh input. I am sure this will continue in the future, as will the close cooperation between yards, designers and ourselves at DNV GL." ▮ **HS**

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Photos: DNV GL, dSign Vertti Kivi & Co

Submersibles open up a whole new world for cruise passengers to explore – including fascinating areas divers cannot reach.

BREAKING THE MOULD

With the increasing popularity of the cruise market and as superyacht owners seek the next thrill, the private submersible sector is expected to grow substantially over the next few years. CRUISE UPDATE looks at some of the latest DNV GL projects in this field.

At the U-Boat Worx production facility in the Netherlands, a group of engineers have gathered around the three-metre-long submersible *Super Yacht Sub 3* for its factory acceptance test. Once it passes a visual inspection and dry tests on the propulsion, electric and hydraulic systems, the submersible is taken for harbour and sea trials. The *Super Yacht Sub 3* is one of the most popular models produced by U-Boat Worx in Breda. The Dutch manufacturer specializes in submersibles for the pleasure boat and research sectors. "Our aim is to make our submersibles as safe, manoeuvrable and comfortable as possible. To ensure they meet the highest quality and safety standards, we have been cooperating closely with DNV GL for a number of years," explains Erik Hasselman, Commercial Director at U-Boat Worx.

3,600 tonnes of pressure

"Submersibles can reach depths of up to 300 metres and open up a whole new world for cruise passengers to explore, including areas that divers cannot reach," says Andreas Fischer,

"To ensure our submersibles meet the highest quality and safety standards, we have been cooperating closely with DNV GL for a number of years."

Erik Hasselman, Commercial Director U-Boat Worx

DNV GL Inspection Engineer – Pressure & Underwater Technology. "Every new model is tailor-made for the customer, and all calculations have to be made against pressure considerations to check whether the sub can withstand these kinds of depths," he adds. At 300 metres the submersibles' acrylic viewpoint has to resist a total force of 3,600 tonnes.

DNV GL works closely with U-Boat Worx from the design to the production phase to ensure new models achieve compliance. "Designing these subs is a challenge because we develop submersibles that can be fitted on board vessels such as superyachts. This means that the design has to be very compact while still being able to accommodate three passengers. Working with experienced staff from DNV GL has helped speed up the design process significantly," says Stefan Franken, U-Boat Worx Manager – Classification & Quality.

SUPER YACHT SUB 3
Capable of diving 300 metres deep, it can withstand pressure equivalent to 3,600 tonnes.

Tight fit

Fitting models such as the *Super Yacht Sub 3* on board a vessel requires a freeboard extender so the submersible can handle sea state three and wave heights of up to 1.5 metres. In addition, the freeboard must not be fixed permanently otherwise the craft won't fit on the superyacht. To ensure the highest safety standards, the submersible's 200-cell lithium-ion battery propulsion system is externally mounted and equipped with a specially developed cell monitoring system to stop the batteries from overheating or deep discharging. The submersible has a 96-hour life support system to provide passengers with sufficient breathing air in case of an incident. The pilot also needs to press a so-called "dead man's handle" every ten minutes otherwise an alarm system is triggered, which immediately takes the submersible safely back to the surface. As an additional safety feature, the submersible can also be operated remotely from the support vessel.

The *Crystal Esprit* makeover

One of the manufacturer's recent projects for the Los Angeles-based company Crystal Cruises, owned by the Genting Group, presented both the U-Boat Worx team and DNV GL classification experts with a particular challenge: fitting a *C-Explorer 3* submersible on the seasoned cruise ship *Crystal Esprit*. "The *C-Explorer 3* was part of a larger upgrade programme for the *Crystal Esprit*. The main tasks were to prepare the foundations for the sub and fit the retractable telescopic crane and the 'access hatch' where passengers board the sub," explains Jamel Eddine Barhoumi, DNV GL Principal Surveyor and Lead Auditor, who worked on the *Crystal Esprit* project at the Sembawang Shipyard in Singapore. >

Photos: U-Boat Worx / Rob Aarsen

C-EXPLORER 3
Designed to be carried on board a cruise ship, the craft enables breathtaking dives for cruise passengers.

> "Making space for the submersible was a challenge and required precise measurements. Quite a few things had to be relocated, for example ventilation ducts and mooring bollards, and pipes had to be rerouted," he adds. DNV GL also worked closely with the superintendent regarding the lifting procedures for the six-tonne submersible. After about three months, the *C-Explorer 3* was lifted and stowed on board *Crystal Esprit* in Penang, Malaysia, and officially launched and tried out in the Seychelles.

The classification society has worked with the owners for more than 20 years. "We know each other's teams very well, there is very good cooperation from top management to the surveyors in the field," says Barhoumi. According to Captain Gustaf Gronberg, SVP Marine Operations & Newbuilding for Genting and one of the group's five certified submersible pilots, *C-Explorer 3* was received very well on the *Crystal Esprit*. "The sub has been in operation for more than a year, and we have taken her to the Seychelles and to Croatia. Often people imagine a cigar-shaped submarine with a tiny window, but this model gives an incredible 360-degree view." *Crystal Esprit* has been a success story for U-Boat Worx's production team as well. The Genting Group has ordered four more submersibles from the Dutch manufacturer.

Biggest cruise ship with submersibles on board

U-Boat Worx has gone on to produce and install two submersibles on the recently delivered cruise vessel *Genting Dream* (see page 22). The Asian luxury cruise liner can carry 3,348 passengers and is the biggest cruise ship to be equipped with submersibles.

"In this case, we faced none of the usual space constrictions. So from a technical standpoint, the installation of the submersibles was relatively straightforward," says Erik Hasselman from U-Boat Worx.

The two *C-Explorer 5* submersibles will be able to carry four passengers and a pilot and dive up to 200 metres under the surface. "They are deployed using a crane, which swings the submersible over board and lowers it 21 metres down to the ocean's surface. This is an unmanned operation, of course, passengers board the submersible from a tender boat," adds Hasselman.

New concepts, ambitious plans

Deployed during anchoring periods at sea, the submersibles can embark upon up to eight dives a day. They are powered by four 130 VDC battery packs (31.2 kWh) and have a typical underwater cruising speed of three knots.

Meanwhile, U-Boat Worx is working on several new concepts, including a seven and a nine-seater as well as a faster sports submersible. DNV GL will continue to support U-Boat Worx in its ambitious plans and ensure new ideas can be taken from the concept to the manufacturing stage as smoothly as possible. ■ **HEH**

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Photos: Meyer Werft/Ingrid Fiebak-Kremer, U-Boat Worx/Ian Schemper

The *Genting Dream* carries two *C-Explorer 5* submersibles that can each take four passengers down to a depth of up to 200 metres.

A look inside the manufacturing facility of U-Boat Worx in Breda, the Netherlands.

THE NEW ECOSHIP

The Japanese NGO Peace Boat takes a daring step into the future of sustainable shipping, joining forces with industry experts to develop the most eco-friendly cruise ship ever.

Cruise vessels are among the most demanding ship newbuilding jobs in the world. Technically sophisticated and subject to very strict regulatory requirements, major cruise vessels demand levels of safety, quality, innovation and engineering expertise unlike most other projects. This makes it all the more astounding that Peace Boat, the Japan-based international non-governmental organization (NGO), would set themselves the task of developing what might be the most innovative and ecologically friendly cruise vessel ever.

"Peace Boat has been sailing since 1983 on our educational and advocacy voyages for peace and sustainability. We have used chartered ships to date, and have become increasingly

MAIN DATA

- Gross tonnage: 55,000 GT
- Total length: 224 m
- Beam: 31 m
- Draught: 8 m
- Top speed: 21 knots
- Optimised cruising speed: 17 knots
- Passenger capacity: 2,000
- Number of cabins: 750

determined to close the gap between our message and the reality of operating a cruise ship," says Yoshioka Tatsuya, co-founder and Director of Peace Boat. "We know that cruising is very visible to the public and it therefore has both great potential and great responsibility to make changes that will accelerate sustainable innovation." From this vision, Peace Boat set out to create a vessel design and a set of specifications that would see the Ecoship not only act as a floating exhibition centre for the latest environmentally friendly technologies and stay ahead of the regulations, but offer a transition model towards a low-carbon economy.

The design process was in its own way a departure from traditional models of shipbuilding. In April 2014, Peace Boat gathered world experts on naval architecture, marine engineering, renewable energy, energy efficiency, maritime law, biomimicry, and biophilia in Hamburg for an Ecoship design charrette.

Sustainable development goals

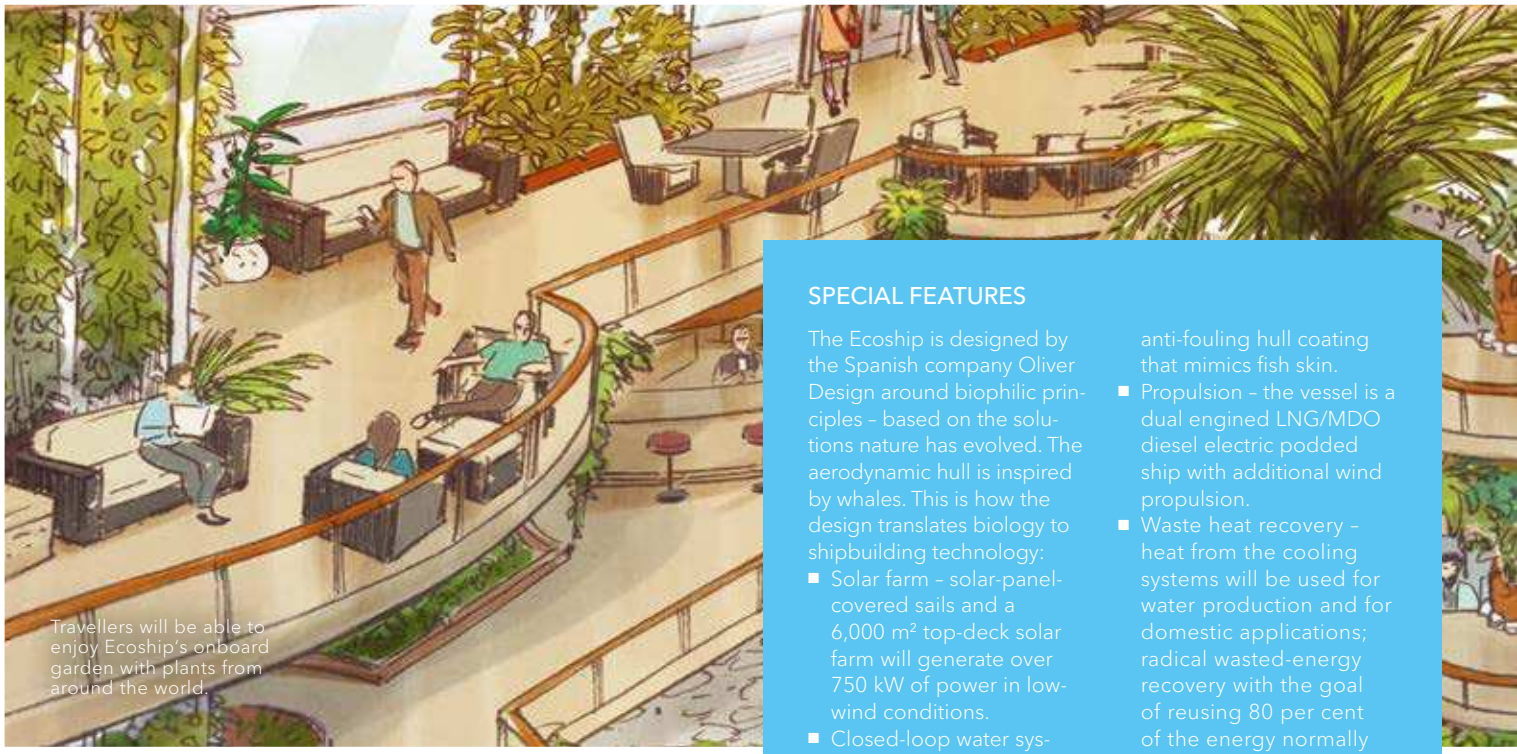
The aim was to come up with a holistic, integrated design approach, based on the belief that elements of a system work best when they are specifically designed to complement rather than to compensate for each other. "When we started the design phase we consulted DNV GL, who were immediately enthusiastic about the project, attended our charrette and played an important role in the development," says Andres Molina, Project >

Photos: Peace Boat/DNV GL

"We know that cruising is very visible to the public and it therefore has both great potential and great responsibility to make changes that will accelerate sustainable innovation."

Yoshioka Tatsuya, co-founder and Director of Peace Boat

Hybrid propulsion combines solar panels with wind, LNG and marine diesel oil for the smallest possible ecological footprint.



Travellers will be able to enjoy Ecoship's onboard garden with plants from around the world.

SPECIAL FEATURES

The Ecoship is designed by the Spanish company Oliver Design around biophilic principles – based on the solutions nature has evolved. The aerodynamic hull is inspired by whales. This is how the design translates biology to shipbuilding technology:

- Solar farm – solar-panel-covered sails and a 6,000 m² top-deck solar farm will generate over 750 kW of power in low-wind conditions.
- Closed-loop water system – it ensures that waste water is reused, purified and re-purposed, along with rain and seawater, for irrigating the on-board garden.
- Ten masts – under optimal conditions, the masts will harness wind energy to reduce propulsion fuel needs.
- On-board garden – an on-board garden serves as the heart and the lungs of the ship, featuring plants from around the world fed by rainwater and organic waste.
- Hull coating – plans are underway for a non-toxic, anti-fouling hull coating that mimics fish skin.
- Propulsion – the vessel is a dual engined LNG/MDO diesel electric podded ship with additional wind propulsion.
- Waste heat recovery – heat from the cooling systems will be used for water production and for domestic applications; radical wasted-energy recovery with the goal of reusing 80 per cent of the energy normally lost in the air and in the water.
- Energy storage – managed by a combination of the latest technology for batteries and hot and ice storage tanks.
- Ballast water treatment – the most environmentally friendly solution is currently being researched.
- Research lab – a climate change and ocean research observatory is planned.
- Ice class – the plans call for a Type C vessel and IMO PC7 ice class with –10 °C design temperature.

> Director, Peace Boat. "We believe DNV GL has a great capacity to evaluate novel designs and is very agile in providing the proper answer to each new safety and technical challenge. Most importantly, we know that DNV GL, with its strong commitment to sustainable development goals, shares our vision for the Ecoship." One of the DNV GL experts who attended the charrette in Hamburg was Andreas Ullrich, Senior Principal Engineer. "Having worked with Peace Boat since they entrusted us with their vessel *SS Oceanic* in 2009 through to their current ship *Ocean Dream*, I was intrigued. For a classification society it is always great to be asked for technical support on such an innovative project because it reinforces our sense of working cooperatively to ensure the best solutions for the customer both commercially and in terms of class rules and international regulations. Also, having just released the new DNV GL rule set at the beginning of 2016, such a project is a great match for

Sustainable luxury on board includes a multi-purpose auditorium for audiovisual presentations and other events.

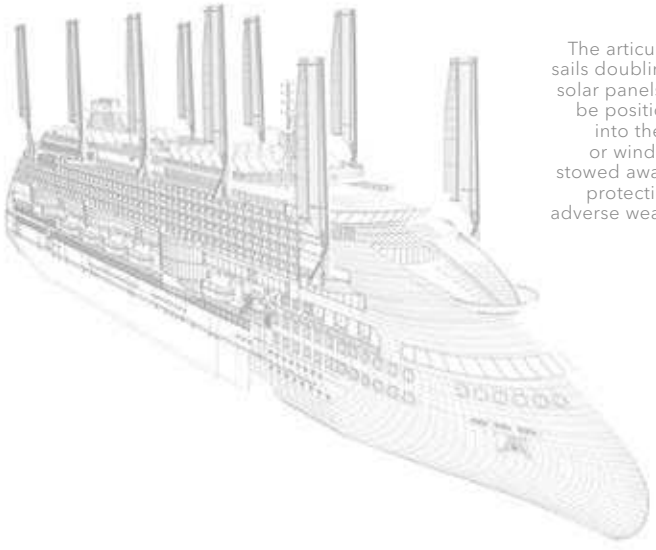
The top-deck solar farm will generate over 750 kW of power in low-wind conditions.

Photos: Peace Boat/DNV GL

the flexibility and encompassing nature of the rules – which are designed to adapt to new technical challenges and modern design," Ullrich says.

Norbert Kray, DNV GL – Maritime Area Manager for Japan, agrees: "It is very special to work with a customer who is so in tune with the values of DNV GL. Their emphasis on sustainability, achieved through innovative approaches and the smarter use of technology, matches our own, and this project could be a great showcase for the industry. It is a privilege to be part of this."

For Peace Boat, the Ecoship is not only important for its mission but for the entire maritime industry: "As the cruise industry is growing so fast, particularly in East Asia, the need to mitigate the environmental impact is very important. Through its technical characteristics and the programmes that it carries out we hope it will encourage a model for 'green' cruising and further innovations in the cruise industry," says Yoshioka Tatsuya. **SA**



The articulated sails doubling as solar panels can be positioned into the sun or wind, and stowed away for protection in adverse weather.

MEMORANDUM OF UNDERSTANDING

At the SMM 2016 trade fair and exhibition, Peace Boat and DNV GL signed a Memorandum of Understanding on the design, construction and operation phases of Peace Boat's Ecoship and the promotion of the Ecoship as a flagship for climate action, the Sustainable Development Goals and sustainability in shipping.

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DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry – across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

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