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NOVEMBER 2017 #28

ENGINEERING TO THE EXTREME



GustoMSC

THE PIONEERS OF OFFSHORE ENGINEERING



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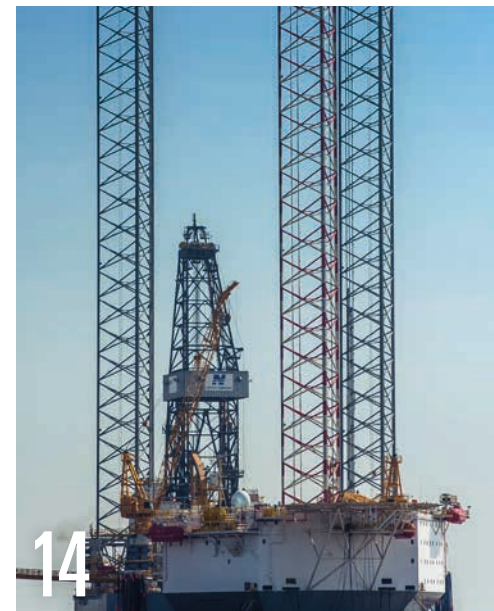
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WORKING SAFELY AT SEA

The current conditions in the energy market continue to put pressure on offshore operations, whilst maintaining quality and safety. GustoMSC's mission statement fits seamlessly to these conditions as we provide core technology for building safe and highly efficient mobile offshore units. First in a series of four articles on the importance of complete and secure solutions.

COLOPHON

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PREFACE ENGINEERING TO THE EXTREME



Although offshore market conditions have improved slightly over the last year, the recurring theme of cost saving remains highly relevant in our industry. All activities at sea are affected by this theme and it involves solving the challenges in new project developments, as well as paying continuous attention to improvement in the ongoing work. Different cases should be explored to find the optimal solution for the problem. It is a difficult puzzle to solve, but luckily not as complex as Rubik's cube with its three billion combinations, since most of the time there are several solutions to choose from rather than a single solution as for the cube.

Like the cube, many steps have to be taken to arrive at the desired outcome. Where the cube is solved by smart algorithms, our battle with the elements is addressed by our people. With our advanced engineering skills and close cooperation with our clients, we translate experience, science and technical knowledge into realistic and innovative ideas. Puzzling these together brings solid, efficient and safe solutions to the market. Our solutions have been around for decades and are relevant for new build situations, but also for upgrades and conversions to make better use of an existing unit. In this issue, we emphasize how our expertise is relevant to owners and operators of mobile offshore units and equipment. Our CEO Nils van Nood and CFO Peter Uitbeijerse, members of our

Executive Board, explain how our mission statement fits seamlessly with the current market conditions, underlined by the interpretation of some of our colleagues.

A wide range of challenges have to be conquered at sea. For GustoMSC this translates into trying to overcome extreme design conditions in combination with economic feasibility and the highest safety standards. In our cover story we discover that a similar challenge can be found in the Volvo Ocean Race. We can learn from the teamwork in this exciting and competitive maritime endeavor: how do you develop a top performing design, what does it demand of your team, and how are cost, safety and performance balanced out in a racing environment?

Furthermore we feature our own efforts in the turbulent offshore environment dealing with new extremes by relying on our specialist knowledge and elaborate experience. You can find the facts and figures of our NG-20000X with a telescoping leg crane, our technology demonstrating flagship for the future of offshore windfarm installation. It combines our proven track record in jack-up and crane design with a crane design innovation that enables installation of heavy wind turbine components at extreme heights, while also being able to install the heavy foundation of the wind turbine. In the same context,

one of our colleagues presents the extreme challenges that we had to conquer to engineer the record breaking CJ70 Cat-J drilling jack-ups. In addition, in an interview with Peter Cunnion, Senior Vice President at Northern Offshore, he explains how his company conquers market challenges with its sharp vision and next-generation of jack-up rigs.

For any puzzle in the field of working at sea, we are looking forward to trying a couple of combinations with you to find the right solution. Using our toolbox filled with our instruments required for engineering to the extreme, we are confident we can solve your challenges concerning working at sea.

We hope you have a nice read.

Sjoerd Hendriks
Manager Marketing and Communication GustoMSC

UP-TO-DATE

SECOND CRANE BOOM INSERT TRUSS FOR FRED. OLSEN WINDCARRIER

In early July of this year, GustoMSC received the order to supply a crane boom insert truss for the Brave Tern of Fred. Olsen Windcarrier. This order resulted from earlier work upgrading the Bold Tern and the Brave Tern and is similar to the lengthening of the boom already performed for Bold Tern. It is the fourth GustoMSC round the leg crane to be upgraded to keep pace with the ever-growing requirements in the offshore wind installation sector.

In 2016 Brave Tern was upgraded with leg extensions and was already prepared for the

lengthening of its crane boom with changes made to the crane's A-frame, winches and 'splitting' of the boom to receive the insert truss for the extra length.

The engineering for these upgrades was performed by GustoMSC, with execution of the actual work on the vessel carried out in the Rotterdam area. GustoMSC's scope of the upgrade includes engineering consultancy on the unit as a whole, engineering of the leg lengthening, engineering of all required changes to the main crane to receive the

lengthened boom, and commissioning of the boom insert truss after installation.

This time our delivery for the Brave Tern includes supplying the insert truss to Fred. Olsen Windcarrier, as well as on-board measurement of the existing boom to make sure the new boom section will be seamlessly integrated when finished.

Alain Wassink
Commercial Director

ISDS LETTER OF COMPLIANCE FOR GUSTO MSC JACKING SYSTEM

DNV GL, one of the largest classification societies for ships and offshore installations, issued a letter of compliance for the GustoMSC jacking system on Statoil's Cat-J units (GustoMSC CJ70 design). The first one ever issued for a jacking system!

The letter of compliance is issued based on assessments and reviews in accordance with the DNV offshore standard OS-D203. This standard focuses on the integration of software-dependent systems, sub-systems, and system components. It also reviews their effect on the overall performance of the unit (ship, rig, etc.) in terms of functionality, quality, reliability, availability, maintainability, and safety. Among other aims, OS-D203 intends to reduce the risk of delays in new-build projects and modification projects and the risk of downtime and accidents in the operation phase. Furthermore, it improves the processes

for maintenance and upgrades of software-dependent systems throughout the life cycle.

In addition, the jacking system software has been submitted to a number of 'Hardware In the Loop' (HIL) tests executed by the Norwegian company Marine Cybernetics (presently part of DNV GL). In these tests, instead of being connected to the actual equipment on the vessel, the jacking control system is connected to a HIL simulator with sophisticated models of the equipment. This enables systematic and comprehensive testing of control system functionality and failure handling without risk to people, equipment, or the environment.

Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Both the HIL tests and the letter of compliance for the GustoMSC jacking system on Statoil's Cat-J units (Askeladden and Askopot) ensure that our customers can safely and responsibly improve their business performance.

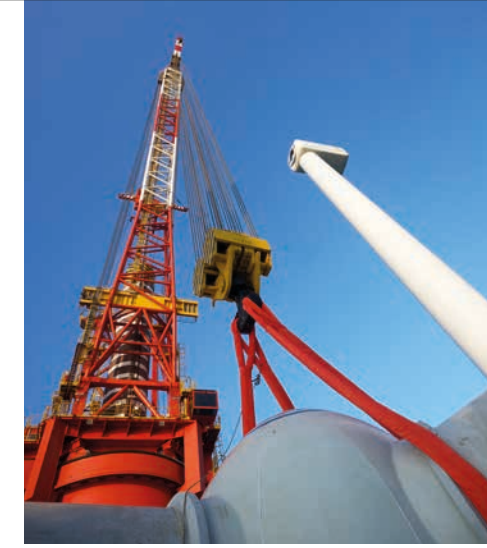
Jack Dalmaijer
Project Manager



RAINBOW CRANE FINAL DELIVERY & FIRST OPERATIONS

The first crane in cooperation with Rainbow Heavy Machinery Co., Ltd. was delivered at the end of July. Currently this crane is successfully installing its first offshore wind turbines. After the collaboration agreement was signed with Rainbow in Nantong in September 2015, the first crane was ordered in December of that year. This is a 1,000 t leg encircling crane with a lifting height of 110 m above the vessel deck for the installation of wind turbines. This crane is a further development of the successful 800 t and 900 t leg cranes which were delivered earlier.

GustoMSC has delivered the basic design and main components for this crane, including the electrical and control system, the slip ring system and the cabin and bogie bearing system, all in accordance with CCS rules. At the start of the project, a team of Rainbow engineers visited GustoMSC to learn and understand the working methods and design. During Rainbow's in-depth design process, GustoMSC engineers paid a visit for final alignment of the design and preparation of the installation and commissioning. Subsequently, GustoMSC was involved in the installation phase, had the lead during commissioning and



load testing and was present for assistance and training during the installation of the first wind turbines in August. Due to this very close cooperation between Rainbow and GustoMSC throughout the project, it was possible to successfully deliver this first crane to the end user in a very short time.

At the time of writing, the commissioning of a second crane, which is a copy of the first one, has been completed and load testing is expected in October/November 2017.

Arjo van Putten
Project Manager Cranes

JOINT INDUSTRY PROJECTS

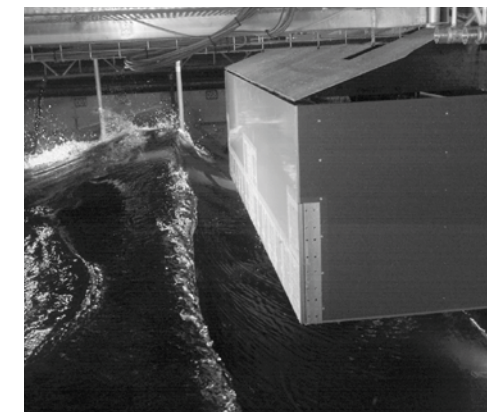
Recently a second series of model tests was performed in the depressurized wave basin of MARIN, where breaking waves were slamming into a deck box structure. These tests were part of the BreaKin Joint Industry Project (JIP) in which GustoMSC is participating. The JIP aims at a better understanding of the physics and scaling effects of breaking waves slamming into a box-type structure.

For GustoMSC, this JIP is a perfect example of how cooperation with other key players in the offshore industry, such as Statoil, Shell, and MARIN, can lead to improved insights and technologies. By working together it is possible to set up experiments which are typically not feasible on a project base, including thorough research and advanced model testing techniques. Moreover, the technical meetings and discussions among technical experts from various companies are highly valuable, setting the standards and paving the way for future commercial applications. An example of the next step towards a commercial application is the Sesam-ICE JIP. The aim of this JIP is to develop a widely available design tool for ice loads on offshore structures. GustoMSC will perform a verification of the numerical tool by comparison with model data. As an experienced designer, we are able to offer valuable input for this project.

The ExWave JIP is a typical example of setting safety standards in the offshore industry. Completed earlier this year, this JIP was initiated after various mooring line losses in sea conditions which were not extremely severe. An extensive desk study, combined with model tests, resulted in new guidelines for the assessment of mooring systems. As DNV GL was heavily involved in this project, the findings will definitely be reflected in the next generation of rules and regulations.

Furthermore, some developments take several consecutive JIPs, such as the development of ComFLOW, a Computational Fluid Dynamics (CFD) solver for violent flows. GustoMSC has been participating in these projects for many years and is now successfully applying this software in engineering consultancy studies.

Fons Huijs
Technology Coordinator Hydrodynamics



AGENDA

17 – 19 JANUARY 2018 EERA DEEPWIND 2018 TRONDHEIM

Paper presentation: Integrated design of a semi-submersible floating Vertical Axis Wind Turbine (VAWT) with active blade pitch control

29 – 31 JANUARY 2018 IADC/SPE MIDDLE EAST DRILLING ABU DHABI

Paper presentation: Enhancing jack-up performance using add-on spudcans

28 FEBRUARY – 2 MARCH 2018 WIND EXPO 2018 TOKYO

Participation in Holland Pavilion

20 – 23 MARCH 2018 OTC ASIA KUALA LUMPUR

Participation in Holland Pavilion
Poster presentation: Enabling SIMOPS from jack-ups

30 APRIL – 3 MAY 2018 OTC HOUSTON HOUSTON

Stand 3567

19 – 20 JUNE 2018 GLOBAL OFFSHORE WIND MANCHESTER

Stand 118

THE VOLVO OCEAN RACE

THE ULTIMATE TEST

The Volvo Ocean Race is often seen as the toughest team sailing competition of them all. It also poses a huge challenge for boat designers striving for the best possible performance. Their task is to achieve that perfect combination of speed, capacity, safety, sustainability and affordability. The extreme conditions of the Volvo Ocean Race mean that the designers face similar challenges to those that designers at GustoMSC have to deal with. In this cover story we discover which lessons we can learn from this thrilling and extremely competitive race across the oceans.

The Volvo Ocean Race is a sailing contest that takes participants all around the world, and is held every three years. The race is made up of stages and takes 8 to 9 months to complete. The first edition was held in 1973 and the race – together with the Olympic Games and the America's Cup – is one of the biggest sailing events in the world.

Fierce competition

The concept is simple: it's a round-the-clock battle to gain the edge over your competitors and triumph in the ultimate ocean marathon, which pits the sport's best sailors against one another as they traverse some of the world's trickiest sailing routes. In terms of team performance the race demands virtual perfection as the teams seek to get the maximum out of their boat.

A close team

The team has to work closely and in perfect synchrony. This is a must if the team is to keep up with the very fast pace of this race. It is also vital that the team can deal with stressful and unexpected situations. The crew shares an extremely confined amount of space on their boat – 24/7 with no comfort or privacy – for several months, often under extreme weather conditions.

A perfect balance

Many boats have participated in the Volvo Ocean Race several times before, and knowledge and experience are essential to beat the competition. Each team therefore needs a range of qualities. The crew needs focus, strength and stamina – and all these qualities need to be in perfect balance.

The 2017–18 edition

- Starting on 22 October 2017 from Alicante, finishing eight months later in The Hague.
- The longest course in the race's history: 45,000 nautical miles – crossing four oceans and visiting twelve major cities.

One Design racing – The Volvo Ocean 65

The introduction of the One-Design Volvo Ocean 65 has revolutionized the race, intensifying competition between the teams and ensuring that the race is won on the oceans rather than on the drawing board.

Before the introduction of the One-Design approach, other factors would generally be the key to winning the Volvo Ocean Race. To begin with, the race organizers regulated the main parameters that determined the speed of the boats, factors such as the length and weight of the boats and sails. The designers on each team would then try to produce the fastest possible boat within those parameters.

Then the design team would give their plans to a boat builder, who would go to the ends of the earth to find the best technology to make the boat as light and strong as possible.

Finally, the builders would hand the boat over to the sailors, who would use all their skills, stamina, strategy and technique to get the maximum out of what the designers and builders had produced, racing their boat as hard and as fast as it would go.

Then everything changed. The Volvo Ocean 65, which was introduced for the 2014-15 edition, is built to a single, tightly controlled set of plans from Farr Yacht Design. No longer do the teams need their own designers: the boat is designed for them. One of the benefits was the reduction in costs because there was only one set of plans, and one team of builders. But much more importantly, it meant that the 2014-15 Volvo Ocean Race was won and lost by the sailors themselves, out on the water.



Auckland

Newport

Itajai

Cardiff

Lisbon

Alicante

Gothenburg

The Hague

Cape Town

Hong Kong
Guangzhou

Melbourne

NATURAL SELECTION

VESTAS 11TH HOUR RACING TEAM

Is it possible to maximize your own success? And what is the true value of teamwork? Charlie Enright (Skipper) and Mark Towill (Team Director) are the co-founders of the Vestas 11th Hour Racing Team. They share their insights and experience of what it takes to make a difference – together.



'We are all working on the same goal: winning the race, regardless of your previous role or what you do behind the scenes.'

Mark Towill

Mark and Charlie first met while filming Disney's Morning Light in 2007, when Mark was 18 and Charlie was 21. They became classmates and teammates at Brown University and have been planning, managing, and sailing together ever since. In this interview, Mark and Charlie talk about their experiences.

Tell us about the balance between speed and safety: how far can you go? How do you control risks at high speed?

Mark: Safety is always our number one priority on board. We are constantly analyzing and assessing that balance between performance and risk.

Charlie: The Notice of Race gives you strict guidelines, like when you need to wear life jackets, and we always stick to those. But at the end of the day it is always our responsibility and as a team we all contribute to making sure the entire crew is safe on board.

'We surround ourselves with motivated people. Everyone is here to win so staying inspired comes easily.'

Charlie Enright

In which dimensions do you explore new possibilities?

Mark: Since the last race, we have looked at the lessons that we have learned and used all the knowledge gained to guide our decision-making process.

How did the last race influence your race concept?

Mark: We had many highlights in the last race as Team Alvimedica, getting around Cape Horn first. The wins towards the end showed us that we were constantly improving, so in between campaigns, we kept that momentum going.

Charlie: More experience leads to more confidence.

We have surrounded ourselves with race-winning experience – four of the crew members already have a Volvo Ocean Race win under their belts.

It is not all about winning. How do you ensure your team is the most sustainable one?

Mark: Thanks to our sponsor, 11th Hour Racing, we have undergone extensive sustainability training to educate ourselves about ocean health, climate change, and sustainability. And we follow a strict sustainability policy that covers everything from water bottles and recycling habits to helping collect data to share with the scientific community.

How valuable are stopovers to you during the race?

Charlie: Stopovers are a crucial opportunity for the team to regroup. We use stopovers as a chance to debrief so that we can continue to learn and improve. And of course, having our families come over is a huge boost to morale.

Your racing team consists of many specialists – how do you manage their expertise to guarantee the best result for the team?

Mark: Everyone has a role in the team but everyone also crosses over.

Charlie: In offshore sailing, all the sailors need to be well-rounded.

How do you keep your team inspired?

Charlie: We surround ourselves with motivated people. Everyone is here to win, so staying motivated comes easily.

Mark: We bring it back to the long-term vision. At nine months this is a long race so there are plenty of opportunities.

Which changes do you think will influence your efforts over the next decade?

Mark: Climate change and ocean health need our attention. So we want to use our platform as a sailing team sailing around the world to reach out and educate as many people as possible in order to inspire the current generation and the next generation.

ENGINEERING TO THE EXTREME

FARR YACHT DESIGN

The Volvo Ocean 65 is the new One-Design boat that contested the 2014-15 Volvo Ocean Race, and is also the One-Design boat being used for the 2017-2018 edition. At 65ft LOA (length overall), the new yachts are slightly shorter than the previous generation of Volvo Open 70s, but are more reliable, robust and affordable, while still giving very high performance. Responsible for this extraordinary achievement is Farr Yacht Design. We speak to their President Patrick Shaughnessy.

Farr has already designed forty boats for the race and has been involved in nine races. During the last few campaigns, the designers have been on the ground throughout to support the teams. Patrick Shaughnessy, President at Farr Yacht Design: 'They really take part in the race. That makes Farr somewhat unique – the combination of maximum support and dedication together with the extensive One-Design experience. To put it simply, in my belief there is no other team in the world that can bring all those elements together.'

We have noticed two new developments in the VOR65. The hard chine in the back of the boat provides added stability at wider angles with a "sitting" effect, reducing the roll when sailing. This improves safety and probably allows for the use of more sail power. However, the wave-piercing bow, which reduces motion, also increases the amount of green water on deck, reducing safety on deck but improving conditions inside the boat. How do you find the right balance between performance and safety?

Our internal goal at Farr Yacht Design was to provide the best possible performance within all the other parameters, particularly because we felt that our client had perhaps wrongly undervalued performance. But I would disagree that the bow design increases green water on deck, by the way. The relatively high freeboard, particularly forward, reduces the amount of green water on deck. And water that is on deck is diverted by the cabin, which is specifically shaped for that purpose. There is a lot of spray on deck, but spray is valued by the client in this case because it produces the right kind of images, in keeping with the event's PR goals.

Offshore racers are famous for pushing the limits and often going beyond them. How do you come up with a design as safe as the VOR 65, for users like the VOR sailors? Do you apply a special design methods for such users?

When you prioritize reliability, you get reliability, so it's not necessarily down to any other special design methods. We were well aware that the One-Design nature of the race would force the crews to push the boats to their limits and that was constantly in our minds when we were specifying safety factors and operational limitations.



We are also aware that history can repeat itself. The race now needs very safe and reliable boats to reassure its sponsors after a period of relatively fragile boats. The reliability provided by the VO65s will likely be undervalued by future generations, which will lead to another period of development, which might then lead a path back toward reliability.

The VOR 65 is designed with a specific layout, which implies a particular mind-set on how to use the boat. How did you approach deck layout? Were there discussions with the different competitors regarding the best layout, or was it a personal choice by the design team?

The initial conceptual layout for the boat was based on our own experience, and driven by our client's design brief. During the initial conceptual process, we relied heavily on sailor input from a few key areas such as the bowman, trimmer, and helmsman. A full size mock-up of the deck was then built, and a wider group of sailors, builders, riggers, shore team, and media resources was on site to work through construction detailing, sailing maneuvers, maintenance and so on. It was a team effort.

Have you adapted the design since the last edition?

Some small improvements have been made to address maintenance issues for this next cycle. Other than that, the majority of the changes have focused on areas that needed replacement in any case, like sails, media equipment, and so on.

In which dimensions do you explore or foresee new possibilities?

We approach our design work with a very open mind. As work on the VO65 progressed, several constraints were included by the team as a whole, and this had a major



‘We challenge ourselves to become fully immersed in the process and to help our clients achieve their ultimate goals.’

Patrick Shaughnessy

impact on the ultimate design of the boat. For example, as requirements on cost control and ease of maintenance were tightened within the design brief, we made the decision to have straight daggerboards that were lifted by control lines on the mast rather than by self-contained lifting struts. That decision dramatically reduced the performance of the boat, but reduced costs as well and resulted in easier maintenance.

In the end, the boat has very few innovative design solutions. Instead, it embodies a comprehensive solution to a group of very difficult constraints while achieving a highly economical and repeatable build. The end result is the most tightly controlled big One-Design boat in the world. And ultimately that is the innovation here, because there had never been a successful One-Design boat on this scale before.

How do you innovate constantly to set new standards for ocean racing?

We challenge ourselves to become fully immersed in the process and help our clients achieve their ultimate goals. We bring that same mind-set to every project we work on. We are unique in the industry because we work on all aspects of research, naval architecture, engineering, styling,

product development, sales, and we do all that under one roof, in one team, across a wide range of project types. Ocean racing is just one part of what we do.

How does Farr Design maximize the benefits for the racers with new features and improvements while minimizing costs and risks?

That really depends on the type of project. If our client is a boat builder they might be very focused on cost control, or warranty claim reduction. If our client is a sailor they might have very few cost control requirements and be willing to compromise quite a bit of reliability in exchange for performance. The unique thing about the VO65 was that our client was ultimately an event that wanted to prioritize reducing risks and costs over performance. That’s a hard thing for sailors to accept. To a certain extent the sailors have had to come to terms with the results of that trade-off – but without that focus, the event might not exist today.

How do you design to ensure maximum fairness with such a wide variety of competitors who all have their own preferences and use handmade mono-design boats?

The best thing One-Design can do is be truly One-Design. In our opinion, the only way to achieve a close competition, allow late teams to succeed, and achieve budget goals was for the event to be completely One-Design, including all equipment and information. As soon as you open up one avenue for development, the better-funded teams will invest everything they can to gain an advantage. We were able to convince Volvo to go for One-Design sails which was a big achievement. We would have liked to see the event control all performance information and level the playing field even further.

Were there many demands on the design concerning transportation, repairs and refits between races, to make sure all teams can finish even when things break?

We made a huge effort in this respect. Every component that was designed for the boats was considered not only

as a racing part, but also as a spare. How large is the spare pool, where does it sit, or move, and so on? Transportation was also a key component. The mast, for instance, was designed to be deck-stepped rather than keel-stepped, and the primary reason for that was to limit its overall length. That meant we could fit the mast into twice as many cargo aircraft and hopefully make it easier to transport.

Were there any design limitations due to logistics, like harbor draft, or bridge airgap?

Yes, all of those things are design constraints. At one stage we reconsidered the keel draft and consciously limited the number of potential stop-over ports. All of these trade-offs were carefully considered by the whole team.

Your design team consists of specialists – how do you manage their expertise to guarantee the best overall result?

Each project in Farr Yacht Design has a lead designer, and a project manager. Each person in our team has a particular area of focus, and together we all work on every project together. The lead designer is responsible for ensuring that the design effort is cohesive, and meets the design brief. The project manager ensures that the team works to a pre-set schedule and serves as a central point of communication. Working like this, in a fully encompassing way, our whole team contributes to the totality of a project in a very open and collaborative way. I would say that we are very self-motivated people who require very little management to achieve great results.

How do you inspire and keep feeding the team’s creativity?

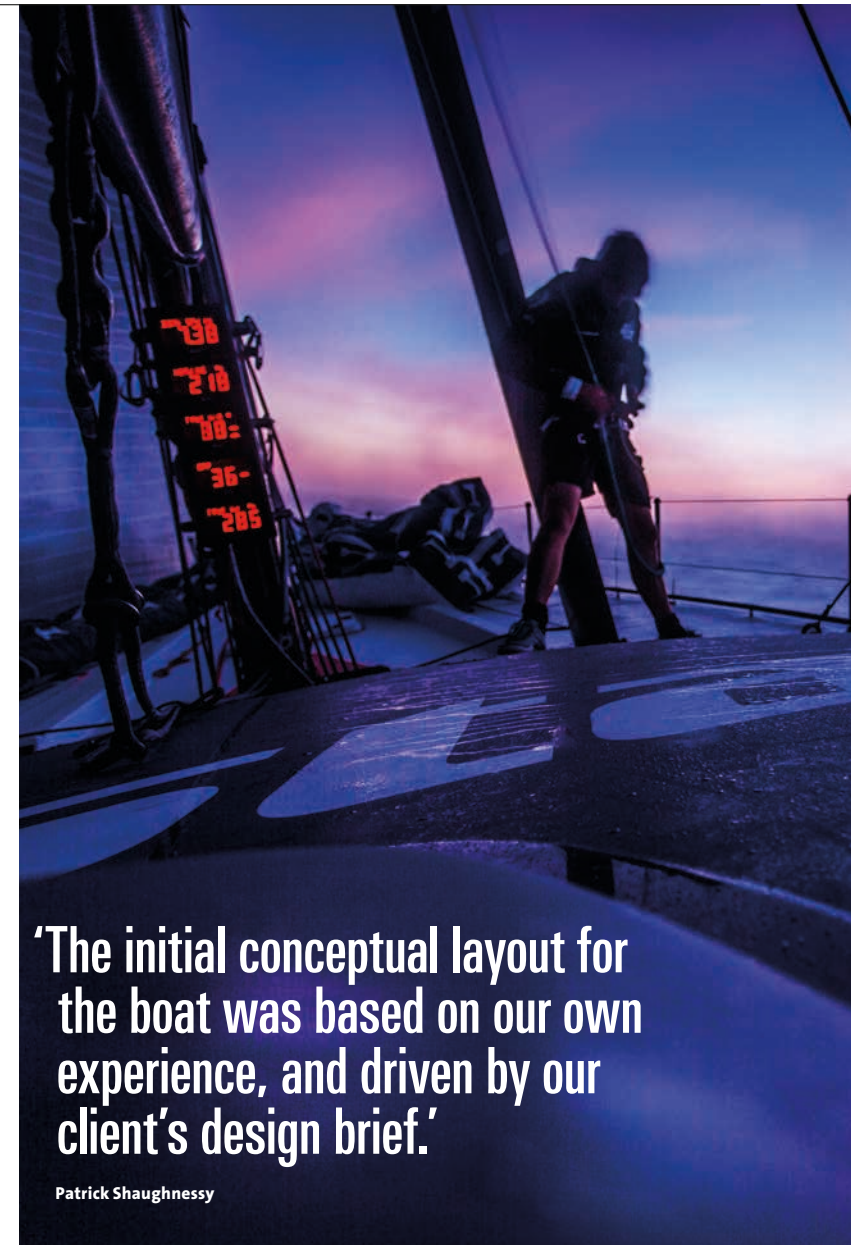
Inspiration is all around us. Our sport, the design world as a whole, and the great environment that we are blessed to work in provide ample inspiration.

Which (technological) developments and trends, including those that you are developing yourself, are relevant at this moment? What do you predict will influence your efforts over the next decade?

It would be hard to ignore foiling as an important trend in our sport at the moment. We have been researching and designing foil-assisted craft for the past three years and have a number of projects underway. Beyond that, I would say that all sorts of innovations are possible. Innovation is very good for the sport as a whole, especially if it can be utilized passively, and if it can ultimately reach the mainstream yachting public.

Do you think we can push mono-hulls even further, or are we reaching the limits of performance?

Of course they can be further improved, and substantially. The biggest limits are ones that we place on ourselves. Unfortunately, the typical rating rules that drive our sport stifle innovation. Because of that, innovation is always



‘The initial conceptual layout for the boat was based on our own experience, and driven by our client’s design brief.’

Patrick Shaughnessy

looking for loopholes to get through, or a fringe to exist in. But that stifling environment slows down the rate of innovation, and particularly the trickle-down to the majority of our sport. It can never be stopped completely though, which is good news for all of us.

What role do you expect sustainability requirements to play?

I hope that they will be very important. At Farr Yacht Design we very much want to be part of improving our environment. We’ve started by looking hard at ourselves and how we interact with our environment. We know that we also have a very unique opportunity to help our clients find a more responsible path forward. We welcome the opportunity to work with regulative bodies to help set sensible rules for our industry. Although sailing is viewed as a green sport, that is very far from the truth when you take a critical look at the whole process from start to finish. We need to do much better.

Do you think we will ever see a carbon-neutral ocean racer (plant-based composites, etc.)?

Yes. We must – and so much more. We owe it to our planet. Anyone who has spent time on boats has had an opportunity to interact with our environment in a very privileged way. We need to protect these things as if they were the most valuable things that we have, because in the end, they are...

2,500 T @ 120 M

NG-20000X THE RIGHT CAPACITY AT THE RIGHT HEIGHT

Since 2003 when the GustoMSC SEA-1250 jack-up 'BUZZARD' installed monopiles at Horns Rev 1, the wind farm installation market has rapidly advanced. To install the larger wind turbines larger and dedicated equipment was developed, leading to the realization of the world's largest self-propelled jack-up: the NG-14000X Scylla, which installed the huge monopiles for the Veja Mate project in 2016. The wind turbines on the drawing board for the near future will require a new generation of installation jack-ups to deal with the increasing weight and installation height of wind turbine components and the ever heavier foundations.

The NG-20000X is the ideal mix of mature technology and a practical telescoping innovation. It enables safe and efficient installation of future offshore wind turbines and their foundations. The design has the advantage of a large unobstructed deck area and a fully integrated jacking system providing a large deck loading capability and an unmatched crane capacity and lifting height on a solid and stable platform, reducing installation risks. The result is a very high variable load capacity of 16,500 tons, so the contractor can make a round trip carrying six complete sets of wind turbine components with nacelle weights of over 900 tons, or seven pieces of 900-ton jacket foundations, optimizing the cost per installed turbine or foundation.

Integrated telescopic leg crane

A key feature is the innovative combination of high hoisting height for tower, nacelle, and blade installation and heavy load capability at a lower height for foundation installation by the leg encircling crane. GustoMSC developed the telescopic leg crane to combine these two extreme requirements. By introducing a telescopic boom with a very high hook when extended, as well as increased hoisting capacity and extra side lead when retracted, it is possible to break the cycle of extremely long protruding booms and growing crane weights, resulting in a more economic crane design and increased variable load available for operations. The compact storage of the crane boom increases the allowable sea states in transit conditions, creating better performance in uptime. By further balancing out the jack-up design with an optimized leg design, the overall performance of the unit is improved even more, resulting in the best operational installation jack-up with a well-balanced CAPEX to OPEX – ensuring safety, efficiency, at low risk. The NG-20000X also offers versatility in other markets, such as the decommissioning of oil and gas platforms.

Jan-Mark Meeuwisse
Commercial Director

**EXTENDED BOOM
1,250 T
@ 160 M ABOVE DECK**
Extending the crane boom by 40 meters from retracted to extended mode can be performed within 16 minutes.

**RETRACTED BOOM
2,500 T
@ 120 M ABOVE DECK**
Installation of jackets and monopiles of up to 2,500 metric tons in retracted mode at a lifting height of 120+ meters.

**SELF-PROPELLED
11 KNOTS & DP2**
Cost saving by reduced mobilization time. Full control entering ports and reducing risk by precise and safe navigation.

**FREE DECK SPACE
FOR WTG COMPONENTS
5,600 M²**
6 complete 10+ MW WTG sets or 7 pieces of jacket foundations.

**MAXIMUM
WATER DEPTH
70 M**
With 90 m leg length under the hull, enabling operations in 70 m water depth.

**VSD
JACKING SYSTEM
150
OPERATIONS PER YEAR**
Specially designed for a design life of 20 years, with very frequent jacking operations.

**VARIABLE LOAD
16,500 T**
Large variable load in transit and in operational jacked-up condition.

**MAXIMIZED
VALUABLE DECK AREA
2ND BOOM REST**
Additionally positioned outside the forward leg, freeing up valuable deck area to load multiple tall objects like jacket foundations.

KNOWLEDGE GAINED FROM ALMOST 20 YEARS PAYS OFF



The Northern Offshore Energy Emerger (GustoMSC CJ46 jack-up design) during acceptance testing operations at the Shanghai Waigaoqiao Shipyard.

This interview shines a light on how Northern Offshore is gearing up to get its new jack-up rigs out into the market. The challenge is to position these new assets in a market where clients demand low-cost, modern solutions to address a new reality without compromising safety in day-to-day operations.

We spoke with Peter Cunnion, Senior Vice President & Regional Manager MEAP of Northern Offshore.

Northern Offshore is building a next-generation company with a next-generation fleet of jack-up rigs. What does your next-generation drilling rig proposition look like?

'Simply put, we aim to offer our customers the benefit of a high-performance drilling rig to drill wells more efficiently in this low-cost environment.'

How are you adapting to this low-cost environment?

'Northern Offshore recognizes cost efficiencies can only be gained through a multifaceted approach to running a smooth and safe operation. Beyond the gains of an efficient and reliable rig design, customers will also benefit from smart manning levels, the use of proven equipment, removing personnel from higher risk areas; such as the drill floor thanks to the use of mechanized pipe handling technology, and working closely with other vendors to reduce overall supply chain costs.'

Regarding your choice for the two rigs, CJ46 and CJ50 designed by GustoMSC: could you elaborate on how these designs meet your requirements?

'The GustoMSC design provided the palette for us to focus on features specific to Northern Offshore that we recognize as requirements as we move forward in our industry. These features are the expansive work area and profile of the GustoMSC X-Y cantilever design, and the large deck area for multiple off-line operations to improve operating efficiencies. Also, the 'X' brace leg design provides the robust operating capability needed for the future application of these rigs throughout their lifetime in the global environment. Each platform provides a great basis for adding equipment and setting up the rig as part of the drilling packages we offer.'

Which technological or operational challenges did you present to GustoMSC?

'When working on the rig designs, we challenged GustoMSC to provide specifications in the top quartile of rigs in the competitive segment. In both cases with the CJ46 and CJ50 this included power generation, torque, hole cleaning, circulating capacity, VDL and tank capacities. At every step of the way we pushed for offline capabilities in the design. One specific example: GustoMSC reworked the rig floor structural supports to allow offline BOP testing with drill pipe lowered from the rig floor. GustoMSC also worked with us to include sufficient power and cutting handling capability for back reaming into the rig's functional design. This feature is generally not considered in most rigs or drilling system analysis, but Northern Offshore requested it because this is one of the most demanding rig operations. We challenged GustoMSC even more when it came to the CJ50. We designed in dual mud systems, each with over 4,500 bbl capacity and many offline capabilities.'

How has the relationship with GustoMSC developed since the start of construction of the first unit?

'Northern Offshore has received outstanding support from GustoMSC since the beginning. Both companies have embraced a collaborative approach to ensure we deliver the most capable rigs to the market. We have used the knowledge collected during nearly 20 years of global operations to provide feedback to GustoMSC on new product design such as the Smart Crane and transom foldable work platform.'

Could you elaborate on the role your rigs can play in Brownfield development?

'The complexities of well designs have expanded with more and more technology applied to extend the life of brownfield properties. Northern Offshore has incorporated its own enhancements in its GustoMSC-designed units in areas such as power, fluid systems and off-line operations to deliver added value that helps extend their viability and continued operations.'

What is your opinion on the performance of the CJ46 and CJ50 rigs?

'Many features in both of the GustoMSC rig designs are performance-driven. Some of the most promising include



The CJ46 X-Y cantilever and NOV drilling package offer a 1,500,000 hook load capacity, 70 ft longitudinal and 40 ft transverse drilling envelope.

a high-variable load capacity, large mud pit capacity, a high torque top drive and high-pressure mud pumps. And not to forget off-line tubular handling, fuel-efficient and powerful main engine systems and the X-Y cantilever skidding system.'

Drilling capabilities vary from region to region. However, the overall increasing demand for rigs capable of drilling Extended Reach Wells, rigs set up for Managed Pressure Drilling and operations in a zero discharge environment were all considered from the beginning. These all played an important role in selecting the CJ46 and CJ50 rig design. What makes them stand out?

'The GustoMSC X-Y cantilever is superior in the Middle East region. Its large drilling envelope, high load path capacity throughout a broad skidding range and large deck spaces have generated real interest among potential customers. Although a proven rig design, the use of CJs has been limited in the Middle East region. However, many of the oil companies are now beginning to recognize the benefits that GustoMSC CJ rig design can offer in field development and HPHT drilling environments.'

Do they meet the challenges of today's market requirements and are the upgrades proving their worth?

'Operators in today's market require rigs that will enable them to drill their wells and develop their fields in the safest and most cost-effective manner possible. It really comes down to drillers working closely with operators in well planning and rig operations ahead of time. This way, steps can be taken to prepare rigs accordingly. There are significant benefits to be gained by moving routine operations such as picking up and laying down tubulars, mixing drilling mud or preparing completion fluid off the critical path. These functional specifications were considered in the selection of the GustoMSC CJ design from day one, along with the use of proven equipment to ensure rig reliability.'

Regarding Northern Offshore's ambitions in the Middle East with the Energy Emerger and Energy Embracer jack-up rigs (GustoMSC CJ46's): what role do you expect the rigs will play in this region?

'We are very pleased to add these two new rigs to our fleet and believe their versatility and capabilities will answer to what operators are looking for in the Middle East. Some of

'It really is about drillers working closely with operators by being involved in planning the well and rig operations ahead of time.'

Peter Cunnion



Peter Cunnion
Senior Vice President Northern Offshore

Prior to joining Northern Offshore, Cunnion was the Vice President - Technical with OES Oilfield Services, Director of Global Procurement for Weatherford International and had a 25-year career with GlobalSantaFe / Santa Fe International. He began working in the oilfield in 1981 with Santa Fe and worked in positions of increasing responsibility including Driller, Tool Pusher, Rig Manager, Rig Upgrade Project Manager, Technical Operations Manager, Rig Operations Manager and Managing Director.

Cunnion holds an associate's degree of Applied Science - Petroleum Technology from Eastern New Mexico University, is a graduate of the SMU Cox School of Business - Financial Discipline for Oilfield Executives, is a member of the Society of Petroleum Engineers, and serves as chairman of the Southern Arabian peninsula chapter of the IADC.

the technical advantages we have discussed are attracting the attention of customers in the region and we are looking forward to having the opportunity to demonstrate these features as rig demand increases in 2018 and beyond.'

Could you elaborate on the strategy the company is following in order to meet its ambitions in the Middle East?

'Respectfully, Northern Offshore doesn't reveal its strategies nor approach in a particular region, country, customer or project. What we will say is that Northern Offshore recognizes the long-term strategic position and importance that the Middle East region plays in the jack-up rig space. Northern Offshore is taking specific steps in our plans and focus that we believe will allow us to add value to our customers' projects in the region as we move forward in the near term and in the years to come.'

With respect to future developments in the offshore industry, what other changes or new requirements do you believe to be necessary in the foreseeable future in order to meet market expectations?

'A good question, and one that is debated all the way from the board room to the company man's office out on the rig. There are many new requirements that could be open for discussion, but for the sake of brevity I will only mention a couple - transparency and collaboration on well construction and delivery. This has been discussed at conferences such as this one for years. Advancing technology and new disruptive technologies and applications require us to be more transparent. We want to cooperate in a manner that acknowledges and allows drilling contractors to provide input and experience-based knowledge before, during and after to enhance the well construction and delivery process.'

What important technical innovations or challenges would you like to see solved for your vessels in operation?

'It is interesting that customers are expecting increased versatility from drilling contractors and the rigs they provide. They want jack-up rigs with high performance drilling capabilities. However, real operational efficiencies and cost benefits can be achieved by ensuring an ability to work at locations with low soil bearing capacity, very shallow water depths, very high air gaps and an ability to

carry out operations ranging from well intervention and work-over to ERD or HPHT with the same rig.'

With respect to future Northern Offshore market challenges: how do you see the role of Northern Offshore evolving in the future? What will the company's position be 10 years from now?

'In 10 years' time we see Northern Offshore focused on the same core values as the day we were formed - our expertise, resources and company-wide efforts prioritized and focused in the field in support of the rig operations to maximize the value we safely deliver to our customers. But we also see ourselves evolving as a drilling contractor that embraces advancing technology and innovation to enhance the performance and service that our assets deliver our customers. Moreover, 10 years from now Northern Offshore will be operating a significantly expanded fleet of premium jack-ups across multiple regions in both the Eastern and Western hemispheres.'

Can you reveal Northern Offshore's global market interests?

'Since its formation in 2000, Northern Offshore has performed drilling operations in most geographic regions around the world with a diverse fleet of semi-submersibles, drill ships and jack-ups. Today, our strategic focus is on operating high-specification jack-ups, such as the GustoMSC CJ46 and CJ50 designs, in all regional markets where customers value safe and professional operations combined with a willingness to pursue innovative commercial approaches which add value to the customer and to Northern Offshore.'



Contributing to the highest safety standards requires an overall understanding of the intended operation and its interaction with man, machine and environment.

The expertise of our professionals who design the offshore platforms make a significant contribution towards our clients' success.

This article is the first in a series, addressing developments in the theme of working safely and highly efficient at sea. This first issue describes GustoMSC's mission on the subject. In three consecutive articles the GustoMSC management team will shed their light on the mission statement in view of business development and marketing, on cooperation models with respect to design and equipment integration and on HR and the development of advanced technical skills; thus elaborating the theme 'Working Safely at Sea' in all its aspects.

WORKING SAFELY AT SEA COMPLETE AND SECURE SOLUTIONS DRIVE SAFETY AND EFFICIENCY

Projects at sea in offshore oil & gas and offshore wind are GustoMSC's most important markets. The current conditions in both markets continue to put pressure on the recurring themes of reducing the cost of offshore operations, while maintaining the highest level of quality. Our mission statement is completely in line with these conditions as we provide core technology for building safe and highly efficient mobile offshore units, but we also utilize our advanced technology, cooperation skills and practical and innovative ideas to support end-users to make optimal use of these units. This applies to new build as well as existing units employed at sea.

Although the markets are historically low, we firmly believe that in the near and far future mankind will keep exploring the seas for natural resources. Energy sources, like oil, gas and wind, but also the newer resources like solar power, water current, fish, minerals, and possibly tidal and kelp will play a role to support the growing population needs. In view of this future of safely and economically harvesting resources at sea, it is important to stress how our expertise is relevant to owners and operators of mobile offshore units and equipment. In this article, we outline how we execute our mission and what our focus is for the next years.

Safety as a precondition

Safety is a prerequisite offshore: it is simply expected to be at the highest level. That does not mean that safety does not require any attention, on the contrary, it continuously requires our full attention. That is why safety remains in the first place in GustoMSC's mission and is embedded in our design work and equipment.

Contributing to the highest safety standards requires an overall understanding of the intended operation and its interaction with man, machine and environment. This includes supplying an integrated and optimized arrangement and layout with safe location of equipment and escape routes, and it also entails providing structural integrity of the MOU and equipment.

We asked a cross section of GustoMSC staff to reflect on the changing context in which they work.

'Diversification is a good way to ensure more stable revenues over a longer period. I believe we have the people and know-how to do so.'

Manno Pals
Controller

'We continue to think of efficient and innovative solutions for problems in an offshore environment.'

Almer de Leeuw
Project manager jack-ups

'Logically, the market conditions now and into the future are inducing us to look outside the energy sector to limit our dependence on solely this market'

Almer de Leeuw
Project manager jack-ups

'More focus on engineering and consultancy is a good idea in a saturated market for mobile offshore units.'

Perry van Uchelen
Project Engineer

'Greater scope to investigate engineering issues in depth and to initiate research with an aim to developing advanced engineering capabilities.'

Perry van Uchelen
Project Engineer

'Our refocus requires internal alignment and a coherent story to tell to the market. It also requires new ways of working as we chase new clients and re-engage existing clients for new types of projects.'

Alberto Morandi
General Manager

The structures must be fully capable of withstanding the loads engaged during its lifetime. To do that thoroughly, we have developed in-house design approaches, processes and tools, which in some cases exceed industry practices to unlock new solutions. A typical example is our dynamic structural analyses that we apply on jack-up design, creating a record breaking performance of the CAT-J rigs with respect to water depth and air gap.

Low motions provide safer operations for floating rigs. The GustoMSC four column semi designs are designed to achieve the best balance between motion characteristics combined with station keeping loads. These optimized motions generate higher uptime, which means more efficiency of the MOU, without compromising on safety.

We apply the same well-balanced considerations between performance and layouts to our ship designs, using naval architecture to unlock drilling efficiency potential. We offer different patented moonpool technologies, targeting reduction of resistance in transit, or preventing sloshing in sailing and stationary conditions. In all cases, contributing to overall safety for equipment and personnel and operational efficiency by reducing waiting on weather. Balanced design, including safety and efficiency aspects, requires uncompromised assessment of environmental, functional and accidental loads. Increasing efficiency is not

only an operational issue, the total investment can also be minimized by optimizing the structures for weight and manufacturability and thus reducing building costs.

Focus on efficiency

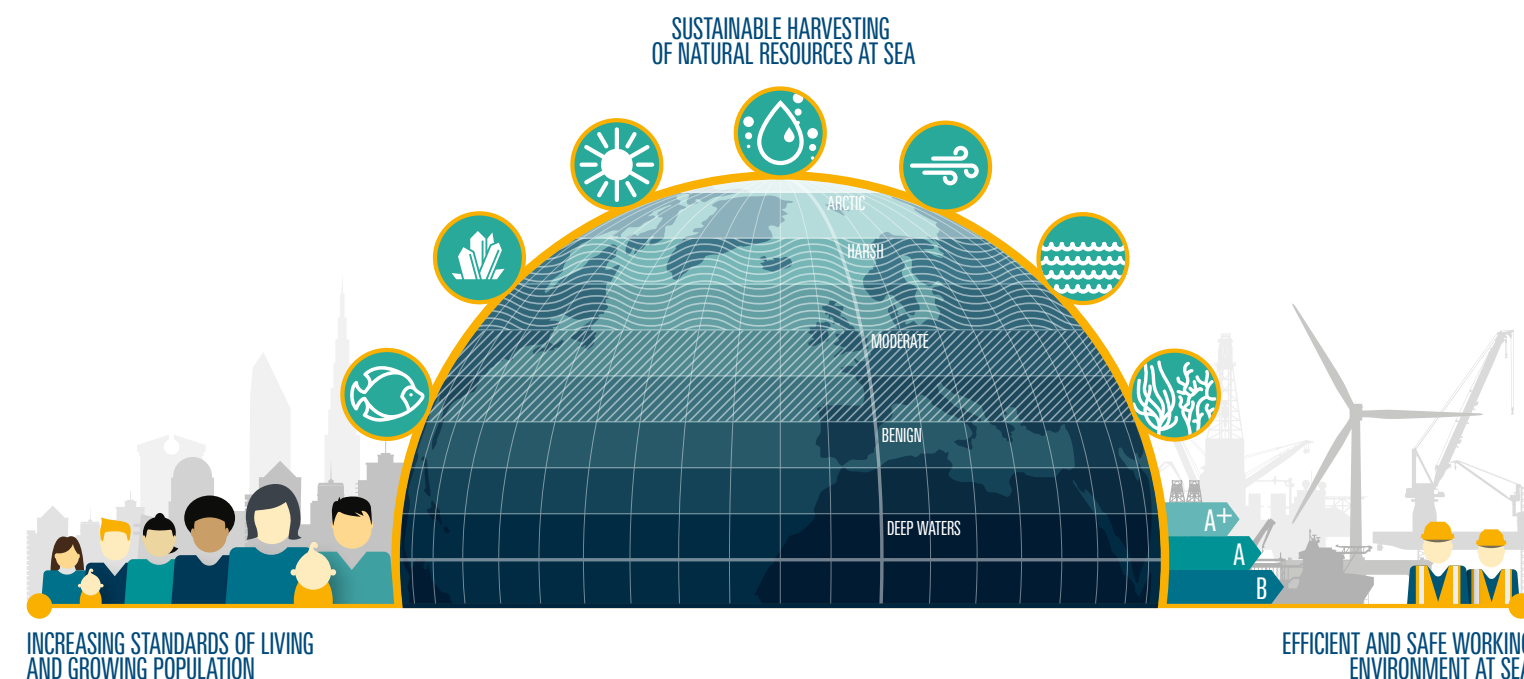
Besides the traditional aspects of a MOU design, GustoMSC adds value by focusing more and more on the efficiency of offshore operations. A MOU is not simply there to provide a safe offshore working platform for its crew, its primary mission is to execute a specific offshore operation. Obviously, the owners of a MOU create the most value for their stakeholders if the offshore operations can be executed at the lowest cost, while not compromising on safety. We translate this into one aspect: efficiency.

It is a matter of balancing the platform's operational mission requirements with other cost factors such as the size of the platform, station keeping characteristics and regulatory requirements. Based on a long track record of new built designs, as well as engineering services and operational support, we develop our knowledge of practical offshore operation and are able to assess their impact on the design and vice versa. In close cooperation with our clients, we are able to comprehend the essential functionality of our clients' mission and help define the requirements. Sometimes a small adjustment in the requirements can have a great effect in cost.

The mission equipment is another crucial aspect. We are able to maximize the efficiency through mission equipment optimization, whether by specification and selection, by efficient layout on the MOU or by designing the mission equipment ourselves using both practical and innovative ideas. For example, 10% reduction in drilling jack-up rig time during plug and abandonment operations can be achieved by adding our SmartCrane: a relatively simple, but at the same advanced piece of equipment. Another example can be found in the Telescopic Crane design, enabling safe and efficient installation of future offshore wind turbines and their foundations. The innovative development concerning automation will in the near future even further increase safety, fast-track results and increase the effectiveness and transparency of management processes.

Our involvement does not end after delivery of our design and equipment. In fact, this moment usually marks the continuation or start of a decades-long relationship. By providing operational support, ranging from engineering services, after sales services, maintenance support and training, we optimize the use of our technology and enable our clients to continue to improve their operations and help them differentiate from their competitors.

Knowing how to optimize efficiency while not compromising on safety is the work of experts and projects teams. This calls for



a combination of highly specialized disciplines and a fully integrated approach, balancing all individual interests.

People are key

The expertise of our professionals who design the offshore platforms make a significant contribution towards our clients' success. It is an important aspect of having adequate knowledge of the client's processes to have these connect with our design teams. Knowing what are clients want to achieve, within which parameters, under which conditions and requirements, are essential steps demanding a very broad perspective and a close and open working relationship.

If the design processes are to be managed effectively, it is essential to address these processes at a higher, overarching level. Rather than focusing solely on the work and the process, one should consider the desired outcomes of the various efforts. Rather than looking only at the construction costs, consider the lifetime costs. Instead of looking only at the construction phase, consider the way in which the overall solution will come into being. The design process becomes a collaborative undertaking with considerable input from our clients. At GustoMSC, we see this as a process of 'co-creation'.

We therefore strive for a team with a broad range of expertise. The overall process is one in which design ability is complemented by various other disciplines to form an integrated

approach which is firmly embedded in everyday practice. The Human Resources department has become a strategic department within GustoMSC to make sure we are and stay equipped for these tasks with the right personnel with the right competencies.

GustoMSC

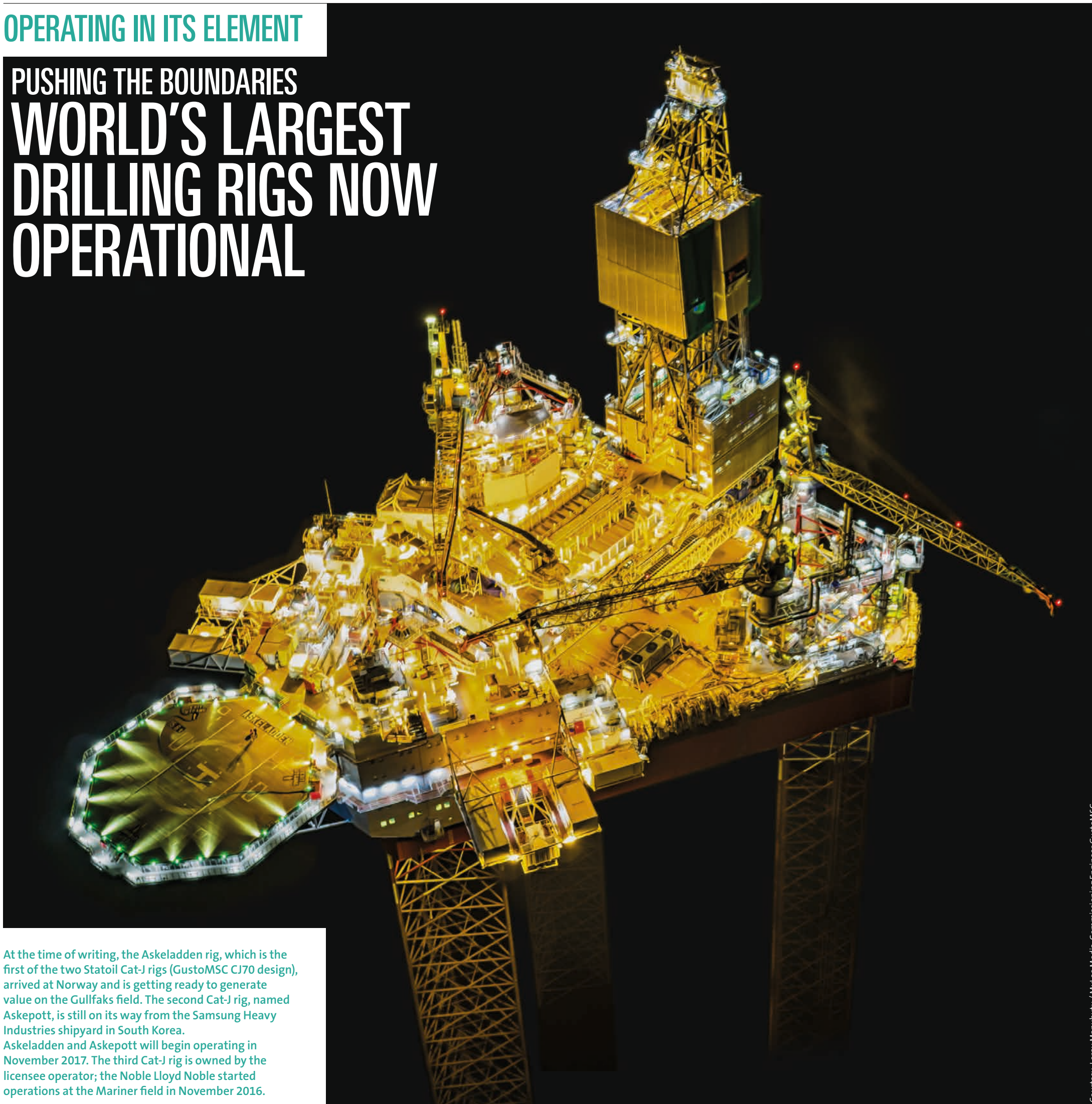
The issues surrounding working at sea are becoming ever more complex. How can we ensure the ongoing safety of personnel, clients and the environment while operating at the highest level of efficiency? To this end, GustoMSC has inhouse specialists in various disciplines. We pay a lot of attention to talent and talent management and have a broad view of the challenges facing the relevant sectors.

We see our future as a technologically-driven strategic partner for our clients. We do so in the firm belief that broad, integrated and well thought-out solutions are the only appropriate response to the challenges of working at sea while contributing to a sustainable future we can all profit from.

THE PIONEERS OF OFFSHORE ENGINEERING

GustoMSC is an independent and reputable design & engineering company of mobile offshore units and associated equipment. In close cooperation with our clients, we translate experience, science and technical knowledge into realistic & innovative ideas. The performance of new and existing jack-ups, vessels and semi-submersibles is further optimized by our operational support and engineering consultancy. In this way, GustoMSC enables and supports safe and efficient operations at sea, contributing to a sustainable future.

PUSHING THE BOUNDARIES WORLD'S LARGEST DRILLING RIGS NOW OPERATIONAL



At the time of writing, the Askeladden rig, which is the first of the two Statoil Cat-J rigs (GustoMSC CJ70 design), arrived at Norway and is getting ready to generate value on the Gullfaks field. The second Cat-J rig, named Askepott, is still on its way from the Samsung Heavy Industries shipyard in South Korea. Askeladden and Askepott will begin operating in November 2017. The third Cat-J rig is owned by the licensee operator; the Noble Lloyd Noble started operations at the Mariner field in November 2016.

Statoil's Askeladden (GustoMSC CJ70) during full height test at Samsung Heavy Industries shipyard in South Korea.

Named after Norwegian folktales, the two Statoil Cat-J rigs will be used for drilling and completing wells on the Oseberg and Gullfaks fields, both located in the Norwegian sector of the North Sea and operated by Statoil. The introductory Askeladden drilling program focuses on proven reserves and gas blowdown wells on one of the Gullfaks satellite fields. Askepott will primarily drill through the unmanned wellhead platform at Vestflanken 2, which is part of Oseberg. The rigs will be able to operate in water depths of 70-150 meters and drill wells up to 10,000 meters deep. They were tailor-made for operations in harsher environments and for wells in the shallow waters of the Norwegian continental shelf.

A PERFECT CASE OF ENGINEERING TO THE EXTREME

Statoil's aim at the beginning of the project was to build jack-up rigs which could operate in a harsh environment and under exceptional operating conditions (such as an air gap of 69 m for the Mariner field) while meeting high safety standards. 'We immediately understood that to cope with these requirements our usual design approach was not sufficient and we had to bring the engineering and design process to the next level,' says Milos Di lasio, GustoMSC project manager of the Cat-J rigs. 'We keep it simple if possible, but go much further than others when needed.'

Ambitious target

Every single aspect of the rig design was analyzed in depth and the structure was optimized to bring the capabilities of the CAT-J beyond those of the standard CJ70. To achieve this ambitious target it was vital to cooperate with experts from other companies like Statoil, the Norwegian Geotechnical Institute (NGI), and DNV GL. 'I think we had a splendid relationship with GustoMSC. We really had to use all the competence and capacity in both companies,' says Geir Ove Eikill, Statoil's Vice President of Mobile New Builds.

More efficiency

The Cat-J unit should increase the efficiency of production drilling and subsea development by up to 20%. This is achieved by minimizing the down-time of the full operational cycle from installation to removal from a specific location. The aspects that are considered for improving efficiency include increased environmental conditions for the installation, increased skidding speed of the cantilever, and optimized sequences of the drilling process.

To optimize drilling operations, several workshops were organized with Statoil / KCA Deutag drilling experts and the supplier of the drilling package NOV during design of the jack-up. The focus during these sessions was to optimize integration of the drilling package with the hull and cantilever structure, facilitate handling of the drilling tools, increase automation, and allow for simultaneous operations.

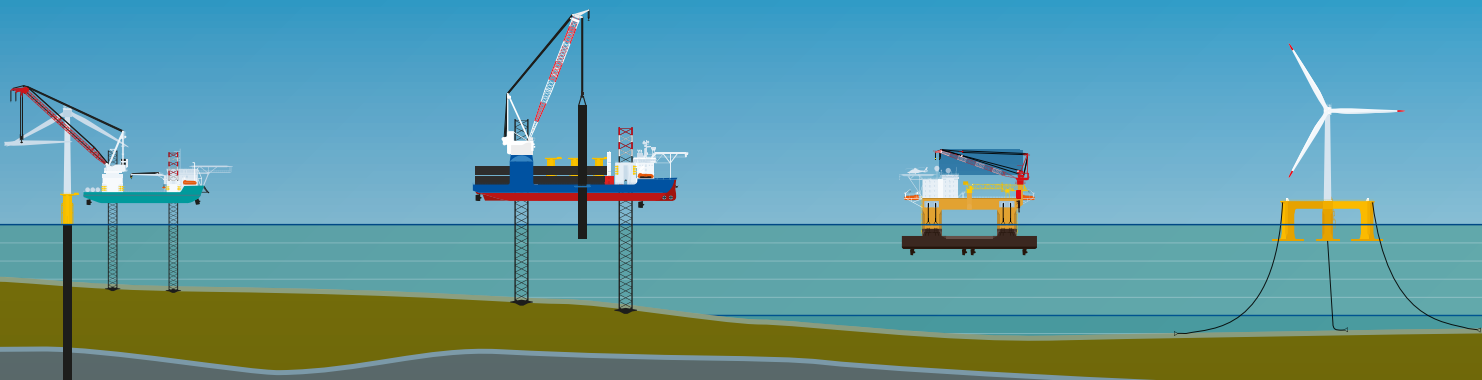
Active involvement

GustoMSC's involvement in the CAT-J project has been very active since it began in late 2011. It started with developing the CAT-J basic design in close cooperation with Statoil, then moved on to supporting Samsung Heavy Industries in the construction of the rigs, and now provides consulting for Statoil and KCA Deutag to support their operations in the field by performing engineering studies and giving customer support for the associated equipment installed on the rigs. Di lasio explains, 'For such a project, where almost nothing is dealt with in a standard way, a few challenges were unavoidable, especially during the construction of the rig. Nevertheless, we were able to overcome all situations by cooperating with the parties involved and aiming, as a first target, at the success of the project.'

After such an achievement, is GustoMSC still able to push the boundaries of efficiency even further? 'We are currently working on a few solutions to increase the CJ70's capabilities even further. We also have our CJ80 design, which is the next step to go into deeper waters and harsh environments while keeping a strong focus on safety,' concludes Di lasio.

Courtesy: Leroy Manuhutu / Mylee Media, Commissioning Engineer GustoMSC

THE PIONEERS OF OFFSHORE ENGINEERING



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AT DIFFERENT
HEIGHTS

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SAFE WORKING
& LIVING
ENVIRONMENT

TRI-FLOATER
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