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Making crewless offshore surveys a reality

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How about transforming the maritime business from crewed to remote and uncrewed operations? This would result in safer offshore operations by moving all crew to a safer onshore environment. It would also result in an improved work-life balance. It's only a matter of time until these new ways of working unlock their full potential. A project in the Port of Rotterdam has proven that uncrewed surveys and inspections are possible and can effectively reduce the carbon footprint of survey and inspection operations, allow faster decision-making through real-time insights and ensure safer operations.

USV | eROV | geodata management | ROC | USV fleet
USV | eROV | Geodatenmanagement | ROC | USV-Flotte

Wie wäre es, das maritime Geschäft von bemannten auf ferngesteuerte und unbemannte Operationen umzustellen? Dies würde zu einem sichereren Offshore-Betrieb führen, indem die gesamte Besatzung in eine sicherere Umgebung an Land verlegt wird. Außerdem würde es eine bessere Vereinbarkeit von Beruf und Privatleben mit sich bringen. Es ist nur eine Frage der Zeit, bis diese neuen Arbeitsmethoden ihr volles Potenzial entfalten. Ein Projekt im Hafen von Rotterdam hat gezeigt, dass unbemannte Vermessungen und Inspektionen möglich sind und den CO_2-Fußabdruck von Vermessungs- und Inspektionsarbeiten wirksam verringern, durch Echtzeit-Informationen schnellere Entscheidungen ermöglichen und einen sichereren Betrieb gewährleisten können.

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Introduction

Today's businesses are increasingly focused on making a positive impact on society and saving our planet. Leadership teams are tasked to transform their businesses to become more sustainable and socially engaged whilst at the same time leading digital change. In the offshore survey and maritime industry these trends predominantly translate to three goals:

- carbon footprint reduction;
- faster decision-making through real-time insights;
- safer operations.

Technical and digital innovations involving remote operations, autonomy and near real-time geodata acquisition are considered crucial to achieving these ambitions and will play a vital role in supporting this transition. However, digital and technological innovations are just enablers for this transition. For a transition to become a reality these enablers must be operationally leveraged at scale across the industry together with their associated new ways of working. Driving change at the forefront of the maritime industry comes with its specific challenges, mostly related to change management, which can dictate the pace of implementation.

This article shares insights on the key challenges that were encountered in the build-up to the first European commercial uncrewed surface vessel (USV) combined survey and inspection project with Fugro's *Blue Essence* USV and its in-built electric remotely operated vehicle (eROV) in the Port of Rotterdam during the fourth quarter of 2021 (Fig. 1).

Conventional site characterisation surveys and offshore asset inspections

Geophysical and geotechnical site characterisation surveys as well as inspection surveys for offshore assets are a complex undertaking. Rough seas and remote areas require projects to be executed with large vessels and substantial project crews that can stay offshore for a substantial period of time, typically ranging from weeks to months. Limited internet connectivity during the execution of the surveys forces most activities to be physically executed on the vessel. This includes operational activities (such as deployment, recovery and maintenance of subsea robots and sensors, and generic marine operations) as well as data-related activities (data processing, quality control, preliminary field assessments and interpretations). After a prolonged period at sea, the vessel returns to port where the acquired data is offloaded for processing, analysis and final reporting in an office or cloud environment, which can take several weeks to complete.

Business transformation and technology development approach

The client as key enabler for business transformation

As with any business transformation, it all starts with a future vision and a strategy. Since footprint reduction, safety and faster decision-making are not just a Fugro concern, the first step was to collaborate with key clients and agree metrics to track progress on our mutual ambitions. In return, Fugro would receive research and development funding or project work to trial new technologies, leading to accelerated and focused developments.

These client conversations led to an agreed vision of transforming the maritime business from crewed to remote and uncrewed operations. This would result in safer offshore operations by moving all crew to a safer onshore environment and as an additional benefit, result in an improved work-life balance.

Due to crewless operations, the vessel size could significantly be reduced, leading to a reduction in carbon emissions. Lastly, uncrewed working would force workflows to be digitised, to allow the crew to execute their tasks from an onshore location. Through these digitised ways of working, clients will benefit from near real-time data delivery, resulting in faster decision-making.

Uncrewed maritime technology development

The first step was to define and validate a technology roadmap pinpointing the key bottlenecks to allow for uncrewed offshore operations. Connectivity was identified as one of the main challenges, thus discussions were started with satellite communications providers to collaborate on a new ship-to-shore connectivity setup. With client assets sometimes located in the most remote areas on the planet, it was crucial to devise a robust solution.

Another challenge was monitoring and maintenance of the vessel, the eROV and the sensors for data acquisition. Normally, crew are able to recognise vessel or equipment faults, or respond to breakdowns, but with an uncrewed solution the technology needs to be monitored in real-time from a remote operations centre. This resulted in a complete redesign of the vessel system, including an internet of things environment, leading to new systems for troubleshooting, propulsion and launch and recovery solutions. To do this, partnerships were established with technology companies with a known track record in building USV solutions that allowed integration of Fugro's survey and inspection technologies.

Fig. 1: *Blue Essence* sailing out of the Port of Rotterdam for its first commercial project

Uncrewed geodata technology development

In addition to maritime challenges, obtaining geodata through uncrewed operations has limitations. The geodata that *Blue Essence* acquires comprises of multibeam bathymetry, and with the eROV, burial depth, potential free spans and cathodic protection can be assessed. Preparations are continuing for the uncrewed acquisition of side-scan sonar and sub-bottom profiler data. During acquisition, it is essential that the quality aspects such as data resolution, noise levels, navigation and data coverage are monitored and validated in near real-time to assure they are fit for purpose and meet the contractual specifications and industry standards.

Up to 80 % of the *Blue Essence* bandwidth is dedicated to the remote operation of the vessel and eROV leaving insufficient bandwidth to upload the large volumes of geodata. Automated (pre-)processing steps, data compression, quality control algorithms and remote support services need to be deployed on the vessel to allow remote quality assurance and keep data transfer rates within the given limitations. This can only be done and managed in a compute and storage environment close to the sensor. This environment needs to be robust, remotely serviceable and allow high-performance computing similar to a connected cloud environment, i.e. an »edge computing environment«. In addition to managing and monitoring the edge environment itself, dashboards proved necessary to manage the geodata logistics to and from the vessel.

Geodata management was another technical challenge as there was no longer a single place in which all data is stored but rather a hybrid and highly dynamic system of multiple storage locations spanning edge, on-premises servers and online cloud environments. In traditional operations this data management is performed by people, but for uncrewed operations a fully automated data-lineage solution had to be developed to allow insights to be generated at any time.

The technologies described above, besides supporting remote geodata quality assurance, are also in support of another key industry driver: faster decision-making. Using near-real time data portals, quality assured field data makes it to the client's desktops significantly faster than in traditional survey operations and allows the asset developers and asset integrity managers to make faster decisions.

Shaping legislative framework

Traditionally, due to legal constraints, maritime authorities do not allow the sailing of a 12 m vessel without a crew and captain being physically present. Most of these authorities have uncrewed and autonomous shipping on their roadmaps and need tangible examples to help make the conversations and regulations around this topic more concrete. Working groups were established to develop training and competency standards to ensure that the regulations keep up with this remotely operated technology.

Facilitating the regulatory response is challenging, but promising achievements have been made like the first Unmanned Marine Systems (UMS) certification from Lloyd's Register for the *Blue Essence* USV. On the competency side more work is needed to develop new standards and a training framework through which employees can be upskilled in the operation of remote and autonomous vessels. This has to be a well thought through process to make sure the regulations we develop are right and ensure the safety of crew and the marine environment.

Fig. 2: The eROV which is docked on the USV and controlled through the remote operations centre can be automatically deployed and retrieved from the water

Another example of legislative limitations is the requirement in some areas of the world to physically have multiple marine mammal observers onboard to look out for protected species and halt operations if these species appear close to the vessel. Technology is being developed to perform this work remotely, but the pace at which we're able to change the regulations to allow its use is slower.

Implementing change

When developing new and innovative ways of working, having a clear vision from the start is vital to receive buy-in from internal staff and client organisations, but difficulties still can arise.

Internally, short-term over long-term thinking may result in a business that requires commitment to deliver on already agreed contracts. Often the largest part of an organisation is set up to deliver on the short-term goals, which makes it hard to free up time and people to contribute to longer term initiatives. To implement a new way of working, time and effort is required from various departments and teams. This is sometimes conflicting with the projects they need to facilitate in the short-term.

In a client organisation it is crucial to have buy-in from across the organisation. All stakeholders will be needed to drive the change in their organisation and can help to guarantee that appropriate resources are available to implement change. For a completely new service offering a client will have to adapt to new work processes during the project, as well as understanding new procedures and accepting new contracts and procurement criteria. In that respect the innovator, or new service provider, will often be asked to take the required technical and operational risks, to guarantee certainty in budget spend.

Another change management challenge is that all stakeholders need to be aware that the transformation will be an iterative process. Many of the technical solution components are interrelated, as are their effects on the operational model. For example, design changes may influence how the operator controls the USV thus impact the operator training programme, or a specific procedure or functional requirement from a client can demand a redesign of certain technical components.

The key to successful internal change is to have the right leadership with clear and open communication between all layers of the (client) organisation.

Outcome of the journey so far – first commercial project in the North Sea

Having previously introduced a *Blue Essence* USV in Australia, it was known that early client engagement would be key to a successful launch in Europe. Therefore, Fugro chose to collaborate with a client known for embracing new technologies and stimulating efficient and sustainable ways of working.

After the first introductions it became clear that the client wanted to work closely together with all stakeholders. As an »early adopter« it would give them the opportunity to shape procedures and technology to their preference. Around four months before delivery of the vessel, the relevant permissions were requested from the Dutch port to allow the sailing of an uncrewed ship in its waters.

In November 2021, the *Blue Essence* USV arrived in the Netherlands for its first commercial project. The project itself would demonstrate the full suite of capabilities of the USV and the eROV (Fig. 2), whilst executing the client's required survey and inspections. To guarantee safe operations on one of Europe's busiest shipping routes, just in front of the Port of Rotterdam, the authorities required Fugro to follow the USV with a guard vessel (Fig. 3). Whilst the USV would be controlled from the remote operations centre (ROC), the guard vessel would be able to intervene if necessary.

During the project, the client representative could monitor and check USV operations in a home office environment, which became extremely relevant during the Covid-19 pandemic. Live video feeds and near real-time data were published in a web-portal which facilitated swift decision-making and collaboration with the crew in the control centres. The local crew were positioned in the port location close to Rotterdam, where the USV would arrive for maintenance or when waiting for bad weather to pass. The USV was planned to operate 24 hours a day, meaning that a crew handover took place after a 12-hour shift. For night operations the local team in Rotterdam would establish the handover of the USV and eROV controls to the Aberdeen ROC, go to their hotel to rest and arrive back in port the next morning.

Lessons learnt

In the development, testing and implementation phases of the USV, many lessons were learnt, three of which are shared below.

The first is organisational; a separate fully dedicated team was put in place to lead and support the new USV and develop the flow of digital geodata. This team was placed outside of the group that develops and executes traditional site investigation and inspection surveys so they could rethink the acquisition and data processing from scratch without bias from the traditional ways of working.

Second was the importance of developing and testing iterations throughout the process. This took the shape of several pilots in test environments and real-life operational settings for digital and remote components of the new intended USV operations and geodata flows. As much as we would like to claim that we pre-empted everything, the pilots proved essential in highlighting issues with the intended operations before implementing the first commercial project.

Fig. 3: Guard vessel accompanies the *Blue Essence* to comply with local regulations in the absence of dedicated legislation for uncrewed vessel operations

Finally, the third lesson was having an »early adopter« client that secured buy-in from their organisation. This resulted in a collaborative mindset from the beginning, and allowed them to shape the solution to suit their needs and helped to test and validate that the technology would solve their project challenges.

Looking at the future

Scaling: more transformations are needed to leverage digital and remote technologies

When looking at the future, the implementation and leveraging of remote and digital technologies at scale and throughout the industry still requires significant transformations on three main fronts:

1. Legislation

Legislative limitations for uncrewed survey operations spans marine, customs and labour laws. Examples include

- absence of local and international laws for uncrewed operations;
- customs clearing of a vessel without a physical captain;
- labour laws prohibiting 12-hour workdays for »shore-based offshore staff« which is common to offshore work.

2. Ways of working

Ways of working need to change, both within a survey company itself as well as in the interaction with their clients and stakeholders. How will the client representative or a marine mammal observer monitor the fieldwork? Will they operate from

Fig. 4: Operational control of the USV is done from dedicated or mobile remote operations centres as well as quality monitoring of the acquired data

home or be in the remote operations centre running the vessel (Fig. 4)?

Do new work processes need to be implemented as we transition from manual geodata management and automated workflows?

3. Skills and competencies

Digital workflows and remote operations draw on an entirely new skill set that is often not sufficiently available in the people involved in the traditional surveys. This applies to personnel executing the survey operations and the support staff, such as IT, edge and cloud services as well as external suppliers. Transforming training, certifications and competence management is required.

Anticipating future scenarios

With the first USVs operational in the industry, it's interesting to look at what the future might hold. As all stakeholders become increasingly convinced about the benefits these remote and digital solutions bring, it's only a matter of time until these new ways of working unlock their full potential.

To start with, the endurance and operability of USVs to stay out on open waters is less than a conventional crewed vessel. As this impacts the operational range and the ability to meet client demands, it is likely that USVs will increase in size (increasing endurance and operability) and quantity (ability to serve demand). These USVs will be positioned across strategic locations in a region, being able to swiftly respond to survey and inspection demands from a client. To allow for fully remote operations, and limited on-site support crew, there will be a requirement to dock and recharge/refuel USVs autonomously.

First attempts towards autonomous docking have been undertaken, referring to the RoboDock development, funded by Netherlands Enterprise Agency from the Dutch Ministry of Economic Affairs and Climate Policy (RVO – Rijksdienst voor Ondernemend Nederland).

Since data streams from the USV and eROV are digitised and data delivery to clients can be done via cloud-based portals, the step towards advanced data analytics is relatively small. Algorithms can identify trends through year-on-year comparison allowing for surveys to be proposed on a risk-based methodology. This offers significant efficiency improvements compared to traditional methods where certain areas are surveyed or inspected on a routine basis. As the USV fleet grows (Fig. 5), the

Fig. 5: A fleet of USVs in the future will enable new operational and business models to be used to offer on-demand and risk-based surveys

combination of risk-based methodologies and strategic USV locations will potentially move the geodata delivery from a project basis to an on-demand and subscription type service model.

Conclusion

The successful commercial uncrewed survey project in the Port of Rotterdam has proven that uncrewed surveys and inspections are possible and can effectively:

- reduce the carbon footprint of survey and inspection operations;
- allow faster decision-making through real-time insights;
- ensure safer operations.

Industry-wide scaling of these benefits of digital and remote survey and inspection technologies will require more than just a digital and technological transformation but a broader transformation in areas such as legislation, ways of working, culture and obtaining new skills and competencies. Without these non-digital transformations, the enabling technologies will not deliver the intended benefits.

The remote and digitalisation journey that we went through for *Blue Essence* identified many lessons learnt, the main ones being:

- dedicate a small but focused team to the development;
- iterate and improve as much as possible;
- focus on and work with an »early adopter« client.

The ability to perform uncrewed remote inspection and provide near-real time survey and inspection results to clients opens the door for many new business and operational models once these technologies can be leveraged at scale.

- Digitised workflows allow advanced analytics to provide clients with deeper insights about their site or asset, allowing them to make decisions based on risk instead of routine, therefore limiting budgets to a minimum.
- Structured and accessible data allows development of machine-learning algorithms across projects, locations and markets and can facilitate proactive advice to clients or could help to derive a deeper understanding of the ocean.
- An autonomous USV fleet may allow us to swiftly respond to risk-based decisions, resulting in on-demand surveys or inspections. //