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EUROFLEETS: FOSTERING LINKS TO INDUSTRY IN THE ADVANCEMENT OF EQUIPMENT INNOVATIONS FOR DEEP SEA OPERATIONS FROM RESEARCH VESSELS

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Abstract

Eurofleets is a key research infrastructure, essential for collecting *in situ* marine data sets from global oceans, regional seas and coastal waters. Research vessels carry and operate shipborne observation equipment and facilitate deployment and handling of a large range of observing and sampling instruments. The infrastructure is also evolving, with fixed ocean seafloor observation and mobile surface and subsea autonomous technologies presenting challenges to the existing fleet to deploy and maintain. Meeting the complex end user needs of European scientists across disciplines and geographic locations is an expensive and complex exercise requiring coordination at national and international levels, and the use of common standards and approaches. To meet the expected challenges, Eurofleets+ (An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities) project is undertaking Joint Research Activities (JRA) with key industry partners. Specifically, the objective of JRA 3.2 led by CSIC, with the Marine Institute and industry partners Hampidjan, MacArtney AS and SEAONICS is the study and conceptual development of equipment for deep sea operations from research vessels co-designed by research and industry partners.

Improving interoperability of Large Exchangeable Instrumentation (LEXI) is a primary aim of Eurofleets+, especially in terms of improvement and standardisation of tools/rigging for more efficient operations.

The collaborative approach aims to develop a new deep-sea winch design, a multipurpose crane/handling system for deep water operations and a dual mode handling system designed for the deployment and recovery of research tools through moon-pools or/and over the side.

Keywords: Research Vessels, Deep Sea, Collaboration, Industry, Interoperability

1. Introduction

Eurofleets+ (An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities) Joint Research Activities (JRA) focus on three topics of interest to marine science and marine exploration in general, with all three focusing directly on equipment and software used on research vessels and in other marine fields.

Exploration of the deep sea is a major challenge and opportunity in marine research. Rigs and related technologies are fundamental to the study of the sea, as they are needed to deploy equipment. Eurofleets2 Deliverable 11.2 *Guidelines and recommendations for ship design on work deck installation and operations for scientific equipment* (Eurofleets2 Consortium, 2015) outlined that the safe handling of larger and more complex instruments in high sea states means that handling equipment is critical. Consequently, Eurofleets+ is conducting investigations relating to deep sea research from vessels aiming to achieve interoperability of rigs to facilitate deployment of different equipment, enabling installation of mobile equipment when needed, and facilitating sharing and installation of equipment across different ships.

Task 3.2 focuses on Equipment innovations for deep sea operations from vessels and more specifically on deck rigs and equipment such as winches and cranes or davits with their essential accessories such as cables. Oceanographic vessels perform a broader spectrum of different manoeuvres and deployments with very sophisticated equipment and a limited budget and so they have evolved and advanced to become multidisciplinary to meet users' needs.

These vessels therefore have become more and more multipurpose, where different operations are increasingly heavy and complex requiring ever more specialized technical support teams. As a result, the vessels have become progressively more adaptable over time. This provides an opportunity to develop deck equipment that is more interoperable to facilitate its use on different vessels, either from the same operator or on third party ships. Some equipment such as ROVs and AUVs have been developed with this in mind and are installed and uninstalled on ships and come complete with their own deployment and recovery systems (LARS). They are therefore portable and interchangeable. This makes rigging and unrigging the vessel much easier and saves time and money. For the ship's own equipment, an attempt is also made to optimize the operations and rigging so as to avoid duplication, allowing space savings on the work deck, where space is at a premium.

Research vessels (or European marine research organizations and their fleets) also share equipment such as ROVs, AUVs, submarines, seismic equipment, ultra-clean winches, etc. which have been outlined in Project Deliverable 3.2 *Overview of Interoperability*

between Eurofleets+ Research Vessels and Marine Equipment'. Therefore, ships need interoperable equipment for their operations or, at a minimum, be able to adapt existing ones to facilitate equipment exchange. Having interchangeable winches for different ships in the fleet is therefore an immediate need and not a long-term goal.

Currently, for economic reasons, the sector is moving towards medium sized Oceanic Research Vessels with Deep-sea capabilities that modern day development in synthetic fibre rope technology has made possible as they are more fuel efficient and require less energy to operate due to the low weight and better tension properties. This has led industry to focus on the development of winches and cables with a reduced footprint on deck as well as increased loads.

Eurofleets+ therefore see that one of the challenges in the design of both Research Vessels, deck operations and rigging is to reduce and/or reuse the equipment already present on the deck. Our goal is to develop solutions to achieve interoperability of rigs to be able to deploy different equipment, and also to have mobile equipment that can be installed on board only when necessary. Also, interoperable and mobile equipment could be shared and installed on different ships, offering practical, flexible, and more cost-effective solutions.

There are three solutions under development with industry partners including (i) portable winches for Deep-sea for operations, (ii) a multipurpose crane/handling system for deep water operations and (iii) the use of a Moonpool for use for deployment and recovery of research tools.

2. Fostering links to industry

The European Marine Board Position Paper 25 'Next Generation European Research Vessels' (Nieuwejaar et al., 2019) recommended a strategic view and closer collaboration of all stakeholders to ensure that research vessels continue to support the study of the ocean into the future. They advised that this recommendation must include collaboration with the Marine Technology Industry, for the research vessel fleet to remain capable and fit-for-purpose. The same paper suggests that to achieve this, both the fleet and its scientific equipment and instruments should be renewed and developed as a matter of urgency.

There has been an impetus to encourage and incentivize this type of co-development approach in both the H2020 funding programme and in the new Horizon Europe Programme. Various funded innovation actions aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services have encouraged industry to partner with both user organisations and academia to further strengthen and accelerate innovations across Europe and internationally. Eurofleets has throughout each iteration of the project focused efforts

on further engaging industry through various activities such as workshops, stakeholder engagement and direct contact, strengthening ties with each project. The collaborative approach taken by Eurofleets combines several activities, which have a primary aim, of delivering a better user experience for all stakeholders.

The Eurofleets+ consortium includes 9 industrial partners, who are central to the three major areas of joint research being undertaken focused on innovative solutions to support marine research and to optimise the services offered by the fleet.

3. Equipment innovations for deep sea operations

3.1 New Deep Sea Winch Design

The design of a new deep sea winch to be interoperable and portable for deep sea operations, using the latest cable technology suitable for use on ocean and regional vessels has been undertaken. With the principle aim of minimising the size and footprint of the winch to ensure a truly portable and interoperable unit. This development will facilitate the utilisation of smaller Ocean class and the larger Regional vessels for the support of deep ocean activities. Detailed requirements' analysis was conducted in order to identify key considerations. These include; consideration of maximum weight, depths, types of securing system and necessity to fit in a 20' shipping container for portability. Following collation of all requirements MacArtney Underwater Technology Group developed the Eurofleets Electric Winch. The winch which will be named EFs+ MERMAC RCRA AHC Winch has been designed with the aim of being flexible, modular and transportable.

Key specifications:

- 20' container footprint;
- Welded steel structure;
- Right angle level wind for optimized deck space;
- Optional davit, for stand-alone applications;
- Modular build;
- Swappable drum;
- Optional Active Heave Compensation;
- Optional Constant Tension functions.

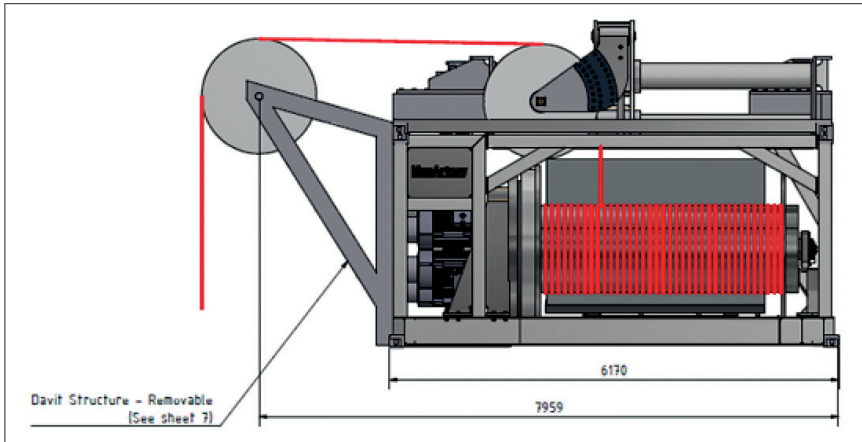


Fig. 1. EF+ MERMAC RCRA AHC Winch.

The winch is proposed as a right angle level-wind type, shown above with an optional davit, for operations straight over the side. The right angle level wind is chosen, to allow for a more flexible winch capable of being mobilised in narrow deck spaces. The interchangeable drum allows flexibility for changing ropes. Optional heave compensation may be added and will fit within the 20' container. The modular build allows for the main winch frame, motors and level wind to be shipped together in a 20' container with the drum shipped separately. The swappable drum allows for shipping in parts and for more than one preconfigured drum, with rope or umbilical and the drum is prepared for electrical/optical slipping.

3.2 Multipurpose crane handling system for deep water innovations

Knuckle-jib cranes are common on-board research vessels. They are used for the loading of material and its transfer and location on the deck of the vessels. The possibility of using such cranes for the deployment of heavy equipment over the side with supports is currently under review. The deployment by means of two cables (traction and coax) and of different material -steel and fiber ropes- is being explored also. This potential multi-functionality would reduce rigging and loading on the working deck of smaller vessels. A conceptual design and specification is being developed for a multifunction crane for handling deep-water research equipment including corers, TV-Grabs, cameras and deployment of sea equipment. Ideally, the crane will be designed for use with a portable winch and suited to larger regional and Ocean Vessels.

There are two options under consideration for this study which is a collaborative effort between CSIC and FERRI SA, winch and deck handling equipment specialists. The first is to use a conventional knuckle-jib crane and make minor modifications to it for

the deployment and recovery operations. The second is to design a crane specifically to be used in the deployment operations of a piston corer but not to affect the crane functions of the ship. The starting points, workload and conditions have been specified, as well as the positions on the manoeuvring vessel and the crane base. Another aspect is the use of fiber rope as the operation line.

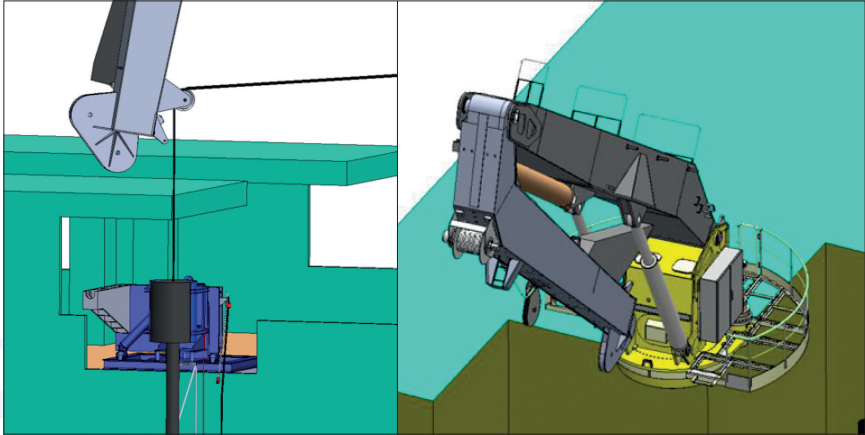


Fig. 2. Multipurpose Crane Handling System for Deep Water Operations.

Because a piston corer operation uses a trigger arm and other elements, it makes it a more complex operation in launch and recovery. The location of the winch as well as the fairleads used are also a critical point of this design and must be taken into account when affecting the deck layout and other deck gears and components.

3.3 Moon-pool use for deployment and recover of research tools

Industry partners SEAONICS, have developed a concept design for Moon-pool use for deployment and recovery of research tools through moon pool and or over the side, as there are currently limited examples in existence. The draft design (fig4) incorporates a dual multipurpose launch and recovery system for oceanographic research tools and equipment such as (but not limited to) ROVs, grabs, drop cameras and observatory components to seabed through moonpool and/or over the side.

The Dual Mode Handling System (DMHS) has been designed for operation in a tough and corrosive offshore environment. Due to the remote areas the equipment will be operated, it will be of rugged design and have remote handling system diagnosis and support. Particular focus has allowed for launch and recovery of a wide variety of equipment while keeping the setup/rigging time to a minimum.

The umbilical winch will be equipped with active heave compensation and has all required functionality for safe and efficient lifting operations, with the possibility to rout the umbilical winch to both over side and moonpool systems. The system will accept other winches (oceanographic) than the dedicated umbilical winch. Operation of the system can either be performed from the operator cabinet located in the operation room or from a remote control on deck. Emergency operations are performed from emergency panels placed on the various components. The drives on the umbilical winch are electric motors operated by frequency converters. There is one hydraulic power unit utilized for the brakes, the level winder of the winch and the over side frame. Electric power is fed from the vessel.

Full Hazard and Operability Study (HAZOP)/ Hazard Identification Studies (HAZID)/ Failure Mode, Effects & Criticality Analysis (FMECA) is planned to validate the design.

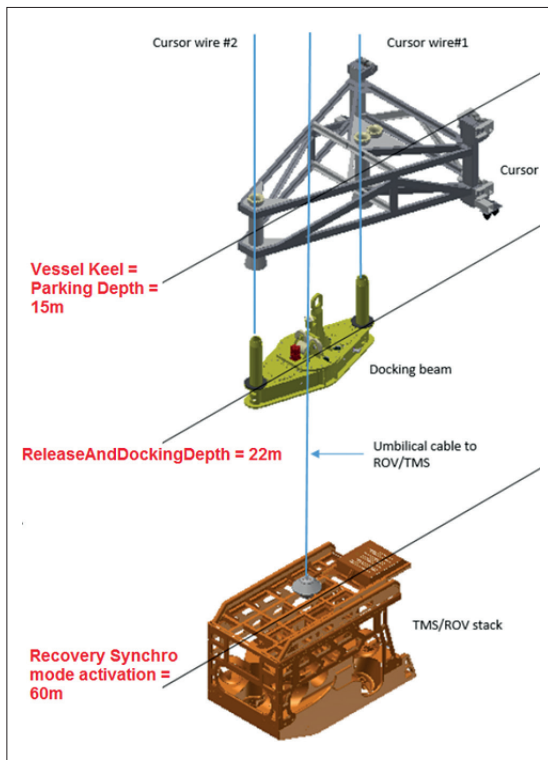


Fig. 3. Dual Mode Handling System.

4. Conclusion

Through fostering links to industry in the advancement of equipment innovations for deep sea operations from research vessels, versatile, modular, and implementable solutions are being created. There are clear demonstrable advantages for all stakeholders including research vessel users, through the increased capacity of research vessels both Regional and Ocean vessels. Building strong sustainable links through partnership and co-creation will provide long-lasting solutions into the future.

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