New Generation Mine CounterMeasures Vessels (NG-MCMV)

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Abstract.
The sea mines are in the rank of the most infamous weapons of the war history and they are back again stronger than ever.
The 20th century witnessed the technical evolution of mines as well as the evolution of systems and platforms to counter it. Mine CounterMeasures (MCM) run after the evolution of a threat in overwhelming technological competition.
Since the very end of the 20th century, the most advanced Navies together with Industries undertook studies aimed to "reduce the risk for crews" involved in MCM operations: with this focus some Navies aimed to keep the man out of the minefield using Maritime Unmanned Systems (MUS).
Today, after twenty years of evolution of MUS, the dilemma is: "Is it possible to keep the man out of the minefield?".
Even though some stakeholders affirm that MCM can be conducted in a fully autonomous way, the truth is that the technologies are far enough to deliver a capability barely comparable to the conventional MCM Platforms in terms of effectiveness and reliability.
Taking into account these considerations, ITN and INTERMARINE are conducting a feasibility study on a new platform able "to provide the optimal pairing of manned and unmanned systems for MCM operations". This challenge takes the name of "New Generation MCM Vessel (NGMV)": the main feature of the project is to keep the shock resistance and underwater low signatures of legacy minehunters, while enhancing a massive use of MUS as extraordinary force multipliers and technological gap fillers thanks to a modular approach of platforms.

Keywords. Italian Navy, Mine Warfare, Seabed Warfare, Mine Countermeasures, Mine Hunter, Mine Sweeping, Naval Mines, Maritime Unmanned Systems (MUS), Glass Reinforced Plastic (GRP).

1. Introduction

The paper will start with the Vision and Operational Concept of Italian Navy in the specialistic sector of the Mine Warfare, approaching the topic from the geostrategic perspective.
Furthermore, there will be a focus on the evolution of both threat and countermeasures according to the main technological and military trends.

After the mentioned analysis, there will be a description of the main features of the New Generation MCMVs project and of the Operational Package. The conclusions will give an update of the art status of the project and some insights on the experimental tests that will be conducted in the next months.

2. Geo Strategic Focus

Prior to illustrate the Italian Navy Mine Warfare vision, it is necessary to fix the strategic area coordinates of country's priority interest.
Today, more than ever, the main focus of the Navy insists in what is defined as «Wider Mediterranean», also known in the Italian literature as «Mediterraneo Allargato». It is a wide area of the globe, centered on the Italian peninsula and embracing areas of trades and strategic interests such as the Red Sea, the Horn of Africa, the Middle East Seas, the Gulf of Guinea till the artic Seas. This area, characterized by growing geopolitical and military tensions, is extremely sensible for the presence of critical choke points and international straits on which pivot all the national trades of resources and goods.
Therefore, the capability developments of the aeronaval instrument need to take into account the wide area in which it has to operate and the challenges of the operations area far away from the homeland.

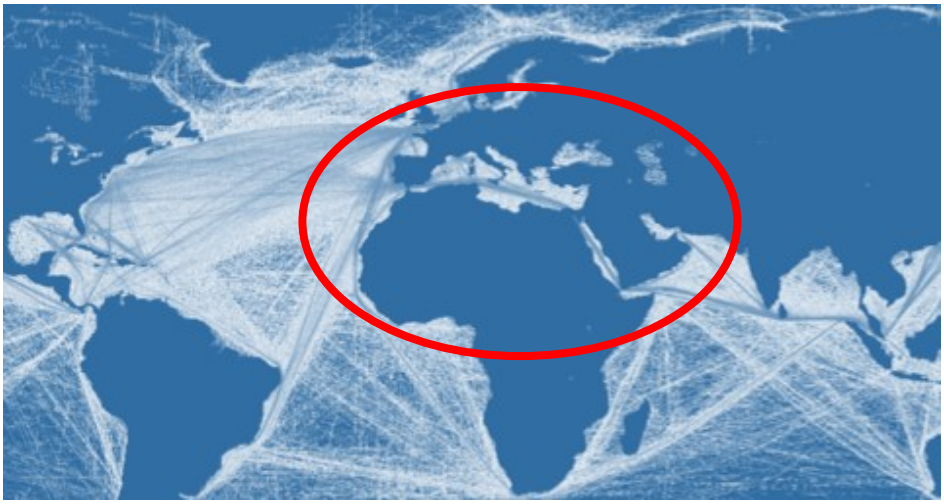

Figure 1. "Wider Mediterranean"

2.1.Operational Focus

Taking into account the geostrategic introduction, the following list describes the missions assigned to the MCM forces and related tasks:

- Homeland Security: described as primary mission and focused on the Defense of National Territory, Territorial Waters and all Access to National Ports;
- Outer Defense: for the Protection of International Straits, Sea Lines of Communications and Choke Points

- Strategic Infrastructures: in the newborn concept of Seabed Warfare, the security of the country will pass also on the capability to monitor and protect the main critical infrastructures as Oil & Gas pipelines, Communications ocean dorsals and nets, etc…
- The Expeditionary Capability: in the modern scenario, the MCM component needs to be deployed in far aways areas and for prolonged periods in order to Operate Within a Joint Task Group and in Support of Amphibious Operations, in national and multinational mission.
- W-IED (Waterborne Improvises Explosive Device): the international scenario characterized by tensions between statal, non-statal actors and terrorist armed groups, saw the proliferation of rudimental ordinance. Therefore, raised the need to face the increasingly diversified occurrence of terrorist acts.

3. Threat and the Future of MCM

3.1.Threat

When approaching the capability studies of the future systems (capable to fully accomplish the abovementioned missions), it is necessary to define the threat expected in the future, and the way to conduct the MCM.

Speaking of the threat, next decades will be characterized by the need to counter more sophisticated mines as well as rudimental weapons like cheap WIED. The new threat, thanks to the accessible technologies, will be represented by smart mines, definitely more difficult to counter and used in unconventional way in the meaning that most likely there will be a diffusion of moving/loitering mines.

Figure 2. Drifting Contact Mine in Black Sea – March 2022.

3.2.MCM Evolution

At the same time, the new technologies will lead to an evolution of the way of conducting MCM: without doubts, the Maritime Unmanned Systems will represent the future of MCM. While same nations are moving straight to an approach completely unmanned, called «standoff» or «man out of the minefield», Italian Navy considers a «Transition» period indispensable. This for two orders of reasons: first of all, the technological level of actual systems is not mature enough. Secondly, it is believed that the tactical environment of the future will be always more complex, multi-threat (where the mine threat may not be the prior threat) and where the level of resilience will be a must.

In this scenario, it is believed that the Navy cannot lose the legacy capability, while enhancing the MUS will be a priority. Comparing the present situation with the past, starting form '80s, most navies abandoned the sweeping capabilities, thinking that the mine-hunting would be resolutive. Today, the same Navies are evaluating to reacquire the sweeping technics with modern systems, paying the price of having loose for decades this capability.

4. New Generation Mine CounterMeasures Vessels - NGMCMVs

All considerations done so far lead to the need for the New Generation MCM Vessels. Italian Navy and Intermarine Shipyard are currently conducting an impressive phase of feasibility and de-risking studies, aimed to define the optimal design for the new platforms and mission systems. Definitely, the main features will be the possibility to operate inside a minefield and the central role of MUS: a massive and extensive use of unmanned systems will be the main drive of the future MCM.

Figure 3. Rendering of NGMCMV.

The capability to navigate and operate in waters potentially mined will be granted by the material of the platform and the characteristics of the whole project: the GRP (Glass Reinforced Plastic) combined with the Monocoque Single-skin without reinforcement technique [1] will guarantee the shock resistance to the underwater explosion. The platform, at the same time, will have a reduced magnetic and acoustic signature able not to activate the logics of modern mines.

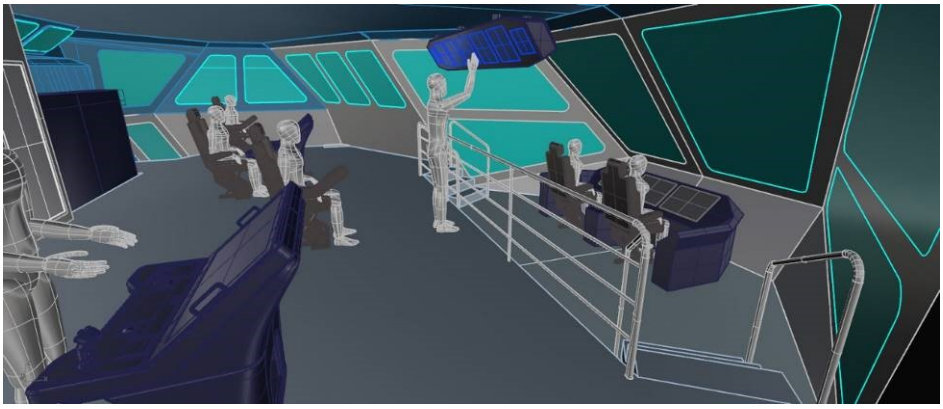

Figure 4. Rendering of the Command Bridge of NGMCMV.

In addition, the new platforms will have expeditionary characteristics, having to operate in far aways areas of operations, integrated with Joint Task Forces and for extended periods.

The possibility to operate in challenging environment and multi-threat scenarios will be afforded by resilience characteristics: every platform will have the possibility to carry on MCM with different MUS and techniques, in addition to legacy and organic systems in GNSS[2] denied environment.

Finally, the complex of national MCM capability will fully fulfil the NATO requirements in terms of standards and contributions to the Alliance.

Without focusing on the details of the project, still object of the on-going campaign of studies, the main features will be the aft working area, capable to embark at least 2

[1] The use of GRP in this complex process aims to produce the hull in a monolithic piece of fiberglass, built without any longitudinal and transversal stiffeners.
Under shock loads the Monocoque Single-skin hull shows a significant elastic deformation, without inducing permanent deformations nor breaking. Materials and production processes are licensed by Intermarine.

[2] Global Navigation Satellite System: is a general term describing any satellite constellation that provides positioning, navigation, and timing (PNT) services on a global or regional basis. (f.i.: GPS).

modules of 20'', the presence of a hangar for all the MUS as well as the presence of a VOA[3] for UAV[4], and the presence of a VDS[5].

Along with the fleet of NG-MCMV, there will be a common Operational Package composed of:

- USV;
- AUV;
- ROV;
- Sweeping Systems;
- Diving OPS equipment.

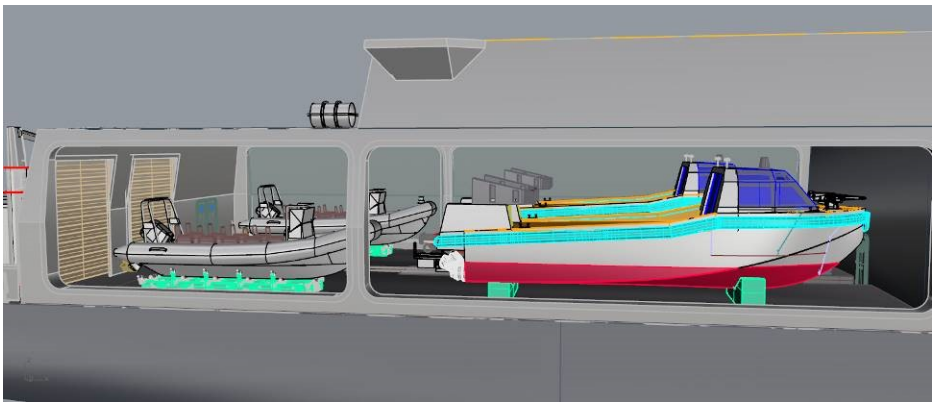

Figure 5. Rendering of the Hangar and Mission Systems of NGMCMV.

In conclusion, the project will not come without challenges. A trade off will be done to the best balance the systems' technological characteristics and the level of affordability and usability by crews. In this respect, the level of Artificial Intelligence of mission systems will be set trying to maximise the integration between systems and integration with standard and protocol of NATO.

Speaking of endurance, the need will be to increase the autonomy in terms of operational time for mission as well as number of charge/missions performed per time.

New sensors and new technologies will produce huge quantities of data to be evaluated and used by specialised crews: appropriate software able to collect, manage, elaborate and disseminate in real time heterogenous data coming from different sources will be the key factor of future operations.

[3] Vertical Operating Area.
[4] Unmanned Aerial Vehicle.
[5] Variable Depth Sonar.

5. NGMCMV Feasibility Studies

The feasibility and de-risking studies conducted by the Italian Navy and Directorate of Naval Armaments involve, in addition to the selection of the optimal configuration of the platform systems, also the structural verification of shock resistance for the NGMCMVs platforms which have to guarantee the capability, similar to the one expressed by the MCMV of the "Lerici" and "Gaeta" classes, to operate "into the mine field", or in other words to be able to conduct MCM operations within potentially mined waters.

Therefore, the construction technique adopted for the NGMCMVs is the same as for "Lerici" and "Gaeta" classes, based on a FRP monocoque single-skin hull without reinforcements. The thickness used for the FRP changes through the structure of the hull, both transversely and longitudinally, in order to adapt to specific local loads and stresses. This construction technique obtains the best benefit deriving from the intrinsic properties of fiberglass, in particular from the elasticity and non-magnetic characteristics, together with minimisation of noise irradiated into the water column. Several live test campaigns conducted on the Vessels produced with the specific process, shown that the hull conceived with the Intermarine project is not subject, under the load caused by the impact of the underwater shock wave, to permanent deformations or damages.

The simulated prediction of the features of NGMCMVs is therefore directly linked to the results of the live test campaigns carried out in the past by the shipyard that allow the control of the local and global response of the vessel by models and procedure applicable to this specific purpose.

The verification procedure is consistent with GRP construction philosophy indicated by ITN for the "Lerici" class and then used and developed by the shipyard for the construction of units for foreign Navies (e.g. US Navy, Australian Navy, Finnish Navy). All the units built by the shipyard adopt the aforementioned monocoque solution where the hull not reinforced by longitudinal and transverse structures, is essentially loaded by the transverse bulkheads and decks connected to it with particular coupling laminations that decouple its movements.

The main difference in the design of the NGMCMVs platforms compared to first units designed in the '70s, is the possibility to use the experimental results collected by the shipyard to adapt and improve the original winning structural solutions to control the effect generated by a no contact underwater explosion. The unequaled real scale data base collected in the several test campaigns is the main driving factor for the control of the inputs and outputs of the shock simulations.

The analisys conducted for the NGMCMVs clearly shown that the structural solutions adopted by the shipyard are still valid to guarantee the best dynamic response to an underwater explosion, despite an improved size and displacement of the new class of ships represent a generational bound compared to the past (approx. 80 meters length of new platforms instead of 50 meters length for the legacy ones).
The advantages of using the GRP and the aforementioned structural solutions allow both the control of the response of the shock wave that hits the hull and the wipping effects

that become critical for metal units with evident consequences already at lower shock factors. In conclusion, the results obtained by similar live tests campaigns conducted on conventional ships (for instance, the test campaign conducted on the frigate ITS Margottini - also known as MARTEST) show definitely the unique capability of GRP platforms to maintain integrity and functionality over a no contact underwater explosion, as verified by several crews operating on the field in the real life occasions.

In the whole contest of the de-risking and feasibility studies for the NGMCMVs, the Italian Navy together with Intermarine are planning to validate simulations and numerical analysis by a live test campaign.