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MODUS for Deepwater Interventions - 4000 m w.d. - from Design to Scientific Application

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Abstract

One major task of 'oceanographic engineering' is the exploration and exploitation of the deep seas, which is essentially supported by Unmanned Underwater Vehicles (UUVs) encompassing both Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs). During the last 25 years standard ROV technology evolved to a reliable everyday tool, used in all fields of oceanographic engineering. This growing ROV market was conducted by numerous theoretical investigations and sea trials covering the whole scheme of static and dynamic questions of operation. Nevertheless the development of a prototype of a specialized ROV that can be used to deploy and recover autonomous benthic seafloor stations (BS - multidisciplinary observatories with the ability to perform long-term scientific missions) with a payload capacity up to 3 tons for multiple use up to 4000 m water depth, still holds a lot of uncertainties. The concept chosen for GEOSTAR (GEophysical and Oceanographic STation for Abyssal Research) derived from the EU-DESIBEL study, which has been carried out around 1996: Deployment and recovery operations are conducted by a ship, winch and umbilical system with a ROV-like electromechanical interface named MODUS (MObile Docker for Underwater Sciences) at its end. For mating operations with the BS the MODUS ROV is equipped with horizontal and vertical thrusters, the umbilical provides power supply and data transmission. To reduce volume, mass and cost, the concept does not require buoyancy material (like 'conventional' ROVs): as a consequence vertical motions are induced by winch – umbilical oscillations and the ship moving in the sea.

Thus the design process of the MODUS ROV has to face both the general challenge to predict the hydroelastic behavior of a vertically tethered system and the flexible configuration of a system, which is dedicated to change its weight drastically due to the deployment or recovery of a heavy payload structure in more than 3000 m water depth.

From 3d design and analysis to prototype

The paper focuses on the 3d design and the hydrodynamic and hydroelastic investigations carried out during the design phase of the MODUS ROV. It describes the iterative process of the computer aided design (CAD) and hydrodynamic analysis (CFD), illustrated by three concurrent design variants (Fig. 1). As a result, a description of the ship, umbilical and the finally built subsea modules as well as the associated hydroelastic simulations is presented. The paper closes with results from deep-sea trials in the Tyrrhenian Sea (September 2000 and April 2001), employing the Italian research vessel R/V Urania (Fig. 2).

References

Clauss G., Hoog S.: "Deep Sea Challenges of Marine Technology and Oceanographic Engineering", Elsevier Science Ltd., Oxford, to be published, 2001.

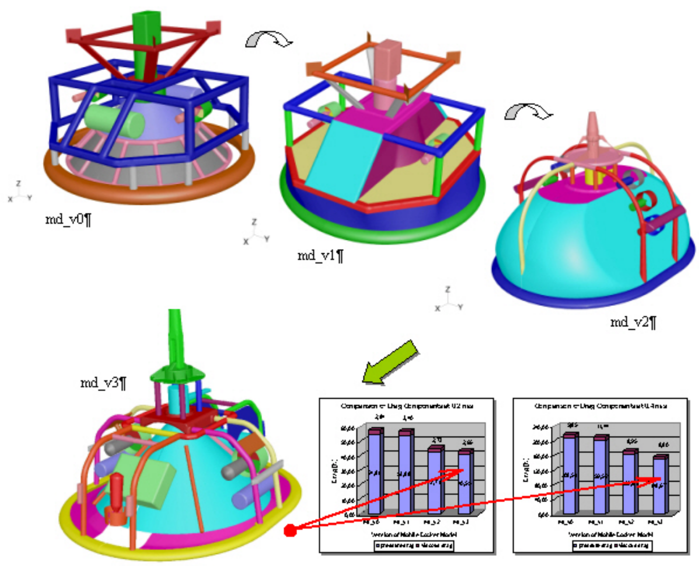

Fig. 1: 'Evolution' of the MODUS ROV: From initial shallow water design to enhanced deep-water design with significant drag reductions. Data from symmetric half model calculations using CFD.

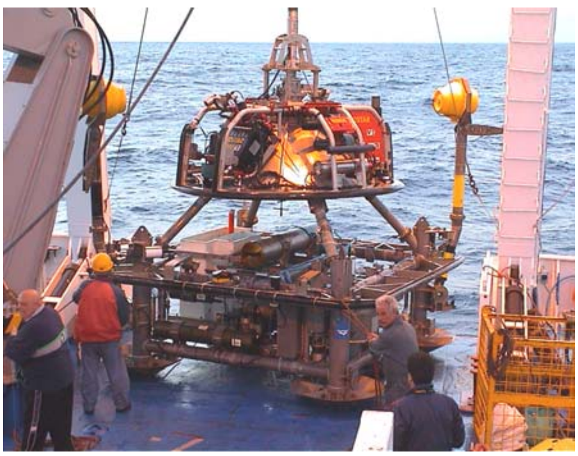

Fig. 2: MODUS (top) after successful recovery of the GEOSTAR Bottom Station