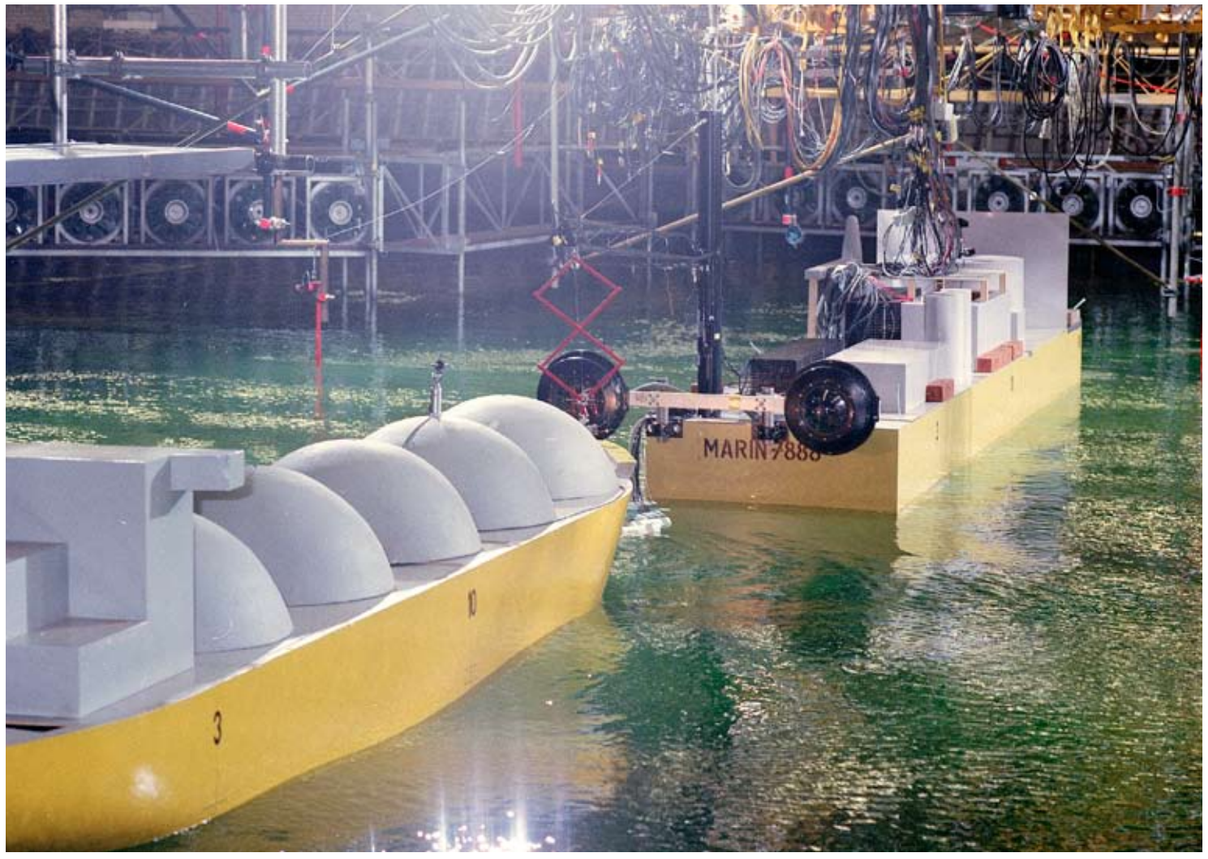
MARIN advances model thruster control technology

Thruster load measurements, combined with advanced control systems, give insight into the operational aspects of dynamically positioned vessels. MARIN has developed technology to better assess the performance of multi-thruster Dynamic Positioning (DP) applications. Report provides an update of recent developments.



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Tandem offloading test results from MARINs offshore basin are used for verification of numerical models

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During DP operations the effective force generated by the thrusters can be significantly smaller than would be expected when the thruster's open water characteristics are taken into account. This is due to interaction between the thrusters with the current, vessel hull and with the wake of neighbouring thrusters. Understanding and quantification of thruster interaction (or thrust degradation) effects is essential for an accurate evaluation of the station-keeping capabilities of any DP vessel.

After thruster interaction is determined a full DP test can be carried out. The thrusters are then connected to the DP control system that uses a position feedback control algorithm to keep the vessel in position. DP drill ships, heavylift and cruise vessels, Navy operations, side-by-side DP for support vessels and tandem offloading are typical DP applications that are model tested.

Tandem offloading In tandem offloading a DP vessel is positioned behind another vessel. This technique is gaining renewed interest because the LNG flexible hose development is nearly completed. Flexible LNG offloading systems facilitate LNG offloading over larger distances and this includes tandem DP offloading. The LNG carrier's thruster capacity dominates the low frequency motion behaviour and therefore, the relative motions between the two vessels. If the relative motions become too large the system should be disconnected. One challenge for MARIN's Instrumentation Group was to measure the thruster loads accurately during model tests and to simulate the control systems and actuator characteristics in a realistic way.

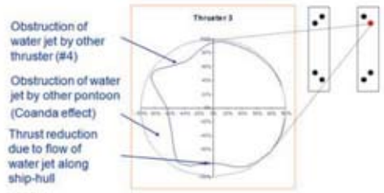
MARIN has developed compact, high quality model thrusters and onboard sensors, as well as measurement and flexible control systems, to assess the performance for configurations with a large number of thrusters. The newest ranges of MARIN thrusters consist of servomotors for the RPM control of propellers, with zero backlash azimuth angle control. The onboard modular actuator can be decoupled easily from the submerged propeller. Additional to 6 component unit forces, propeller torque and thrust are measured on the rotating shaft between the propeller and housing bearings to exclude measurement errors due to bearing and gearbox friction.

Multiple thrusters In case of multiple thrusters, the amount of required measurement channels increases fast. MARIN's Scalable Measurement System (MMS) is the ideal tool for this task. All thrusters come with electronic drives to control propeller RPM and thruster angle. Limitations like accelerations, rates of turn and working range, can be configured for individual thrusters to provide a realistic dynamic response. The electronic drives also monitor the operation of the motors and thus, contribute to quality checks during tests. The MARIN Basic Steering System (BSS) provides a software interface between thruster hardware, operators and high level control applications.

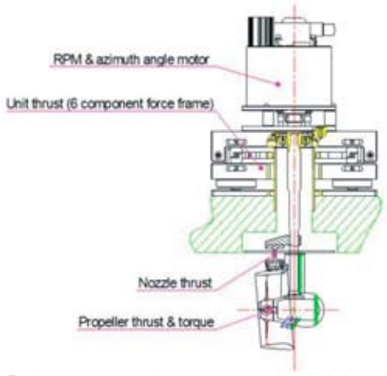
During model tests, specific motion control and/or propulsion characteristics are required to simulate complete vessels or offshore systems. These control applications are included in software and connected to MMS and BSS using software links.

Autopilots, roll stabilisation and DP are examples of motion control. Constant torque, power control or dedicated torque-RPM curves can be used to model the effects of real life propulsion systems. Control systems require real-time input from measurement systems and they provide command values to actuator systems. In the measurement & control system overview the cooperation between all components is shown. This architecture is the starting point for a rich set of available control functions. In addition, third-party control applications can be and have been integrated into model tests using the software links to BSS and MMS, in order to test the overall performance of controller and vessel.

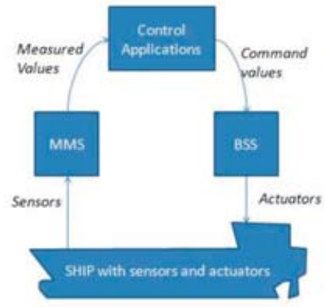
In the future there will be continuous improvement of the availability, flexibility and quality of system components to optimally support the DP model testing services.



Typical result of thrust reduction for a semi-submersible



The thruster is equipped with sensors to measure the individual contributions of the propeller and nozzle



Measurement & control system overview

MARIN is continuously developing the available hardware and this means we can also go further in our hydrodynamic research. MARIN has recently initiated the TRUST JIP to gain further insight into the physical phenomena, quantifying thruster interaction effects and investigating possibilities for improvement. If you have any questions please contact Hans Cozijn. (j.l.cozijn@marin.nl)