

# Success of renowned 'Wageningen B' followed by the future-ready C & D-Series

A three-year JIP leads to 35 new, open and ducted Controllable Pitch Propeller (CPP) designs after a test programme involving more than 750 open water tests.

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The results from a new series of open and ducted CPPs have recently been implemented in a practical, designers' software. The software enables propeller manufacturers and naval architects to customise design propellers and to derive geometry and thrust/torque characteristics, as well as blade spindle torque for arbitrary design cases.

Many ships and offshore vessels are equipped with open or ducted CPPs, which are used for navigation and dynamic positioning (DP). For these types of propellers, not only the thrust-power performance over the complete rpm/speed range is of importance, but also the blade spindle torque. However, until now no systematic data has been available for CPPs.

**15 pitch settings** Based on the success of the well-known Wageningen B-series,

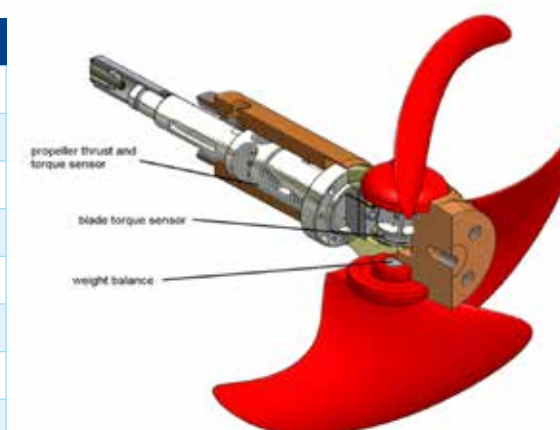
MARIN initiated the Wageningen C&D Propeller Series JIP three years ago. With the support of leading CPP designers and manufacturers worldwide, an extensive systematic series of contemporary design propellers were developed. In total, 20 open and 15 ducted CP propellers were designed. The series comprises four and five bladed propellers with blade area ratios ranging from 40% to 75%. The D-propellers are combined with both duct No. 19A and No. 37. Each propeller with a specific design pitch was tested at more than 15 different pitch settings. In total the test programme thus comprised more than 750 open water tests.

As conventional open water tests would require more than two years work in the towing tank, a new quasi-steady testing technique was developed. During one run

the speed is varied at constant rpm, whereas in a second run the rpm is varied at constant speed. From these two runs the full propeller characteristics and blade spindle torque is derived for each pitch setting. The results from the quasi-steady and conventional open water tests concurred well. The test results were processed to generate the open water diagrams for all quadrants and these were delivered to all participants, both in tabular and graphical form. Results showed that the new propellers perform well; often better than the B-series fixed pitch propellers.

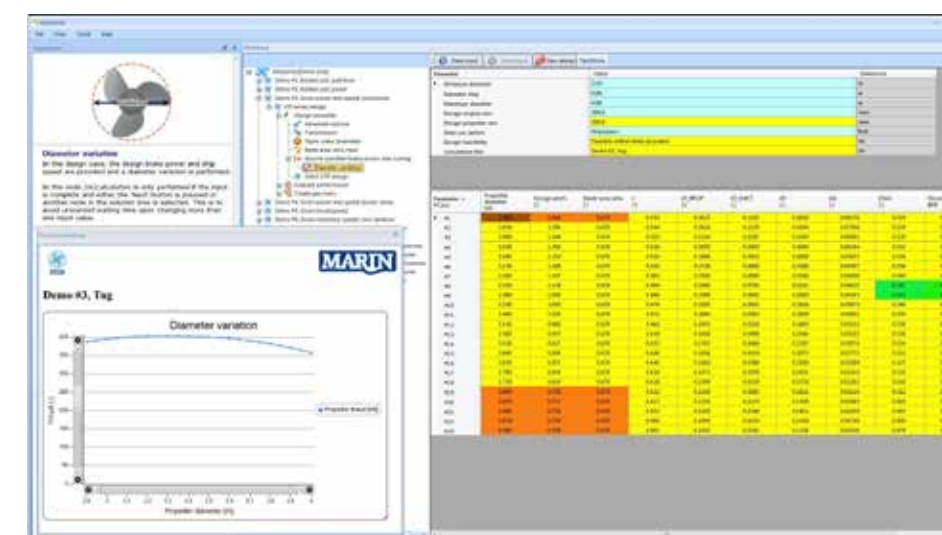
**MCD software** The abundance of data produced in the JIP requires a dedicated tool which provides practical access for naval architects and propeller designers. To this end, MARIN developed and delivered the MCD software in an extension of the JIP. The function of the software includes:

The Wageningen C & D Propeller Series							
C-4.40	P/D =		0.8	1.0	1.2	1.4	
C-4.55	P/D =		0.8	1.0	1.2	1.4	
C-4.70	P/D =		0.8	1.0	1.2	1.4	
C-5.60	P/D =			1.0	1.2	1.4	1.6
C-5.75	P/D =			1.0	1.2	1.4	1.6
D-4.40	P/D =	0.0	0.8	1.0	1.2	1.4	in 19A & 37
D-4.55	P/D =	0.0	0.8	1.0	1.2	1.4	in 19A & 37
D-4.70	P/D =	0.0	0.8	1.0	1.2	1.4	in 19A & 37



- the basic design/selection for the optimal diameter or shaft rotational rate at a given power or thrust, for bollard or sailing conditions;
- scenario analysis for the selected propellers in any operational conditions, including combinator modes and extreme operations, such as crash stop and backing;
- generation of selected propeller geometry both in ITTC standard format, as well as 3-D computer blade models.

After taking user comments about the Beta version on board and integrating them into the new program, the MCD software 1.4 was released in November. The launch was accompanied by a training session during the Vessel Operator Forum at Damen Shipyards, Gorinchem, the Netherlands.



MCD software

As part of the JIP extension work, the cavitation characteristics of the new propellers were established. The focus on this work was on thrust break down and spindle torque in cavitating conditions. During the JIP several participants conducted their CFD analysis for selected propellers and presented the comparisons with the measured characteristics. MARIN also conducted extensive analysis with the ReFRESKO code to quantify the scale effects.

**E and F-Series** Based on the success of the Wageningen C- and D-propeller Series, MARIN is now preparing two new series: the E-Series for Renewable Energy from tidal turbines, and the F-Series for modern fixed pitch propellers. You are welcome to participate in both JIP initiatives. □



Participating companies in the Wageningen C&D Propeller Series JIP extension



Final participants meeting hosted by MAN in Frederikshavn, June 2015