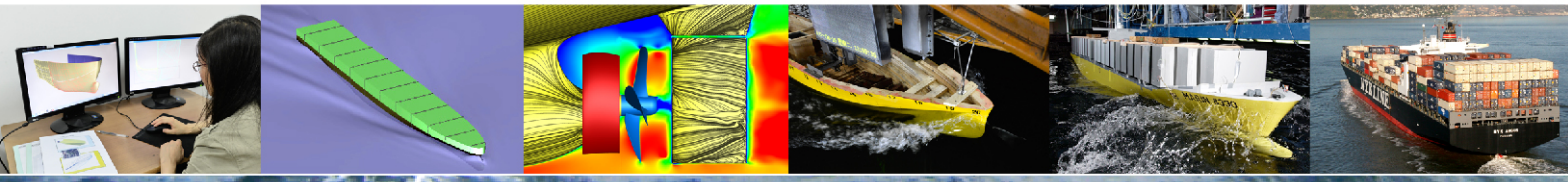

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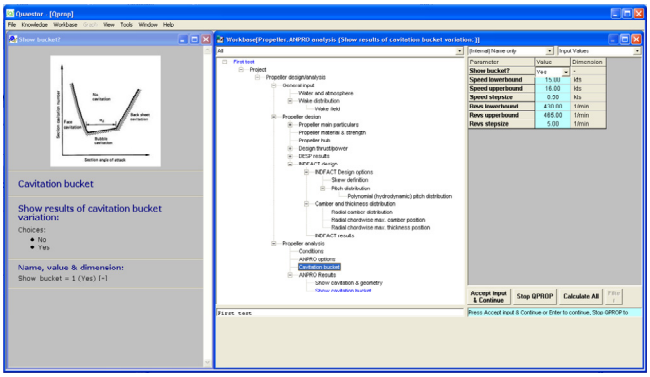
Propeller design and analysis workflow solutions 螺旋桨设计和分析工作流解决方案

QPROP

QPROP provides propeller design and analysis workflow solutions based on the Quaestor knowledge-based workflow framework. QPROP greatly reduces the time spent on iterative propeller design, analysis and reporting activities as all incorporated tools make use of the same pool of project-related input data and (intermediate) results.



Example of a QPROP workflow QPROP 工作流案例

The workflow is arranged on the basis of the tools that are included per software suite. Two standard suites are available, either combined or separately:

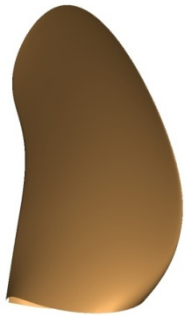
1. Propeller selection and design suite
2. Propeller analysis suite

Apart from enabling a much more efficient use of the incorporated design and analysis tools QPROP allows you to perform specific sets of calculations and analyses with a combination of tools. In both suites for example, QPROP generates a cavitation bucket, being the operational envelope of a propeller in terms of cavitation, (relationship between cavitation number, propeller loading and cavitation occurrence by cavitation type). This requires multiple ANPRO runs the results of which are parsed, summarised and graphically presented in an Excel spreadsheet.

Furthermore, the QPROP workflow presents the variety of input data of the software tools orderly and well structured in a single graphical user interface. All input and (intermediate) output is managed in solutions, each being part of a project. Data consistency is maintained by Quaestor, so if you make any change in one of the inputs, the framework will re-execute all dependent calculations.

The QPROP suites comprise different software tools. For each software tool a separate leaflet is available with a detailed description. In this leaflet the general workflow of the QPROP framework is described.

基于 Quaestor 软件知识工作流框架 QPROP 提供了螺旋桨设计和分析工作流解决方案。QPROP 大大减少了花费在螺旋桨设计、分析和出报告上的时间，因为所有合成工具利用了相同的有关项目的输入数据和（中间的）结果。



工作流设计的基础工具包括每一个软件套件。两个标准套件是可用的，或组合或单独使用：

1. 螺旋桨选型和设计套件
2. 螺旋桨分析套件

除了能够更加有效地使用合并设计和分析工具，QPROP 允许运用组合工具进行计算和分析。以这两个套件为例，QPROP 生成一个空化斗，作为空化过程中螺旋桨操作的包络线（空泡数、螺旋桨载荷和空泡发生之间的关系）。这要求对多个 ANPRO 运行结果进行分析、总结和以 Excel 电子表格的形式生动地展现出来。

另外，QPROP 在单一的图形用户界面中有序且结构良好地显示了软件工具的各种输入数据。在解决方案中管理的所有输入和（中间）输出，每一个都是项目的一部分。由

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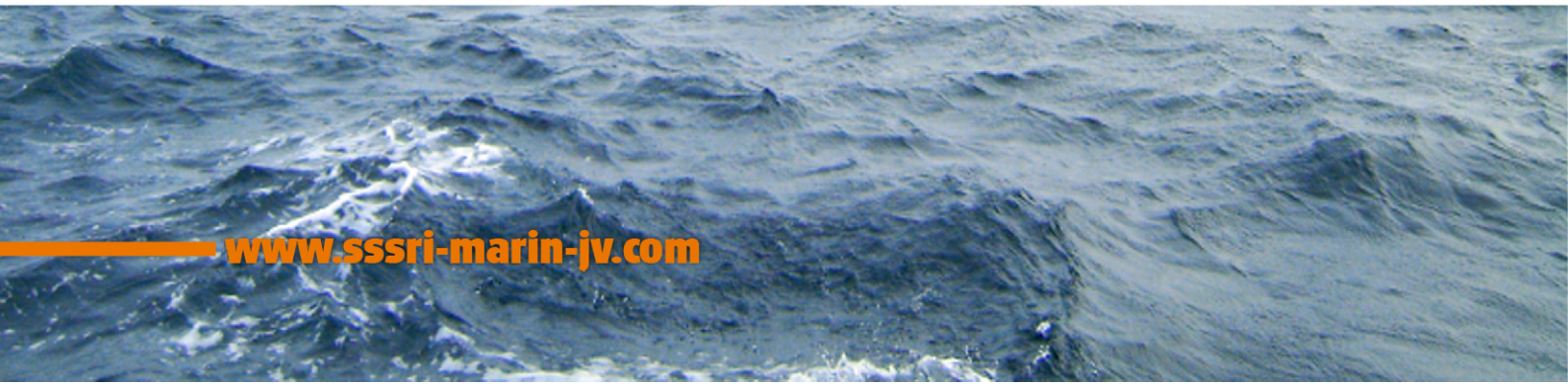


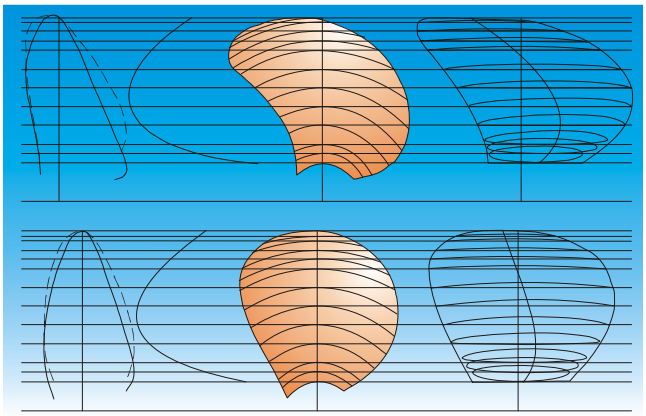
Quaestor 软件维护数据的一致性，因此如果你对其中一项输入做了改变，该软件框架就将重新执行所有相关计算。QPROP 套件包括不同的软件工具。对于每一个软件工具，都有单独的一份介绍，提供了详细的说明。在这份介绍中描述了 QPROP 框架的一般工作流程。

Propeller selection and design suite 螺旋桨选型和设计套件

The QPROP propeller selection and design suite comprises the tools CSPDP or DESP, and INDFACT. The design process can be started either with CSPDP or DESP. Although CSPSP is not a Quaestor-based application, the output of CSPDP can be loaded as input in QPPROP as starting point. CSPDP offers the designer a quick design and selection tool for three types of propellers: open propellers, ducted propellers and tunnel thrusters (respectively B-series, Ka-series and the Mitsubishi TT propellers). The result of CSPDP is a propeller geometry with sections based on the applied propeller series without the effect of radial wakes. As an alternative to CSPDP, propeller selection can be performed with DESP, based on the well known Holtrop & Mennen method. DESP allows you to perform a power prediction and preliminary propeller selection based on the Wageningen propeller series.

DESP is a Quaestor-based application. Departing from the results of CSPDP, DESP or from other sources, a wake-adapted propeller can be designed with INDFACT. INDFACT is a lifting line program which implies a hydrodynamic model of the propeller using straight bound vortices for the blades of the propeller and a series of free vortices behind these blades, positioned on concentric cylinders and having constant pitch.

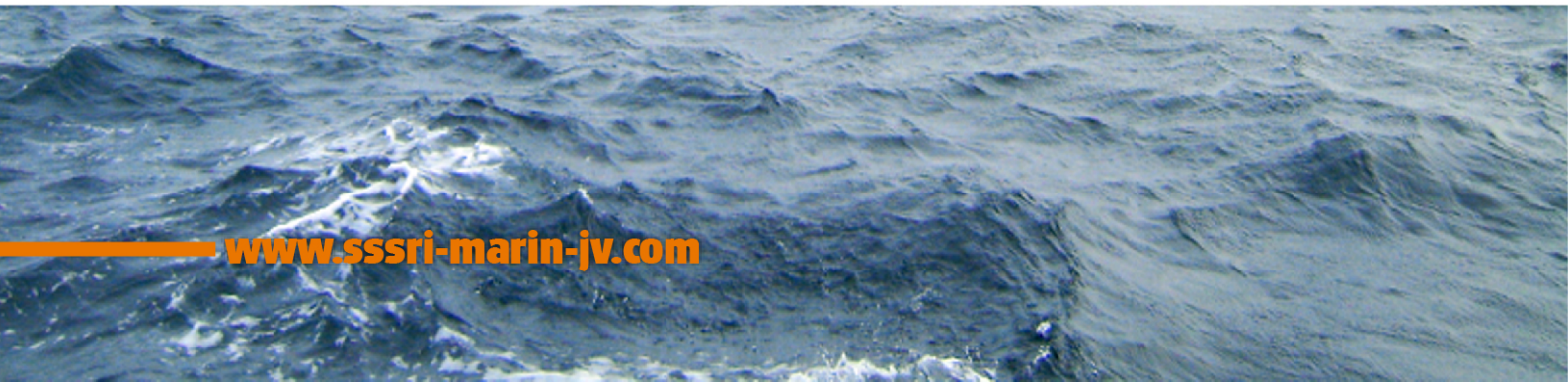
INDFACT incorporates an iteration procedure which combines cavitation on both sides with a strength calculation. It produces chord length, section thickness and camber distributions.



Propellers with varying skew in INDFACT INDFACT 中带有不同桨叶侧斜角的螺旋桨

INDFACT does not provide information on unsteady behaviour of the propeller in the ship's wake, nor does it provide input for FEM calculations. The propeller geometry generated by INDFACT can be used as input for ANPRO as part of the following Propeller analysis suite. Before running the propeller analysis in ANPRO, the designer can modify the camber distribution in QPROP proposed by INDFACT while maintaining the design virtual pitch.

QPROP 螺旋桨选型和设计套件包括 CSPDP 或者 DESP 工具和 INDFACT 工具。设计过程从 CSPDP 或者 DESP 开始。尽管 CSPSP 不是 Quaestor 软件基础的应用，但是 CSPDP 的输出如同 QPPROP 的输入一样作为开始点被加载。CSPDP 针对三种类型的螺旋桨为设计人员提供了一个快速设计和选型的工具：常规螺旋桨、导管螺旋桨和侧推器（分别为 B 系列、Ka 系列和三菱 TT 螺旋桨）。CSPDP 的结果是基于可应用螺旋桨系列且没有径向伴流影响的带有截面的螺旋桨几何形状。作为 CSPDP 的替代物，可使用 DESP 进行螺旋桨选型，基于众所周知的 Holtrop & Mennen 方法。DESP 可以进行功率预报和基于瓦根宁根螺旋桨系列的初步螺旋桨选型。



DESP 是 **Quaestor** 软件基础的应用。离开 **CSPDP**、**DESP** 或来自其它途径的结果，可用 **INDFACT** 设计一个顺应伴流场的螺旋桨。**INDFACT** 是一个基于升力线理论的程序，这意味着直接使用桨叶附着涡和一系列叶背的自由涡建立螺旋桨的水动力模型，其位于共轴圆柱面且具有定螺距。

INDFACT 包含一个迭代过程，该过程将桨叶两侧的强度计算和空化进行了结合。它生成弦长、剖面厚度和剖面弧度分布。

INDFACT 不提供船舶伴流中螺旋桨非定常转动的信息，也不提供有限元计算的输入数据。由 **INDFACT** 生成的螺旋桨几何形状可用于 **ANPRO** 的输入且作为接下来螺旋桨分析套件的一部分。在用 **ANPRO** 进行螺旋桨分析之前，设计人员可以根据 **INDFACT** 提议的内容同时保持设计的有效螺距在 **QPROP** 中修改螺旋桨剖面弧度分布。

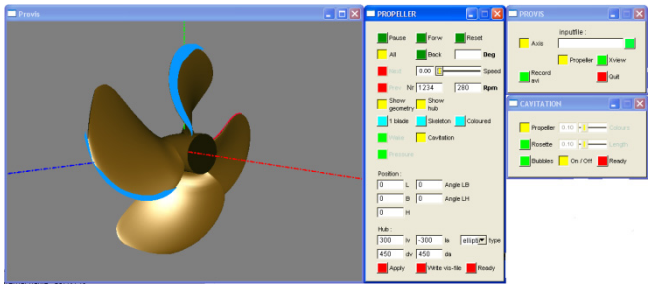
Propeller analysis suite 螺旋桨分析套件

The QPROP propeller analysis suite comprises the tools ANPRO and PROVIS. ANPRO uses a robust lifting surface method for the computation of the quasi instationary blade loading of a propeller in a ship's wake field. With this tool experienced propeller designers are able to make a well-balanced design regarding propeller efficiency and harmful cavitation types such as pressure side cavitation and isolated cavitation patches. The result of the complete workflow can be displayed in de QPROP GUI and PROVIS, the 3D visualisation tool for cavitation patterns computed by ANPRO. For ducted propellers, the program DUCTPROP can be included in QPROP. DUCTPROP uses a model where the propeller is replaced by an actuator disk with prescribed radial loading distribution combined with a vortex distribution around the duct. The induced velocities are provided as input to ANPRO.

This suite can be used to analyse propellers that are designed in the propeller selection and design suite or originating from other sources, which will be the case if this suite is used without the propeller selection and design suite.

QPROP 螺旋桨分析套件包括 ANPRO 工具和 PROVIS 工具。ANPRO 使用一种稳健的升力面方法计算船舶尾流场中类似非稳态螺旋桨叶片载荷。运用这个工具有经验的螺旋桨设计人员能够做出关于螺旋桨效率与例如压力面空化和分离式空化团这些不利空化类型之间的均衡设计。完整的工作流程结果可以在 QPROP 图形用户界面和 PROVIS 中显示，PROVIS 是一种经 ANPRO 计算出空化形式的三维可视化工具。对于导管螺旋桨，DUCTPROP 程序包含在 QPROP 中。DUCTPROP 使用一种模型，模型中螺旋桨盘面由指定了径向载荷分布结合导管周围的涡流分布。提供诱导速度作为 ANPRO 的输入。

这个套件可用来分析螺旋桨，该螺旋桨是在螺旋桨选型和设计套件中设计的，或者来自其它途径，也就是说可以在没有螺旋桨选型和设计套件的情况下使用。

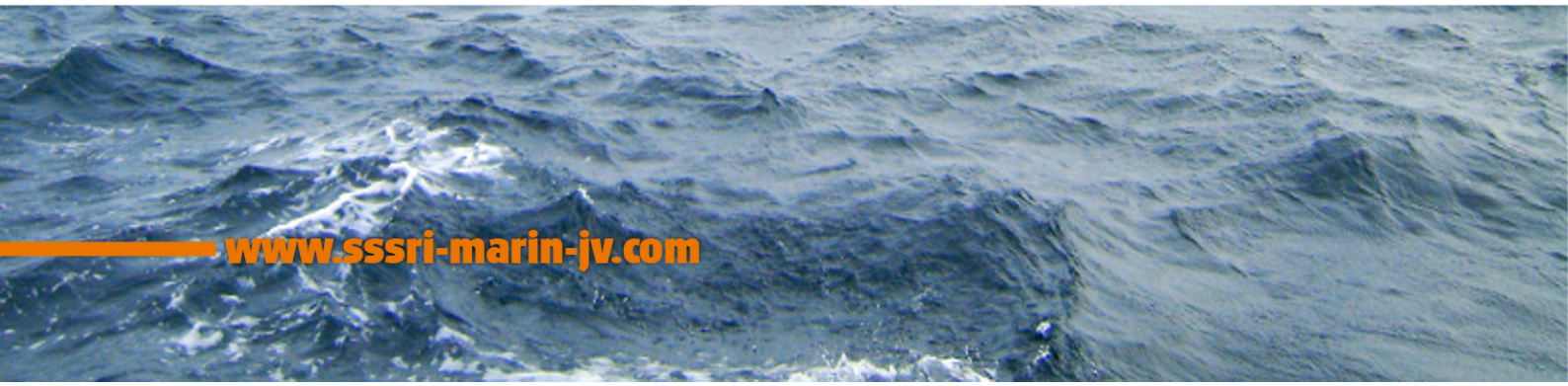


Visualisation of cavitation patterns in PROVIS PROVIS *中空化模式的可视化*

Application 应用范围

QPROP can be used to design moderately loaded fixed pitch and controllable pitch propellers, with and without nuzzle, depending on the software tools that are included.

QPROP 可以用来设计中度载荷的固定螺距螺旋桨和可调螺距螺旋桨，并根据包含的软件功能计算带与不带导管的情况。



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