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In the Engine Room & Outside the Hull

Overcoming the Propeller Supply Bottleneck

Hydrocomp's PropCad facilitates in-house Process Control of Propeller Design and Manufacture.

By Don MacPherson and Adam Kaplan

Maritime Tactical Systems Inc. (MARTAC) is a Florida-based company building next-generation unmanned vessels for military applications. In preparation for the "Rim of the Pacific" (RIMPAC) military exercises in Pearl Harbor this last July, MARTAC needed a new propeller design for their MANTAS series high-speed vessels. Unfortunately, their current supplier was not meeting delivery schedules for the high-quality surface-piercing propellers that they need, so MARTAC made the decision to design and build propellers themselves. As part of this new in-house process control for propeller design and manufacture, MARTAC teamed with HydroComp for acquisition of the PropCad propeller design software, as well as design services for an initial prototype.

ADOPTING IN-HOUSE MANAGEMENT OF PROPELLER DESIGN AND MANUFACTURE

For many companies, propeller supply can be a major project bottleneck, as lead times can be long and delivered propellers sometimes needing additional rework to meet QA requirements. Further, large propellers require foundry and machining equipment that make own-control of manufacture unrealistic. MARTAC's MANTAS vehicles are small (less than 3 meters length), so the scale of the propellers made it feasible to manage the manufacture in-house.

A multiple product series of propellers was to be required by MARTAC, so they decided to conduct the design in-house and adopted the PropCad software for the geometric modeling of the designs. A parent design provided by HydroComp would be used as a design "template" for later variants developed within PropCad. With less than 30 days to RIMPAC, the deadline for creating an initial design, manufacturing the necessary sets of propellers, testing their performance, and selecting a final design for RIMPAC was extremely tight.

WHEN RAPID REALLY MEANS RAPID

Within six days from the start of discussions with HydroComp, MARTAC acquired PropCad, received the design geometry for the prototype propeller, and sent the 3D CAD files to be manufactured by a national 3-axis production company. The propellers were completed and shipped three days later, for testing that weekend. A slight revision was requested for updates to the drive line connections, and a second design iteration was completed and sent out for machining four days later. The final propellers arrived 19 days from the start of discussions between HydroComp and MARTAC, with plenty of time to spare before RIMPAC.

How was MARTAC able to overcome the propeller supply bottleneck and meet such an impossibly tight timetable? By leveraging the facility of the HydroComp PropCad software to own the design-to-manufacture process with the added value of the propeller design expertise of HydroComp staff.

HYDROCOMP PROPCAD SOFTWARE

HydroComp PropCad is industry-standard software for developing marine propeller designs, 3D models, 2D drawings, and various inspection reports. Used by over 160 professionals in more than 40 countries, PropCad has made possible the in-house management of propeller design and manufacture – whether that be by a propeller builder with their own foundry or a company like MARTAC using an outsourced production company.

Standard CAD tools are poorly suited to develop the special non-orthographic shapes of propellers that are oriented along a helical surface. Prismatic shapes and planar sketches are simply inadequate, as well as frustrating and costly. PropCad is a dedicated propeller design environment that makes developing the blade sets fast, easy, and cost-effective. It is a parametric tool that develops the propeller surfaces from the design objectives you specify – there is no manual manipulation of the CAD surfaces required. This means that users do not need extensive CAD experience to quickly develop accurate and well-behaved propeller CAD models with its integrated parametric modeling. PropCad's various export options insure that users can develop virtually any 3D "design-for-manufacture" propeller geometries that are required.

MANUFACTURING AND INSPECTION SUPPORT

PropCad is not only used for design geometry, but can be used to compensate a design for different manufacturing

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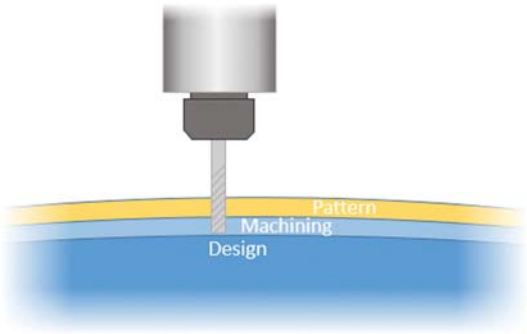

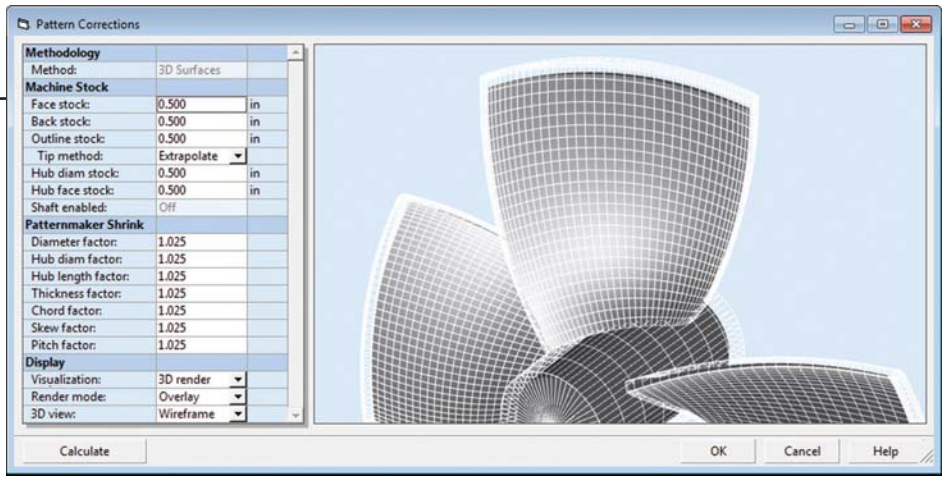

processes, such as plastic injection molding, lost-wax casting, green-sand casting, or CNC machining. A new Pattern Corrections utility in the Premium Edition of PropCad allows users to specify machine stock and shrinkage factors to create machining models, casting patterns, and mold geometries. Eliminating direct manual manipulation of the propeller design surfaces, the utility allows these corrections to be specified as parameters. The changes are applied mathematically and directly to the propeller parameters, with calculation and visualization of corrected sections, blade parameters, and radial distributions. Consequently, adjustments to a pattern can be made by simply adjusting the parameters instead of directly manipulating the surfaces.

PropCad can export to a variety of CAD and CAM packages, including Unigraphics NX, Rhino, Solidworks, Pro/Engineer, Creo, SurfCam, MasterCam, DELCAM Powershape, and others. Additionally, PropCad exports to a variety of universal formats, such as IGES and point clouds. This flexibility in CAD/CAM output enables users to migrate propeller and pattern designs into a variety of packages to add details and produce CNC tool paths.

After the propeller has been produced, PropCad includes many different methods for quality assurance. These include detailed inspection maps and local pitch reports. For high value projects, data points from the surface can be measured and input into the Scan Converter module. The 3D geometry from the measured propeller are derived and compared to the design values in order to verify the accuracy of the manufacturing process.

RIMPAC SUCCESS

While at RIMPAC/Trident Warrior 16, MARTAC operated and demonstrated the MANTAS with their new PropCad-designed propellers. The operations were wildly successful, and many groups including the Navy Mid Pacific Afloat Training Group (ATG), Coastal Riverine Squadron (CRS-3), several U.S. Congressman and their staff, high ranking military personnel, Defense Ministers of Allied Countries, and even the Undersecretary of the Navy were provided initial operator training and were able to successfully operate the MANTAS craft both from shore, and in the case of the ATG and CRS-3 personnel, from onboard their Rigid Hull Inflatable Boats (RHIBs) and Riverine Command Boats (RCBs). Through the acquisition and application of the HydroComp PropCad software, MARTAC was able to – in a very short time – take complete control of the propeller design process, thereby resulting in a significant increase in the number of potential manufacturers for their designs, and a dramatic reduction in the lead time for obtaining propellers for their MANTAS series vessels.

MARTAC's Chief Technology Officer Jack Rowley perhaps said it best, explaining, "PropCad was a key component in the ultimate success of the MANTAS craft operations in the RIMPAC/Trident Warrior naval exercises. As we further expand the design characteristics of the craft, we expect that PropCad will continue to be a highly useful tool for improving our craft performance hydrodynamics."

Donald MacPherson *is co-founder and Technical Director of HydroComp, Inc., a consultancy established in 1984, specializing in applied hydrodynamics with particular emphasis on the numerical prediction of vessel and propulsor performance. MacPherson is a graduate of the Webb Institute of Naval Architecture, a Fellow of the Society of Naval Architects and Marine Engineers, a member of the SNAME H-8 Propulsion Hydrodynamics Panel, and a frequent author and speaker on ship resistance and propulsion, sea trial and bollard pull analysis, and propulsor design.*

Adam Kaplan *is a mechanical engineering graduate of the University of New Hampshire and project engineering with HydroComp. With an extensive background in CAD/CAM and manufacturing, he currently leads development of new versions of PropExpert and PropCad software at HydroComp. Adam is an active member of the Society of Naval Architects and Marine Engineers (SNAME) and the National Marine Propeller Association (NMPA).*

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