Preserving the environment is a major issue that concerns all industry sectors today, and cutting fossil fuel consumption globally is a major goal. Within the marine sector, worldwide fuel consumption has been estimated by the International Maritime Organization at 160 million tons per year, so marine engineers are continually looking at innovative applications of technology to reduce this.

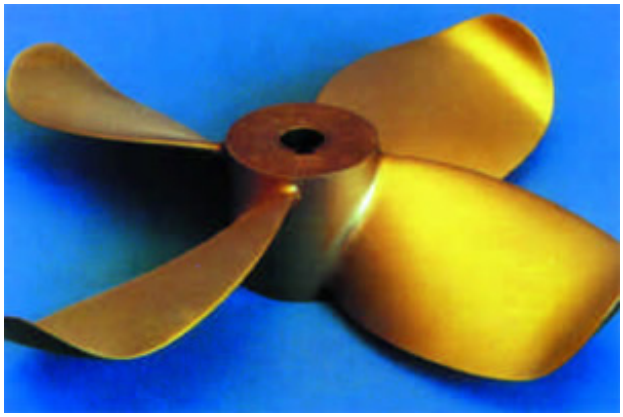
Among those putting the latest technology and theory into practice is Stone Manganese Marine (SMM), one of the leading manufacturers of large fixed propellers in the world. The company just announced an important innovation in propeller design that reduces fuel consumption in ships by a significant amount.

Based in the UK at Birkenhead, SMM has been involved in designing and manufacturing ship's propellers for more than 100 years. SMM's primary products are fixed-pitch marine propellers of single castings for all types and sizes of merchant and naval ships. It has the facilities to produce propellers with a finished weight exceeding 100 tons that are destined for container ships, tankers, bulk carriers, and warships.

Being a world leader in propeller design, SMM was therefore a logical candidate for the KAPPRICCIO project, an initiative funded by the European Commission to design and manufacture a revolutionary new propeller.

A Unique Application of Aerospace Technology

Among the innovative thinkers stepping up to this challenge was Danish naval architect and marine engineer Jens Kappel, who reasoned that the principles behind the latest aerospace technology could be applied to create a new approach to the propeller. As a result of his work, this new propeller, known as the Kappel Propeller, is more efficient and uses less fuel while reducing both noise and vibration. Working alongside Jens Kappel at each step of the project was SMM and its technical manager Lyn Bodger.



Bodger explained the concept of the Kappel propeller further: "A propeller is fundamentally a series of wings that happen to be built on a helical surface rather than attached the side of a plane. On the newer generation of airplanes a non-planar principle has been adopted, in which a small winglet is now placed at the plane's wingtips. The idea behind this winglet is that it reduces energy losses toward the tip. This application of the non-planar principle was the technology Kappel applied to propellers."

Working with the Technical University of Denmark, hydrodynamics laboratories in Copenhagen and Hamburg, plus ship owner D/S Norden A/S, Jens Kappel and SMM took on board the development of the digital design, model tests and then finally production of a full-scale propeller for sea trial.

Enter ZW3D

SMM needed to replace its existing surface modeler with a CAD/CAM software package that would assist them at the manufacturing stage of the project for the construction of the full-scale propeller. SMM drew up a list of functionality that was required for the project including surface vectors, intersections, fitting accurate curves through propellers (the curve fitting had to be absolutely accurate through all points), extending surfaces and intersecting surfaces. After an analysis of leading CAD/CAM products, ZW3D was chosen for the job. ZW3D offered the functionality required at a fraction of the cost of its competitors.

SMM's use of ZW3D is not exactly conventional. Many ZW3D customers use the software as a design tool forming the shape of consumer products, in which making a product look and feel good is vital to its success. Propellers are different—they're all about pure engineering function in which a propeller's hydrodynamic performance is of paramount concern and it is this, rather than aesthetics, which determines its geometry.

Propeller manufacturers such as SMM typically develop their own design software to establish the detailed shaping of the blade. The output of the hydrodynamic design software will provide information such as the diameter, the pitch angle of the blades, where they are set and the detailed shaping of the propeller. When this is calculated, ZW3D performs an important intermediary role for production purposes.

ZW3D assisted SMM in producing the accurate and complex shape castings for the propellers. At this stage of the process SMM's specialized data is transferred from its own software and imported into ZW3D, which provides the essential data interoperability tools needed for this process, leaving no room for inconsistencies or inaccuracies. SMM has made good use of the ZW3D design automation capabilities, a macro programming language which, in this case, has enabled the automatic mapping of point sets to splines and surfaces.

ZW3D was then used in the manufacturing process. The three-dimensional surfaces accurately mapped through design data points by ZW3D were then interrogated, again using ZW3D, to produce points files which were then used to product accurate and complex timber patterns for mold construction and also templates for checking final blade geometry.

In addition, ZW3D was used to calculate the mass properties. This is particularly important as both weight and inertia can affect the level of vibration caused by the propeller.

"For this process we simply fed the density of the material into ZW3D," said Bodger. "From here the results were generated, volumes, weights and moments of inertia were calculated, everything we needed was right there. It's extremely helpful."

Sea Trials Validate the Concept

The final stage of the project was to take the Kappel propeller to sea trials with a full-scale propeller. These took place in mid April and the results were impressive."We were very satisfied with the results. It's achieved an increase of efficiency of four percent," Bodger noted.

When taking this figure and applying it to the consumption of fuel in large ships worldwide this propeller could have significant environmental implications. Today fuel consumption is estimated at 160 million tons per year. Therefore the worldwide yearly fuel consumption could be reduced by 6.4 million tons with the Kappel propeller on board.

"What's more there was a big improvement in vibration performance. We were expecting some but it was greater than we had predicted," said Bodger.

Now that the results of the sea trials have been a success the next stage of the project is to market the Kappel propeller. It is relevant for a broad range of marine propellers including single screw, multiple screw, fixed pitch and controllable pitch propellers.

"Customers are quite enthusiastic about adapting new technologies if they are sure that there is a short payback period," concluded Bodger. "We believe it will take less than two years to make a difference."

SMM's long and impressive heritage of marine innovation has made it one of the most important manufacturers of propellers in the UK. With the help of the advanced surface modeling tools provided by ZW3D, SMM has played a vital role in continuing marine development with proven environmental benefits.