

Making custom propellers requires a precision finish that despite the uniqueness of each propeller, is best done by robots.

Big ships big propellers

By Bob Emmerson
Photos Ruben Keestra

> Big products with fine precision. That's what the Finland-based company Wärtsilä is all about. The company designs and produces controllable pitch propellers for the commercial, military and super-yacht market. These are unique products, the first design of which dates back to 1903. Controllable pitch propellers are custom-designed for each ship and in turn they form part of a custom-designed propulsion solution that includes the rudder, gearbox, and engine. It's an A to Z solution that starts with the control system on the bridge and ends with the propeller. The pitch is controllable in order to accommodate different speed and load requirements. Wärtsilä works closely with the owner of the ship and the yard in order to ensure that the propeller delivers the optimum performance in all operating conditions. More than 10,000 propulsion solutions have been deployed and Wärtsilä is market leader in this sector.

The blades are cast, machined and assembled in Drunen, the Netherlands, as well as Rubbestadneset, Norway. There is a wide variation in size: heights go from around 80 cm up to 3 meters and weights from 100 to 4000 kg. Propellers have four or five blades, so the final product can be very large and heavy.

The manufacturing process is very demanding. It starts in the foundry where a block of high-density (60 kg per m³) Extruded Polystyrene (EPS) is milled using an ABB IRB 6400 robot. The profile is not that of the blade since EPS could not support the high temperature of the molten metal. Instead, it is used (via an interim process to produce a sand copy) to create one half of the mould. Two halves are then clamped in a metal frame, into which "cunial" — a copper-nickel-aluminum bronze is poured and the casting is left to cool, which can take several days.

Blades are then transported to another part of the factory complex where the blades are ground and polished using two ABB robots, both of which have a linear track. Both sides of the blade have to be ground. They are turned using an index turning table. The edges of the blades are then machined by hand. Grinding and polishing can be done by hand, and it was done by hand in the past, but it requires specialist staff and they are no longer available.

Robots are ideal for this application since no two solutions are the same. The blades are curved, so a 5-7 axes robot has to be employed.

The grinding process automatically accommodates progressive reductions in the depth of the grinding material. The pressure is controlled, together with the robot feed or speed. This process is complex because of the different angles and material stock.

The milling process will typically take six hours. Grinding will depend on size but eight hours is a typical figure. In addition some manual work is needed.

>FACTS

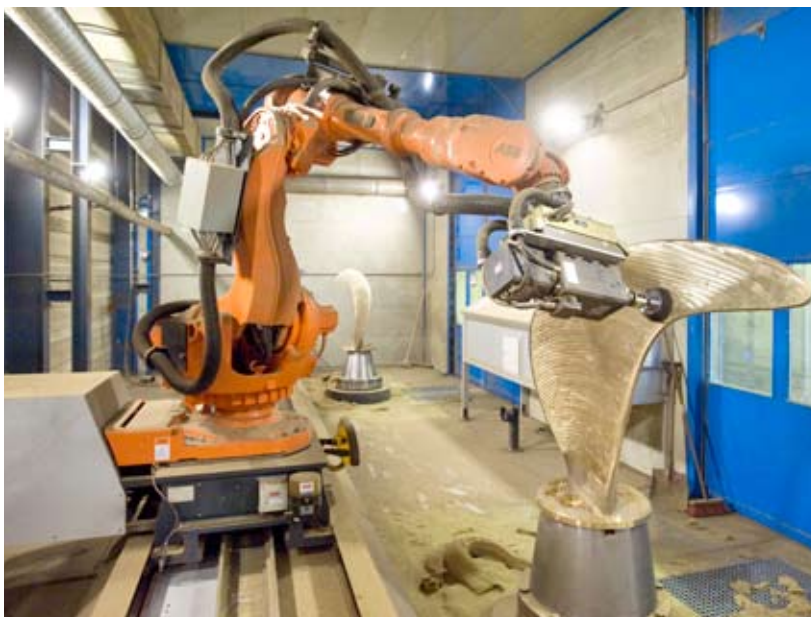
Special needs for special products

Blade profiles are determined by the design of the solution. They are generated automatically and translated into instructions for the robots. There are no production runs: each solution meets an individual set of requirements. ABB robots are ideal for this type of application since everything is linked to that design.

Manual grinding is tedious and it is difficult to ensure that the requisite amount of material is removed. It is very hard to find employees having the necessary skills. Robots work round the clock and deliver consistent results. Availability is very high and with low production downtime due to the robots.

The first robot has been in use for nine years and it is still going strong.

ABB robots were selected because they combine reach with rigidity and are protected against foundry dust (Foundry Plus Protection).



Wärtsilä at a glance

Wärtsilä is a Finnish company whose roots date back to 1903. The company offers reliable, cost-effective solutions for all marine power and propulsion needs. The relationship starts with the initial design concepts and continues throughout the lifetime of the vessel.

The company markets power plants and ship power systems with propulsion solutions having controllable and fixed pitch propellers.

More than 10,000 solutions have been installed and the company's propellers are in use around the world.

Wärtsilä has 130 locations in 75 countries around the world. There are 900 employees at the Delivery Center Propulsion factory in Drunen and a total of 17,500 worldwide.



The grinding process is done two-up so the robot line will typically produce four blades a day.

The ABB IRB 6400 robot has been operational since 1999 and a second robot, an ABB IRB 6600, was added in 2008. Says André Janssen, Manager Manufacturing Technology & Tools at Wärtsilä: "We gained a lot of automation experience with the first robot and the second was needed to increase our production capacity. The new model employs an electric high-frequency motor instead of hydraulics and this allows tools to be changed using a standard HSK tool adaptation system, as in a CNC (computer numerical control) system. In December 2008 a fourth robot, an ABB IRB 6640 will be installed for manufacturing EPS patterns."

The A to Z solution determines the finished profile, i.e. it is an integral part of the design. A computer system is used to take inputs from the CAD/CAM system and translate them into robot language instructions. The robots can be programmed to grind and polish the same blades or those of different propulsion solutions. The process complies with ISO-484 manufacturing tolerances.

"Apart from the complexity of the shape, robots are the only way we can meet our production schedules," says André Janssen. "Our order book is full and to meet the demands of our worldwide customers we run the production line 24 x 7 with minimal downtime." ☉