The development of Azipod propulsion system started some 20 years ago and the product has been modified step by step and improved while gaining a position as a major propulsion system for luxury cruise ships and ice going tonnage. However, in principle, Azipod has been based on the same main ideas and solutions as was the case with the first prototypes.

In order to develop a completely new Azipod generation, a comprehensive development programme was started within ABB Marine in January 2006. Based on over 4.5 million Azipod operational hours gained through the years, this development programme fundamentally challenged all of the earlier chosen solutions and took a fresh approach to the mission, not only from technical point of view but also from the viewpoint of safety, maintainability, reliability, production, human interface, life cycle cost, environmental features and overall design. Customers gave important input in selecting the right solutions from a wide variety of possible alternative configurations.

Innovation does not pop out of the bush and say “hello, here I am!”. Real innovation is the result of the continuous evaluation of new ideas and possibilities. Tens and hundreds of ideas are needed to discover the real innovation behind the most obvious solutions. This was the way it went during the development of the Next Generation Azipod.

Evaluation of ideas and further development were achieved in very close operation with several yards.

**Figure 1:** Innovations are inside the Azipod XO®
and end users. After all, it was concluded that good ideas do not become true innovation without direct customer feedback!

Even if, on the face of it, the Next Generation Azipod (now branded Azipod XO®) looks quite conventional, new innovations are to be found on the inside.

Podded propulsion has already been proven as improving hydrodynamic efficiency compared to conventional electric shaft line systems by about 10 to 15%, depending on ship type and operation. However, the project team was encouraged to put their efforts to investigate the possibilities for reducing energy consumption further, and thus also the CO2 emissions of the vessel.

Being a complex product with many different considerations to be borne in mind, such as maintainability, ship installation and cost, hydrodynamic design has its limitations, and compromises have to be made with respect to different design features. Roughly 15 different new hydrodynamic shapes were developed and analysed with CFD (Computational Fluid Dynamics). Again, many test sessions were held at a model basin to verify the practicality of new ideas. Finally, a definitive shape was selected for the new Azipod.

For the outsider, the new hull looks quite the same shape as was the case for the previous generation. However, the propeller hub and Azipod hull diameters have been reduced and Azipod strut shape has been further optimized. This new shape brings with it about a 2 per cent improvement in hydrodynamic efficiency in a tested case. This might sound like a minor matter but, for a typical cruise ship, it means a half a million Euro savings per year, on top of the 10-15% efficiency saving already achieved over conventional propulsion.

**INTERSPACE – REVOLUTIONARY SHAFT SEAL SYSTEM**

One example of an open minded and innovative solution that has been adopted is the new sealing system for the propeller shaft. It is easy to imagine that, if seawater leaks inside the pod and into the high power electric motor, the leakage most will most probably cause costly harm to equipment and bring about time consuming dry-docking to repair the motor. At least as important, from the environmental perspective, is that lubricants from the bearing do not leak into the sea.

The interspace concept is a really revolutionary innovation (patent pending). This concept makes seal maintenance possible inside the Azipod and gives the ship operator a huge advantage minimising risk in operation. With a designed-in redundant temporary seal arrangement, all seal rings can be changed. This arrangement also divides seal packages for water and oil seals, meaning that it is just not possible for water to leak into the bearing or for bearing oil to leak into the sea.

The seal against the water is equipped with an active system that controls the seal’s operational environment and optimises its condition for an extended lifetime. For example, the balance between pressure and heat is automatically optimised. The system also enables advanced condition monitoring to a degree not seen in the market.

**Azipod® XO – innovations inside**

- Improved efficiency: less is more
- Interspace: revolutionary shaft seal system
- Hybrid bearing: thrust to your business
- Easy access to the Azipod: safety first
- Advanced condition monitoring for preventive maintenance
- Fully electric steering system for redundancy, environment and comfort
- Maintenance friendly steering module
- Intelligent bridge control interface for efficient operation practices
- Modular design targeted to varying customer requirements
HYBRID BEARING – THRUST TO YOUR BUSINESS

The hybrid bearing (patent pending) is in principle a very simple bearing arrangement. It combines two different known bearing technologies: the slide and roller types. Nevertheless, the combination is new to the market. Radial support of the shaft line is achieved using well proven roller bearings. The thrust bearing is of the slide type and carries all thrust loads of the propeller in both forward and backward directions. Thrust pads are of the white metal type and it is possible to change them from inside the Azipod. This innovation gives the ship operator a significant benefit; submit to an extended dry-docking interval of thrust bearing maintenance, when this can be done at sea?

EASY ACCESS TO THE AZIPOD – SAFETY FIRST

Special attention in the design has been paid to human safety during installation, operation and maintenance of the product, e.g. safety when moving about inside the Azipod hull during maintenance. Also for safety reasons, the interior of the Azipod hull has been made as spacious as possible, while special ‘Azigear’ work gear has been developed for maintenance personnel needing to work in confined spaces. Together with Azigear, permanent ladders, safety rails and better lighting increase the safety level of working inside an Azipod significantly.

ADVANCED CONDITION MONITORING

Today, preventive maintenance and predictability of maintenance are getting more and more important in the shipping industry. To meet future needs, Azipod XO was designed to include a very advanced propulsion condition monitoring system (PCMS). PCMS monitors most vital parts of the whole propulsion system; from propulsion drives to the Azipod bearings. This system collects data from multiple sources, processes it and produces easily understandable graphics of the system’s status for the crew to follow up. For example, bearing temperatures and vibrations, oil contamination and propulsion motor temperatures are all monitored.

In addition to that, the system enables remote diagnostic services: for land-based monitoring by the customer and/or ABB. The PCMS is a very useful tool for life cycle management and for trouble shooting.
Azipod XO steering is fully electric, instead of the earlier hydraulic solution. This new system brings with it such benefits as easier installation, improved efficiency, reduced need for maintenance and less noise. The small amount of oil needed is also an important factor.

The basic electric steering principle is to control steering motor speed and rotation direction with frequency converters. Each motor has its own steering drive which yields redundancy advantages, because any single failure does not reduce available steering capability. Steering motor power is transferred through the reduction gear to the pinion and on to the gear rim, which is rotating the Azipod. The system is controlled by an Electric Steering Control Unit (ESCU), which includes the intelligence of the system. The location of the steering drives and ESCU can be selected in a flexible way that is advantageous to the yard when designing machinery spaces.

The slewing bearing, located inside the steering module, is one of the most vital components in the Azipod system; it carries all loads from the propulsion module. Therefore, slewing sealing, which prevents water entering the bearing, is a very important part of the system. Naturally, seals are wearing parts and that is taken into special consideration in the Azipod XO steering module design.

Azipod XO slewing seals can be changed from underneath the ship’s hull with relative ease; even afloat, depending on the ship’s water line. In addition, there is an air actuated emergency seal for risk management. This seal can be activated at a very early stage when system indicates that leakages have started. This emergency seal allows normal operation to carry on for extended periods, giving the operator the breathing space to plan the next maintenance work.

Even if the slewing bearing is designed with a very long life in mind, it may have to be changed on occasion. For this reason maintenance friendliness has also been considered here, with the slewing bearing positioned so that it can be changed on the ship’s side, in order that there is no need for major operations inside the ship.

360° rotatable podded propulsion is a fantastic tool for ship handling. Nevertheless, there are also some drawbacks. With very powerful devices, it is possible to harm other devices or use too much power and additional fuel if the deck officer is unaware...
of what is happening under the ship’s stern. It is understandable that a ship of 300m length or more does not necessarily give the helmsman a “feeling” as to what is happening at its other end. For this reason, the Azipod XO intelligent bridge control interface has been developed.

The Intelligent bridge control interface is the part of the system for steering and moving the ship – maybe the most important system in the whole ship. Improvements in this new system are:
- only the most important information is presented on the main screen
- indication of fuel economy is presented
- recommended and not recommended steering angles are presented to minimise unnecessary loads to other Azipods as well as cavitation
- status of the system vibrations are presented
- data history is stored in the system for deck officers’ self training – where did I do it right and where do I have something to improve
- available power plant capacity is presented
- command and actual steering angles as well as thrust are presented
- individual and combined force vectors of two or more Azipods are presented
- the system is built up as a modular construction to make it easy to install it as a part of the other bridge systems
- Field bus based – less cabling for easy installation

The intelligent bridge control interface improves usability of the Azipod system and enables operator to minimise the life cycle cost of the ship.

The experience of first generation Azipod units has been that the product has to be of modular construction. This philosophy has a lot of benefits: by standardization, the product quality is improved and manufacturing is simplified. However, it is essential that the modular, standard solutions, and alternative solutions and available options, are selected in a clever way. The Azipod XO product family is made up of roughly 300 modules and some tens of optional modules. With a product “pallet” like this, a fast and reliable response to varying customer requirements is ensured.