ECOLUTION

A revolutionary hybrid-powered Aerorig Schooner under construction

At the premises of Marvis Jachtbouw in Groningen, one of the most interesting sailing yachts in recent years is taking shape. The yacht, called *Ecolution*, is the brainchild of owner Wubbo Ockels, well known in Holland for being the first Dutchman in space in 1985. After his career as an astronaut, Mr. Ockels has continuously been a forerunner in the development of alternative energies and sustainable development. It is thus no surprise that he was involved as a consultant in the design process of Ethereal, a 58 m sailing ketch with hybrid propulsion delivered in 2009 at Royal Huisman Shipyards. He is now using his experience to develop a first yacht in what will hopefull series

Lab-boat

While its main goal is to become a trustworthy blue-water cruiser for a circumnavigation, the *Ecolution* can also be considered as a laboratory for innovative solutions. The driving principle of Mr. Ockels is that global warming should not restrict the options of people to entertain themselves or lower comfort levels. Instead, if we do things in a different way, we can enjoy ourselves just as much, or even more, without burning massive amounts of fossil fuel. Some of the most notable innovative features found onboard are:

- hybrid propulsion
- storage tanks for heat
- floor heating
- heatpump
- airhandling and heat recovery
- adaptive propellers
- power generation during sailing
- aero-rig for easy handling

Because the *Ecolution* will also be used for sponsored and charter activities, it will be built under the rules of the MCA Large Yacht Code. This also means full classification of hull under supervision of Lloyd's Register.

Short-handed sailing

It is intended that the *Ecolution* will be as enticing to typical motoryacht clients as to experienced sailors. Also, the owner and his wife will make a short-handed circumnavigation with-

The swimplatform folds out on port side

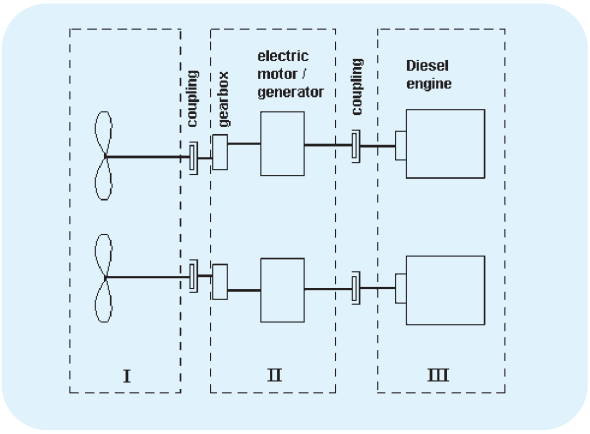
out additional crew. These requirements led to the choice for a dual Aero-rig, consisting of two freely rotating masts with booms attached to it fore and aft. The angle of attack of the four sails can be controlled with just two outhauls on electrically powered winches. Sail handling is thus reduced to a minimum and tacking or gybing involves no manpower at all.

Design

The hull design of the *Ecolution* was based on an existing hull shape developed by Dijkstra & Partners Naval Architects, which is rapidly becoming a household name in eco-friendly yachts and ships. The final design has been a cooperation of Wubbo Ockels and Gerry Dijkstra, leading to a somewhat longer hull of 25.6 m and a large deck/pilot house. The company developed a spreadsheet which calculates the optimal heading and sail trim for maximum sailing speed and/or power generation.

Propulsion

The drivetrain setup is comparable with the one found on Ethereal. Two diesel engines are in line with the propellers, but between engine and propeller, a clutchable electric motor is mounted on the shaft. The electric motor can be used both for propulsion and power generation.



In this way, the following modes are all possible:

1. the engine drives the propeller only
2. the engine drives the propeller and the motor/generator
3. the motor-generator drives the propeller while the engine is turned off
4. during sailing, propellers drive the motor/generator to charge the batteries
5. the engine drives only the motor/generator for power generation

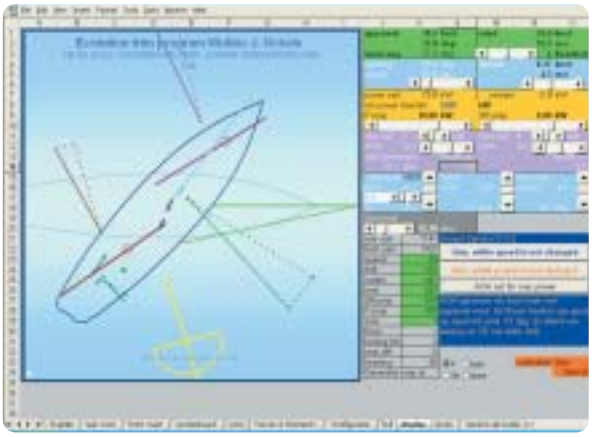
In winds of force 5, the propulsion power generated by the sails is around 200 kW. Each of the propellers can generate a maximum 10 kW, which results in a loss of sailing speed of less than 1 knot, and even 0 knots in optimal conditions. The generated 20 kW not only suffices amply to supply the onboard consumers, it is also used to charge the batteries. Calculations show that one day of sailing in favourable winds will produce enough energy to live aboard for four days without using fossil fuels.

Battery bank

The electric power generated during sailing is stored in a large battery bank under the accommodation floor. The 10 tons of these batteries substitutes the conventional lead ballast in the keel. The batteries are conventional gel-type lead-acid batteries. In future builds, more advanced types of batteries, such as Lithium polymer, may be considered. Four Quatro converters from Victron convert the 24V DC power of the batteries to 220 V AC for the onboard consumers. The battery bank can store enough power to live comfortably on board for a month.

Fail-ops-fail-safe

Based on his experience with the Space Shuttle, Wubbo Ockels has specified a completely redundant propulsion and power supply system. When one component fails, the normal



operation can still continue (fail-ops). If a second component fails, there is still a back-up (fail-safe). This is achieved by the dual propulsion installation (starboard and portside) and of course the sail power.

Adaptive camber

The revolutionary twin-bladed propellers on *Ecolution* are Contur-F propellers from Voith Turbo. These propellers, claimed to be the first "intelligent" propellers, can adjust their pitch without additional mechanical components. This is achieved by an elastic material mix, which envelopes the carbon cores of the propellers, resulting in a modifiable profile, a technology known as camber-adaptive. The deformations of the propeller blade surface render the propeller the characteristics of

The propellers have a profile with flexible skin

a controllable pitch propeller, without the added mechanical complexity. The propellers will rotate in the same direction whether they are used for propulsion or as turbines for power generation.

Heat storage

Instead of a conventional power-hungry air-conditioning system, the HVAC system onboard is more related to the systems used in passive houses. In cold climates, the heat of the extracted air is used to pre-heat the incoming fresh air. An electric heat pump from Alpha-Innotec in the fresh air handler can either heat or cool the incoming air. Two large insulated tanks can store heat in the form of hot water for long periods of time. These tanks can be heated by the cooling water of the main engines. In hot climates, the floor-heating can circulate seawater, providing an economic cooling effect.

While the level of comfort remains uncompromised, certain consumers onboard are chosen for their low power consumption. LED lighting is used, both inside and for the navigation lighting. A new type of clothes drier from Miele with a built-in heat pump only consumes 25 % of the power of a conventional drier. The decks will be made of a synthetic material to preserve slow-growing teakforests. The wood used for the interior, designed by Jan des Bouvries, is also FSC certified wood. As an anti-fouling paint, a new paint from International will be used, which does not release biocides into the marine environment.

Keels

The *Ecolution*'s underwater appendages are designed in such a way that the boat can remain standing on the beach when the tide recedes. This is achieved with a long retractable keel and two side keels which hold the rudders. The side keels also house the keel coolers for the main engines' cooling water. The keels feature a cut-out to create a weak link where they break in case of unintended grounding, thus preventing damages on the hull.

Future mods

A side project which shows significant promise is the possibility to take out the forward aerorig and substitute it with a kite-power installation. Wubbo Ockels holds the patent for the laddermill, which is a method of power generation with kites. Winds are always stronger higher above the sea surface. By using kites, the laddermill can tap into this source of energy, both for propulsion of the *Ecolution* and for onboard power generation.

Series

The *Ecolution* is the proof-of-concept for what will become a series of eco-friendly yachts. The company Ecolutions B.V. was established by Wubbo Ockels, Marvis Jachtbouw and No Limit Ships B.V. to market and build the yachts. Undoubtedly, extensive testing on the first yacht will yield improvements on future vessels in the series. The cost of an Ecolutions vessel is estimated to be around 3.5 Million euro.

Ockels gained his appreciation for ecology by watching the planet from space. He realised that there is just a thin layer of 20 km of atmosphere between the Earth and space, where there is no oxygen and temperatures are more than 200 degrees below zero. It is essential for our survival that we take good care of our little oasis in space. ■

The structural work is completed

The accomodation has floor heating