MDV-1 ‘IMMANUEL’

Photo by Flying Focus

A sneak peek at the **future** of fishing vessels

Bring several tech- and fishery-oriented people together with a clean slate, a healthy brain and a clearly defined goal, and magic starts to happen. This is exactly what came about with MDV-1, the first of a new generation of fishing vessels. In a sector where traditions are honoured and innovation is often frowned upon, big steps can be taken. The MDV-1 project was conceived when two competing shipbuilders - Padmos from Stellendam and Hoekman from Urk - joined forces with two ambitious fishermen - Hendrik Romkes and Hendrik Kramer, both from Urk - to develop a new type of fishing vessel. They were supported both financially and with technical knowhow by the Masterplan for Sustainable Fisheries (in Dutch Masterplan Duurzame Visserij - hence MDV), including among others innovation manager Frans Veenstra.

The foundation Masterplan Sustainable Fisheries was established in 2012 to push forward the innovation in the Dutch fishery sector. Many parties have worked together to turn the vision into a success. Flynth, a Dutch company in consultancy for fishing companies, headed the coalition of cooperating parties. Auke Hoefnagel, director: “It is important to keep communicating on the right level at every moment. From the builders to the Dutch government, all parties involved have to be informed properly at every stage. This project is a beautiful example of cooperation on the full scope.” The European Fisheries Fund (EFF) has financed the innovations that are integrated in the ship, which made an important contribution to the whole project.

Evolution or revolution?

Fishing trawlers have gradually evolved into their current form over hundreds of builds, with small innovations making each vessel better than the previous one. The only way to improve on such a tried and tested design is to do radically different. Shipyard Padmos had for some time developed a new fishing vessel type and presented a 3D-print of this at the Europort trade show in 2011. Around the same time, Shipyard Hoekman was brainstorming in Urk with local fishermen to develop improved fishing methods. At the height of the fuel prices and a low in fish prices, fishermen were working most of their week just to pay the fuel of their vessels. In some cases, having embarked on Sunday night, it was only by Thursday evening that the fish they caught would generate an income.

Under the impulse of the prospective owners, both competitors Padmos and Hoekman became partners to jointly develop a new fishing vessel type. The goal: developing a twin-rig fishing vessel suitable for efficient fishing on both plaice and sole with a capacity to carry 850 boxes. And then things moved quickly. Leon Padmos: “After initial feasibility studies, the blueprint of a new design started to emerge. It became a sport to seek efficiency improvements in every area, be it hull design, propulsion system, fishing method or even power consumption on board.”

> MDV-1 IS AS INNOVATIVE ON THE INSIDE AS SHE IS ON THE OUTSIDE

Hull design

The most striking feature of *MDV-1* is the way she looks, both above and below the waterline. The principal dimensions were determined using statistical data from MARIN to find an optimum between cost, power, length and seakeeping. After a preliminary length/deplacement analysis by MARIN and following discussions, this resulted in a length-over-all of 31 metres. The hull shape was designed by Kramer Marine Engineering. Klaas Hoekman: “Calling in the help of an outsider - in this case a yacht designer - is a very efficient way to spur innovation.” CFD software was used by D3 Applied Technologies (Spain) to compare various hull shapes in various wave conditions, always comparing with the standard trawler as a benchmark. The best performer of these in typical North Sea conditions was then chosen as the basic hull shape. It is characterised by a wedge shape in planform: a nearly vertical narrow bow, a full body amidships and a wide and relatively flat aft ship, with little transom immersion. Above the waterline at the bow, a wider section was applied to create extra reserve buoyancy and reduce the probability of green water on deck, and to create a

Propulsion is diesel-electric with a variable-speed generator

spray rail. Notable is the shape of the bilge keels: instead of long narrow profiles, these are short and wide. Apart from being more efficient (due to their higher aspect ratio), they also perform an essential function in the machinery department. The bilge keels are built with longitudinal framing forming an internal labyrinth structure. The cooling water of the main engine enters at one side and exits cooled at the other, without the additional resistance caused by sea chests or external pipework.

Because of her unconventional hull shape, giving her a low added resistance when sailing in waves, *MDV-1* is less frequently forced to sail with her beam to the waves to maintain sufficient fishing speed.

Longitudinal structure

Almost all fishing vessels are transversally framed with a frame distance of 450 millimetres. On *MDV-1*, the main stiffening is longitudinal, with fewer transversal frames. As the longitudinal stiffeners contribute to the overall strength, this is a lighter construction for the same strength. Frans Veenstra: "The choice of material was also put into question, but a combination of cost, delivery time and regulations settled the choice on steel. When comparing with composite, steel can also be recycled more easily at the end of life and repaired in the case of damage." Nevertheless, the doors in the superstructure were made of composite and the option for a composite deckhouse remains on the table for future builds. Instead of conventional anti-fouling, the hull is coated with a prototype adhesive film from Sigma PPG Coatings, which is said to be absolutely biocide free and hydrophobic.

FUEL EFFICIENCY DRAMATICALLY IMPROVES PROFITABILITY

Powering

MDV-1 is as innovative on the inside as she is on the outside. The propulsion is diesel-electric with a variable-speed generator and a DC-bus. This allows to run the generator always at a very high efficiency, at speeds ranging from 800 to 1,200 rpm, and it allows to equip the boat with two generators (one running) instead of three in the case of AC (where normally two would be running). The larger generator (500 kW) is used during transit and fishing, while the smaller one (117 kW) is mainly an emergency generator, capable to bring the boat back to shore at a lower speed. The E-motor on the shaft line is from Oswald and is water-cooled with a freshwater cooling system. The electrical installation was devised jointly by Elektro Westhoeve and Emerson Industrial Automation.

The gains made by the diesel-electric installation are in part due to the highly variable load profile of the vessel: either the vessel is towing at a slow speed (3.5 knots) with a high pull or she is sailing lightly loaded at transit speed (10.5 knots). Doing this with a diesel-direct propulsion would require a controllable pitch propeller, which has a lower efficiency than a fixed-pitch propeller. The high torque available at a low speed from the E-motor allowed for a very large propeller, driven directly without a gearbox (and gearbox losses). Where other similar vessels typically have a propeller of 2,500 millimetres in diameter, on *MDV-1 Immanuel*, it is a big three-bladed prop of

A lot of thought went into creating an ergonomic bridge layout

The aft deck has plenty of working area

3,000 millimetres, and it can be rotating at any speed between 0 and 110 rpm. A large, slow turning propeller is more efficient at producing forward thrust than a smaller, faster turning propeller, and the boat was largely designed around this simple fact. The propeller nozzle increases the efficiency during trawling, as it produces about 30 per cent of the thrust in that case. The hull shape guides the water cleanly towards the integrated nozzle. The rudder is shaped asymmetrically, converting some of the rotational energy in the propeller wake into forward thrust.

In the case of a crash stop (pulling the lever from full ahead to full astern in seconds), the water will drive the large propeller, which in turn will drive the E-motor. This then becomes a generator, which would send unwanted 'reverse power' into the system. To prevent this, the energy is absorbed by a dedicated load bank, consisting of a heating element.

House efficiency

Saving power is easier than producing power cleanly, and therefore each and every consumer on board was examined critically with the goal of saving power. While double glazing and ample insulation reduce the required heating capacity, the shipyard also installed a large heat accumulator in the engine room. This consists of an insulated steel tank, holding 5,000 litres of water. The cooling water of the genset (normally 80 to 85 degrees) passes through a coil in this tank, heating it to about 75 degrees, before going to the coolers in the bilge keels. This provides enough heat to keep the accommodation warm while sailing, but even during weekends in the harbour, with the engine turned off, the capacity is usually sufficient to keep the boat heated to 12-13 degrees. Additional electrical heating coils are installed in the buffer tank, but are hardly used. The shipyard has gone so far as to put thermal insulation in the engine room to conserve energy and to reduce the heat transfer to the fish processing deck and fish hold.

Another big consumer on board are the pumps. While these are normally running at full power and the flow is regulated with a valve (creating losses), on *MDV-1* all major pumps, including the hydraulic pumps of the steering system from Trydo, are equipped with a variable frequency drive. This allows the pumps to run at a low rpm (and low power consumption) when the demand is low. The lighting on board is entirely of LED type for low power consumption and is automatically switched off with sensors when nobody is in the space. And then there are simple things, such as a single 'unmanned switch'. When leaving for the shore, this one switch turns off every consumer that is not needed during the weekend, and sets the heating to 14 degrees.

MDV-1 features the first twin rig with pulse gear

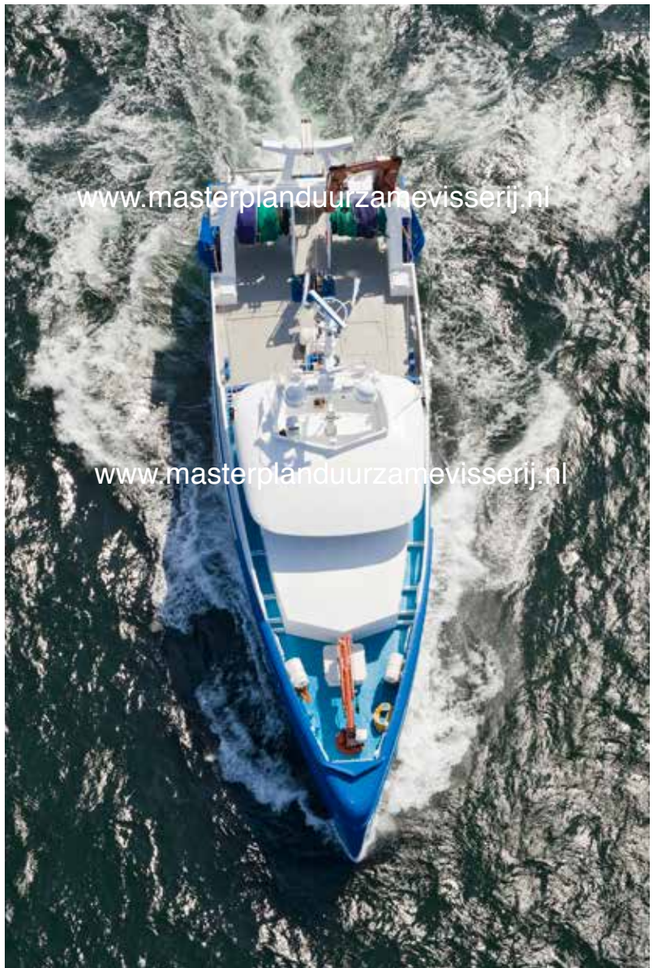
Fishing efficiency

Perhaps the biggest energy saving on *MDV-1* comes from the new fishing method installed. Beam trawlers, fishing for sole, have had good success with pulse fishing. This method relies on sending electrical pulses into the ground, causing the fish (which lay flat just below the sand) to curl up and easily be scooped up by the net. This avoids the necessity to drag a heavy chain on the ground, stirring everything up, and therefore also reduces the resistance and power demand from the main engine by about 45 per cent. Although also a groundfish, plaice is slightly different. It is fished with twin rigs (two nets next to each other) held apart by trawl doors. *MDV-1* is the first vessel on which a twin rig fishing gear is equipped with pulse gear. Not only does this allow the vessel to fish on both plaice and sole simultaneously, but even for plaice fishing, the pulse method improves the efficiency. If no sole is required, it is simply a matter or switching off the pulse gear.

A new type of plaice gutting machine is installed

Catch processing

More innovations can be found in the catch processing. First of all, the hopper at the stern, into which the catch is dropped from the nets, has an adjustable grille at the stern, allowing undersized fish to escape right away. Below decks is the catch sorting table. After sorting, plaice can be gutted in an innovative gutting machine, the first prototype of this kind developed by Leba Metaalbewerking (Enkhuizen). A sorting machine - with origins in the agriculture business - sorts the fish by length per box, a process which is normally done ashore at the fish auction. That means that the fish are temporarily removed from the cold chain. Sorting the fish on board therefore improves the quality of the fish. After sorting, flo-ice is poured over the fish boxes and they are placed in the refrigerated fishhold. The shelter deck is spacious enough for possible future retrofitting of new fish-processing equipment.



Ergonomics

A lot of consideration was given to excellent sightlines from the wheelhouse and ergonomics. In addition, the noise level is much lower than on other fishing vessels, which reduces fatigue. The noise level is about 50dB(A) in the accommodation, both during steaming and trawling. Vibrations are virtually non-existent as the generator sets are mounted more flexibly than a diesel engine in the case of a diesel-direct propulsion installation. A requirement at the start was also that the vessel should be multi-functional. The aft deck is sufficiently large to place a 20-foot container, for example with survey equipment, and extra beds are provided. This allows the vessel to seek work outside of the fishing industry, if the market dictates this. The foredeck is much smaller than on other fishing vessels, but is only accessed during mooring and unmooring.

The net handling can entirely be done on the spacious aft deck, sheltered by the deckhouse and the bulwarks.

Fleet renewal

While the construction, the launching and the first half year of fishing on *MDV-1* can already be called a success, the goals are bigger. It is expected that this will be the new standard in twin-rig vessels. The Dutch fleet has been reduced from 585 vessels 25 years ago to 275 vessels today. The fish stock of plaice is now bigger than ever since 1957, showing that the fishing grounds can support the current fleet. However, the fleet is aging, as hardly any new vessels have been built in the past decade. If we wish to continue to eat fish, new vessels will be needed, and there is a fair chance that many of them will resemble *MDV-1*. The same applies for neighbouring countries, like Denmark, Belgium, France and the United Kingdom. Co-owner Hendrik Kramer summarises: "With *MDV-1 Immanuel*, we've sometimes had the fuel for an entire week paid already after the first emptying of the nets. Nothing explains this concept better than that." During fishing, *MDV-1* typically consumes 55 to 60 litre per hour. When steaming to the fishing grounds (at ten knots), it usually is 80 to 90 litre per hour. The fishing vessel which looks like a friendly whale shows what teamwork can do.

Bruno Bouckaert

Principal particulars

Builder (construction/design)
Padmos, Stellendam, the Netherlands

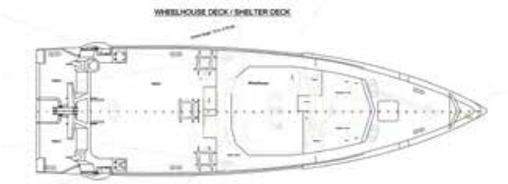
Builder (outfitting/engineering)
Hoekman, Urk, the Netherlands

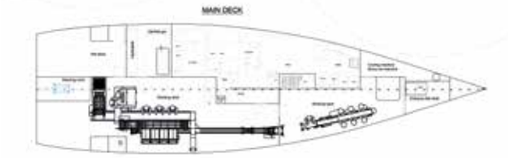
Design
Kramer Marine Engineering, Zwijndrecht, the Netherlands

Length o.a.	30.15 m
Length l.l.	28.95 m
Beam o.a.	8.60m
Draught	3.75 m
Depth to main deck	4.87 m
Length shelter deck	8.54 m
E-motor	1 x 400 kW
Generator	1 x 500 ekW
Harbour generator	1 x 117 ekW
Max. speed	10.5 knots

Capacity

Crew	max. 8
Cabins	4
Fuel tanks	15.9 m^3
Fishing boxes	850 (34 tons)





Subcontractors and suppliers of equipment fitted on board the MDV-1 'Immanuel', YN 151
Blokland non-ferro, Sliedrecht: oil coolers; **Bureau Veritas,** Rotterdam: classification; **C.C. Jensen Benelux,** Gouda: separators, filters; **C.S.R (Casco & Sectiebouw Rotterdam),** Rotterdam: hull construction; **Datema,** Delfzijl: engineering fire & safety plan, lifesaving equipment, nautical inventory, nautical pubications; **De Boer Marine,** Urk: nautical equipment; **De Jong IJmuiden,** IJmuiden: *Iron Fist* cranes; **De Olde en Ten Napel Consultancy,** Urk: consultancy; **DESMI K&R Pompen,** Utrecht: pumps; **Distrimex Pompen & Service,** Doetinchem: centrifugal pumps; **Dromec,** Rhenen: captive winch; **Econosto Nederland,** Capelle aan den IJssel: valves and fittings ; **Elektro Westhoeve,** Stellendam: electrical installation ; **Emerson Flynth,** Urk: consultancy and accountancy ; **Gebr. Sluyter,** Rotterdam: P&I insurance ; **Hi-Safe Systems,** Dordrecht: fire protection equipment; **Hoekman Shipbuiding,** Urk: main contractor outfitting and engineering of engine room ; **Hora,** Leusden: glued windows; **Hylkema Hydrauliek,** Reahûs: hydraulic systems; **IJtama Scheepsbetimmerbedrijf,** Stellendam: carpentry wheelhouse and accommodation ; **IL&T,** Den Haag: classification; **Intersona,** Heerde,: niose and vibration; **K.J. Coenen & Zonen,** Schildersbedrijf, Urk: painting ; **Kramer Marine Engineering,** Zwijndrecht: construction drawings and calculations; **L. Post en Zn,** Urk: processing area and fish hold; **Leba Enkhuizen,** Enkhuizen: plaice gutting machine ; **Leroy Somer,** Soesterberg: generator ; **Padmos,** Stellendam: hull design, main contractor and supply *Mitsubishi* main generator, auxiliary generator with *Mitsubishi* engine and *Leroy Somer* generator, fishing net drum winch, fishing winch and propeller shaft unit; **Pinta Nieuwburg Unisol,** Ridderkerk: insulation; **PPG Protective & Marine Coatings,** Uithoorn: anti-fouling and paint; **SB Installatie Techniek,** Urk: delivery and construction of plumbing systems; **Ten Napel Brandbeveiliging,** Urk: fire extinguishers, hoses; **TryDo Steering Gear,** Drachten: steering gear; **Vabo Composities,** Emmeloord: doors and hatch covers; **Van Voorden Castings,** Zaltbommel: propeller and nozzle; **Van Zonderen Painting,** Oude Tongen: painting; **VCU- De Maritieme Specialist,** Urk: cooling, processing plant, ice system, weighing systems, fully automatic catch sorting system; **Winteb,** Winschoten: *WIN200 HIAS* pipe heads; **Wortelboer,** Rotterdam: bow anchors, anchor chains.