Oceanwings: a solution for decarbonising the shipping industry

by

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Overview

Marc Van Peteghem is an authority on cruising and racing multihull design. His agency designed Oracle, the trimaran which won the America's Cup in 2010 and was rigged with a furlable and automated wingsail. Adapting this system to motor boats saves energy consumption and reduces greenhouse-gas emissions in the shipping industry which accounts for 90% of world trade. On a more personal level, Marc Van Peteghem created the NGO Watever to help finance naval construction in Bangladesh, and in 2013 cofounded The Sustainable Design School which puts people at the centre of innovative solutions for sustainable development.

Report by Florence Berthezène • Translation by Rachel Marlin

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I started sailing when I was nine years old, and I knew immediately that I wanted to become a naval architect. When I began my studies about forty years ago, the world of naval architecture was very different from that of today. At that time, a naval architect did everything, from designing to making calculations about naval architecture and structure. This is no longer the case today.

Over the past fifteen years, I have been particularly interested in climate and societal change. I increasingly felt the need to become involved personally, and it was very important to me that the extraordinary vessels which we design in our agency have a real, practical purpose. This conviction found its expression in two activities that I undertook.

The first was in 2007 following a meeting with Yves Marre, a sailor with a social conscience. He had transported a barge, by sea, from the River Seine to Bangladesh, where he transformed it into a floating hospital on the Brahmaputra River in the north of the country – a remote zone whose inhabitants live in abject poverty. In the very early stages of his project, Yves had contacted my agency to ask us to design an ambulance-boat. This was exactly the opportunity I had been hoping to get myself involved in. Together we created the Watever association whose aim was to develop a shipyard and training centre based on analysis of the boats already used by the local population, in order to make them more efficient, and, above all, safer. The first type of boat we designed was made from composite materials. It was not suitable because it was too expensive, and the fishermen did not own the boats they used. This was a perfect example of a badly designed project when one is certain that one is doing the right thing, but the key components of the project have not been validated by the end-users.

The second activity I undertook was when I created The Sustainable Design School with Patrick Le Quément and Maurille Larivière in 2013. The aim of this school is to educate a new generation of young people about developing creativity using design tools in order to create a desirable future while not losing sight of the problems we face today. This school is located in Cagnes-sur-Mer. It is in its seventh year and has about one hundred students, 20% of whom are from abroad. We are part of the Cumulus association which brings together about 200 art and design schools throughout the world, and we have exchange programmes with schools in India, China, and the United States. It is an extremely stimulating environment because it is these new generations of young people who have the power to make change happen! Change is key to our thinking.

VPLP Design: thirty-six years of naval architecture

Vincent Lauriot-Prévost and I created VPLP Design thirty-six years ago. This agency is first and foremost the story of a friendship. We met each other while we were both students. At that time, computers occupied 4 square metres, lines plan drawings used weight and batten, and surfaces were measured with planimeters.

Skills and values

VPLP Design has a team of 32 people including about fifteen engineers, four administrative staff, naval architects, and designers all of whom are based in our offices in Vannes and Paris. We work together. This is very important. We need all the skills our team offers, and by developing them, we are able to adapt and deal with every issue in a cross-disciplinary manner.

We are motivated by strong values, starting with those found in friendship, but also honesty and empathy. We also recognise the benefits of an interdisciplinary approach.

Sailing vessels

We began by designing multihulls for racing and cruising. The success of our first racing boat encouraged us to design more. On a larger, industrial scale, we designed the first Lagoons for the Beneteau Group. In total, we have made more than 4,000 boats in polyester – I am not very proud of this, but there is still no alternative to this material –, yachts and racing boats.

We won our first Route du Rhum in 1990 with our friend Florence Arthaud. Since then, we have won this race every year, as well as having made several records around the world. We have had a great deal of luck but probably also a small amount of ability, and, above all, we have had exceptional sailors who keep placing their trust in us even though their profession has changed considerably. Today, computer-aided navigation is very important. In fact, we are currently developing a dynamic simulator which we can use to take into account structural problems.

For some time now, we have also been building monohulls including those which took part in the Transat Jacques Vabre and the Vendée Globe races.

Fifteen years ago, we would have predicted that we would be the potential end-users of the vessels we were designing, however, today this is simply not possible. Today sailing is not for mere mortals. Being on board is a kind of out-of-body experience! Formula 1 racing car designers know exactly what I am talking about.

On the one hand, boats travel at very high speeds. They are like carbon drums bouncing across the surface of the water at such speed that wearing a soundproof helmet is essential. Even if the sailor is lying inside the boat on his bunk, he is regularly thrown around. It is unbearable! On the other hand, there are an increasing number of parameters which need to be mastered, not to mention floating litter which is the cause of frequent accidents. At a speed of more than 30 or 40 knots, hitting litter is as violent a shock as a collision with a car. The most modern boats do not have open decks; they are entirely covered. Sailors can open hatches – the equivalent of putting one's head out of a window of a car travelling at 60 kilometres/hour when it is raining –, but the cockpit is completely protected. Ultimately, boats have become like surface-level submarines.

Shipping vessels

In 2009, while we were carrying out in-depth studies into the power and ease of use of the gigantic wingsail of the BMW Oracle trimaran which won the 33rd America's Cup, we wondered whether this technology might be of interest to the shipping industry. In fact, this wingsail gives almost twice as much power as a traditional sail.

At any point in time, there are about 55,000 vessels sailing on the world's seas. These boats are international trade's life blood: 90% of world trade uses maritime transport. This is enormous!

In terms of kilogrammes transported, maritime transportation produces the least pollution. Because of the huge volumes which are transported, this is an important subject. Until recently, vessels consumed heavy fuel oil containing 3.5 to 4% sulphur as well as particles of sulphur oxide, nitrogen oxide and carbon oxide. Consequently, the IMO (International Maritime Organisation) decided that this pollution could not continue, and that vessels had to be fitted with scrubbers to clean the exhaust fumes. Unfortunately, the majority of these scrubber devices are open-looped and dump pollution into the sea. Most ships should therefore run on diesel fuel or at least a fuel which has less sulphur but the cost is 70% greater than heavy fuel oil. In all events, if we do nothing, greenhouse-gas emissions will increase by 250% between now and 2050.

In SECAs (Sulphur Emission Control Areas), the highest permitted sulphur content for fuels used by maritime vessels is 0.1%. There have been discussions for the Mediterranean to become a SECA. Northern Europe is in the process of becoming a NECA (Nitrogen Emission Control Area). The carbon tax looms heavily over this industry, and there is also a certain amount of social pressure which has a noticeable impact. A growing number of logisticians are becoming involved in approaches which pay more respect to the environment. In order for ship owners to commit themselves to making this effort, they need to see an interest in it for them from a marketing point of view. In any case, change is on the way.

The Oceanwings project

Oceanwings is a highly efficient and automated wingsail which is furlable, reefable (in other words, the surface of which can be partly reduced by folding), predictable and, if possible, controllable. It allows the creation of a hybrid propulsion system with an energy mix of wind power and conventional propulsion.

A vision

Insofar as it is possible to predict the lift of a boat in accordance with the direction and force of the wind, we wanted to devise a solution which would allow us to harness the energy from the wind without the need of a crew experienced in sailing techniques. This is how we thought up the idea of creating a powerful and easy-to-use wind propulsor for small and large recreational boats as well as for fishing and commercial vessels.

It was very important for the wingsail to be furlable, automated and, potentially, reefable. We then had to consider the possibility of industrial manufacture in order to ensure a price which would enable a return on investment based on fuel savings.

The solution

A weathervane measures the direction and force of the wind. A seagoing computer, which has been used to pre-calculate the optimal trim settings of the wingsail, makes it possible to forecast various constraints such as the listing of the vessel, the angle of incidence allowing the wingsail to rotate 360°, and trimming the camber of the flaps in order to give twist to the stern. This database makes sailing relatively simple.

Between 2016 and 2017, with financial support from the ADEME (*Agence de l'environnement et de la maîtrise de l'énergie*: France's environment and energy management agency), we were able to build a prototype, in the form of a 7-metre trimaran with an 8-metre wingsail operating via remote control. Today, we are working with the CNIM (Constructions industrielles de la Méditerranée) company in order to transition from prototype to industrial product.

We studied the Energy Observer, a renewable energy industrial demonstrator which has a wind propulsion wingsail on each of its two hulls. Over short distances, it is powered solely by solar energy and a hydrogen production system. It sailed to Spitzberg in the Summer of 2019 and will set sail to Japan in March 2020. Its wingsails are relatively short. When the vessel is only propelled by wind, the propellers turn in the opposite direction and charge the batteries. With the electricity surplus, the onboard electrolyser produces hydrogen which can be stored. This virtuous loop of energy generation perhaps represents the future of the shipping industry because these technologies have proved that they work.

We have designed larger wingsails for the shipping industry. These vessels are not powered solely by the wind as there is a hybrid engine which combines wind power as an addition to the main energy generation in order to save fuel. So that the vessel arrives on time at the desired location, we take away the wind-powered part from the vessel's propulsion system. Our solution therefore is a reminder of the necessity for navigation. I tested our prototype on the canals of Amsterdam. I noted that it was possible to programme a target speed and that the electricity consumption adjusted itself according to the wind. Generally speaking, we are very satisfied. Today, the vessel is being prepared in Saint-Malo, and the wingsails have been sent back to La Seyne-sur-Mer for potential flaws to be corrected.

In the next stage, we envisage manufacturing wingsails in various formats in order to make this an industrial product and adaptable to different markets.

Overall energy savings

Because the propeller and the engine have to be adjusted so that the vessel glides on the water partly without them (when it moves forward pushed by the wind), we had to think of a way in which this method of functioning

could save energy. Rather than just having a simple propelled wingsail, we wanted to suggest a solution whereby energy savings could be made across the board. As it happens, these savings will be achieved by harnessing the wind and adjusting the power of the engine and the propeller to this new method of propulsion.

Since routing is important in sailing, we adapted the simulation tools which we developed for racing boats. We also analysed weather charts from the past ten years to simulate digitally sailing conditions. We came to the conclusion that a boat moves more quickly when it does not have a pre-set route. This conclusion could greatly influence the sailing routes of commercial vessels. Much is at stake, especially because the shipping world is not very open to change.

The Canopée project

At the end of 2017, the ArianeGroup, the leading aerospace company, wanted to renew its contract for the transportation of rocket components between certain European ports and Kourou (French Guiana). It wanted to halve its transportation costs. It put out a call for tender, intended for ship owners, but we still made an offer.

We joined forces with the start-up Zéphyr & Borée, which had made a joint venture with the ship owner Jifmar Offshore Services based in Aix-en-Provence. The Zéphyr & Borée team specialises in merchant shipping, and was adamant about the need to revamp the shipping industry. We studied the problems associated with each port of call – Bremen, Rotterdam, Le Havre, Bordeaux and Kourou – in accordance with the size and weight of the transportation crates. The vessel used had to transport not only the rocket components, but also the fuel, and this required special care. We designed a ship with four wingsails measuring 360 square metres. We calculated that with twelve round trips between Europe and Kourou every year at an average commercial speed of 16.5 knots, fuel savings would be approximately 25%; nine yearly round trips would increase the fuel savings to 30%. In the end, we won the call for tender, beating all the major ship owners including the Louis-Dreyfus Group, CGA CGM, the Compagnie Maritime Nantaise and even Bolloré !

The ship can carry 5,000 tonnes. The rocket components and transport crates weigh 1,750 tonnes. The ship unloads the full crates in Kourou, and leaves with the empty crates left over from the previous delivery which it drops off with the manufacturers on its return, where it reloads new, full crates.

The future

We studied the feasibility of wingsails using wind-engine propulsion for methane tankers and various types of oil industry ships. Our findings showed that paradoxically the faster the vessel, the less important the wind power factor, but the greater the volume of fuel saved. This therefore represents a significant return on investment for ship owners. Clearly, with regards to global emissions, it would be better to reduce the vessel's speed, as this would make more use of the wind propulsor. Trying to strike a balance between these two factors is what I find interesting. I followed discussions at the IMO in terms of setting potential limits on the speed and power of ships very closely. In the end, the IMO decided to regulate on a case-by-case basis, based on a report about transport and the emissions produced which are requested of the flag States.

Developing the logistics chain is a huge challenge. In my opinion, the ever-greater requirement for speed is directly responsible for a large part of carbon emissions. Convincing people to travel more slowly is a societal challenge. Today, if a ship owner has to reduce the speed of his fleet, he will simply increase the number of ships on the water because the flow has to remain the same, however this should reduce the amount of energy used in transportation. The client will also have to agree to a greater time delay.

Shipping represents 10% of emissions in the entire logistics chain. A container ship, for example, can transport up to 21,000 12-foot containers, which represents nearly 100 kilometres of lorries placed bumper to bumper. We have to deal with increasingly large container ships and fewer and fewer ports which are able to receive them. One large ship costs much less than several small ships. Generally speaking, however, shipping is not expensive

enough to encourage change. It would be interesting, for example, if the labels on clothes stated the number of sea-miles travelled. We need these sorts of indicators.

It is a very interesting situation because everything needs to be revamped!

Discussion

The VPLP Design agency

A speaker: *Honesty is a quality which you prize. Is it a competitive element as well as an attractive factor for your team?*

M. V. P.: In a competitive world, we choose to be honest. For example, we do not belittle our competitors. I do not know whether this sets us apart, but we try to do what we say we do. When we make a mistake, we admit it. This is also present in our scientific rigueur. Vincent Lauriot-Prévost and I were lucky to start our business in the racing and cruising sectors, using industrialised boats. Initially, the racing sector did not make much money, but it enabled us to develop our *savoir-faire*, and we reinvested the profits made from cruise boats into software and the recruitment of highly-qualified engineers.

Speaker: *At VPLP, has your 30-year friendship withstood the test of time?*

M. V. P.: I had a great deal of experience in ocean racing, and I am perhaps more scientific than Vincent. Our paths crossed at a time when he wanted to get more involved in racing. He went to live in Brittany, to be close to the racing boats, and we had to split the agency into two. We have weathered some storms. The crisis in 2008 in particular was terrible for the cruise ship sector and innovative projects. However, at the same time, we won the America's Cup. There have been difficult times, but we are as close as brothers.

Speaker: *Is one of you 'crazy', and one of you 'wise'? One, a manager, and one, an engineer?*

M. V. P.: Vincent is more in charge of day-to-day operations, whereas I tend to be looking at events five years from now.

Speaker: *Do you receive financial aid other than that awarded by the ADEME?*

M. V. P.: We benefit from ADEME's Initiative-PME policy (which encourages innovation in small- and medium-sized enterprises). In this context, we received 200,000 Euros from the ADEME which helped to finance the total cost of 450,000 Euros for the wingsail prototype. This is the only financial aid we have received. With regards to our project with the CNIM, we are requesting further aid.

Wind-propulsed wingsails

Speaker: *Can your wingsails be installed on any vessel?*

M. V. P.: Yes, because they are placed on the slewing ring. The shipyard manufacturers know this manoeuvre very well. We supply the design of the interface between the wingsail and the main deck of the vessel, then we fix the ring with bolts. If the structure of the vessel has to be strengthened, we inform the manufacturers of the screw coefficient so that further calculations can be made.

We can resort to the refitting market in order to transform existing vessels just as easily as for new ships. The wingsail arrives on site with all the necessary equipment.

Speaker: *Does the engine stay the same?*

M. V. P.: Yes. However, old vessels have specific consumption and will not function at 25% of capacity. Therefore, with them, it would not be optimal, and the gain would only be partial.

On new vessels, however, multiple solutions are possible, either conventional, thermic, electric or hybrid. With Canopée, there are four engines, coupled two-by-two on two drive shafts. We arrange the power in tiers so that each engine works according to its optimal speed by adapting to the wind. We designed the propulsion chain with this in mind.

Speaker: *How much did the ArianeGroup invest in Canopée?*

M. V. P.: The ArianeGroup does not own the vessel. Its call for tender was just for the transportation contract. Our solution reduced transportation costs by nearly half. The ship owner invested 35 million Euros of which 4 million Euros alone was for the four wingsails. The depreciation period is seven years, and the fuel price is 600 Euros per tonne. One needs to add the CO_2 tax - 750 Euros per tonne - on top of this. Either way, regardless of the vessel, each shipment always costs much more than the vessel itself. There are other solutions apart from ours, such as the Flettner rotor with the Magnus effect, and suction wing propellers which were designed for Commander Cousteau onboard the Alcyone. Fortunately, we are not the only ones in the market and competition is healthy.

It is interesting to note that all these approaches are made by French companies. All the factors are in place to create an industry with solar, hydrogen and wind energy, and France is the leader in this field. I know of at least three competent French companies each of which is developing a technology. It would be interesting, if we followed the English example, to finance an entire chain, from start-up to ship owner rather than blow-by-blow.

Speaker: *If the hydrogen engine is successful, will it not wipe out your hybrid solution?*

M. V. P.: I think that there will be more nuclear propulsion systems. Hydrogen is an interesting alternative, but it takes up too much space. Mariners have been harnessing the wind for 5,000 years. It is free, it is everywhere, and it does not pollute. And yet, this is only part of the solution, because we will not revert to sailing.

Speaker: *Is your solution viable for open-deck vessels? Does it help to solve problems of container losses due to listing?*

M. V. P.: We have not solved this problem. It is a risk which certain transporters take when they load more containers than they should. We know how to limit listing. When transporting livestock, a list of 5 degrees is the maximum. We can put a constraint on the wingsails, at a list of 3 degrees, for example. The vessel's attitude can be perfectly mastered depending on the force of the wind, but the energy gain will be less.

Speaker: *Do you not face constraints experienced in commercial shipping, such as predefined shipping routes?*

M. V. P.: There are compulsory checkpoints between the Pointe du Raz (western Brittany) and Northern Europe. Once the ship leaves this routing, the wind takes over.

Speaker: *How do you deal with the passenger cruise ship market? Are your technologies transferable?*

M. V. P.: Huge cruise ships can carry up to 8,000 passengers. They are too tall for us to be able to equip them. They could perhaps order wingsails, but this would be a commercial gimmick. On the other hand, we could make improvements to smaller boats like Le Ponant.

Speaker: *Because the surface of the wingsails is so large, is it possible to increase the surface for photovoltaic sensors?*

M. V. P.: Even though the films on which the sensors are placed are extremely thin, they are still rigid. This rigidity would prevent the wingsail from being furled. Sensors could only be fitted on roller sails. On the wingsails themselves, one would have to put on small strips which would not break if the wingsail was folded. The fact that they are vertical would however make the mechanism less efficient. On Canopée, we covered all the hold with a protective net, and then placed parts of rolled-up film between the sails in order to harness all the potential energy on board.

Speaker: *Is it easy to move from designing racing boats to industrial production?*

M. V. P.: It is complicated. Some people manage to do both, but racing and manufacturing are very distinct sectors. As far as the former is concerned, performance takes precedence regardless of cost. As for the latter, one has to give priority to a given performance with low cost. Subsequently, one must coordinate different teams accordingly.

Canopée

Speaker: *Why did you decide to react to the ArianeGroup's call for tender?*

M. V. P.: We met the Zéphyr & Borée team. They had just graduated from the École nationale de la marine marchande (French merchant navy school) and had written their theses on propulsion assistance. They needed a technology, and we were learning the ropes in the propulsion field. One of our interns informed us that the Arianespace transportation contract was being put out to tender again. We had just a month-and-a-half to respond to the call for tender, compared to the usual period of three months. We were sure that we were not going to be given it, but we wanted to treat it as a preparatory exercise before teaming up with Jifmar.

Speaker: *Do you know why your project was chosen?*

M. V. P.: Our project really appealed to the logistics team. Navigating Port Pariacabo in Kourou is very complicated as there is a 3-metre high draught. There are two further constraints: firstly, once in the Kourou River, the ship cannot cool down the engine with fresh riverwater; secondly, the ballasts have to be filled with ocean water before entering the port. The crates weigh hundreds of tonnes and everything has to be kept stable (thanks to the ballasts). In the light of these constraints, we designed a complicated, made-to-measure vessel to make these operations easier. ArianeGroup got exactly the ship it wanted, even down to the last detail.

In the beginning, being a small ship owner who had only worked with ocean racing boats was not to our advantage. On the other hand, the fact that we had experience with unique objects which had high-level performance was a very positive factor. I also think that our marketing played in our favour. However, most importantly, we were able to offer a contract over a fifteen-year period which fluctuated little in price. The force of the wind may increase, but its price remains the same!

Speaker: *Did you take fluctuations in crude oil prices into account?*

M. V. P.: The contract can be readjusted to take this parameter into account.

The digital contribution

Speaker: *What it is the role of digitisation? Do we have enough knowledge in this field?*

M. V. P.: We used very advanced codes in hydrodynamics and aerodynamics. We now know as much about what is happening on the water's surface as we do above it and below it. Studies have shown that the six wingsails on the first version of Canopée had more lift than six times the lift of one wingsail.

Speaker: *Is it possible to create a comprehensive digital system?*

M. V. P.: Yes, ships can be made into models. This digital simulator is essential.

Speaker: *The use of wind power is of even greater importance for routing. Do we possess reliable data, notably as a result of ocean racing?*

M. V. P.: Absolutely. We intend to sell wingsails with the routing system I described which uses two software packages, one of which is dedicated to trimming the wingsail according to the wind conditions. We have analysed such conditions using meteorological charts from the past ten years. We are developing this solution with D-ICE Engineering, a company which intends to create a single system to make savings, including those associated with navigation.

Furthermore, my next non-industrial project will involve foils. Seagoing vessels can reach speeds of up to 45 knots, or 80 kilometres/hour. They can therefore start to compete with aeroplanes, for example, as a means of transport between Greek or Pacific islands, but also for the transportation of personnel to oil rigs. A vessel measuring about 30 metres long can carry between 100 and 200 passengers, and this method, which is already being used in southern China, is much more stable than ferries. Furthermore, on 80-tonne ships, foils reduce consumption by 50% because the resistance curve is reduced.

Speaker: *In the future, will software be able to compete with and beat the best human sailor?*

M. V. P.: I fear that this may be the case! We have studied the possibility of putting small sails on drones to monitor maritime areas in Polynesia. This surveillance is currently being carried out by two speedboats despite the fact that this area is larger than Europe. This solution would be useful in the field of oceanographic cartography as it could link submarine probes to satellites. The drones which are already being used today do not need to move very quickly. For the time being, they are powered by solar energy, but this would not be sufficient over greater distances. We loaned our wingsail prototype to carry out trials. If this works, the entire operation could be automated.

Speaker: *What is there left for sailors to do today in the light of progress in information technology (IT)?*

M. V. P.: On a ship, anything which could possibly go wrong necessarily does so offshore, in the ocean. For example, IT is useless in circumstances where there are unexpected floating objects, such as waste or marine mammals. During the Transat Jacques Vabre, the keel of the Hugo Boss boat was cut in two by a container. During the Brest Atlantiques race, the Macif boat had to finish the race early in Rio de Janeiro, because its rudder had been torn off. Even though IT can act as a cushion against certain impacts, it cannot do everything. In our project to design ferries with foils, we are looking at ways in which we can detect these floating objects in all shapes and forms.

Industrialisation

Speaker: *What will happen if your projects in the commercial shipping sector are crowned with success and you manage to change ship owners' attitudes? The transition from being a craftsman to an industrialist is rarely smooth.*

M. V. P.: As well as VPLP, we have a small company dedicated to wingsails, Ayro. We are working with the CNIM and its 2,500 staff who are in charge of assembly. We are also devising a distribution system because, apart from the fact that it costs a fortune, transporting wingsails of this size from La Seyne-sur-Mer to Korea or China would be too expensive. A wind turbine blade currently costs 9 Euros/kilo. Our aim is to create two factories, one in Europe and the other in Asia, to manufacture sub-assemblies which would then be loaded onto container ships and assembled by shipyards.

A massive increase in capital is clearly necessary, and we would have to find an industrialist to manage the project. Personally, I do not think I am capable nor do I have the desire to be operationally involved in this next stage. But I still want to be in charge of industrial strategy.

Speaker: *Would it be conceivable to enter into a partnership with a large ship owner?*

M. V. P.: We will have a partnership with Jifmar, ArianeGroup's ship owner. The vessel is currently under calls for tender. Furthermore, if our project to create two sub-assembly factories succeeds, we will be able to deliver products at reasonable prices. I have already identified and met potential partners in the field.

Speaker: *How are other countries becoming involved in this revolution?*

M. V. P.: A recent study carried out by the University of Delft shows that between now and 2050, it will be necessary to transform between 2,700 and 10,000 vessels in order to make them wind-powered. The British Department for Transport estimated that the turnover of this sort of operation would be between 2 and 3 billion Dollars. Today, out of a total of 50,000 vessels, the renewal or transformation rate is approximately 5% per year. The largest global carrier, Maersk Line, announced that its fleet will be totally decarbonised by 2050. Cargill Ocean Transportation, which has 650 vessels, has also indicated that it will be using wind power.

The ability to make two-digit energy savings is only possible if one uses hydrogen, nuclear propulsion or wind propulsion systems.

Speaker: *Are the various people and companies involved able to do this?*

M. V. P.: The project which we developed with Jifmar convinced the ArianeGroup. In northern Europe, we are conducting several trials with Flettner rotors. In comparison, even with the slightest amount of wind that our sails can create, our solution presents the advantage of a broader aerodynamic operating range. On average, the angle of the wind received by the wind propulsion system is approximately 30 degrees. However, at 30 degrees, a Flettner rotor hardly turns at all, whereas a wingsail can turn at 20 degrees and more. In North-South routes with dominant crosswinds, the Flettner rotor is very well adapted. However, depending on the context, this is not always the case. Wind propulsion systems exist for every conceivable circumstance.

Because the lifespan of a vessel is twenty-five to thirty years, decisions must be taken now, and the right questions need to be asked, such as how much wind power should be integrated into the system, and what type of engine should be used. There should also be discussion about the design of the vessels.

Speaker: *Do you have ownership rights?*

M. V. P.: Wingsails have existed since the 1960s. They are the equivalent of the flaps on aircraft wings during take-off. We filed a patent regarding the kinematic element and the furlable capacity of the sail. This is the innovation we developed for the America's Cup. Initially we thought that our trimaran would race with traditional rigging, but we came up with the idea of increasing the size of sails already used on small boats. We were developing this project in parallel when the trimaran's mast broke as a result of a gybing manoeuvre during a test run, one hundred days before the start of the race. Since there was no spare mast, there was only one solution - to use the huge wingsail we were working on and which we had never tried out. And it worked!

Speaker: *Could Chinese competition manage to by-pass the industrial patent?*

M. V. P.: I am sure we will be copied one day, even if our patent is watertight. We shall have to move even faster than our competitors and invent something else.

Speaker: *Being copied is a sign of success.*

M. V. P.: True, but I am not motivated by money. I am really interested in reducing shipping emissions: I have five children and I am very concerned about the future.

Speaker: *In view of the difficulties encountered protecting the intellectual property of software, is the quality of optimisation a truly long-lasting, competitive advantage?*

M. V. P.: The small company which we created has the task of recording all the data which can be emitted from vessels. For the Energy Observer, this represents an enormous amount of data which we shall have to sort out in order to constantly improve the system. This is how we think we will manage to move a little faster than our competitors.

Speaker: *If you wanted to move faster in development and marketing, what do you think you are missing: money, human resources, lobbying?*

M. V. P.: We are currently drawing up a business plan, and we will make a capital increase of about 5 million Euros, which is substantial for us. I am not worried because various people have already reacted positively to the project. We will have to find a CEO with industrial experience, preferably in the shipping industry. We will have to share an industrial strategy with the CNIM. We have already started a project with them, but I do not know whether they will be interested as the project moves forward.

I have always worked in environments where people work together. I can remember, for example, that when we were faced with problems relating to structure, we discussed our plans with an English architect (who was actually a rival), on the assumption that what was bad for him would also be bad for us.

Presentation of the speaker

Marc Van Peteghem: co-founder, with Vincent Lauriot-Prévost, of the naval architecture agency VPLP Design, specialising in the design of multihulls for racing and cruising, and yachts. He also created the Watever association with Yves Marre. This NGO assists underprivileged populations living on the shores of oceans and rivers, notably in Bangladesh. He co-founded The Sustainable Design School in Cagnes-sur-Mer.

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