eCat hybrid

> power catamaran design study

Juri Karinen | 2011

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Lahti University of Applied Sciences
Institute of Design and Fine Arts
Furniture Design
Graduation Project
Juri Karinen

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abstract

eCat is a study in motor catamaran design. The guideline of the project is the design approach. It is based on the idea that we may have inventions and technologies, which for different reasons not always succeeded on the market or are not yet in common use. One of those inventions is possibly the catamaran. It is a type of boat, which in a certain category would make an in many ways superior product. Still it is scarcely produced. One of the main reasons is probably, that they are not "traditional", there is no universally accepted design formula for them. A boat is an object with deep roots in traditions. Yachts are supposed to embody elegance and something, which could probably be described as "nautical spirit". These conventions make it hard for technical solutions, which drop out of the frame.

This design study is about developing power catamaran design and bringing it closer to the concept of traditional motorboats. The project examines the construction and form language of power catamarans. In combination with innovative technology is created a product concept, which could meet the high demands of today's and tomorrow's motor yacht clients. Design evolves from engineering to operate as the human interface of new technical possibilities.

key words:

power catamaran, design study, concept

tiivistelmä

eCat on moottorikatamaraanin muotoilututkielma. Projektin sisällöllinen tavoite on muodonannossa. Taustalla on ajatus, että on olemassa jo keksintöjä ja tekniikoita, joita ei vielä ole jostain syystä hyödynnetty markkinoilla menestyneesti. Kaksirunkoinen vene on mahdollisesti yksi näistä keksinnöistä. Kyseessä on venetyyppi, joka tietyssä kategoriassa voisi olla useilta ominaisuuksiltaan ylivertainen tuote. Sillti kaksirunkoisia veneitä tehdään vähän. Yksi päällimmäisistä syistä on mahdollisesti, että ne eivät ole "perinteisiä", niille ei ole olemassa yleisesti hyväksyttyä muotokieltä. Vene on esine, jolla on syvät juuret perinteissä. Jahdin oletetaan olevan tietyt piirteet kuten eleganssi ja jotain mitä voisi ehkä kuvailla sanaalla "merihenkisyys". Uusien teknisten ratkaisujen sovittaminen tällaiseen perinteiseen mielikuvamaailmaan voi olla kehityksen este.

Tämän tutkielman tarkoitus on kehittää moottorikatamaraanin muotoilua kohti peinteistä moottorivenettä. Opinnäytetyön tietoperustassa tarkastellaan katamaraanien rakennetta ja moottorijahtien muotokieltä. Yhdistettynä innovatiiviseen tekniikkaan syntyy tuotekonsepti, joka voisi palvella tämän päivän sekä huomisen moottorijahti asiakkaitten korkeaa vaatimustasoa. Teknisten ominaisuuksien kautta kehitetty muotoilu palvelee uusien mahdollisuuksien inhimmilisenä kosketuspintana.

Avainsanat:

moottorikatamaraani, muotoilututkielma, konsepti

> content

> specialist terms

aft..... situated at or towards the rear of the boat
beam..... the most extreme width of a boat
berth..... a build-in bed in a boat
bilge..... the lowest inner part of a hull
bow..... frontmost part of the hull
bouyancy..... upward acting force exerted by a fluid, that opposes an object's weight
CAD..... computer aided design
chine..... the line of intersection between the side and bottom of a flatbottom or V-hull
CG..... center of gravity
draft..... vertical distance from the bottom of the hull to the waterline
displacement..... weight of water equivalent to the immersed volume of the hull
deadrise..... the V-angle of a planin or semi-planing hull
flybridge..... an upper deck where a boat is steered and the captain stands
green water..... water from waves running over the deck
gunwale..... the upper edge of the side of a boat
quartering sea..... waves hitting the boat at a 45 degree angle in relation to the route
hysucat..... hydrofoil supported catamaran, a trade mark of a patented catamaran foil design
keel..... the principal structural member of a ship, running lengthwise along the center line from bow to stern, to which the frames are attached
lifting strakes..... rails at the bottom of a planing hull, turning down spray and adding lift (spray rails)
LOA..... length over all, extreme length from one end to the other
LWL..... length at waterline
multihull..... a boat with more than one hull
passerelle..... a retractable entering bridge on a yacht
planing..... riding on the surface of the water
sheer..... the upward curve or amount of upward curve of the longitudinal lines of a hull as viewed from the side
spray rails..... rails at the bottom of a planing hull, turning down spray and adding lift (lifting strikes)
sponson..... the single hull of a catamaran
stern..... the rear-most part of a boat
SWATH..... "small water plane area twin hull" a special form of catamaran hull
transom..... the stern of a square-sterned boat when it is a structural member
waterline..... imaginary line circumscribing the hull that matches the surface of the water when the hull is not moving

Boats have always fascinated me**.** As a kid I used to build big LEGO boats, filling the hull with foam and then letting them float on the lake me and my parents where living next to. Later I had a small classic wooden motor boat for some time, making excursions on the Saima lake area.

During summer 2009, I participated in a project for the company RMJ Saksman to create an ecological motor pleasure boat. Saksman is a company specialized among other in interior components for boat manufacturers. The brief was for a roughly 30' by 10' catamaran design. After studying the subject I was inspired by the possibilities of more unconventional boat designs. The fact that sailing multi hulls are not allowed to compete with traditional mono hulls because they are "to fast" shows the superiority of the multihull construction for certain types of boats. The now obvious question was, what are the reasons that multihulls seem to be so unpopular? And what are the actual benefits and drawbacks of multihull constructions? So I had found an interesting subject for my imminent graduation work and I decided to find answers to these questions by examinig the subject more closely.

For the frame of my work I took the brief of RMJ Saksman. The concept was about an easy to handle pleasure motorboat constructed as a catamaran. The original brief was for a fully electric propulsion system. It was clear that a product based on the ideas of Saksman would lead eventually into a completely new type of pleasure craft with priority in low emission and ease of use. After studying the subject for a while I felt I needed to make some changes for the frame of work, to better suite my personal interests. Creating a totally new form of a motor propelled pleasure craft seemed to me to be a subject with an almost undefined frame. Having never designed a boat before, I was interested in the traditional definition of motorboat design and exploring the possibilities lying within this conventional frame. As my study of the current market situation suggested, there

seemed to be a true gap between the design quality of traditional motorboats and many technically superior concepts. The later ones seemed to be designed more or less by an engineering approach, thus lacking style and elegance. This is probably a reason why many highly interesting inventions end up being labeled as curiosities. But what if we took the most advanced designs and technical components and then tried to wrap them into a most stylish package which fits into the classical definition of a motor yacht? Is it possible to design a catamaran to meet these ideas?

Boats are designed in a variety no other means of transport comes close to. And there are countless purposes for seagoing vessels. This in mind it is self-evident that we can never talk about any type of boat without specifying its purpose and application. A rowing boat must have different features than a motorboat of the same size. And of course there are many types of rowing boats. I've always been drawn to means of transportation with engines. It's the power of an engine, the aesthetics of raw engineering. It implicates freedom of movement, which is capable of making motor powered means of transportation fascinating. In pleasure boats like in sports cars, movement can become an end in itself, making them pointless and superfluous as far as necessary is defined as serving human survival. I believe however that live is as much about experiencing and joy for our senses. From this point of view necessity and function is not defined by fundamental needs and purposes. For me the actual question is not so much about necessary or not, it's more about responsibility and consequences of our actions. As long as motorboats for pleasure are not made illegal there is a need to search fore more responsible forms and solutions, which can help make motorboats sustainable for the future.

In accordance to the style study I wanted to base the design on the best technologies available today. Usually cars are the main focus when speaking about new solutions in transportation. This is obvious, as cars are an irreplaceable and integrated part of the structure of our developed society. However boats could proof a suitable platform for testing and developing new forms of energy conversion, as they are larger than cars and thus less affected by possible extra weight or costs. Technologies, which still are not mature for mass production in the automobile industry like hydrogen fuel or solar panels, could be more competitive and already in use in the marine sector. No one is spending any money on ideas, which are not promising profits. By finding the right marketing opportunities and demands for developing ideas there is a possibility to create new solutions. Battery development is a good example. Through the wireless revolution of our information technology, batteries are now much more powerful and lightweight, offering new applications like for example in electric automobiles. Military and space technology is another field which creates development and solutions which later migrate into civil use. Fuel cells and solar cells are among them.

Energy management solutions which work off shore could proof worthy applications for domestic use, especially in places with little or no infrastructure where local, small-scale independent energy sources could be the solution. I'm thinking of remote inhabited areas with extremely low population density, developing countries with lacking power grids and low infrastructure. Another sector could be agriculture. For example methane gas is a natural by-product in farming. It happens to be a very harmful greenhouse gas, but could be purified and transformed into electricity via fuel cells, creating a local energy source.

The yacht business may be very elitist and marginal, yet a yacht could be good advertisment for cutting edge technologies, on the way to more large scale applications.

2.1 *definition and history*

A yacht is a recreational boat. The term originated from the Dutch / low German "jacht" meaning hunting or hunt. It was originally defined as a light, fast sailing vessel used by the Dutch navy to pursue pirates and other transgressors around and into the shallow waters of the Low Countries. Charles II of England spent part of his time in exile during the period of the Commonwealth of England in the Netherlands and became keen on sailing. He returned to England in 1660 aboard a Dutch yacht. During his reign Charles commissioned 24 Royal Yachts on top of the two presented to him by Dutch states on his restoration. As the fashion for yachting spread throughout the English aristocracy, yacht races began to become common. Other rich individuals in Europe built yachts as the sport spread. Yachting therefore became a purely recreational form of sailing with no commercial or military function.

(wikipedia, edited)

In modern use the term "yacht" designates sailing and power boats for leisure purpose. There is no defined minimum or maximum length for the term, but below 10 meters it would probably be rather called a boat whether sail or power. The EU guidelines for pleasure boats define a private sports boat with any kind of propulsion, as between 2,5m – 24m long. Above 24 meters yachts are classified under same standards as commercial ships. So perhaps above 24m we could generally speak about super yachts. Then there are the additional terms "Mega-", "Maxi-", and "Giga Yacht". The problem is that these terms are not clearly defined by any size requirements and it is even unclear whether a "super yacht" should refer to a ship smaller or bigger than a "mega yacht". The term maxi yacht on the other hand can also refer to the sailing yacht class used for racing under IOR (international off shore rule). They where around 24.4m – 25,6m long. Today racing "supermaxis" are limited to 30m. So the different terms are in the end all about marketing and may be due to change as the size of privately operated ships for recreational use has been growing until today. Let's just wait for new yachts in dimensions probably defined as "hyper yachts". As for the size of my catamaran concept it is clearly simply a motor yacht and far away from the definition of any super yacht.

hull design of a semi displacement yacht

2.2 *hull types*

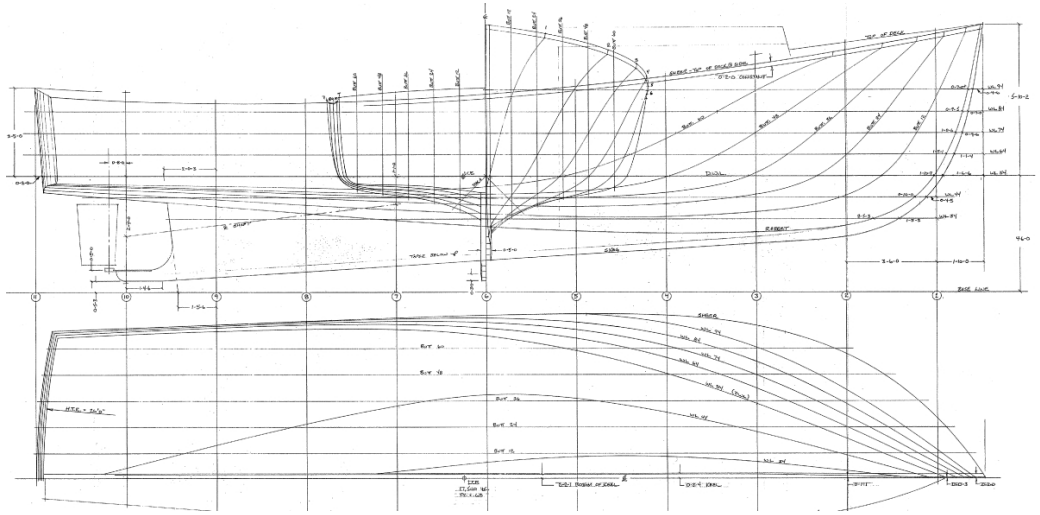
As boats are build for many different purposes, operating speeds and environments it is obvious that there are almost countless different types. One way of categorization is by the design of the hull. This study is about the design of a motor catamaran. Therefore the special type of hull is basically the starting point and also main element of the whole concept. When I was introduced to the subject during the summer project for the Saksman motor catamaran concept, I first realized the manifold possibilities of hull design. What makes it interesting is the fact that there is not one "right" and one "wrong" way for the design of a hull. Basically a hull is more or less the result of compromising different conflicting properties like efficiency, payload, stability and maneuverability. Then these properties must be optimized for the desired size, speed, use and operating environment. So it is evident that the range off possibilities is vast and there is still development going on in optimizing different hull concepts. One recent example is the so called "displacement glider" or DG-hull, which combines to some extend the shape of a slender displacement hull with a flat bottomed gliding hull. The idea of the construction may be around two hundred years old but could now be optimized using modern computer aided design and hydrodynamic simulations.

As the type of boat for this design study is defined precisely, I want to restrict the explanation to the different types of hulls and their characteristics with focus on catamaran constructions. Basically we can define between three differently operating hull forms, this being planning hulls, semi-planning or semi-displacement hulls, and displacement hulls.

www.sporttrawler.info/specifications_hullform.html

displacement

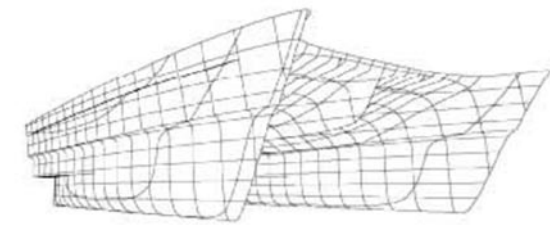
The hull is supported exclusively or predominantly by buoyancy. Main features of a displacement design is good efficiency at hull speed, great payload, and good sea-going qualities. They travel through the water at a limited rate, the so-called "hull speed", which is defined by the waterline length. Hull speed, sometimes referred to as displacement speed, is the speed of a boat at which the bow and stern waves interfere constructively, creating relatively large waves. Displacement hulls tend to have pointed bows and sterns because this form poses the least wave making resistance at "displacement" speeds. It takes a relatively small amount of power to push a displacement hull at its "hull speed." Though the term "hull speed" seems to suggest that it is some sort of "speed limit" for a boat, in fact drag for a displacement hull increases smoothly and at an increasing rate with speed, as hull speed is approached and exceeded, with no noticeable inflection at hull speed. Light, narrow boats with hulls not designed for planing can easily exceed hull speed without planing; indeed, the unfavorable amplification of wave height due to constructive interference diminishes as speed increases above hull speed. For example, world-class racing kayaks can exceed hull speed by 70%, even though they do not plane. Semi-displacement hulls are intermediate between these two extremes.



semi displacement hull plan of a lobster boat

semi-displacement, or semi-planing

This form of hull is an attempt to combine the good qualities of a displacement design with an increased range of speed. At low speeds the immersed strait transom will cause turbulences of the water flow in the aft resulting in increased drag, which is overcome at operating speed when the water flow at the stern continues uninterrupted. The hull form is capable of developing a moderate amount of dynamic lift, however, most of the vessel's weight is still supported through buoyancy. Semi-displacement hulls tend to have wide, flat aft sections. These hulls are designed to partially climb on top of the bow wave and separate the transom from the stern wave. Semi-displacement speeds are usually in the area of 1.5 to 2.5 (square-root LWL) in knots. The flat wide stern sections help to provide additional lift in the stern.



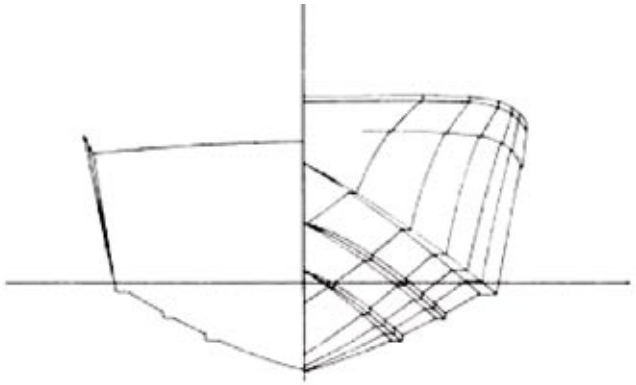
catamaran hull constructed as dispacement glider

www.boatdesign.net/forums/attachments/open-discussion/3481d1120586048-building-raft-75-table_boat.jpg

planing

Planing hulls are designed with straight sections aft. A typical deep-V bottom hull has the same angle to the 'V' (the same "deadrise" angle) from midship to transom. They are designed to climb completely out of the water at high speed and "hydroplane" on top of the water. At low speeds every hull acts as a displacement hull, meaning that the buoyant force is mainly responsible for supporting the craft. Due to the hull shape with the characteristic straight cut transom a hydrodynamic disturbance is created with an effective low pressure at the stern pulling the vessel against its direction of movement through the water. This makes the hull shape very energy consuming at speeds below the planning threshold. At planing speeds, water is breaking cleanly from the transom and the hull is riding on its straight aft sections. The greatest resistance at planing speeds is frictional resistance. It takes more power to climb out of the water over the bow wave than it does to maintain planing speed once this is achieved.

Now this three differently working basic principles can be constructed in a variety of ways, the most common being a monohull. A monohull is a type of boat having only one hull, unlike multihulled boats, which can have two or more individual hulls connected to one another. There are countless types and designs of mono hulls, which is why I do not explaine them at this point, but go straight ahead to the design of catamarans.



cross section of a planing hull

www.acbs-bslol.com/Porthole/images/DeepV.html

2.3 *Catamaran types*

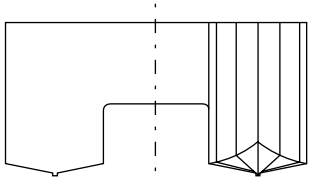
The word "catamaran" comes from the Polynesian Languages meaning "tied up trees", describing the historical out-rigger or twin-hulled sailing vessels which were developed to perfection and which enabled the Polynesians to spread their civilization over the Pacific Sea. Thus, the approval of the catamaran hull for seagoing craft was actually established long before our time. In the 1870s when the catamaran design first was introduced in America they sailed so successfully against monohulled boats that they were barred from racing. The twin-hulled sailing or motor boat has since become a popular pleasure craft, largely because of its speed and stability. High-speed catamaran ferries can exceed 40 knots (74 km/h). Catamarans range typically from 15 ft to 330 ft in length and are among the world's fastest sailing and motor craft. As a constructive characteristic they cannot achive the high pay load of monohulls with a square-like cross-section. Also the advantage of low resistance and a higher cruise speed is lost with the growing size of a catamaran, as the hullspeed increases in proportion to the length of a monohull. At the same time propulsion power needed to use a possible efficiency benefit of a catamaran grows exponentially. So there is a size range and boat type where the constructional advantage of a catamaran come to best effect. What makes it interesting, is that this range covers well the areas where a monohull has its most drawbacks.

When taking about catamarans we are not speaking of just one type of hull, but merely a whole hull category with many different types of constructions and optimization for different purposes. As the catamaran hull is basically the starting point of this study it is necessary to understand the basic constructional differences and types. As a designer I am mergeing my visions with engineering. Therefor I try to study and understand the technical basics of the concept I am involved in before actually designing anything. Only this way I am able to develop a design based on function rather than on fiction.

I would like to refer to the knowledge of Prof. Jacob van Renen van Niekerk from South Africa, who has over forty years of experience in mechanical engineering design, including marine engineering. His examples of the different catamaran types not only exemplify their hull construction, but also the resulting properties which gives a good idea how significantly the effects of rather small hull modifications may turn out. I came across this information by chance after my hull design was actually already completed. To my delight the article backed most of the assumptions I had made about an effective and appropriate hull form in regard to the desired performance.

"Power catamarans come in many shapes, and in different parts of the world preference is given to specific types. This is an effort to analyze the 10 hull shapes of medium- and high-speed existing boats. Racing boats have deliberately been excluded, because comfort, safety and low-cost construction take a poor second place to outright speed in that type of boat.

characteristics of Type-A



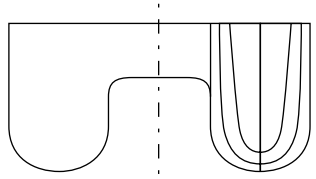
A. Australian type with symmetrical sponsons, fine entry, medium-square tunnel, low deadrise.

This shape became popular in Australia when it was found that two identical symmetrical sponsons cut construction costs and gave a beamy boat with lots of deck space. Lateral stability at rest is very good and a vast improvement on monohulls. With a fine, deep forefoot it slips through a small chop without fuss and gives comfort and economy, provided that the wavelet heights are less than half the tunnel height.

By twisting the bottom from almost vertical at the bows to almost horizontal at the stern – a severely warped bottom – the resistance in calm water is kept low with a small wetted area and low wave-making resistance. This type is still popular on rivers and in large harbors, but the problem starts when it ventures out to sea where conditions are not as favorable.

Bad habits include severe tunnel-roof slamming in high, short seas and the choking of the tunnel to slow down when those symmetrical sponsons channel half of the water displaced into the tunnel. Type-A rates as a good smooth-water boat, but a very poor offshore craft. And this is before we start on the high vertical deceleration – bumping – that occurs at speed in confused and uneven seas when the boat leaves the water and lands on the flat-aft-bottoms. This can cause structural damage and change the idea that it is always most comfortable at the stern of a planing boat. They are also load-sensitive, and frequently a slight overload will prevent it from getting on the plane, resulting in high fuel consumption as it struggles along, bows up, at 15 knots instead of planing at 32 knots.

characteristics of Type-B.



B. Sailing-boat type symmetrical, round-bilge and tunnel, deep forefoot, no strakes.

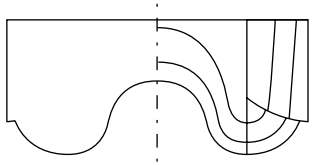
The sailing boat type. This has symmetrical round bilge sponsons and wide, lowish tunnel. It has a deep forefoot without spray rails or chines, and keels in miniature. After the French proved that a catamaran can outsail any monohull of the same size, powerboaters started to look at this hull configuration for medium speed cruiser's without sails. Without lift rails and chines the amount of lift at speed is negligible, so there is no reduction off wetted area. But the long, slim sponsons with their fine entry have very little wave-making resistance, which partly compensates.

Nevertheless, this type must be operated in the 15-25 knot speed range to give reasonable economy when loaded in the way powerboaters are inclined to do. This is a lot quicker than normal displacement speed for a hull of the same length, and nicely fills the gap left by the demise of the semi-planing hull.
The round-bilge shape gives a soft ride and can't slam as such, but the short and white flat tunnel does that with a vengeance when you try to go directly into a head sea – a situation that is almost unknown to sailing man, so they never allowed for that in their design and development.

Because of the wide overall beam and the lack of vertical tunnel sides low down, the Type-B leans to the outside on corners but to a lesser extent than Type-A. The fine entry and deep forefoot slice through the chop nicely, but it lacks the buoyancy or lifting surfaces to save it from some stuffing into the back of the next wave.

Type-B has a relatively small water plane area, so it can carry light loads relatively easily before slowing down drastically when overloaded to the extent where the tunnel roof stays in contact with the sea for a large increase in resistance. Type-B can benefit from some new patented idea such as the Hysucat to lift it at speed and improve the top speed.

characteristics of Type-G



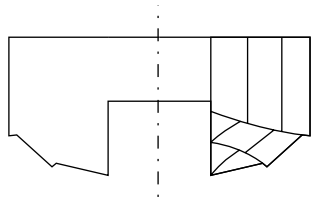
G. Kenton cat type with low round tunnel and round bottoms, tunnel lifting at bow.

I apologize for jumping the queue but there is a certain number of common features with Type-B such as round-bilge sponsons and symmetrical bows sections. But Type-G has a lower, full-length, rounded tunnel and a lot less beam to change its sea-behavior completely. That soft entry and landing of the rounded bottom of the sponsons are completely overshadowed by the bang that occurs when solid water hits that low, round-tunnel roof and finds that it has nowhere to go.
As a matter of interest, it is our conviction that the well-known spitting (sneezing) of a bucketful of water forward, out of the tunnel mouth, at speed, is caused by the speed of sound in the two phase medium being exceeded.
This happens when aerated water is suddenly compressed. Many of the low-tunnel builders put in small steps in the tunnel roof to try and capture this forward flow but we doubt if they were successful.

Type-G usually uses chines on the outside and, together with the tunnel which is submerged at rest, has considerable lift at speed. As a matter of fact it probably is the best load carrier of all catamarans, providing it can get over the hump – another big difference from Type-B which has no real hump in its resistance curve.

Type-G behaves reasonably well in following seas when that large bellmouth comes to the rescue, when diving is imminent, but it does slow down in the process.

characteristics of Type-C



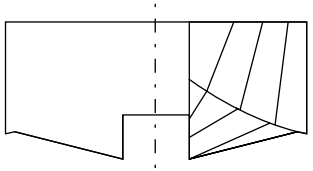
C. Asymmetrical sponsons with low deadrise bottoms and no-trip chine, medium height square tunnel.

The fully asymmetric sponson- shape lowish deadrise bottoms and non-trip chines have a lot going for it. It will bank to the inside in turns and have a good directional stability in head seas and following seas.

However, in quartering seas it weaves as the seaward-curved bow causes it to "steer." A steering correction to the opposite side gets aggravated when the other bow enters the same wave and does the same, resulting in an uncomfortable corkscrew yawing motion which is highly conducive to producing motion sickness. The medium-height tunnel also has a limit on wave heights that it can handle at speed without severe slamming. The many flat panels, as opposed to compound curves, makes this shape a good candidate for construction in aluminum, steel or plywood, but the flat panels need more stiffness to prevent panting that can cause fatigue.

Depending on the deadrise angles of the bottoms it can have a good ride even in rough seas and will react safely when sliding sideways off large swells. In following seas it behaves well because of the full bows, but at an angle, a broaching action may be felt when the leading bow hits the bottom of the trough and then veers off. Lateral stability is excellent and it will need abnormal loads to make it roll too far. Ride wetness will depend on the detail shape of the forward chines and the amount of flare in the bows, but it should be much better than the Type-A. It can carry reasonable loads and its Center of Gravity (CG) position is not critical, within bounds, of course. Economy should be good with a well-balanced unit.

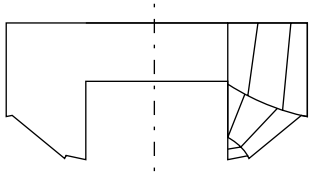
characteristics of Type-D



D. Split monohull with narrow, low square tunnel with high attack angle at bows.

Strictly speaking, this should not be called a catamaran because its parent was a monohull that got split down the middle, and the halves were moved apart by a small amount, and the gap covered over. The result is a hybrid which inherited the worst characteristics of both monohull and a bad catamaran. It slams and bangs in any kind of head sea, or even chop, and does it with a noise like a thunderclap. The transverse stability has been improved from that of its original monohull, but not to the extent that would match any decent catamaran.

characteristics of Type-E



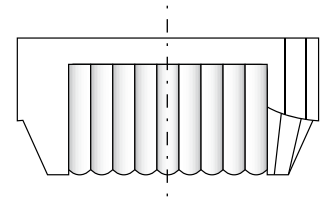
E. Super-slim sponsons with medium-to-high tunnel, fine entry, designed to be used on protected waters.

The idea of a super-slim sponsons was started by English designer Nigel Irens when he designed the 21m trimaran, Ilan Voyager, which broke many records previously held by planing craft. This type has high aspect-ratio sponsons that have very little wave-making resistance. You only have to look at one of Philip Hercus' wavepiercers in action to see what we mean. At certain speeds there is an advantage for the super-slim. However, in doing this, a large area is running wet, and skin friction resistance has increased over that of a similar sized planing craft. Because of the minimal bow lift there is no dynamic lift and almost no buoyant lift. Therefore Type-E is fine in small chop and wave lengths of less than half the boat length, but it urgently needs a helping hand in the way of a third sponson or tunnel roof extension to prevent stuffing.

To counter this unacceptable quick stopping action, Hercus decided to take advantage of scale and, by all accounts, his 120m ferries are doing very well, but they are ships and not compatible with the boats we are discussing here. Vertical acceleration from the sponsons is very low, but the tunnel roof will slam if it is flat and not high enough for the sea state. Because of the low water plane area, Type-E is sensitive to load shifts and it becomes important to control people movement and other factors that can offset the critical center of gravity.
Because of its wave penetrating action, it cannot be used offshore or where large waves and rollers occur. In other words, this is a protected-water boat similar to Type-A and Type-G. The narrow sponsons pose problems in installing wide engines and long cardanshafts, such as those used in SWATHs and SES may be needed and that adds to the cost.

Lateral stability will depend on aspect ratio, but is less than on other, more normal types of catamarans. You should have a dry ride until the chop overrides the bows and runs up the sides. Construction is not difficult but speeds (for economy) are within a narrow range.

characteristics of Type-F

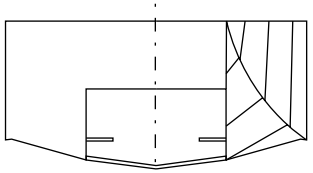


F. SES (solid side skirt) hovercraft with low tunnel and skirts at bow and stern.

The solid side skirt hovercraft is not considered a catamaran by many, but it does have two long, slim sponsons almost like Type-E, but with the addition of flexible skirts fore and aft. The skirts are there to contain the cushion – air that is pumped into the big empty space between the sponsons, skirts and tunnel roof to lift the craft up to where it has minimal draft and wetted area. The SES was developed by people who were unhappy with the normal hovercraft where air-propulsion is needed. They thought that these slim sponsons would allow populsion by water-jet or propeller and so make it more efficient. Another handicap of a pure hovercraft is its susceptibility to cross winds and its consequent need to wheathercock to counter them. So don't be surprised if you see one traveling almost sideways to go along a certain course. Having slim hulls in the water helps offset this to a considerable extent.

But it is costly to build and maintain and its ride characteristics are not acceptable to many. It is load-sensitive and the CG has to be dead right. The ride is wet and becomes hard when the waves hit the relatively low tunnel.

characteristics of Type-H



H. Hysucat with one main foil and two trim foils, high deadrise bottoms and medium-high tunnel.

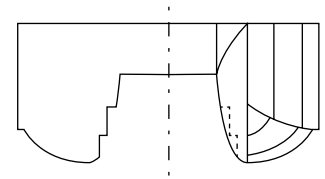
Professor Günther Hoppe was testing one of the early Bobkat catamaran models in the circulating tank at Stellenbosch University when he decided that the resistance-to-weight ratio was too high and needed improvement. Firstly, he changed the cross section of the sponsons by introducing a wide, and low-deadrise bottom with no non-trip chines. This immediately reduced their resistance, but not enough for Hoppe, and he continued experimenting until he hit on the novel idea of fitting a foil between the sponsons to carry part of the load and, in so doing, reduced the wetted area.

It is a proven fact that long and narrow wings of aeroplanes produce more lift at low and medium speeds than short, wide ones. The same goes for hydrofoils. The Russians developed hydrofoil craft for use on their rivers where a low wash was needed, together with economy at high speeds. Many configurations were tried out but all lifted the hull completely clear of the water which gave them the best speed, but introduced other problems. Among these were deep draft at rest and wide foils extending beyond the sides of the boat to make docking difficult, and sometimes downright dangerous. It was also very expensive to produce, and large shaft angles made propulsion inefficient.

The Hoppe solution, registered as HySuCat, is a low-cost compromise that has been developed to give excellent results within its effective speed range. The foils between the sponsons are positioned to not only lift the boat when planing speed is reached, but also to adjust the trim for optimal main foil and sponson attack angles.

The sweeping bow with the chine going right up to the gunwales has poor buoyancy and dynamic lift with all the problems previously mentioned for asymmetrical hulls. At low speeds the tunnel may slam a bit, but once the foils come into action at about 14-18 knots, and lift the whole boat a considerable amount, the tunnel clearance is also increased and very much larger waves are needed to create an uncomfortable slamming. We have found that the foils also dampen action such as heaving and pitching, which improves the ride even further. The main advantage of the foil system is the dramatic reduction in the resistance, resulting in a higher top speed and improved economy. Recent applications of the Hysucat system on other hull shapes such as Type-A improved the speed and lifted the tunnel a bit but it could not cure the other inherent bad habits in the basic design.

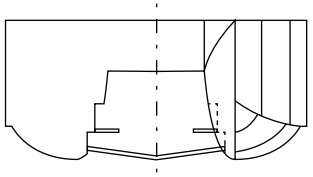
characteristics of Type-I



I. Bobkat with round, asymmetrical sponsons, high tunnel with tunnel-chines and bow steps.

The Bobkat covers a range of power catamarans from 2.5m-33m that have similar looking hull shapes, but with detailed changes for different sizes and speeds. The almost symmetrical bows prevent wandering when quartering seas and provide plenty of buoyancy when needed. It is almost unknown to take green water over the bows even in the Cape of Storms' worst seas. Stepping the bows in the front section of the tunnel allows asymmetrical sponsons for the rest of the way to give that all important banking to the inside, which is considered a prerequisite for safe seakeeping – and keeping your passengers on board. The convex shape incorporates the equally important non-trip below the wide chines to further improve safety in beam seas and quartering swells in a large following sea. The rounded section does not slam and gives a comfortable ride in rough water, even when jumping the large waves at high speed. Spray rails are used at the bows to keep spray down and to provide a dry ride, even with a southeaster off the bows. The patented tunnel chines running fore and aft behind the bow-step are there to mix this solid water with air to form a two-phase medium that is compressible and therefore reduces the tunnel slamming experienced by other tunnel shapes.

type J



J. Bobkat with Hysucat foils.

The tunnel is also the highest of the boats listed and when the foils are fitted on the Type-J the effective tunnel height allows high-speed travel in severe sea states. A 20m patrol boat, for instance, can take 3m high head seas at 26 kns without discomfort.

At other headings there is almost no limit to speed accept in following seas when the boat starts flying off the crest and loses propulsion while airborne. The tunnel chines lift up in a flattened S-shape near the stern as does the tunnel roof, to provide an increased tunnel area for waves to enter when traveling at speeds below 20 knots in following seas. This not only lifts the stern but prevents that sudden forward lurch you get with other transoms. For the sports fisherman this feature also allows for backing down at speed when fighting a large fish without any danger of swamping.

a HySuCat catamaran planing

The overall aspect ratio of 3:1 with a sponson ratio of 10:1 reduces wave making resistance, especially on the foil, while giving excellent lateral stability. The progressive increase of sponsons width with draft gives a load ability which is further enhanced in the foil-assisted J-type. The metacentric height of most catamarans results in a restricted roll action of small amplitude that people soon accept and prefer to the motion of monohulls, where alarming roll angles can develop in beam seas and rough waters. Type-J is fast, economical, and most seaworthy with a built-in characteristic of looking after its occupants.

after prof. Jacob van Renen van Niekerk, published in the "Power Multihulls Magazine", spring 2000 (edited)

3.1 *scenario*

The original idea of the design was a to create a displacement hull catamaran with a maximum in efficiency, a true ecologic and economic yacht. It happened that during the drawing process I came across the Hysucat hull, which was a turning point of my design. The possibilities of the technique became a new source of inspiration and I made the decision to go for a light and fast sport yacht. I skipped the previously drawn hull forms for displacement concepts and started to design a planning hull. The idea behind this decision was that a boat with a length around 60' offers certain possibilities. First of all it is a boat of considerable size but compared to a Super Yacht rather small. That means if someone has the necessary amount of money and he wants a yacht he will buy a much bigger one. This was where I was thinking about the features of a compact sized motor yacht, a bigger yacht has not. One is definitely the ease of use, no need for a crew or a skipper.

Another point is the maintaining and operation cost. Even rich people don't waste money, or perhaps especially not the rich. But it is also an opportunity to turn it into a yachting experience which is positively different compared to larger yachts, a little closer to the sea, the opportunity to be in the drivers seat your self. Like driving a sports car rather than being driven in a limo. So the character of the ride would be crucial. Offering features a super yacht cannot. Of course there are those super yachts like the Wally Power 118, but they can't be called very affordable and their practicability might be rather questionable. What I was thinking about was a Mediterranean way of style, think St. Tropez, mahogany Riva boats, fast day trips… It must be a boat which would have a certain sports car-like aura about it. Thus it would be without compromises, not comparable to more expensive solutions, a class of it's own, like the Aquariva of yesterday.

this page: yachts of different size in the marina
right page: detail of the motor yacht Sunseeker Predator 60

trainingroomexpress.com/wn-Mega-Yachts/

There could be different interpretations of the same yacht concept, one being a more economical and ecological longer distance traveler for exploring nature and a long weekend off shore. The other version could be a sport boat with emphasis on performance, enabling shorter and faster trips or excursions.

The design aims at a yacht category, which could still be "owner operated" thus reducing operation costs and keeping the whole concept much simpler. Making an easy and safe yachting experience combined with a trustable performance is a main priority, offering qualities a bigger ship cannot. So this type of boat can't be seen as inferior to bigger, more expensive Yachts. The concept doesn't compromise. It is actually a very straight forward approach with a clear message: enjoy the ride! This type of pleasure boat could therefore also be a second yacht for someone already operating a bigger ship, offering a different view of the maritime experience.

3.2 *category*

This project being my graduation project, I wanted to take the freedom and create something I was interested in and which would also be challenging as a task. After all there will not be a freedom like this after graduating, when you have to make a living out of your work. My previous project which was about catamaran design, also had provided many ideas which I wanted to further develop.

As a constructional frame I chose the catamaran hull. I believe that this special type of boat could make an extraordinary product with virtually no drawbacks, if designed carefully an optimized in size and performance for the desired operating environment. From a technical point of view, there is definitely a defined range of application as also a restricting range of size which could be constructed successfuly as a multihull. As stated earlier, when it comes to vessels with emphasis on displacement for maximum payload and less need for speed, a monohull design will provide the solution. But for my concept in mind a traditional monohull design goes along with many shortcomings. First off all the power-to-displacement ratio for higher speed is never good. Economic hull speed for a displacement hull is quiet low, so the desired performance would require a semi-displacement or planing hull. As the efficiency of a planing deep-V hull is limited, I believe there is a good possibility for extraordinary hull types to offer improvement.

When we take a fast luxury yacht concept in the range around 60' and a probable displacement of 20 to 30 tons, it is evident that even a smaller improvement bears the possibility of significantly increased over-all efficiency. The chosen motor yacht type and size of my concept will belong into this category. The different load situations are within limits, mainly caused by varying fuel and water loads. The aimed speed-to-length ratio is high. Maneuverability, soft

left page top: Aguti mahogany motor yacht, Germany
bellow: dashboard of a yacht by Frauscher, Austria

this page top: BMW design study "Gina"
bellow: Lamborgini Murcielago

sea keeping and hull efficiency are of high priority. Also available wide deck space of a catamaran construction is a considerable advantage.

The yacht could be a day-cruiser but capable of traveling longer distances as 300 nautical miles and more. Accomodation should be for about six persons. I made the decision to go for an around 60 feet yacht for mainly to reasons. First, it is a size, which is to some extend customized to the specifications of the owner, meaning that the concept could be realistic and competitive even when produced as a one-off. A less expensive yacht would also face much more competition on the market. As a basic idea was to imply some less common and cutting-edge technology on board like solar panels and possibly fuel cells in combination with a diesel-electric propulsion system, this all favored a slightly bigger Yacht. The competitiveness would be less affected by additional costs.

Second is a simple construction specific fact. A catamaran consists of two more or less narrow hulls with nothing in between. This makes the design a little tricky for the layout. A catamaran simply needs a certain size to create acceptable cabin volumes and proportions, unless one ignores the appearance from the outside, turning the catamaran into a bulky floating home. This fact leads me strait to the core of the concept. A common problem in catamaran design is simply their appearance which is often massive in addition to being unusual.

Last but not least a yacht of this size would guarantee enough media-visibility, which can be an not to underestimating point, considering it to be a showcase for different technical solutions and the possible companies involved.

3.3 *style*

There are catamaran designs some of them more stylish than others and the numbers being build seems to have been slightly increasing over the past years. However, there is probably a fundamental problem with the concept of most multihulls. They rarely seem to be able to express that nautical style, the elegance and lines of more traditional designs. There is no commonly accept-ed design-formula. A possible exception are the off-shore racing catamarans and F1 boats which are simply dictated by their extreme purpose.

This study is based on the idea of designing a motor catamaran from scratch to bring catamaran design closer to monohull design, thus making it a more attractive motor yacht concept. A source of inspiration was sailing yacht design. The clean cut, very distinctive lines, which all seem to serve a single purpose. Forms as perfect as the round rocks of a seaside, being ground by the sea over thousands of years. Especially in the segment of large sailing yachts there can be found beautifully "down to basic" designs. Such names like the Italian design studio **Wally** or naval designer **Luca Brenta** being masters of the trade. For me the beauty of a sailing yacht is the impression that the yacht is build to be in harmony with nature, the boat uniting man and sea in a respectful unification.

this page: Ferretti Yachts, Italy
right page: Mahogany Runabout by Pedrazzini, Switzerland

www.boatdesign.net/forums/attachments/open-discussion/3481d1120586048-building-raft-75-table_boat.jpg

> the style icon

Yacht design is an interesting field of different form-languages. The field is much more divers as for example automobile design and split into deliberately "retro" styled yachts, more modern designs and some rather radical design approaches either for racing or breaking some other record. In 2005 the Italian yacht design studio Wally showed the world a new motor yacht design, Wally Power 118, which seemed to look like the yacht Darth Wader would ride, if he visited earth. A powerful edgy design, like a military stealth boat. I believe companies like Wally have probably contributed to the quality of yacht design, showing new possibilities and interpretation in an otherwise rather traditional scene.

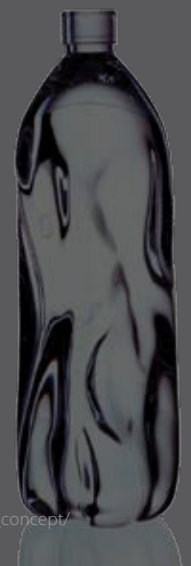
It is clear that the development of a yacht lacks in time, money and facilities far beyond the resources available for the automobile industry. On the other hand yacht design does not have the same pressure the automobile design faces, due to production and development costs and the resulting need to succeed on the market, to find customer acceptance and face hard competition. I assume yacht design offers many possibilities for creative solutions, which can more easily made real, as design teams are small and production numbers low or even one-off.

Designs which apply round lines and oval forms clearly dominate the motor yacht scene bellow the super yacht category. I'm not a fan of the style, which applies concave elements as seen in many motor yacht designs. The thing is, that these designs based on sharp oval forms easily become heavy and even confusing, as lines do not start and end at defined points but look more like added elements, not being necessarily part of the technical structure but rather a styled cover. Typical are the concave split windows of the deckhouse, with curved supporting structures above them melting into the flybridge and aft deck roof support. Another interpretation of these concave lines is the "organic" style of large wavy forms, partly intersecting. It is a design language, which is also emerging in automotive design, seen in many concept cars by manufacturers like for example Citroën. The risk is, that this design-language produces confusing objects, which are like made out of a "liquid turned solid". They seldom fit into any other surrounding than a white studio space. Of course it could be the perfect form-language for a yacht, given the fact that they are cruising on the sea, a unique surrounding, free of any disturbing, man-made elements.

www.lucabrenta.com/ www.ferretti-yachts.com/_vti_g2_1_aspx_rpstry_28_--yacht-design-barche-cabinati-cantiere-barca-lusso.sphtml

I approached this design task with quiet some seriousness, as I believe yacht design should take itself seriously and not be about emerging and passing trends. A trend is a fleeting idea of the spirit of today, a direction detectable in common behavior. Capturing a trend is crucial in marketing. So important in fact that marketing has understood not only to trace the latest trends, but to create the trend itself, the need for cutting edge fashion. Of course yacht design, as it is commercial, can't make an exception to this. But a yacht is different from a pair of trousers by its longevity and price tag. And above all it has to be honest and humble in front of the operating environment and functionality to call it's owners happy. So, as a designer I somehow respect the very traditional part of yacht design. Things which have evolved over hundred of years should be traded with respect, there are often many good reason why they are made in a certain way.

As a designer I feel a need to question, and to research existing designs to better understand the task I have in front of me. It opens my eyes to see the technically essential parts of the old designs and encircle where function encounters forms not necessarily dictated by functionality, but rather by traditions, or they may be remains of production techniques no longer used. These are the challenges for a design based on the idea of evolution, to build up on functional elements questioning every part, but without making deliberately everything different for the sake of being modern. The idea of "Less is more" in the world of design is sometimes leading to doubtful solutions compromising usability and even leading to hidden constructions of more complex solutions in order to show a minimalist surface. This kind of design, which praises itself to serve pure functionality and probably production techniques or economics, in many cases turns out to be a mere design-vision.



left page: Sailing yacht design by Luca Brenta
yacht design applying an oval-based
form language by Ferretti, italy

this page: Citroën design study "Hypnos" 2008
Organic water bottle design by Ross Lovegrove

www.netcarshow.com/citroen/2008-hypnos_concept/

tomdesign.co.uk/blog/wp-content/uploads/2008/04/ross-lovegrove-ty-nant-waterbottle-2.jpg

Styling is not to be considered as the foremost design approach. The search for beauty, elegance, for a style, leads to the design metamorphosis of the function as a base, evolving into a visual and materialized form of engineering. I like to think of a form to have its roots in the purely physical function, which then has to evolve into a form with metaphysical functions, able to express and visualize the ideas and emotions behind the purely technically defined properties. This is where a shape becomes a dimension of human communication, "the design speaks to us". This makes us feel surrounded by a world for human life.

I somewhere came across the sentence of a yacht designer who stated: "No one needs a yacht." I think this is a good starting point for any yacht design, because it implies the question, if no one needs a yacht, what is the yacht about? This in mind it is evident that even the most advanced and practical yacht would never make it, unless she comes with the necessary amount of "Je ne sais quoi" about her. This formula of evoking desire is the force of the persuaded design and to make it more complicated, always in subordination to function.

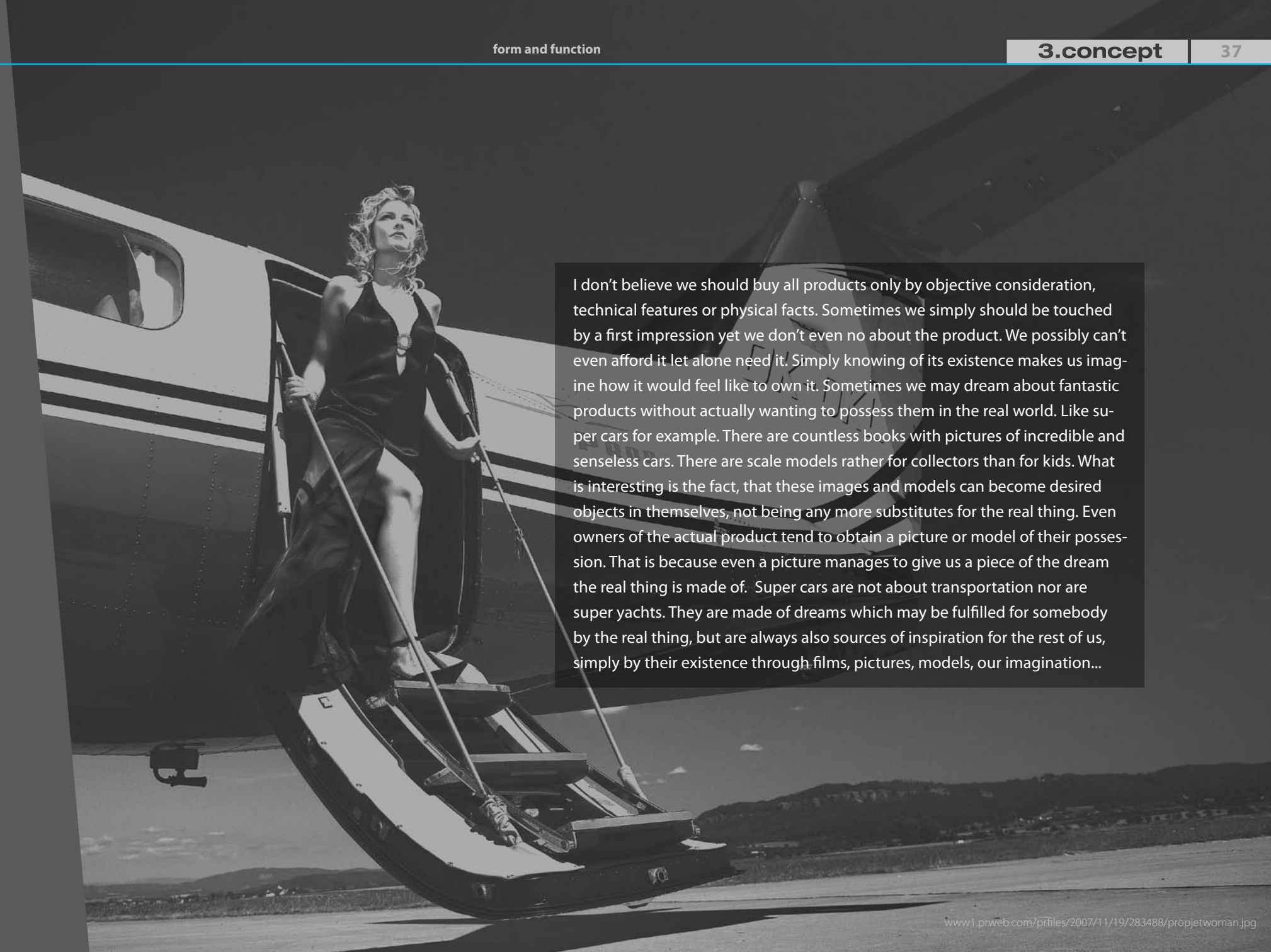
3.4 *form and function*

Form as a result of the function. But which function? How can we define the function(s) of a yacht or let's say just for example the hull of a yacht. She has to float, has to be hydro dynamically optimized and must perform safely and reliable in different sea conditions. But these are almost self-evident properties, solved best by naval engineers.

new concept rendering by Blohm & Voss, Germany

What if the function of a line is to make a yacht look fast. Then that line definitely follows a function. I dare to make a last comparison with cars. I believe that very few people buy sports cars only to go faster, speed limits make it illegal anyway, but simply for the character of the car, the embodiment of power, vitality, aggressiveness, lifestyle etc. So the most important part of the design is possibly not the speed itself, but the cars ability to visualize speed while being parked. This interpretation of function doesn't even deprive the design approach, because this kind of product was always meant to fulfill simply human desire and imagination, not survival. Human needs can never be united in basic things like breathing, eating, etc. Our needs are undefined and infinite. So the possible forms to follow this "function of human life" must also be undefined an infinite. Otherwise we are not designing for humans anymore but for machines, for the industry, or for political concepts with commonly dictated and permitted needs. If we take the factor of emotions out of the frame of our design definition, we should probably better call it simply engineering.

www.blohmvossyachts.com/index.php?level=1&CatID=21&inhalt_id=21–



I don't believe we should buy all products only by objective consideration, technical features or physical facts. Sometimes we simply should be touched by a first impression yet we don't even no about the product. We possibly can't even afford it let alone need it. Simply knowing of its existence makes us imagine how it would feel like to own it. Sometimes we may dream about fantastic products without actually wanting to possess them in the real world. Like super cars for example. There are countless books with pictures of incredible and senseless cars. There are scale models rather for collectors than for kids. What is interesting is the fact, that these images and models can become desired objects in themselves, not being any more substitutes for the real thing. Even owners of the actual product tend to obtain a picture or model of their possession. That is because even a picture manages to give us a piece of the dream the real thing is made of. Super cars are not about transportation nor are super yachts. They are made of dreams which may be fulfilled for somebody by the real thing, but are always also sources of inspiration for the rest of us, simply by their existence through films, pictures, models, our imagination...

www1.prweb.com/prfiles/2007/11/19/283488/propjetwoman.jpg

3.5 *sustainability*

Take a sail and you will have a most environment friendly boat! But the concept of sailing is fundamentally different from motor yachting. I guess someone being a real "sailor" would never even dream about having a motor-boat. On the other hand the majority of yachts being sold are motor powered. According to the statistics published in "**Boat International**" for the sales of super yachts from 24m upwards, around 85% of the new commissions are for motor yachts. Without having the statistics for worldwide pleasure boat sales below the super yacht category, it is obvious that the vast majority of pleasure boats being sold are motor powered.

It may be a fact that even if motor yacht operation was made illegal, there would be now measurable effects in environmental stress. The development of the propulsion technique and general efficiency of commercial vessels is definitely of much greater importance, as it will have some actual environmental impact. For me however environmentally responsible acting is definitely a moral question. What I mean is that for example using an airplane, is not anymore a decision whether I can afford it or not in terms of money, but whether I have a right to do so or not, because if everyone acted like me it would eventually lead into a disaster.

At the moment we are all claiming exclusive rights which are based on our exceptional living standards and the only thing which makes these acts in a short term sustainable is the fact that the majority of humans are to poor to afford the same. It would be rather hypocritical for me to denounce someone buying a super yacht while I might use air travel for my own holidays as both acts are based on equal terms.

wallpaperblog.files.wordpress.com/2007/12/blue_sky_1920.jpg www.skysails.info/

I hope we can develop these somehow elitist things like for example a motor yacht in a way, making them more efficient and sustainable for the future, so they can exist and be available to even more people. But as I stated earlier above, I do also partly accept a world of unequal possibilities, because I don't believe that "everybody needs everything". I probably would rather enjoy cycling to work than going by car, but it would definitely delight me running across a Lamborghini on my cycle trip. Based on this view, I have an interest as a designer to improve even very luxurious products, so they would better contribute to a responsible future. I also like to see many exclusive objects as works of art. They can contribute to our imagination, our sense of beauty. This does not involve the necessity of ownership. On the base of this ideas I like to design a better yacht nobody will ever need, but many might dream of.

s582.photobucket.com/albums/ss266/Metin_RO/sky/?action=view&current=24sun_and_sky.jpg&sort=ascending

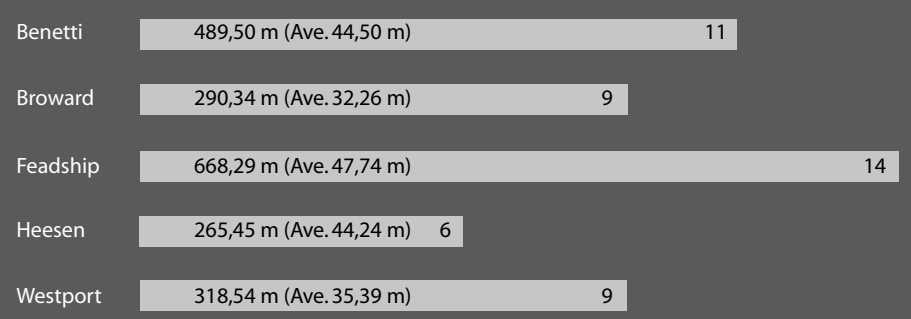
4.1 *competing products*

When having a look at yachts, which could be considered as competitors for the design, there are some features which must be specified. First there is the price of the Yacht. Then comes the size and technical features, which must be similar or otherwise be considered an option competing for the same customer groups.

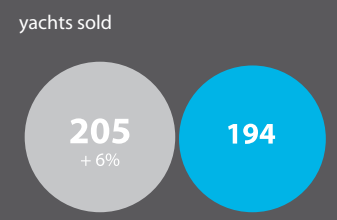
There is a range of manufacturers of boats in the category of the design study. These are no more products "of the shelf" but will be constructed and customized per order. The British brands **Princess** and **Sunseeker** are possible candidates, having several designs in the range between 1 and 2 million €. One contender is the **Sunseeker Predator 60** which I would like to oppose to my design concept, as the Predator 60 is conceptually an in many ways similar motor yacht. It's all about high performance, powerful cruising, and luxury on board, at a high quality standard. With the Sunseeker Predator 60 the fun starts from 1,5 million € upwards, depending on the configuration. Specifications of the eCat concept and the Predator 60 are opposed in the section "layout" on page 104.

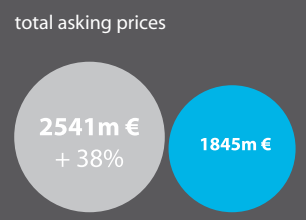
www.sunseeker.com/

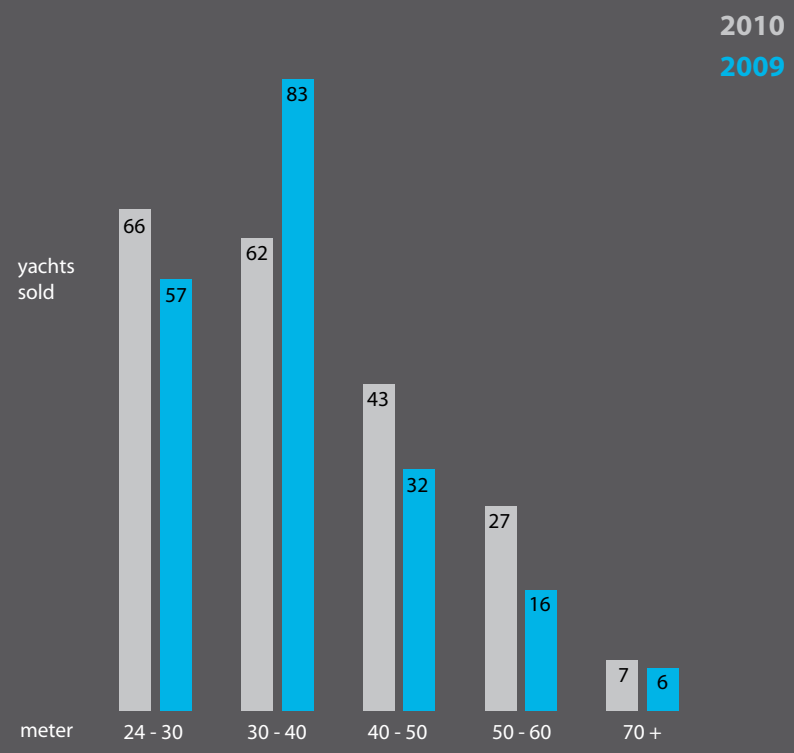
The following statistics show the numbers of super yachts (from 24m upwards) being sold 2010 and 2009. These statistics are provided by "Boat International". They give a good insight of the super yacht business worldwide. It clearly shows that the sector is very exclusive (given the fact that all yacht are stated by their names in some statistics). The annual sales numbers are around 200 yachts, showing now a slight recovery from the economic regression. There is also a trend towards bigger, more expensive Yachts. The average length being sold is around 37m. Unfortunately the range covered by these statistics does not show anything about the category of the design. It is evident that the target group of this study is significantly larger. Never the less this statistics have some interesting information. The percentage of new sailing yachts sold is only around 15%. The worldwide leading yacht manufacturer measured by production numbers and price is Italy, followed by The Netherlands and then the United States. The geographical site of manufacture is of less concequence as one might think, as Finland for example launched 2010 just one super yacht, Spain two, but Turkey 21 and The Netherlands 26.



meter of waterline and number of yachts sold by leading manufacturers







4.1 *catamaran design*

This pages show some of the different approaches to motor catamaran design. The pictures show clearly that the field is very non-uniform and wide. At one end there are futuristic and zero emission designs, at the other there are super fast yachts and racing boats. Between those extreme ends there are very few catamaran yacht designs, which could be compared to the design quality of the best monohulls. This current situation speaks explicitly for the ideas behind this design study. At the moment one of the best designs available are probably produced by the polish studio **Sunreef**.








Porsche design (concept)
Rene Van Der Velden (concept)
King Cat (HYSUCAT)
Paritet Boat
Sunreef

> power catamaran design

www.yachtchartersinmiami.com/62CatamaranVessel.htm
www.yacht-design.biz/portfolio/catamaran-76/catamaran-76-02.htm
www.luxist.com/tag/rff+135/
mariahcarey.com/
fooyoh.com/geekapolis_gadgets_camcorders/4223829
www.aeroyacht.com/power-catamarans/
www.sunreef-yachts.com/
www.sunreef-yachts.com/







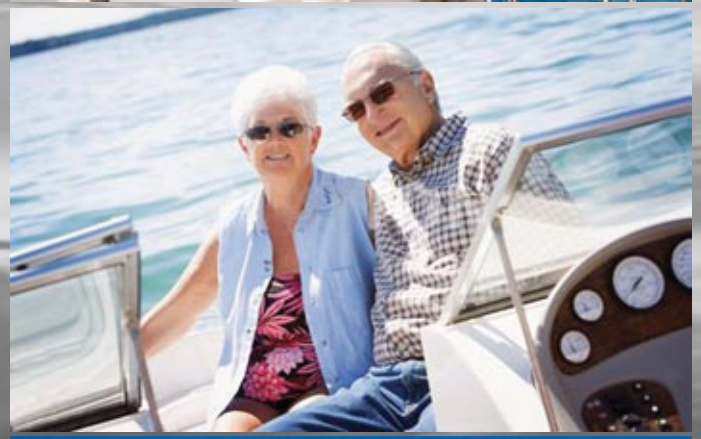
www.comail.ch/king/kingcat3.swf
www.jonashakaniemi.com/
bruceroberts.com/public/HTML/CUSTOM-SAILBOATS.htm
www.paritetboat.com/
www.screamandfly.com/showthread.php?169851-SST-120-F1-boat-for-sale
www.jurikarinen.com/#903437/eCat-hybrid
cubeme.com/blog/2008/11/03/first-ever-hybrid-yacht-using-solar-diesel-and-electric-power/
www.taratours.com/GalapagosQuickReference.htm

4.2 *clientele*

To make things short: anyone who has around 1,5 million € redundant and loves the idea of a fast and luxurious motor yacht.

Obviously the design competes on a very exclusive and marginal market. It is a product in a category which already exists, meaning there are direct competitors and existing customers who may have a more or less conservative conception about the concept of a yacht. The main point of the whole concept is to create a technically superior product, which would be safer, easier, more economic and more luxurious than all simillar competing designs. It is possible that this could even lead to new customers, which otherwise would not buy a yacht at all. For example seniors, who are already restricted in their capabilities. Wide deck space and high handrails are among the features, which are seldom found on yachts of this size, but are a few of those qualities, which will make this catamaran concept outstand from the competition.

But I don't think the concept has to find new customers in order to be successful. It is a highly marginal product and in any case would obviously not be mass-produced. If there would be even one customer (I would like to bet there are more) and the concept could proof what it promises by being actually build, I would call it a huge success. Serving as a source for new ideas and forthcoming concepts, possibly contributing to an evolution in motor yacht design, which is very much needed, would be an achievement.



www.matton.com/ www.matton.com/ www.lmykinacoulis.com/articles.asp?catid=6

> defining the possible

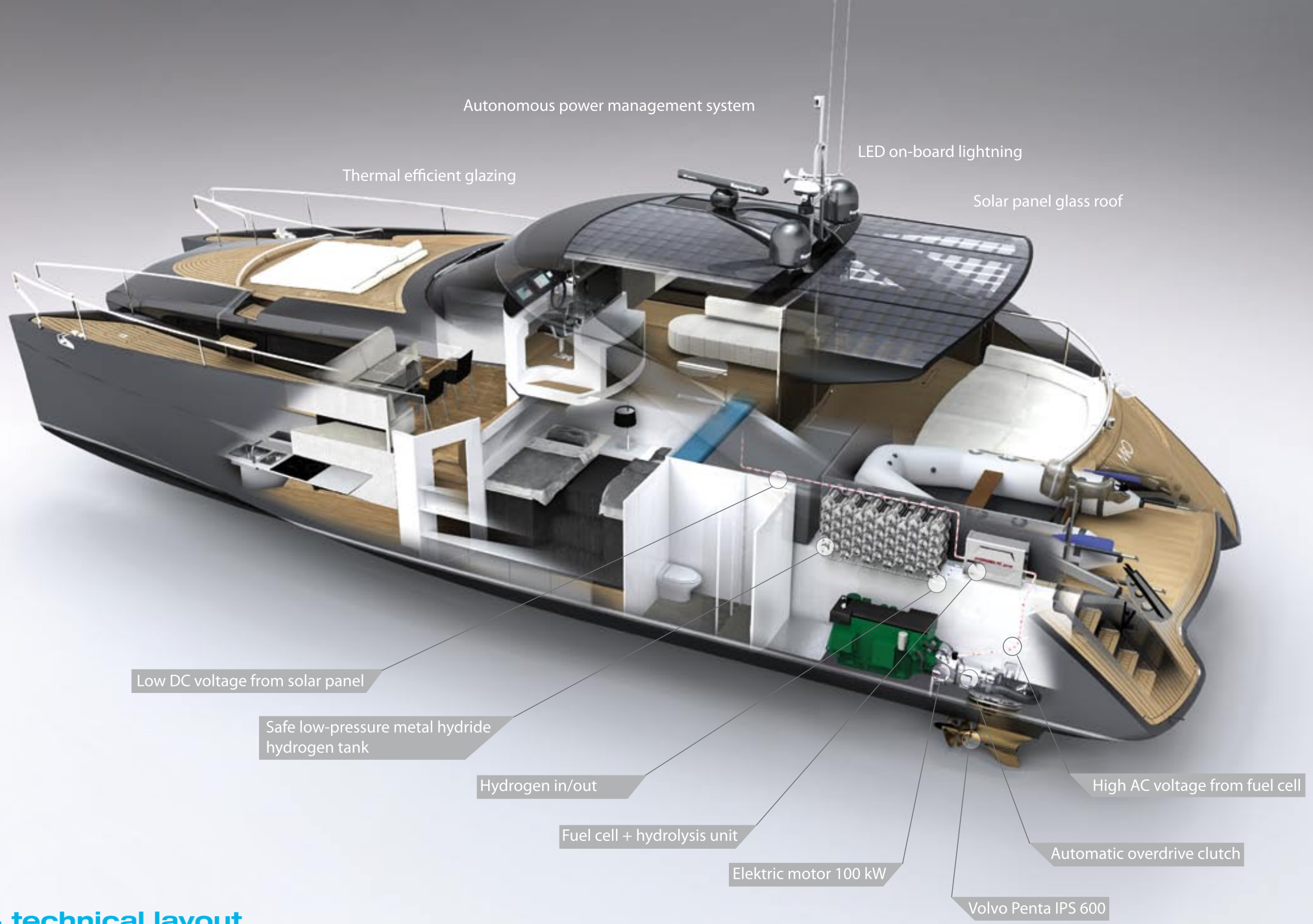
5.1 *technical layout*

The frame and focus of this study is the design and styling of a motor catamaran. Never the less it is impossible to design a highly technical product without knowing about the basic engineering. Form has not only to follow function, but rises from function. A design dictating feature was the idea to employ solar cells. This meant a larger-than-normal roof area. As the idea of the concept was to show what a motor yacht could be today, I tried to suggest only existing technology which is on the market and has proofed to work.

The innovative value does not drive from a single technical solution, but from the right combination. In addition to the already energy efficient catamaran hull, the patented Hysucat hydrofoil is added if possible, in addition with the Volvo Penta IPS pod drive, to set new standards in ecology and performance. To top this, the boat is designed to be a Diesel-electric hybrid. Electric motors could be used whenever possible in addition to the diesel engines, thus reducing fuel consumption and emissions.

The eCat concept proposes hydrogen as storage for excess electricity, produced on-board with 23m2 of solar panels. This will be a frequent situation when the boat is not running. Therefore the electric motors are not depending on infrastructure like an electric plug or hydrogen filling stations. The hydrogen could be transformed by so-called "unitized regenerative fuel cells", a combination of a hydrolyser and fuel cell and then stored in metal hydride tanks. So the boat is refueling itself autonomously, constantly for free and truly zero-emission. The system would also make the normal diesel-power generator overdue. As hydrogen storage is developing all the time, cheaper and more lightweight solutions like glass capillary storage should be taken into account.

A major task will be the efficiency of the solar energy conversion and storage and of course the effort and cost of the system. The current state of development may force to scale down the hybrid propulsion idea and use possible solar energy via battery storage only for on-board appliances like lightning and air conditioning. This would mean lower construction costs and an absolutely realistically working system. And I would like to say, that it would still be a most advanced concept and a contribution to motor yacht development for the future.



> technical layout

5.2 propulsion

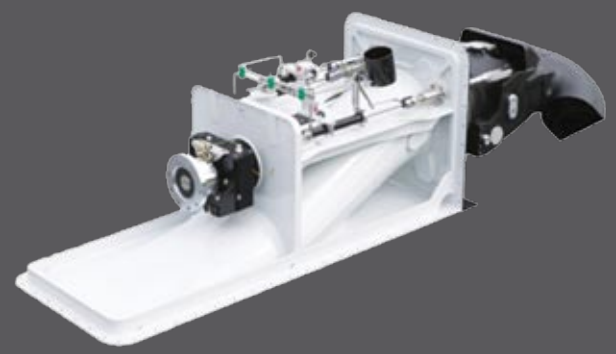
A motor yacht is probably not the most obvious means of ecological transportation. Also the word transportation does not really apply, as it is not about going from A to B but rather cruising from A to A. Thou it is possible to cruise while taking the environment into account, as the fully solar powered "Planet Solar" is proofing right as I'm writing. A look at the Planet Solar website tells me the boat is right now "sailing" somewhere on the pacific, halfway between South America and Australia, day 183 on sea. But floating at 5 knots in the middle of an ocean is a slightly different concept than what this design concept is about. Then comes the circumstance that I personally like engines, preferably powerful and noisy combustion engines. There is something about raw engineering, about unstoppable horsepower and torque and of course also the mechanical beauty of pure form-follows-function of an engine. High tech electronics covered under neat plastic will hardly replace this. But there has been a lot of improvement for the old diesel engine, which still isn't facing any replacing source of propulsion in the marine sector. A modern diesel has made actually a big leap towards sustainability. For example it is easy to modify an existing diesel engine into a methane gas burning engine. This increases consumption but leads to cleaner emissions. Further more methane is a non-refined fuel, and also a by-product of many processes, for example in agriculture. The use of catalytic converters for diesel engines further adds to emission minimisation.

www.volvopenta.com/volvopenta/finland/fi-fi/Pages/pentahome.aspx

www.volvopenta.com/volvopenta/finland/fi-fi/Pages/pentahome.aspx

www.arneson-industries.com/

Volvo Penta IPS joystic control
Volvo Penta IPS
Arneson Surface drive for high speed
Kamewa water jet unit



The power train has to be in accordance with the aimed performance and weight of the yacht. Powering a motor yacht the size of a house and the speed of a bird is obviously a contradicting venture. Moving fast on the sea demands raw power.
There is basically still now other option than Diesel on the market. Methane gas as a cleaner substitute for diesel fuel could be a development for a more sustainable future.

The recently developed IPS pod drive by Volvo Penta should be an interesting and efficiency improved power train with its forward pointing coaxial propeller and very compact dimensions. The IPS comes with a neat joystic control, enabling unmatched maneuverability in the marina. At higher speed cavitation will set limits and in addition the use of the Hysucat foils (which I suggest in this concept) might lift the hull so high on to the surface, that ventilation might become an issue, especially in choppy seas.

For higher speed demands of 35 knots upwards there could be either the proven Arneson surface drive or water jet propulsion, for example by Kamewa or Hamilton. Water jet propulsion efficiency improves at increased speed and can add positively to the handling characteristics, as it suck in the water stream at the rear bottom of the hull providing "grip". Further more there are no propulsion parts bellow the bottom of the hull. resulting in a shallow draft. Surface drive and water jet will work with hydrofoils, as they are ventilated or super cavitating. Adequate modern high revolution CDI diesel engines could be found in the range of the market leaders, MAN and Caterpillar.

www.rolls-royce.com/marine/products/propulsors/waterjets/

5.3 *hybrid propulsion*

The words "hybrid" has become almost something like a synonym for "eco-friendly", it immediately evokes the idea of an efficient low emission power train. The word itself means something having a mixed origin or combining (two) different components into one. In relation to cars it means commonly the combination of a conventional combustion engine with an electric drive. There are several configuration possibilities in a hybrid power train of an automobile. From a regular combustion engine aided by one or more electric motor(s) to a fully electric power train, getting the electric power by means of a generator powered by a fuel burning engine. The technical advantage of the fuel-electric hybrid for the automobile application is obvious when looking at the different load phases of a moving vehicle. Unless we are rolling on an even highway, there are continuously changing loads, acceleration and breaking, ups and downs. When we don't look at the efficiency characteristics of a combustion engine we see that every engine has only a narrow bandwidth of rpm and torque where it operates at optimum fuel efficiency. The electric motor on the other hand has a very linear output, operating with an almost constant efficiency factor at constant torque. Furthermore it can be simply switched to act as a generator while braking. This makes it an ideal propulsion for automotive use either alone, or in combination with a fuel engine in hybrid mode.

Now when we take this promising concept offshore, things start to look very different. No up- or downhill, no stop-and-go in the congested down town, no braking… In marine use the engines are running most of the time at constant rpm, at a moderate range. So a different approach of the hybrid configuration is needed. Diesel electric propulsion has been successfully used for quiet a while in so-called pod drives. There an electric motor is placed directly to the propeller axle at the shaft, which, depending on the construction, can rotate vertically acting as an active ruder up to 360°. The needed electrical power is created by generators driven by diesel engines. Apart from being highly maneuverable, this construction eliminates the heavy gearbox and torque converters, axles and bearings, thus reducing friction. This are effective set ups for big vessels, but the dimensions, hydrodynamics and speed-to-length ratio of a 60' planning hull are completely different. An electric motor cannot be planted outside the hull at the propeller axel, the powertrain is not comparable to the one of a big commercial vessel. As a possible solution I could see a fully electric drive getting its electricity probably by efficient and lightweight fuel burning turbines driving the electric generator. But turbines are generally expensive in maintenance so more realistic would be a set up with diesel powered generators.

The fully electric Frauscher Alassio 650 powered by 4,3, 10 or 40 kW

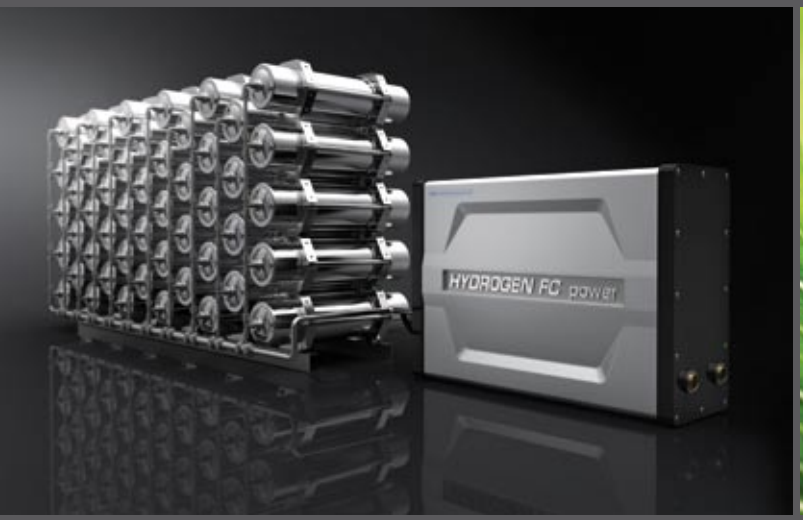
Diesel electric hybrid powered motor boat by Greenline 33
(Diesel engine by Volkswagen + 7 kW electric motor, speed 7 knots)

Voith Inline Propulsor by Voith Turbo Marine
An axel free propeller with direct electric drive in the outer ring

Diesel electric hybrid engine by Steyr Marine

An efficient powertain does not come by one or two efficient components but it is a chain with has to be regarded as a whole from the fuel source to the transformation of the power into thrust. It can not make much sense to drive a generator by a diesel engine to create a currency for an electric motor who in turn drives the gear and propeller, when the diesel engine could also drive directly the gear and propeller without efficiency loss. A possible solution could be a slightly modified array, where the propeller is driven by a diesel engine. Between the diesel and the gearbox however could probably be placed an additional electric motor. The diesel engine would be the main engine, but could be assisted by the electrical motor to reduce load and thus reduce fuel consumption and emissions. For a short time and at a slower speed the yacht could possibly be operated with the electrical motors only, for maneuvers in the marina or areas, which are restricted to normal motorboats. The question remains from where to get the (extra) electric currency.

www.frauscherboats.com/ www.greenlinehybrid.com/ www.voithturbo.com/vt_en_paa_marine.htm www.steyr-motors.com/marine/



5.4 energy storage

Storing electric energy efficiently is a major issue in the development of alternative propulsion technology. Battery storage has made a lot of progress, partly fueled by the demand of wire-less technology. For an application in vehicles, characteristics like recharging time, size and the weight-to-power ratio is crucial.
Hydrogen has still not redeemed its promises, being a complex solution. The over all efficiency is low, given the fact that the energy needed to produce hydrogen is high compared to the output. Further more storage and delivery is a problem. New inventions like immersing hydrogen in glass capillary tanks could help change this.

Rendering of a Hydrogen tank with Unitized Regenerative Fuel Cell

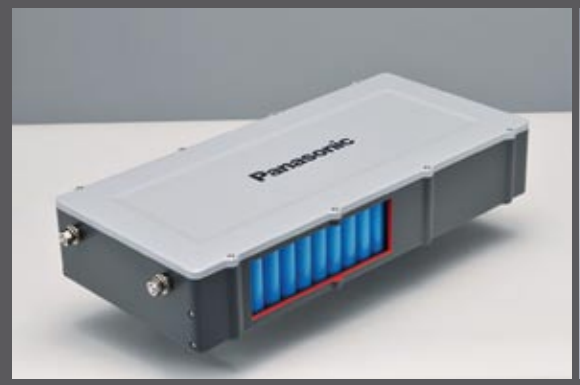
Battery developement by Panasonic

Rendering of a glass capillary based hydrogen storage.

Hydrogen power developement for pleasure boats by Frauscher / Fronius

The Unitized regenerative fuel cell by Fronius

www.flickr.com/ www.flickr.com/



Another approach to the challenge is the development of molecules, which bind and release hydrogen in a liquid state. This hydrogen fuel could be handled like traditional fuel. Carrier molecules could release the pure hydrogen and afterwards be recycled or more precisely "reloaded" with hydrogen. Hydrogen as an energy carrier is still interesting, as its energy is convertible cleanly.

At the moment the most mature technology are batteries. A strong feature is the very high efficiency of over 90%, compensating for the low energy density. New battery developments like lithium sulfur cells push the boundaries and may soon turn many concepts into reality. In 2008 a solar powered plane first applied successfully this new type of batteries.

> energy density, storage / converter:

battery, lithium ion	0,17 kW/h	1 kg
battery, lithium sulfur	0,5 kW/h	1 kg
regenerative fuel cell	0,45 kW/h	1 kg
metal hydride hydrogen storage	2,3 kW/h	1 kg
glass capillary hydrogen storage (ca.)	3 kW/h	1 kg

> energy density, fuel:

Diesel	10,3 kW/h	1 liter
Hydrogen (compressed at 700 bar)	1,5 kW/h	1 liter
Hydrogen gas	0,003 kW/h	1 liter

www.coated.com/wp-content/uploads/2009/12/panasonic_battery.jpg www.frauscherboats.com/ www.fronius.com/

The world record venture with the solar powered yacht "Tûranor PlanetSolar" using solely energy provided by the sun with the help of 440 m2 of solar cells for a trip around the globe. The yacht was build in Germany and designed my LOMOcean from New Zealand and has a cruising speed of 7 knots, made possible by only two 10 kW electric motors driving Voith Turbo Marine surface propellers. Total displacement, 85 tons, length 31 meters, wide 15 meters (23 meters with flap wings).

5.5 solar power

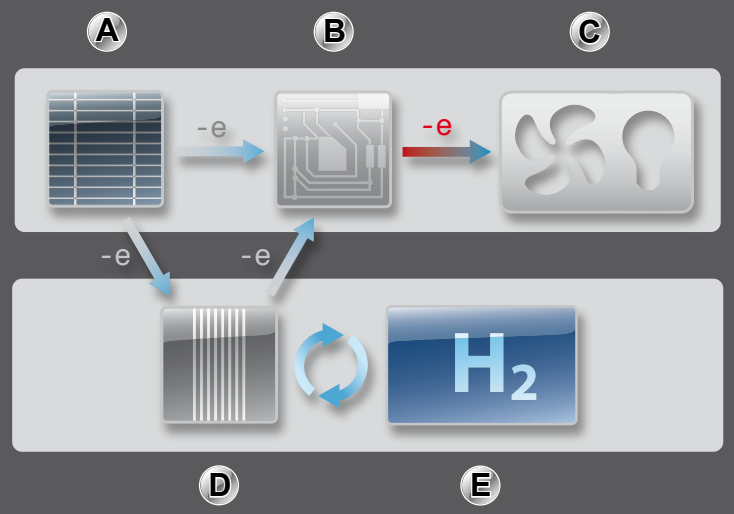
As an emission free energy source solar power is a tempting alternative. The approximate radiation power on a sunny day, known as the solar constant, is over 1000 W/h m2, when taking into account the sphere shape of the earth and the loss by the atmosphere the remaining energy is still 170W/h m2. For marine application the transformation of solar power into electric currency via solar cells is assumable the most suitable array. There has been a steady but slow progress in the efficiency of the photo voltaic cell. The best possible techniques are able to convert up to 40% of the incoming sun into electricity. Commercially available and less costly cells are reaching up to 30% efficiencies. But due to extenuations in the actual using environment by clouds, ineffective angles, heat etc. the actual efficiency will always be significantly lower. Never the less solar cells are attractive, because they have become cheaper and more flexible in design and the converted energy is free of emission and cost.

For my concept it was an early decision to include solar cell energy. This was also the greatest single factor dictating the design concept. The area of the deck house roof was maximized, within the limit of not interfering functionality and proportions. This excluded a flybridge, but let to a light and clean lined design. The final available roof surface to be covered with solar cells of the design is 23m2, reaching realistic efficiencies of delivering 5kW/h of electric power.

The next page shows an energy transforming / storage array for solar power via hydrogen. This technology is for example already in use by the austrian company Fronius, who develops battery charging, welding, and solar technology. Fronius uses Solar power generated hydrogen in a development project called HyLOG (Hydrogen powered Logistics System) at their site in Sattledt, Austria.

solar / fuel cell energy

solar energy storage via closed hydrogen cycle



Solar cells — A
Currency Inverter — B
Current-consuming appliances — C
Unitized Regenerative Fuel Cell — D
Hydrogen Storage — E

The solar modules **A** capture the sunlight and turn it into DC current. Power needed immediately is supplied straight to the points of consumption **C** by the way of the electronic currency inverter B . Excess electric power is used by the unitized regenerative fuel cell (URFC) **D** to split water into its twin constituents, oxygen and hydrogen. The hydrogen is temporarily stored in a reservoir **E** . When electricity demands exceed the supply by the solar cells the temporarily stored hydrogen is fed to the URFC **D** and turned back into DC current. This DC current from the URFC is then converted into usable AC current by the currency inverter **B** . With the URFC, then, solar energy can be stored and delivered whenever it is needed.

> system layout for solar / hydrogen energy

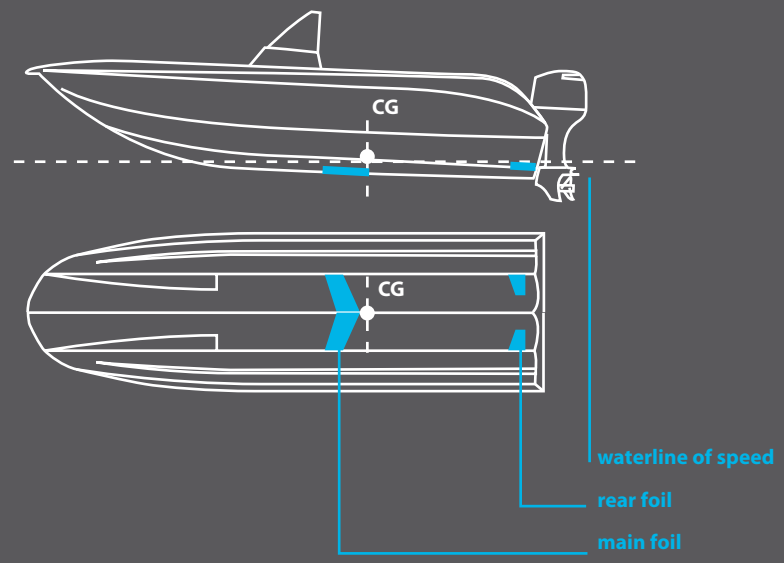
5.6 hydrofoil

The abbreviation HySuCat stands for Hydrofoil Supported Catamaran and is a patented foil design by Fast CC. A power catamarans a seagoing planing catamaran with a hydrofoil arrangement between the two demi-hulls which carries a part of the craft's weight at speed. The drag-lift ratio of a foil is much higher than of a hull at speed. This means that the efficient load carrying capacity of the hydrofoil in combination with the high stability and pleasant sea-keeping of the planing catamaran result in a most economical craft.

The system consists of a main wing-shaped foil mounted between the keels short in front of the center of gravity in a very precise position. An auto-trim balance of the system is achieved by a pair of stern foils mounted near the transom. There are no moving parts involved, resulting in very reliably working low-cost solution. Further more the system has an in-build capability of smoothening the ride in choppy seas, thus enhancing the quality of the sea-keeping even more.

high planing Hysucat, touching only the surface of the sea

- > **up to 40% increase in speed compared to deep-V monohull**
- > **smaller engines, less fuel consumption, longer range**
- > **faster acceleration, less speed loss under payload**
- > **less wake at high speed, improved sea-keeping**
- > **lower planning threshold, smoother ride**



fastcc.hysucraft.com/Default.asp?Page=PhotoGallery

> HySuCat foil technology for planning hull optimisation

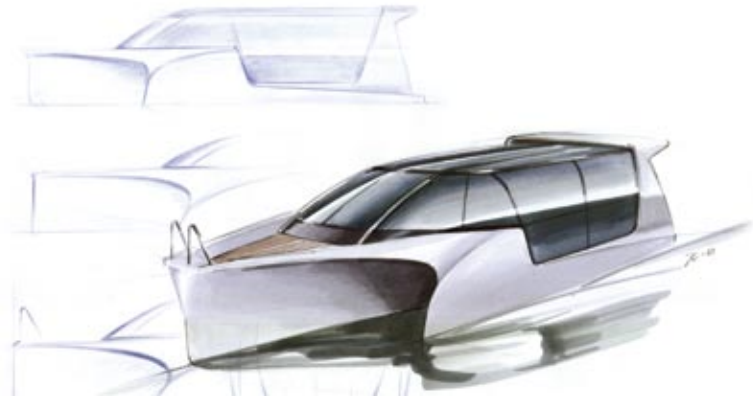
6.1 *sketches*

The drawing process started on the base of a short previous project, where I attempted to design a 33 foot displacement hull catamaran with a low emission electric propulsion. The original idea was to scale up the design to better suite constructional characteristics of an ecological catamaran.

While drawing different types of possible hulls, it happened more than once that I came up with an idea I first thought of having probably invented on my own. After doubting this, a search on the web confirmed the fear, but actually also confirmed of having approached the subject in a possibly right manner as the idea actually turned out to already exist an probably work.

The first time this happened when I wondered about the behavior of the bow of a catamaran in rough or choppy seas. In order to reduce tunnel slamming without having to lift the tunnel roof unnecessarily high above the waterline I draw the middle section of the cat as an deep v-hull elevated by the sponsons. The bows of the sponsons I tried to reduce to a minimum above the surface to eliminate the impact of quartering seas. As a cat has twin bows, waves would hit them slightly one after another, resulting probably in uncontrollable lateral movement and steering effects. As the bows are extremely slender, they have in any case very little buoyancy, thus acting always more or less as wavepiercers. Many fast ferries are constructed as wave piercing catamarans, but also smaller designs from around 40' upwards. LOMOcean from New Zealand is a design bureau specialized in this form of catamarans .http://www.cld.co.nz/welcome.htm

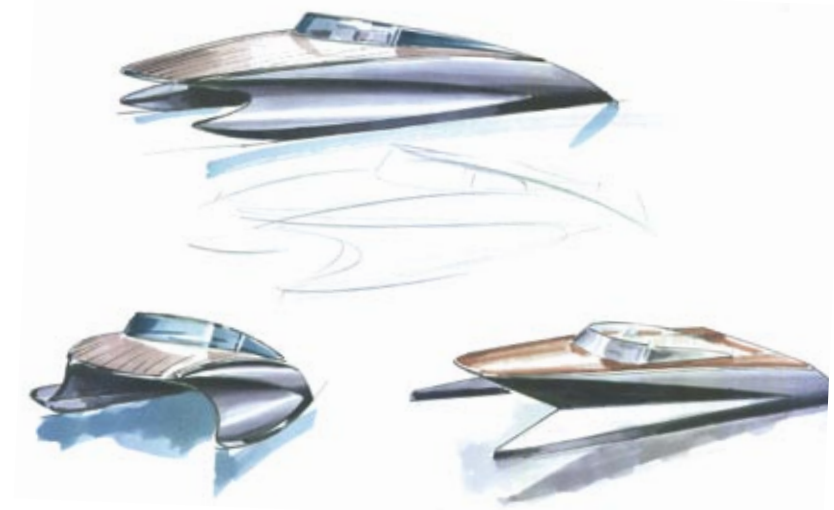
top: wave piercing catamaran design by LOMOcean, New Zealand
bellow: super fast ferry designed as wave piercer

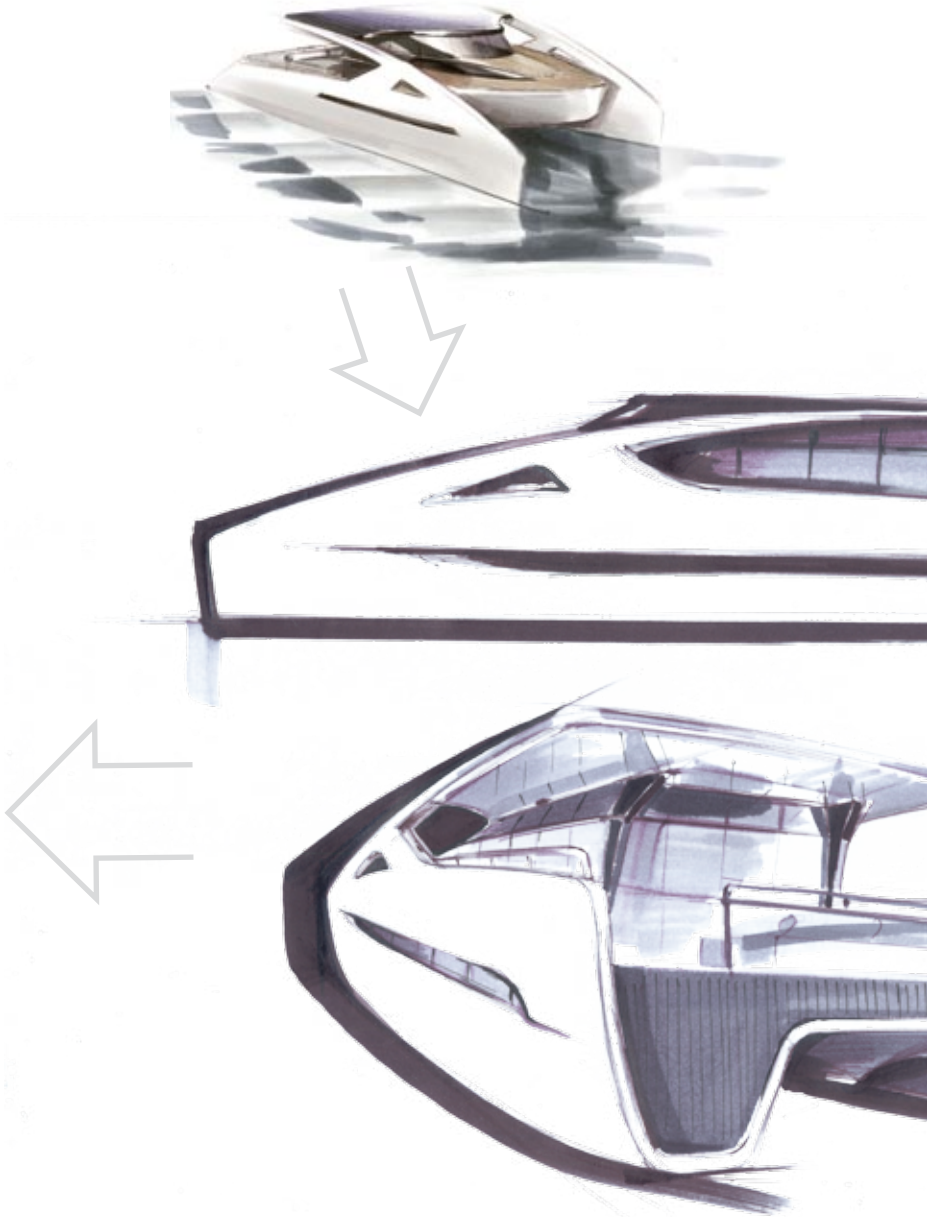


First sketches of the "eco catamaran" concept for RMJ Saksman. The frame of the ideas concerning the form was not restricted, leading to futuristic designs.

Increasing size meant more realistic dimensions of the layout and above all much better possibilities for alternative energy sources, as the solar cell area is bigger, hull speed becomes encreases but at the same time the desired cruising speed need not to be elevated.

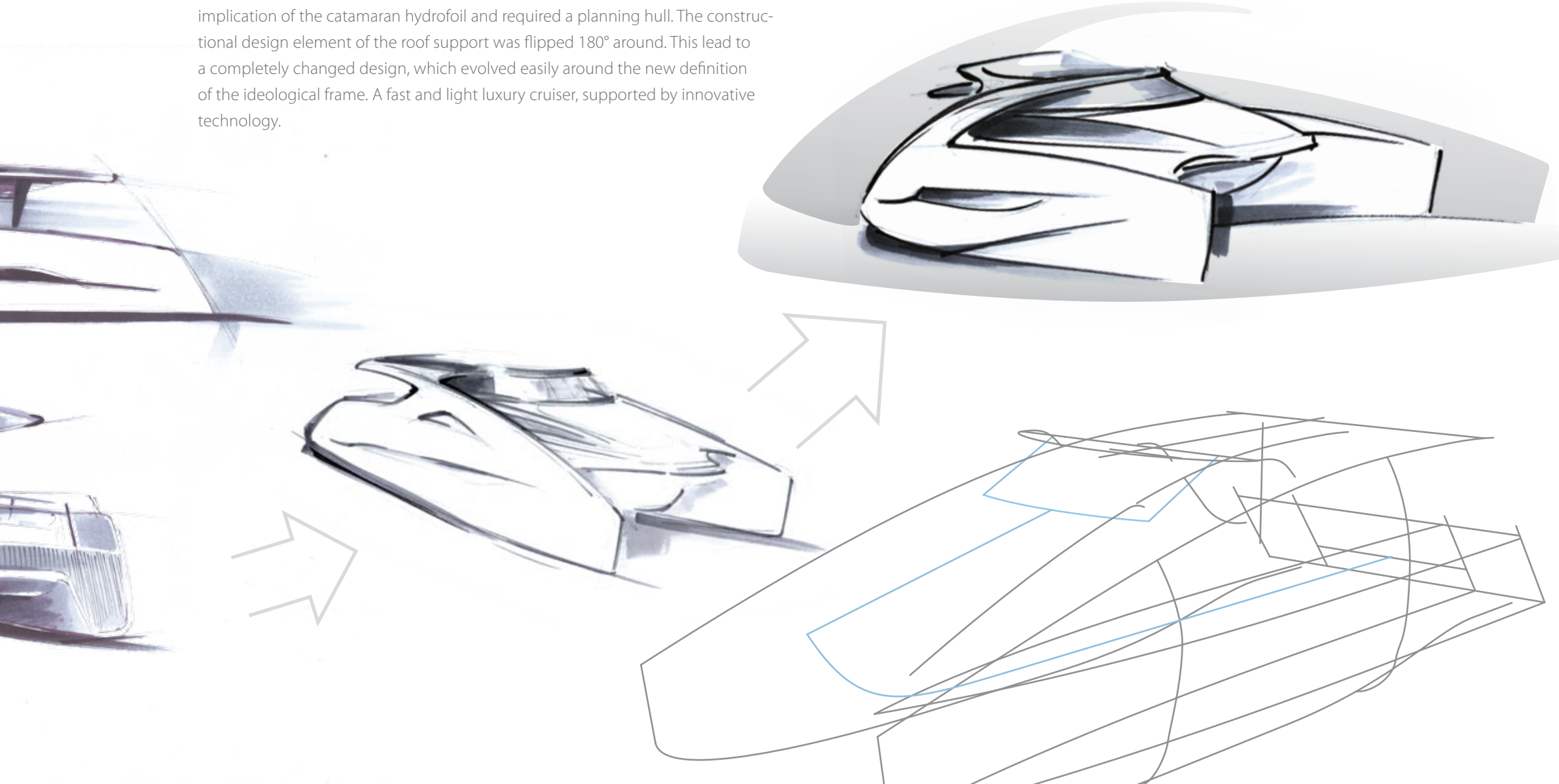
Some ideas from this stage remained until the final design. There is the "cut open" hull line at the transom with the wooden cover continuing the deck into a constructional element. Then there is the swimming platforms and the glazed deck house, which is an autonomous construction on the deck, not a continuous part of the hull.



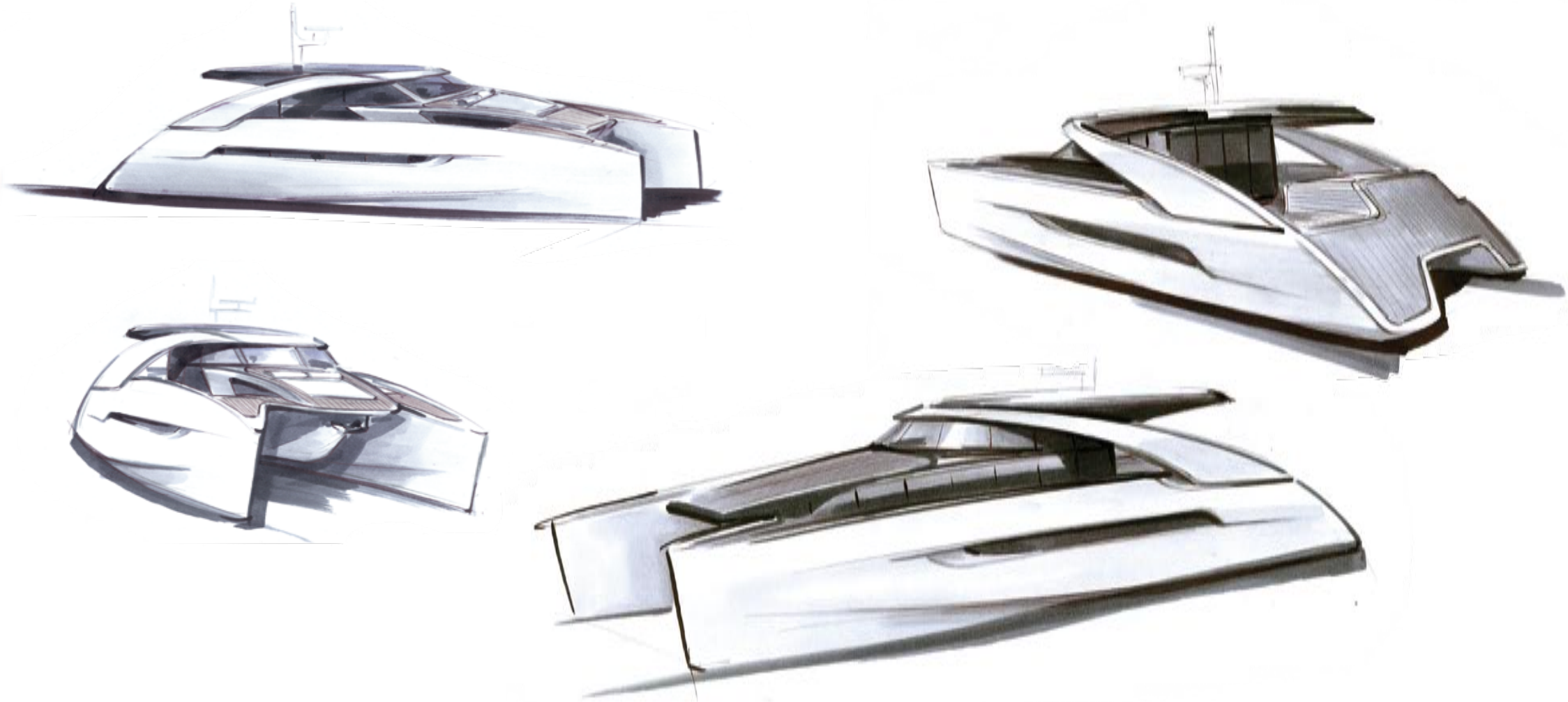


Above a photoshop rendering of the eco catamaran idea. The design is emphasized futuristic. The need for large solar panel areas easily leads to radically different constructions, compared to traditional designs. This concept bears many features I would like to further develop and will eventually end again on my drawing board. Up scaled into a super yacht category around 30 meters it could be a realistic low-emission concept. The solar energy capturing capabilities in relation to propulsion energy needed in a smaller design are to unfavorable.

The turning point of the design in the true sense of the word came with the implication of the catamaran hydrofoil and required a planning hull. The constructional design element of the roof support was flipped 180° around. This lead to a completely changed design, which evolved easily around the new definition of the ideological frame. A fast and light luxury cruiser, supported by innovative technology.



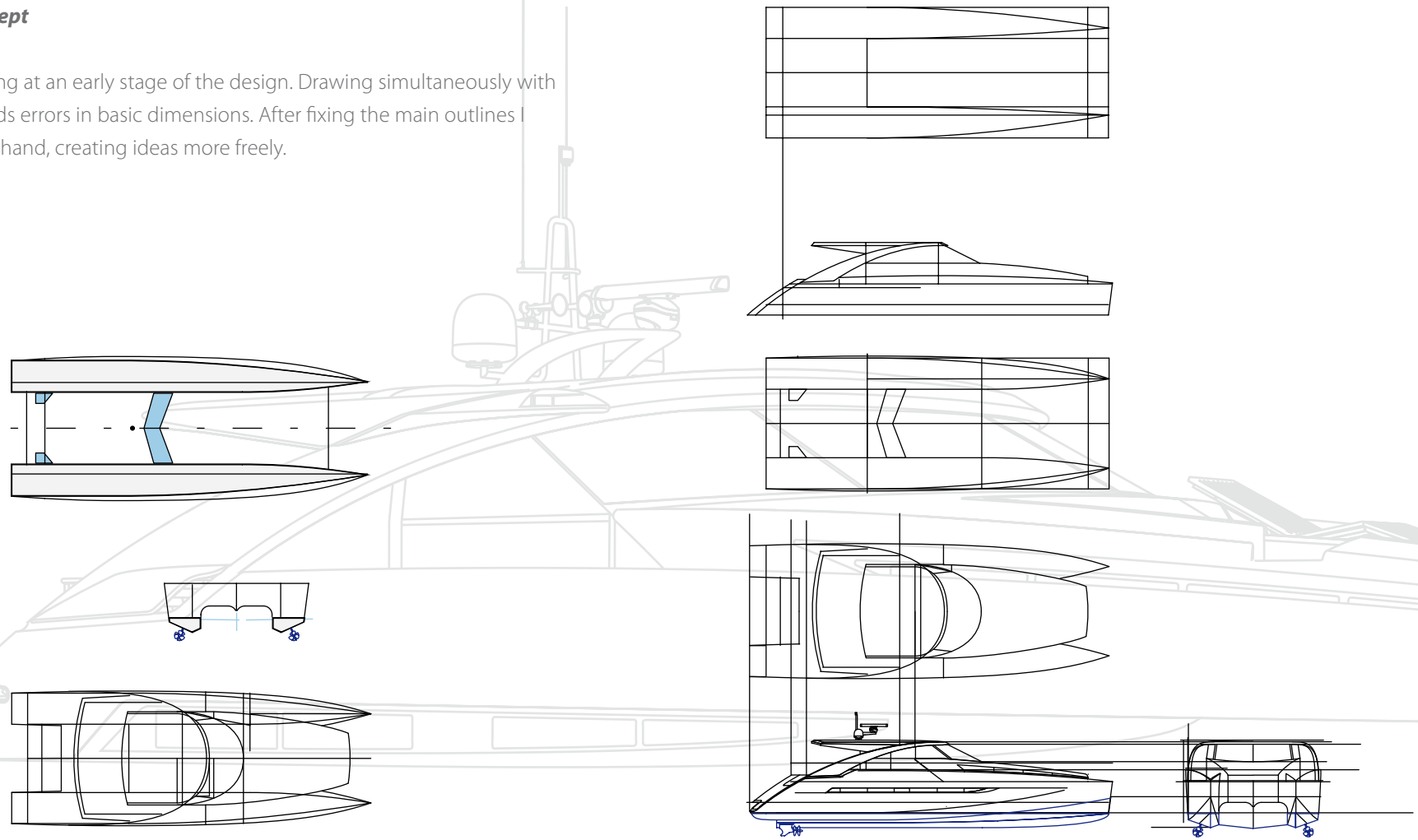
> final concept



> defining dimensions and proportions

6.2 *final concept*

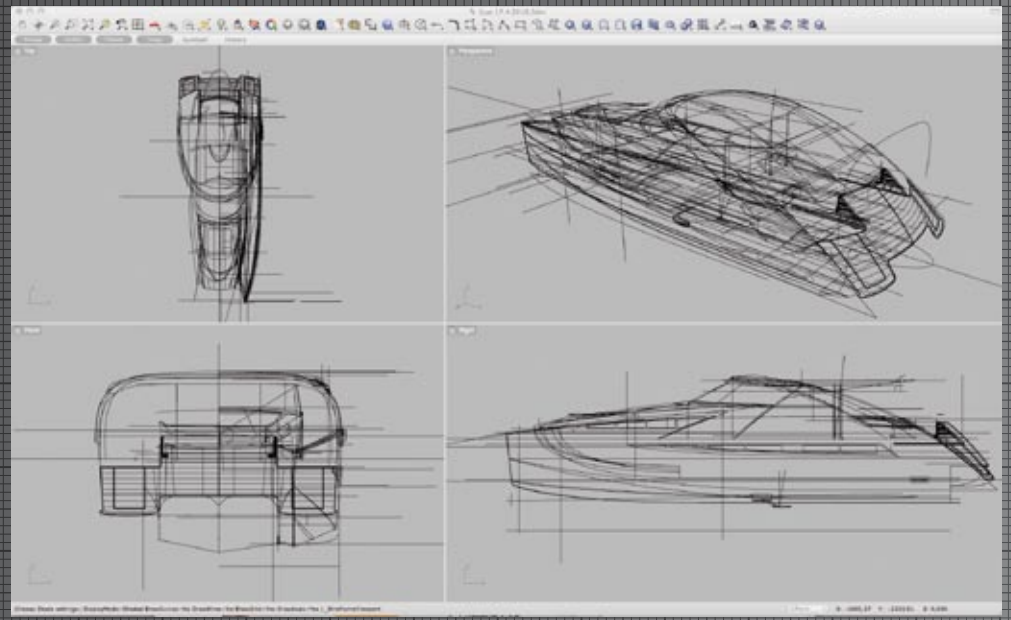
I imply cad modeling at an early stage of the design. Drawing simultaneously with the computer avoids errors in basic dimensions. After fixing the main outlines I still like to draw by hand, creating ideas more freely.

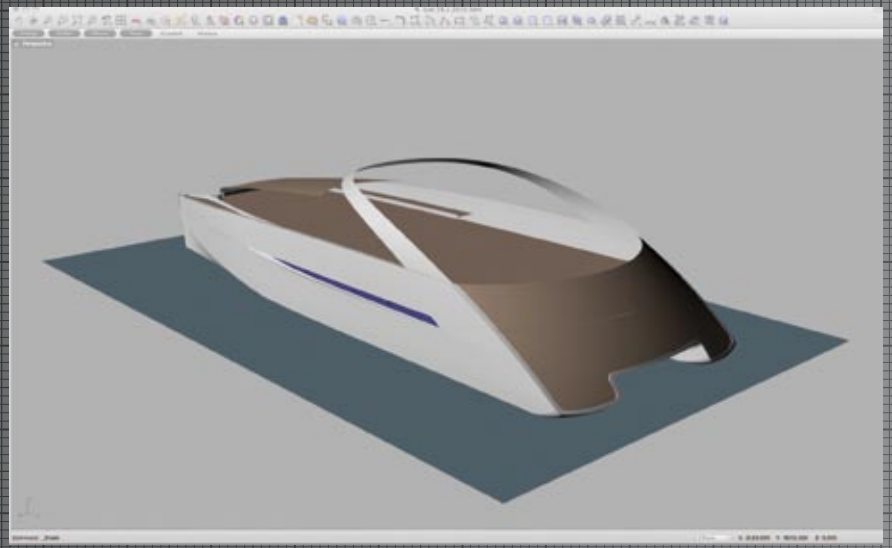


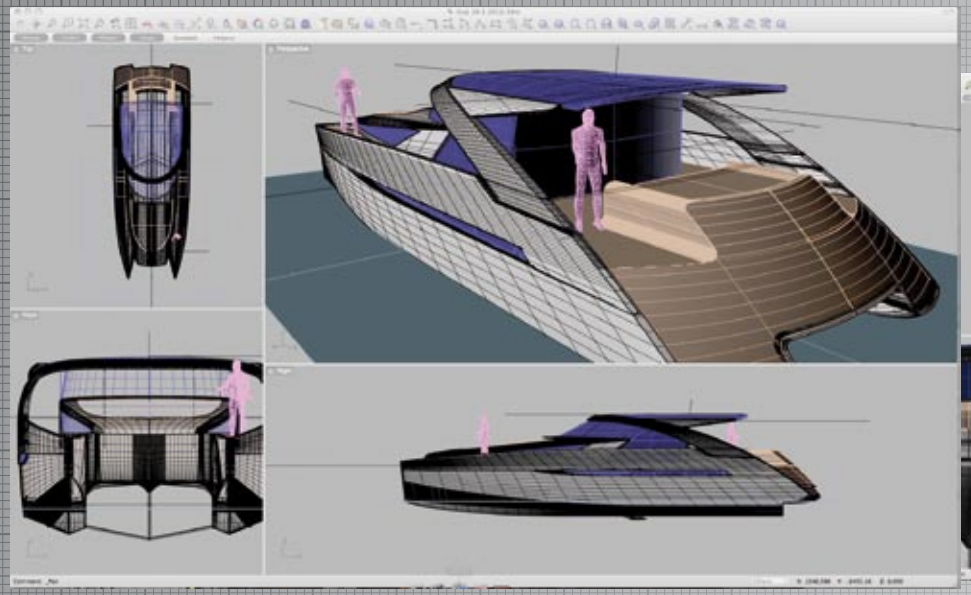
6.3 *CAD modeling*

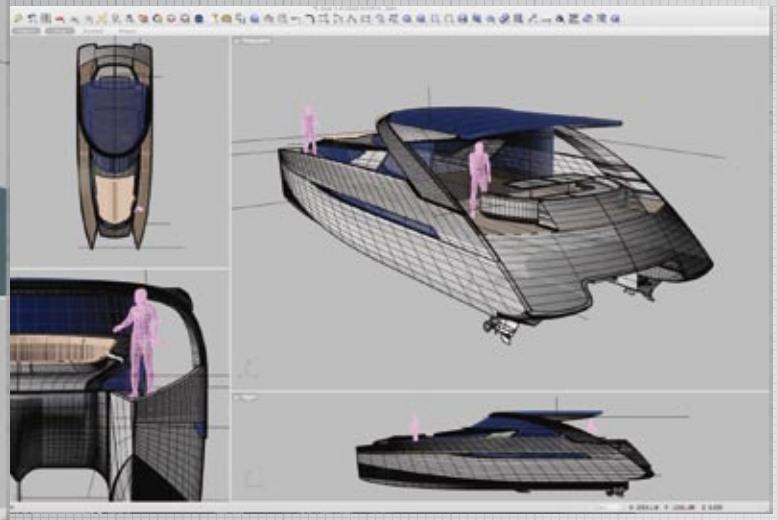
First stages of defining shape and proportion with cad. At this point the hull was accidentally not high enough, offering to low cabin space. The use of human model figures helped to understand scale. On this page the hull windows are still narrow. The missing details of the air-intake openings and position light elements let the design appear naked.

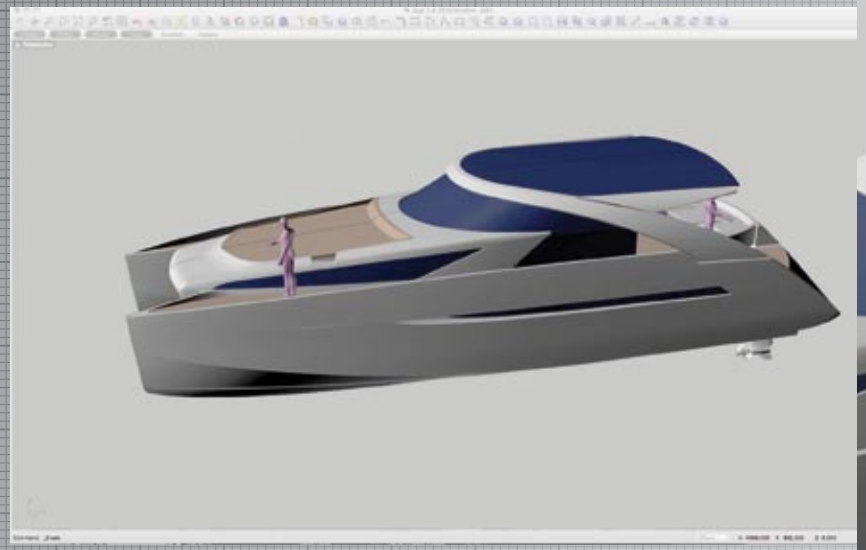
The opposite page shows some improvements. The large curved supporting arch is now interrupted by the position light element and also made to appear stronger by the widening above the windscreen. The front sundeck still resembles an escutcheon and is due to change.

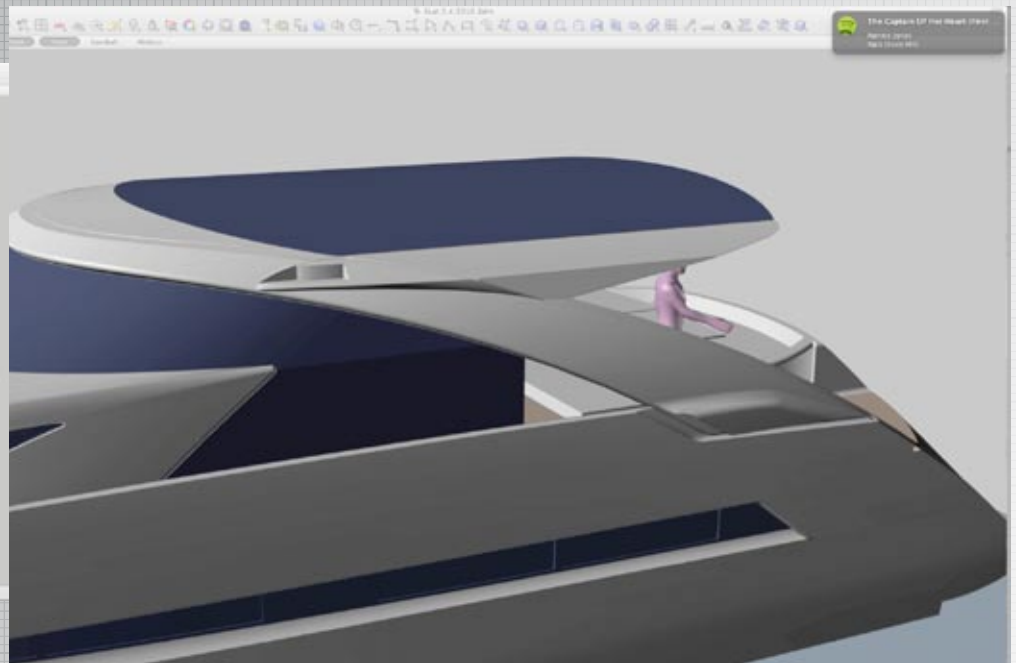












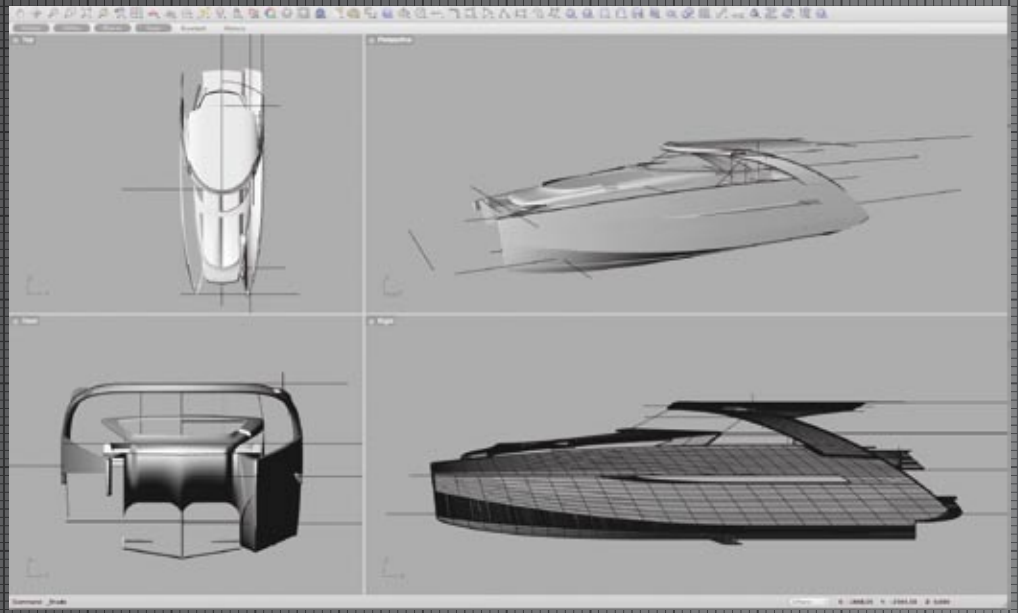
CAD modeling

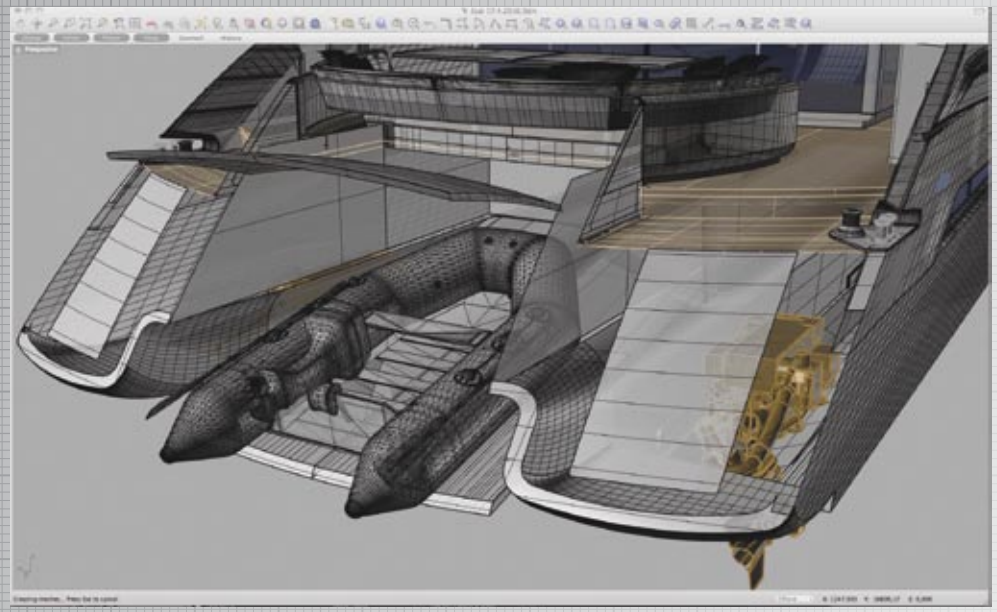
This page shows the redrawn hull with corrected height. The design benefits from the more compact proportions of the higher demi-hulls. Additional technical equipment like radar and satellite antenna domes do not seem to interfere negatively with the design but even add to a believable over all impression.

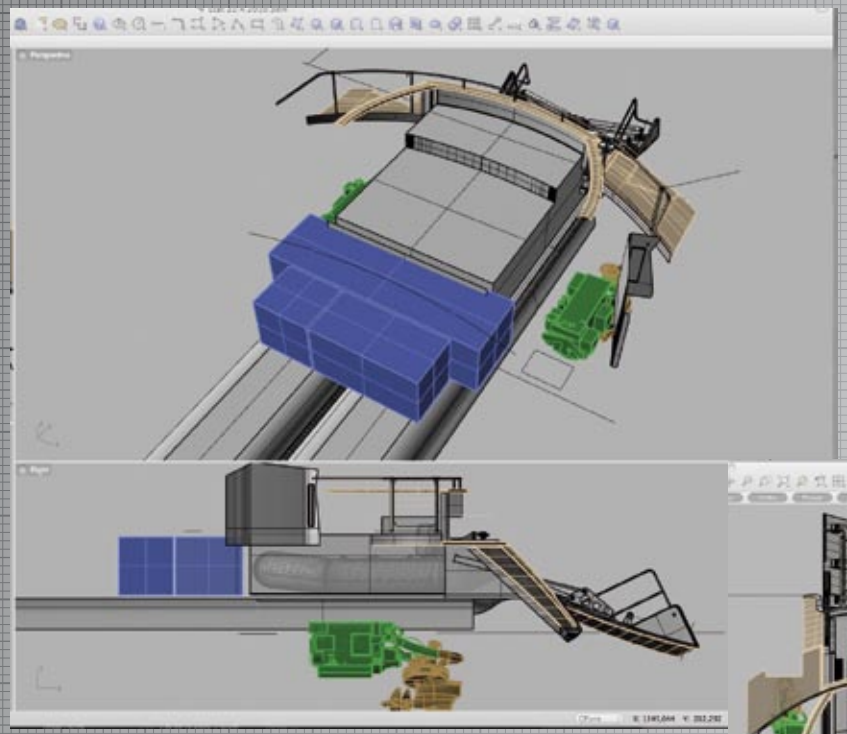
Even though the composition of the deckhouse and roof supporting structure is rather unusual for a small yacht, they hopefully manage to seem familiar and self evident. This idea of "traditional" was a target of the design.

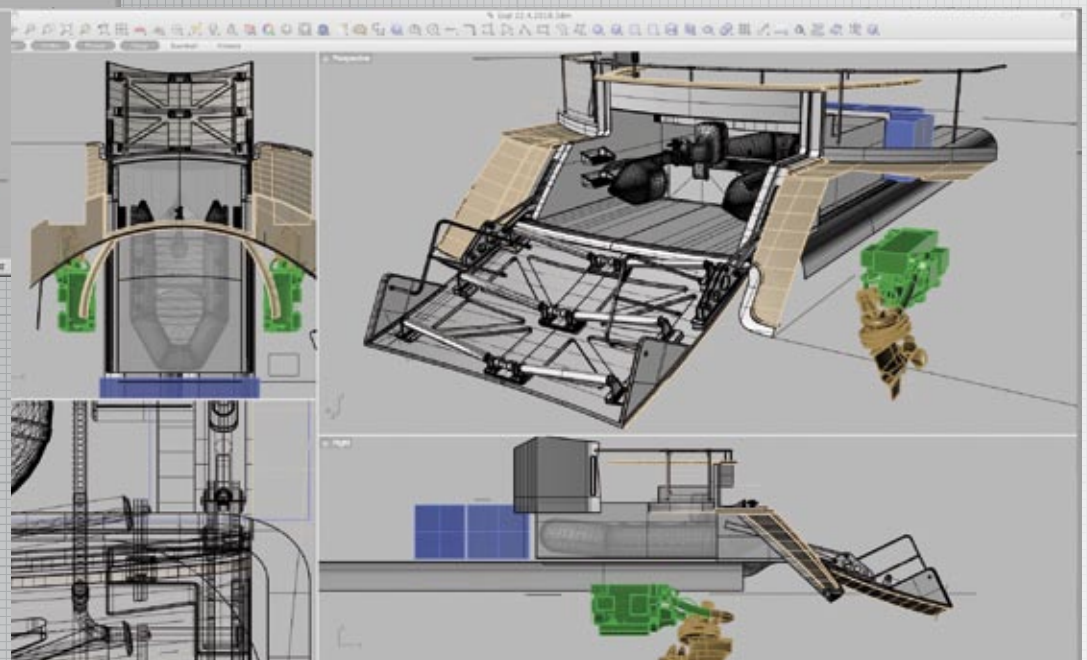
The opposite page illustrates an earlier stage, where there was the idea of a tender garage with a floor that could be lowered into the sea to make for an easy docking. I then dismissed the idea, because it would have meant a bigger, more complicated mechanism and an unusable garage floor for storage. Functionality in bad weather conditions could also be an issue. The final design shown on page 96 is probably still to complicated.

Other technical equipment as engines and tanks were included right from the start to create a realistic layout. The placement of the fuel and water tanks towards the middle should guarantee little shifts of the center of gravity with varying loads.









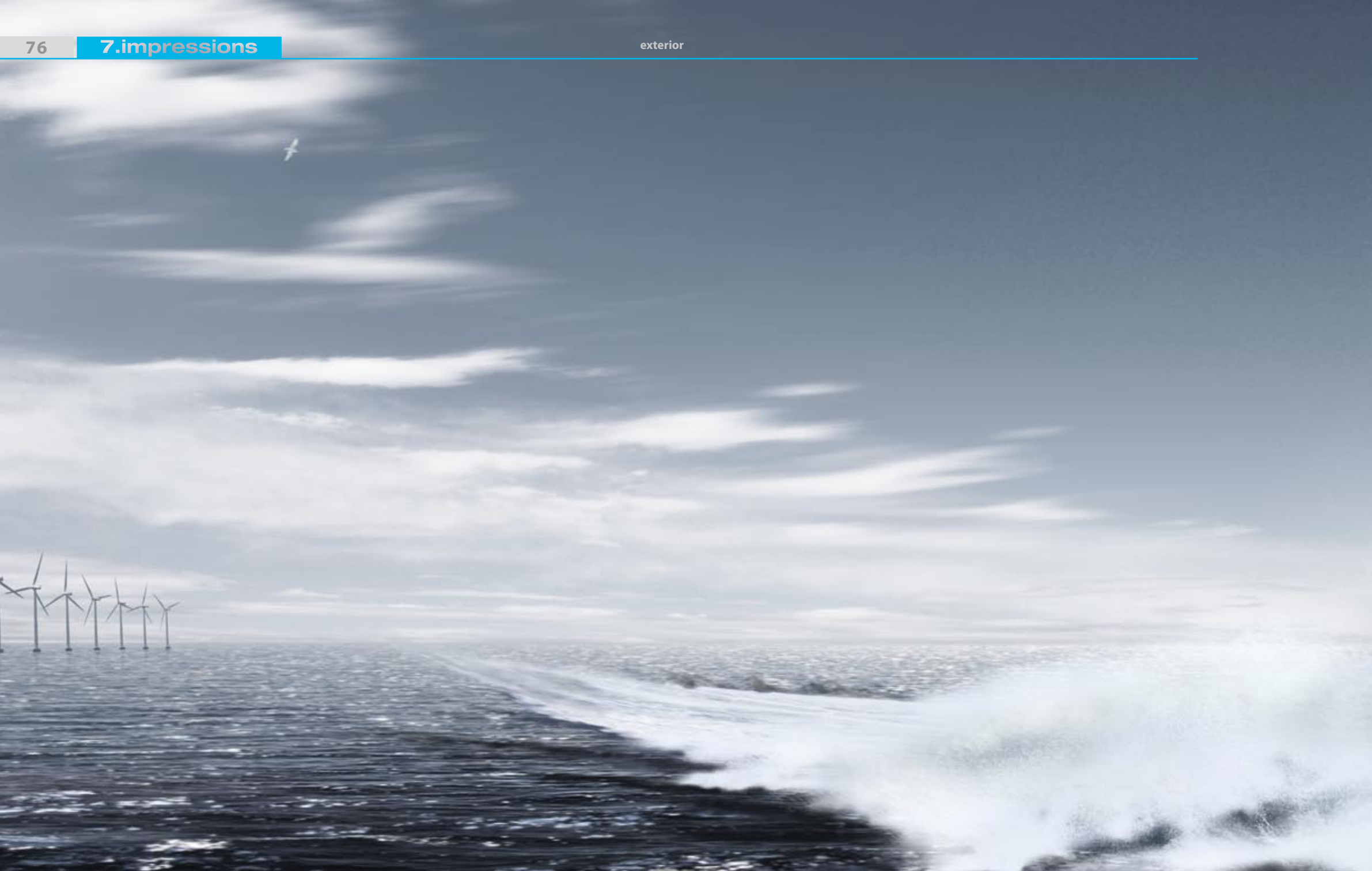
> different stern hatch designs

Including Handrails to the design seemed at first as possibly superfluous and even disturbing the lines of the hull. Never the less I decided to include these additional fittings as they would be necessary or at least improve safety on board considerably. After a week of rail design I hope of having found a solution, which does not interfere with the main lines of the yacht and may even contribute to the stance of the over all impression. The handrails are about 85 cm high, exceptional for a yacht of this size and are definitely enhancing safe moving on deck.

> hand rail design

CAD modeling

Some rough renderings of the interior layout giving a first impression of the living space available under deck. The area is divided in three levels. The use of angled walls could probably increase a feel of space in the otherwise narrow sponsons of the catamaran construction.

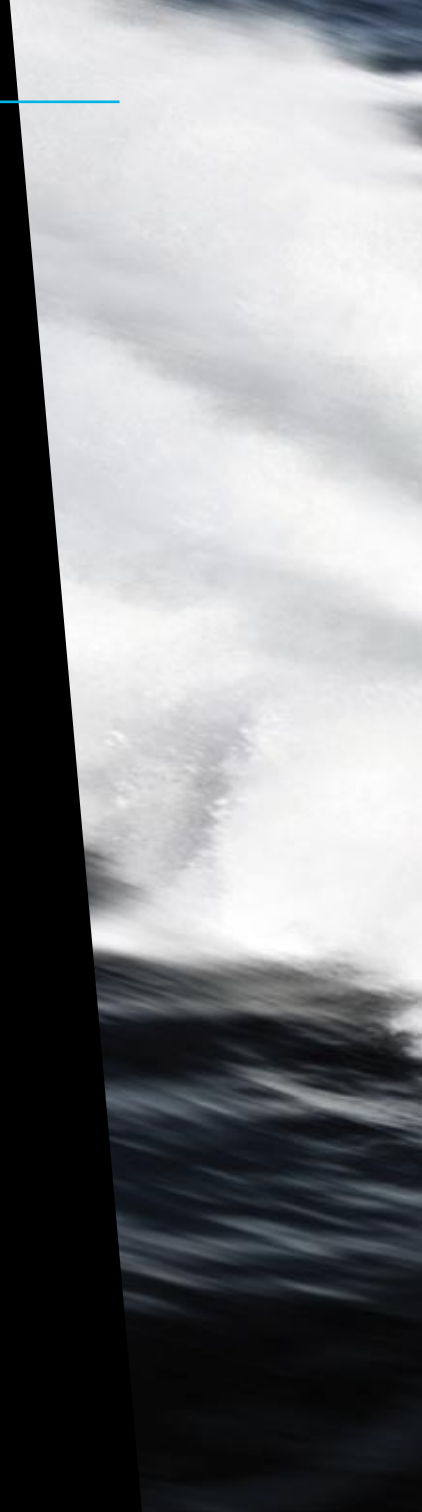



eCat

The following pages show some computer generated images of the design study. The 3D model includes more detailed fittings than for a design concept necessary. This was a very deliberate decisions I made for different reasons. First of all I like traditional fittings which are basically non-designed additional parts, being somehow added "afterwards". They add an honest functional appeal to the general appearance. Those parts include the anchor at the bow, the pollers which are not hidden, handrails and electrical winches as also some compulsory technical equipment on the roof.

Second, those parts have an influence on the design and leaving them away delivers a, deliberately or not, altered image of the concept. And last, time was not money for me, so I had some fun making exact 3D models of fittings.

This picture shows the large round arch continuing the line of the “cut” transom in a large curve including the deckhouse. The intersecting design elements containing the position lights interrupt this large curve, giving it needed posture. This elements also serve as a starting point for the roof supporting structure towards the aft.



> the dna

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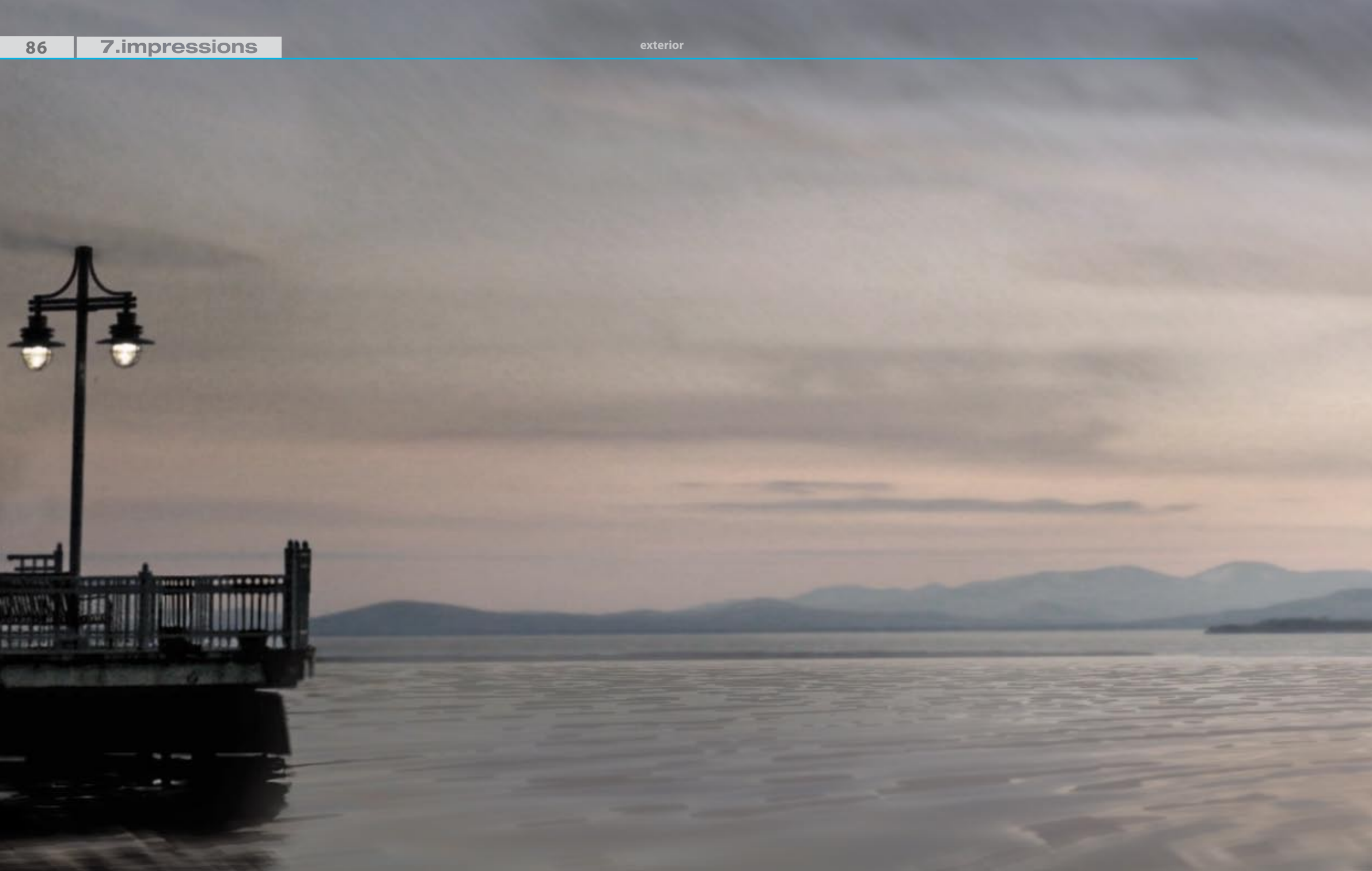
superboat.com/2010/04/20th-annual-miami-super-boat-grand-prix-heats-up-south-florida/

www.sea-tec.it/uk/myda-award/ecat-hybrid.asp

This two pictures at the left show the strong visual effect of shifting perspective. When looked at from the front, the large round curved lines create an illusion of the deckhouse being moved towards the aft, emphasizing the long bow lines. When viewed from the aft, the deckhouse moves to the front, stretching the supporting arch of the deckhouse roof. (both rendering were done with the same lens focal)


eCat



At the start of the project I didn't want to design anything below the waterline as I don't wave the necessary expertise. As it then turned out I couldn't resist the temptation and made a couple of technical suggestions but basically all of them are existing solutions. The hull is an asymmetrical planning catamaran with a typical deep-v planning hull deadrise of 18°. This improves the ride in choppy sea conditions and turning characteristics with inside banking over flat bottomed catamarans which have a tendency to lean outward. The design also employs not fully asymmetrical sponsons but slightly outwards shifted keels for a bow with a light curve inwards. This slightly improves the floor space inside the sponsons which can be lowered compared to a deep-v cross-section in a fully asymmetrical hull design. The idea was also to reduce unwanted steering movement when penetrating crossing waves. Spray rails and chines are used to keep spray down and to provide an increased lift. The tunnel is after the short bow curve completely straight to prevent water disturbance for maximum foil efficiency. Now afterwards I would prefer slightly angled tunnel walls to increase buoyancy in waves and reduce tunnel roof slamming. This would reduce the wide of the tunnel roof and increase interior space. Also the idea of using chines or ventilation steps in the tunnel walls and the roof design, to create ventilation in high seas when the tunnel is fully immersed into waves, seems like an interesting design field. By mixing a maximum of air into the water flow of the tunnel it would create a compressible air-water mixture which could probably reduce or soften tunnel roof slamming. Now the roof is designed in a common manner trying to avoid flat surfaces and maximizing stability.

> details

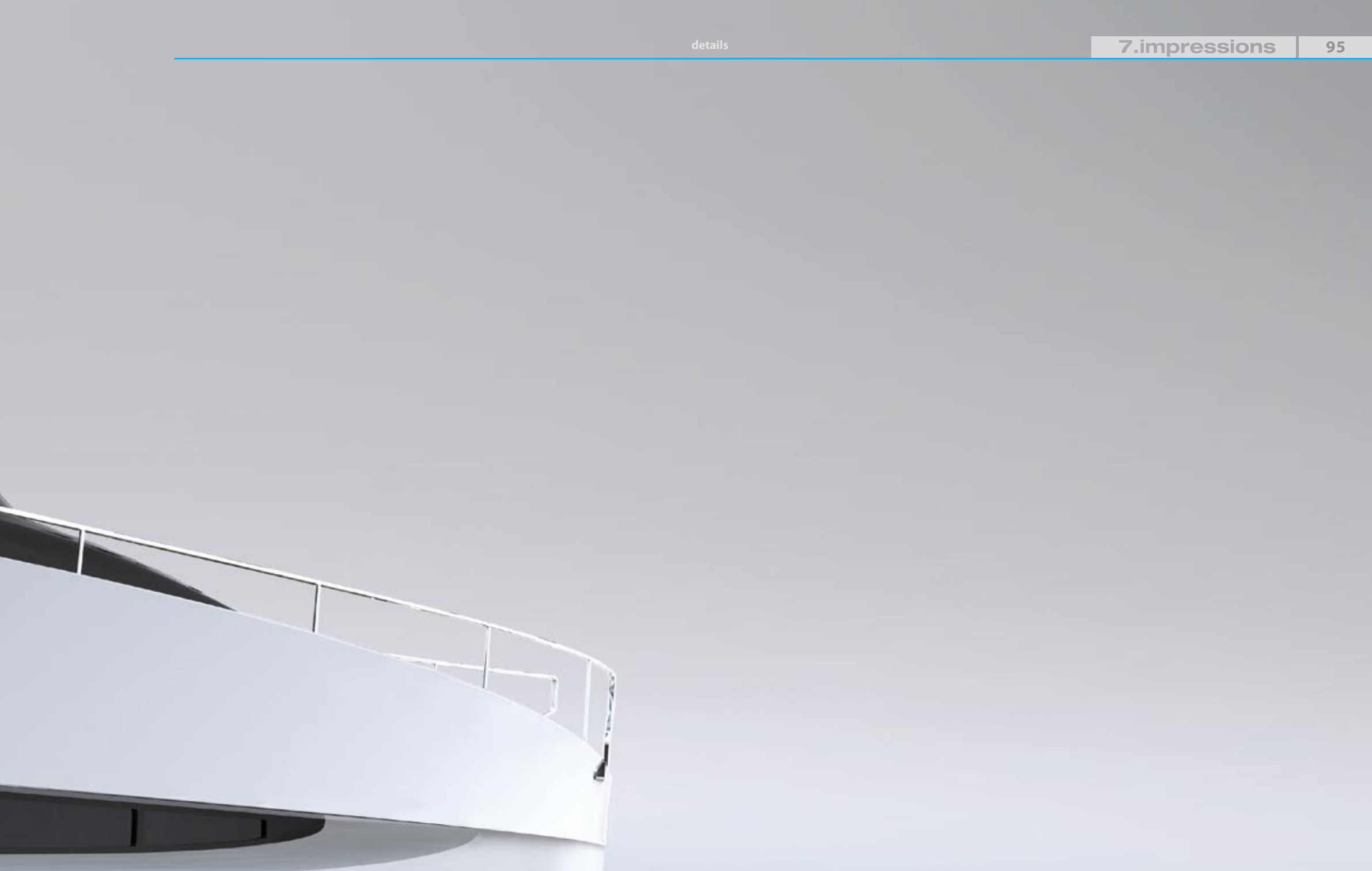

Raymarine
Raymarine
MiO

An early idea was the clean cut and simple stern, resembling the one of a sailing yacht. I had a design in mind, where the shape of the hull was quasi "cut" at the aft and the deck becoming like a core of wood covering the whole even transom. This could suggest the visual effect, that the wood of the deck is not only a slim added cover on a plastic construction but rather a constructional element. The challenge of this design was that it needed to cover some essential functions of the transom with hatches.

This picture shows clearly the super yacht like dimensions of the wide deck. The around 6,45 meter in beam is un-matched in this yacht category and one of the strong arguments in favor of multi-hull designs. To further enhance the appearance of a much bigger yacht there is the style element of the generous glazed and chromium framed sliding doors of the deckhouse. The round sofa which is convertible into a large sun-bathing platform has a luxurious dimension of 4 by 1,8 meters, occupying alone the space of the entire aft deck of an equally long mono-hull motor yacht.

The vertical bow of the sponsons is probably the most questionable point of the hull design. I assume that it could provide a better ride at low speeds bellow the planning threshold. My doubt now is that a long waterline only increases the wetted area in planning mode, increasing drag. And as the catamaran has a twin bow it could be prone to the impact of quartering seas at planning speed, resulting probably in steering movements, as it will tend to pierce waves due to the slender bows which have little buoyancy. This is of course only speculation by me knowing close to nothing about the trade. For this ideas and question I should consult a professional. But I believe it is an interesting field of development where there may be still inventions and optimization for existing concepts to be made. I leave this thoughts now to their own as they do not much affect the actual design concept.


marine
eCat hybrid



The sundeck with the integrated lounge chairs. The chairs pop up and are easily adjustable, as they are supported by gas springs. The front deck view reveals also the exceptional wide and accessible deck space.

The final hatch design aims at functionality. It is submersible into the sea for a safe and easy docking of the tender. The major drawback is that it doesn't really serve as en extension of the living space of the deck. Then there are the small hatches transforming into swimming platforms, which cover the steps in the transom. In the end these platforms, or bridges, are rather narrow being a bit of a safety issue and probably not convenient enough. Now afterwards I'm thinking of a simplified construction with only one big platform covering the whole wide of the transom. This platform would serve as an extension of the deck space and could be used as a safe swimming platform, for releasing the tender and for entering the yacht at the pier. Now are three different hatches not forming a united platform and being only limitedly usable for boarding the yacht, leaving probably still a need for a passerelle, which would be difficult to mount.

The design now makes a clean and clear lined transom which I think is a nice visual element of the yacht. Yet the technical solution does not offer all possible advantages, at the same time being excessively complicated for a yacht of this size. So this is a part I would like to redraw.

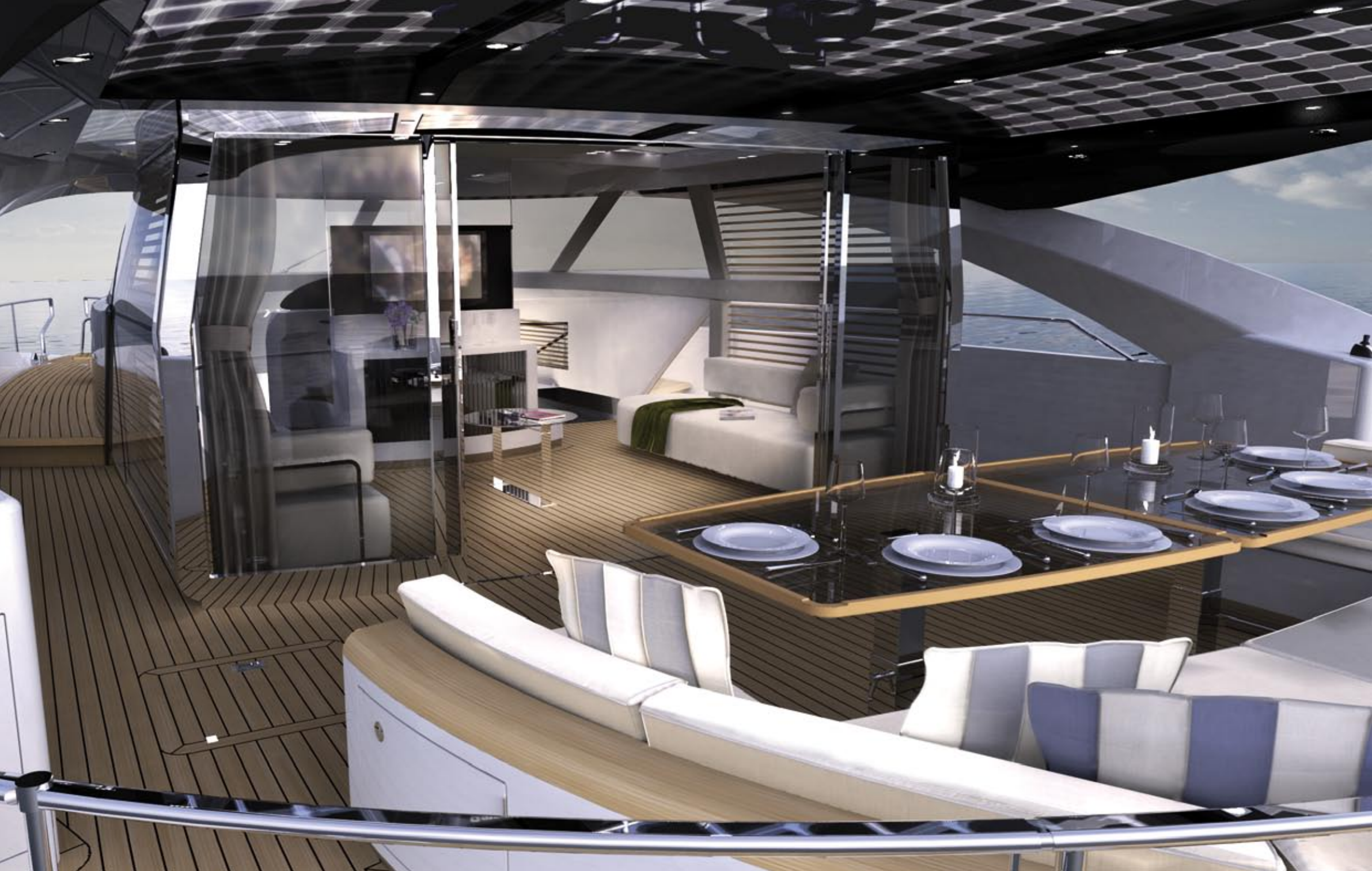

raymarine

The interior layout is kept rather lavish, not making efficient use of all space available. Of course this could be arranged differently. The upper deckhouse is furnished with only two large sofas and a small coffee and game table. The table could be folded and retracted down into the deck, as below is a supporting wall structure. The sofas where thought to be fixed on bearings and could be turned 90° around the y-axle and moved along the z-axle along a rail in the deck, creating a more versatile arrangement for different situations.

The dining area under the deck is kept open. The large windscreen transforms into a skylight, creating a true feeling of space with a height of over 3 meters. The rounded operating console is also a cabinet wall, containing entertainment electronics and storage space. The half round stairs on both sides add to a generously luxurious layout. In the upper deckhouse, frame structures and the control desk are covered dark to prevent glare.

I dropped the gunwale to the bow to meet the deck for an obstacle free view onto the sea from the aft. This could provoke an increased amount of green water on deck, on the other hand the gunwale could never be high enough to prevent waves running over the bow.

The final design language of the style study applies large curved lines. The gentle curvature of an element creates interesting perspectives, making the space and masses look different, depending of the position of the beholder. Shifting perspective creates an illusion of space. The true dimensions become less defined than they would be by rectangular shapes. This let's the outlines of the yacht immerse into the surroundings, creating a spacial feel rather than defining borders.

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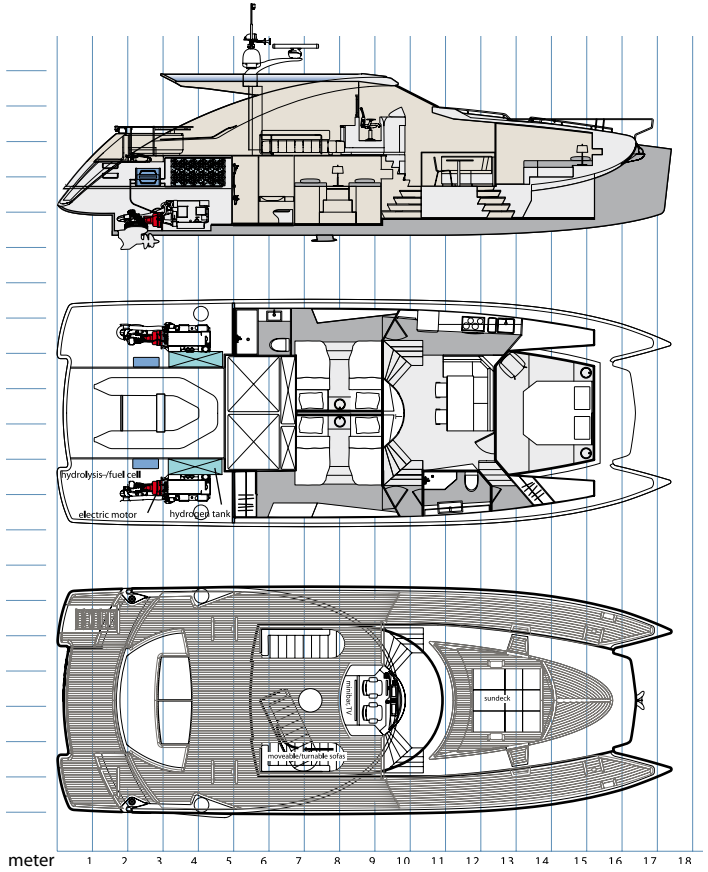
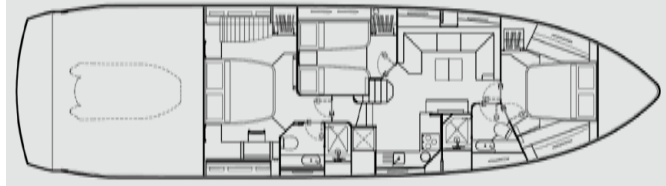
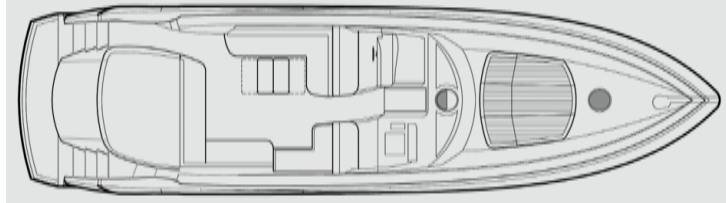
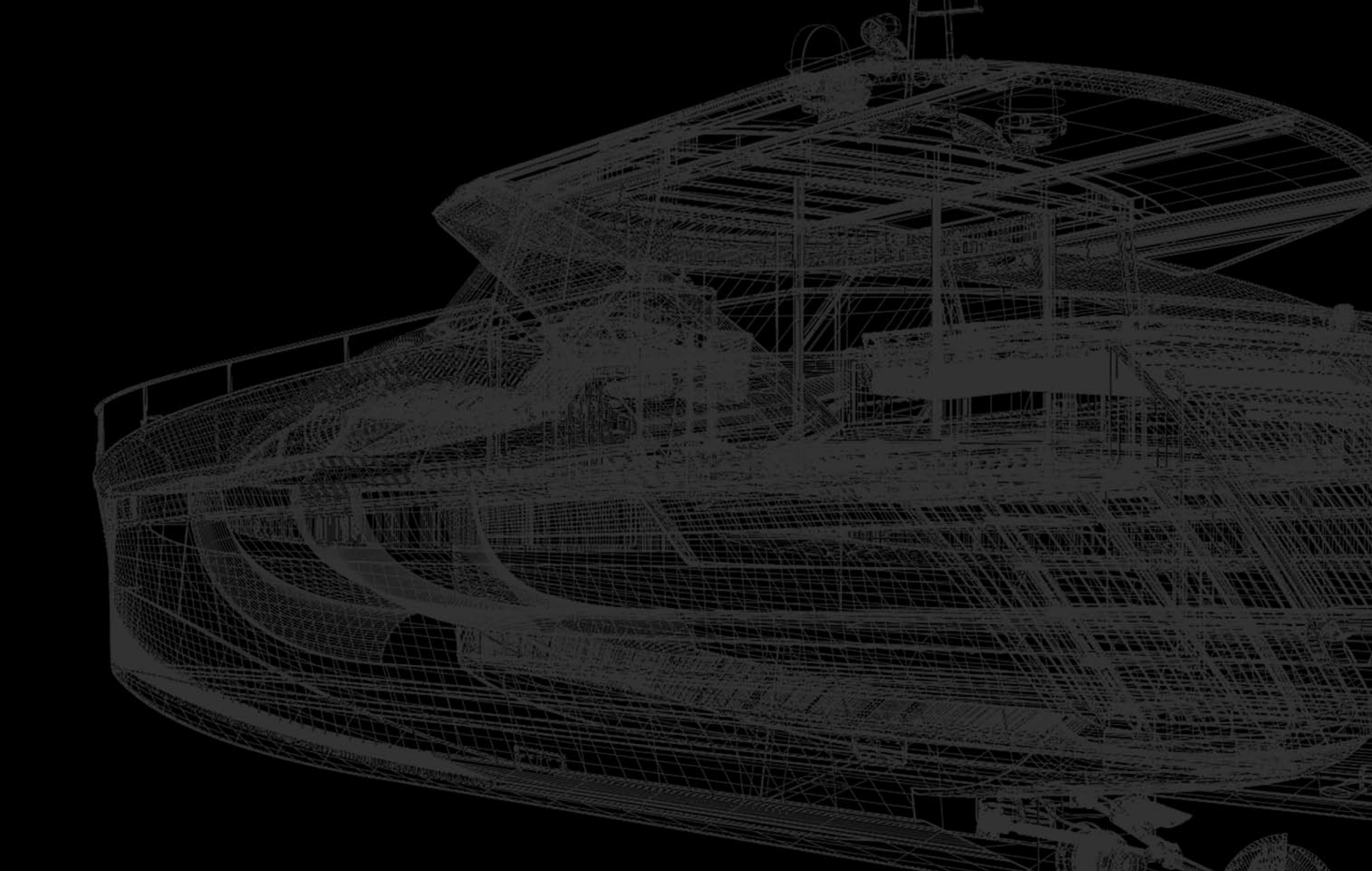
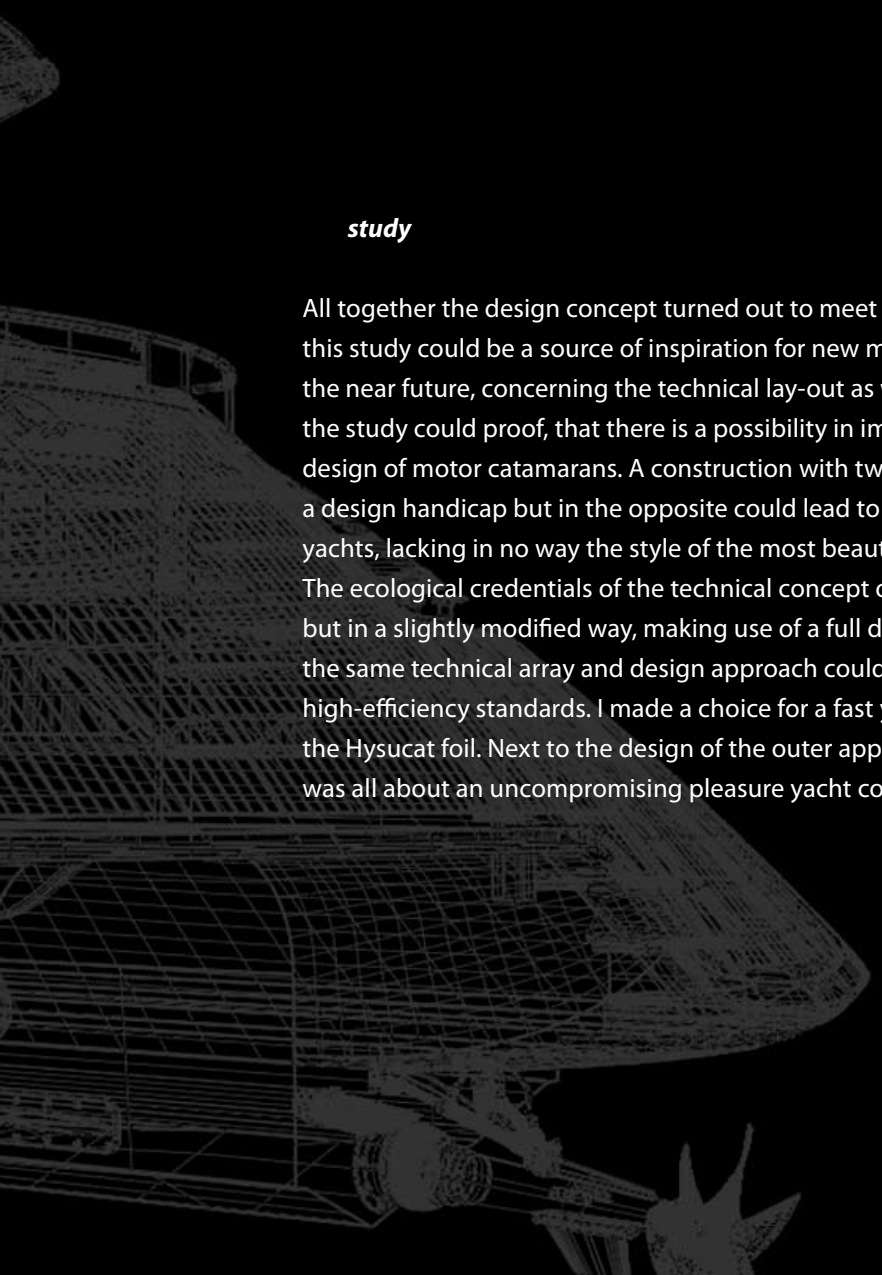
> technical specifications	eCat hybrid	versus	Sunseeker Predator 60
LOA	17,38 m		19,92 m
LWL	15,64 m		14,67 m (@ half load)
Beam (maximum)	6,45 m		4,95 m
Dislacement (@ full load)	(aimed ≈ 25 000 kg)		33 500 kg
Propulsion	Diesel-electric, (twin Volvo Penta IPS 600 /900 + 2x 100 kW electric motor		Twin shaft - fixed pitch propellers
	(Alternative Sport version 2300 bhp, surface drive or water jet)		Twin Arneson - fixed pitch propellers, (up to 2534 bhp)
Fuel capacity	3800 liters		3000 liters
Fresh water	800 liters (+ waste water 400 liters)		700 liters
Performance	hybrid 10-35 knots, Sport version up to 50 knots		up to 40 knots, cruising speed 28 knots
Accomodation	6 berth in 3 cabins		6 berth
Solar power	23 m^2 (on glass roof, see-through)		
Hydrofoil	HYSUCAT		
Energy management	Fully autonomous hydrogen production/storage on-board,		
	(solar panel / unitized regenerative fuel cell)		











study

All together the design concept turned out to meet my expectation. I hope this study could be a source of inspiration for new motor yacht concepts of the near future, concerning the technical lay-out as well as the design. I think the study could proof, that there is a possibility in improving the quality of the design of motor catamarans. A construction with two hulls do not need to be a design handicap but in the opposite could lead to very desirable and elegant yachts, lacking in no way the style of the most beautiful traditional designs. The ecological credentials of the technical concept of the study may be small, but in a slightly modified way, making use of a full displacement hull, basically the same technical array and design approach could create a yacht, setting high-efficiency standards. I made a choice for a fast yacht when I came across the Hysucat foil. Next to the design of the outer appearance, the guide line was all about an uncompromising pleasure yacht concept.

process

This being my very first attempt to draw a yacht I think I can be quiet satisfied with the result. But of course I'm not, as I see all the flaws and details I would do differently or better now. I probably have to start all over again and make a new version. But this is how it is supposed to be, trial and error. The work was the most challenging and instructive single project within my design studies. It thought me good basic CAD modeling and rendering skills, which was a personal target. I stretched the timeline for the project a little too much. I should have developed and finished the work faster, as it becomes easily a problem to keep up the original idea when you do the same project over an extended period of time. You get distracted by new Ideas, start questioning the basic concept of your work and of course you learn along the process, which can make you want to dismiss the starting point and begin all over again. I was lucky to define the frame of my work clearly at an early stage, after having a helpfull conversation with my instructor, naval engineer and industrial designer Jarkko Jämsén from the Aivan! design studio In Helsinki.

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