PHOTO: GIOVANNI ROMERO

Crystal clear

Glass is exerting a huge influence on the future of yacht-building. No other material dominates the exterior look of superyachts as much as it does. Designers and suppliers are steadily pushing back the boundaries of what is feasible.

Text Martin Hager

"Yas": currently the world's ninth largest yacht at 141 metres, she sports an impressive composite superstructure featuring around 700 square metres of US-made glass.

Glass lamination in a vacuum: Sedak makes laminated glass in state-of-the-art autoclaves, which can take panes up to 17 metres long.

Aluminium and loads of glass is what you see when you take an initial glance at what is likely one of the most spectacular yachts of the last few decades. 78-metre "Venus", owned by the late Steve Jobs polarises opinion like no other yacht. Design icon Philippe Starck spent years creating a spectacular and revolutionary exterior design, which has ensured "Venus" a place in superyachting's history books. Huge glass surfaces in the superstructure and in the widebody section dominate her minimalistic look, which as you can see without trying too hard is based on the modern look of most Apple products.

In order to make the extensive – and in fact size-wise to date unique – glass panes a reality on board this aluminium displacement yacht, the "Venus" team secured the expertise of glass designers, Eckersley O'Callaghan, who previously partnered closely with Jobs to action his many Apple flagship stores. The IT visionary recommended a supplier of glass with excellent references to the yacht builder Feadship: Sedak based in the Bavarian town of Gersthofen. Apple has been a client of this medium-sized company, which has supplied the glass stairways and facades for more than 70 Apple stores and for the modern Apple Campus 2, since 2001. Jobs spent a long time searching for a manufacturer that could produce glass panes in the required dimensions. "If it hadn't have been for Sedak, we would not have been able to design our modern headquarters in Cupertino the way we had envisaged", Apple CEO Tim Cook is quoted as saying. The same applies to "Venus" as well.

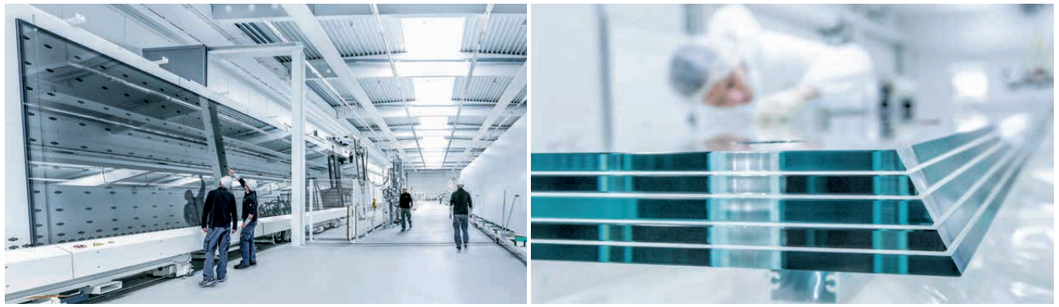
Yachts with glass surfaces of 800 to well over 1500 m² are on the drawing board

"In the case of 'Venus', our first ever yacht, we were contacted very early on in the design process", Ralf Scheurer, who is responsible for international sales at Sedak, explains. "We had to examine how great the structural loads on the extensive glass panes in the superstructure and hull would be and to this end cooperated with our partner, GL Yachtverglasung, in drafting the feasibility study." GL Yachtverglasung (GLY), which specializes in planning and installing yacht windows/glazing, was tasked with making the windows on this impressive project a reality.

Depending on requirements, this firm based in the Hamburg metropolitan area, partners with a pool of glass suppliers like Sedak and other well-known manufacturers. Yacht projects are now so complex, according to GLY, that the glass has to be supplied by various companies. Very curved panes come from one supplier, large, straight panes are supplied by another, while bullet-proof panes are made by yet another provider. GLY also outsources the production of glass mounts and frames to subcontractors. "We know what production capabilities the various manufacturers have and can compile glass portfolios for the builders

PHOTO: G. ROMERO/THEYACHTPHOTO.COM

"Venus": Apple's founder, Steve Jobs, ordered this Starck design from Feadship. Nearly 400 square metres of glass adorn the 78-metre yacht's modern exterior.



Sedak plant: at Gersthofen in Bavaria the glass experts also manufacture Lloyd's Register-certified GLY MarineCobond laminated glass, especially developed for marine applications. The multi-layer panes are very rigid and therefore suitable for heavy-duty applications.

to match their projects", Andreas Schipper, who heads up the yacht business unit, explains. GLY now has its own product line – GLY MarineCobond, a Lloyd's Register-certified laminated glass that is produced by Sedak and that was developed for the yacht market in particular. "Our MarineCobond lamination foil transforms the bonded glass panes into a shear-resistant laminate, which is considerably thinner than conventional glass design computation fundamentals would otherwise specify", Andreas Schipper continues.

The 78-metre "Venus", which features nearly 400 square metres of glass in her hull and superstructure, was a complex, high-profile glass project actioned by GLY in close cooperation with Sedak. At the time of her launch the dimensions of the glass panes that she featured had never previously been actioned on a yacht. The bridge windshield was delivered in one piece and measures 6.50 by 1.80 metres. The even larger, bent-laminate side panes on the pavilion deck each weigh just 2.8 tonnes and measure 10 by 2.45 metres. "There were plenty of sceptics around when 'Venus' was launched", the glass expert recalls.

"However they have now fallen silent. This yacht has already crossed the Atlantic under her own power for the sixth time, has weathered several storms, and the owners, as we hear, continue to be immensely keen on her and use the yacht a great deal."

Four-tonne pool pane

Spectacular orders like "Palladium", "Graceful" and several Lürssen superyachts then followed. The GLY development team, which is made up of structural engineers and naval architects, can sometimes spend up to one year working on some special-purpose glass panes. For example, the yacht glass experts delivered the heaviest window ever installed on a yacht for the 147-metre Lürssen, "Topaz". This pane of glass measures 5.30 by 2.80 metres and serves as the rear wall of a pool in the yacht's stern, which holds 170 tonnes of water. Given the anticipated high water pressure, this multi-layer laminated glass pane is more than 100 millimetres thick and weighs four tonnes. "Given a lack of experience in handling this complex issue, the classification organisations continue to confront us glass suppliers with exorbitantly stringent demands", Andreas Schipper relates. The GLY team has also put in an enormous amount of development work into the entire exterior glazing on board the 142-metre sailing yacht, "A", which is currently in the process of completion at Nobiskrug in Kiel and is scheduled to be delivered to her owner at the end of this year. This includes the world's longest curved glass pane (weighing 1.8

PHOTO: MARK O. CONNELL/THEYACHTPHOTO.COM

"Enigma": this Martin Francis design, delivered in 1991 named "Eco", features a spectacular superstructure with spherically curved glass panes made by Flachglas.

"Como": this 46-metre Dubois design features XXL-format windows. The builder, Feadship, even incorporated large panes of glass in the bulwark, which guarantee experienced owner Neville Crichton superb views from his master suite.

Concept: the Dutch firm Azure Yacht Design is also championing the use of glass in hulls and superstructures.

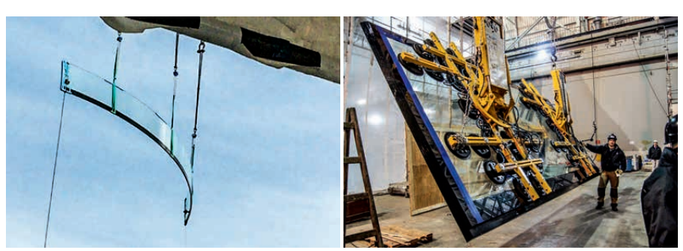
tonnes) at 15 metres, which will be used as a bulwark forward of the bridge.

"Philippe Starck wanted as clean a look as possible and preferably no ship's rail", Schipper relates. An almost invisible bulwark was therefore only feasible if glass was used. Two more 11-metre glass panes are used as bulwarks on Deck No. 7, as is a 14-metre glass wall on the owner's deck. GLY was also commissioned to provide three 4-metre-long and 1.80-metre-high elliptically curved glass panes for an underwater lounge, which is located in the keel and provides guests with an unimpeded view of the depths below, given the appropriate underwater lighting. "The panes consist of several layers of GLY MarineCobond glass", Andreas Schipper explains. The twelve-centimetre-thick laminated glass is designed to cope with a water depth of 90 metres, which it has to withstand without breaking. In this case 90 tonnes of pressure are acting on one square metre of glass pane. If you picture this for a moment – the pane measures nearly 8 square metres, each square metre is subjected to a load equivalent to that of 2 40-tonne trucks; i.e. 16 fully loaded articulated trucks could stand on that pane of glass without it breaking. "The underwater lounge would not have been feasible using conventional glass", the glass expert adds proudly.

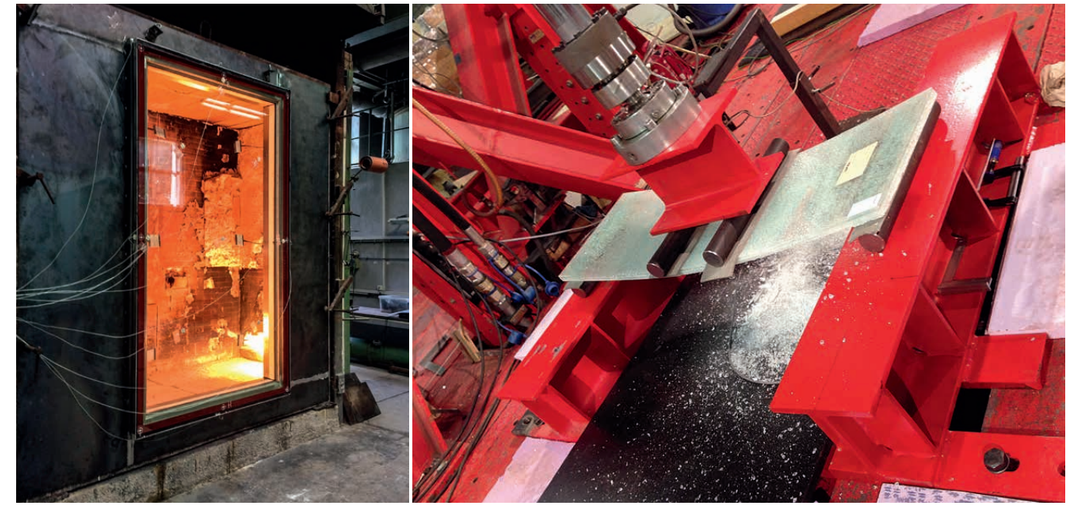
In order to satisfy the classification organisations, a large number of tests and worst-case simulations were required to gain a permit. Added to that was the fact that this spectacular underwater space plays no role at all in "A's" buoyancy. Given watertight bulkheads and an extra safety lock, any unexpected flooding of this section of the yacht would at most have an adverse effect on the health of the lounge guests but not on the buoyancy of the yacht.

Lots of glass for more comfort

For years Feadship has also concentrated on incorporating large glass panes into hulls and superstructures. Back in 2006 the Dutch builder unveiled its forward-looking "X-Stream" concept, where the superstructure consisted almost entirely of glass and the bow featured a windowed observation lounge – very similar to the lounge that was installed on board "Venus". Back then the feedback about this concept was so positive that Feadship decided to launch an intensive programme of research. As part of this programme the Feadship engineers focused on the integration of very large panes of glass into hull and superstructure architectures and they also examined how great the influence of glass on the level of comfort perceived in the interior was.



Tricky handling: GL Yachtverglasung delivered the world's longest curved pane of glass (15 metres) for the yacht, "A" (l.). Four-tonne glass panes (r.) are routinely moved around.



Material testing: glass suppliers have to prove how strong, dense or fireproof their panes are. The flexural strength test (r.) provides information about bend strength, while fire-retardant glass (l.) has to withstand temperatures of up to 1000 degrees Celsius.

Superyacht designer Espen Øino – who learnt a lot as project manager for "Eco" when he worked for 'the glass man' Martin Francis – also deals with the issue of bright, daylight-fed interiors. "It's not a matter of what the yacht looks like from the outside; what's more important is how well you can look outwards from the interior. We as designers are creating a new living space for owners. For this reason I usually kick off the design process by including the layout and the interior concept. Exterior design only comes right at the end. Nowadays glass is one of the most important materials used to build a yacht." In the opinion of this well-known naval architect, the quality of life on board a yacht is directly related to the amount of daylight that brightens up the interior. "Personally I love incorporating windows, which allow you to sit in... comfort on the sofa and look out onto the ocean without window frames getting in the way and impeding your field of vision, into my blueprints", says Espen Øino. He frequently receives enquiries about minimum-height bulwarks or bulwarks made of glass, in line with this concept.

"These days owners want plenty of glass on board their yachts, they want to be able to look at magnificent landscapes (and seascapes) when they are cruising, they want to feel the sun on their skin and yet feel protected against the elements when push comes to shove", says yacht designer Philippe Briand, whose impressive reference list includes yachts like the 67-metre ketch, "Vertigo" or the 73-metre explorer yacht, "Grace E". These days yachts no longer just commute between the Mediterranean and the Caribbean, they also explore latitudes in the far north and south that are characterised by extreme weather conditions and temperatures.

"As a designer I have the tough job of having to think in terms of innovation and find the best and safest solutions

Intensive development work: glass suppliers like GL Yachtverglasung or Tilse typically spend up to a year working on custom-made products for superyachts.

Quality control at Tilse: a glass specialist examines each individual pane for items trapped, scratches and flaws in the glass prior to delivery to the builder.

for such destinations", says Briand. "I want to introduce greater transparency on board yachts. And yet a yacht is not a loft. A yacht is always a ship and therefore safety is the priority."

Cast resin as an interlayer material

If we are talking yacht glass safety and security, nobody knows more about this subject than Hans-Joachim Tilse and Henning von der Thüsen, who are joint managing directors of Tilse Industrie und Schiffstechnik GmbH, and have successfully supplied their "Formglas Spezial" product to a large number of builders for many years. The firm, which is based in Hamburg and manufactures in Brandenburg, prefers to use cast resins to produce complex laminated glass, in contrast to its competitors. During the production process this fluid resin is poured between the layers of glass and cured using UV light. "Our cast resin forms a physical bond with the glass, which gives our laminated glass panes considerably greater strength than we could achieve if we used adhesive films", Henning von der Thüsen explains.

"We are currently helping to draft a new ISO standard for laminated glass, which factors in the physical properties of the interlayer material into pane strength calculations." This means that in future panes of Tilse glass will be much thinner, which of course will have an impact on the weight of the glass panes and on a yacht's overall displacement and stability, much to the delight of the naval architects. "Formglas Spezial" is a laminated safety glass consisting of two or more chemically tempered panes, which can be delivered in plane, bent or spherically curved format. "In addition to its high strength, the resin we use is also non-ageing, resistant to yellowing, UV-absorbent, 100% moisture-resistant and can withstand temperatures ranging from minus 40 to plus 120 degrees Celsius – in other words it is perfect for the sometimes extreme conditions encountered at sea", says von der Thüsen in conclusion.

However the structural stress issues, which the glass suppliers have to address, do not interest owners. They are much more concerned about their own security and that's why demand for bullet-proof glass is increasing steadily.

"Some owners have a really major need for security and want bullet-proof glass on every deck. However that is not feasible, given the significantly greater weight of these security panes", Hans-Joachim Tilse relates. What matters most with bullet-proof glass is absorbing the energy of the bullet. Tilse's "Formglas Spezial BB" bullet-proof product, which consists of a varying number of glass layers bonded with variable-strength cast resin, depending on the protection class required, can absorb this energy. "We collaborate with a number of different official firearms test centres, where we fire at glass panes in accordance with different standards and using different weapons", says Tilse.

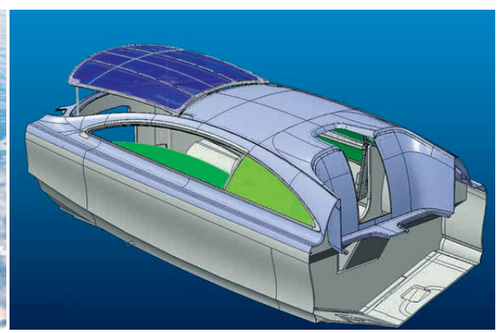
The quantity of glass on board yachts is increasing from year to year. GLY is currently project-managing several yachts featuring glass surfaces ranging from 800 to well over 1500 square metres. Tilse also confirms the existence of this trend. One of its most recent projects is the 101-metre Feadship/Van Lent flagship, "Symphony", for which a total of 376 exterior glass panes covering a total area of 618 square metres were supplied. Weight: 30 tonnes. Added to that was an order for 70 interior panes weighing nearly 1.5 tonnes and covering an area of 61 square metres.

Such large window frontages confront yacht designers and builders with major challenges. "Owners and their guests attach maximum importance to their privacy, which we have to safeguard come what may and usually using all available means", Espen Øino explains. "Given the ever increasing size of continuous window frontages, it's getting more and more difficult to guarantee privacy. Up to a certain size of window, blinds can be relied on to block out any unwanted gazes, beyond that only electric switch-operated glass panes are effective." So the Monaco-based designer is currently collaborating closely with Lyon-based French company, Vision Systems, which provides an electrically dimmable solution, its "Nuance" product, which is already used on board Boeing's state-of-the-art Dreamliner aircraft. This is a laminated glass to which a liquid crystal film is added and which changes progressively from a translucent to an opaque state and back again by applying an electric voltage. There is a choice of various films with different maximum "Nuance" degrees of translucency (light, dark and extra dark). How the film called "XLite" works is simple to explain: if the dimmable pane is powered up, the liquid crystals in the film are aligned in parallel and the pane becomes translucent. If the power is switched off via the on-board management system or via an app on a tablet computer, the molecules revert to their omnidirectional state and the pane turns opaque. Differing amounts of light penetrate the laminated glass, depending on the degree of translucency selected. For many years Tilse has also provided its own solution – "Solardim" is a glass with a dimmer switch function, which is available in either plane or bent format and enables the user to safeguard their privacy at the touch of a button. "This infinite transparency control function means curtains or blinds are not needed, and in opaque mode the windows can also be used as hi-res display screens", says von der Thüsen.

This year Vision Systems is venturing into the yacht industry for the first time, partnering with Silver Arrows Marine. The French company, renowned in the global aeronautical and automobile

Owners want security – demand for bullet-proof glass is increasing steadily

"Nuance": Vision Systems developed an electrically dimmable solution, which is already used on aircraft and which is now set to conquer the yacht market.



"Arrow 460 Granturismo": Vision Systems of France supplies side windows for this 14-metre Silver Arrows Marine day cruiser, which can be lowered using an electric switch. The large roof window sports an electric dimmer function and can also be raised.

PHOTOS: SCOTT PEARSON

Arcadia 85: an angular glass superstructure gives the yacht models made by the Italian builder Arcadia Yachts a distinctive look. The striking, greenhouse-look superstructure lets in plenty of daylight and provides spectacular views from the comfort of the sofa.

industries, is providing an innovative product package for the 14-metre "Arrow 460 Granturismo" day cruiser, which you would be more likely to find on a hot-blooded sportscar on land than on an athletic planer. The side windows on this maritime Silver Arrow can be lowered using an electric switch, while the extensive roof window can be electrically dimmed and raised if required, meaning it functions as a bimini. "This combination of glass and window innovation is enabling Silver Arrows Marine to revolutionise the yacht industry and gives yacht owners a totally new world of experience", says Vision Systems CEO, Carl Putman, enthusiastically.

The Italian builder Arcadia Yachts has for years been doing its own equally innovative thing. The company, which is based in Torre Annunziata near Naples, has a portfolio consisting currently of four models (Arcadia Sherpa, 85, 100, 115) that feature unusually angular and strikingly styled glass superstructures designed by its in-house naval architect, Francesco Guida. These superstructures, which are reminiscent of greenhouses, have an obvious advantage – the main and upper decks are flooded with daylight, the views from the sofascape are unrivalled, not just on this size of yacht. The superstructure consists to a large extent of multi-layered laminated glass and Arcadia's engineers have incorporated Schüco photovoltaic systems in the roof. "The latest generation of solar panels that we have incorporated into the roofs of our yachts deliver 6 kWh of output, which is already 25 percent more than the panels that were available on the market a few years ago", Francesco Guida explains.

Windows morph in to TV screens

"Photovoltaic systems are set to evolve a great deal in the next few years. We currently supply smaller items of equipment, like TVs, refrigerators and ventilators with electricity from the roof." The windows in the superstructure also offer further technology potential. "Windows will soon morph into TV screens", says designer Espen Øino. What sounds like an invention from the science-fiction blockbuster "Minority Report" is in fact set to become reality in the very near future. The Korean technology giant, Samsung, recently unveiled its "Smart Window" system – a transparent LCD screen sized 46 inches, which is set to go into serial production soon. Each owner must decide for themselves to what extent it makes sense for them to block off the magnificent views of the ocean and the landscape.

Builders, designers and suppliers all have a unanimous opinion on the subject of glass: glass is the material of the future and it will play an increasingly important role in the interior and exterior design of yachts, as it does now in shore-based architectural projects. This fascinating construction material, which separates and links spaces in equal measure, provides almost infinite design flexibility and gives owners the visual freedom that they desire. That is with or without an integrated LCD screen.

Glass as a material now offers designers almost infinite design flexibility