



»»»» INSIDE THE YARDS

FEEDING

Bavaria Yachts isn't the world's biggest boatbuilder, but it's arguably the most efficient

BY BILL SPRINGER
PHOTOS BY MALCOLM WHITE

BOATS AND WATER ARE SO CONNECTED THAT IT SEEMS odd to look for one of the world's biggest boatbuilders deep in the middle of farming country, hundreds of miles from the nearest ocean. But there's a good reason why Bavaria Yachtbau is content to be landlocked in rural Gieselstadt, close to the center of Germany where it is almost equidistant from its major markets in the Mediterranean, Baltic, English Channel, and North Sea. With 15 boat-laden trucks lumbering out of the gates each work day, that counts for something, and it is only one example of Bavaria's efficiency. The numbers tell the story: In what is effectively a single 600,000-square-foot building, well over 2,000 boats are built each year.

Bavaria can do this because it builds more boats with fewer people. It has spent millions automating the production line; machines do most of the dirty work. Most companies have a CNC machine

to cut components. Bavaria has 12 of them, including machines that cut every port and through-hull in a fraction of the time humans can do it. The factory has an automated gelcoating booth where a robot arm evenly sprays the exact amount of gelcoat on every mold. Once the hulls and decks have been laid up by hand, they get baked in an 120°F oven to speed the curing process.

Price efficiencies are enhanced by the company's enormous buying power. Bavaria buys engines, winches, masts, and other parts by the thousands allowing it to keep material costs and retail prices down. Bavaria works with J&J Designs to produce fast, fun-to-sail boats ranging from 30 to 50 feet, as well as a powerboat line, and 85 percent of the company's total production is built for export.

Not bad for a company that was born from a window factory. Winfred Herman stopped building windows and started building boats in 1978, and his company has been at the forefront of high-volume boatbuilding ever since. Bavaria is now the second-largest sailboat builder in the world; only Groupe Bénéteau builds more.

Bavaria's high-volume production line has a voracious appetite. Each team of workers is essentially feeding the machine. General manager Rudolph Mueller summed it up best when we arrived at the end of the production line: "Ten days ago this boat was in the resin silo." Here's how they do it. 🐼

Bavaria's assembly line holds over 50 boats at a time



THE MACHINE

1 To save time, on the production line the first step is to paint the covestripe and boottop with ISO/NPG gelcoat (this can be any color as long as it's blue or white). The mold is taped off, and experienced painters apply the gelcoat stripes by hand, remove the tape, and prepare the mold so it's ready for the first coat of hull gelcoat.

2 Bavaria has spent millions to automate production and contain labor costs. The gelcoat for each hull is applied to exact tolerances by a computer-controlled robot in the gelcoat booth. This also eliminates toxic fumes resulting from spraying gelcoat out in the open.

3 Each mold rotates and is mounted on wheels that run along tracks on the floor. The hull takes shape as each of eight layers of precut fiberglass is applied. Overlapping layers of fiberglass cloth on the centerline increase strength and stiffness. Bavaria is always looking to improve productivity, and the time it takes workers to complete each layer is closely watched. Lamination takes place in eight stages. Hulls in varying stages of layup move along the line at regular intervals.

4 To guard against styrene fumes, workers wear sophisticated respirators, masks, and gloves; they use rollers that pump the proper amount of resin directly onto the hull. The factory uses 35 tons of vinyl ester resin per week. Special resin-storage silos are filled twice a week from tractor-trailer trucks. Each roller is fed directly from the silos.



1



2



3



4

»»»» INSIDE THE YARDS

5 All of Bavaria's hulls are solid fiberglass below the waterline, from the bow to the engine mounts, and are cored with Airex foam above the waterline and in the stern. The core reduces weight and adds stiffness. The foam is precut to reduce waste; it is glued to the hull and then glassed in. Once a hull has been completely laid up, it moves into a large oven at the end of the line that bakes it in the mold at 120°F. This practice reportedly reduces curing time from 8 to 10 days at room temperature to 2 to 3 hours in the oven.

6 Once the hull has been laid up and baked, it immediately enters the assembly line. The first step is to install the grid. The hull is rolled next to the grid stockpile, where the proper grid is lifted with a roof-mounted crane and dropped in. Then it is glassed into place.

7 Once the grid has set, fuel and water tanks are installed. They are tabbed into place.

8 The deck is built the same way the hulls are. The deck mold is laid up with multiple layers of fiberglass and is cored with Airex foam throughout. Mounting points for the deck hardware are reinforced with aluminum blocks. Decks are also baked in the oven to save time.

9 Over 10 years ago Bavaria invested in two enormous CNC machines. These machines have robot arms with a multitude of cutting heads that make it possible for one machine operator to cut every through-hull and port on both a hull and a deck. The deck machine cuts ports, trims the companionway, and even drills the holes for mounting deck hardware. The machines cost millions, but jobs that used to take a four-man team four hours to complete now take less than 40 minutes. The machines can trim and cut over 25 decks and 25 hulls per day.

10 The decks move from the CNC machine to the deck-finishing area, where hatches, and ports are installed. The windlass, stanchions, handrails, and other deck hardware are fitted. Decks that have completed this stage are moved into place and mounted on completed hulls.

11 As the hulls and decks make their way through the layup and CNC processes, all of the interior components are cut and varnished on an automated line. Each plywood component is cut and varnished before it reaches the assembly room. Numerous components are cut by a single CNC operator. These are then moved to a conveyor belt that applies and dries multiple layers of varnish with the push of a button. A piece of rough lumber can be turned into a varnished, finished component in 10 minutes.

12 Even with all the automation, skilled workers are required to assemble the pieces. Workers are specialists who can build multiple units per day. This galley unit is a collection of highly engineered, precision-cut puzzle pieces that are assembled more than built. Notice that the places where the unit will be tabbed into the hull have already been routed away.



5



6



7



8



9



10



11



12



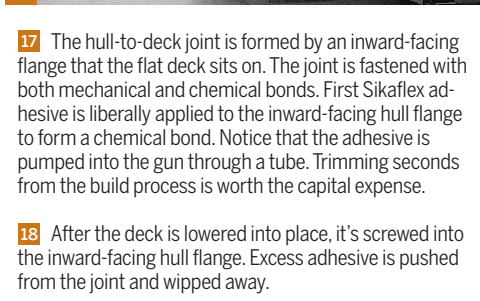
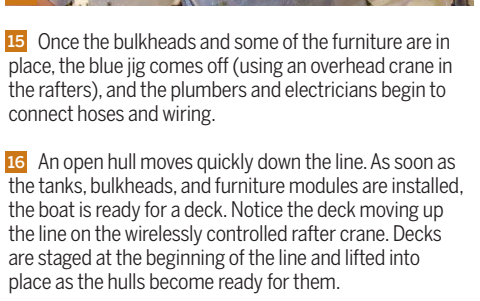
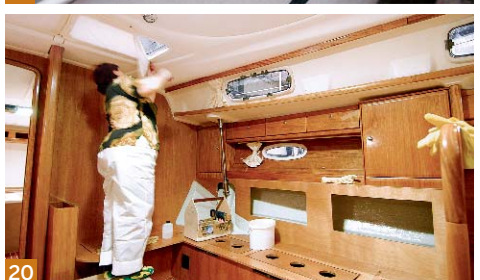
13



14

13 Every aspect of the Bavaria factory is designed to feed the assembly line in the most efficient way possible. The way engines are received from Volvo is a prime example. Volvo is open to Bavaria's requests because the company buys over 2,000 engines per year. Bavaria wanted reusable metal crates designed that would reduce waste and save money, so Volvo provided these crates, which stack easily and can be reused indefinitely. Engines are shipped with the saildrives installed and oil in place. Engine-installation time went from over an hour to 20 minutes.

14 As soon as a hull has had its through-hulls cut by the CNC machine, it joins one of three truly impressive assembly lines (two sail, one power). The boats are lined up side by side on rolling carts. Each line has 28 stations, and each moves in unison every 2 hours. It's just like a drive-in car wash. A siren sounds, and all 28 hulls move one step closer to the end of the line. This hull has just started to make its way up the line. The engine has just been installed. Notice the blue-steel framework of the hull. This jig maintains the shape of the hull as the bulkheads are tabbed into place farther down the line.



15 Once the bulkheads and some of the furniture are in place, the blue jig comes off (using an overhead crane in the rafters), and the plumbers and electricians begin to connect hoses and wiring.

16 An open hull moves quickly down the line. As soon as the tanks, bulkheads, and furniture modules are installed, the boat is ready for a deck. Notice the deck moving up the line on the wirelessly controlled rafter crane. Decks are staged at the beginning of the line and lifted into place as the hulls become ready for them.

17 The hull-to-deck joint is formed by an inward-facing flange that the flat deck sits on. The joint is fastened with both mechanical and chemical bonds. First Sikaflex adhesive is liberally applied to the inward-facing hull flange to form a chemical bond. Notice that the adhesive is pumped into the gun through a tube. Trimming seconds from the build process is worth the capital expense.

18 After the deck is lowered into place, it's screwed into the inward-facing hull flange. Excess adhesive is pushed from the joint and wiped away.

19 The joint is then screwed down with stainless-steel screws every 4 inches forming the mechanical bond; the interior of the joint is glassed over and the toerail is installed.

20 Once all the bulkheads have been bonded to the deck, workers continue to finish off the interior. The installations of all secondary wiring, such as the compass, windlass, and navigation instruments, are completed, and the boat is thoroughly cleaned inside and out.

21 The end of the line. Upholstered cushions are added and several quality-control checks are completed. Notice the blue rack on which the last boat has been riding up the line. Each rack collapses flat and is attached to a cable in the floor (notice the blue square on the floor) that pulls the entire line in unison. When the boat comes off the end of the line, the rack is returned to the beginning of the line via a cable under the raised work area behind the line.

22 The last step in the production process is installing the keel. An overhead crane lifts the completed hull over a keel. Workers use a laser sight (notice the red dot where the keel meets the hull) to insure the keel is perfectly aligned before drilling holes in the bottom of the boat to accept the keelbolts. Adhesive is applied to the top of the keel; then the boat is gently lowered onto the keel and the bolts are secured with two nuts in the sump.

23 Completed boats line up waiting for trucks to take them to destinations around the world. Bavaria built the building in the background so truck drivers have a place to sleep. Bavaria does extensive testing on each model before it goes into wholesale production. However, the company does not test each boat after it comes off the line. The company feels it has such control over the production process and such strict quality checks at every step of the process that testing each completed boat is unnecessary.