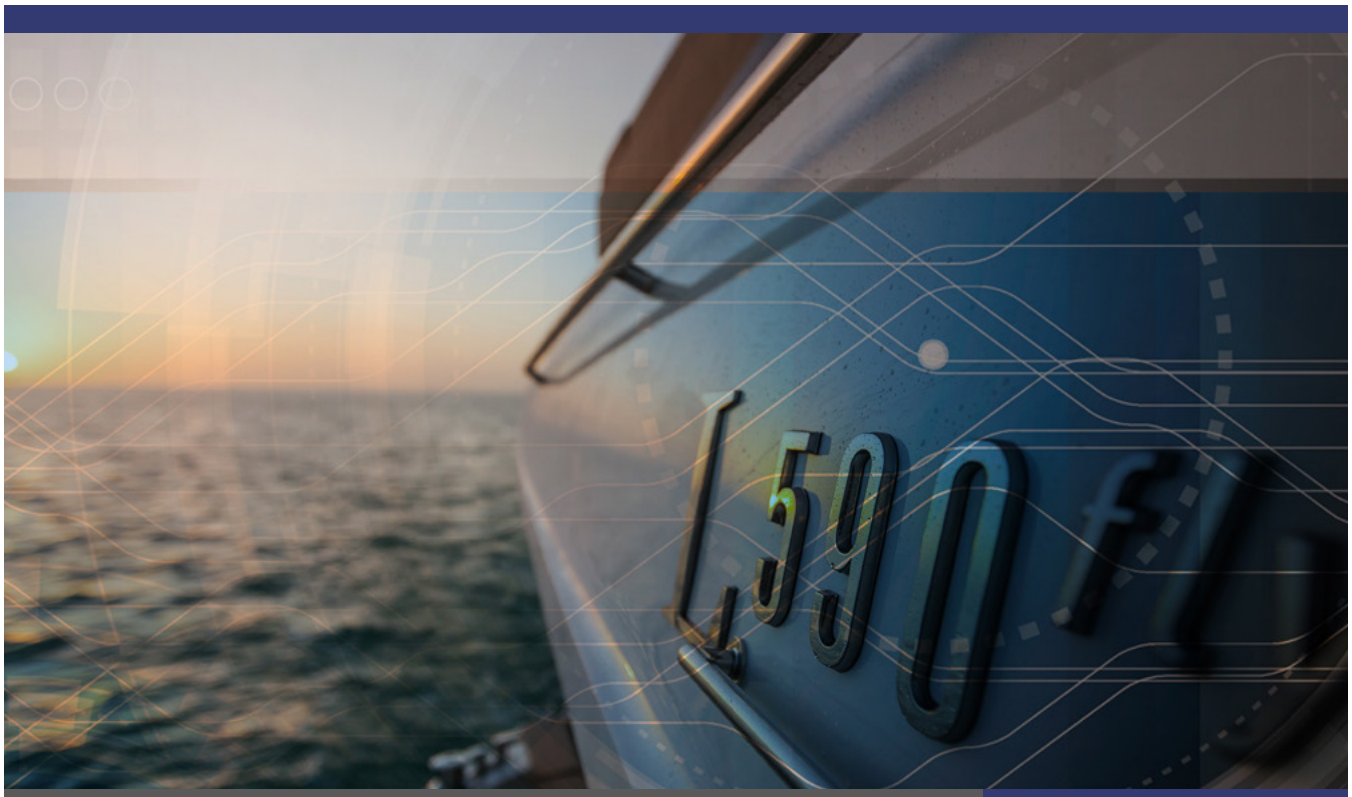

White Paper

# Real-Time Data Acquisition and Control System Helps Boat Builder Keep Hull Weight and Thickness on Track

by
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In the highly competitive leisure boat market, consistently delivering products that adhere closely to their published specs is critical from both customer satisfaction and manufacturing costs perspectives. One of the most important specs is the boat's weight; overweight boats eat up horsepower, waste fuel and compromise performance. It is also important that the weight be distributed properly to avoid creating structural deficiencies.

At Brunswick Boat Group's Advanced Composites organization at Merritt Island, Florida, engineers are developing and refining data acquisition and control tools designed to give the workers responsible for spraying fiberglass hulls and other parts the constant feedback they need to avoid adding unnecessary weight to the finished boat and ensuring each area receives the thickness of fiberglass intended. Sean Minogue, a structural engineer in Sea Ray's product development and engineering group, has been developing these tools since 2014.

To grasp the Material Monitoring System (MMS) for data acquisition and control that Sea Ray's engineering team developed, it's first necessary to understand the process the company uses to create a fiberglass boat hull or other fiberglass part. Parts are formed using a female mold; for Sea Ray's largest yachts, this mold can be up to 60 feet long, 16 feet wide, and 10 feet deep; a finished yacht hull should weigh 14,000 pounds. The first step in the process is applying a thin layer of mold release compound by hand, which allows pulling the completed hull out of the mold like an ice cube out of a tray. A worker sprays a pigmented resin gelcoat inside the mold, which gives the hull its slick surface, deep color and high gloss. The next, and most critical, step is to apply the correct amount of "chop spray" to the part in precise layers. A chopper gun chops fiberglass filaments from a spool into sprayable pieces from 10 to 40 millimeters in length, then combines them with a thermosetting vinyl ester or polyester resin for application to the gelcoat. However, without concrete feedback on the amounts of fiberglass and resin being consumed for each area, the quality of the chop spraying process depended in part on an individual worker's ability to gauge the level of material being applied visually. This made it difficult to ensure that each section of the hull received the exact amount of fiberglass intended for it. Over-spraying not only added to the weight of the hull, but wasted fiberglass and resin.

Minogue came aboard in 2012, charged with updating many of the shop floor processes at Brunswick's multiple boat-building facilities, all focused on cost and weight savings and on allowing them to build boats to higher tolerances. The previous methods used to monitor consumption of fiberglass and resin were something less than ideal. For example, tracking

fiberglass consumption required monitoring the revolutions of a wheel around which the fiberglass filaments were wound; resin consumption was calculated based on the output of a stroke counter linked to a pneumatic pump. Even when both devices were operational, they tended to be inefficient and not particularly exact.

In his proposal for a new system, Minogue explained, "The system will track resin, chop and other bulk material usage by part. This gives us the much needed visibility of our work in progress by comparing usage to requirement data in real time. The system is expandable to track pull weight data, SKUs, labor hours, cure cycles, takt time (average time between the start of production of one unit and the start of production of the next one), historical weight data, and most of all, provides live target data to the operators."

Today, Sea Ray's new MMS, now in the last stages of a year-long beta test on the yacht production line, dispenses with the wheel and stroke counter. Instead, Minogue has linked a PMX signal conditioning system **(Figure 1)** to load cells from a high accuracy scale to a pallet holding the fiberglass spools and to a flow transmitter connected to a flow meter that controls the amount of resin that goes to each of two chopper guns. A lamination monitor **(Figure 2)**, a custom-built Power over Ethernet system with connected Honeywell barcode scanners, provides constant progress updates to chop spray operators. Each operator simply scans the barcode associated with each section of the hull, which appears on the screen of the lamination monitor. As the operator pulls the trigger on the chopper gun, the lamination monitor displays the material usage and compares it to the specified amount in real time.


***Figure 1.*** *The PMX Modular Measuring Amplifier System is widely used in industrial production and test bench applications that demand high accuracy because it offers low-noise 24-bit A/D conversion.*

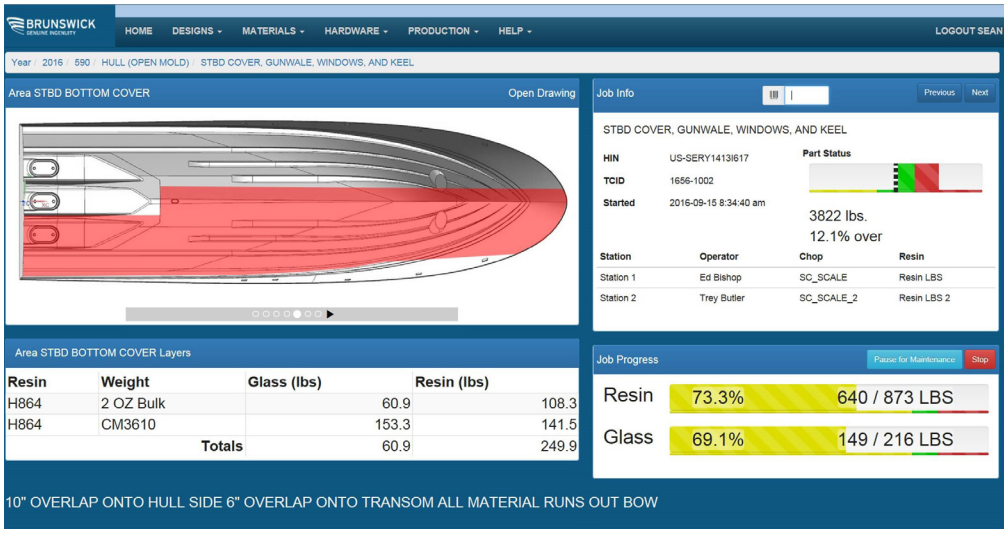


***Figure 2.*** *This lamination monitor for the fiberglass chop spray system is part of Brunswick's Material Monitoring System (MMS), now in the final stages of beta testing.*

The lamination monitoring system, custom developed by DragonPoint Software, Inc., provides status updates on job progress to managers, updates inventory, etc., as well as reporting results to the facility's engineering and quality database **(Figure 3)**.

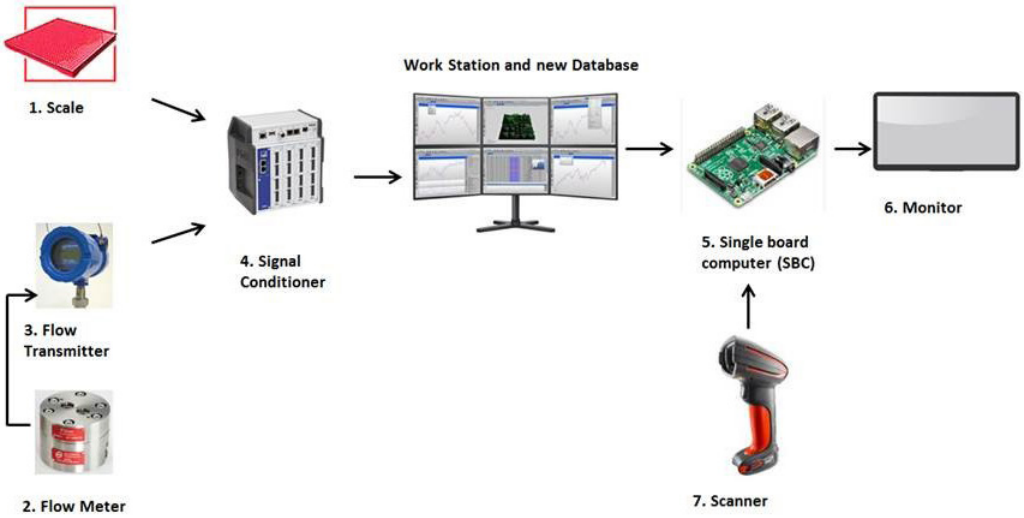


***Figure 3.*** *The heart of Sea Ray's MMS system is a WGX002 PMX Modular Measuring Amplifier System (#4) from HBM, Inc. Plug-in instruments include a PX01EP Ethernet/IP interface card for integrating the PMX chassis with the facility's Ethernet/IP networks and a PX401 four-channel, 4-20mA measurement module for reading the analog input signals produced by the digital scale and the flow transmitter.*

A variety of factors weighed into Minogue's decision to choose a modular signal conditioning solution as the basis for his Material Monitoring System. He originally considered using individual signal conditioners to read the signals from the analog equipment, mostly because they're both readily available and inexpensive. However, he was particularly motivated to choose a system that could offer the flexibility to add more signal channels easily for additional equipment for measuring gelcoat usage, temperature, humidity or other factors. When measuring only weight and flow signals, a single 16-channel PMX system has the capacity to run eight chopper guns. Minogue notes, "We've used HBM's SoMat ruggedized mobile data acquisition equipment in our testing lab for years, so I was pretty familiar with what they could and couldn't do. I looked at the PMX because I needed a device that was pretty advanced and had a built-in Application Programming Interface (API) that would let me build a database to read signals from all this equipment."

Minogue's MMS has proven itself invaluable over the course of a year of beta testing on the Sea Ray yacht line at the Merritt Island facility, helping operators reduce material costs, work more efficiently by enhancing process control and keeping the finished parts compliant with the weight specs. For the Sea Ray 590 hull, the use of this technology has resulted in a 1,000-pound savings in chopped glass and resin. Currently, the MMS is slated to roll out on production lines for Bayliner, Boston Whaler and other Sea Ray models in other Brunswick production facilities over the next two years.

## About HBM, Inc.

For more than 65 years, the name HBM has stood for reliability, precision and innovation all over the world. HBM offers products and services for an extensive range of measurement applications in many industries. Users worldwide rely on the perfectly matched components of the measurement chain that guarantees maximum accuracy of measurement results and enables optimization of the complete product life cycle, from the development through the testing stages, as well as in manufacturing and production. Their product range covers sensors, transducers, gauges, amplifiers and data acquisition systems as well as software for structural durability investigations, tests and analysis. The potential fields of application can be found in every branch of engineering in both virtual and physical test and measurement.

HBM has 27 subsidiaries and sales offices in Europe, America and Asia. HBM also has representatives in another 40 countries around the world. In addition to headquarters in Darmstadt, Germany, other HBM production facilities are located in Marlborough, Massachusetts, and Suzhou, China.