The New Science of Sail Trim

Sail Tech by Andrew Scott

The integration of cameras, computers, and trimmers takes the guesswork out of getting sails set up correctly.

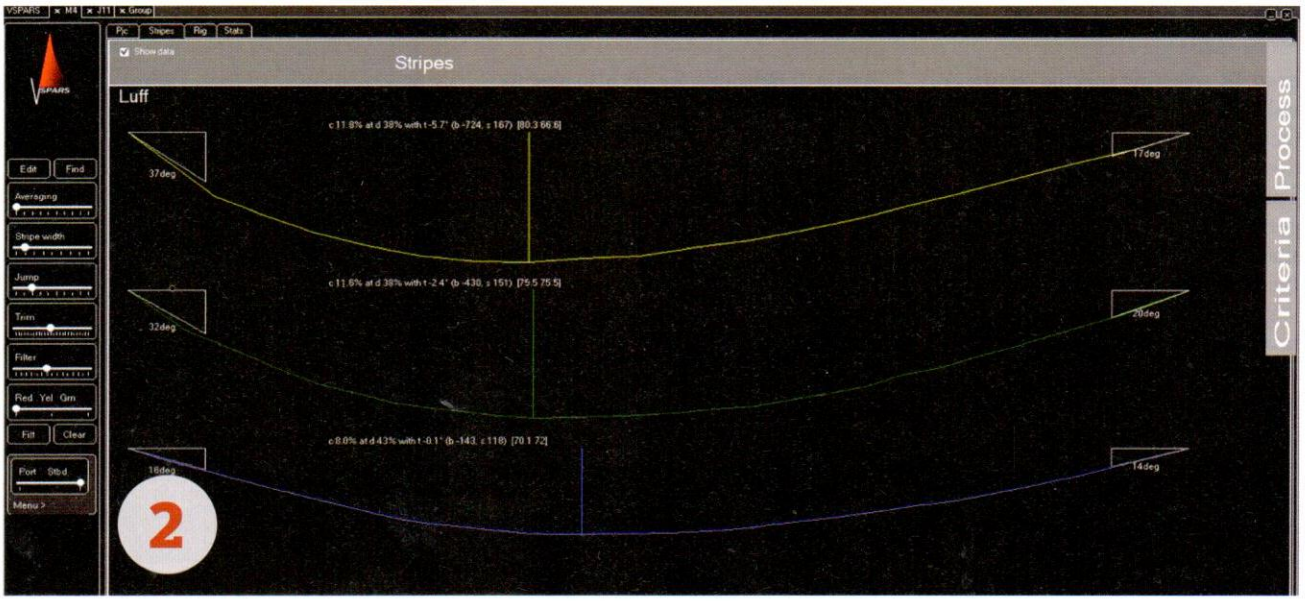
With seven teams, the 2011 Audi MedCup TP52 fleet was smaller than previous years. But with fewer boats mistakes were magnified, and passing even a single boat was difficult. Going into the fifth and final regatta, Quantum Racing had just a 3.5-point lead, but we had a secret weapon we'd been developing for more than five months.

Halfway up one beat in that final regatta, the boat was going great on starboard tack. We tacked to port, and after sailing for a minute, sensed we weren't going as well. Realizing something wasn't right with our sail trim, Brett Jones looked at his wrist-top PDA, then relayed to main trimmer, Skip Baxter, that the mainsail was half a percent flatter on port tack, specifically at the middle draft stripe, and that he needed to power up the sail. A couple of slight adjustments later, we were back to full speed. The data on the trimmer's PDA was a feed from our VSpars RealTime system, a groundbreaking technology that streams sail-shape and trim analysis straight to the trimmers. The benefits of this technology are substantial.

Professional trimmers and sailmakers typically take pictures of sails in action and then later process these images on shore using a computer program that determines the sail's depth, draft position, and twist. Finding the correct setting for any given wind and sea state is a mix of art and science, and usually involves a lot of experimentation. The ability to quickly replicate fast settings is what separates the best boats from the pack, and that's where the VSpars program is so powerful.

For all its utility, the VSpars RealTime system is very light and non-obtrusive. Onboard Quantum Racing, we had a dedicated fit-PC—a compact, highly energy-efficient computer—stored below decks and three VSpars high-definition cameras, two for the mainsail and one for the headsail. The fit-PC is wired into the boat's network, so it receives all of our performance data—boatspeed, windspeed, true- and apparent-wind angles, heel, forestay load, performance percentages based on polars—and it time-stamps

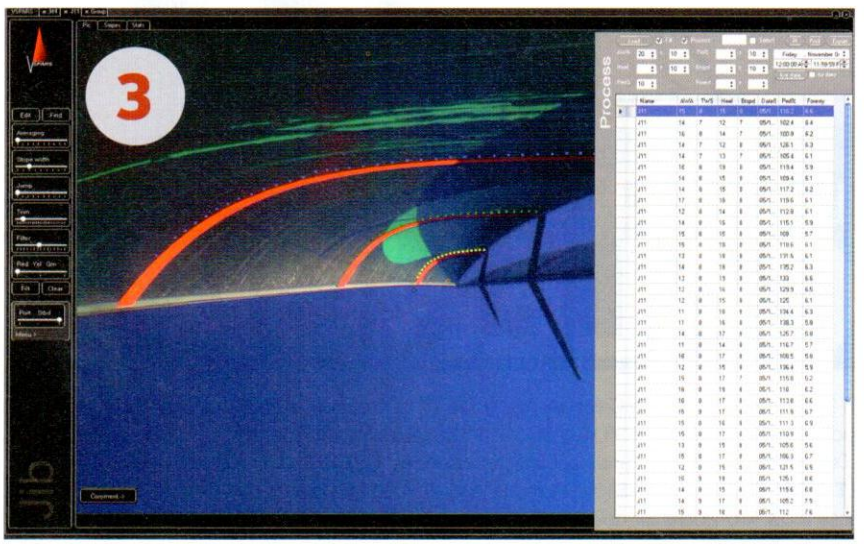
COURTESY QUANTUM RACING



1. BEFORE RACING, and when a new sail is hoisted, the first stop is the "Main" page (left) where the VSpars program can be tweaked to ensure it's picking up correct draft stripes. The three dots (above the head, above the lower spreader, and above the "B" in Sebago) frame the working area where the program looks for the draft stripes, which are bright orange or yellow. The yellow, blue, and green dots along the draft stripes are the data points the program uses to analyze the sail shape.

2. WHILE RACING, the program captures and digitizes a picture every three seconds, creating a draft profile for each sail. This information, for both sails, in text form, is relayed to the wrist-mounted PDA worn by one of the trimmers, allowing the them to access to precise sail-shape analysis during the race. This information can be used to ensure the sails are setting up the same on both tacks or to show where the sail shape requires adjustment when the boat doesn't feel fast.

3. AFTER RACING, VSpars allows the team to sort through every photo of a particular sail and save those taken when the boat was going exceptionally well, or very poorly, for further analysis and future reference.



each picture so we can later call up the boat's performance data for any picture. Our mainsail cameras are mounted into the cockpit sidewall just underneath the mainsheet winches. The jib camera is recessed into the foredeck, just behind the forward hatch. That's it for the hardware.

Once the cameras were mounted, the team took a full set of measurements to determine the precise locations of the cameras, using the center of the mast at deck level as the reference point. They also took measurements of the draft-stripe locations on each sail and entered them into the computer, along with the sail type: jib, main, or spinnaker. Each camera has a calibration file to compensate for distortion caused by the curvature of the wide-angle lens.

When hoisting a new sail for the first time, we recorded initial pictures without any load on the backstay or sheets. This established where the draft stripes intersected the mast and headstay. This information enables the program to determine how much headstay sag or mast bend we are sailing with at any given time.

When the VSpars system is active, the cameras take a picture every three seconds and digitizes them, saving the pictures, sail-shape analysis, and the boat's performance data to a folder associated with the specific sail.

The software computes the sail's camber depth, location of maximum camber along the chord, twist, entry angle, exit angle, headstay sag, mast bend, and sag at each draft stripe in the sail. To take full advantage of the technology, we built the mainsails and headsails with three draft stripes each to give us the best overview of the sail while racing. The wireless PDA (which could be an iPhone or tablet) enables the trimmers to have real-time access to the sail-shape information.

Another powerful application is post-race evaluation of sail shapes, based on the boat's performance. We can load all the images from the day into one folder and, using filters, extract the pictures we

need. By selecting specific pictures of sail shapes when the boat is going best (according to the boat's instrumentation), we are able to build a library of fast sail shapes. When the boat is underperforming, we are able to observe sail shape at that moment and determine if there's anything wrong with our setup.

Since the VSpars RealTime system saves the X, Y, and Z coordinates in true dimensions, we are also able to take the draft-stripe data of the actual flying shapes and overlay them with our design-file shapes. We can then use this data to refine shape files for the next generation of sails.

During the first MedCup event we only analyzed our sail shapes and setups at the end of the day, never looking at the VSpars data in real time, but by the time we were out for the first practice day at the second event in Marseille, France, we had a new mainsail to look at. To everyone's eye, the mainsail looked slightly different from tack to tack, and we needed to get the mast and sail setup perfect before we went in for the day. So, I grabbed my screen while we were sailing upwind, and sure enough, the entry angle at the top draft stripe was 5 degrees steeper on one tack over the other, and the main was setting up 0.5-percent fuller. We had real data backing up what we were all seeing. We adjusted the top spreader sweep and "D" tensions and went upwind again. The VSpars data showed us that this was a step in the right direction. We did this several more times and got the sail to set up identically on both tacks, with real data to confirm it. Without the VSpars system, we would've made slight adjustments on the water to get it close, but not perfect. We would've sailed in at the end of the day and then digitized all of the pictures. The following day, we would've had to go out and to do more rig adjustments to accommodate for any issues we saw in the digitized pictures.

The next step was to create a system that allowed the trimmers to view that information while racing, and once we did that we had one of the most advanced sail-trim tools ever created.

The heart of the VSpars system is a fit-PC and three cameras. Two mainsail cameras are mounted into the cockpit walls (above) while the jib/spinnaker camera is recessed into the foredeck just aft of the hatch. Each camera takes and stores a picture every 3 seconds.

"I love working with Quantum because they have the technological horsepower to come up with the kind of fast, accurate solutions that are needed at this level. You can't fake the results they've achieved; you can only get those with great tools, precise data and the best people."

— Marcelino Botin, Yacht Designer & Partner Founder, Botin Partners

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iQ: think smart

Tested and validated at the Grand Prix level, Quantum's iQ Technology® brings the ultimate in computational design horsepower and advanced construction methods to every sail built, for every type of sailing, for you.

Photography: Ian Roman

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