Building the perfect Dragon

by Jon Osterberg

What makes a boat great? Typically, four traits: a committed owner; a smart, talented crew; superb driving; and innovation.

In post-1950 hydroplane racing, dominant teams have raced boats named *Slo-mo-shun, Thriftway, Budweiser, Pay 'n Pak,* and *Atlas Van Lines.* Great boats driven by great drivers named Fageol. Taggart. Muncey. Chenoweth. Remund. Henley. Hanauer. Kropfeld. D'Eath.

From 1963 through 1965, the dominant team raced a boat named *Miss Bardahl*, driven by the great Ron Musson. Starting with the last event of 1962 and running through 1965, the "Green Dragon" won 12 races, including three consecutive Gold Cups and National Championships. That team later beget another great *Bardahl* and driver Bill Schumacher.

Several factors made the third *Miss Bardahl* supreme: a dedicated owner who funded his team adequately, but not lavishly. A young, well-coordinated, highly skilled crew. A superb driver. Reliability. And — make no mistake about it — speed. Though remembered more by some for its consistency, *Bardahl* was fleetest of the fleet when it had to be.

Yet one key to *Bardahl*'s success escaped much notice: The U-40 team, under the leadership of Hall of Fame crew chief Leo Vanden Berg, used technology and innovation to carve an edge over its rivals. This came at a competitive time in racing when a mere five mph often separated the top six boats. Called by some the end of racing's "golden era," *Bardahl*'s rule coincided with the likes of Muncey and *Thriftway*, Cantrell and *Gale V,* Thompson in *Tahoe Miss*, Brow aboard *Exide,* and Manchester with *Notre Dame.*

Ted Jones designed *Bardahl* in early 1962 to replace the 1958 hull, which Musson drove to victory at Seafair in 1961. In the October 1962 issue of *Motor Trend,* Jones said he designed the new boat for faster turning and rapid acceleration. No unlimited ever had been built with its particular dimensions, he said, citing a wider tunnel — the bottom area between the sponsons — and a beveled left-hand sponson.

The Green Dragon differed in other ways, too.

"In my mind, *Bardahl* was the first low-profile hull, along with the '59 Maverick," said Vanden Berg. "It had a lower crown than other boats, a lower center of gravity that was farther back. At first, the cg was 18 inches behind the sponsons. Later, we shifted it to 52 inches."

Bardahl's "break" — the point where the bottom changes angles — also was farther back than most boats. The crew developed quick-change air traps of different sizes that could be bolted on and off between heats. Vanden Berg also said *Bardahl* was the first to use a cavitation plate.

Bardahl showed promise in 1962, but persistent porpoising kept Musson from using full power. After the season, he phoned Ron Jones, Ted's son, and urged him to help. Ron Jones decided to saw 11 inches off the back of *Bardahl*'s sponsons. Jones and Bob Mackey, the boat's primary builder, also rebuilt both sponsons with less angle of attack and moved the skid fin.

The results were dramatic and immediate: Musson steered a stable Green Dragon to three wins and the National Championship in 1963, including a Gold Cup victory and a little-publicized 120+ mph qualifying lap at Seattle.

"After the sponson change, that boat rode close to perfection," Vanden Berg said. "And we won all those races in the turns. We didn't set it up for chute speed; we'd top out at only 160 mph. But we ran nine-second turns when everyone else ran 11. That's because we could accelerate all the way through the turns. We didn't throttle back."

Vanden Berg's crew was unusually young during the 1963-65 glory years. Leo was 46 in 1963, when volunteers Scottie Freeman (44) and Gernie Freeman (42) added their experience. But the primary crew members were teenagers and young adults. Jerry Zuvich was 22, Dixon (Dax) Smith was 19, and his brother Dave was 16. Gary Breakfield, Skip Schott, and Roger Kruse all were in their early 20s. Youth and energy worked to their advantage.

"We were young and full of ideas," said Dax Smith. "Being young, nobody had serious objections to trying new things. On lots of crews people say, 'We've always done it that way; don't mess with it.' We looked at stuff and said, 'OK, it broke. Why? How can we make it better?' Every time you break an engine, you ought to learn something. We spent a lot of time analyzing broken stuff.

"But Leo definitely was the stabilizing force," he continued. "Had Leo not been there, it wouldn't have happened. He had this bunch of teenagers, all pretty aggressive, all want to win, and everybody's got their own idea. And if it isn't your idea, it's no good."

Much of *Bardahl*'s edge stemmed from new ideas and refined old ones. Crew members replaced their Rolls-Merlin engines' standard, recessed through-bolts with larger, stronger, tight-fitting ones. They reheat-treated the main-cap studs, which increased strength and hardness. They heli-coiled the main caps, remachined oil passages near the main bearings to improve oil flow, and put counter-weighted cranks on the crankshaft. They took shot-peened rods and *re*shot-peened them.

"We did those things to increase engine life," said Zuvich. "They didn't increase horsepower, but we bought ourselves an extra three minutes or so of hard running."

"As far as I know, we were the first people to do some of that stuff," Smith said.

As might be expected, oil played a key role. *Bardahl* was the first hydro to successfully run two oil pumps, and Vanden Berg worked with Bardahl's chief chemist to tailor oil for the boat. He also worked with Dick Gordon on a quick-change gearbox that could be swapped intact without disassembling it.

Fragile quill shafts drove racers nuts back then. Technically called a spring drive in the Rolls-Merlin, it comprised five pieces that often broke. More than one team worked to strengthen them; *Bardahl*'s answer was a solid quill that consistently lasted up to 10 hours.

The *Bardahl* team ground its propellers to shape a "progressive pitch," something *Thriftway*'s team had done. Vanden Berg used gear ratios and smaller props suited for fast corner speeds. *Bardahl* also experimented with three-blade props, one of which in 1966 propelled Ron Musson to his death aboard the cabover U-40.

What really optimized all those improvements and innovations was Vanden Berg's strict quality control program.

"We used to keep detailed time logs on all our engines and parts," he said. "And I made sure everybody was cross-trained, even though they excelled at certain jobs."

"We were one of the first ones up in the morning and in the pits," said Zuvich. "We concentrated on our jobs and did all the little things some crews forget, like putting gas in the boat, putting rear plugs in, throwing a rope without letting both ends go."

"Whenever time allowed, we double-checked each other's work," said Smith. "At races, each guy had specific areas of responsibility. Barring something abnormal, we could go from one heat to the next and essentially not talk to each other, because we knew exactly what to do.

"Before the solid quill, we did quick quill-shaft changes between heats," he said. "Jerry and I did those right in the boat. We knew who was responsible to take *each nut* off. We *practiced* this stuff. When a blower came off, we knew who was in the bilge doing what, who was handling parts, who was handling tools. We could go in and out of an engine probably as fast or faster than anybody else."

The result: four race victories and another Gold Cup and National Championship in 1964.

One significant *Bardahl* innovation sprouted from the University of Washington library. In 1964, Smith was a physics and math major who came across a government report from the National Advisory Committee for Aeronautics titled "Nitrous Oxide Supercharging of an Aircraft Engine Cylinder." The title told Smith NACA was looking for horsepower.

"I read it and thought, wow, neat stuff," he recalled. "I showed it to the guys, and they were skeptical. I kept talking about it until, probably to shut me up, Leo agreed to let me try testing it in the boat."

Nitrous oxide is a gas that turns liquid when compressed. It holds twice the oxygen per volume than regular air. Nitrous' advantage is it injects more oxygen into the engine, allowing more fuel to burn, which makes more fire and more horsepower. The horsepower comes not from more oxygen, but from the additional fuel the oxygen allows you to burn.

When *Bardahl* tested with nitrous, the effect was intermittent and sporadic. Smith didn't understand some of its properties and used the wrong valves. When nitrous escapes, it gets very cold and absorbs heat as it converts to gas. That froze the valves and left a sticky residue. Sometimes, Musson came in saying, "Man, that really works!" Other times, nothing.

"The NACA report came from lab experiments," Smith said. "The military never did use nitrous in the war. So things like what kind of valves you use, precisely where you squirt it, how you control it, how long you can use it before you scramble an engine, were all unknowns.

"We went through half a dozen types of valves before we found something that worked really well," he continued. "*Exide* used nitrous too. I found out much later, when I did consulting work for *Budweiser* and saw the old *Exide* records, the amounts they put in were about a third of ours. So they likely didn't have those valving problems. But by the end of 1965, we should have been getting more horsepower out of our system."

In search of more power, the *Bardahl* team also secretly experimented in 1964 with high-dome, or "flat top" pistons. Previously tried only in Allisons, the crew welded aluminum into the concave top of Rolls pistons to increase combustion. Mickey Thompson forged high-domes from scratch for *Bardahl* in 1965.

"We developed lots of power," Vanden Berg said. "We beat everybody. But we also blew 800 spark plugs. The added pressure blew the porcelain right out of them. Champion then custom-built us a spark plug with a lower heat range and better crimp that would last.

"Another thing we did that others didn't do is knurl our pistons," he said. "They looked like a screwdriver with a knurled handle. We did it on the edges, where they rubbed. The knurling held oil and kept the pistons from scoring."

The final significant refinement was water-alcohol injection, which increased boat speed and engine longevity. Zuvich said *Bardahl* was among the first to run a Merlin with alcohol, trickled through the aftercooler. The technology came in 1964 from Chuck Lyford's Rolls-powered, Bardahl-sponsored P-51 airplane, in exchange for *Miss Bardahl* engine secrets.

"We modified his system after, again, finding reports in the UW library," said Smith. "At first we picked water up out of the lake and used a little Mickey Mouse regulator to squirt it into the engine. That was neat until we got to San Diego. You can't put salt water in a motor. So, we installed a tank in the back of the boat and filled it with water and alcohol."

Bardahl unleashed all of the team's collective technology just one time: In October 1965, Musson throttled the Green Dragon to a perfect, record-shattering win at San Diego. He won each heat with ease and set lap (117 mph), heat (116), and race (115) records that stood for years.

"Everything came together there," recalled Smith. "I remember Musson came in after one heat with a big grin on his face. He'd pulled right up next to *Exide*, looked over and smiled and waved bye-bye to him. Then he floored it and pulled away. By that time, we had engines that really could take a lot of abuse."

1965 ended with four victories and a third consecutive Gold Cup and National Championship. In virtually three full seasons of racing, *Bardahl* had garnered 12 race wins. Innovation and technology helped Musson's mount earn the right to be listed among the sport's greatest hydroplanes.

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