WINGING IT

ORACLE TEAM USA’s INCREDIBLE COMEBACK TO DEFEND THE AMERICA’S CUP

DIANE SWINTAL, R: STEVEN TSUCHIYA, and ROBERT KAMINS

Sample Chapter
Millions of sailing enthusiasts and casual fans alike watched the America’s Cup in awe as the ORACLE TEAM USA trailing one point to New Zealand’s eight, was first to the finish line in eight consecutive races. Now here is the inside story of that historic win, a narrative that goes beyond the emotions of the day to explain how the many months of innovation, research, trials, and failures helped secure the Cup in the final race on September 25.

Winging It features insights from naval architects and builders on their radical boat designs, the consequences of racing these untested boats, and explanations of how the foils and wingsails—rarely seen on boats before—work. The book explores the impact of events that led up to the Cup, including how a sudden capsize threw the entire event into doubt before the 2013 America’s Cup ultimately delivered an epic finale.

The 2013 Americas’ Cup was one for the books—Winging It helps sailors and armchairs sailors understand why.

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August 29 in New Zealand is the middle of winter. Six thousand, five hundred miles from San Francisco, one year and eight days before the 2013 America’s Cup match, Emirates Team New Zealand skipper Dean Barker was learning how to sail, in his words, “a monster.”

This was the fourth day of test sailing their first AC72 class yacht, the boat having been launched at the end of July. Just warming up, they had already topped an astounding 31 knots.

Meanwhile, ETNZ’s competitors were spying on the Kiwi’s new boat. In fact they had been spying on ETNZ for many months, monitoring the progress from small test-bed designs to the full-fledged AC72. All the teams kept an eye on their rivals—it was permitted as long as a minimum distance was maintained—but no one wanted to show their cards to their opponents too early. ETNZ sometimes took care of the problem by pretending to test conventional designs when they were being watched, playing coy until the spies gave up and went home for a while. Today ETNZ had more than the usual reasons to want some privacy.

Eleven sailors were onboard, plus technicians armed with computers to monitor structural loads in real time. Flanking the AC72 were their own chase boats, with dozens of design and technical staff keeping tabs.

It was time to fly.

The crew made adjustments to the daggerboards, Glenn Ashby trimmed the wing into position, Dean Barker at the helm turned the wheel down, and the big cat began to gather speed.

A catamaran normally sails fastest when heeling only slightly, leaning just enough to get the windward hull clear out of the water, cutting the underwater drag nearly in half. With the efficiency of the wing sail, the boat could fly the windward hull even in 6-8 knots of breeze. Today they had another trick in mind, too.
As the AC72 picked up speed, the apparent wind, the combination of the true, atmospheric wind and the motion of the boat itself through the air, angled forward and grew in speed.

Two 72-foot-long hulls, built of carbon-fiber and other composite materials, stretched away on both sides of the yacht, connected by two giant crossbeams, all kept stiff by a web of bracing structures. The “platform,” as it was termed in Cup-speak, was wider than a tennis court and nearly as long, the spaces between crossbeams covered with a trampoline of open netting for the sailors to walk on.

The wing trimmer looked up at the wingsail, over 13 stories into the sky. The forward half of the wing was the spar, the structure that gave it the strength to stand upright, anchored by stays and shrouds. The second half of the wing, trailing just behind the spar, was comprised of flaps, which pivoted independently in several sections, adjusted in combination with the spar for efficient air flow over the two sections of the wing to suit conditions. Constructed of carbon fiber ribs covered with industrial heat-shrink film, the wing was more powerful than a soft sail of the same area, typically 50-85% more efficient depending on conditions.

It took two years to design and 20,000 man-hours to build just the wing itself. The rest of the boat, the first of two yachts ETNZ would build, took over twice that, not counting 140,000 man-hours of design.

The wing was the new toy on the AC72, the most visibly high-tech feature, expected to be the focus of sophisticated engineering development for all of the teams chasing the historic yachting trophy for 2013. Until today.

As the speed edged over 10-12 knots and kept climbing, the boat settled in at a comfortable angle of heel. And then something else happened. The leeward hull began to rise from the water, too. The entire tennis-court-sized platform and 131-foot wingsail, 15,000 pounds including the crew, were a meter or more in the air, being lifted by the daggerboard and rudder foils.

Nearly 21 feet tall, a pair of the oddly shaped daggerboards for the boat cost $400,000 just by themselves, and took three months to build.

The boat came out of the water, and now with no hulls in the water, just the lifting foil of the leeward daggerboard and a sliver of rudder foils in contact with the sea, an enormous amount of drag vanished. The boat leapt ahead, 10 knots faster, 15 knots faster. The faster she went, the more the apparent wind built. Boats of her kind had been planned to sail at 30-35 knots. With these lifting foils before long they would be flirting with 45 knots and more, over 50 miles per hour, the wind across the deck like putting a hand out the car window on the highway. When she was out of the water, the boat rode steadier on the foils than sailing on the hulls, and quieter, too.

Despite their success, the team kept quiet on August 29. No publicity photos or press releases. They had been spotted from shore, though, and predictably a photo was posted on the Internet. The image caught
ETNZ flying on her foils. That the Kiwi team had managed this feat was stunning. That they had managed it at all was a shock to some, including designers on other teams. A few people even wondered if the photo was a hoax. Less than a week later, ETNZ let a television crew film from the team's 1200-hp support boat, as the cat jumped out of the water and sped away, accelerating, leaving slack-jawed journalists speechless.

ETNZ was nearly two months behind schedule, but none of the other teams had launched their own cats yet. The New Zealand team had barely ten months until they had to be ready to race, and there was still a second new boat to come.

Back in San Francisco, the team that would defend the America's Cup, ORACLE TEAM USA, was in the process of stepping their new wingsail for the first time, and taking their first boat for its own early trials. They had some flying in mind, too.

The AC72s had become foiling catamarans. The teams needed faster chase boats, just to keep up. The crews needed helmets, body protection, and a long list of safety equipment that would continue to grow. Photographers had to acquire faster and longer lenses to deal with the subject's greater speeds and distances. A whole new technology would be used to apply the rules, and to make races on TV intelligible. Everything would happen quicker, and be more complicated, and expensive, in a tougher competition than anyone ever expected.

After her triumph in the waters around the Isle of Wight on another August day in 1851, when that silver prize was hauled aboard the schooner America, would anybody present then have thought that 162 years later there would be people still trying to win the Cup? Let alone hydrofoiling multihulls with wingsails? But an element of these AC72s racing each other at speeds often over 40 knots would have been familiar.

From the very beginning, at its core, the Cup is a history of innovation, of advanced technology in yachting. That's why the Cup was won in the first place, why it was defended, and why it still compels attention.

One person, after more than 25 years of involvement with the America's Cup, observed that winning the America's Cup is not about excellence. Excellence is the starting point. If you were to try to win the Cup and be merely excellent, you would lose. Winning the America's Cup has always been about going beyond.
When Pete Melvin co-wrote the design rule for the AC72 catamaran, he knew there were two distinct areas of development that could determine the winner of the 34th America’s Cup: the hard wing, an aspect of ORACLE TEAM USA’s Cup-winning monster cat brought forward to this new era of Cup technology, and the foils. As it turns out, the 131’ wingsail, initially regarded as the radical innovation of this America’s Cup cycle, was overshadowed by the realization that these giant catamarans could foil not only downwind but upwind.

From the beginning of Melvin’s role on the AC72 design team of Emirates Team New Zealand, the watchword was “stable flight.” The team learned pretty early on that getting as much of the huge cat out of the water as possible was the key to speed. Consequently, the foils underwent a tremendous amount of development, from early models tested on the team’s SL33s to the “V”-shaped version that led ETNZ to win the Louis Vuitton Cup.

“When we were working on the rule, we knew you wanted to get as much lift as possible when you were going fast downwind,” Melvin said. “For instance, in the 2010 America’s Cup, sailed on giant multihulls, the maximum amount of lift we thought we could get was about 50 percent of the weight of the boat. At that time, we were still relying on the hull to provide pitch control, so what’s come out of this is the boats all now have elevators (the horizontal foils on the rudders).

“At Team New Zealand, we developed a new type of foil that allows you to keep your height above the water more or less steady. No one had been able to do that before, at least not on a course-racing boat that was not going downwind. We developed that mostly on our SL33 test boats—they came with the stock constant curvature “C” foils and with those kinds of foils, you can generate 50 percent boat weight lift before they get unstable. But we noticed that when we could get one boat up fully foiling for a few seconds, it would really accelerate away from the other
boat—and that got the wheels turning. How, with such a huge potential benefit, can we achieve stable flight downwind? So our design team came up with the ‘up-tip’ type of boards. We refined those on the 33s, and our 72 is designed to do that and fortunately it worked right out of the box.”

As with many new Cup revelations, ETNZ’s first problem was how to test something as radical as foiling without showing their hand too soon. Opposing teams and sailors now freely admit the sheer number of hours spent on Waitemata Harbor, keeping a very close eye on the Kiwi’s development plans. How did ETNZ keep the prying eyes at bay?

“When we first achieved stable flight, it was on the SL33s and we did a pretty decent job of keeping those sailing sessions out of the eyes of our competitors,” says Melvin. “They would come out every few days and watch us—and when they did, we would go back into ‘normal’ mode. After a while, they would get bored and go away.

“But they could see what we were developing and they were probably wondering why we were sailing with these strange looking foils, though I’m sure they were figuring out what we were doing just by analyzing the shapes that we had. When we launched our 72, that was when pictures started appearing on the Internet. There were cries of it being Photoshop; people couldn’t believe it.”

Now that the foils have been proven to be a success, Melvin can admit that even he was somewhat caught by surprise.

“When we wrote the rule, we honestly weren’t sure if we could fully foil,” said Melvin. “All we knew was the higher the lift we could generate, the faster we could go. That was a central focus of our foil development program, to try to push that limit. Initially, we thought that if we could get 70 or 80 percent lift, that would be a giant gain over our competitors. The boat would accelerate like crazy, so incrementally we pushed it until we could fly 100 percent of the time.

“Our initial foils on the 72 were a little more conservative and even more stable than the foils we have now. Some of it is technique, though, to achieve stable flight—steering, trimming, and the setup of your wing and sails, the elevators. We’re still on a very steep learning curve but we were able to design foils that have less drag, but are a little less stable than our original foils. There’s a compromise between foiling stability and drag—you can have larger elevators, which give you more pitch stability, but it’s more drag. Trialing these solutions and understanding exactly how hard and where you can push the envelope—that’s where we had a good advantage initially, because we had more time on the water doing that.”

All the teams had to compromise when it came to foil size and shape—for instance, a larger foil means the boat can lift at lower wind speeds, but the larger foil means more drag, especially at higher speeds. And the higher speeds bring their own problems, such as cavitation. As ORACLE TEAM USA and ETNZ navigate the trade-off between drag and speed, at least it’s a decision that can wait until nearly the last possible moment—all foils are premeasured, so teams have until 8:00 pm the night before a race to declare their foils.
As a designer, Melvin enjoyed watching the other America’s Cup teams launch their new boats, seeing how each design team put their personal stamp on the AC72 Rule that he and his staff put together. While no design truly surprised him, he doesn’t mind borrowing a thing or two he’s picked up along the way, especially from the team they face for the America’s Cup.

“Clearly, we were in a little bit different design space than Oracle. They went for a much more aerodynamic solution but with a little bit of a compromised structure. Their boat was clearly more flexible than ours. We went for a stiffer structure and perhaps gave away some aerodynamics, though I’d say we’ve worked hard on aerodynamics since we’ve seen their boat and they worked pretty hard on stiffening their boat up. With foiling, you need to have fairly good stiffness control of your boat, because if the whole boat is moving it’s hard to control your foils.”

Gino Morrelli puts some numbers to the AC72: “It’s a 72-foot, 45-foot wide, 12,000-odd-pound beast that can fly a hull in about 6 knots of wind, and can fully go airborne like this in about 10 or 12 knots of wind.”

Top-end speeds over 50 mph have been flashed in racing, documented on LiveLine telemetry. “It can do that in about 20-something knots of wind, so it’s about a 2-point-something windspeed boat,” says Morrelli.

As fast as a wingsail multihull is, a foiling cat is faster. Getting the boat up on foils and keeping it up was key to winning the 2013 America’s Cup. With foils it takes about 10 to 12 knots of wind to fly barely, 16 to 18 knots to fly fully. The payoff for getting an AC72 up on foils is immediate; the boat speed jumps by about 5 knots at the low end when the leeward hull gets airborne, and the gain at the top end can be twice that or more, with top speeds going from the 30-plus-knot range into the 40s and edging toward 50 knots. Foiling has changed the game.

THE FOILS

“These are the really weird curved daggerboards we’ve been developing. They’re what really... the whole game is about,” said Morrelli. As for the hulls, “We call them a ‘board-delivery device.’ They barely even touch down even during tacks and gybes.”

A few smaller boats have effectively used lifting foils in the past, such as the Moth dinghies, and in the last few years the A-Class catamarans, but fully flying a large multihull on foils was rarely done except for isolated situations.

“The French had been playing with foils for 15 years, foil stabilized,” Morrelli said. “But they were still basically sailing on the main hull, leeward hull being lifted, but not trying to fly the whole boat, except for boats like Hydroptère, which are completely other animals. We’ve been following some of those trends and some of those trends have been dictated by carbon rigs and carbon sails, because we didn’t really have the power to get the boats out of the water until engines got better.”
Upgrading the engines took improving multihull designs in all areas, including the structural platform, the rigging, and the control systems.

“The problem has been in the past—even with Kevlar sails—they are too elastic and our boats are so stiff in righting moment, that to get the hull out of the water you’ve got to translate all that power through the rig, through the shrouds and the mainsheet, to get the boat out,” says Morrelli. “And if the rig is twisting and flexing to get the boat out, then you are giving up that power and the boat doesn’t come out of the water. So it’s been the evolution of sail development, and lines, hydraulics, to translate the power back into the platform. Now we have plenty of power and now we can lift the boat out of the water.”

Having the power to fly is one thing; having the ability to control a foiling cat was another feat completely new in the 34th America’s Cup.

AC72s on foils are “dynamically supported,” where the motion of the water over the foils creates the lifting forces that elevate the hull out of the water. That sounds straightforward, but it cuts both ways. Foils come with inherent issues, including that as speed increases, lift increases, which can make the foils themselves rise to the surface of the water and suddenly lose effectiveness, setting off a sequence of losing support, dropping back down, slowing, and then accelerating again to repeat the inefficient cycle. Or if the boat gets out of hand, for example, the angle of attack can increase too sharply, shooting the bows skyward while dropping the transom. Out of control is not a recipe for winning.

HOW THEY DO IT

It’s obviously critical to control the angle of attack of the daggerboard foils, letting the crew adjust the board to suit speed, angles, and wind conditions. The goal is to sail the boat in a steady balance and let speed build, to say nothing of just keeping the boat upright and intact. There is just one problem, though: the rules don’t allow the crew or an onboard system to actively adjust the angle of attack of the foils when the boat is racing. The rules also don’t allow any adjustment at all of the foil angles on the rudders during the race. The daggerboards can be raised and lowered while sailing, but under the AC72 Class rule there are strict limits on managing the boards.

Pete Melvin explains the restrictions: “According to the rule, you are allowed to adjust rake and you’re allowed to adjust cant. The rule also states that you can’t move the lower bearing but you can perform any sort of rotation you want. So there’s a possibility that if you had, say, a trim tab on your daggerboard, you could control lift that way and it would require far less power and force to actuate that than to move the entire board. But when we were working on the rule, our group thought that limiting moving parts on the foils would reduce cost and complexity, but possibly that was a mistake. If we’d known these boats would be fully foiling, there could have been a better solution.”
In the tradition of unintended consequences, the AC72 Class rule was written this way to control costs and promote healthier designs, but it created a huge technical challenge for the design teams.

The Class rule actually started out differently in draft form. Morrelli says: “Oracle let us write a rule that said there was unlimited development of the foils: you could have flaps; you could tweak your rudder; you could have active controls; you could have a wand dragging in the water like a Moth, the sailing dinghy. It was basically an open game; there were no rules. Whatever you brought that could fit in the box, you could run.”

But the Class rule is the product not just of designers. The Class was shaped by a meeting of the minds between the Defender and the Challenger of Record, who at that point in time was Club Nautico di Roma, represented by Mascalzone Latino. Compromise was involved.

“The Italians vetoed that extreme open example because they thought it was too expensive,” Morrelli says. “It would be detrimental to the Cup developing boats that were reliable, and they squashed it.”

The performance potential of lifting foils was too great to be left untapped, though. The question became how to control an AC72 catamaran on foils within the AC72 Class rule. Smaller boats can rely on crew movements fore-and-aft to achieve stable flight on foils, but the AC72s were too big for that approach, so more creative solutions were necessary. “That left designers with a problem of trying to find ‘how do we fly it without flying the boat?’ It’s not like an airplane, you have a stick, and you can change the rudder and the ailerons,” Morrelli says. “We basically had to build a boat that was self-flying, because there was very little opportunity to articulate the boat without sensors.”

Emirates Team New Zealand’s technique was to attach their foil to a curved daggerboard. When the board is lowered, the meeting of the extended foil and the rest of the board forms a V shape instead of an L. The ETNZ boat sits on the V so that when boat speed increases, and lift increases, the foil rises higher in the water with both legs of the V at an inclined angle instead of nearly horizontal.

“The advantages/disadvantages are this V is self-leveling,” Morrelli said. “As it raises up to the surface at high speed, it loses lift, because it stalls a little bit, and it settles back down—where a true L will go completely out of the water, and you have to find another way of controlling the angle of attack and the amount of lift it creates.”

Because the foils extend to their tips at an upward angle instead of flat, as the foil reaches the surface, the portion of the foil with water flowing over it, generating lift, is reduced incrementally, and the boat comes down gradually to an equilibrium point. The idea is to balance the forces as speed changes, avoiding the all-or-nothing conditions that a more horizontal lifting foil encounters.

It’s not the only solution for an AC72, but for the pragmatic New Zealand team, it seemed to fit.

“There are these ways that people are trying to control their dag-
Morrelli & Melvin’s experience with foiling actually goes back to power boats, where as long as power is sufficient, the decision to foil is primarily a calculation about saving fuel costs. But adapting foils to multihull sailboats has been a series of explorations, first in development classes like the A-Class cats and then in limited-production boats.

“We started with A’s probably five to six years ago,” Morrelli said. “Then we started playing with the Nacra 20, that’s about five years ago, and that was the first production attempt at building a 20-foot boat—a carbon boat with curved foils and carbon rig—and it’s been pretty successful. From that we moved to the SL33 and the F17 in the years after that.”

As a platform for foil development, and to give their crews hands-on experience, Emirates Team New Zealand used a pair of Morrelli & Melvin–designed SL33s. “We actually designed [the SL33] a year before the Cup even went to catamarans, so it was only fortuitous that we had a boat already designed and already under construction. We were building them in New Zealand just by chance.

“We did most of our daggerboard experiments on these boats because
they were easy to do and cheap to do, relatively,” said Morrelli. “A daggerboard on one of these is about a five-grand, eight-grand problem. A daggerboard on our AC72s? A pair of boards is $400,000. So we didn’t want to make many of those.”

America’s Cup teams are limited to building ten boards for the big boats, but as long as the test platform is a boat under 10 meters, there’s no limit on the number of daggerboards that can be tried.

“So we made lots of these,” Morrelli said, referring to the SL33 boards. “We can build these in the shop, and whack them off and change them. So that’s where we’ve developed to. The boats are very fast, flying downwind now on foils very steadily.”

**TESTING AND DEVELOPMENT IN THE AC**

Foil development was also a function of time factors and the nature of attacking the AC72 design problem within the context of the America’s Cup. The teams were allowed to build two boats, six wingsails, and ten daggerboards/foils, but the lead times for design and building made it impractical to feed very much real-world data back into major changes to the hulls and wingsails. The first boat by rule couldn’t even be launched until about a year before Louis Vuitton Cup competition started. ETNZ was the first team with an AC72 in the water and they still had to commit to the design of the second of two AC72s just weeks after boat one got wet. The schedule let them validate their first design in a general sense, but not spend a lot of effort to test and optimize on a large scale, let alone explore concepts that were more radical.

Even if the teams were not restricted by rule in the number of hulls and wingsails that they could build, and even regardless of budget, there simply wasn’t the capacity to build and deploy enough iterations in a short enough time to take advantage of a methodical step-by-step development program for all the major components. The end result was that the AC72 hulls and wings had to be good enough, subject to minor modifications, but not perfect, and a lot of the performance deltas in Louis Vuitton and America’s Cup racing would come from boat handling, maneuverability, and foiling performance.

That meant a lot of resources funneled into the boards. And even with all the design ingenuity at hand, the foils ran into limitations of physics.

“It becomes a material science problem,” Morrelli said. “We’re building those things as thin and as deep as humanly possible given our level of technology and understanding. They’re pretty much solid carbon, but the way we build them, the way they are manufactured under high intense heat and pressure, the most aerospace part on the boat is really the daggerboards.”

“They take about three months to build, once we have a set of tools. They are super labor-intensive.”
There appeared to be differing schools of thought when it came to building daggerboards, though. “In fact, we were shocked when Oracle’s broke,” Morrelli said. “The first day sailing they broke one of their daggerboards and it popped up and it floated away.” That’s not what the ETNZ guys would have expected. “Ours would sink like a stone . . . and be down in 18 feet of mud.”

With a lot left to learn, and the ability to keep drilling into the foil problem, teams were building and testing them even into the summer of 2013 as racing was under way.

Foil development was always expected to keep going, probably going on until the last second, Morrelli said. “How small can we make it and fly upwind? And compare it to a boat that’s got an 80 percent lift fraction as opposed to 100 percent, work it back to an 80 percent boat, and test the delta between those two extremes.”

TRICKLE DOWN—OTHER FOILING SAILBOATS

America’s Cup racing has often been a test bed for design and technology that transfers to mainstream racing classes, cruising boats, and other civilian applications. But not always. Wingsails, for all their efficiencies, may require too much specialized handling to ever see widespread adoption, but foiling technology is another story.

“All of this board development is going to trickle into racing, big time,” Morrelli said. “We’re already stealing it and sticking it on our cruising cats. The sail-area-to-weight ratio that benefits from curved boards and angled boards and ‘J’-boards is being approached by cruising boats like our Gunboat series or our custom MM65 series on a regular basis right now. We’ve already got clients looking for us to design basically semi-lifting—what we call lift fractions—to start putting lift fractions onto cruising cats, big custom carbon things. That trickle is happening as we speak. We recently just stuck a set of big asymmetric canted-end foils on one of our Gunboats, escalating that war down there in the Caribbean. That’s a 62, it’s a 40,000-pound boat. So they are benefiting from some of that experience, too. The next generation of custom cruising cats will definitely get some of this stuff. For doing Antigua Race week or Heineken or Caribbean 600, you’re going to see some pretty wild 90- to 100-foot cruising cats flying a hull around the course in the near future.”

**Nacra 17**

Want to fly your own small catamaran? Off-the-shelf lifting foils may be coming soon to a beach near you. Morrelli & Melvin’s design for a 17-foot beach cat with curved foils was adopted as a new class for the 2016 Olympics. Intended for a crew of two, the Nacra 17 has retractable curved foils to go with a high-aspect sail and a carbon rig.

“It’s really a fun boat. It’s also a boat that misbehaves,” Morrelli says.
"It will pull wheelies. This boat doesn’t have ‘T’-rudders, so you use your body weight and you move your body weight fore and aft to control the angle of attack, and by raising and lowering the board you get more or less surface area, so it’s a combination of board position and body weight.

“You can get these things to nearly fly with just barely the transom touching and the leeward bow . . . completely out of the water. So they are quite fast, quite active fiberglass hulls, carbon rigs, carbon boards. They weigh about 313 pounds, and retail at about 26 grand, and you can’t get one.” At least not yet. The first hundred boats were pre-sold to the Olympic sailing teams, in sets of ten boats, for use in their national trials.

The small boats are instructive as to the advantages of the foils. How much faster is the Nacra 17 than a similar cat, or even the larger ex-Olympic-cat, the Tornado? “[The Nacra 17] doesn’t have an advantage over anybody in light air,” Morrelli says. “In fact with the curved boards we actually give away a little bit of performance, because in light air you really want the straight super-deep boards, but at about 6 knots of wind it crosses right over to [where] the curved-board boats are faster. As soon as you can fly a hull, the curved-board boats are faster these days. Anything above 8 to 10 knots, they’re faster downwind all the time. It’s still a close race upwind with some conventional—what we call conventional—cats.”

What did foils do for the SL33? “On our little test boats, the SL33s, the fastest we could make those go before we started putting the foil package on was about 24 knots, because we just ran out of stability, we
the yacht provided that it fits inside the “box.” A box rule is a relatively open approach to a Class Rule in contrast to a formula-based rule that tries to control specific aspects of the shape of the yacht in more detail.

**Class Rule.** A set of design specifications which the race yachts must satisfy. The yachts that sailed in the 2013 America’s Cup were catamarans of the AC72 Class Rule.

**Clysar/Cryovac.** Trade names for high-performance shrink wrap film used, among other applications, as the “sail cloth” for the rigid-wings of the AC45s and AC72s.

**Code Zero.** An asymmetric tight, reaching soft-sail, often used for sailing upwind.

**Daggerboard, daggerfoil.** The retractable appendages used by the AC72 yachts to resist leeway and to lift the hulls off the water.

**Development Class.** A type of Class Rule that permits significant modification to the yachts of the Class.

**Fleet Race.** A race among three or more yachts at the same time, in contrast to a match race.

**Foil (noun).** In AC34, the hydro-foiling element of a daggerboard or a rudder that provides a lifting force for the boat. Or, more broadly, used to refer to the entire daggerboard. In general, any airfoil or hydrofoil might be referred to as simply a foil.

**Foil (verb).** To sail a boat borne primarily on the lifting foils of the daggerboard and rudder, with the hulls clear of the water.

**Flaps.** Movable element or elements of the wing-sail that trail behind the spar that help shape the camber of the wing-sail. AC72 rules permitted any number of elements in trail, and in practice the flaps were divided into multiple panels to allow trimming the wing in different configurations varying with height.

**Gennaker.** An asymmetric tight, reaching soft sail, often used for sailing downwind or reaching.

**Gybe, gybing.** A maneuver whereby a yacht that is sailing downwind or reaching turns its stern through the wind.

**Hook.** To gain leeward position on the same tack and use right-of-way rules to gain control over the windward boat, forcing them to luff into the wind or tack. Primarily a tactic for AC72s during the pre-start.

**Knot.** Shorthand for one nautical mile per hour: 1 nautical mile equals about 1.15 statute miles.

**Layline.** The direct line of travel which allows a boat to reach (lay) the mark or gate on the most effective point of sail, without having to make additional tacks or gybes. A boat that hasn’t reached the layline upwind can’t reach the mark yet. A boat sailing past the layline has unnecessarily sailed extra distance.

**Match Race.** A race between two yachts.

**Nautical Mile.** 6,076.12 feet, which is longer than the statute mile of 5,280 feet by about 15%.

**Platform.** The hulls, cross beams, and bracing structure of an AC72, but not the wing-sails or rigging.

**Soft Sail.** Traditional flexible sails. On an AC72, only the jib, gennaker, and code zero were soft sails.

**Spar.** On a wingsail, the forward element which provides the structural support of the wing in addition to playing an aerodynamic role.

**Starboard Tack.** On a point of sail where the sails are on the port side of the boat and the wind is coming over the starboard side.

**Port Tack.** On a point of sail where the sails are on the starboard side of the boat and the wind is coming over the port side.

**To Tack, or Tacking.** When sailing upwind, to change direction from port to starboard tack or vice-versa by turning the bow through the eye of the wind.

**Wingmast.** Usually meant broadly to refer to the wing-sail, or just to the wing spar, though more precisely a wingmast is any mast that is large enough in profile to generate lift. Wing masts were developed on beach cats in the 1960s, with soft sails trailing behind them, and were forerunners of the complete wing-sail.

**Wingsail.** AC72 mainsail, with a rigid articulating structure consisting of the spar and flaps, covered with heat-shrink film.
ran out of righting moment,” says Morrelli. “By the time we got the full package on, those boats can go over 40. So we added 16 knots of top end to the little boat.”

**HELMING AN AC72: “IT’S HYPER”**

Once an America’s Cup team made their design bets and put their boat on the water, the size, speed, and power of the large foiling cats changed the game for helmsmen, too.

“You have to be super-careful because it’s super-controllable,” Morrelli said. “You can throw the boys off the back of the boat by flicking them. When you are rotating the boat about the daggerboard . . . there’s no resistance.”

Getting the right sort of person on the helm was a priority, made more difficult because there was no proven pool of AC72 foiling skippers. Teams had to figure out which sailors had the skill set to excel. While ORACLE TEAM USA’s James Spithill and ETNZ’s Dean Barker transitioned to multihulls from experience in America’s Cup Class monohulls, most of the new talent came from small high-tech dinghies, either foilers or trapeze boats that are high velocity and physically intense.

“That’s why I think we’ve seen this really healthy transition to the 49er sailors,” Morrelli said. “Because they were born at the end of a flicking tiller, you get an innate sense of that pressure point. . . .

“That’s obviously where the 49er sailors came from. We’re almost transitioning, where a lot of the guys in my generation may be surpassed as we go to foiling, and this 49er crowd, the Moth crowd, is going to be the drivers of the next go-around.”

Beyond the sensitivity needed just to get the boats cranked up to speed, AC72 helmsmen must also bring the anticipation and tactical awareness to manage all that energy around the course. Match racing at 40 to 50 knots is a recalibration of the normal scale of yachting experience. Ten seconds down the racecourse is 600 to 700 feet away.

“It’s more like aiming a rocket,” Morrelli said. “You’re not really sailing a boat. You are looking at targets and you are aiming. There’s no trimming going on anymore. You basically set the thing and go. You grind the jibs down; they’re self-tacking. You grind them down, and they are staying. And you are aiming the boat to hit the target. The only one trimmer is the wing trimmer. He’s basically trimming for twist. The things are so fast it’s only when they are whacked up, way overpowered, that they are dumping the mainsheet.”

“It’s probably like F1 [Formula 1, racecar driving],” Morrelli said. “A real good F1 driver has feeling that a normal human being doesn’t have.”

There was no precedent for racing boats like these around the buoys, and barely any for sailing boats like this at all. Nobody’s ever really done it before and everybody’s learning.
September 7 had arrived. The 2013 America’s Cup, the vision of giant wingsail catamarans, now transformed into foiling flying 50-mph beasts that awed their creators, stunned the spectators and commanded the sailors’ complete respect. Some said the day would never come; some in the city of San Francisco or in the Cup world tried to keep it from coming amid a mini-industry of honest skeptics, heartfelt traditionalists, and the just plain mean and myopic trying hard not to enjoy a boat race they had never seen.

Two of the most advanced racing craft on the water were going to meet for the most historic, most famous, and most difficult-to-win trophy in sailing.

ORACLE TEAM USA had won the Cup 43 months earlier, brought it home to the City by the Bay, and now the New Zealanders were set to take it back, if they could. ETNZ had launched the first AC72, foiled the first AC72, built another for the Italians, were the first to launch a second AC72, foiled that one too, and swept the Louis Vuitton Cup except for one DSQ. In the process, the tough, practical, and hardened ETNZ had taken on the aura of an irresistible force. When Luna Rossa began breathing down New Zealand’s neck upwind in the Louis Vuitton Cup Final, the Kiwi boat Aotearoa did everything except utter the Road Runner’s “Meep-Meep” as it took off to parts unknown. Dean Barker and Grant Dalton and their boys likely had a whole deck of cards still up their sleeves, and they had been upgrading their performance at every chance. They were in the tenth year of their quest with one goal: get the trophy back.

They faced a vast yacht-racing industrial complex. ORACLE TEAM USA was the only team to field two boats simultaneously; throughout the summer Olympian Ben Ainslie sparred with Cup-winner James Spithill. OTUSA’s boats sprouted uncountable trick bits, backed by an incredible
The public wouldn’t watch sailing on TV, and people weren’t going to come out in San Francisco for a boat race. Race 4 put an end to that talk. The vision of the 2013 America’s Cup running on all 72 cylinders was powerful stuff.

On the piers and in Marina Green, a whole other set of fans was now cheering, too, partially for the American victory, and partially because the gauntlet had been picked up. It seemed like anything could happen.

**Monday, Lay Day**

OTUSA was out on the Bay on Monday, training hard in wind conditions that trended into the upper 20s, utterly flying, a hawk among the Golden geese of the Superyacht Cup fleet. What they were learning is anybody’s guess. ETNZ had braved winds 10 to 15 knots higher with their boat one, so that was not unknown territory for them either, but ETNZ instead spent the day in their boat shed, surely working something up.

**Race 5, Tuesday, September 10**

With the battle joined, Tuesday looked exciting. ETNZ was up 3-1 on the scoreboard. OTUSA had erased half of their penalty, and still needed another win before scoring points, but now that either team had shown they could win, a different energy level surrounded the event.

By some counts OTUSA could have been up three races and tied on points with better tactics, a few better breaks, and one or two of the non-penalty calls. The New Zealanders were looking tough, but not invulnerable. And regardless of what OTUSA could have done, New Zealand was the one winning.

Barker was matter of fact about the Race 4 loss. “The second one we could have done better, but what we take out of that race is the fact that we sailed—by our standards—a pretty average race and we were still pretty close at the end,” he said.

Spithill had talked enthusiastically in Sunday’s press conference about the momentum having shifted to his team, which might have been more an attempt to get into his competitors’ heads than a deep insight. Each race was its own race, as events would soon reinforce.

Race 5 was expected to be in strong winds, 18 to 22 knots.

Detailed analysis of the data so far showed OTUSA closing the gap in average speeds upwind, downwind, and tacking. The numbers showed the boats becoming much closer in performance on all points of sail. Both teams had made mistakes on Sunday; OTUSA’s just cost them less than they did ETNZ.

Spithill went head-to-wind at the line, getting Barker underneath him to leeward, the Kiwis trying for the hook but undermined by the flood current moving both boats to the pin end. Barker sitting further downwind at the gun had little leeway to give on the reaching leg, and it was Spithill this time who could put the bow down, hit the throttle, and ruin
his opponent’s air. It was an excellent execution by Spithill of the technique that Barker had been taking to the bank all summer. Spithill was in command, leaving Barker behind by a half dozen boat lengths heading downwind.

Coming into the bottom mark with ETNZ close but not gaining on starboard, with ORACLE TEAM USA ahead, tactician John Kostecki called for a foiling tack so they could quickly head back into the “cone” behind Alcatraz, where the flood current, near its maximum strength for the afternoon, would have less impact. But the tack was slow, with the Americans seeming to completely stall out. Tacking onto starboard when they reached the right-hand boundary, ORACLE TEAM USA crossed ahead of Emirates Team New Zealand, but the Defender inexplicably chose to continue across the flood current toward shore. ETNZ continued offshore, staying out of the flood current, and when the boats tacked and came back together Emirates Team New Zealand had the lead, continued to build on it, and never looked back. They won Race 5 by 1:04.

After a brilliant start for ORACLE TEAM USA, one bad foiling tack, and a decision to let ETNZ head out of the current alone, had spelled disaster.

Criticism mounted for OTUSA tactician John Kostecki. Others blamed him less than the fact that the setup on OTUSA’s boat had Kostecki grinding a winch, head down, so often that he couldn’t focus on the other boat enough to stay on top of the situation and guide Spithill. ETNZ’s arrangement gave Ray Davies, their tactician, better awareness and easier communication to Barker.

Whatever the reason, the pattern of losses was continuing: boat-handling mistakes, tactical missteps, and not enough speed. OTUSA was now down 4-0 in points, needing ten wins to the Challenger’s five. Another loss and ETNZ would be able to win the trophy back in only two more days of racing.
Race 6—Postponed

An intense group conversation could be seen on board the Defender’s boat between races. Ten minutes before the start of Race 6, as permitted by the rules, ORACLE TEAM USA requested postponement of the second race of the day. Each team was permitted to do so one time only for the entire span of the match, and only for the second race of the day.

Since it was a card that could be played only once, it was often regarded as an option only if damage to the yacht guaranteed a loss. OTU-SA’s boat wasn’t damaged, and under the rules it didn’t have to be in order to make the request. Spithill, on board, had polled his crew, and they had agreed with the decision.

Whether it was wise to play the postponement card and not have it in hand in case the boat suffered damage in the first race of a future day was
one question—but the fact that Spithill had played it at all suggested how deep their trouble was. It was a very public no confidence vote.

Onshore, the move was not very well regarded by some. To critics, OTUSA's refusal to race made them look afraid of ETNZ.

A thorough defeat of OTUSA in Race 5 despite a masterful start, and then the disarray culminating with the decision not to race, drained all the energy from the proceedings. ETNZ was looking like they couldn't be stopped. OTUSA looked desperate.

The post-race press conference was marked by a somber mood among the participants and audience alike. Criticism of the foiling tack and ensuing tactics abounded. John Kostecki had been up on stage next to Spithill the first two days, but he was not present at Tuesday's press conference, his absence interpreted as a question concerning his future in this edition of the Cup. Inquiry was made as to whether ORACLE TEAM USA's other AC72 could be brought into service. The substitution of wing trimmer Kyle Langford for the excluded Dirk de Ridder was a topic for the third race day in a row. There was concern about what message the decision not to race sent to fans. With the Kiwis still needing to win five more races, ETNZ's skipper and tactician were asked if the Protocol for the next defense in Auckland was ready to be signed with Patrizio Bertelli, Luna Rossa's CEO, who happened to be standing in the media room.

The tone was that the regatta was slipping away from OTUSA, and maybe it was gone already.

To Spithill fell the task of bringing balance back to the dire tone of the proceedings, and to overcome the inference from the media that what he described as a re-grouping was instead a collapse. There was a lot to handle. Langford was doing a great job and absolutely not a factor in the losses, Spithill said as he had repeated since Race 1. No decision had been made on what changes would be made for Thursday, he said, and when asked to guarantee that Kostecki would be on the boat, Spithill was quick to point out he couldn't guarantee that he himself would be on the boat.

ETNZ's Ray Davies rightly ducked a question about the next defense as being above his pay grade, not to mention outright premature.

The closest anyone came to giving the Kiwis a tough question was America's Cup–winning tactician Gary Jobson, here again as a TV broadcaster, who probed Dean Barker to see how concerned he was about losing the last two starts to Spithill and what the NZL crew might do to get better. Barker registered no worry on the subject and said that they would carry on as before.

The crowd in the room wasn't hostile, but the assumptions about the outcome of the Match, and OTUSA's ability to compete against ETNZ, were unmistakable. The American team was nearly written off.

There were theories that the re-grouping explanation offered publicly for the ORACLE TEAM USA postponement was a smokescreen for more serious problems with the boat—the wing, the foil system, a mismatch in
their preparation, or something else that gave the team reason to expect a loss in the second race of the day.

On the television broadcast, Nathan Outteridge offered a perceptive take, saying that OTUSA had won one race, New Zealand had won one race, and OTUSA had lost three races. Though definitely not giving full credit to everything ETNZ had done right in their wins, Outteridge’s calculation dovetailed with the point of view that James Spithill expressed Tuesday that, much more so than in America’s Cup monohulls, teams pay huge penalties very quickly for small mistakes in AC72s.

New Zealand was now up 4-0 in points, with OTUSA yet to get on the board. The Kiwis needed five wins, the Americans ten.

**Wednesday, September 11**

ETNZ kept their boat in the shed on Wednesday, giving the AC72 and the crew a certain amount of respite, although they all worked on improving aspects of their operation, according to Dean Barker. For his part, Spithill said ORACLE TEAM USA would be doing all that, plus sailing on the water.

**Race 6, Thursday, September 12**

ORACLE TEAM USA put Ben Ainslie on the boat, replacing John Kostecki. Ainslie would work with Tom Slingsby on tactics while Spithill concentrated on helming. There were changes in the jib configuration, which had made ORACLE TEAM USA slow in tacking, and many as yet unseen adjustments.

The winds for Race 6 were 12 to 13 knots. ORACLE TEAM USA blocked ETNZ away from the line, started directly ahead of them at the gun, and led by 8 seconds at Mark 1.
Upwind, a split at the bottom of the leg allowed ETNZ to pull even, the boats taking turns ducking each other at crosses, New Zealand chipping away until finally the Kiwis had enough edge to try hunting their opponent when they came together, the confrontation known in match racing as the “dial-down.” The America’s Cup Racing Rules allow the right-of-way boat on starboard tack to “hunt” the give-way boat on port, something the normal rules prohibit. Hunting is when the starboard tack boat keeps pointing right at their opponent, even as the opponent is trying to keep clear, until the give-way boat ultimately has to turn away, sailing the wrong direction, downwind on an upwind leg. The meeting of the boats is essentially a game of chicken, threatening a head-on collision that the starboard tack boat gets to win. This was a first for the AC72s.

It’s a bit of a swat on the nose, and here the dial-down cemented a small lead for NZL that they used to keep OTUSA on the boundary. NZL left OTUSA two bad choices, either too many tacks (each adding slightly to ETNZ’s lead) or else OTUSA not tacking with ETNZ sitting on them from ahead. Again ETNZ converted a small lead at the top mark into an unrecoverable gap on the final downwind leg. OTUSA made gains downwind, about 100m out of the 590m lead, but using half the leg to do so.

ETNZ won Race 6 with a finish delta of 47 seconds. New Zealand was up 5-0 on points, not even counting the penalty, and four wins from taking the Match.

Race 7

Winds were up slightly, 16 to 17 knots. ETNZ to weather again won the drag race on Leg 1. Downwind trailing by barely 60m, a slow gybe cost USA another 40m.

Upwind, ETNZ covered. OTUSA tried to get out of phase, but in the tacking NZL’s lead grew halfway up the leg to 300m, insurmountable unless something went wrong for ETNZ. At the windward gate, the lead hit 400m. They would be well on their way home by the time USA got there 55 seconds later, with a 1000m lead downwind for ETNZ.

ETNZ won Race 7 by 1:06. They were now three victories from the Cup while USA still needed ten races.

A trailing ORACLE TEAM USA couldn’t match ETNZ upwind. Changing the crew had not changed the outcome.

The press was all over Spithill. How could OTUSA keep going? Why couldn’t they win?

“Well, we’re going to fight the whole way,” Spithill said. “We’re going to go out every single race thinking we can win. We have to, and we believe that. We still have a couple of options with the boat that we are going to make changes in this day off. A little bit of it depends on the weather, but we are going to have to be pretty aggressive now and obviously push as hard as we can, but look—we know if we sail well out there we can win races.”
Spithill’s strong conviction didn’t quiet the press. In the context of the events of the last few days, and the score, and the negative penalties, and winning the starts only to lose the races, this looked easily like bravado on Spithill’s part. Prodded again on the topic, he showed his boxing skills, slipped away and did a little counter-punching.

“I think the question is, imagine if these guys lost from here, what an upset that would be,” Spithill said, referring to Dean Barker and crew sitting next to him. “I mean they’ve almost got it in the bag. So, that’s my motivation. That’d be one hell of a story, that’d be one hell of a comeback, and that’s the kind of thing that I’d like to be a part of. I’ve been involved in some big fight-backs, you know, with some big challenges, and facing a lot of adversity, and that’d be the kind of thing I’d love to be involved in. I know I speak on behalf of all of the team, so that’s our motivation going in to the rest of this series. We feel we’ve got just as much chance to win this, and we’re going to do everything we can.”

He was the team leader and wasn’t going to admit defeat until the Match had actually been lost. After being on the defensive for so many days in the post-race briefings, Spithill was also trying to put the spotlight on Dean Barker, who up until then had mostly enjoyed the luxury of trying not to look too confident in the face of good results. Spithill was talking tough, but time to back it up was running out.

**Race 8, Saturday, September 14**

ORACLE TEAM USA did not sail in practice on Friday, a sign that in addition to giving the sailors a chance to refresh, though by no means rest, OTUSA also was making modifications to their boat. On Saturday, one visible change to 17 was a much shorter bowsprit.

OTUSA was getting out-tacked, out-pointed, and eventually out-raced on the upwind leg. Downwind they were somewhere between even and ahead of Emirates, but that wasn’t going to cut it. Emirates Team New Zealand were leading.
Emirates Team New Zealand leading near the top of the upwind leg. (© 2013 ACEA/Photo: Gilles Martin-Raget)
Zealand needed just three more races to take the America's Cup. OTUSA needed ten.

Better tactics to windward would help. In Thursday's racing ETNZ did everything they could to make the contest about their greatest advantages over the Defender. OTUSA got trapped near the boundary, with no good way out, having to tack repeatedly and lose ground each time. ETNZ had done better playing the flood current protection near Alcatraz Island, but Saturday would be an ebb current race, changing up the tactical landscape.

At the start of Race 8, Spithill couldn't get any advantage on Barker coming to the line, and ETNZ won the start. Downwind, USA traded gybes, ETNZ getting the better of the Defender by one maneuver. Delta at the leeward gate was just 8 seconds.

Upwind the boats started a tacking duel, working up the shore near the city, looking for small advantages in the wind. ETNZ tried to cover, but OTUSA started making gains, a 70m lead down to 50m. Nearing the top of the course, ETNZ was to the left of OTUSA, both on port tack. OTUSA had been inching up, the lead down to 5m, but the boats were several lengths apart across the course. OTUSA tacked to starboard, hoping to get to the left side and set up for the mark rounding. ETNZ was ready for their move, and tacked right on their track, dead ahead, a repeat of the way ETNZ had put an end to OTUSA's threat in Race 1.

NZL tacked in front of OTUSA, cranking hard in her turn with OTUSA close, and the boat coming out of the tack suddenly heeled up at nearly 45 degrees, the classic small-boat capsize about to happen with a 13-story wing at 20 knots. Aotearoa looked like it was going over. The boat hung there nearly ten seconds, somewhere close to the knife's edge, possibly the whole challenge campaign hanging in the balance. The crew called out “Hydro! Hydro!” apparently not having the pressure in their system to control the wing. The ETNZ wing was not self-tacking, and they needed the hydraulic system to ease the wing.

Spithill, sailing at 26 knots, had planned to duck below, saw his opponent's AC72 head up in his path, dead ahead. OTUSA had to crash-tack away to avoid a collision. There was no telling how quickly ETNZ was going to come down, in what direction, or where the boat would be headed after she landed.

ETNZ was penalized for tacking in front of OTUSA and not keeping clear, but by the time the Kiwis gathered their wits, they were far enough behind that the penalty was done. OTUSA was 300m ahead, about to take a big lead onto the final leeward leg. Downwind that quickly became 700m, and ORACLE TEAM USA won Race 8 by 52 seconds.

With their second victory, OTUSA had erased their penalty, and any wins after this would score points. ETNZ might have lost everything had they flipped over. Nothing appeared to be damaged, but OTUSA had finally broken TNZ's aura of invincibility. Sailing better, OTUSA had drawn close, and a simple mistake with big consequences had given them the opportunity to win.
The Match stood at 6-0 on points, with the penalties cleared, ETNZ still needing three races, OTUSA now needing nine.

**Race 9, Try 1, Second Race of the Day**

Winds were coming in at 19 to 20 knots, delaying the start by 15 minutes.

At the start, Spithill was slightly back and to windward of ETNZ, not close enough to roll over them in the drag race, and Barker to leeward held OTUSA past the reaching mark before bearing off with a small 60m lead downwind to ETNZ. Both boats were right on top of each other. Delta at the downwind gate was 7 seconds, with ETNZ barely ahead, when the winds built over the limit again and the Race Committee abandoned the race.

Barker was pleased by the starts, but still recovering from the near-capsize.

“We had two leads round Mark 1, which is something that we’ve been working hard on, so that’s encouraging,” Barker reported. “And then sailed the runs well. The second we were shaken up, it was still tight, but we felt we’re in a pretty nice spot, the boat felt better, we made some changes from the first race, and I think it would have been an interesting race. But tomorrow is another day and we’ll come out absolutely full on to make sure we win some races.”

Jimmy Spithill was happy to have something good to talk about, getting ahead of the New Zealanders, even if it had been while they were looking at the world from 30 to 40 feet in the air. “I think we’ve gained a lot in that we’ve improved our boat,” he said. “We’ve seen we’ve come from behind on the upwind leg and passed. So that is a huge step for our
team and a huge confidence booster. It’s exactly what we need. The guys have already got more ideas, and they are going to work all night again. And we’ll come out tomorrow ready to try and step it up once more.”

**Races 9 and 10, Sunday, September 15**

Barker was aggressive in the start of Race 9 (second attempt), but Spithill held ETNZ to windward, away from the line, letting USA break away first, and taking a 4-second lead at Mark 1.

USA extended on the first downwind leg to nearly 200m at the downwind gate. Delta was 18 seconds.

With NZL working the shore side of the course and OTUSA on the other, a right shift helped USA edge out to a 300m lead. The Kiwis were not gaining. USA was also battling to round the upwind gate before wind limits might cause the race to be abandoned. They were well ahead, a delta of 33 seconds.

ETNZ split from the Defender on the leeward leg, hoping there was something that could be done other than follow, but Leg 4 was no kinder to ETNZ when they were losing than it had been to anyone else. A 500m lead grew to 740m.

OTUSA won Race 9 by 47 seconds. The score stood 6-1 for ETNZ. The first to nine points now would win.

There was something more than just the victory if you looked closer. ORACLE TEAM USA had gained on every leg of Race 9.

At the start of Race 10, winds were near the limits of 21.5 knots.

NZL wanted the pin end. Barker sailed down past the lay line a bit, trying to get Spithill on his right, and block him from the line. Spithill tried to chase him closer to the line, tried to push him too far to lay the pin. After the starting gun, NZL maintained the overlap, preventing USA from getting in front. It was a 3.5-second delta for NZL at Mark 1.

Onto the downwind, USA cut a 200m lead to 120m, but a slow rounding for USA gave up distance to NZL. It was a 10-second delta at the downwind gate.

Upwind, OTUSA closed up the lead, down to 150m. Wind on the left looked better, but NZL tried the right looking for better current. NZL soon tacked back, with the lead under 100m.

A long port tack paid off for USA. The boats converging, OTUSA pulled in front and crossed ahead by 20m, taking the lead as NZL, on port, had to duck.

With the upwind gate coming, there was a big cross near the port lay line. USA had to dip. NZL was back in front!

On the next tack, they might make the gate. NZL couldn’t get in front, crossing each other just below the gate. OTUSA didn’t hunt them, and instead went to the left mark. NZL went to the right. Less than a one-second delta was between them at the upwind gate. Two legs remained.

ETNZ gained on the offshore side of the course and was ahead again
by just meters as they came together on the final downwind leg. Spithill went behind them and stayed on port gybe, but he lost distance. NZL pulled out to 100m. There was no place to make more gains for OTUSA. NZL had a line to the mark and the finish, and won Race 10 by 16 seconds. The score was now 7-1.

Race 10 would stand as the height of the battle, one wild race where the lead changed hands four times, and the deltas at the marks were never larger than 11 seconds.

The AC72 yachts had been amazing to watch, especially in person, where the size and visceral speed of the boats was almost hard to comprehend. A 131-foot-tall boat, with a footprint the size of a tennis court, screaming across the finish line 8 feet in the air, seconds ahead of their opponent, was an adrenaline rush even for spectators. It was a technological achievement that even the authors of the Class rule didn’t know was possible when they started.

“I can honestly say this is the most fun and exciting sailing I’ve been involved with,” said Ben Ainslie after the race.

“If you didn’t enjoy today’s racing, you should probably watch another sport,” said Barker.
Though USA and NZL had been clocked nearly equal if you looked at average speeds, USA had gained on only one leg, the upwind. Even then they had lost the lead. But the Defender and Challenger had never looked so equal since the Match started.

Spithill wouldn’t confess as to exactly what they had changed on-board 17 to improve their performance, but he was willing to say they weren’t done.

“This is a development boat. Like any racing sport, whether it’s F1 or Moto GP, you’re constantly learning how to race them,” said Spithill. “Even today we have a heap of stuff we’d like to do to the boat.”

The question was whether ETNZ would give them time to manage it.

**Race 11, Wednesday, September 18**

Two races away from winning the Cup, ETNZ could now win the regatta if they swept the day. OTUSA was getting better. They seemed to have fixed their weaknesses, and the teams looked even. With ETNZ needing two races to OTUSA’s eight, splitting the daily outcomes as on Day 7 would do the trick before too long.

At the start of Race 11, the boats were late rather than early to the line for a change, Barker with position ahead. Mark 1 showed a 3-second lead for NZL.

On the downwind leg, NZL loosely covered, keeping a 6-second lead at Mark 2. NZL turned left, USA turned right, giving separation to USA as they started Leg 3 upwind.

The right turn paid off for USA, and they took the lead, but a tacking duel erupted, sustained until finally NZL succeeded with a lee bow tack onto USA, right ahead, and USA had to short tack to get away, giving back the lead to NZL.

The tacking duel continued, but OTUSA trailed by about 120m at the crosses, both teams working the left side of the course to minimize current.

NZL was hanging on to a 100m lead, but USA was making gains now in the middle of the course, with both boats on port tack. The lead went down to 50m, then down to 30m. USA tacked to starboard, but NZL just made it past them without having to duck. NZL tacked on them and USA tacked back. NZL got the better of the exchange.

USA came into the gate on starboard, NZL on port. USA was downspeed and gave NZL about a 100m lead around the mark. It was a 16-second delta at the windward gate.

A 300m lead for NZL downwind. USA was gaining slowly, but it was too big of a deficit to overcome with not much time left. OTUSA got close, very close, but ETNZ rounded Mark 4 at much better speed and held them off.

ETNZ won Race 11 by 14 seconds. Match total now stood at 8-1—match point for NZL.

USA was close, and starting with a lead rather than behind might have made the difference. A slow tack at the top of Leg 3 put them in a
hole they couldn't get out of, despite cutting NZL’s lead from 300m down to under 100m on the second-to-last leg. Race 11 had been close, and USA might have had enough boat speed, but ETNZ prevailed on tactics in the start, upwind, and at the downwind mark.

In Race 12, Try 1, the wind limit was called 15 seconds before the start, abandoning the race, and rising winds prevented another start before time ran out for the day.

Race 12, Thursday, September 19
America’s Cup match point now. ORACLE TEAM USA’s back was to the wall, every race now a must-win for them.

In the pre-start, USA and skipper Jimmy Spithill caught NZL on their back foot and got a nice jump at the line while ETNZ was headed up, though still it was just a 5-second delta at the line.

Downwind, both gybed, 110m lead for USA, but NZL gained slightly on the gybes. Coming into the gate, OTUSA ahead rounded first, turned left, taking the offshore side. NZL turned right, 11 seconds behind.

USA went up to the right-hand boundary, then tacked. Both boats now on starboard, NZL made gains, the lead going to NZL. They tacked to port. Cross coming, lead going back to USA, who had right-of-way and crossed ahead. USA tacked at the left-hand boundary and when they came back were well ahead of NZL—a 115m lead. USA consolidated their lead, tacking ahead of NZL, and bounced them back to the left.

It was a struggle all the way up the leg, though. USA crossed the tide line, NZL got a boost from the ebb current. Both settled in on port for a long tack. USA gained slightly and tacked to protect the favored left side now. NZL stuck it out on the right. The USA lead was 145m.

NZL had an extra tack before rounding the gate. USA clear ahead rounded first, turned right, and went for the offshore and some favorable current. NZL turned left, behind by just 10 seconds.

On the final downwind leg, the gap started out at 200m, but was quickly up to 400m. USA had a much better angle. Quickly it was an over-500m lead for USA.

ORACLE TEAM USA won Race 12. Match score was 8-2 for NZL—still match point.

Race 13, Try 1: Winds over the limit scratched the second race of the day just as the boats were entering the starting box, pushing Race 13 to Friday.

Race 13, Friday, September 20
The Heartbreaker
ORACLE TEAM USA had a new measurement certificate, now with a longer bowsprit in order to fly a code zero in the very light conditions expected.
Race 13, Attempt 2: Very light winds reported at 7 to 11 knots. Low fog was heavy on the windward end of the course, near the Golden Gate Bridge.

With the unusually light breeze, USA set up immediately for the line on a time-and-distance start. NZL came back and got to windward of them. Slight lead for USA at the start, just 20 knots boat speed on the reach to Mark 1, where usually the yachts were going 40 knots plus. USA luffed NZL, keeping them away from Mark 1. All was in slow motion compared to earlier races.

It was a 10-second delta for USA at Mark 1. USA ahead, NZL slightly behind and to weather. Downwind boat speeds were only in the teens. NZL got advantageous current first and pulled nearly even. Then NZL found some wind, enough to fly a hull, and soon built a lead. They were 400m ahead while USA was still trying to find better wind, and 600m ahead by the bottom gate.

USA rounded 1:41 behind, but not the biggest factor. ETNZ was racing against the clock. There was a time limit of 40 minutes this course, per the Sailing Instructions, and it took 14 minutes just for Legs 1 and 2...
Millions of sailing enthusiasts and casual fans alike watched the America’s Cup in awe as the ORACLE TEAM USA trailing one point to New Zealand’s eight, was first to the finish line in eight consecutive races. Now here is the inside story of that historic win, a narrative that goes beyond the emotions of the day to explain how the many months of innovation, research, trials, and failures helped secure the Cup in the final race on September 25.

Winging It features insights from naval architects and builders on their radical boat designs, the consequences of racing these untested boats, and explanations of how the foils and wingsails—rarely seen on boats before—work. The book explores the impact of events that led up to the Cup, including how a sudden capsize threw the entire event into doubt before the 2013 America’s Cup ultimately delivered an epic finale.

The 2013 Americas’ Cup was one for the books—Winging It helps sailors and armchairs sailors understand why.

Diane Swintal has written about yacht racing as well as auto racing for 25 years, covering the America’s Cup, the IndyCar series and sports car racing.

R. Steven Tsuchiya is a historian and freelance photographer of the Americas’ Cup. Steve is a contributor to Sailing World magazine and other yachting publications.

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