

Riblets for Stars & Stripes

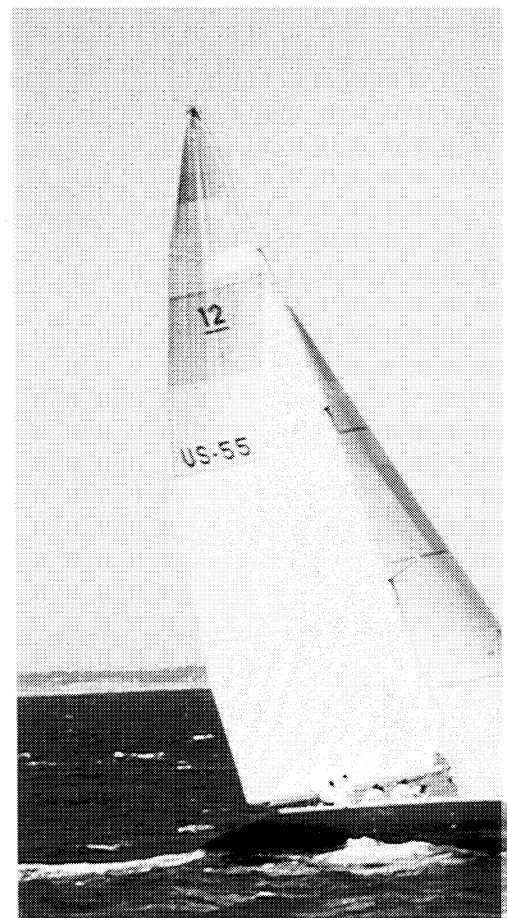
On February 4, 1987, Skipper Dennis Conner and his 10-man crew guided the blue-hulled racing yacht *Stars & Stripes* past the finish line at Fremantle, Western Australia and brought the America's Cup back to the United States.

Representing the San Diego (California) Yacht Club, Conner and *Stars & Stripes* scored a 4-0 clean sweep in the best-of-seven finals over Australia's *Kookaburra III*, after a lopsided 4-1 semifinal victory over *New Zealand*. Rarely headed in those last nine races, *Stars & Stripes* performed magnificently in a variety of wind and wave conditions. There were many contributing factors to *Stars & Stripes'* convincing superiority, such as overall boat design, tactics, sail selection and, most importantly, the impressive seamanship of the 11-man team. An additional factor was NASA technology.

In a Fremantle press conference, *Stars & Stripes* design coordinator John Marshall disclosed the boat's "secret weapon": the hull's underside was coated with "riblets," a technology developed by Langley Research Center as part of NASA's continuing investigation of ways to improve aircraft fuel efficiency. Marshall said his group had selected riblets to improve boat speed after testing more than 40 hull coatings "from gops to goops and paints."

In aeronautical research, riblets are small, barely visible grooves on the surface of an airplane intended to reduce skin friction by smoothing the turbulent airflow next to the skin. The grooves are v-shaped with the angle pointing in the direction of the airflow; no deeper than a scratch, they have a pronounced beneficial influence on air turbulence.

At Langley, the first riblets were machined on flat aluminum sheets



and wind tunnel tested. When engineers of 3M Company, St. Paul, Minnesota learned of the experiments they advanced a suggestion: why not mold riblets into a lightweight plastic film with adhesive backing and press it into place on an airplane? This would be simpler than grooving metal and would offer the extra advantage that the riblet film could be applied to existing aircraft as a relatively inexpensive retrofit measure. Langley accepted the company's offer to produce riblet tapes for research and used them in 1986 tests on a Learjet aircraft. The film riblets demonstrated in flight a drag reduction capability similar to that found in wind tunnel tests—about eight percent.

The technology offers a means to reduce hull friction for vessels moving through water. A collaboration among 3M, The Boeing Company and the Flight Research Institute of Seattle, Washington resulted in the first water tests of riblet film in 1984.

A racing yacht adaptation of NASA drag reduction technology heads a selection of spinoff applications for consumer, home or recreational use



Stars & Stripes (US 55), with Dennis Conner at the helm, rounds a buoy in America's Cup competition off Fremantle, Australia. The American boat's hull incorporated a NASA drag-reducing technology called "riblets."

Courtesy Nils Salvesen, Science Applications International Corporation

of computerized design technique, offshoots of the aerospace-originated practice of creating a mathematical model of a design and "flying" it by computer simulation to study the performance and structural behavior of many different designs before settling on a final configuration. Aided by a number of aerospace companies, who developed special "flow codes" for computerized measurement of water forces on a hull design, and in some cases by NASA-developed computer programs, the 12-meter yacht developers employed advanced fluid dynamics techniques to optimize their designs.

In addition, most America's Cup yachts—including *Stars & Stripes*—had "winged keels," adaptations of aircraft winglets, another technology developed by Langley Research Center to reduce air drag. On the 12-meter craft, the winglets were fins extending horizontally on either side of the keel to provide greater stability through balanced lift when the yachts heeled sharply to one side.

Langley's winglets are already in service on a number of operational aircraft; riblets may soon follow. They are still in an early stage of development, but Langley researchers feel that they can double the demonstrated drag reduction of eight percent. A reduction of 15-16 percent would translate into five percent less fuel expenditure; for the U.S. commercial airlines alone that could mean cost savings in the hundreds of millions annually. ▲

Among several boats fitted with riblet tapes, one was a U.S. rowing shell that competed in the 1984 Summer Olympics at Los Angeles in the four-oar-with-coxswain category. It won a silver medal in an event where no U.S. team had triumphed for several years. Boeing, the world's largest producer of commercial airliners, has initiated its own research program investigating the application of riblets to jetliners.

Riblet film was not the only aerospace technology employed by the 1986-87 America's Cup teams; in fact, it would have been fairly safe to predict in advance that the eventual winner would feature some type of aerospace technology. Virtually all of the competing syndicates used some form



Photo by Richard Sands.

Members of the Stars & Stripes syndicate examine the riblets on their boat's hull. Riblets are tiny grooves, visible only by very close inspection, molded into a plastic film with adhesive backing; they smooth waterflow over the hull and thus reduce drag.