EXCERPTS ONLY

THE GRUMMAN STORY

RICHARD THRUELSEN

PRAEGER PUBLISHERS

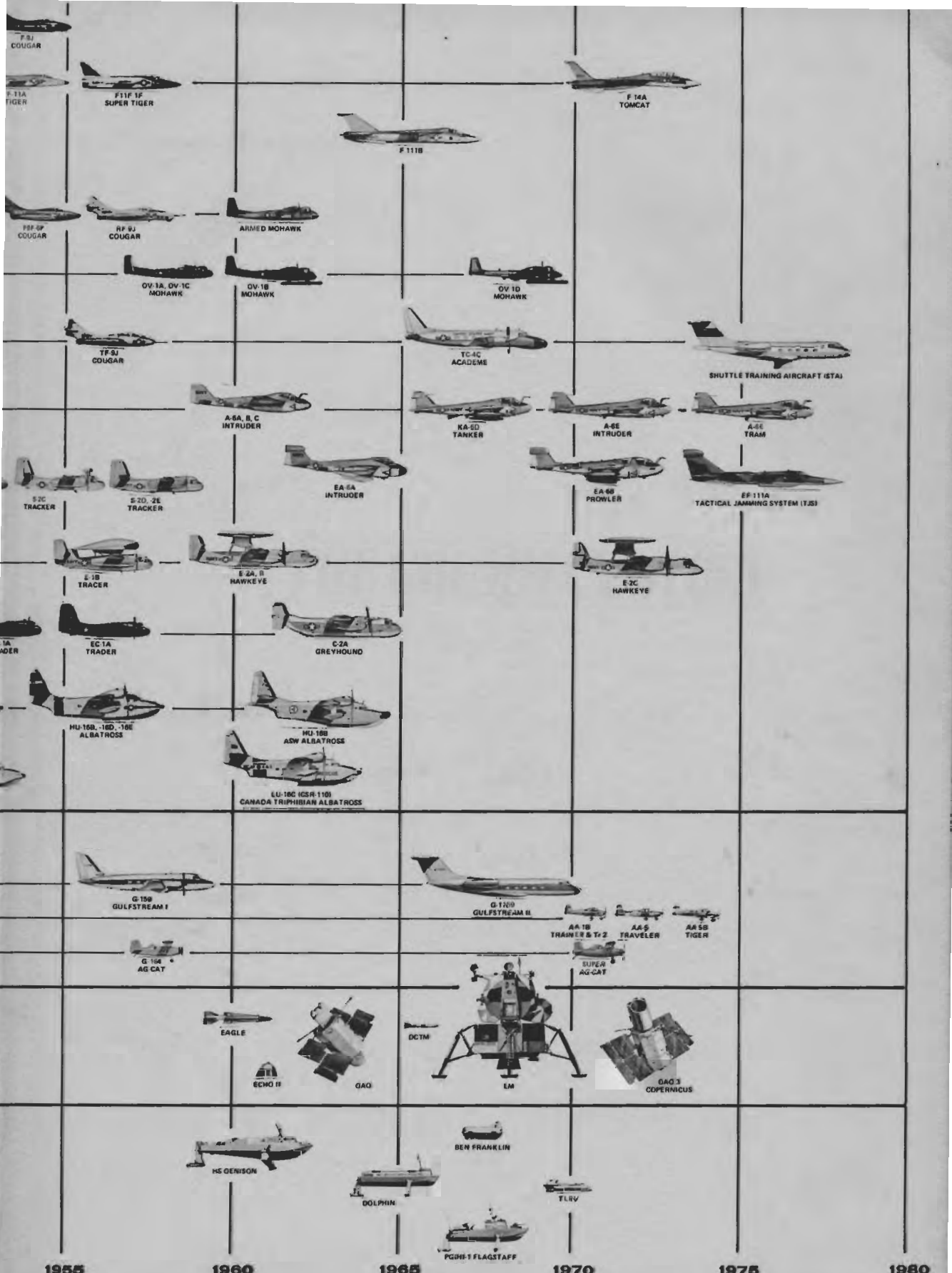
NEW YORK

Published in the United States of America in 1976
by Praeger Publishers, Inc.
111 Fourth Avenue, New York, N.Y. 10003

Second printing, 1976

Library of Congress Cataloging in Publication Data
Thruelsen, Richard.
The Grumman story.
Includes index.
1. Grumman airplanes. 2. Grumman Corporation.
I. Title.
TL686.G78T48 338.7'62'9133340973 75-13832
ISBN 0-275-54260-2

Printed in the United States of America


F-9J COUGAR
F-11A TIGER
F11F-1F SUPER TIGER
F-14A TOMCAT
F-111B
F8F-2P COUGAR
RF-9J COUGAR
ARMED MOHAWK
OV-1A, OV-1C MOHAWK
OV-1B MOHAWK
OV-1D MOHAWK
TF-9J COUGAR
TC-4C ACADEME
SHUTTLE TRAINING AIRCRAFT (STA)
A-6A, B, C INTRUDER
KA-6D TANKER
A-6E INTRUDER
A-6E TRAM
S-2C TRACKER
S-2D, -2E TRACKER
EA-6A INTRUDER
EA-6B PROWLER
EF-111A TACTICAL JAMMING SYSTEM (TJS)
E-1B TRACER
E-2A, B HAWKEYE
E-2C HAWKEYE
EC-1A TRADER
C-2A GREYHOUND
HU-16B, -16D, -16E ALBATROSS
HU-16B ASW ALBATROSS
LU-16C (CSR-110) CANADA TRIPHIBIAN ALBATROSS
G-159 GULFSTREAM I
G-1159 GULFSTREAM III
AA-1B TRAINER & TR-2
AA-5 TRAVELER
AA-5B TIGER
G-164 AG CAT
SUPER AG-CAT
EAGLE
ECHO II
OAO
DCTM
LM
OAO-3 COPERNICUS
HS GENISON
BEN FRANKLIN
DOLPHIN
TLRV
PGM-1 FLAGSTAFF
1955
1960
1965
1970
1975
1980

they have operated. One AgCat, under its own power and by short stages, flew from Elmira to the coffee fields of Ecuador—quite a trip for a little plane that is designed to fly from one end of a field to the other.

The Albatross. The Albatross, the big, twin-engine air-sea rescue and transport amphibian Grumman produced for the Air Force, the Navy, the Coast Guard, and various foreign countries during the late 1940s and early 1950s, was back in Bethpage during this period. Most of the planes came back as part of the IRAN program, which had been established in 1955, and about half of the returnees underwent a substantial modification.

IRAN (inspect and repair as necessary) was a maintenance project that took planes out of service after a given number of hours and restored them to first-flight condition. The air-weary aircraft were inspected by government and Grumman inspectors and given a major overhaul, which included new and improved parts and equipment.

Some 240 of the SA-16A Albatrosses that returned to Bethpage were modified so substantially that they were given an SA-16B designation. The major changes included a larger wing with a new curvature, larger tail surfaces, and various other aerodynamic improvements. With these modifications, the rate of climb improved, the payload was increased, and the stalling speed was lowered. Straight-line range was extended to 2,600 nautical (3,000 statute) miles or, alternatively, the cruise speed could be increased by 25 knots. The services got a "good-as-new" airplane with an improved performance for a relatively modest investment. As an air-sea rescue aircraft, the Albatross more than earned its keep in Korea.

The Hydrofoil. During the decade that followed World War II there was a renaissance of interest in the hydrofoil. The application of a lifting surface to raise a boat's hull out of the water and obtain more speed and efficiency, first demonstrated by Forlanini in 1905 and later developed by Alexander Graham Bell, looked like a concept that would fill the gap between the fast surface vessel and the much faster airplane. There were both military and commercial possibilties to be exploited.

The Navy was interested mainly from the point of view of antisubmarine warfare. The submarine's underwater speed capability was increasing rapidly, and since the rule of thumb was that the sub's adversary should have a two-to-one speed advantage there was a very real possibility that the fastest surface vessels might soon be outpaced by the subs.

The commercial possibilities held a more immediate promise. By the early 1950's several countries, including Russia and Italy, had developed hydrofoils that were performing successfully in commercial operations involving passengers and cargo on rivers, lakes, and relatively protected offshore waters. These craft weighed from 30 to 80 tons and operated in the 40- to 50-mile-an-hour speed range when foilborne.

For Grumman, the hydrofoil concept was a natural line of diversifica-

The Sea Wings were a spin-off from Grumman's hydrofoil research.

tion. The company knew just about all there was to know about airfoils, which acted on the same general principle as hydrofoils; its plants had turned out more amphibian airplanes than all the other manufacturers combined; it had both the equipment and know-how for aluminum construction, which was mandated for the hydrofoil vessel; and, finally, it was already in the boat business with its small craft and its Pearson subsidiary.

Hydrofoil studies began in 1956, and during the next two years Grumman engineers and designers worked under several dozen contracts, most of them for the Navy, on various research projects involving the hydrofoil itself, the vessel which carried it, and the performance parameters under varying sea conditions. This work in fluid dynamics was highly technical and, incidentally, far closer to the environmental conditions that would later be encountered in space than the acrodynamics involved in atmospheric flying.

Grumman's first substantial commitment to a hydrofoil program was the purchase of a 50 per cent interest in Dynamic Developments, Incorporated, in August 1956. Dynamic Developments was a small concern in nearby Babylon, Long Island, which, under the direction of a gifted engineer named William P. Carl, had been studying the dynamics of the hydrofoil for some years. The company had built an experimental 53-foot hydrofoil boat which, powered by aircraft engines, had reached a maximum speed of 79 knots—just over 90 statute miles per hour. Dynamic Developments became a Grumman subsidiary, through merger, in 1960.

Grumman's first marketable hardware in the field was a pair of retractable fiberglass hydrofoils that could be attached to a 14-foot aluminum Grumman runabout or any similar light-displacement craft powered by an outboard motor. The hydrofoil kit, called Sea Wings, increased the maxi-

Grumman's aluminum runabout, one of a varied line of small boats.

mum speed of such a boat by 25 per cent. They sold for $495 when factory installed on a Grumman boat and for slightly less as a do-it-yourself kit. Following an exhibit in the 1958 New York Boat Show, some 200 sets of Sea Wings were sold.

The Sea Wings were an incidental by-product of Grumman studies; over a period of three or four years, they established this country as a leader in hydrofoil research. Among the areas investigated were the properties of subcavitating and supercavitating foils and propellers. (Cavitation is the formation and collapse of vapor pockets in a flowing liquid in regions of low pressure, i.e., over a foil moving through the water at high speed.) There were also studies of the capabilities of surface-piercing versus fully submerged foil systems, hull designs, power plants, and transmissions for hydrofoil vessels and of the autopilots needed to actuate and control fully submerged foil surfaces in operation.

From these studies, with the aid of a good deal of sophisticated test equipment, Grumman in 1960 developed a 20-foot manned working model of a modern hydrofoil vessel. It was called the *Great Expectations* and, true to its name, led to the development, in the early 1960s, of the world's first high-speed open-water hydrofoils for military and commercial use. The initial contract in this field, for the design and development of a 104-foot, 90-ton commercial hydrofoil vessel, was awarded to Grumman by the Maritime Administration in February 1959.

Boats and Bodies. Grumman's metal boats division, formed shortly after the launching of the aluminum canoe project in 1945, prospered during the ensuing decade, though its balance sheet was dwarfed by the cash flow involving Grumman's aeronautical activities. In the late 1940s the divi-

sion added a dinghy and a small runabout (both of aluminum) to its line, and in 1954, needing more production space, it moved to a plant in Marathon, New York.

The post–World War II cutback in the military aircraft programs was still a lively memory at Bethpage, and the company has continued to explore any likely avenue for diversification into nonmilitary markets. In 1959 Grumman bought a controlling interest in Pearson Yachts of Portsmouth, Rhode Island, a company that had built a fine reputation for its design and construction of fiberglass sailing yachts and motor-sailers, which ranged up to 42 feet in length. Under Grumman direction, Pearson continued to operate as an autonomous unit. In 1963 both Pearson and Grumman Boats were merged into a new subsidiary, Grumman Allied Industries.

It will be remembered that Grumman built a number of truck bodies as side-work during the lean times at Baldwin. The purchaser of those bodies was Ted Lyon of the Motor Haulage trucking firm, and during the war Lyon, an old friend of Roy Grumman, went to work at Bethpage. When Grumman, seeking diversification, began to build truck bodies again in 1946, Lyon was the logical person to head the program.

The truck bodies, all of them of aluminum and most of them at that time for delivery vans, were built for several years in Plant Number 1. They found a ready market, and as production expanded (and aeronautical production began to recover) Grumman decided to move the project to its own plant. A facility was found in Athens, New York, and the truck body operation, now a full-fledged subsidiary named Aerobilt Bodies, moved there in the early months of 1949.

There's a story about the launching of Aerobilt Bodies, told by Pat Cherry, who was then chief accountant at Grumman and who became treasurer of the new body company. According to Cherry, Roy Grumman

Grumman aluminum truck bodies come in all shapes and sizes.

after he had swept the leaves out of the Baldwin garage. Bill Schwendler was chairman of the executive committee. Ed Poor was treasurer. Joe Stamm was secretary.

There were eight vice presidents overseeing various phases of the company's activities. Six of them have already appeared in these pages: Dick Hutton, Bill Hoffman, George Titterton, Bob Hall, Henry Schiebel, and Joe Bolger. The other two, newly elected, were Lew Evans, a lawyer with a background of government service, and Ed Clexton, a retired admiral who functioned as a planning executive.

During 1960 the Grumman payroll averaged 14,400 employees. Sixteen of these employees were from the Baldwin group of twenty-one originals. Sixty-seven per cent of the 1960 Grumman payroll had been with the company for more than five years. The average "turnover rate" was just over .6 per cent per year, less than one-quarter of the rate for the aerospace industry as a whole.

Grumman's gross sales for 1960 were $325.5 million, a record that just topped the previous high of $323.7 million during the World War II year of 1944. Its net income for 1960 was $7.1 million, 2.21 per cent of its gross sales. There were 11,737 shareholders and 2,201,400 shares of common stock outstanding. The annual dividend rate was $1.50 per share.

At the end of 1960, Grumman listed its assets at $105.7 million, of which $24.7 million represented fixed assets—buildings, machinery, equipment, and land. Its total liabilities were $46.1 million, and it had retained $53 million in earnings for use in the business.

This tight-knit organization and this balance sheet, a healthy one by any standards, served as Grumman's launching pad for the Spectacular 'Sixties.

The Boat That Flies. Grumman's first involvement with the hydrofoil concept during the middle 1950s—its studies and development work for the Navy, its absorption of Dynamic Developments, Inc., its production of the Sea Wings kit and, later, of the working model *Great Expectations*—was described in the previous section.

By the late 1950s the hydrofoil project, for all its achievements in the R & D field, seemed to be running out of thrust. Grumman was ready to put its hard-won knowledge to work in designing a sea-keeping hydrofoil boat of practical dimensions, but it lacked a customer. The black-shoe Navy (the seagoing Navy, as distinguished from the brown-shoe, or flying, Navy) was interested in the research but showed no inclination to fund an experimental vessel of any size. In formal Navyese, by the way, there are now three systems commands: NAVAIR (Naval Air Systems), NAVSHIPS (Naval Ships Systems), and NAVELEX (Naval Electronic Systems).

Grumman looked around for an alternative sponsor for hydrofoil development and found one in the Maritime Administration. Charles Denison, an engineer with the agency, was deeply interested in the potential of the hydrofoil concept for large vessels, and through his efforts Grumman,

The Denison *foilborne at a speed of approximately 60 knots.*

in 1957, received a contract for a study of the possibilities and problems involved in ships in the 50- to 200-knot speed range, with displacements from 100 to 3,000 tons and with ranges up to 3,600 nautical miles.

This feasibility study concluded that "hydrofoils offer an efficient and practical means of transportation at speeds significantly greater than conventional craft." Unfortunately, Denison, the hydrofoil's chief proponent in the agency, died while the plans and Marine Administration funding for a 100-ton, 80-knot prototype were still in the discussion stage. What finally evolved was a 90-ton proto, for which the administration contributed about $1.5 million. Grumman contributed about $2 million in material and labor to the project, General Electric provided a 14,000-hp. gas turbine engine (a conversion of a turbojet aircraft engine) for the main power plant at no cost, and forty-two other American companies contributed equipment and engineering services.

Work on the craft, named the *H. S. Denison,* was begun at Bethpage in 1960, and the ship was launched in Long Island Sound in June 1962 —the world's first high-speed open-ocean hydrofoil vessel. The *Denison*'s LOA was 128 9″, its beam was 23′, and its draft was 6.2′ with foils up and 15.4′ with foils down. Two hydrofoils, one on either side, were placed just forward of the midships line and a third at the stern. In foilborne operation, the main gas turbine drove a free turbine, which turned a supercavitating propeller set in the stern hydrofoil; when hullborne, the ship was driven by two water jets powered by a smaller turbine.

The *Denison,* with its V-bottomed, slab-sided aluminum hull and its high dead rise running from bow to stern, was no beauty when it was hullborne. When foilborne, however, and running full bore at 60 knots (almost 70 miles per hour) it was a spectacular, gravity-defying sight. Leo Geyer,

Moving the 90-ton Denison *from the Bethpage plant across Long Island to the Sound presented some problems.*

who was in charge of the project for preliminary design, recently recalled its operational history:

"The *Denison* was quite a successful boat. It was strictly a test-bed, though. It was designed simply to prove feasibility. Later, down the road, Maritime decided we ought to put on a passenger compartment and move people around, so we stuck a compartment that would take about a dozen passengers up on the bow.

"We moved the *Denison* up and down the East Coast, taking out groups of VIPs at various ports-of-call. It was a sort of educational and promotional effort. We had it out in some pretty rough stuff, and it always gave a good account of itself."

The *Denison* had both trim control and a computerized automatic feedback control, which adjusted the angle of attack of its surface-piercing foils in various sea conditions. The vessel could sustain foilborne operation in head seas with waves up to 6 feet, and its maneuverability, including high-speed turns, was superior to conventional ships of its size.

After its trials and test programs and the promotional junket the *Denison*, being a test vehicle, had no place to go. Grumman had no reason to maintain the vessel and the Maritime Administration had no use for it, so it was given to the Navy, which took it out to the West Coast. There, the *Denison* was given more trials and then put into service as a transport ferry to the islands off Point Mugu, California. The *Denison* was finally mothballed and, eventually, cannibalized.

Grumman's next substantial hydrofoil project (after working on a number of Navy proposals involving landing craft and amphibious vehicles with

hydrofoils) was a design for a 300-ton, destroyer-type vessel with a fully submerged foil system and two of the GE *Denison*-type gas turbines for foilborne propulsion. In these converted jet engines, the jet exhaust turned a free turbine, which was attached to the propeller shaft.

The AG(EH) (auxiliary general-purpose experimental hydrofoil) vessel was 220 feet long with its foils retracted and had a 15-foot clearance between the keel and the smooth-water line, enabling it to operate in sea state 6, with 10-foot waves. Its projected top speed, foilborne, was 50 knots; this could be increased to 80 knots with additional power.

The AG(EH) project was generated within the Grumman preliminary design group and, after a good deal of hustling, sold to the black-shoe Navy in Washington on the basis of a preliminary design and the general specifications of the projected vessel. The Navy proposal for final design and specifications involved a competition among nine of the leading aerospace firms. By this time, 1962, the whole industry was getting interested in the hydrofoil act. Grumman won the competition and proceeded with the detailed design and engineering for the vessel.

The next step—and the next Navy proposal—was the construction of a prototype. Grumman, which had teamed up with Newport News Shipbuilding for the hardware phase, was by this time high on the learning curve in the hydrofoil business, and its estimate for the cost of building the prototype vessel was on the order of $16 million to $18 million. The Navy, which had set aside $12 million for this construction, thereupon took over the drawings, plans, and specifications and set them on a block for anyone who wanted to build the prototype for the funded $12 million.

Lockheed bought the package and after considerable travail and, understandably, a number of specification changes, produced its version of Grumman's design. The AG(EH) went into experimental service but experienced a lot of operational problems. Grumman entered the vessel's up-and-down career once again in 1972, when it received a Navy contract to redesign some of the AG(EH) systems with a view to improving the vessel's performance. The AG(EH) was still operational in 1974 and was based in Bremmerton, Washington.

During its inconclusive experience with the AG(EH), Grumman produced the design of its third open-water hydrofoil. This was to be the *Dolphin*, an eighty-passenger, 45-knot ferry utilizing the fully submerged foils and many of the other advances incorporated in the AG(EH). A 50-ton vessel with a windowed passenger compartment aft of the control area, the *Dolphin* employed a gas turbine for foilborne operation and two diesels driving water jets for hullborne propulsion. It had about the same seakeeping capabilities as the earlier *Denison*.

As it was to be a commercial venture, the project was funded by Grumman and the companies that shared in its engineering and construction. The Garrett Corporation, which produced the autopilot control for the foil system, also acted as marketing agent for what was planned as a continuing production effort. Since Europe presented more immediate mar-

The 50-ton Dolphin *had an in-and-out track record as an oceangoing ferry.*

keting possibilities than the United States, the German firm of Blohm and Voss was selected to build the vessel.

The prototype *Dolphin* was completed in 1966 and after successful sea trials in the Baltic was transferred to Maritima Antares, a Spanish shipping firm, in May of the following year. The vessel then made a foilborne passage of 2,500 miles to the Canary Islands, off the coast of West Africa, where it was put into ferry service on a 50-mile open-water run between Las Palmas and Santa Cruz de Tenerife.

The Canary Island experience was a sad one for everybody involved. Being a prototype, the *Dolphin* suffered from its share of bugs (the remote Spanish islands were a bad place for a technical debugging operation), and the sea states often taxed the capabilities of the vessel as it attempted to maintain a regular ferry schedule. After eleven troublesome and contentious months, Maritima Antares exercised its option to return the vessel to the Grumman group, and it was shipped to Florida for further fixes and testing. A second *Dolphin* in the construction stage was, meanwhile, abandoned.

The extant *Dolphin* was, subsequently, leased to a group that employed it on a run between Miami and Freeport, in the Bahamas. Here again, it had trouble maintaining a ferry schedule across the sometimes turbulent Gulf Stream. In the autumn of 1969, it moved on its own bottom to the Virgin Islands (snagging a coral head off Samana, in the Dominican Republic, en route), where it operated during the winter season as a ferry between Saint Thomas and Saint Croix. In December 1970 the *Dolphin* was sold to the Navy. It is now in San Diego, where it has been partly cannibalized for equipment needed in the Navy's other hydrofoil projects.

The unhappy experience with the *Dolphin* as a ferry dampened Grumman's enthusiasm for the hydrofoil as a commercial venture in the civilian market. Meanwhile, the company's marine engineering group had designed a patrol-boat type of vessel (functionally, it would be analogous to the World War II PT boats) using substantially the same hull, foils, and propulsion systems employed by the *Dolphin*, a military version of the passenger ferry. The Navy liked the concept and contracted with both Grumman and Boeing to build prototypes. The vessels were similar in size and performance, but the Boeing proto used a somewhat different foil configuration and employed water jets for its foilborne propulsion.

Both the Boeing *Tucumcari* and the Grumman *Flagstaff* proved to be successful test-beds, and the Navy has used them since 1968 to evaluate various weapons-system configurations. The two vessels are still operational and are based in Bremmerton, Washington.

What are the course and heading of the hydrofoil concept? Its proponents think it is a part of transportation's future and will be part of the military arsenal. Boeing has recently built a prototype hydrofoil gunboat, the PMH, for NATO and expects that it will be produced in quantity. The same company is now planning or building a number of hydrofoil ferries for use in various parts of the world. Grumman's marine engineering staff, surely one of the most knowledgeable groups in the field, is still enthusiastic and working on Navy studies and plans for a super *Flagstaff*. And the Navy, which has recently shown a disposition for smaller and faster war vessels, may now be taking a long second look at the hydrofoil.

The hydrofoil idea may be a concept that had to wait for its hour to strike.

The 67-ton Flagstaff, *a patrol gunboat, has served as a successful test-bed for Navy hydrofoil experiments.*