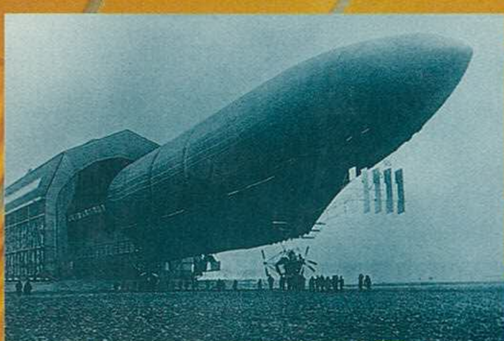
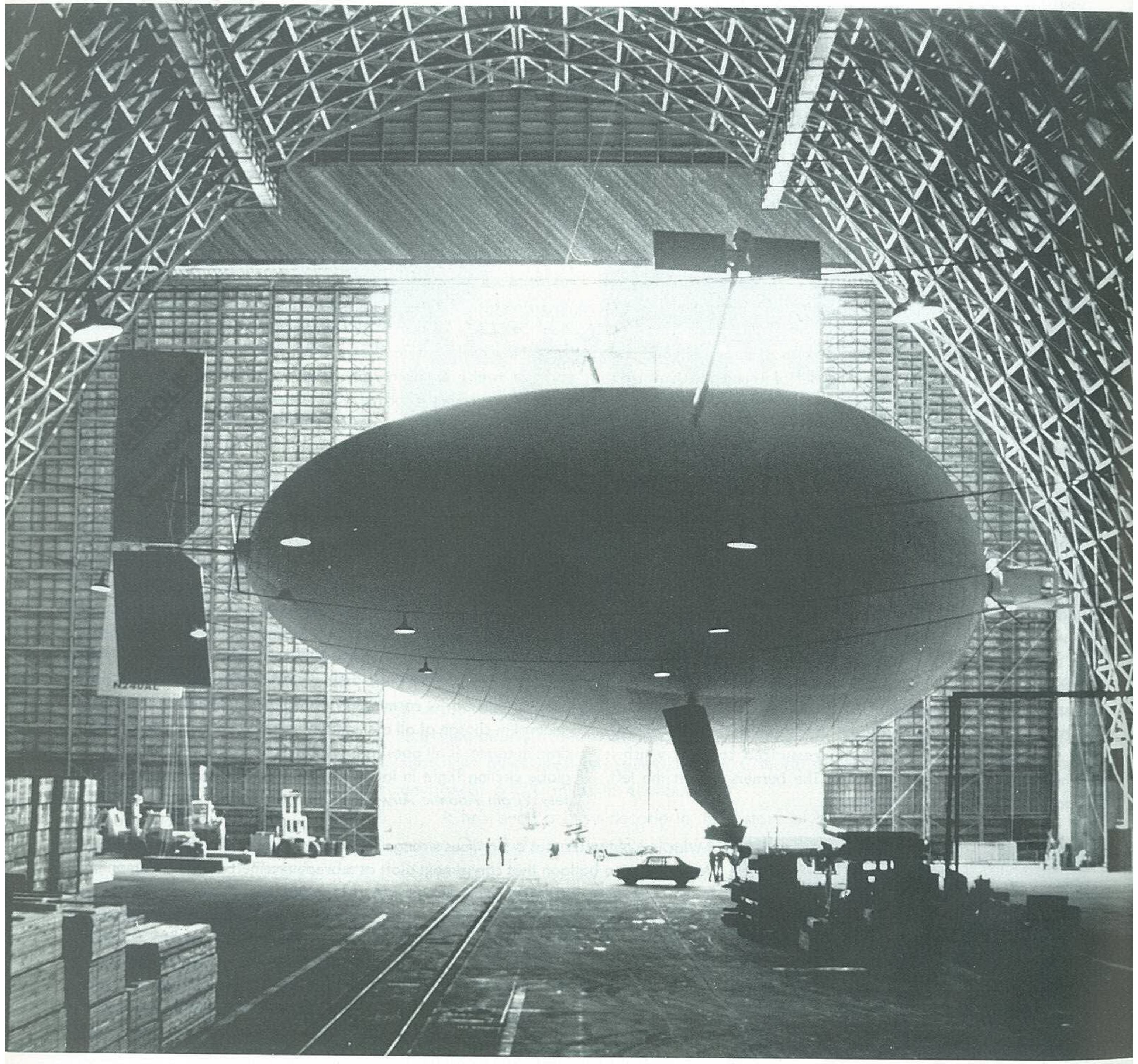
LIGHTER THAN AIR

AN ILLUSTRATED HISTORY OF THE AIRSHIP

LEE PAYNE





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THE AIRSHIP AND THE FUTURE

Vladimir Pavlecka is undoubtedly the leading airship designer in the world today.

Admiral Carl J. Seiberlich[1]

When the last U.S. Navy blimp was dismantled in September 1962 it seemed like the closing of a chapter in the history of aviation. The airship had been born, had ruled the skies and then had died, all in less than two hundred years. It was a tale that had run its course and all that remained of the world's once mighty dirigible fleets were two little blimps—Goodyear's *Mayflower* in the United States and another advertising blimp in Germany. At no other time in this century had the airship's numbers or its fortunes fallen so low.

What went wrong? The airplane had finally caught up. But it was not, as many still believe, the fiery crash of the *Hindenburg* in 1937 that put an end to the airship's monopoly on transoceanic air service. That could occur only when an economically viable alternative form of air transport appeared on the scene. That had to wait until 1952 and the first flights of Britain's Comet jetliner. By then it was no longer a question of the airplane's ability to fly the Atlantic. Hundreds of World War II

OPPOSITE: The $4.5 million Cyclo-Crane is inside one of the World War II navy blimp hangars at Tillamook, Oregon. The ship consists of a helium-filled center body pierced by an axial shaft to which are attached the control car at the bow and the tail fins at the stern. Protruding from the middle of the center body are four airfoils, each with a propeller and wing at its end. These turn the entire center body at up to thirteen revolutions per minute, not unlike a roast being turned on a spit. The action both reduces drag and increases lift. *Courtesy Aero Lift Inc.*

bombers had done that. But it was still a question of the airplane's being able to do it at a profit. The invention of the jet engine allowed the commercial airliner to operate in the thin air above thirty thousand feet where very low air temperatures produce high thermal efficiency. This enables the airplane to fly economically at high speeds over very long distances.

Britain's introduction of the jet airliner in the early 1950s finally allowed the airplane to equal the airship's great range and low operating cost. The jetliner's additional advantage of high speed—five times that of the airship—tipped the scale in its favor. The airship could no longer compete.

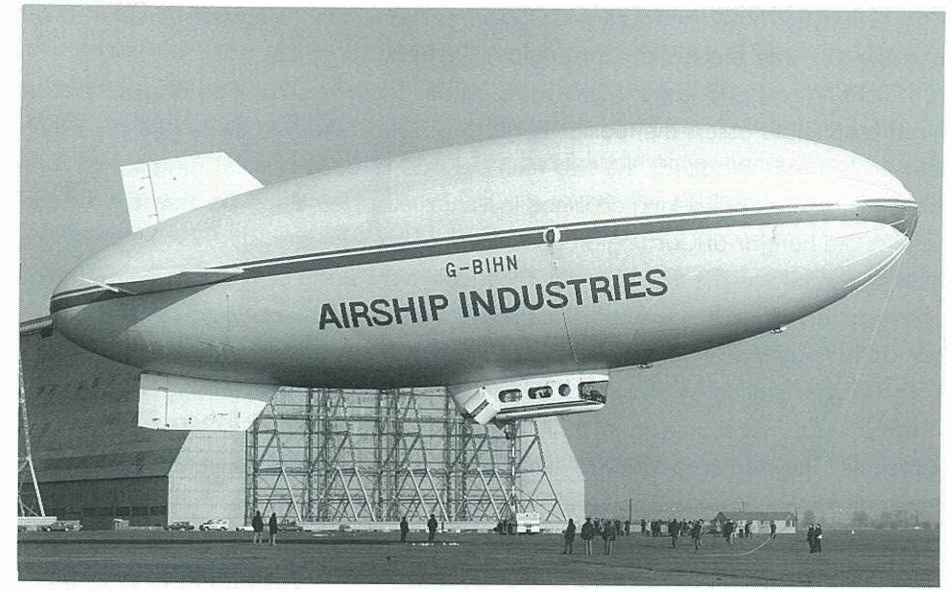
But if the end of the dirigible's use in commercial air transportation can be explained, the end of its military usefulness is less clear. Its endurance, range, load capacity, and all-weather capability remain, to this day, beyond that of any other aircraft. Why, then, could no use be found for it back in 1962?

Jack R. Hunt was often asked that question. He was operations officer of the Naval Air Development Unit, South Weymouth, Massachusetts, from 1955 to 1958 during the offshore station-keeping experiments in the worst winter weather in seventy-five years. He was also command pilot of ZPG-2 *Snowbird* on her epic eleven-day, unrefueled, nonstop flight from the United States to Africa and back again. Then in civilian life Jack Hunt became president of Embry-Riddle Aeronautical University and traveled widely as he struggled to establish that now flourishing institution. He sought support from everyone connected with aviation. The question was often asked of him by former naval airshipmen who loved their blimps and knew what they could do. Why was there no longer a place in military aviation for the airship?

In reply, Hunt would ask his questioner to name as many airplane manufacturers as he could. Boeing, Douglas, Lockheed, Northrop, North American, McDonnell, Martin, Grumman, Convair, Bell, Hughes. It was an impressive list. Then Hunt would ask how many companies built airships. Goodyear. His questioner began to see Hunt's point. But he could make it even clearer. How many congressmen are directly responsible to voters who make their living building airplanes or parts of airplanes? Even if the airship is better than the airplane in several important areas, given enough time and enough of the taxpayers' money, it is always possible to find some way for an airplane to perform the airship's missions almost as well as the airship can. The airplane simply had too many friends and the airship found itself out of a job.

Yet even the influence of friends in high places cannot prevail forever against the laws of economics. The jet airplane's single greatest advantage over the airship is its speed. But that speed has a price. The price is high fuel consumption—70 percent greater than that of an airship carrying the same load. When the jet offered its higher speed at an equal cost, there was no question of its advantage over the dirigible. But in the 1970s, OPEC changed the equation. Jet fuel that sold for a dime a gallon in 1973 rose to a dollar a gallon by the end of the decade. Lines formed at the gas pumps, Detroit found itself building the wrong kinds of cars, everyone became interested in alternative energy sources, and a number of people suddenly realized that an airship is a very fuel-efficient vehicle.

In the stress of worldwide economic disruption, the seeds of the airship's rebirth had already begun to stir. As oil prices skyrocketed, so did the airship's perceived potential. Interest crystallized in 1974 when the navy, NASA, the FAA, and the



Launched in February 1979, at Cardington, England, the *Skyship 500* is 164 feet long and 46 feet in diameter. When filled with 181,200 cubic feet of helium, she can carry up to eight passengers and a crew of two. Powered by two Porsche 930 engines, she has a top speed of nearly seventy miles per hour. The ship's propellers are mounted inside ducts for improved efficiency. They are also vectorable, that is, they can be turned downward as shown in the photo for added thrust during takeoffs and landings. *Courtesy Airship Industries Ltd.*

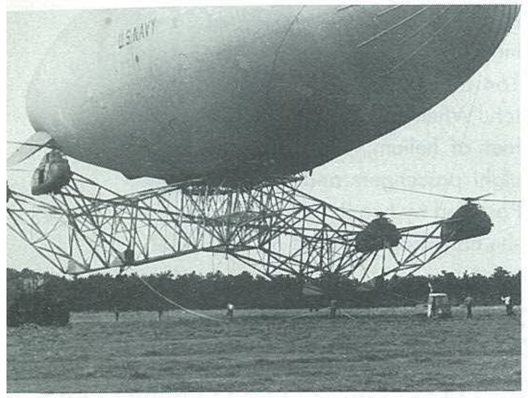
Department of Transportation sponsored a workshop on lighter-than-air vehicles at Monterey, California. To everyone's surprise, seventy-nine scientists and engineers from seven different countries asked to present papers.

The gates were open. If the first four decades of this century can be called the "age of the airship," then the decade of the 1970s was surely the "age of the airship study." Both the U.S. Forest Service and its Canadian counterpart studied the airship's potential in logging operations. The Shell Oil Company investigated the possibility of transporting natural gas from North Africa to Europe by dirigible. The World Bank and the Canadian Province of Alberta considered the use of airships as a means of servicing underdeveloped areas that have few roads, railways, or airports. The Japan Industrial Technology Association concluded that dirigibles would be valuable in providing air service to the many small Japanese islands that have no room for airfields. A member of the Hawaiian State Legislature similarly suggested that the airship would be an ideal vehicle for inter-island freight and passenger service.

The U.S. Navy and the Coast Guard found that the airship really might, as its adherents claimed, combine the versatility of a helicopter with the range of an airplane while adding a flight endurance far beyond the capability of either—all valuable qualities in the management of the United States' new two-hundred-mile-wide ocean frontiers.

The studies were unanimous in concluding that there were a number of jobs the modern airship could do. But there remained considerable disagreement as to how profitable the airship would be and how many were needed. A Booz-Allen-Hamilton study for NASA's Ames Research Center projected a worldwide market for 1,270 dirigibles of all sizes.

Each passing year brought new studies. Aerospace companies such as Bell, Goodyear, Boeing-Vertol, and Lockheed became involved. Paper proliferated. Dirigibles did not. It eventually became clear that it was time to stop studying the problem and start building ships. By the end of the decade every assumption had been assessed, every econometric parameter had been extrapolated, and, most important, the people who were really serious about airships had begun to build them.



Frank Piasecki demonstrated his first helicopter in 1942. By the 1950s Piasecki had built his company into one of the largest helicopter manufacturers in the world. After selling it to Boeing in 1955 he concentrated on new vertical-lift concepts including the Heli-Stat. Originally funded at $10.7 million by the U.S. Forest Service, this first tethered flight took place at Lakehurst on October 22, 1985. By using the old ZPG-2 blimp bag and surplus army H-34 helicopters, Piasecki hoped to cut costs and speed development. Only the intricate connecting structure was newly designed for the aircraft. It was flown by a pilot in the left rear helicopter. Each of the other three are manned by a mechanic. Thrust from the four 1,525-horsepower rotors was expected to lift a twenty-five-ton payload, nearly twice that of the largest helicopters currently used in logging. *Courtesy Piasecki Aircraft Corporation.*

Goodyear had a head start. *Columbia* and *America* joined *Mayflower* in 1969 and *Europa* was erected at Cardington, England, in 1972.

John Wood and Roger Munk were also in England. They had originally been hired by Shell to assess the feasibility of transporting natural gas by airship. When that project was dropped, the two men decided to build a small dirigible of their own. With financial backing obtained in Venezuela, their ship was assembled in the *R.101*'s old hangar at Cardington and launched on February 3, 1979. A little more than a month later she was caught at the mast by a storm and had to be deflated. She was rebuilt and a number of sister ships have followed. Wood's and Munk's company is called Airship Industries and their ship is the Skyship 500.

Though similar in size and design to Goodyear's advertising blimps, the Skyship 500s were unique in that they were built with the latest in space-age materials. They featured a Kevlar-reinforced bow on a French-built titanium dioxide and polyurethane-coated polyester gasbag. They were powered by two Porsche engines with vectored-thrust propellers.

A year after the Skyship 500 was launched in England, work began in the United States on a completely different type of airship, the Heli-Stat. This was the creation of Frank Piasecki, a pioneer in modern helicopter technology. With $10.7 million from the U.S. Forest Service and the use of one of the navy's big airship hangars at Lakehurst, he set out to build a hybrid aircraft, one that joined four surplus army H-34 helicopters together with a twenty-year-old navy ZPG-2 blimp bag. Piasecki's idea was that the million cubic feet of helium inside the blimp bag would lift the entire weight of the ship. The thrust from the four helicopter rotors would then be available to lift a cargo of up to twenty-four tons.

Unfortunately the extensive framework required to connect the helicopters and the blimp bag turned out to be heavier than expected. Instead of achieving neutral buoyancy with all the ship's weight offset by the lift of its helium, the Heli-Stat weighed six tons. It therefore required the thrust from its helicopters to take off and remain in the air. And all four helicopters had to act in concert or the craft would become seriously unbalanced.

On July 1, 1986, after a four-minute hovering test, the Heli-Stat landed, turned eighty degrees and took off again. Seconds after the wheels left the runway the right rear helicopter lost power and appeared to break loose from the connecting framework. With that, the entire craft began to disintegrate. Fragments of the rotor blades sliced through the gasbag, which folded up and settled to the ground. Fuel tanks ruptured and ignited but were extinguished by navy firefighters. Four of the ship's five crewmen suffered minor injuries. The fifth, aboard the helicopter that first lost power and broke off, was killed.

While the Heli-Stat was using secondhand components in an attempt to keep costs down, an entirely new but equally unconventional aircraft was under construction in the former navy blimp hangar at Tillamook, Oregon. Called the Cyclo-Crane, its development was sponsored by FERIC, the Forest Engineering Research Institute of Canada, as a joint venture with four of the largest lumber companies in British Columbia.

Developed by Don Doolittle and Arthur Crimmins, much of the Cyclo-Crane's engineering and computer simulation was done by Dr. H. C. Curtiss of Princeton University. He predicted that the Cyclo-Crane would have the controllability of a helicopter, something no airship had yet achieved.

FERIC is the Canadian counterpart of the U.S. Forest Service. Their studies show that helicopters are currently being used in only 1 percent of Canadian logging operations. But airships, with their lower operating costs and greater load capacity, could profitably assist in 20 percent of the timber harvest.

The $4.5 million Cyclo-Crane was first brought out of her hangar on August 5, 1982. A month later the U.S. Forest Service joined the project by awarding the company, Aero Lift Inc., $850,000 toward the ship's test program. Two months after that, the Cyclo-Crane broke loose from her mooring mast and crashed in a nearby field.

Of the first three new airship designs, not one survived its test program. But while Piasecki's Heli-Stat was a total loss, both the Skyship 500 and the Cyclo-Crane were rebuilt and flew again.

A second Canadian-financed project was underway in Ottawa. There a $2.5 million, one-tenth-scale prototype had been designed and built by Frederick Ferguson. His design was based on principles discovered by nineteenth-century German physicist Heinrich Magnus. Magnus found that a rapidly spinning ball would fly farther than one that does not spin. The effect became even more pronounced when the surface of the ball was rough rather than smooth. This was proved by the British in the 1870s when they found that they could hit a worn cricket ball farther than they could a new one. This, in turn, led to the dimpled surface on modern golf balls.

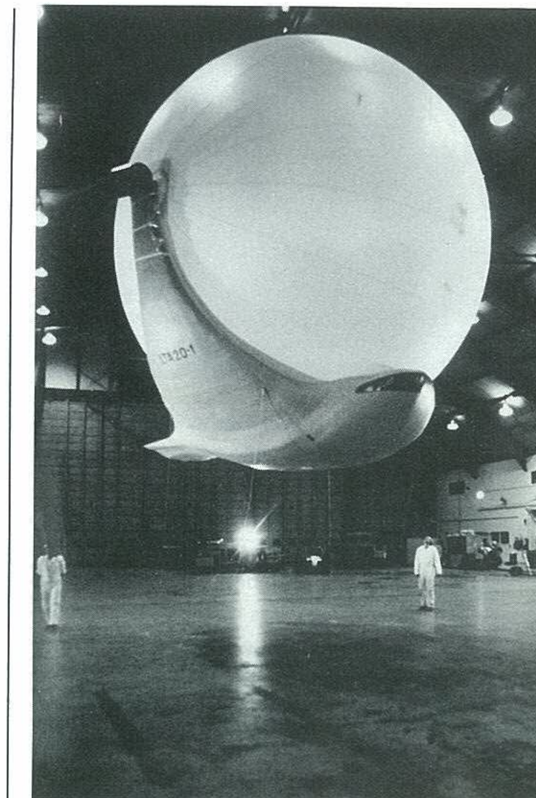
Ferguson applied the principle to an airship. Wind tunnel tests at the University of Toronto showed that by spinning the round hull of his Magnus-effect ship on its horizontal axis, additional lift was produced while drag was reduced. Ferguson's Van Dusen Development Corporation announced plans for a $4.5 million full-scale ship.

Aside from logging, which most studies pinpoint as the industry where airships would prove most useful, similar potential may exist in heavy-lift support of construction projects in remote regions where rail and road networks are lacking. Pipelines and refineries in Alaska and the Canadian north are mentioned as the areas where heavy-lift dirigibles would seem to be the most cost-effective.

But there is a third part of the world that appears to have been specifically designed for modern airships. It is the only nation aside from the United States that has commercial quantities of helium, the nonflammable lifting gas. It is the Soviet Union.

The Russians have long been interested in airships and have studied the potential of their use in Siberia. There, new dams in the far north are being planned to supply hydroelectric power to the cities of the south. The electricity will have to be transmitted over hundreds of miles of power lines. The job of setting in place the huge steel towers that carry these transmission lines has been identified in a number of studies as one of the tasks best performed by heavy-lift airships, especially when these lines must cross inaccessible terrain where roads do not exist.

A long power line is supported by thousands of these huge towers, each of which is too heavy for even the largest helicopter. In the past the towers have been assembled in place along the route. Girders and assembly crews are trucked or airlifted to each site and with three or four towers per mile, a thousand-mile transmission line is a massive undertaking. Considerable savings in time and labor would be possible if the towers could be assembled at a central location and lifted by airship to their sites.



Described as resembling a manta ray hugging a beach ball, this is a one-tenth-scale prototype of a Magnus-effect, heavy-lift dirigible. Designed by Frederick Ferguson and built by his Van Dusen Development Company in Ottawa, Canada, this $2.5 million test vehicle features a twenty-foot, helium-filled sphere that rotates around a horizontal axis from which is suspended an aerodynamically designed gondola. The ship is powered by engines mounted at each end of the horizontal axis. The sphere on a full-scale dirigible would be 160 feet in diameter and hold 2,100,000 cubic feet of helium. This would provide seventy tons of lift. *Courtesy Van Dusen Development Company.*

McBlimp was the second ship built by Theodor Wullenkemper in West Germany. His first blimp was launched by his Westdeutsche Luftwerbung in August 1972 and flew in Germany for several years before being sold to Japan. This was his first ship to reach the United States. *McBlimp* was 193 feet long and 54 feet in diameter, with 211,888 cubic feet of helium. She could carry up to eight people and featured a large computer-controlled night advertising sign similar to the ones on Goodyear blimps. McDonald's cancelled their lease after a number of franchises complained about paying for a blimp that was unlikely to ever visit more than a handful of the chain's restaurants. Since then, the ship has flown for Sea World and for Metropolitan Life. *Courtesy McDonald's Corporation.*

Reports in the Soviet press suggest that their projected heavy-lift airships might be driven by electric engines that can be charged from the same power lines that the ships are helping to lay. This would eliminate the airship's traditional problems with the change in equilibrium as the weight of fuel is consumed.

If any of these plans can be turned into reality, it would represent a significant advance in airship technology. Engineers at the Bechtel Corporation in San Francisco have determined that the use of heavy-lift airships could save 20 percent of the cost of their Arctic and sub-Arctic construction projects. Soviet engineers may well have reached the same conclusions.

It is interesting to note that most of the airship projects now underway are privately financed. The military, which in the past played a major role in funding airship development, has come late to its rebirth. That does not mean, however, that there has been a shortage of studies of modern military airship applications.

Maj. Reed M. Anderson, USAF, 1977 Air University Report

Any vehicle that has the potential to move large quantities of outsized cargo to Europe in three days can significantly enhance the military strategic airlift capability.[2]

Maj. Jimmy L. Badger and Maj. Ronald M. Lebert, USAF, 1977 Air University Report

The authors feel that there are a number of vital roles that the airship could fulfill as well as, if not better than, any other aircraft now in the inventory or planned for the future.[3]

These authors all caution that important questions concerning the military potential of the modern dirigible remain to be answered. The U.S. Navy hoped to find many of these answers by observing the Coast Guard's Maritime Patrol Airship in action. Working through the Naval Air Development Center (NADC) at Warminster, Pennsylvania, the Coast Guard drew up ten mission profiles for tasks ranging from search and rescue to antisubmarine warfare to buoy tending.

The Coast Guard needed a vehicle that was faster than a patrol boat, with greater range and load-carrying capacity than a helicopter, yet one that could remain on station for days at a time in every kind of weather, deliver emergency equipment, and remove injured personnel from ships at sea—all while burning significantly less fuel than their present ships, helicopters, and airplanes.

It was obvious that the vehicle the Coast Guard needed was an airship. During World War II these missions were repeatedly performed by navy blimps. A preliminary contract statement was prepared by NADC and issued on January 21, 1981.

The Coast Guard was not, however, looking for a recycled 1950s blimp. By setting their mission specifications beyond the performance of those last navy airships, NADC and the Coast Guard planned to lead the way toward a new generation of lighter-than-air vehicle. The Maritime Patrol Airship was to have a top speed of ninety knots (103.5 miles per hour), be able to hover within a ten-foot-diameter circle, and land with a ground crew of less than eight people. Each of these requirements is beyond the capabilities of any airship that has ever flown before.

The bidders' conference on the Coast Guard contract was held at Warminster on September 23, 1981. Representatives from a number of interested companies including Westinghouse, Northrop, Grumman, and Goodyear were present. A week later a telegram from NADC to all prospective bidders canceled the project

"due to severe curtailment of funding allocations previously designated." The Reagan administration had scuttled the Coast Guard's airship.

In spite of funding constraints, the navy's interest in airships continued. They had already invited Goodyear to give a live demonstration of airship capabilities to the Coast Guard and the Customs Service. Preliminary flights were made by the Goodyear blimp *Enterprise* in August, 1981. More extensive tests were conducted in November, immediately after the NADC contract cancellation.

The mission was to interdict drugs being smuggled into South Florida from the Bahamas as well as those that were brought north aboard large ships and transferred to speedboats off the coast. Goodyear's *Enterprise,* based at Pompano Beach, was in an ideal location but with a volume of only 202,700 cubic feet was a bit small for the mission. The Coast Guard's proposal had called for a demonstration ship of around 240,000 cubic feet to be followed by a fleet of eight-hundred-thousand-cubic foot ships.

Still, the results with *Enterprise* proved interesting. On one of her first flights she encountered a heavily laden cruiser moving out at high speed from Bimini toward the Florida coast. As soon as the blimp was spotted, the boat turned tail and ran back to the island.

It wasn't until the last phase of the program in December 1981 that effective surveillance equipment finally arrived. When this airborne radar from Litton Systems Canada was installed, several night flights were undertaken. Night vision equipment was also used.

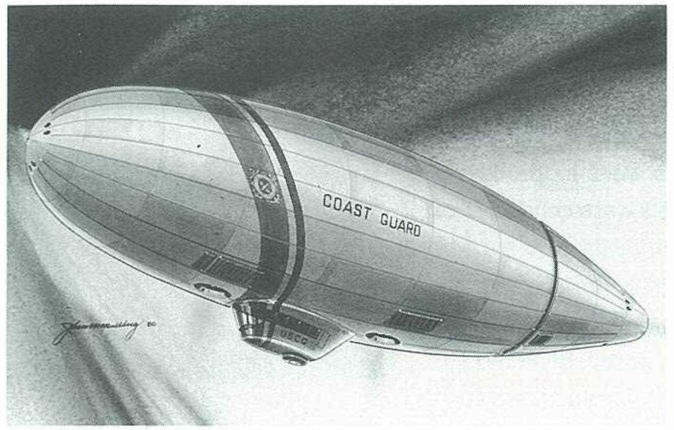
By the end of the experiment in January 1982, the Coast Guard had arrived at four official conclusions:

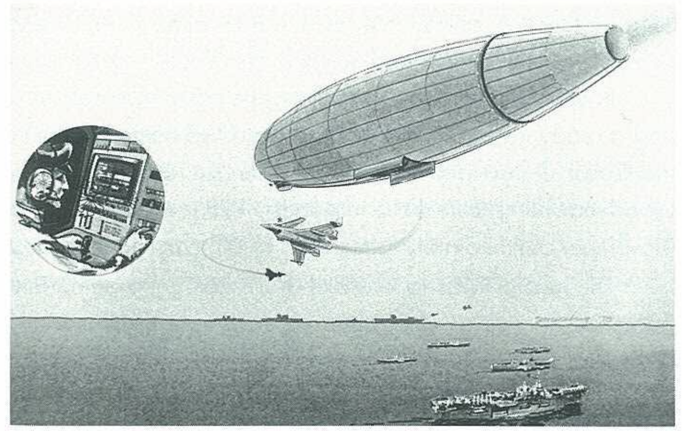
1. The airship is a stable observation platform.
2. It is adapted to the use of radar systems.
3. Only the airship can provide long aerial endurance.
4. Personnel fatigue is low on an airship.

None of these conclusions would come as startling news to the hundreds of naval officers and men who routinely flew thousands of airship hours during and after World War II, but perhaps they had to be proven once again to a new generation of bureaucrats.

At the operations level the experiment had gone smoothly. Further up the chain of command at both NADC and Goodyear, there were problems. Goodyear was accused of arrogance—as if theirs were the only blimps in town—which, in fact, they were. Some were annoyed that, with the tests conducted during football season, Goodyear chose to honor *Enterprise*'s previous commitments to the television networks. This meant the blimp was available only from Tuesday through Thursday and that the surveillance equipment had to be removed every Thursday and reinstalled every Tuesday.

For their part, some people at Goodyear were annoyed by reports that the military was annoyed, especially in light of the fact that they were getting it all for free. At the end of the test program in February 1982, Goodyear offered to lease the retired *America* to the Coast Guard at what a company spokesman described as "a very attractive rate." The Coast Guard was then forced to concede that they had no money in their budget for an airship and were even being forced to lay up some of their cutters because they couldn't afford the fuel to run them.





LEFT: The modern airship has a number of potential military applications. Coastal surveillance and protection is one of the most obvious. In the United States this is the job that falls traditionally to the Coast Guard. The Coast Guard's missions include fisheries regulation, drug smuggling interdiction, oil spill detection and cleanup, international ice patrol, airborne radiation monitoring, NOAA data buoy support, escort of vessels carrying hazardous cargo, port traffic control and fire fighting, search and rescue, buoy maintenance, and, in wartime, antisubmarine warfare, convoy escort, minelaying, and minesweeping. Airships would seem to be the most appropriate vehicle for all these tasks, but so far the money has not been allocated. *Painting by John Mellberg, courtesy Airships International Inc.* RIGHT: The Falkland Islands War demonstrated an area where airships could be of service. Fleet protection on station and in convoy, even when aircraft carriers are present, would allow more of the carrier's planes to be used for attack rather than defense. Other potential military applications include servicing unmanned Arctic early-warning stations, tracking Soviet submarines under the Arctic icecap, as cruise missile launchers, for beam weaponry and for air mobility with the Rapid Deployment Force. *Painting by John Mellberg, courtesy Airships International Inc.*

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Two months later on April 2, 1982, Argentina invaded the Falkland Islands. The entire world was about to receive a demonstration of the potential value of the airship.

As the British fleet steamed south they had time to reconsider the wisdom of selling their last aircraft carrier. Operating thousands of miles from a friendly airfield, they were forced to rely on Nimrod radar planes for long-range detection of incoming Argentine planes and missiles. But each Nimrod required air-to-air refueling sixteen times on the flight to the Falklands and back. And after all that, it was able to spend only two hours on station over the fleet. The British had to use refueling planes to refuel their refueling planes and they still lost ships and men when the Nimrods were not on station.

A ZPG-2 blimp, on the other hand, could have flown to the Falklands, refueled from a ship of the fleet, and remained on station with its early-warning radar for weeks at a time. And the ZPG-2 is a thirty-year-old design. What might a modern airship be able to do?

The Falkland Islands War gave the U.S. Navy a number of things to think about. The most disquieting conclusion to emerge from their analysis was the vulnerability of surface ships with no early-warning air cover. The best defensive systems had proven less than effective against only moderately sophisticated air-launched Exocet missiles.

The U.S. Navy had plans for four task groups to be formed around recommissioned battleships. These task groups would have no carriers.

As a result of these deliberations, NADC announced immediate plans to bring a Skyship 500 to the U.S. for tests. The contract was signed in January 1983, and two months later, Skyship *500-03* was shipped from England by air to Toronto, where she was inflated. The navy and Coast Guard each paid $350,000 toward the lease while NASA added one hundred thousand dollars more. The demonstrations were flown out of the Naval Air Test Center at Patuxent River, Maryland, and the Coast Guard station at Elizabeth City, North Carolina, during the summer of 1983.

All those who professed disappointment at the performance of Goodyear's *Enterprise* in the winter of 1982 declared themselves delighted with the Skyship 500 in the summer of 1983. Though smaller than the *Enterprise,* the new ship was not weighed down with a night advertising sign. This gave her 2,270 pounds more disposable lift: 5,090 pounds versus *Enterprise*'s 2,820. The Skyship 500 was also fifteen miles per hour faster and, thanks to her vectored-thrust propellers, noticeably easier to maneuver.

The turnaround seems surprising. Before the Falkland Islands War the Coast Guard was alone in its desire for airships. The *Enterprise* trials were paid for by Goodyear. Then eight hundred thousand dollars was found to lease a Skyship 500 and everyone was excited by the results.

The navy spent all of 1984 trying to find some other solution to their problem. There was none. The airship appeared to be the only airborne platform capable of early detection and tracking of low-flying Soviet cruise missiles either at sea, the navy's prime concern, or in the Arctic, where the air force has jurisdiction. The air force hopes to automate its radar stations in northern Canada and in Alaska. The stations are beyond the range of helicopters, there are no roads and, without anyone to shovel the snow off the runways, planes cannot land. There, too, airships seem the only answer.

Meanwhile, 1984 proved to be a banner year for Airship Industries. They sold a Skyship 500 to Japan Air Lines and leased another to Fuji Film for use at the Los Angeles Olympics. Australian businessman Alan Bond bought 31 percent of the still struggling company and, most important, their new Skyship 600 made her first flight. An expanded version of the 500, she was larger than the Goodyear blimps, designed to carry twenty passengers. The newest company in the airship business was now flying the biggest ship in the sky. Goodyear's response would not be airborne until August 1987.

In February 1985, after a year of deliberation, NADC issued a request for proposals for a Battle Surveillance Airship. It was to perform both AEW (airborne early warning) and ASW (antisubmarine warfare) missions with a naval task group that would not include an aircraft carrier. The airship was to be deployed as a regular naval unit accompanying the group. It would be resupplied by other ships in the group. It would be expected to demonstrate low-speed controllability and the ability to take on supplies while the group was underway. NADC announced that it had two hundred million dollars to spend.

To anyone unfamiliar with government procurement procedures, the system needs a bit of explaining. In the first stage, the navy decided that it really wanted an airship and was willing to pay for it. This took up all of 1984. NADC then drew up a detailed list of mission requirements, things the proposed airship would be expected to do. Then it issued the RFP, the request for proposals. Anyone who wanted to build the navy's airship was entitled to ask for the specifications and submit a bid. The catch was that if NADC decided from your bid that you didn't know much about airships, they were allowed to throw it out.

LEFT: Airship Industries' largest ship was the Skyship 600, a stretched version of their 500 series. Her first flight was made at Cardington on March 6, 1984. With a gas capacity of 235,400 cubic feet and a length of 194 feet, she was 30 feet longer than the 500 and could carry up to twenty passengers. *Courtesy Airship Industries Ltd.* RIGHT: Of the three hundred airships built by Goodyear since Melvin Vaniman's *Akron* in 1912, fifty-five were retained by the company and flown as part of their own blimp fleet. This newest blimp, *Spirit of Akron,* was christened on August 4, 1987. Built partly as a response to Airship Industries' Skyship 600, the *Spirit of Akron* is the largest airship now flying. She is 205.5 feet long, 47 feet in diameter, and holds 247,800 cubic feet of helium. Ships of this new GZ-22 design were to replace all four of Goodyear's GZ-20 blimps. The GZ-20s are 192 feet long with a volume of 202,700 cubic feet and a top speed of fifty miles per hour. The new ship is fifteen miles per hour faster with vectored thrust propellers. She carries ten people rather than the GZ-20's seven, plus a more elaborate night advertising sign. But since the sale of Goodyear's aerospace division to Loral, it is unclear whether any more GZ-22s will be built. *Courtesy Goodyear Tire and Rubber Company.*

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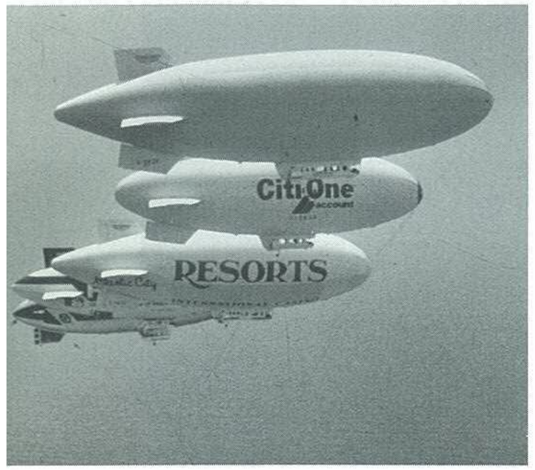


Jack R. Hunt always insisted that the return of the airship must begin with many small ships rather than a few very large ones. The old skills would have to be relearned in the shop, on the ground, and in the air with smaller ships before they could be transferred again to the big ones. On the civilian side this process is already underway as can be seen in the Great Blimp Race over New York harbor on July 5, 1986, during the birthday celebration for the Statue of Liberty. The five blimps in the race were (back to front) Westdeutsch Luftwerbung's *McDonald's*, Fuji's Skyship *500-06*, Resorts International's SK *600-03*, Citibank's SK *500-03*, and the sponsoring *Daily News*'s SK *600-04*. The Fuji blimp won. *Courtesy Airship Industries Ltd.*

After reading all the bids, some of which ran to hundreds of pages, NADC selected the finalists. These were companies or teams of companies that submitted serious proposals for ships that looked like they could perform the navy's missions.

Now NADC had to come up with enough money to allow each finalist to prepare a much more detailed design of the ship they wanted to build. This money was allocated so as not to penalize a small company that might have a good idea but could not afford the extensive engineering work required to make sure their idea would really fly. The government paid the finalists to prepare their proposals.

In May 1985, NADC awarded three $650,000 study contracts to Goodyear teamed with Sperry and Litton, to Westinghouse teamed with Airship Industries, and to Boeing teamed with Wren Skyships. Three additional contracts of three hundred thousand dollars apiece were awarded to Hughes, Westinghouse, and RCA for the ship's electronics.

Boeing put in eighteen months' work on a 4.2-million-cubic-foot, semimonocoque design before dropping out of the competition. Then Goodyear unexpectedly found itself under attack by a corporate raider, Sir James Goldsmith. He had acquired twelve million shares of Goodyear stock and declared his intention of taking over the company. Goodyear management fought back. They announced a tender offer for fifty million of their own shares. But in order to finance the massive debt this move required, they were forced to sell several subsidiaries—including Goodyear Aerospace.

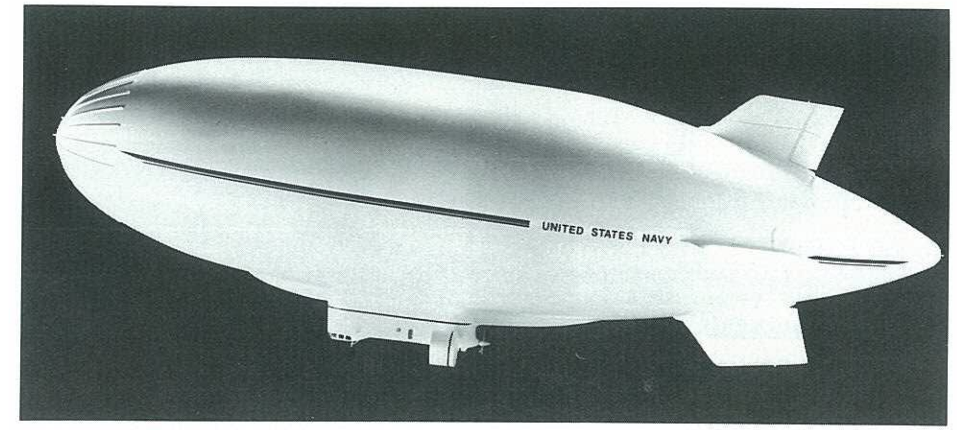
Goodyear is the largest tire manufacturer in the world. Airships have always been a highly visible but generally unprofitable sideline. The deal was made. The management of the Goodyear Tire & Rubber Company retained control of the core of their organization. Sir James Goldsmith reportedly took home a profit of ninety-three million dollars by selling his stock back to the company. He had to promise not to do it again for five years.

Everyone was pleased with the arrangement—with the possible exception of the entire lighter-than-air organization.

In March 1987, Goodyear Aerospace was sold to the Loral Corporation, a New York–based defense electronics contractor, for $588 million. Three months after that, on June 5, 1987, the U.S. Navy awarded a $168,900,000 contract for a single prototype Radar Surveillance Airship to Westinghouse and Airship Industries.

Goodyear lost the competition by proposing an updated version of the 1,500,000-cubic-foot ZPG-3W. They had even retrieved a discarded ZPG-3W control car from Lakehurst where it had been sitting for nearly thirty years and hauled it back to Akron to see if it could be reused. Loral later raised the size of Goodyear's proposal to 1,933,000 cubic feet but it was too late.

Airship Industries won with a design they called their *Sentinel 5000.* It would be 423 feet long and 105 feet in diameter, with a volume of 2,350,000 cubic feet—more gas than the *Shenandoah!* It would carry a crew of ten and be powered by two Italian-built 1,625-horsepower diesel engines driving two vectored-thrust propellers. It would also have a 1,750-horsepower turboprop engine in the rear of the control car driving its own pusher propeller. This engine would be for short, high-speed runs while the two more fuel-efficient diesels would be used for extended cruising at lower speeds. The control car would be eighty-one feet long and three decks high. The ship would carry a Westinghouse phased-array radar antenna with a two-hundred-mile range and be armed with air-to-air missiles and ASW weapons. It would be ready for navy service by June 1992.



If completed, the *Sentinel 5000* will be 423 feet long and hold 2,350,000 cubic feet of helium, the largest nonrigid ever built. Her hull will be a single ply of Dacron laminated to films of Mylar for strength and Tedlar for impermeability to helium. Though the concept was originally designated the Battle Surveillance Airship, it was later called the ODM or Operational Development Model. It is not the same as the NAP or Naval Airship Program, which is to follow, assuming that the ODM proves successful. The navy has already decided that follow-on airships will have to be larger than the ODM. This ship will therefore be a one-of-a-kind dirigible whose main function is to provide data to support the studies that show the airship can perform the navy's missions. *Courtesy Westinghouse-Airship Industries Inc.*

As Adm. Robert Leuschner, director of Anti-Submarine and Assault Programs, Naval Air Systems Command, freely admitted, the proposed Battle Surveillance Airship would be called upon to revive technology that has been absent from the navy for over a quarter of a century. And it would have to do it with a single vehicle, one 50 percent larger than any nonrigid airship ever built before, which would be maintained and flown by an inexperienced crew.

Whether this unusual approach will lead to success may never be known. Most of the funds for the new airship were cut from the Pentagon's 1989 budget and its completion date was extended by several years.

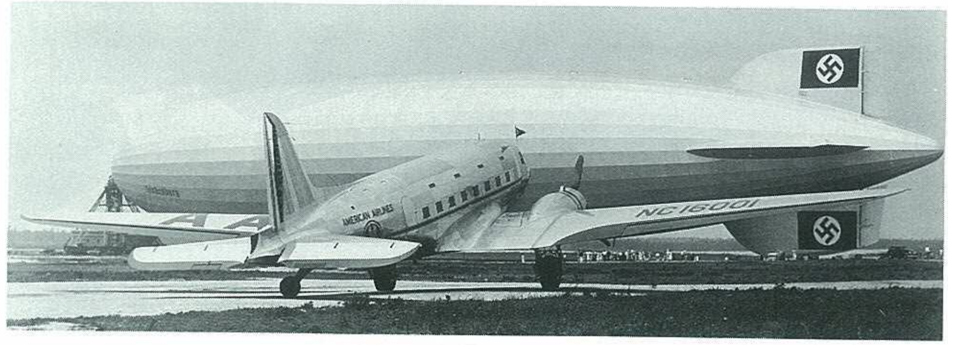
Does this mean the navy's search for an alternative to the airship has been successful? Not according to Adm. Robert F. Dunn, deputy chief of naval operations for air warfare. In the *Proceedings of the U.S. Naval Institute,* he said that the budget cut reflects the need to save money, not the merit of the concept, which is as valid as ever.

The fate of both the Coast Guard's Maritime Patrol Airship and the navy's Battle Surveillance Airship offers further proof of Jack R. Hunt's contention. The airship still lacks friends in high places—influential congressmen who can shepherd appropriations safely through the budgetary gauntlet. These episodes also underline two drawbacks to dealing with the U.S. government. The first is that its word is not necessarily its bond. The second is less obvious. Airship Industries' design for the *Sentinel 5000* now belongs to the U.S. Navy. So does Goodyear's plan for an updated ZPG-3W and Boeing's for their semimonocoque ship. The navy paid $650,000 apiece for them. By entering the design competition, the companies lost exclusive control over their own work.

One man who hoped to avoid these pitfalls was Vladimir Pavlecka. After a lifetime spent working on government-sponsored research projects, he vowed he would build his airship with private funds. Had he been successful, his innovative design would now be in the air and available for purchase at far less than the navy's projected cost. Unfortunately, Pavlecka found that private industry in the United States—once bold and innovative—has grown timorous and obsessed by short-term profit. His ship remains on the drawing board.

Why should Pavlecka's design be of more interest than any of a thousand others—all unbuilt? How did he elicit comments like those of Admiral Seiberlich's at the beginning of this chapter?

Working with America's leading dirigible designer, Pavlecka helped build the



In 1936 the only way to fly from Europe to the Midwest was to cross the Atlantic aboard the Hindenburg, then make the connection at Lakehurst by DC-3 to Chicago. These two machines stood together as the most advanced aircraft in their respective fields of aviation. In the half-century since this photograph was taken, the DC-3 has evolved into the Concorde, the Stealth bomber, and the Space Shuttle. What kind of dirigibles would be flying today if lighter-than-air technology had come as far? *U.S. Navy photo in the National Archives.*

most advanced airship of its day. That was sixty years ago. Since then he has played a major role in the creation of the modern aerospace industry. The past and the future were uniquely combined in this singular individual whose vision of the airship of tomorrow deserves a closer look.

Vladimir Pavlecka was born in 1901 in Bohemia, then part of the Austro-Hungarian Empire, now Czechoslovakia. The first aircraft he ever saw were German Zeppelins that flew over his village on their way to the eastern front.

Vladimir Pavlecka

> Sometimes at school we would hear the sound of their engines but by the time we ran to the windows they would be far off on the horizon. Then one day, one came over flying against a strong headwind that slowed him down quite a bit. He was not over six hundred or seven hundred feet high. I ran along beneath it and could easily keep up with it. I could see the crewmen looking down at me and smiling as I ran along. I ran with it for miles and miles, fascinated by the huge ship floating in the air over my head, until finally it flew away and I found myself far from home. But I didn't mind the long walk back.[4]

Pavlecka's father was an engineer and young Vladimir graduated from the technical school at Praha where he studied turbine engineering with Professor Zvonicek, one of the men who developed the modern turbine. He also learned thermodynamics at a time when that science wasn't yet being taught in the United States.

He left Praha in 1923 to study electrical engineering at Union College in Schenectady, New York. After graduation he moved to Detroit where his brother got him a job at General Motors Research Laboratories. There he worked on the layouts for the first Buick straight-eight engine. He also met two young men in the same building who were designing an all-metal dirigible. At the end of 1925 Pavlecka left General Motors to join their company, the Aircraft Development Corporation.

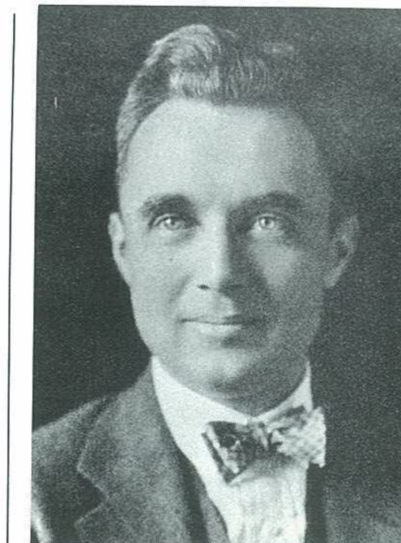
One of Pavlecka's new employers was Carl Fritsche, a lawyer and Republican Party fund-raiser. The other was Ralph Upson, the former head of Goodyear's Aeronautics Department and a leading balloonist. He won the Gordon Bennett International Balloon Race in 1913 and the National Balloon Race in 1919 and again in 1921. In 1920 when he left Goodyear to start the Aircraft Development Corporation, he was the leading dirigible designer in the United States.

Vladimir Pavlecka

> The story of the founding of the company is so unusual that it invites doubt. But Carl Fritsche told this to me personally as we were driving in a car together, just the two of us, and I have absolutely no doubt that he was telling the truth. He said he was sailing on a Great Lakes steamer from Detroit to Cleveland on Lake Erie. This was in the days when passenger ships made overnight trips between cities on the Great Lakes. It was August and there was a beautiful full moon. Rather than go down to his cabin, Fritsche decided to spend the night on deck. He was sitting there in the moonlight when an old man came up to him and they fell into conversation. The old man was talking about metal airships and his enthusiasm soon infected Fritsche. They discussed the subject for hours and when Fritsche finally excused himself and went below to his cabin, he realized that he had forgotten to ask the old man his name. The steamer was docking in Cleveland early the next morning and Fritsche went up before they put the gangway over so he would be sure to see the old man when he got off. But the old man did not appear and Fritsche never saw him again. But his enthusiasm for metal airships remained and at the first opportunity Fritsche went to Goodyear in Akron, the only company in the United States that was then producing airships. There he was introduced to Ralph Upson and when Fritsche explained his newfound enthusiasm for metal airships to Upson, Ralph said that he had been considering the design problems of the metal airship for some time. They formed a partnership and Fritsche went out to raise the money. He had been doing this for years for the Republican Party. He went to his friends in the Detroit automobile industry. Ford was already involved in the Stout trimotor airplane. This seemed like an opportunity to make Detroit the aviation as well as the automotive capital of the world. Fritsche got backing from Edsel Ford, Charles Mott who was the biggest stockholder in General Motors, Charles F. Kettering, and a number of others. When the development work was completed and they were ready to build their ship, Fritsche went to his friend, Arthur Vandenberg, the Republican leader of the Senate. Once Fritsche convinced him of the value of the metal airship Vandenberg added an appropriation for a metal ship to the navy's budget request for that year. When the budget was approved, the navy found itself with money it had never asked for to build a ship it didn't want and the only company capable of building it was, of course, the Aircraft Development Corporation of Detroit.[5]

Construction began in 1926. The next year, the company moved into its own angar at the southern end of Grosse Ile, a wooded island in the Detroit River not far om downtown Detroit. As Pavlecka recalled, "The hangar was right in the woods. I ould open the window of my laboratory and a tree branch would come in."

Fritsche convinced Alcoa, the Aluminum Company of America, to join the enture. They supplied quantities of 17-ST alloy aluminum sheet that arrived packed fish oil against corrosion. "The whole place smelled of it," Pavlecka said. The rgest sheets Alcoa could produce were ten feet long but only eighteen inches wide.



Ralph Hazlett Upson (1888–1968). A graduate in mechanical engineering from Stevens Institute of Technology, Upson joined Goodyear in 1910. He was construction supervisor on the gasbag of Melvin Vaniman's *Akron* in 1912 and helped develop all the navy's early blimps after the *DN-1*. He also designed a number of army blimps including the first TC ships. During World War II he worked on gliders for the Heinz Company in Pittsburgh and ended his career in Seattle on the X-20 Dyna-Soar project. He died at the age of eighty while on a mountain-climbing expedition. Vladimir Pavlecka said of Upson, "He was an intellectual of the first magnitude. He seemed to see things much bigger than the rest of us saw them." *Courtesy Vladimir Pavlecka.*

ladimir Pavlecka at the age of twenty-eight at one of the *ZMC-2*'s hull access ports.

> In 1919, just as my brother and I entered the technical school of higher learning in Praha, there descended on all the schools a great number of young men, former soldiers, whose education had been delayed by the war. Now they were all coming at once to make up for this postponement and it was apparent that they, who were several years older than the rest of us, would receive preference in finding jobs upon graduation. So the future for those of us who were too young to be in the war but who would be graduating at the same time, did not look good. My brother and I studied English then and upon graduation in 1923, we came to the United States. This I have never regretted.
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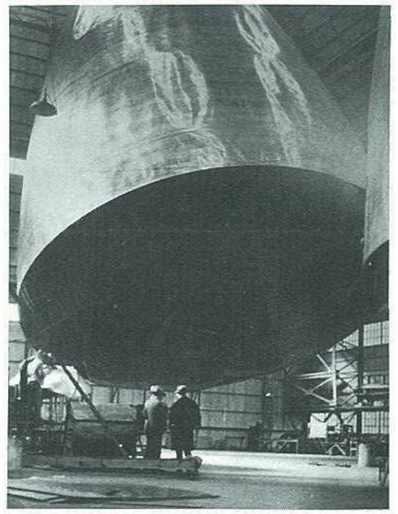
> Vladimir Pavlecka

noto courtesy John Roda.



The completed stern section hanging from the top of the construction shed shows the ripples in the unpressurized metal skin. Though the aluminum-coated duralumin was rolled to a thickness of only .0095 of an inch, about the same as that of a matchbook cover, it had considerable strength, which was increased even further when the hull was filled with helium under pressure. "Then," Pavlecka said, "all the wrinkles which were present simply disappeared as if it were alive." When the two halves of the metal hull, the bow and stern sections, were lowered to the horizontal and joined together, they fit perfectly. No adjustments were necessary and the final seam was riveted from the inside by hand. *Courtesy John Roda.*

A riveting machine had to be designed to stitch the many pieces together automatically with a gastight seam. As work progressed on the stern section it was found that the first sheets had already begun to corrode. Upson pleaded with Alcoa to find a better alloy. This was eventually discovered in an expired French patent. Made of duralumin rolled in pure aluminum, it was christened Alclad and is still in use in airplanes today.

While they were waiting for the first shipment of the new alloy, the original stern section was set in concrete and filled with water until it began to pull away from its base. Then the water was pumped out until the vacuum caused the section to collapse. Finally it was refilled with water until it popped back into shape. Close examination revealed no signs of failure. It was then that Upson knew his concept would work.

By this time Pavlecka had been promoted to chief of hull design. The *ZMC-2* was launched on August 19, 1929. She remained in navy service until early in 1941 when, still airworthy but too small for long patrols, she was dismantled. She was the world's first and only successful all-metal airship. Fritsche and Upson tried to interest the government in larger metalclad designs but without success.

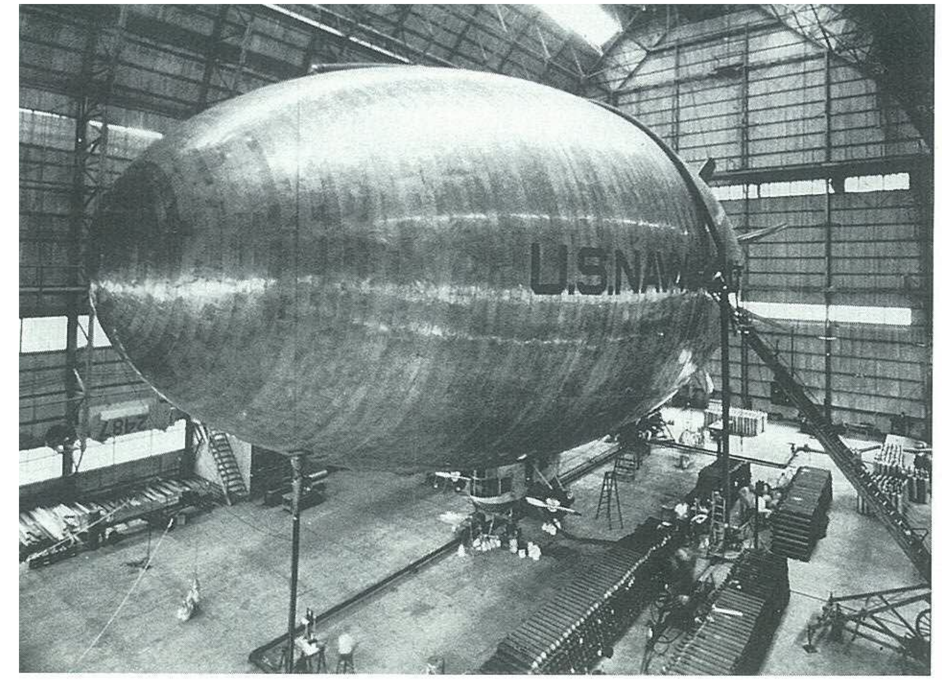
After the completion of the *ZMC-2* the company changed its name to the Metalclad Airship Corporation and, as the depression worsened, purchased a number of failing airplane manufacturers including Ryan, Lockheed, Blackburn of England, the Eastman Flying Boat Company, and even Parks Air College. Detroit was truly going to be the aviation capital of the world. But in 1931 the depression caught up with the Metalclad Airship Corporation and it, too, went bankrupt. The Lockheed and Ryan engineers who had been brought to Detroit returned to California and, two years later, Pavlecka and his friend and co-worker, John Roda, went west to join them.

The Douglas Aircraft Company at that time had a problem. They had just completed what was to become the most successful airliner of its day, the DC-2. Its prototype, the DC-1, carried twelve passengers. The DC-2 had been lengthened by two feet so it could carry fourteen. The airlines wanted still more but the DC-2 was already the largest twin-engine landplane ever built in the U.S. How was Douglas to put more people inside without making the outside too big to fly?

The obvious answer was to make the plane lighter. Less metal meant more lift for more passengers. Douglas needed an expert on light-metal aircraft structures, someone, for instance, who had just built a metal balloon.

Vladimir Pavlecka

I got three job offers that day, one at Lockheed, one at Douglas, and one at Vultee. I took the one at Douglas. I was hired by Lee Atwood, who was the head of the proposals department. He later became president of North American Aviation. Douglas had around 150 engineers, which was a big operation in those days. I got the job because I knew light metals. There was no history of light-metal aircraft structures in the U.S. Germany was ahead of us. There the experience had come from airships where every extra pound has to be eliminated. In Germany it started with two men, Claude Dornier and Adolph Rohrbach, and both of them got their start with Count Zeppelin. He set both of them up in the metal airplane business. Rohrbach built some very advanced metal flying boats after World War I and licensed them in England, France, Czechoslovakia, and to Heinkel in Germany. His principle was of a series of metal boxes united one to another, each gaining strength from the others. That way, each box could be of a lighter



LEFT: The *ZMC-2* is shown as she neared completion inside the construction shed on Grosse Ile in the Detroit River. Hundreds of helium containers are stacked on the hangar floor. The first attempt to build the hull had to be halted when the aluminum began to corrode. Alcoa was then encouraged to develop Alclad, an alloy originally used on the *ZMC-2* and still in wide use today. Sections of the *ZMC-2* hull that still survive at Northrop University and in the National Air and Space Museum remain as supple and corrosion-free as when they were first rolled, more than half a century ago. *Courtesy Northrop University.* RIGHT: Launched on August 19, 1929, the *ZMC-2* remained in navy service until 1941 when she was dismantled and her hull melted down for the aluminum. She logged a total of twenty-three hundred hours of flying time during her twelve-year career. The inscription on this photograph to John Roda, one of the crew members on the first test flight, is from the ship's official army test pilot, Maj. William Kepner. It says, "To John W. Roda a crew member of the *ZMC-2*. It was, in my opinion, the strongest airship ever built. It exceeded all requirements of the U.S. Navy acceptance tests. It could have provided many answers to airship 'Air Transportation.' " Kepner, an experienced balloon and airship pilot, retired with the rank of major general after World War II. *Courtesy John Roda.*

gauge than if it had to stand alone. This was the principle that came from Zeppelin construction through Rohrbach to airplane construction. It was a technique that was introduced in this country by John Northrop. He built some very beautiful single-engine airplanes with it. And this principle was continued in the DC-2 but it was still too heavy. To accept light gauges still made people very uneasy. The pieces did not look strong enough and individually they weren't but collectively they were. From the outside, the DC-3 looked like the DC-2. It was only twenty-six inches wider and had 5 percent more wing surface. But inside, it was a very different airplane.[6]

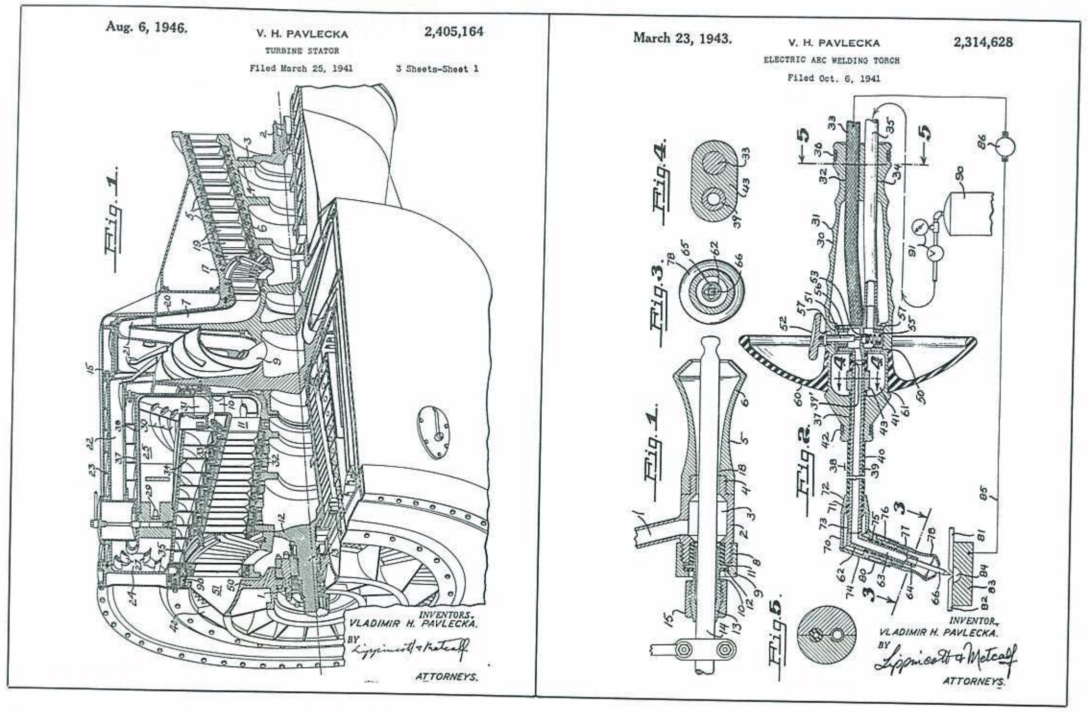
The DC-3 could carry a 50 percent greater payload than its predecessor: venty-one passengers instead of fourteen. For the first time the airlines had a plane ıat could make a profit on passengers alone. They no longer needed a government ıail contract. "The pilots were scared to death of the first DC-3s," Pavlecka ecalled, "because the wings flexed. They had never seen that before. I gave eminars for the airlines explaining the principles involved but the pilots didn't elieve me. Only experience allayed their fears."[7]

For his work on the DC-3, Douglas promoted Pavlecka to head of structural esearch. He was given his own shop and a staff of twenty-two engineers. They ıvented the hexagonal stop nut, hydraulic wing folding for naval aircraft, and flush veting. They developed the first tricycle landing gear ever used on a large irplane, the B-19, as well as its mechanically self-sealing fuel tanks. They designed ouglas's first pressurized fuselage for the DC-4, developed the modern method of ydropressing with rubber dies, and changed Douglas from extruded to rolled sheet ıetal sections, the aerospace industry standard today. "It's one of the few improvements Boeing ever had to learn from Douglas," Pavlecka proudly recalled.

Pavlecka's early schooling in turbine technology was still with him. In Detroit he ad designed a steam turbine for a large metalclad that was never built.

ladimir Pavlecka

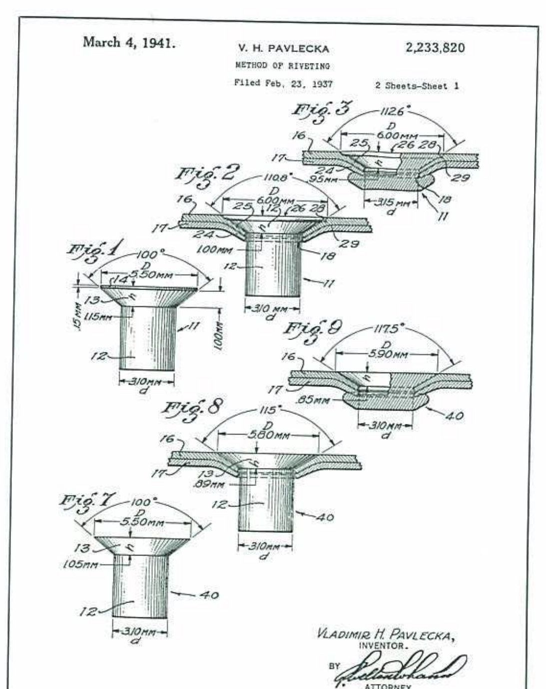
When we began to design very large airships we encountered a problem. There were no suitable engines for them. We ended up proposing to use the Curtiss V-12 pursuit plane engine, which was totally unacceptable but there was nothing else. So I began thinking about steam turbines and I did quite a bit of work on it. I determined that it was feasible but nothing ever came of it. Then later at Douglas we had the same problem. In 1935 we



LEFT: Patent 2,405,164, Turbine Stator. This is the original stator patent that was finally issued to Pavlecka in 1946 after eleven years of delay and disinterest in the jet engine on the part of both government and industry. In those same years the jet engine was developed independently in England and Germany. Frank Whittle's engine was financed by private investors in England while Hans von Ohain's was built by Ernst Heinkel in Germany. Both flew before the end of World War II and only Hitler's meddling prevented the German jet fighter from playing a significant role in the war. The first jet plane to fly in the United States, the P-59, was powered by a U.S. copy of Whittle's British engine. RIGHT: Patent 2,314,628, Electric Arc Welding Torch.

In the oxyacetylene welding process, impurities are picked up from the air and show up in the weld. The idea of shielding the welding arc with an inert gas like helium or argon was related to my familiarity with the use of helium in airships. I remember being called into Jack Northrop's office one day. The chairman of the board was even there so I knew it was something important. They said I was spending too much money trying to develop this welding thing. I asked how much I had spent. They said it was already up to $3,400. I looked at the figures and I showed them where the welding department had been charging their expenses to my research department. I had, in fact, spent only three hundred dollars on it. They let me continue with the project but only if I was able to finish it up in one more month. Well, we did finish it, and a few years ago *Fortune* magazine said that Heliarc welding is now a six-billion-dollar industry. That's not bad for a three-hundred-dollar investment.

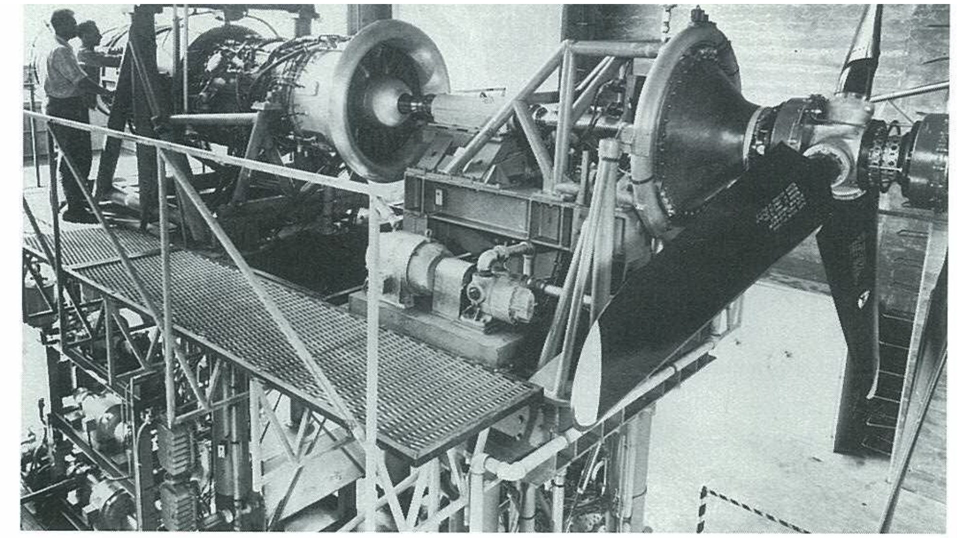
Vladimir Pavlecka



Patent 2,233,820, Method of Riveting.

The standard rivet was then eighty-six degrees. It didn't produce a good flush rivet because it had too much metal in the head so we had considerable redesigning to do to get the particular form of the one-hundred-degree rivet that is the standard in the industry today. When the patent for the riveting tool was applied for, I put the names of myself and five of my staff on the application. The patent examiner responded by saying that six people could not invent anything. I asked him how many people could and he said that three is the largest number of people who can invent something. So the patent has only three of us on it. There is a story that Howard Hughes heard about our rivet just as his newest speed plane was nearing completion. He ordered all the old rivets removed and our new flush rivets installed. There were thousands of them but he gained a significant increase in speed because of the smoother surfaces.

Vladimir Pavlecka



Conceived in 1935, begun in 1940, changed from a jet to a turboprop by the navy early in 1941, and not completed until 1945, Northrop's Turbodyne engine never flew. John Northrop may have intended to use the engine to power his Flying Wing, another farsighted project that was delayed and eventually killed by government interference. Pavlecka was forced to leave Northrop after a series of disagreements with Theodore von Karman, a Northrop consultant. Pavlecka was forced out at the end of 1942. "To leave that engine was the hardest thing I ever had to do," he said. "It was like leaving a child to be raised by others." *Courtesy Northrop Corporation.*

designed the B-19, the largest plane ever built and it was driven by engines that were much too small for it because there was nothing else. And I began to think again of turbines. Not steam turbines because they would be too heavy in an airplane, but gas turbines. The gas turbine had a bad reputation among engineers then. One had been built in France in 1906. It worked but had an efficiency of only 3 percent. Yet the company made a fortune on it. All the torpedoes in those days were powered by steam turbines. This company replaced them all with gas turbines. It is an interesting fact that no company has ever lost money building turbines. I collected all the information I could find on gas turbines and determined that, despite its bad reputation, it could be used as an efficient aircraft powerplant.[8]

In 1935 Pavlecka took his preliminary designs to Douglas management. Douglas gave them to Pratt & Whitney who sent them to their consultants at the Massachusetts Institute of Technology. Three months later an answer came back from Pratt & Whitney. They agreed with their experts at MIT. The jet engine could not work and even if it did, there would be nothing useful for it to do.

It took four years before Pavlecka found someone to back his jet engine. In 1939 John Northrop asked him to join his new company as its first chief of research. Pavlecka agreed but only if Northrop would seriously consider his jet engine. "What's a jet engine?" Northrop asked. Pavlecka explained and Northrop agreed. Northrop Aircraft was formed late in 1939. Work began on America's first jet engine early in 1940.

Northrop financed the initial work with company funds. When they took their plans to the Army Air Corps, no one understood what they were talking about. The navy was afraid the flame from the jet exhaust would set the wooden decks of their aircraft carriers on fire and ordered the design changed to a turboprop. It became Northrop's Turbodyne project and was not completed until 1945.

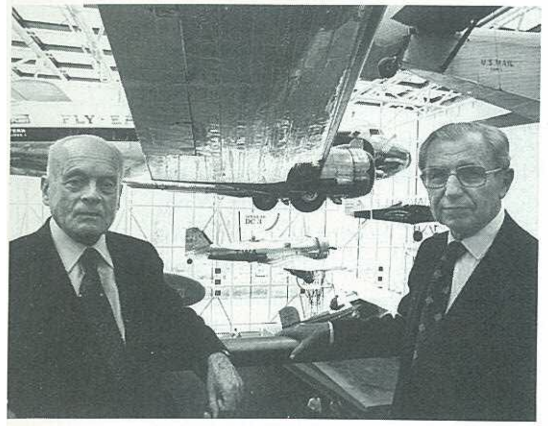
Meanwhile in England, Gen. Hap Arnold was invited out into the countryside to witness a test flight of a new airplane, the Gloster E 28/39. Arnold approached the plane with curiosity. "Where is the propeller?" he asked.

"There is none," his British hosts replied. "It's a jet."

"What's a jet?" Arnold asked.

The man at Arnold's side, Maj. Donald Keirn, knew what a jet was. Nine months earlier it had all been carefully explained to him by Vladimir Pavlecka. Keirn hadn't believed it then. He began to believe it now.

The E 28/39 made two brief flights that day. Arnold was astonished. He sent for a B-17 to fly two of the new British engines back to the U.S. They were delivered



Vladimir Pavlecka (left) and John Roda in front of a DC-3 on display at the National Air and Space Museum in Washington, D.C. Both men began their careers working on the *ZMC-2*, then came to Douglas. Pavlecka became head of structural research while John Roda served for twenty-seven years as general factory superintendent at Douglas's El Segundo plant, where he originated the multi-model, variable-speed production line. He also lectured on prototype and production aircraft manufacturing techniques at Caltech. Without the production procedures pioneered by these two men, especially the use of sheet metal rather than extruded sections, the American aircraft industry would have been even harder pressed to meet the challenges forced upon it at the beginning of World War II. *Photo by the author.*

to General Electric. The reasoning was that since GE already made turbines for hydroelectric power plants, they should also be able to quickly produce turbines for airplanes. The reasoning was wrong. The only jets to fly in combat in World War II were German.

Back at Northrop, Pavlecka invented the Heliarc welding process and then returned to Douglas where, in nine days, he and Fred Dallenbach designed the world's first production turboprop engine, the Allison T-38, which was later used to power the Lockheed Electra. After that he worked on the Apollo moon rocket and completed development of the centripetal compressor and the contra-rotating gas turbine.

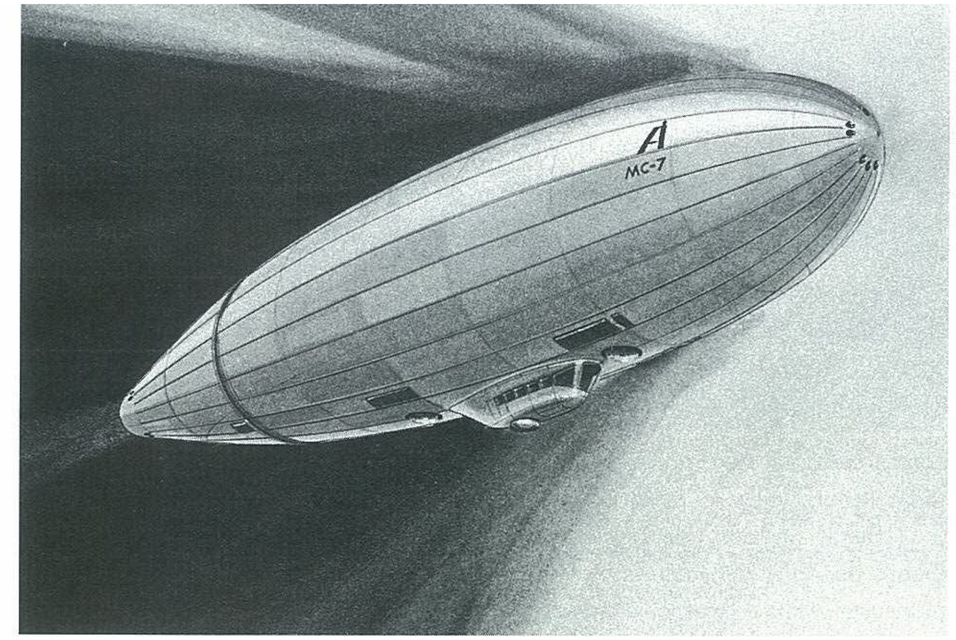
In a history such as this, with events taking place in a dozen nations and from the North Pole to the jungles of Brazil, it is easy to lose track of the fact that all this has happened within a very short time span. But here we have a single individual, Vladimir Pavlecka, who watched in awe as German Zeppelins flew over his village schoolhouse on their way to the eastern front, and who also worked on the rocket engines that lifted the *Lunar Lander* from the surface of the moon.

It has been a period of incredible technological progress. Even more surprising is the fact that so much of it has been touched by the efforts of this same individual. Take the Boeing 747 as an example. Its Alclad sheet metal sections formed by hydropressing, its tricycle landing gear, its jet engines, and pressurized fuselage—Vladimir Pavlecka had a hand in all of them. The 747's stop nuts, its flush rivets, and its Heliarc welds—all these patents have his name on them. Yet even after fifty years at the very center of the modern aerospace industry, he never forgot his first love, the metal airship.

Vladimir Pavlecka

I have always regarded airships as an important form of transportation. I was dismayed that they were not taken more seriously by others in the aerospace industry. Even after the very successful performance of the navy blimps in World War II, I was amazed at the depth of negative feeling about them. I even hesitated to talk about them for fear that I would be considered odd. But that did not stop me from continuing to work on their development. And I am convinced now more than ever that Ralph Upson's metalclad principle is the key to the future. At first he tried to convert a fabric ship into metal. He was very familiar with fabric ships but their shape is deformed by the pressure of their lifting gas. They are not circular in cross section and they are generally working with different principles than metalclad ships are. Upson's was a completely original concept in shell structures. We knew very little about shell structures at that time. Since then a great deal of work has been done on them in the United States, in Europe, and in Russia. But Upson's contribution, his insight, was a very fundamental one, yet one that was completely original with him. We proved it first in the water model and then in the *ZMC-2*. There is no doubt in my mind that it will be the basis of the airship of the future and I have continued to work toward its perfection over all these years.[9]

His continuing interest in airships combined with his pioneering work in the aerospace industry placed Pavlecka in a unique position with regard to the airship's revival. In the past the key to success in lighter-than-air design has been the experience of the people involved: hard-won experience gained over years of work building and flying airships. Today that experience is almost gone. Yet even if the men who built the great rigid airships were still active, their knowledge would be half a century out of date. The *Hindenburg* and her sister ship, the *LZ-130*,



The *MC-7* is Vladimir Pavlecka's vision of the airship of the future, the next logical step beyond the modern blimp. Its design specifically addresses the blimp's two primary shortcomings of low speed and the necessity for a large ground crew. A metalclad, the MC-7 hull varies in thickness from .006 to .008 of an inch. Its computer-controlled thrusters at the bow and stern are activated by electronic sensors for precise hovering and ground control. With no tail fins to add to drag and with hull slots for boundary layer removal, the ship's two internal five-hundred-horsepower turbine engines will be able to drive it at speeds in excess of a hundred miles per hour. *Painting by John Mellberg, Courtesy Airships International Inc.*

represented the highest achievements in rigid Zeppelin design but they are no more modern dirigibles than their contemporary, the DC-3, is a modern airplane.

Technology has come a long way in the last fifty years and few people combine both the hard-won airship experience of the past with a knowledge of the very latest in aerospace materials and techniques. One who did was Vladimir Pavlecka.

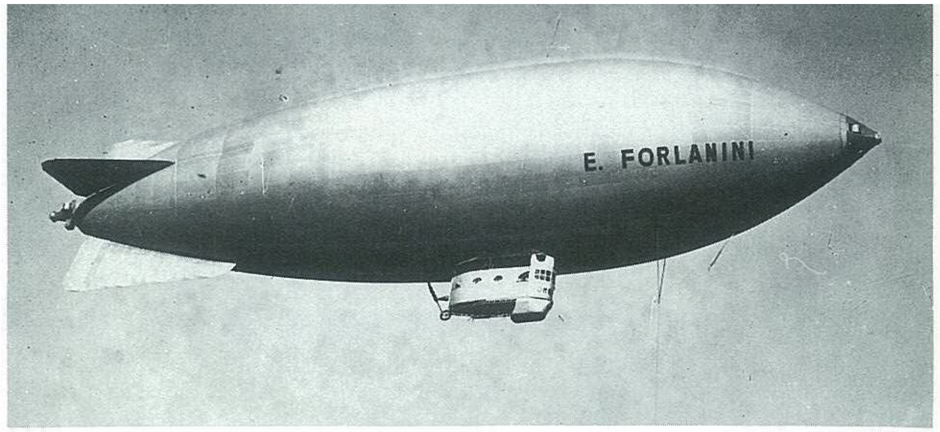
Several years ago, after completing contract studies on the subject for NASA and the navy, Pavlecka became convinced that the time would soon be right for the return of the airship. He and John Roda, with financial backing from Dr. Earl Kiernan, a former Strategic Air Command flight surgeon, formed Airships International in Tustin, California. Joined by several leading specialists in the aerospace industry, friends of long standing who added their expertise to his, Pavlecka set to work. His goal was the creation of a truly modern all-metal airship.

Vladimir Pavlecka

The *ZMC-2* gave us Alclad and the development of light-metal structures that led through the DC-3 to modern aviation. Now the aerospace industry can return the favor. There are things we wanted to do on the *ZMC-2* that simply couldn't be done. The technology was not yet in place. Today it is. Today, with metal bonding, epoxy laminates, aluminum-magnesium-lithium alloys, carbon and boron fibers, gaseous fuel turbines, computer-activated thruster control, and boundary layer removal, we can create a new generation of metal ships as far ahead of the *ZMC-2* as today's jumbo jets are beyond the plywood airliners of the 1920s.[10]

A number of the developments that Pavlecka envisioned for use in his new metalclads are still on the drawing boards. Pavlecka was always ahead of his time but, as a practical engineer, he designed his first modern dirigible around systems and materials already available.

This first design doesn't look quite like other airships. It has no tail fins. These have always been a problem in airships. They add considerable weight to the tail where the least amount of lifting gas is available to carry that weight. Pavlecka calculated that tail fins with their control surfaces, the rudders and elevators, add an average of 20 percent to hull weight and 14 percent to drag. In addition, they are useless when the ship is flying slowly or is stopped in the air. With no airflow over its



The *Omnia Dir* was a semirigid, 170 feet long, forty feet in diameter, with a gas capacity of 140,000 cubic feet. She was completed in 1931 after the death of her designer, Enrico Forlanini. She was described as an experimental prototype built only to test the new maneuvering system. She was powered by an old 150-horsepower Isotta-Frascheni engine that also turned two centrifugal fans, which blew into cloth tubes sending compressed air to the bow and stern where it could be directed in any of five directions through the valves. *Courtesy Stato Maggiore Aeronautica, Rome.*

control surfaces, the dirigible becomes little more than a free balloon and requires a large ground crew to assist in landing it.

This is, in fact, one of the major shortcomings of the airship that the Coast Guard hoped to eliminate in its Maritime Patrol Airship by requiring the ability to maneuver within a ten-foot-diameter circle and land with a ground crew of less than eight people.

Pavlecka felt he had solved the problem by replacing the traditional tail fins with cold-air thrusters at his ship's bow and stern. The idea of thrusters was originated back in 1930 by Italian dirigible designer Enrico Forlanini. His ship, the *Omnia Dir,* was completed after his death and on June 11, 1931, was flown directly out of her hangar at La Valle airport near Baggio without the aid of any ground crew at all.

Città Del Popola, June 12, 1931

Angioletta Forlanini, age five, the granddaughter of the inventor and godmother of the new ship, pulled the string that made the traditional champagne bottle break against the propeller hub. The *Omnia Dir* received in this way her baptism. It was then that the dirigible moved out of the hangar on its own means, the airmen on the field restricting themselves to crowd control duties. After a few minutes, the *Omnia Dir* lifted off and, with propeller turning, set off to Milan. After circling for some time, the dirigible came back to the airport and with surprising nimbleness repeated the maneuver, landing without throwing out the ballast rope. Just as easily, it moved rapidly into the hangar. The Duke of Bergamo, the only passenger on this first flight, jumped out of the cabin, and expressed his best congratulations to the relatives of Forlanini and to the workmen.[11]

Since their introduction by Forlanini, thrusters have been used on the *Lunar Lander* and are built into most modern merchant ships. Ships have the same maneuvering problems as dirigibles. In port at slow speed, a large ship has no flow of water past its rudder and requires the assistance of tugboats to get it to the dock. An airship must use people hauling on landing lines for the same purpose.

Pavlecka believed that computer-controlled thrusters mounted firmly on his airship's rigid metal hull would give it the same maneuverability as a helicopter. When this is added to the dirigible's great range, load-carrying ability, and fuel efficiency, it will result in a vehicle of unequaled versatility.

The second of the airship's traditional shortcomings that Pavlecka addressed was speed. This is the problem that concerned the Coast Guard when they required a top speed for their Maritime Patrol Airship of ninety knots (103.5 mph). The U.S. Navy's ZPG-3W blimps were the fastest airships ever built but their top speed was less than ninety miles per hour.

A blimp's speed is limited by a phenomenon called bow dimpling—an innocu-

ous way of describing the collapse of the ship's bow by the pressure of the air pushing against it at high speeds. The lines that can be seen radiating from the bows of most blimps are battens, strips of reinforcing material attached to the envelope to give the bow more support.

But a metal-hulled ship with a pressurized interior would be far more resistant to bow dimpling and the resulting increase in drag. In addition, Pavlecka proposed to insert boundary layer removal slots near the stern of his ship to siphon away the turbulent air that attaches itself to all aircraft hulls at high speeds and results in additional drag. In this way he believed that the 10 percent increase in speed required by the Coast Guard could easily be attained and surpassed.

Pavlecka's design was well advanced at his death. He called it the MC-7. (The MC stands for metalclad.) One of the errors he had noted in the schemes of airship promoters over the years was their fondness for immense ships.

Vladimir Pavlecka

Even Count Zeppelin didn't start with the *Hindenburg.* We have to start back at the beginning with small ships both to prove the design concepts and to train the people who are going to build and fly them. Yet by the same token, we made a mistake with the *ZMC-2* by building it too small to perform a useful mission. What we need to design is the smallest airship that can still accomplish an economically useful function.[12]

Pavlecka's *MC-7* was to be 277 feet long and seventy feet in diameter, with a gas capacity of seven hundred thousand cubic feet. This would give it a useful lift of ten tons. Two five-hundred-horsepower turbine engines would drive it at a top speed of one hundred miles per hour. It would have a maximum range of forty-three hundred miles.

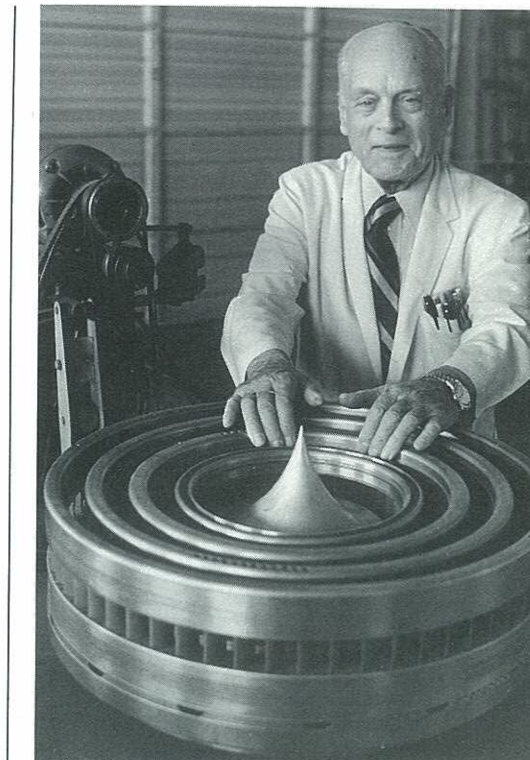
On June 28, 1980, while shopping for a new suitcase to replace one lost by the airlines, Vladimir Pavlecka suffered a heart attack and died. The modern airship, like so many of his dreams for man's future, was still a vision on his drawing board. What was it that drove him to this last task when most men his age were already into their second decade of retirement?

Vladimir Pavlecka

I am the last surviving member of the *ZMC-2* design team. If I don't do this, it may not get done. All the plans to revive the airship must deal with the fact that the men who built them, the engineers with a lifetime's experience, the skilled workmen, and technicians, have all grown old and retired and many of the best have died. Anyone else would have to start back at the very beginning. I can do it but it has to be now. I feel a great responsibility to pass my knowledge on. I owe it to Upson and Fritsche and to all those people who believed in the airship. And I owe it to my country. I owe it to the United States.[13]

Vladimir Pavlecka died before his work was completed. Yet his dream of the return of the airship may still come true. New ships have already been launched in the U.S., Canada, England, Germany, and the Soviet Union. Government funding continues for the *Sentinel 5000* but at a lower rate than originally planned.

Modern materials and technology, when applied to the balloon, led to vehicles that can remain aloft for years at the very edge of space. What will be the result when truly modern technology is finally applied to the airship?



Born in the Austro-Hungarian Empire before the Wright brothers flew at Kitty Hawk, Vladimir Pavlecka helped build the engines that lifted men from the moon. His work goes on, continued by Dr. Earl R. Kiernan and by his friends from the aerospace industry through Airships International, the company he and Kiernan founded in Tustin, California. Here he is shown with his contrarotating centripetal compressor. At 92.5 percent, it is the world's most efficient. Work continues on his shrouded wind and water turbines, his turbo-supercharger and on his metal airship. *Photo by the author.*

· EPILOGUE ·

At a distance of fifty years and more, the event stands out in memory without prologue or epilogue—a day in the life of a ten year old boy, vanished and irretrievable, except for a few seconds when a great silver ship thundered by.

I do not recall that there was any expectation that the *Akron* would appear. The first indication was a shout from someone outside the house, together with the sound of engines, engines such as were not commonly heard in 1932. I rushed out the back door and there it was, immense and gleaming in the morning sun, not very high, closely framed by the trees and houses which hemmed in the small backyard. In a few seconds the airship had moved swiftly behind the trees and was gone. The engines were not thrumming with quiet power and the airship was not moving with the measured majesty that the *Hindenburg* presented when I saw it at a much greater distance in the early fall of 1936. The *Akron* was barreling along, its engines roaring with purposeful urgency. Can this be correct? In my mind it is; the mind in this case, curiously, of a ten year old, yet at the same time the mind of a sixty year old considering a memory that stands out against the far horizon of the remembered past. It is often said that no one who ever saw a rigid airship ever forgot it. Considering the vivid quality of this close encounter, as strange in its way as any we hear about in these later days, that is hardly to be wondered at.

I think I may have read somewhere of a flight by the *Akron* up to Boston about this time but I cannot find it now. Probably the exact date of this marvelous apparition could be discovered. Its like will not be seen again, and we, now old, were fortunate to see it when young, sometimes in a most dramatic way.

Ralph M. Holmes of Costa Mesa, California,
recalling a memory from his boyhood in Stoughton, Massachusetts.
Quoted in *Buoyant Flight*, May–June 1983.

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