GOING DOWNTOWN —

The Fairey Rotodyne, the vertical takeoff and landing airliner time forgot

"I thought it was this forgotten branch of aviation—and it never really had its chance."

ERIC TEGLER - 2/16/2020, 2:00 PM

If things had gone a little differently, the Rotodyne could have been a more convenient way to short haul air travel than the regional jets we now use. Hulton Archive/Getty Images

The phrase "Urban Air Mobility" (UAM) seems like it's been with us for quite a while, but really it's only been in widespread use for two or three years. NASA officially recognized UAM in 2017, calling for a market study of remotely piloted or unmanned air passenger and cargo transportation around an urban area. Most people would probably call this the "air taxi" idea—a vision of hundreds of small, unmanned electric multi-copters shuttling two or three passengers from nearby suburbs or city spaces to vertiports at about 100 mph (roughly 161 km/h).

But if things had worked out differently in the late 1950s and early 1960s, we might have a very different understanding of UAM—something more like mass-transit. We might have had a city-center to city-center 55-passenger vertical take-off and landing (VTOL) airliner shuttling between urban heliports at 180 mph (289 km/h).

Actually, we did have that, it's just few people remember. It was called the Fairey Rotodyne.

Born by grounding

Fairey Aviation was born in a western London suburb in 1915. With World War I in full swing, the story goes that Charles Richard Fairey, a gifted young engineer with Short Brothers Aircraft, was prevented from joining the Royal Naval Air Service (RNAS) because Britain's Admiralty Department felt he'd be more useful as an aircraft designer/builder than a (likely short-lived) pilot.

Irked at being barred from joining his peers, the 26-year-old Fairey agreed not to make a fuss if he were given a subcontract for aircraft production that allowed him to form his own company. Airplanes were in high demand as the latest thing in weaponry, so the Admiralty consented and he was given a contract to build 12 Short 827 seaplanes for the RNAS in mid-1915.

Fairey Aviation grew from there, producing its first in-house design, the ship-borne Campania seaplane, in 1917. The company continued to design and produce seaplanes, fighters, and bombers through WWII and the 1950s, including the Firefly, Swordfish, and Gannett.

With peace on the horizon in the closing months of WWII, manufacturers then building military aircraft realized there would shortly be much less demand for their output. Commercial aviation was an obvious new vein of business. Meanwhile, rotary-wing flight development had accelerated dramatically during the War. Fairey competitor Westland Aircraft had started locally license-building the S-51, a helicopter developed by the American company Sikorsky, in 1947.

Like other British airplane makers, Fairey wanted a piece of this new helicopter market.

Tip drive, autogyros, and jets

Most early "helicopters" were multi-rotor machines, not the single main rotor helicopters we think of now. One of the few early single rotor designs, the Brennan Helicopter, began development in England during WWI. It departed from the complexity of most helicopters, which spun their rotors by coupling them directly to an engine via chain or geared drives. Instead, its Irish inventor, Louis Philip Brennan, came up with the idea of rotating the blades using thrust from a small four-blade propeller mounted at the tip of each rotor blade.

The tip-propellers were powered by drive shafts, which ran through a hollow tube (spar) that supported the rotor blade. These connected to an engine below the rotor head via shafts and right-angle gearboxes. Brennan's "tip-drive" helicopter was capable of lifting a pilot, four men, and an hour's worth of fuel, but control issues meant it never flew higher than 10 feet (3m). A crash in 1925 shook confidence in the project, and the emergence of another machine, the autogyro, diverted interest from Brennan's tip-drive concept.

Central Press/Hulton Archive/Getty Images

Enlarge / Spanish pilot Juan de la Cierva (1895 - 1936) in Hendon before flying his gyroplane or autogyro from London to Paris after the King's Cup Air Race, September 17, 1928.

Conceived by Spanish engineer Juan de la Cierva in the early 1920s, the autogyro looked like a helicopter and airplane combined. That's because Cierva wasn't designing a helicopter. He was trying to design an aircraft that could fly at low speed without stalling.

An autogyro sustains flight by pairing small wings with a free-spinning rotor that turns solely because of the passage of air through it in forward flight. A separate engine and propeller (in tractor or pusher configuration) provide forward thrust, and the rush of air across the angled rotor blades causes them to rotate and generate added lift. Autogyros generally aren't capable of vertical takeoff. But they can make short takeoffs and vertical landings by virtue of their "autorotating" blades.

Cierva later partnered with Scottish industrialist James G. Weir to establish the Cierva Autogiro Company in England. Though they never really made the big time, improvements to autogryos by Cierva and American aircraft maker Pitcarin saw them become popular novelties in the 1930s.

Concurrently, Englishman Frank Whittle and German Hans van Ohain were each working separately on the turbojet engine. The world's first jet airplane, the Heinkel 178, first flew in 1939 in Germany. Three years later, Austrian engineer Friedrich von Doblhoff decided to combine Brennan's appealingly simple tip-drive concept with the jet engine.

The Doblhoff WNF 342 was a three-bladed helicopter that used a piston engine driving a compressor to provide compressed air. When mixed with fuel, it was fed up through the rotor hub and out through the three hollow rotor blades to be burnt in tip-mounted jets, generating rotor thrust. The rotor jets were only used for take-off, hovering, and landing.

The war aborted development of the WNF 342, but in the following 15 years Fairey engineers would ultimately bring together the threads of Brennan's, Cierva's, and Doblhoff's work.

Compound interest

While the modern helicopter configuration was well established by 1946, the desire to minimize torque, vibration, and stress on the drivetrain was also well known. Helicopters were amazing, but they weren't particularly reliable. Fairey recognized this as a real commercial limitation. So they set out to design something else—a compound helicopter.

Fairey recruited Dr. J.A.J. Bennett, who previously worked with the Cierva and Weir companies. Leveraging a proponent of designs that blended helicopter and autogyro traits, Dr. Bennett proposed a "Gyrodyne" concept. The aircraft would have a powered rotor like a helicopter but also stub wings and a thrust-producing propeller like an autogyro.

Powered by the same engine that drove the rotor, the starboard wing-mounted prop counteracted rotor torque as well as providing thrust. Most of the engine's power was transferred to the rotor for takeoff, hover, and landing. In forward flight, it went to the propeller. The rotor then autorotated, alleviating stress on the rotor head and transmission while still generating lift along with the stub wings.

Reduced rotor rpm allowed for higher cruise speeds. Seven months after its first flight in 1947, the first of two Gyrodyne prototypes set a world helicopter speed record flying at 108 knots (124mph/200km/h). The aircraft made progress in testing, but a fatal crash in 1949 paused the program.

Among the Fairey staff looking at further development were German engineers recruited from Doblhoff. With their encouragement, the company decided to retrofit the second Gyrodyne as a test-bed for a tip-jet drive system. Its rotor and gearbox were removed, replaced with a two-blade tip-jet driven rotor. The tip jet rotor worked by taking air from two compressors driven by the engine, which flowed through the rotor blades alongside kerosene, which was then mixed and burned by the jet.

Like the Gyrodyne, the rotor was powered for takeoff and landing. In forward flight the jets were shut off and the aircraft flew as a gyrocopter. Forward thrust and yaw control came from engine-driven pusher propellers on the stub wings. The Jet Gyrodyne could only maintain level flight as a gyrocopter for short periods, but its promise convinced Fairey to undertake two other tip-jet designs. The first was a small purely tip-jet powered helicopter called the Fairey Ultralight Helicopter. The second was the ambitious Rotodyne.

Listing image by Hulton Archive/Getty Images

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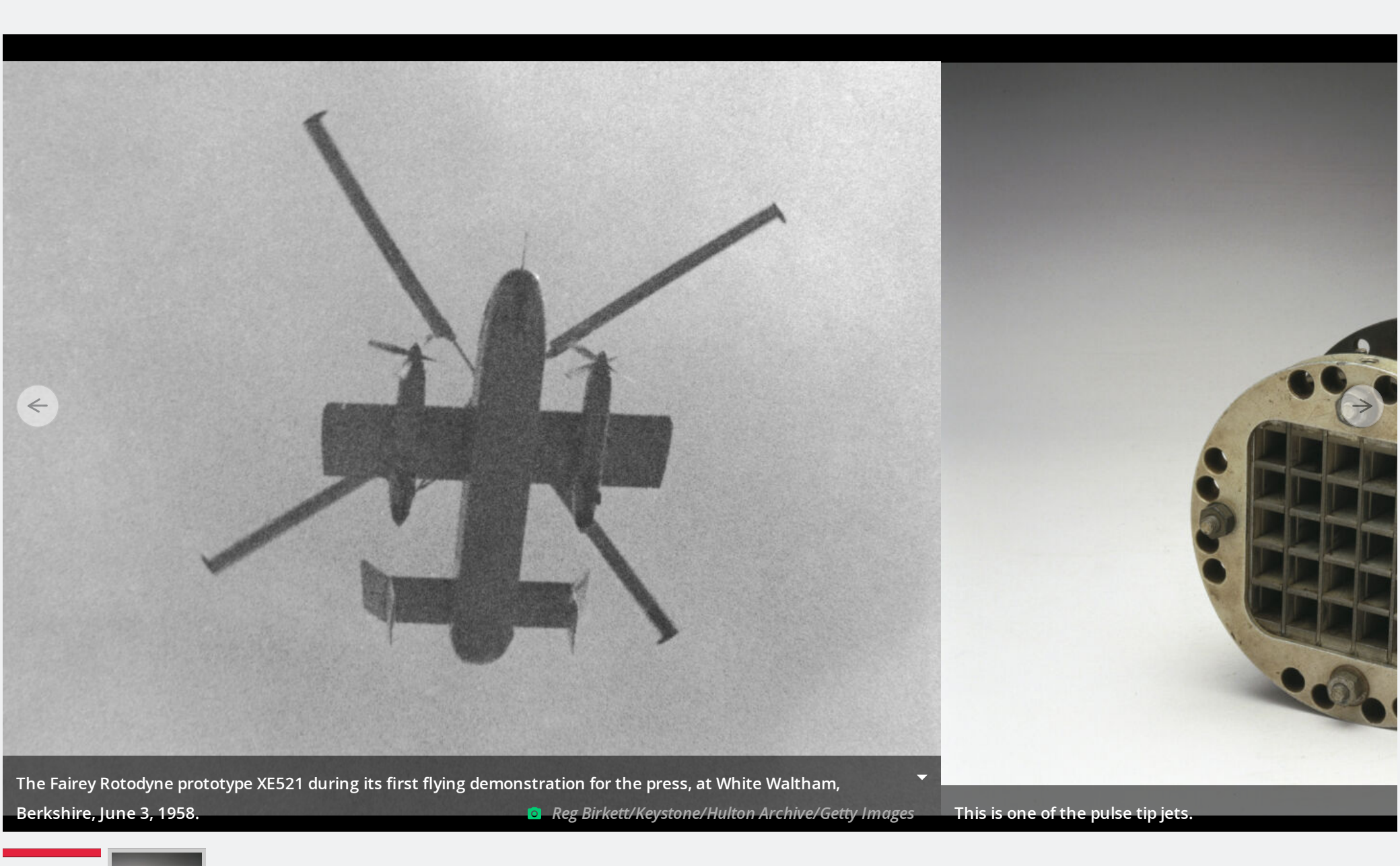
The Heli-Liner

While Fairey was proving the feasibility of the Gyrodyne and Jet Gyrodyne, futurists in America, Europe, and the UK were imagining airliner flight with helicopters. Short-range city-to-city passenger transports that could land downtown without need for an airport were recognized as potential money-makers by airlines including British European Airways (BEA), which solicited proposals for a short haul heli-liner in 1951.

Fairey submitted its own heli-liner proposal to BEA and to the UK Ministry of Supply, which planned to award a contract for a prototype aircraft combining the VTOL capabilities of a helicopter, the speed of a gyrocopter, and the passenger capacity (40 seats) of an airliner. Though Fairey proposed several designs over the years, its Rotodyne proposal won the contract (which called for a cruise speed of 150mph and a range of 250 nautical miles) in 1953.

The "Rotodyne Y" looked like a twin-turboprop airliner with short wings and a huge four-blade tip-jet rotor on top. Like the Jet Gyrodyne, its rotor would be powered-up for landing and takeoff; in cruise flight the jets were switched off and the blades autorotated, producing lift along with the wings. Two 2,800hp (2,089kW) Napier Eland N.E.L.3 turboprops provided thrust in cruise. The transition between helicopter and autogyro flight took place at about 60mph.

In helicopter mode the engines supplied power to two compressors, which fed air (and fuel) to the combustion chambers of the tip jets through each of the 90-foot (27.4m) rotor blades. Each engine supplied air for a pair of opposite rotors. If one turboprop failed, the pair of tip jets supplied by the remaining engine could still spin the rotor. In low speed flight yaw was controlled by varying the turboprops' propeller pitch via rudder pedals.



The Fairey Rotodyne prototype XE521 during its first flying demonstration for the press, at White Waltham, Berkshire, June 3, 1958. Reg Birkett/Keystone/Hulton Archive/Getty Images

This is one of the pulse tip jets.

The Rotodyne's boxy 59-foot (18m) fuselage could accommodate passengers or cargo that could be loaded through clamshell doors in the tail. Triple vertical tails gave the Rotodyne directional stability in cruise but folded after landing to accommodate the droop of the halted rotor blades. On November 6, 1957, the Rotodyne made its maiden flight, piloted by Fairey test pilots, Squadron Leader W. Ron Gellatly and Lieutenant Commander John G.P. Morton. In April 1958, it made its first successful transition from vertical to horizontal and then back into vertical flight. As flight testing continued, the prototype demonstrated what it could do.

The Rotodyne was publicly displayed at the renowned Farnborough Air Show in 1958 and '59, impressing both commercial and military observers. Fairey emphasized its safety—it could hover with one engine shut down, and the prototype demonstrated several airplane-like landings as an autogyro.

On January 5, 1959, it blew away its speed requirement, setting a world speed record in the "convertiplane" category, at 190.9mph (307.2km/h), over a 60-mile (100km) course. In June of that year, the Rotodyne flew a load of passengers from Heathrow Airport to the 23rd Aeronautical Salon in Paris with stops in Brussels and Issy Heliport in Paris. It cruised at 180mph (289km/h).

Fairey flight test engineer (later chief engineer for Westland) David Gibbings recalled in a BBC documentary called *The Golden Age of Flying* how effortlessly the Rotodyne flew: "It leaped off the ground and into transition as if it had done so a thousand times. You didn't feel it was a faltering, 'Let's see how it goes this time chaps' affair. It was confident in the extreme."

In Paris, it was met with interest by American firm, Kaman Helicopters and Japan Airlines. BEA had already announced that it was interested in purchasing six aircraft, with a possibility of up to 20. The RAF placed an order for 12 military transport versions. After calculating that a larger Rotodyne could operate at *half* the seat-mile cost of helicopters, New York Airways signed a letter of intent to purchase five with an option of 15 more, though it wanted a 60 passenger version that Fairey would seek to develop as the Rotodyne Z.

It seemed the Rotodyne was on its way.

The way but not the will

Money was always tight for Rotodyne development, with Fairey's own resources limited by fewer defense contracts and diminished government financial support in the mid-1950s. Noise was considered a problem, too. With the tip jets in action in VTOL flight, the Rotodyne was loud, reportedly 113dB at 600ft (180m) away. Gibbings told the BBC that working at Fairey's White Waltham ground-test facility located on one corner of the airfield there: "It was quite a fun place to work because [the Rotodyne] made so much damn noise they kept you miles away from anybody."

BEA was concerned that the public would not accept the noise. Fairey, and later Westland, worked on dozens of tip-jet silencer designs, reducing the volume to 96dB with a projected further reduction to 95dB at 200 feet (61m). Fairey even conducted test flights over central London with several landings and departures at Battersea Heliport without noise complaints. Like present day UAM developers, Fairey claimed average city noise canceled out maximum Rotodyne noise, which lasted only during takeoff and landing.

Hulton-Deutsch Collection/CORBIS/Corbis via Getty Images

Enlarge / A Rotodyne under construction at Fairey's factory.

But the Rotodyne had a bigger problem—politics.

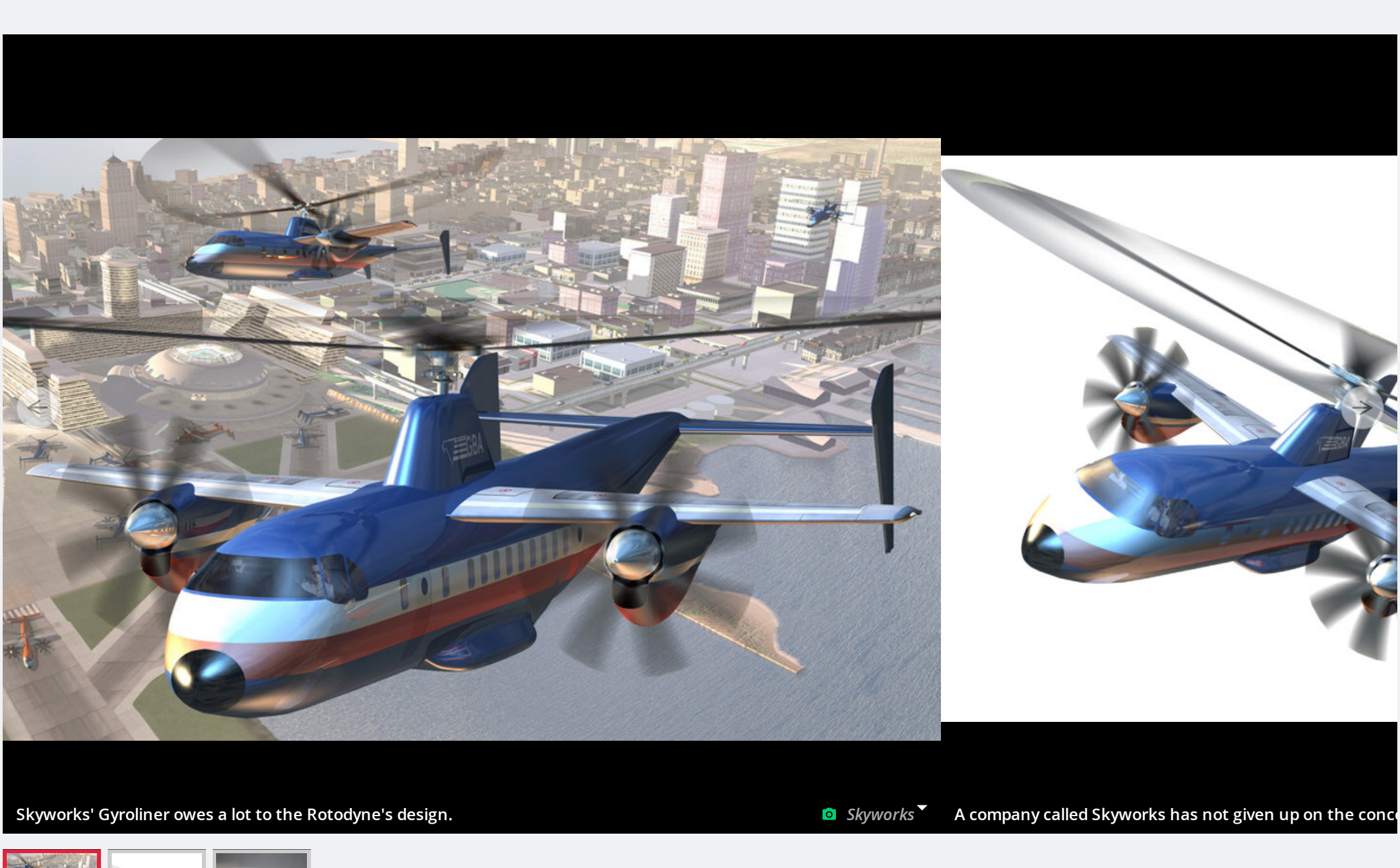
The drive to control Britain's economy by nationalizing industries from mining and utilities to healthcare, which began with Labour Prime Minister Clement Attlee in 1946, continued through the 1960s. At the beginning of 1960, there were more than 20 aircraft manufacturers in the UK. By 1961, the government had forced them to consolidate into just three. Fairey was absorbed by Westland which became Britain's only helicopter maker. Westland planned to continue the Rotodyne project, but government defense and civil support was largely withheld. Potential airline and foreign buyers lost confidence in the yet-to-be-built Rotodyne Z, and in February 1962 the program was ended.

Classified as government property, the Rotodyne Y prototype was mostly destroyed. A portion of the fuselage, rotors, and rotorhead mast remain on display at a museum in Weston-super-Mare.

The Rotodyne lives?

If not for social policy, could the Rotodyne have succeeded on a technical and cost-per-seat basis? "Definitely," says Mike Hirschberg, Director of the Northern Virginia-based Vertical Flight Society (VFS). He acknowledges that the larger Rotodyne Z would have required more engineering and investment but adds that it was decidedly achievable.

Today, VFS is active in highlighting the merits of the approximately 215 known eVTOL (electric VTOL) concepts being studied around the world. More than a dozen are in flight testing including Uber's all-electric unmanned air taxi being developed by five manufacturer partners for "regular urban eVTOL transport by 2023." The desire for pure electric power by Uber and others has driven the mass air taxi strategy. As Hirschberg told Ars, the energy density limits of batteries constrain the possibility of large eVTOL aircraft. And yet, the promise of Rotodyne was its cost-per-seat basis, estimated as low as $0.04/seat-mile in 1960.



Skyworks' Gyroliner owes a lot to the Rotodyne's design. Skyworks

Even leaving infrastructure costs aside, small eVTOL air taxis will struggle to match the Rotodyne's cost efficiency—unless they can stretch their energy further. "There are companies today who are proposing similar aircraft to the Rotodyne," Hirschberg observes. Uber partner Jaunt Air Mobility is building a gyrocopter-like concept called Reduced rotor Operating Speed Aircraft (ROSA). Another firm, Skyworks Global, has a rotodyne-type design called Vertijet, a combination bizjet/gyrodyne aimed at the UAM and military markets.

The project grew out of DARPA's frequently forgotten early-2000s Heliplane program which sought a long-range, light jet-sized compound VTOL aircraft intended to be faster than helicopters. The program was aborted in 2008 but former DARPA program manager Don Woodbury tells Ars the Rotodyne inspired its development. "If [the Rotodyne] had made it into commercial use, our whole notion of inter-city transport would be far different than it is today. The Rotodyne would've been a formidable competitor in terms of cost and performance."

Woodbury is now chief technology adviser at Skyworks Global where he works on the Vertijet and a potential new Gyroliner. He remains an admitted Rotodyne enthusiast. "I thought it was this forgotten branch of aviation and that it never really had its chance," he says. But nearly 60 years after the Rotodyne program ended, the idea remains very much on the mind of today's transportation engineers.

Promoted Comments

Perfectly Frank / Wise, Aged Ars Veteran JUMP TO POST

Thanks for a great reminder of the days when these were the future, think I was familiar with it from the Eagle's centre spread cutaway drawing – the design matches Dan Dare at that time.

> Quote:
> The drive to control Britain's economy by nationalizing industries from mining and utilities to healthcare, which began with Labour Prime Minister Clement Attlee in 1946, continued through the 1960s. At the beginning of 1960, there were more than 20 aircraft manufacturers in the UK. By 1961, the government had forced them to consolidate into just three. Fairey was absorbed by Westland which became Britain's only helicopter maker. Westland planned to continue the Rotodyne project, but government defense and civil support was largely withheld. Potential airline and foreign buyers lost confidence in the yet-to-be-built Rotodyne Z, and in February 1962 the program was ended.

Bit unfair to mention Labour, but not note that the Conservatives won in 1951 (Winston Churchill) and were in power (with various scandals, Anthony Eden, Macmillan, Douglas-Home) until Labour led by Harold Wilson beat them in October 1964. So the cuts were under the Conservatives.

It'd have been great if these could have joined the Mini as an emblem of the UK in the swinging sixties, and maybe the noise issues could have been overcome, but from a modern viewpoint they don't seem very practical.

[edited a couple of times because of saving it when I meant to preview work in progress!]

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