Jets drove propellers from the skies. But radical designs are bringing props back, creating engines that promise jetlike speeds and enormous fuel savings.

The next step

By Howard Banks

They look like the curved blades of an overgrown Cuisinart, but they promise the greatest improvement in airline economics since widebody jets entered service in 1970. They're propellers, and could be on airliners as quickly as 1991.

These are not, however, the propellers of old. They will push an airliner as fast as today's jets without the rattles and vibrations of old-fashioned propeller craft. But more than that, their great potential lies in projected fuel saving. If successful, these proppans, as they are called, will produce at least a 25% improvement in fuel efficiency over the best versions of high-bypass jet engines, called turbofans, expected to be available by 1991.

This means a 160-seat proppan design flying full would use as little as 3.8 gallons of fuel per passenger on a 500-mile journey. The best conventional jet turbofan expected in 1991 would use 5.8 gallons. Today's most common type, the 145-seat Boeing 727, burns close to 9 gallons per passenger. At today's fuel prices, then, the 727 uses fuel costing $1,090 to carry a full load on that 500-mile flight. The best conventional jet turbofan foreseen for 1991 on a 160-seat plane would use fuel costing $820. The new proppan? Only $600 of fuel.

"That blows your socks off," says Murray Booth, Boeing's director of future programs. Multiply this savings for a major airline with 100 such medium-range planes, a United or an American Airlines, and it works out to an annual fuel-bill savings of at least $65 million.

Remember, that's at today's jet fuel prices. Who doesn't think jet fuel will cost more in seven years? But remember, too, that if this savings can be realized as expected, it won't come overnight. It will take until the end of the century to replace existing fleets with new proppan-driven planes.

The implications, nevertheless, for the airlines, for airframemakers, and for such enginemakers as General Electric, Pratt & Whitney and Rolls-Royce, are enormous.
How it works

Propfans are like old-fashioned propellers in that they, too, push the aircraft along as their blades force air backward. The expectation is that they will do it at jet speeds but more economically than a jet engine, which gulps air at the front and burns it with fuel. The plane squirts along as hot gas streams out the back.

Work on three types of propfans is under way: GE's revolutionary looks like a normal jet engine, are two rows of curved contrarotating propfan blades. GE won't publicly discuss how it plans to drive these blades. In a normal turboprop, a gearbox reduces the rotational speed of the engine's high-speed turbine wheel to a level that propeller blades can handle. A key factor in GE's design, it has been learned, is that there will be two sets of turbine blades: One set mounted on an inner shaft will drive one of the contrarotating propfans, the other will be mounted so that it can drive the second propfan propeller in the opposite direction.

"It's not done by mirrors," says GE aeroprop boss Brian Rowe. "The effect of having two separate sets of blades that rotate against each other is to cut the mean rotational velocity of the gas passing through the turbine wheel from around 1,000 feet a second to 300-to-400 feet a second," slow enough to eliminate the need for a gearbox.

The first demonstration engine GE is building for flight in 1986 is not a prototype of a production engine, but uses existing parts, where possible, to save money and time. In GE's case the gas generator, the hot core of the engine, will be from an F404 fighter engine of the type that beat Pratt & Whitney for the maj or Air Force orders last February. The rest of the UDF will be anything but conventional.—H.B.

For the airlines, the competition resulting from deregulation means they cannot ignore such potential cost savings. They give the big carriers, traditionally the first to buy such new-technology planes, a fighting chance against lower-labor-cost upstarts [like People Express] that have been slicing into the business.

For the airframemakers, there is an expected market between years 1990 and 2000 of 1,500 to 2,000 short-to-medium-range planes (up to 1,500 miles) with 100 to 150 seats. That's $24 billion to $36 billion [in 1984 dollars]. These planes would replace the 727s, the DC-9s and the like now in service. To Boeing, McDonnell Douglas and Airbus Industrie, it means soaring business or disaster, depending on which technology they bet on (see box, p. 33).

It's big business for the engine-makers, too. A pair of engines sells for around $4.5 million. Powering those 1,500 to 2,000 planes would mean a market of about $8 billion.

The most startling development was disclosed before last Christmas by General Electric. GE privately revealed to a NASA-organized gathering of senior engineers from airlines and aircraft makers that its researchers had come up with a technological breakthrough in their propfan program: They had eliminated the need for a massive gearbox between engine and propeller. GE calls this the un-ducted fan, or UDF, engine.

There have been years of sometimes painfully slow research into propfans by the aviation industry and NASA. All those developments known publicly have been based on a more or less conventional approach, using a massive gearbox to slow down a gas turbine's ultra-high speed to a propeller's slower turning rate.

GE's UDF development was given a lengthy technical review by the aviation industry's top brass. NASA then speedily gave GE a development contract for $20.4 million to build a demonstration engine. GE doesn't need government money; there is $5 billion or so in the corporate kitty. But to GE's top brass, the NASA grant is important evidence that its engine men have something hot.

In theory, a design with a gearbox is marginally more efficient than one without it. But GE believes getting rid of the gearbox has several attractions. For one, it makes the engine simpler. But, no less important, the unducted fan engine will use smaller-diameter blades than a geared fan for the same horsepower. That means a smaller and lighter structure will be needed to mount the UDF engine on the aircraft, offsetting the engine's higher weight. And if it proves possible to eliminate gearboxes on relatively small engines, like the 13,000hp engines needed for a 130-to-150-seat airliner, it will also be possible to do it on much bigger ones. Further along, GE is thinking of propfans for planes needing 40,000hp engines, the size suitable for jumbo 747s.

What really has set teeth on edge for other engin makers [like United Technologies' Pratt & Whitney, the U.K.'s Rolls-Royce and General Motors' Allison] is that GE is off and running with its new engine. "We are going," says an excited Brian Rowe, senior vice president who heads the aeroengine group. He plans to have the demonstration engine working by the fall of 1985. He also plans to have two of these engines flying on a modified Boeing 727 by summer 1986, only 25 months from now. Says Rowe, "If Boeing will not cough up its share, we'll do it alone."

Work on the geared propfan approach is moving fast, too [GE is hedging its UDF bet by continuing a geared propfan program]. In fact, it's a race that will accelerate the development process. Lockheed Georgia is working together with Gulfstream and Allison on a propfan engine with traditional gearing, not the no-gear UDF approach of GE. This team won a $30 million NASA contract, but it covers
only ground testing. Getting into the air depends on squeezing more money from Congress.

There are still problems with all propfans. Interior noise is one. The high-speed propeller blades could bounce supersonic minibooms off the aircraft’s cabin. Curving the blades, making them thinner and mounting the engines at the rear is expected to solve most of that. Flying a bit slower, say at 70% of the speed of sound against 80% [much in line with today’s fuel-saving commercial practice], will help, too.

Pratt and Rolls think GE has overestimated the weight to be saved by eliminating the gearbox. Pratt thinks propfans are many years distant. Pratt, though, has to hope so. It has invested heavily in three new fan-jet engines: the PW4000 for Boeing’s 747; the PW2037 for the Boeing 757; and the V2500 in a five-country collaboration for the coming European Airbus A320. More efficient propfans would compete directly with the V2500.

“The last thing Pratt needs is someone muddying the waters with something better,” says a Rolls engineer.

The crucial year is 1987. By then it will be clear if propfans—GE’s UDF approach, the geared approach of the Lockheed-led team or both—can deliver on their promises. That’s also the year when new, lighter-weight aluminum-lithium alloys will be available in commercial quantities for airplane bodies.

There’s a snowballing effect at work here. An engine that burns less fuel needs to carry less fuel. That, in turn, affects the weight of the entire structure, which means a smaller engine would do. The new aluminum-lithium alloys and composite materials will cut structural weight by 10% or so, meaning less fuel to carry a given payload the same distance. A great slimming cycle could begin.

This is no game of technical one-upmanship. There’s life-and-death competition among the world’s engine- and planemakers. This race is not unlike the great struggle that began in 1964, when the Air Force bought the enormous C5A transport that was powered by an unprecedented high-bypass-ratio GE turbofan engine. Boeing took its failed competing airframe, married it with the Pratt & Whitney engine the Air Force had spurned, and created the 747.

That led to the great jumbo-jet war, which almost destroyed Douglas and Boeing when orders dried up in the early 1970s. But Boeing emerged as king of the skies.

It’s approaching that time again.

The curse of the leapfrog

If the American engine designers are right about the potential of the propfan, the future of Europe’s airframe consortium, Airbus Industrie, is at stake.

Airbus is spending $4 billion on a new 164-seat plane, the A320. Deliveries start in 1987. That’s the year the Americans, at General Electric and Boeing, expect will be picked as decision time on the radically new propfan engine. If the development is successful, they can have a new propeller plane flying by 1991.

In order to hold down Airbus sales between 1987 and 1991, the Americans would play leapfrog, urging customers to wait a few more years to get a plane with an additional 25% fuel savings. In the meantime, they would use cheap offers and giveaway finance on existing planes like the Boeing 737-300 and McDonnell MD-80.

Airbus would be left with its huge investment in an outdated plane and with dubious hopes of squeezing more development money from its government backers, like the U.K., which was dragging its feet into the A320 project, and West Germany, which already has spent more on Airbus Industrie than on its own troubled steel industry. Airbus then would limp from crisis to crisis.

The enginemakers have their own anxieties. GE and French Snecma, in a joint venture, built the fan-jet engine, the CFM-56, that will go in the first A320s. And Pratt & Whitney, in a five-nation consortium, is developing a fan-jet with 14% greater fuel efficiency. Called the V2500, it probably will go in later A320 models.

GE will decide by 1987 if it can play leapfrog with its new propfan engine or will have to redesign its CFM-56 to compete with the V2500. “By that time we will all have a better handle on what we can do,” says Tom Sutter, executive vice president at Boeing. Boeing is spending much of its R&D money this year on propfans, and Sutter says a Boeing propfan airliner could be in service as soon as 1990.

Boeing, of course, is hedging its bet by getting ready to modify planes that match the A320’s size and economics.

McDonnell Douglas, the weakest player in the commercial business, thinks propfans would make a neat fit with an updated version of its rear-engine DC-9 family. The company is running harder than Boeing with the propfan idea because, if the new propfans work on its old family, then McDonnell Douglas would be right back in the big game.”—H.B.

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Airbus Industrie A300 “uwitetail”—unsold—at Toulouse, France headquarters

The alarming prospect: a huge investment in an outdated plane.