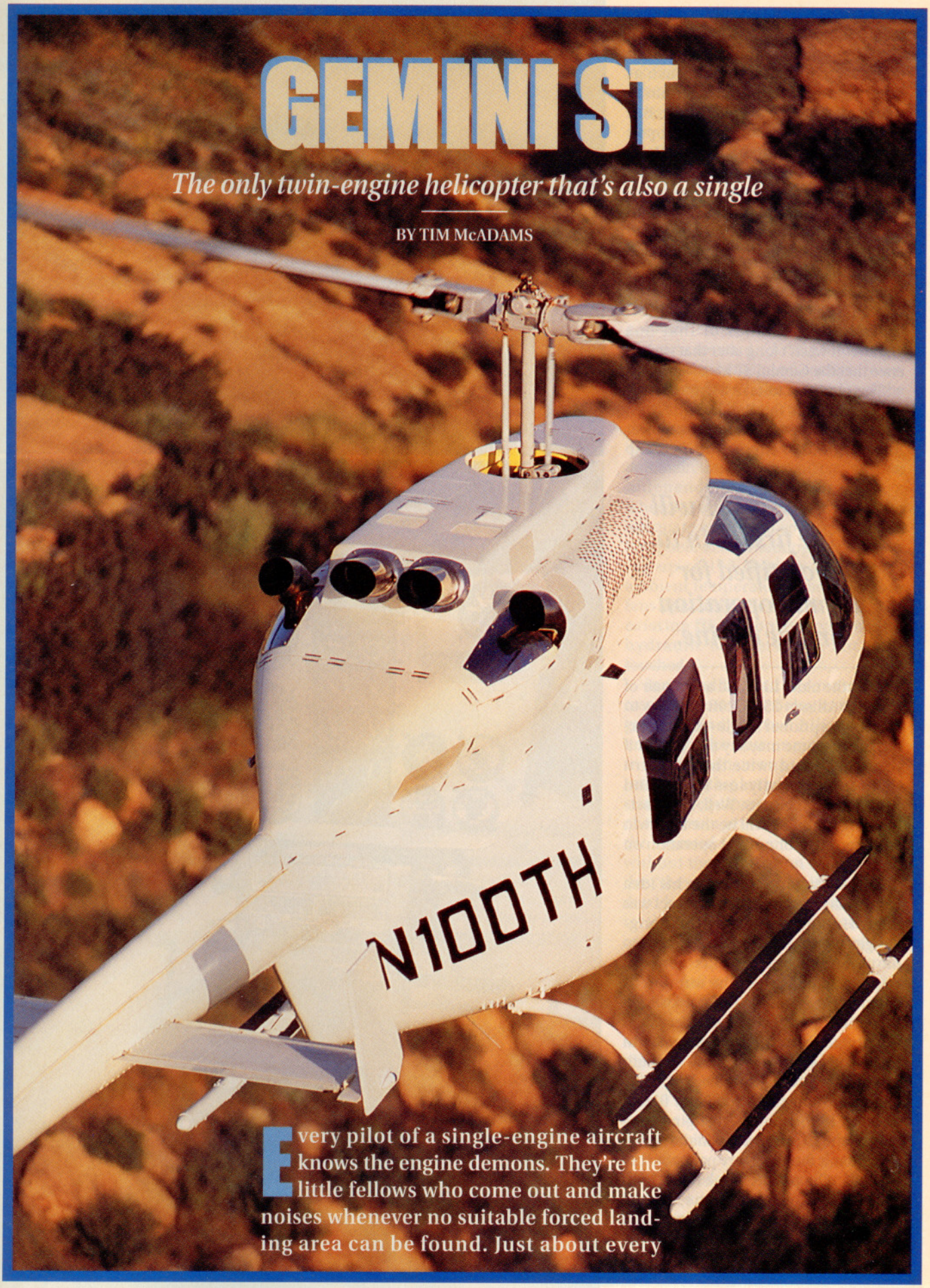
GEMINI ST

The only twin-engine helicopter that's also a single

BY TIM McADAMS



Every pilot of a single-engine aircraft knows the engine demons. They're the little fellows who come out and make noises whenever no suitable forced landing area can be found. Just about every

PHOTOGRAPHY BY MIKE FIZER

helicopter pilot I know has been in a situation where a power loss would make for a difficult landing, such as hovering over less than ideal terrain or flying over a dark area at night. But Doug Daigle, a 14,000-hour helicopter pilot and president of Tridair Helicopters, got a different perspective on engine failures while working on a U.S. Forest Service contract. He had an opportunity to try rappelling and found himself 100 feet in the air suspended on a rope from a hovering Bell LongRanger helicopter. Looking up at the aircraft's belly, he thought, "My life is literally in the hands of that one engine." It wasn't long after that experience that the Gemini ST idea was born.

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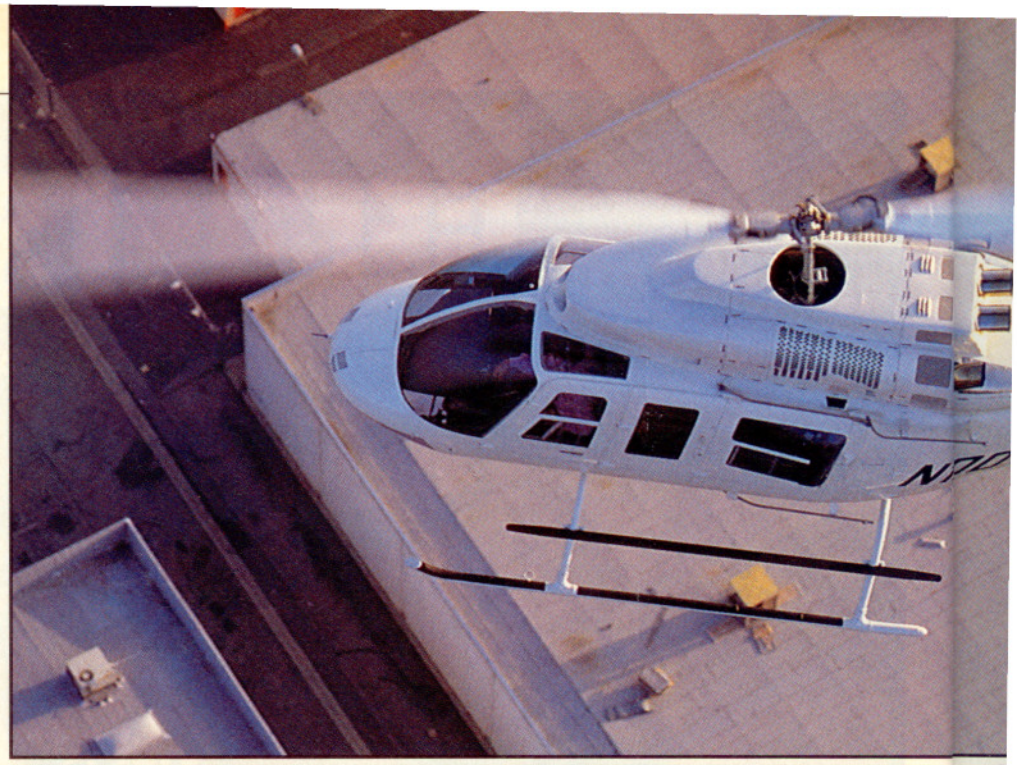
C28 for the older L1s) and add a pair of 450-shp Allison 250-C20R engines to create exceptional single-engine performance. Some may say that's great if you don't mind twice the fuel burn (with subsequently less range) and twice the engine costs. Well, not exactly—the Gemini ST will be the first twin to be certified for normal operation on one engine.

Daigle started working on his idea before his forestry service contract was over. He found out that the LongRanger's type certificate would have to be amended because his concept required a change in the number of engines. However, the Federal Aviation Administration will issue a grant of exemption from this requirement if an increase in safety or economic benefit can be shown. Daigle decided to pursue the exemption and hired Larry Blackaller, a California-based engineering consultant, to produce the initial design and submit the necessary paperwork to the FAA. The process took nearly two years, and during that time, almost everyone in the aviation industry who had heard about the proposal felt the exemption would be denied. However,



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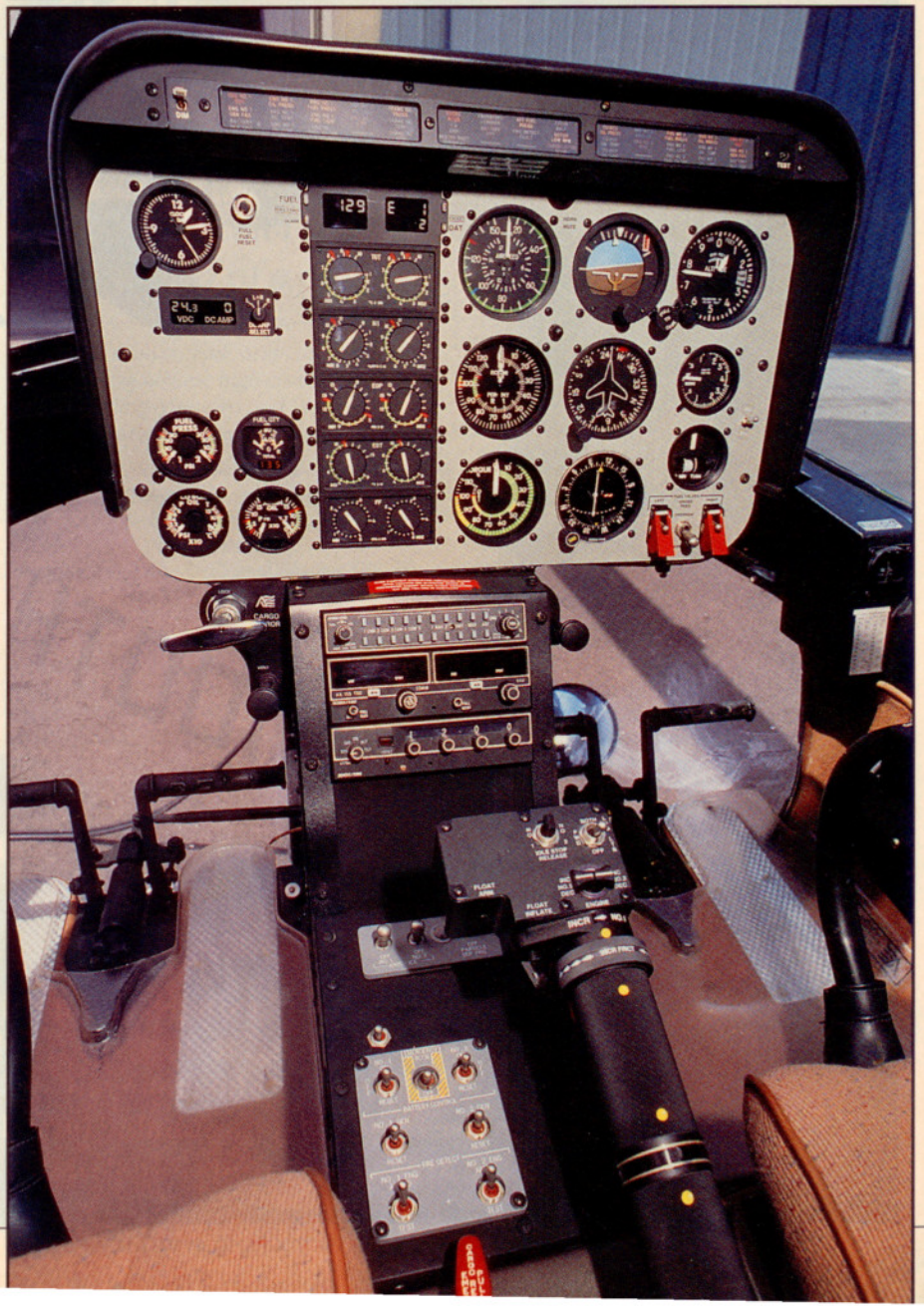
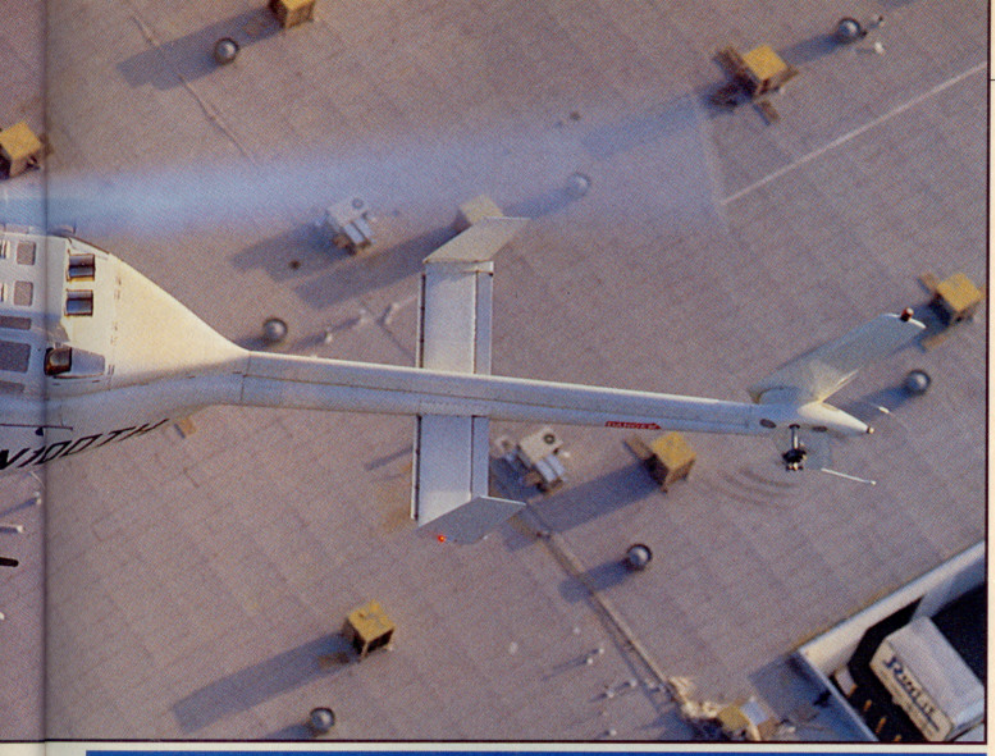
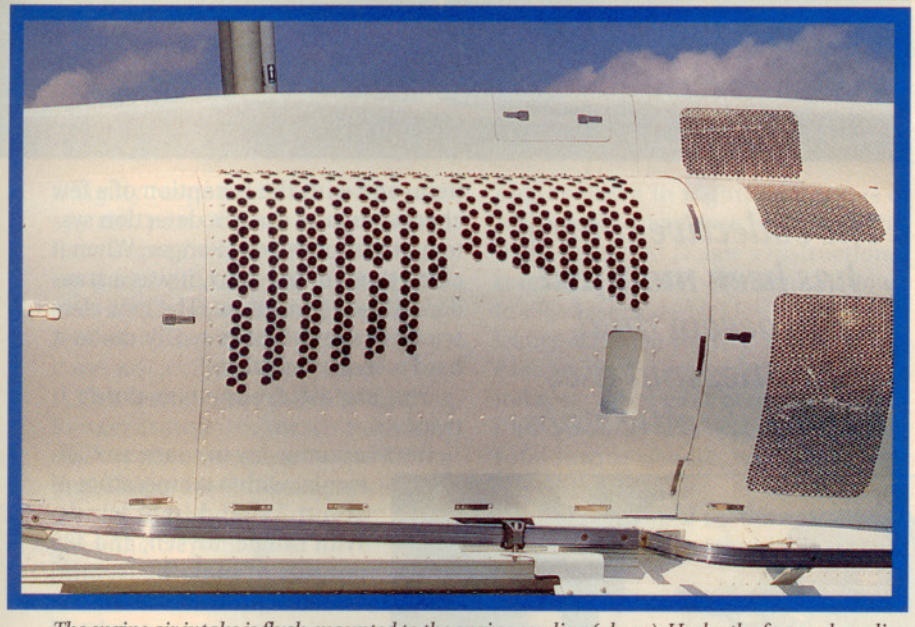
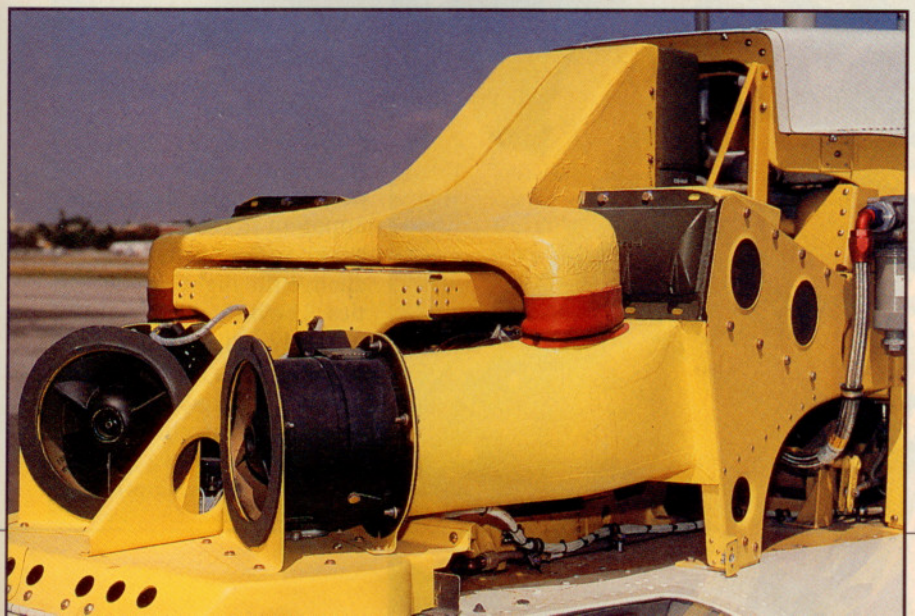






The engine air intake is flush-mounted to the engine cowling (above). Under the forward cowling are the engine oil cooling fans, ducting, and intakes (below). The modified instrument panel (left), with the Transicoil package and the new throttle arrangement on the collective control.



in March 1989, the exemption was granted, and Daigle immediately received a call from Bell. That started a salutary relationship with the manufacturer, one which Daigle felt was necessary for the commercial success of the Gemini ST. Daigle then hired Soloy Corporation of Olympia, Washington, to develop the final design, produce the necessary combining gearbox for the engines, and do the modifications to the prototype.

All the upper cowlings have been redesigned and replaced to allow for the installation of the engines, related accessories, and other modifications. The new forward cowling houses two independent engine oil coolers, reservoirs, and filters. The front part of the cowling has two circular air intakes that force air through each oil cooler and then past the combining gearbox and main transmission oil cooler. Two independent electric fans kick on when insufficient ram air exists for adequate engine oil cooling. One fan is capable of maintaining proper cooling up to 115 degrees Fahrenheit ambient temperature, and with both fans operating, the limit is 128°F. The existing flight control system and hydraulic boosters have not been touched.

Installed behind the main rotor transmission is the Soloy combining gearbox and the two Allison C20R engines. The new engine cowlings include flush-mounted engine air intakes with particle separators as standard equipment. One advantage of this arrangement is that it allows the Gemini to fly in blowing snow without the installation of snow baffles; they are required with the standard LongRanger. Also, it makes the intakes less obvious and gives the aircraft a clean look. As a matter of fact, almost everyone incorrectly assumes that the oil cooler inlet ducts are the engine air intakes.

The engines are fed fuel through separate forward fuel cells, each drawing from the main aft tank. The system uses the existing fuel tanks and boost/transfer pumps but essentially reverses the flow. This was done to meet the independence requirements for Category A operations. (Category A refers to Federal Aviation Regulations Part 29, airworthiness standards for Transport-category rotorcraft. Helicopters meeting the regs must have two engines, dual electrical systems,

independent engine fuel systems, and fire detection and suppression systems.) Also, for compliance with Category A, the Gemini comes with a standard fire detection system and an optional fire suppression system.

Some small external modifications include an enlarged battery compartment and door (any 206 pilot who has tried to change batteries will appreciate that), a 3-inch extension to the horizontal stabilizers to accommodate a change in airflow produced by the enlarged engine cowlings, and some intriguing-looking exhaust stacks.

With the exception of the cockpit, the interior remains unchanged. The collective control has been modified to accept dual throttles and uses electric throttle stops. This simplifies the start by allowing the pilot to just open the throttle against the stop, wait for the engine to reach the correct speed, then hit the release and bring the engine up to full rpm. This system came from Bell Helicopter and is the same one used on the 412. One nice feature is the relocation of the start switch to the cyclic control. This allows the pilot to easily engage either starter while in flight. Because you can routinely shut down and restart one engine in flight, this is a safety issue; however, it would be a beneficial addition to the LongRanger, as well.

Although the flight instruments remain unchanged, engine, fuel, and electrical systems are monitored by a new group of instruments provided by Transicoil. The package can record any engine exceedences, calculate fuel flow, and show endurance. One useful feature is the ability to display any one of the instruments in digital format. Another gauge LongRanger pilots will find different is the torquemeter, which has three needles—two small ones labeled one and two for their respective engines and a larger one that shows the sum of the two (total torque). In addition, the caution and warning light annunciator panel is slightly enlarged to handle the additional engine lights.

Once I was in the pilot's seat and strapped in, Daigle handed me the check list. I went down the list item by item, and with the exception of a few checks, such as the fire detection system, it was pure LongRanger. When it came time for the start, it was a standard Allison procedure. The new electric throttle releases really make it hard to make a mistake.

The big difference was doing it twice.

It was a sunny day in southern California, with a temperature of about 75° and light winds. With Daigle, myself, and 480 pounds of fuel, the Gemini was 800 pounds under the maximum gross weight of 4,250 pounds. Van Nuys Tower cleared us for takeoff, and I hovered out to the taxiway and departed south. Once clear of the Class D airspace, I tried some tight turns, out-of-ground-effect hovering, and some approaches, and it became apparent that the addition of a second engine did not change the flight characteristics. The only difference was possibly a slight increase in roll and pitch sensitivity in a hover. This may be due to a slightly higher center of gravity. Because I have recently been flying a helicopter with

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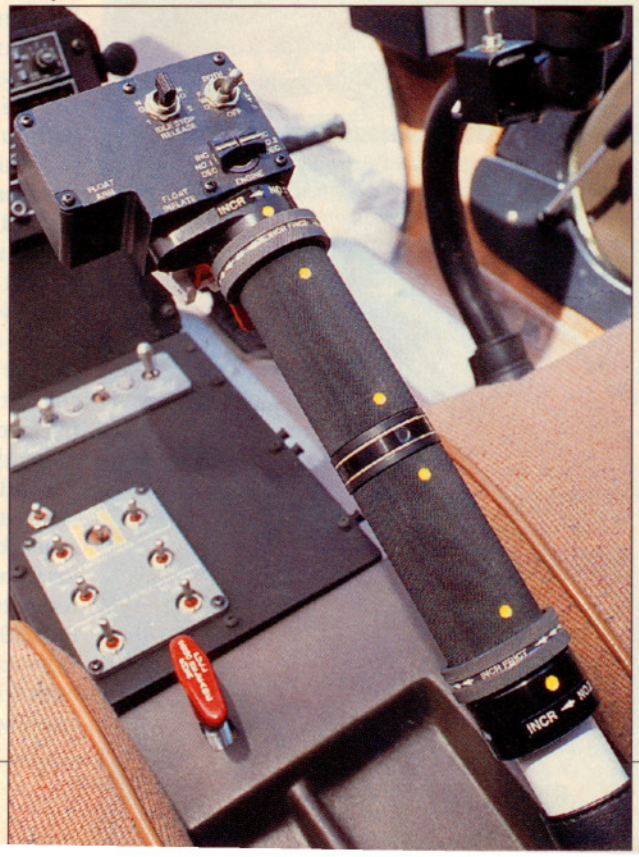

a highly responsive hingeless rotor system, part of the perception may have come from overcontrolling on my part. I did smooth out the inputs after a bit, and watching Daigle hold a rock-stable hover really convinced me it was just a matter of practice.

The Gemini uses the existing LongRanger transmission, so both helicopters have the same torque limitation. This causes both engines to operate well below their power limits and gives the Gemini good hot and high performance.

So now came the real test: Shut one engine down in flight, do a series of high-power maneuvers, then do an in-flight restart. At Daigle's instruction, I rolled the number-two throttle down to idle. Instinctively, I lowered the collective but soon realized it wasn't necessary. As the number-two torque indicator dropped to zero, the number one came up and married with the total torque needle, which was well below redline. Also, as the number-one engine picked up the entire load, it remained well within its temperature limits.

After raising the collective back to cruise power, letting the engine cool down, and then shutting it off, we headed for a helipad located at 4,000 feet msl. Even though we were 800 pounds under maximum gross weight, I thought a single-engine steep approach at a respectable density altitude might be a good challenge.

On final, I began to decelerate behind the power curve and started adding power. Daigle sat quietly, his hands nowhere near the controls, obviously confident in the Gemini's single-engine performance. As I transitioned to and held a 6-foot hover, the power limits never exceeded the maximum continuous settings. It was just like flying . . . well, a LongRanger. I then tried a 360-degree left pedal turn (a power-consuming maneuver) and again no problem. The Gemini has enough power that even at maximum gross weight, it, unlike most twins, would have true single-engine capability. Thinking back, my first turbine job was flying the older LongRanger (206L), which had the 420-shp Allison 250-C20B engine. This engine produced fewer horsepower than the Gemini's 250-C20R engine, and I flew it around all day without ever having the option to start a second one.

After some more approaches, departures, and out-of-ground-effect hovering, I was convinced that the Gemini can do everything with one engine that it can do with two.

On the return trip to the airport, I performed an in-flight restart of the number-two engine. With my right thumb, I engaged the starter switch located on the cyclic control. At the proper N_1 turbine speed, I opened the throttle, monitored the turbine outlet temperature, and brought the engine up to idle speed. After bringing the number-two generator on-line, I increased the engine to full rpm, and we were again flying a twin. In the event of an engine failure, this process could be done in under 60 seconds and would require about 1,200 feet of altitude. If you want to fly lower than 1,200 feet agl, use both engines or do what a LongRanger pilot would do when the engine quits: Perform an autorotation.

When operating both engines, the Gemini consumes fuel at 45 gallons per hour, compared to the LongRanger at 38 gph. Because both helicopters have the same fuel capacity, endurance drops from 2.9 hours for

BASIC DIFFERENCES, TECHNICALLY SPEAKING

The Bell LongRanger was first introduced in 1973 as the 206L and used an Allison 250-C20B engine producing 420 shp. Next came the 206L1 with an Allison 250-C28B engine rated at 500 shp. This model was followed by the 206L3 with the 650-shp 250-C30P. The current production model, the 206L4, uses the same engine as the L3 but with a beefier transmission and a maximum gross weight increase from the L3's 4,150 pounds to 4,450 pounds. The 206LT TwinRanger is a basic L4 manufactured by Bell as a twin under Tridair's STC.

The Gemini ST conversion can be applied to the 206L1, 206L3, or 206L4 but not the 206L model. This is because of engineering difficulties with the C20B engine mounts. In reality, there are not many Ls remaining in service. When an L1 or L3 is converted to a Gemini ST, the maximum gross weight increases to 4,250 pounds; however, this is still 200 pounds less than a converted L4's maximum gross weight. This is due in part to the more durable transmission installed in the L4. Tridair will focus on the L1 and L3 markets for conversion to Gemini STs. Although the company can still convert L4s, it doesn't seem likely when customers can purchase a TwinRanger directly from Bell. But some may purchase L4s with the intent to convert later, and if Bell decides not to seek single-engine approval, a Gemini ST conversion would need to be done to get that option. *—TM*

the LongRanger to 2.5 hours for the Gemini. However, the Gemini's C20R engine burns only 28 gph in single-engine mode, and this increases the endurance to 3.9 hours. There is no penalty to pay here unless both engines are engaged for the entire flight, and long trips will normally have extended cruise flight, an ideal time to fly on one engine.

The trade-off with the Gemini is the smaller useful load of 1,610 pounds, compared to 2,175 pounds for the current-production LongRanger. The Gemini can carry 740 pounds of fuel (the same as the LongRanger), which leaves a payload capacity of 870 pounds—not a lot for a seven-place helicopter. There are operations where the reliability of twin engines could prove more important than the payload penalty: For example, lift work that can be performed with lower fuel amounts or that must overfly congested downtown areas. The maximum external load for both the Gemini and the LongRanger is 2,000 pounds.

Tridair has received a supplemental type certificate to convert existing LongRangers (models 206L1, 206L3, and 206L4 only) to twin-engine aircraft; however, the company is expecting certification this summer that will allow the aircraft to also be used in single-engine operations. At the FAA's request, Tridair is currently modifying the engine-out warning system, so when flying on one engine, the shutdown engine's warning lights can be turned off to prevent any possibility of distraction to the pilot.

Bell Helicopter has entered into an agreement with Tridair Helicopters to manufacture the helicopter as a new aircraft under Tridair's STC. Bell is calling it the TwinRanger and has started deliveries from its Mirabel, Quebec, facility, and it will sell for approximately $1.5 million. However, Bell is undecided as to whether it will seek approval for single-engine operations.

Tridair will handle all conversions to a Gemini at a cost of $745,000. This includes two Allison 250-C20R engines, combining gearbox, new lightweight and fire-resistant carbon fiber cowlings, and all related modifications. Tridair is in the process of appointing approved modification centers, so customers can have the kit installed locally. Also available, depending upon condition and remaining times, is up to a $70,000 credit for trading in the existing engine, cowlings, and related parts.

The market for the Gemini ST and the TwinRanger could prove to be enormous. Bell has received orders for the TwinRanger from corporate customers and civil agencies, and the Gemini ST we flew was going to Japan after a demonstration tour in the United States to emergency medical service and offshore operators. Like the Gemini, Bell's TwinRanger is also certified to meet FAR Part 29 Category A requirements. With the international trend toward restricting single-engine flight over congested areas and at night, economical and flexible twins like the Gemini ST and TwinRanger will have broad acceptance in the European markets.

Just how does Daigle feel about the success of his idea? He says that from the start, his goal was to make a safer helicopter, and he has no desire to be in the helicopter manufacturing business. In fact, he said, "The sooner the Gemini program becomes stable and I can get back to flying helicopters, the better." Coming from a man whose personal projects include restoring the only flying Bell 47B model helicopter to perfect condition and then using it to break the world's longest hover record (50 hours 50 seconds), it is clear that he is a helicopter enthusiast who loves a challenge. □

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Tridair Gemini ST
Conversion price: $675,000 to $745,000

Specifications

Powerplants	Two Allison 250-C20R, 450 shp ea
Recommended TBO	3,500 hr
Main rotor diameter (same as 206L4)	37 ft
Main rotor disc area (same as 206L4)	1,075 sq ft
Height (same as 206L4)	10.25 ft
Length (same as 206L4)	42.7 ft
Seats (same as 206L4)	7
Max gross weight: Converted L4	4,450 lb
Converted L1 and L3	4,250 lb
Standard configuration weight	
Converted L4	2,913 lb
Converted L1 and L3	2,740 lb
Useful load: Converted L4	1,537 lb
Converted L1 and L3	1,510 lb
Max external load	2,000 lb
Fuel capacity (usable)	110.5 gal

Performance

Service ceiling	20,000 ft
Service ceiling (OEI)	10,000 ft
IGE hover ceiling	10,000 ft
OGE hover ceiling	6,900 ft
Max continuous cruise: Converted L4	108 KTAS
Converted L1 and L3	101 KTAS
Range, no reserve, both engines	
Converted L4	260 nm
Converted L1 and L3	246 nm
V_{NE} (same as 206L4)	130 KTAS

Note: At time of publication, single-engine performance figures were unavailable.

Tridair Helicopters, Incorporated, 3000 Airway Avenue, Suite 250, Costa Mesa, California 92626; telephone 714/540-3000; fax 714/540-1042.

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, gross weight conditions and apply to all conversions unless otherwise noted.

Tim McAdams, AOPA 925518, is a CFI and has accumulated more than 4,400 flight hours, of which 4,100 are in helicopters. He is employed as a pilot by Omniflight Helicopters and flies a BK 117 for Grant Medical Center's LifeFlight program.