COMMERCIAL AIRCRAFT SURVEY . . .

VTOL AIRCRAFT

NOTHING ENCOURAGES TECHNOLOGICAL DEVELOPMENT quite like a war, and the conflict in Vietnam has brought major advances in the helicopter state-of-the-art. Turbine engines are now of a higher power-weight ratio than ever before, and are flat-rated to high ambient temperatures. Rotor head and blade improvements permit higher cruising speeds and longer life, while drive systems, auto-stability and other special equipment have a background of experience running into many thousands or arduous flying hours. The fall-out is already being witnessed in the civil market—there is a boom in small-sized private helicopters, and in medium-weight types for a multitude of hire and reward tasks. But helicopters have still not been taken on for scheduled commercial services in a big way—except in a few special cases. There are a lot of promising new ideas going around, but the economic, business and social considerations involved in a major switch to VTOL seem to raise nearly as many problems as they are supposed to cure. The issue is further complicated by the rival attractions of new high-speed surface transportation systems—some of which would be as fast as aircraft on inter-city journeys of 300 miles or less.

Nevertheless, as medium- and long-haul trunk route traffic continues to expand, the problems of runway conjestion and of access to the airport from surrounding cities can only be tackled by a bold look at the available transportation systems. The aeronautical engineer has two solutions: the STOL fixed-wing type and the various kinds of VTOL device. The former is reviewed in the small short-range aircraft and third-level aircraft sections of this survey, and the latter, including transport helicopters in production, are presented below.

Boeing-Vertol 107 Model II is the civil version of the CH-46, widely used by the US Navy and Marines. Powered by the 1,250 s.h.p. GE CT58-110-1, the standard version is offered with a clip-in end-loading baggage pack or a normal rear ramp entrance. The 1,400 s.h.p. CT58-140-1 is optionally available to give sufficient engine-out performance for city-centre operation. The 107 Model II is the latest development of the twin-engined tandem-rotor family which was conceived in the mid-fifties, first flew in April 1958, and entered military service in 1961. The civil version was certificated in January 1962 and six have been in use with New York Airways since July 1962.

Boeing-Vertol Future Projects For several years Boeing-Vertol has been refining design proposals for twin-rotor helicopters in various sizes up to an entirely new machine of about 100-seat capacity and with a gross weight of 71,500lb. The smaller aircraft (50 and 65 seats) are developments of the CH-47 Chinook. The design cruising speeds range from 160/170kt for the developed Chinooks to 188kt for the new aircraft. Innovations to cut noise and vibration include hte avoidance of rotor overlap, the fitting of rotating balance weights "force balancer," and a composite rubber/metal flexible "elastomeric" rotor hub bearing. For the 300-500-mile range inter-city requirement Boeing-Vertol is pressing on with pioneering work on tilt-winged machines.

The Boeing transport aircraft company in Seattle is leading the group research into jet- and fan-lift VTOL systems. This has included studies of a deflected-jet version of the Boeing 737 with lift jets mounted horizontally below floor level and exhausting through swivelling nozzles.

Dornier To this German company goes the credit for having flown and demonstrated the world's first VTOL jet transport. The Do 31 display was the highlight of the 1968 Hanover Air Show (see *Flight* May 9, page 709 for a description of the aircraft, its performance, handling and future test programme). Further operational trials are proceeding on limited funds.

Hawker Siddeley has two projects for inter-city VTOL aircraft of 300-500-mile range. One, being developed by the Manchester design group, is based on the induced-flow rigid rotor principle patented by the National Gas Turbine Establishment. The other is for a jet-fan-lift aircraft, and that is the concern of the Hatfield design group. Together with a third British proposal (the Westland tilt-engine idea) these systems will be evaluated in the light of a Ministry of Technology specification to be issued in December This will define the major requirements for an inter-city trunk-route VTOL transport. It is expected that one of the designs will be chosen for Government financial backing and that prototypes will be built—possibly of about 100-seat capacity.

Lockheed Projects In recent years Lockheed has emerged as one of the leading exponents of the helicopter art, and with its rigid-rotor compound (fixed wings, and conventional thrust for level flight) research vehicles has demonstrated new realms of speed, efficiency, ease of handling, mechanical simplicity and potential reliability for VTOL aircraft. The company's immediate pre-occupation is with the AH-56A Cheyenne high-speed ground-attack machine ordered in quantity for the US Army. Based on the mechanical components of this aircraft (which first flew last year) Lockheed has done considerable drawing-office research work into a possible 30-seater, to be known as the CL-1026 and powered by two free turbines in the 3,500 s.h.p. class. The company believes that the CL-1026 will have an 8 cents per seat-mile direct operating cost on 100-mile stages—about half that of the 26-seat S-61N in service today.

While the purchase price of the 1026 is bound to be a lot higher than that of the S-61N, the improved economics will come from the higher cruising speed and the greater mechanical reliability over the life of the aircraft. In wing-borne cruise, the 1026 will fly at 200kt at sea level or at up to 222kt at 15,000ft. Cruise power from the two engines is fed through a common shaft to a pusher propeller on the rear end of the fuselage. Proper engine-out safety standards, even in hot-and-high conditions, are another significant advantage of the new-generation helicopters.

Lockheed also has designs for a much larger and entirely new

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Type	Powerplant	**Overall Dimensions** Rotor Diameter Length Height	**Undercarriage** Track Wheelbase LCN	**Accommodation** Max seating (N°, pitch, abreast) Hold vol (cu ft)/ (N° compartments) Press diff (lb/sq in)	**Weight (lb)** Take-off Ops wt empty	**Fuel (IG)** Std Opt	**FAR Field Lengths (gross wt)** ISA, s.l. ISA +20°C, s.l. ISA, 5,000ft ISA +20°C, 5,000ft Take-off	Landing
Boeing-Vertol 107-II twin-rotor helicopter	2×1,350 e.s.h.p.* General Electric CT58-110 turboshafts	50ft 83ft 4in† 16ft 11in	12ft 10in 24ft 10in 15	25/32/3 155‡/1 Unpressurised	19,000 ¶ 11,901	291 —	420§ — — —	275§ — — —
Lockheed CL-1026 single-rotor compound helicopter project	2×3,500 s.h.p. General Electric T64 turboshafts	51ft 5in 55ft 10in 12ft 9in	n.a. n.a. n.a.	30/32/4 200/1 Unpressurised	23,500 14,371	n.a. —	vertical vertical* n.a. n.a.	vertical vertical n.a. n.a.
Lockheed CL-1090 Air Commuter single-rotor compound helicopter project	4×3,500 s.h.p. General Electric T64 turboshafts	102ft 110ft 17ft 1in	n.a. n.a. n.a.	95/32/4 n.a. Unpressurised	80,000 n.a.	n.a. —	vertical vertical n.a. n.a.	vertical vertical n.a. n.a.
Sikorsky S-61N* single-rotor helicopter	2×1,500 s.h.p.† General Electric CT55-140	62ft 77ft 17ft 6in	23ft 11in 14ft n.a.	26/32/3 150/2 Unpressurised	19,000 12,256	341 528	n.a. — — —	n.a. — — —
Sud-Aviation SA-321F Super Frelon single-rotor helicopter	3×1,500 s.h.p. Turbomeca Turmo IIIC3 turboshafts	62ft 75ft 7in 16ft 6in	n.a. n.a. n.a.	37/30/4* n.a. Unpressurised	26,455 16,711	883 1,323	vertical n.a. n.a. n.a.	vertical n.a. n.a. n.a.