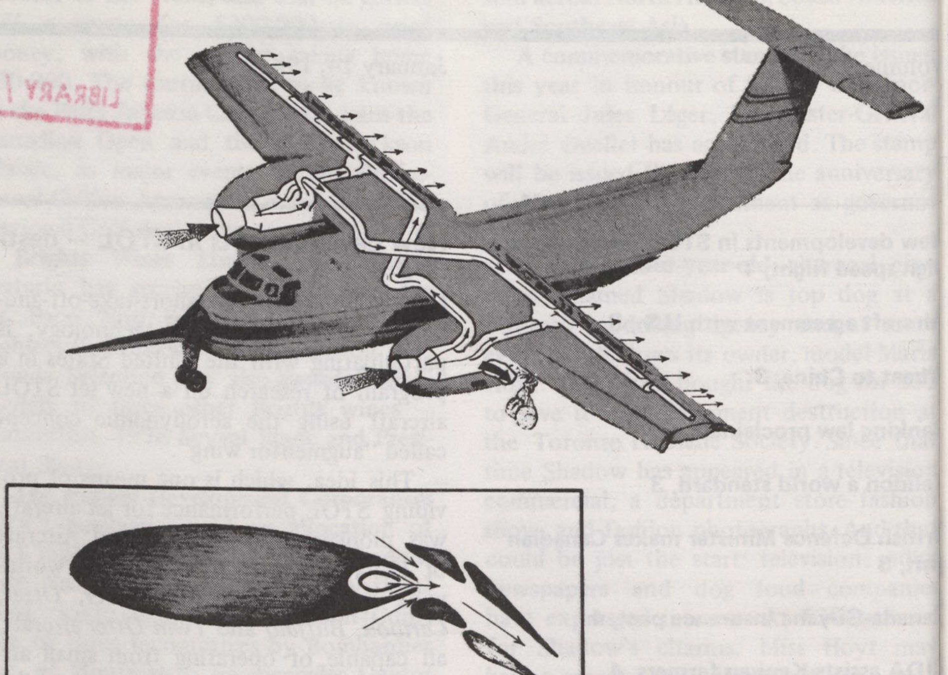

This illustration shows how air compressed by the engine fan (cold bypass air) is channelled through the wings to the hollow flaps to augment aerodynamic lift. Air from each engine is channelled to both wings by cross-over ducts, greatly reducing the lateral asymmetry which would otherwise occur in the event of a single engine failure. To produce additional direct lift, engine gases are exhausted through two nozzles which can be swivelled downwards. The nozzles can also be used to control thrust and drag during a landing approach to a short runway. The inset shows a cross-section of the aircraft wing and illustrates how the augmentor wing concept works. High-speed, engine bypass air ejected from the ducts spanning the wing entrains or combines with some of the air flowing past the upper and lower surfaces of the wing. The thrust of the high-speed air stream is thus augmented through mixing with the entrained flow – hence the term augmentor wing.

bases.

What are the prospects for designing new STOL transport aircraft capable of high cruising speed? During the past two decades, research has led to the technology for achieving this objective. To attain high cruising speed a smaller wing is necessary, but this requires additional lift to allow the slow speed for short take-off and landing performance. To achieve this additional lift, engine power can be used, either directly through a jet nozzle deflected downwards, or less directly by diverting part of the jet engine flow past the wing and flap surfaces, which in turn deflect the flow downwards, creating additional "powered lift". Aerodynamic research has shown that with certain flap configurations even greater augmentation of lift may be achieved.

Canadian involvement

In Canada, this research led to the augmentor-wing concept, pioneered by de Havilland. During the past seven years an augmentor-wing experimental aircraft has been thoroughly flight-tested. The operations, nearing completion, are being conducted at the National Aeronautics and Space Administration (NASA) Ames Research Center in California.

NRC's involvement has been strongest in the research phase of the program in progress since 1975, through the participation of the staff of the Flight Research Laboratory. Research pilot/engineer Bill Hindson, from the Laboratory, has been assigned to NASA throughout this phase. Other NRC personnel have taken part in the program at NASA for shorter periods.

The augmentor-wing aircraft, with all its digital computing facilities and special instrumentation and display systems, has proved to be a most versatile research vehicle, completing, to date, more than 2,300 landings in the powered-lift STOL configuration. The work has led to a much greater understanding of the related requirements of the airport and airway system within which future civil STOL aircraft may operate; it has also shed light on the criteria which must be applied in certifying the safety of powered-lift STOL aircraft for passenger-carrying operations. Its principal legacy, however, has been a wealth of engineering data directly applicable to the design of a new generation of high-speed transport aircraft with STOL capabilities.

Safety tests

One research area in particular investigated by the Flight Research Laboratory is the adverse effects of single engine failure during landing approach, and how to minimize height loss. For reasons of safety, preliminary flight tests simulating partial engine failure were carried out at altitudes well clear of the ground. In preparation for more realistic tests near the ground, exploratory flights were made at Ottawa using a unique facility, an airborne V/STOL simulator built and operated by the Flight Research Laboratory.

It has been possible to carry out a program of flight tests in which the simulated augmentor-wing aircraft experienced an engine failure on the final landing approach near the ground. Information acquired on corrective action techniques and height loss minimization has been incorporated into the augmentor-wing research program planning at NASA's Ames Research Center.

Potential unlimited

With the present research program using the augmentor-wing aircraft nearing an end, what then is the likelihood of designing and building a new aircraft incorporating the program's results? As in the past, an aeronautical concept initiated in Canada and, in this instance, evolved with a systematic engineering effort supported by the most up-to-date research findings, is approaching that critical point when a decision must be made on its exploitation. A further program of development, culminating in the production of operational aircraft, would entail greatly increased expenditures, even if shared, for example, by Canada and the United States. The potential benefits, however, are incalculable.

(Article by Sadiq Hasnain from Science Dimension, *No. 4, 1980.)*