Germans' Aircraft Industry

Cade deflection angles. Dornier says that the radius of action of the type depicted here would be 320 st miles, 200km with a 2,000lb, 1,000kg-plus weapon load on a lo-lo, high-speed mission.

Shaft-driven fans have been investigated, but are not as advantageous except at lower fan pressure ratios (optimum would be 1:1:1), when hover endurance would be higher than for gas-driven units.

Although the weight of the shaft engine is reduced with decreasing pressure ratio, the weights of fans, gearboxes and airframe increase considerably, which results in a reduction of the useful load.

With increasing fan pressure ratio, gas-generator power and fuel consumption increase as well. On the other hand, high-speed performance, manoeuvrability and radius of action are improved. The amount of useful load remains almost constant, since the increasing gas generator weight is offset by decreasing fan and airframe weights. The wing would be sized primarily on the basis of combat-manoeuvrability requirements.

Air superiority fighter

Dornier anticipates a NATO requirement in the early 1980s for a lightweight (less than 10,000kg gross) air-superiority fighter. The company's studies assume a "moderate" thrust-to-weight ratio, slightly above unity, but with a low wing loading to provide most of the manoeuvrability. Low wing loading allows the aircraft to fly at a lower lift coefficient, thus reducing the induced drag and allowing high-g manoeuvres to be maintained. Extreme speed above Mach 2 is not a requirement, nor is long range—both would lead to a bigger aircraft. Dornier favours a twin-engine single-seat canard layout for such an aircraft, which is in the Northrop P-530 class. Advantages claimed for canards are:

- Spacious main wing to accommodate a wide-track undercarriage as well as fuel (drop tanks would also be carried).
- Lift changes are in the "correct" sense during trimming, using the foreplane.
- Excellent roll characteristics.

Short-fibre composites

Fibre-reinforced composites have been in engineering use for a considerable period—indeed, glass-fibre-reinforced plastic mouldings began to be used in aircraft more than 20 years ago. Since then, much research into and development of composite materials has taken place; new resins, new fibres and whisker reinforcements, and new combinations of reinforcement and matrix have appeared. The properties and potential for development of this type of material seem to leave little doubt that composites, in the form of metals and plastics reinforced by fibres or whiskers, will gradually replace some, at least, of the traditional homogeneous or monolithic materials on which the engineer.

More recently, much interest has been stimulated in short-fibre or discontinuous-fibre reinforcement. Many required shapes, particularly in the aircraft field, are complex in form and embody compound curvatures. Such shapes cannot readily, if at all, be moulded from continuous-fibre laminates. Another factor in the development of short-fibre-reinforced composites is that some high-strength fibres, such as asbestos or synthetic whiskers—the strongest fibres so far known—are available only in the discontinuous form.

If the properties of fibre and whisker reinforcements are to be used to maximum effect, it is necessary to pack the greatest possible amount of reinforcement into a composite without damaging the fibres in the process. Such a result can be achieved only by obtaining a high degree of parallel alignment in the fibres in the matrix of the composite. Misalignment of only a relatively small proportion of the fibres can cause a disproportionately large decrease in the density of the fibre packing.

Airing out of these conditions and requirements, the Process Research Division of the Explosives Research and Development Establishment* has developed methods for the grading and alignment of short fibres, generally in the range of 0.01mm to 10mm in length. Alignment is done by a filtration process, which produces a dense, highly aligned fibre mat which is then impregnated with a matrix resin. This prepreg material can then be moulded into a wide range of composite components, the material lending itself notably to the production of three-dimensional forms.

Alignment

The alignment process is based upon the initial dispersion of the fibres in a liquid carrier, the degree of dilution being such that there is little or no interaction between the fibres during alignment. The dispersion must be sufficiently stable to prevent flocculation or separation of the fibres. Alignment of the fibres is effected by continuous acceleration of the liquid carrier in which they are suspended. The aligned fibres, still in suspension, are deposited onto a flat filter bed and, by the deposition of successive films or layers, a mat is built up in which the fibres retain their alignment within the liquid carrier without loss of orientation. Removal of the liquid carrier is then necessary and is accomplished by vacuum-pump suction.

For the first two stages of the process, dispersion and alignment, a viscous fluid carrier is desirable, but in the third stage of removing the carrier low viscosity is preferable. The medium used in the ERDE process is glycerine which is water-soluble and has a high temperature viscosity coefficient. Other liquids could be adopted, and in some circumstances the actual matrix-resin of the composite might be used, although to do so could create handling problems and impose certain limitations on the process.

The filtration alignment process is shown diagrammatically in an accompanying illustration. A dilute suspension of fibres in glycerine is transferred, by a peristaltic pump from a mixing tank to a feed reservoir, which is pressurised by compressed air. From this reservoir it is fed to an alignment box, in the bottom of which is a tapered slit. Through this slit the fibre-glycerine is extruded, while the box is reciprocated horizontally above a wire-mesh filter bed, at right-angles to the length of the slit. Movement...