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BAe shows Saba alternative

KINGSTON

British Aerospace has revealed more background to its small agile battlefield aircraft (Saba), including a turbofan alternative to the P.1233-1 single-seat canard configuration with an unducted fan pusher engine, (see *Flight*, last week).

The Saba project has been under way for about two years. BAe foresaw the need for something to operate at very low level over the battlefield to combat highly agile helicopters and unmanned vehicles, and also a need for very accurate close air support, especially at night and in foul weather. The company also reasoned that nobody had ever *really* explored the limits of aiming for high agility, as the main design point, with such criteria as speed and take-off requirements taking a back seat.

From the very high agility (VHA) requirement grew the basic ground rules for Saba's design. The team based Saba's agility on the ability to turn through 180° in 5sec at Mach 0·4. This would enable Saba to meet a fighter in the F-16/MiG-29 class head-on, and turn and shoot an infrared missile before the adversary could get out of missile range, given an initial bogey speed of Mach 0·6.

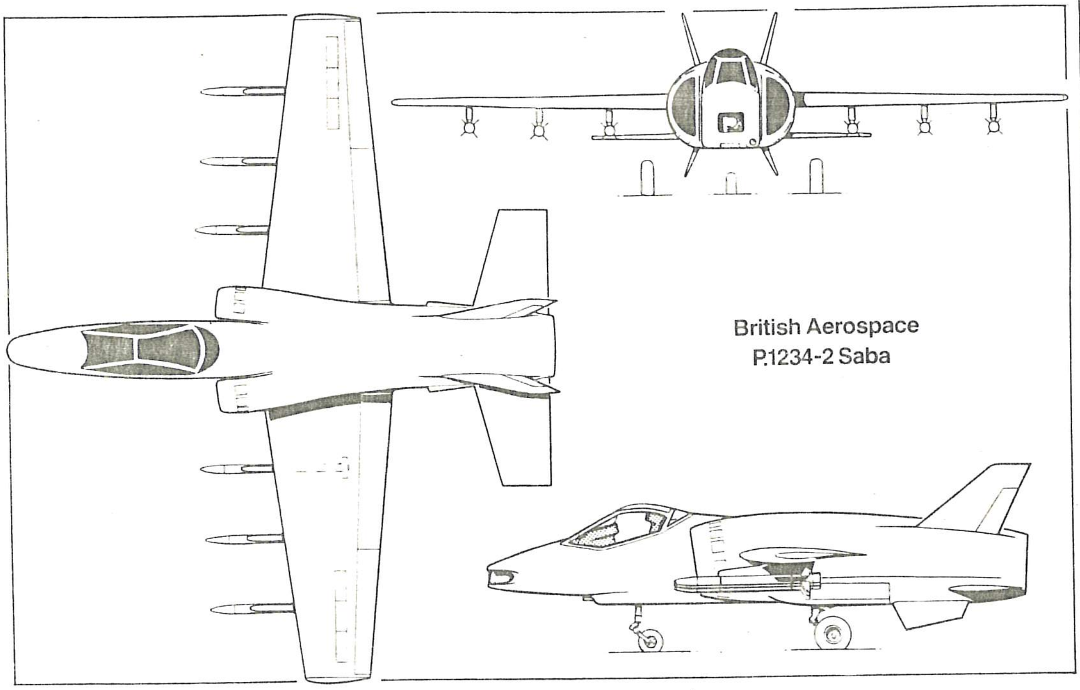
Fired after 5sec of turn, the missile would impact 7sec later, or 12sec after the Saba met its opponent head-on. This level of agility could be achieved with a slower aircraft, but BAe wanted the Saba to transit the battlefield at 400kt-450kt plus to enhance survivability. Also, the Saba would be small and therefore hard to detect visually. Acoustic, infrared, and radar detection would also be difficult. The basic rules included "a useful weapon load", the ability to operate from a 250m "true dirt strip", and an endurance of more than 4hr with full war load.

Several airframe configurations were considered. The first, design P.1238, had a pod/twin-boom layout with a single-disc pusher unducted fan. The P.1238 had a maximum take-off weight of 5,034kg and a wing loading of about 40-45lb/ft². Its metal airframe was basically stable and would have needed a fly-by-wire system to produce carefree-handling with high agility. The warload was six missiles, two under each boom and one on each wingtip. A bubble canopy ensured good all-round vision.

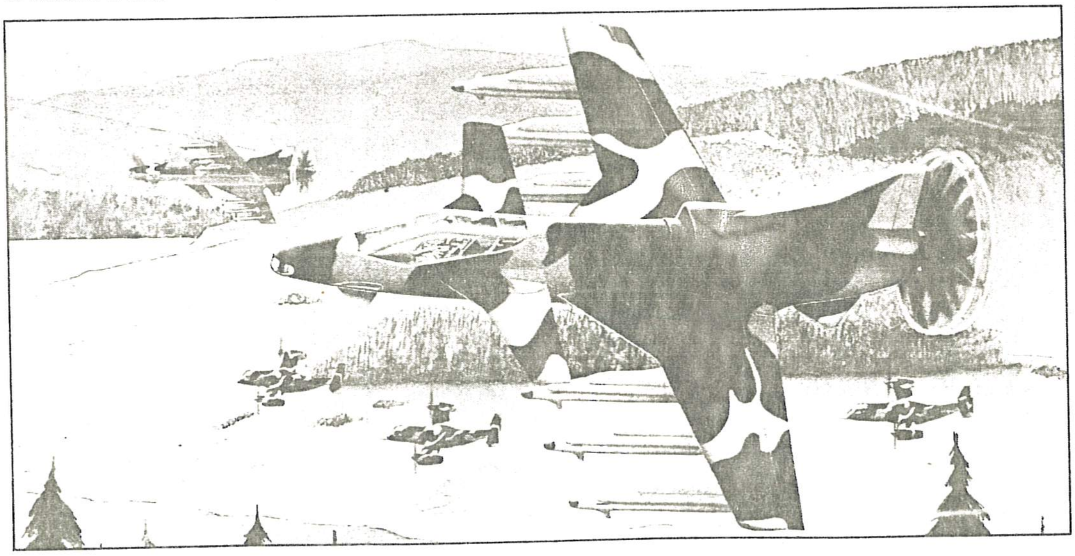
The P.1234-1 was a tailless delta design weighing 5,754kg, with a wing area of 35·95m², and powered by a 25·4kN Rolls-Royce Adour turbofan. At this time helicopter suppression was regarded as the main role, and the armament consisted of two air-to-air missiles and a 25mm cannon mounted in a belly-mounted cupola that could be trained through 360°. The idea was that the aircraft could engage targets throughout a spherical envelope by combining the cannon's 360° traverse and the aircraft's 360° of roll.

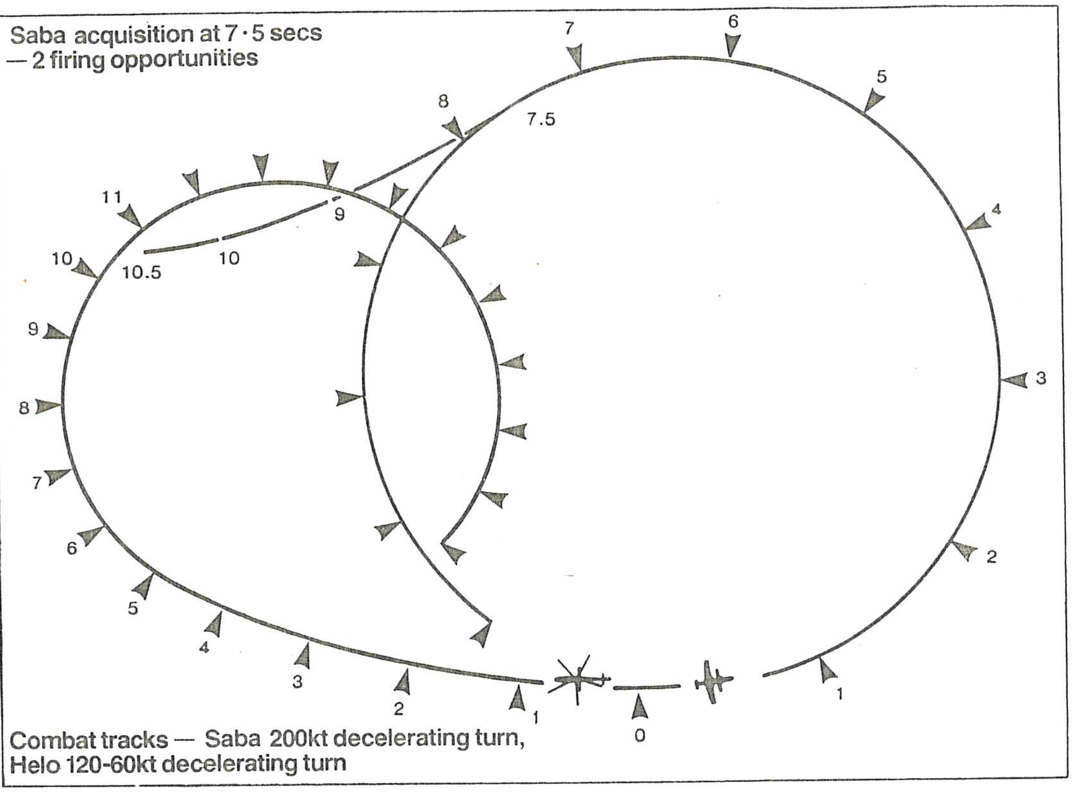
Design P.1234-3 took the turreted armament idea a stage further. Again a small, very clean tailless delta, the P.1234-3's weight was estimated to be 5,782kg. It had a wing area of 30·75m², and was powered by an Adour.

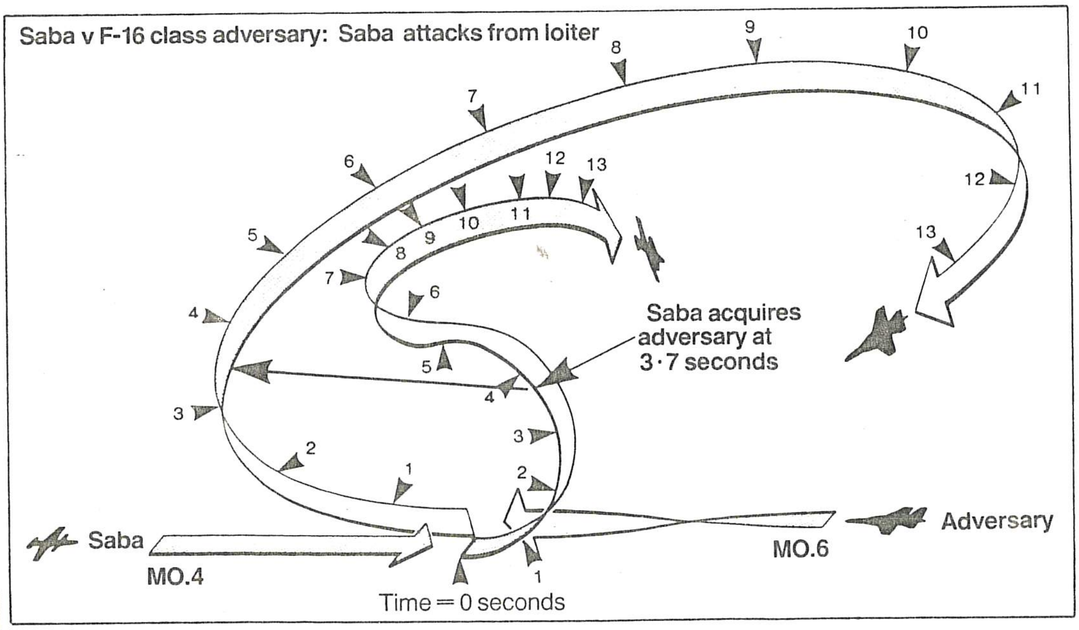
The instantaneous turn rate was calculated to be 40°/sec. Instead of a cannon, the turret would fire hypervelocity missiles (HVM) from two tubes, with about 12 HVMs carried internally. These were aimed by inputs from three sensor turrets; one in the nose and two carried dorsally on each side of the fuselage waist. The weapon



Above *The P.1234-1 Saba is a turbofan-powered alternative to the pusher unducted-fan P.1233-1 Saba.* **Below** *With this weapon fit of six Asraams the P.1233-1 has a combat weight of 4,535kg. Total maximum warload will be around 2 tons*







Top *How Saba would handle a head-on confrontation with a high-performance helicopter.* **Above** *Saba's computer-projected performance in the vertical plane against an F-16-MiG-29 class of adversary*

envelope was ±20° in pitch in the 360° azimuth plane of the aircraft. Again, rolling the aircraft could give a spherical engagement envelope out to the HVM's effective range.

The team then reverted to a simple conventional weapon-launch concept, combining the VHA P.1233-1 with a highly agile dogfight missile. An unducted fan was chosen as the powerplant to take advantage of its economical high power, providing a good power-to-weight ratio and long endurance. BAe's P.1233-1 performance figures are based on a fan using the 3,357kW (4,501 h.p.) Avco-Lycoming T55 as a core, but BAe says it is considering a more powerful variant.

The canard configuration is lighter than the other propfan-powered twin-boom configuration, the P.1238. A canard layout was chosen because the inflow to the disc dominated a conventional tailplane and large elevator or rudder inputs generated only a very small coupling. Therefore pitch control is by the canards and yaw control is by the forward-mounted ventral rudder. The dorsal engine air intake avoids Fod ingestion, and the foreplane and wing vortices ensure a clean flow to the intake at high AoA.

The wing benefits from experience gained in the National High-Lift Wing Programme undertaken by BAe and the RAE and used in the Airbus programme.

BAe is a world leader in subsonic/transonic wing design, and the P.1233's C^{L}Max and g limits intersect at about Mach 0·3. (For the Airbus the lines cross at about V_2). The company hopes to increase this to Mach 0·35, but attention must be paid to wing flexing, which can alter the slat gap and flap shroud gap if the slats and flaps do not flex at exactly the same rate as the mainplane.

Overall, the P.1233 will have low radar, visual, and aural signatures. The small size and small intake contribute to a low radar cross-section as does the adoption of a flat-plate and frame helicopter-type cockpit canopy and windshield, rather than a bubble canopy. This also reduces the visual signature by eliminating glint. The infrared signature is low, and matt camouflage reduces both visual and infrared signatures.

The engine exhaust will be pre-cooled by entraining airflow, and is then further dispersed and cooled by passing through the fan. A side benefit is that the exhaust heats the blades' inboard sections; the tips are heated kinetically and thus blade de-icing is not needed and weight is saved. The propfan is quieter, and an approaching pusher propfan will not be audible to persons on the ground, especially in a battle, until it is too late to react.

The propfan or UDF is relatively new technology, and BAe is prudent. Should the combination of a new airframe with a new-technology engine prove untenable, BAe would produce its trump card, the P.1234-2. This conventional configuration weighs about 5,986kg and has an 18·58m² wing. The unit would be the Avco-Lycoming ALF502 of 33·4kN static thrust. The design is unstable, and would use fly-by-wire technology for VHA. Its armament would be identical to that of the P.1233-1, and its performance similar.

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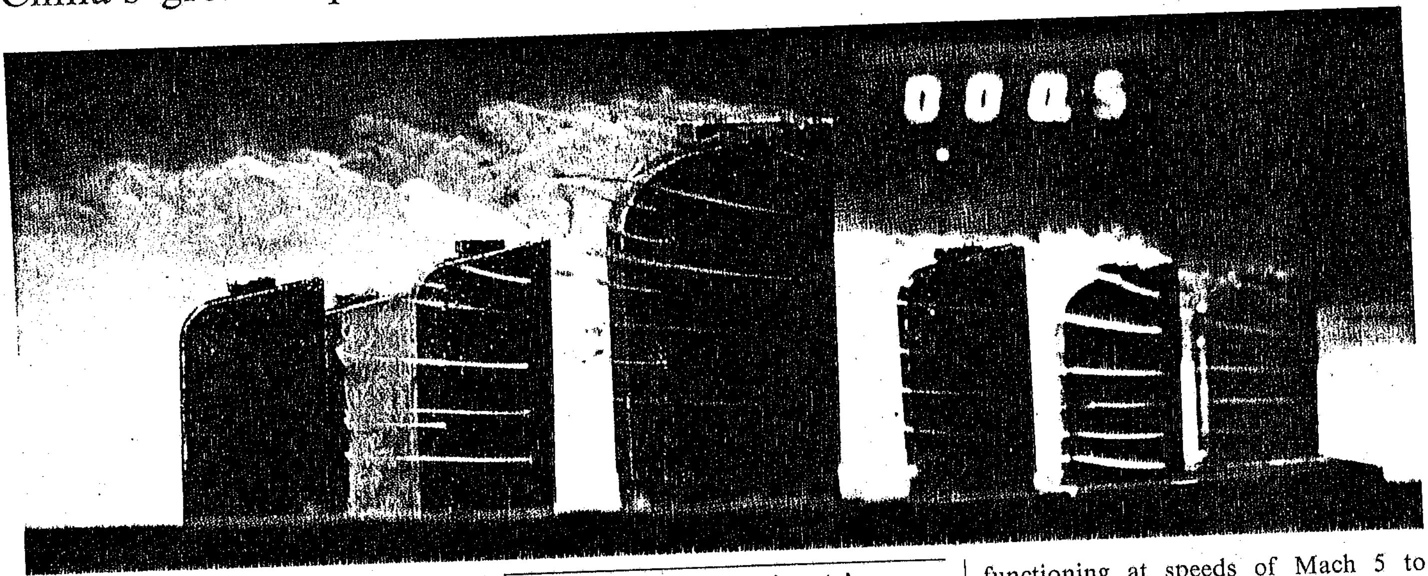
Searchers of the Middle Kingdom

China's great leap forward in aerospace starts in the lab



As Asian Aerospace '88 gets set to open its doors in Singapore (see page 8), the focus is more than ever on the emergence of East Asia as an area to be reckoned with in the air and space field.

No country demonstrates the swiftness with which the region is coming up in the aviation world like the People's Republic of China.

A mere copycat of Russian designs as recently as 1980, the Chinese are now becoming an acknowledged force in some areas of military and civil aviation (see ACM Nov 87, p. 51) and the commercial launching field (**ACM** Dec 87, p. 48).

These accomplishments are due in large part to the presence of a full-fledged, firmly-based air and space research capability ranging from transonic, supersonic and hypersonic wind tunnels to advanced test instrumentation and modern data reduction systems.

Although these R&D resources show significant duplication and are not always as modern as those in the West, they are extensive, comprehensive and in some cases unique. The French national space agency CNES, for instance, is considering the use of Chinese hypersonic test facilities to help develop the Hermes spaceplane.

Over half of the PRC's research infrastructure is concentrated within the Chinese Aeronautical Establishment, an organization created in 1970 by the Ministry of Aeronautics. The CAE's 8,000 employees cover the whole range of aeronautical disciplines, from aerodynamics, structural analysis and turbine engineering to avionics and flight mechanics.

Its numerous installations include

Flow visualization experiment in CARDC water tunnel (above). Fighter undergoes wind tunnel tests (below)

wind tunnels, engine test platforms, computer centers and a flight test facility near Xian in Shensi.

Most military research is handled by the Chinese Aerodynamic Research and Development Center, founded in 1976. Run by the State Commission of Science, Technology and Industry for National Defense, CARC employs 1,700 persons.

The facilities at CARDC are China's largest and most sophisticated. They include:

- three low-speed wind tunnels offering three different tunnel cross sections: 16 x 12 m (25 m/s), 8 x 6 m (100 m/s) and 4 x 3 m (also 100 m/s);
- 0.3 x 0.3 m, 0.6 x 0.6 m and 1.2 x 1.2 m supersonic (Mach 0.3-3.5) air tunnels;
- a 0.5 m dia Mach 5-12 intermittent tunnel;
- a heated-flow low-density nitrogen tunnel, 0.3 m in diameter, capable of functioning at speeds of Mach 5 to Mach 23;
- Mach 6-25 hypersonic shock tunnels;
- a hyperbalistic tunnel capable of attaining a velocity of 6.5 km/s.

The CARDC research center is located at Mianyang, north of the Szechwan capital city of Chengdu.

A third major R&D organization is the Beijing Institute of Aerodynamics, situated 60 km northwest of the Chinese capital. Part of the Ministry of Astronautics, the BIA was spared the worst excesses of the cultural Revolution—perhaps helping to explain the relative strength of the Chinese in the space area.

Specialized in missile testing, BIA boasts transonic, supersonic (Mach 0.6-4) and hypersonic wind tunnels, as well as a test instrumentation division and a theoretical dynamics department.

The two major aeronautical engineering teaching centers, the Beijing Institute of Aeronautics and Astronautics (BIAA) and the Nanjing Aeronautical Institute (NAI), also have major research facilities, including supersonic wind tunnels of the same design as those at CARDC.

As in the areas of aerospace design, development and manufacturing, China is promoting maximum cooperation with foreign researchers.

The CARDC, for example, has established close ties with seventeen overseas R&D organizations. These include America's Nasa, Germany's DFVLR and the French national aerospace R&D organization Onera as well as the Royal Aircraft Establishment of Britain, the Institute for Space and Astronautical Science in Japan and Canada's National Research Council. □