Report from Avro Canada's Chief of Technical Design, Frank Brame, to J.C. Floyd to assist with the Hawker Siddeley SST effort – Dated 9 July, 1959. Brame would go on to lead many efforts at Boeing, including their SST design studies.

image © RL Whitcomb 2001

AVRO AIRCRAFT LIMITED

MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

REPORT NO: TD/M/2

3.0 SUPERSONIC TRANSPORT-

The design studies summarised in this report have concentrated on an aircraft to carry 120 passengers on the North Atlantic route at about M = 2. The configuration has been assumed to be a slender delta-type wing with integrated fuselage. This configuration seems to have great promise and is also a logical extension of the company's experience on the Arrow.

Adopted for the HSA.1000 SST design

The inclusion of systems studies at this stage is necessary because:-

a) The air-conditioning problem is a serious one at these cruise Mach numbers, and
b) The high fuel/gross weight ratio combined with the slender configuration makes the fuel system design critical.

3.1 PERFORMANCE ANALYSIS

Available engine data was combined with drag estimates of a selected supersonic transport aircraft design, to determine range performance in detail. Range performance was determined for various cruising Mach numbers. From this an appreciation was gained of the fuel used for various stages thoughout the flight, including loiter and diversion. Drag estimates were then refined and somewhat optimized which together with estimated greater potential engine cruise performance gave considerably better range performance. A total of 8 range flights were calculated, in which the first four gave a pessimistric result and the last four showed what was achievable under realistically refined conditions. The latter gave more than the desired performance, which should cover any off-design conditions or any over optimistic assumptions.

AERODYNAMIC DESIGN OF SUPERSONIC TRANSPORT

Since the configuration is very slender (aspect ratio less than unity) the design of the aerodynamic shape is based on Adams and Sears "not-so-slender body theory". This is merely a series expension of linearised theory in terms of a slenderness parameter. It is of course not so accurate as linearised theory, but its simplicity enables the shape to be optimised directly for minimum drag. The design of the aerodynamic shape is of course divided into thickness and lift effects which are treated separately.

3.2.1 Thickness Effects.

The area distribution and cross-section shapes have been computed to give minimum wave drag consistent with the restrictions of internal space required for passengers, fuel, undercarriage, etc. It has been found that considerable drag reductions seem to be possible by a spanwise redistribution of area near the trailing edge, so that the area is concentrated further outboard toward the tips. It is proposed that this drag reduction be checked by a supersonic area rule analysis on the IBM 704. This programme will also be used to check the range of Mach numbers in which the "not-so-slender body theory" is valid.

Avro seems to have been the first to create "computational fluid dynamics" models on an "at the speed of light" computer.

4621