IRE Avionics Show Case

U.S. Industry Peak Forecast for 1958

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Avro's Arrow

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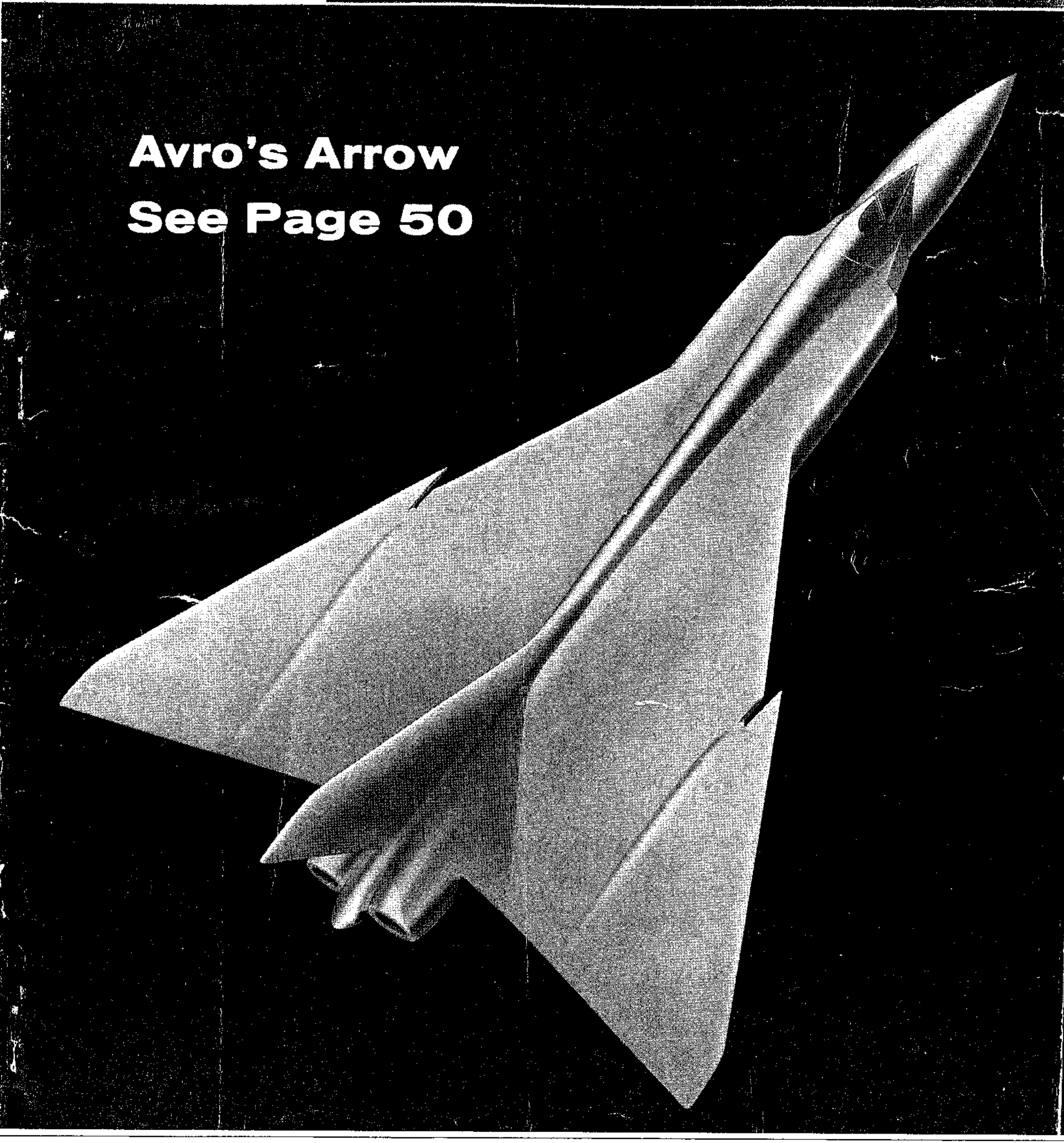
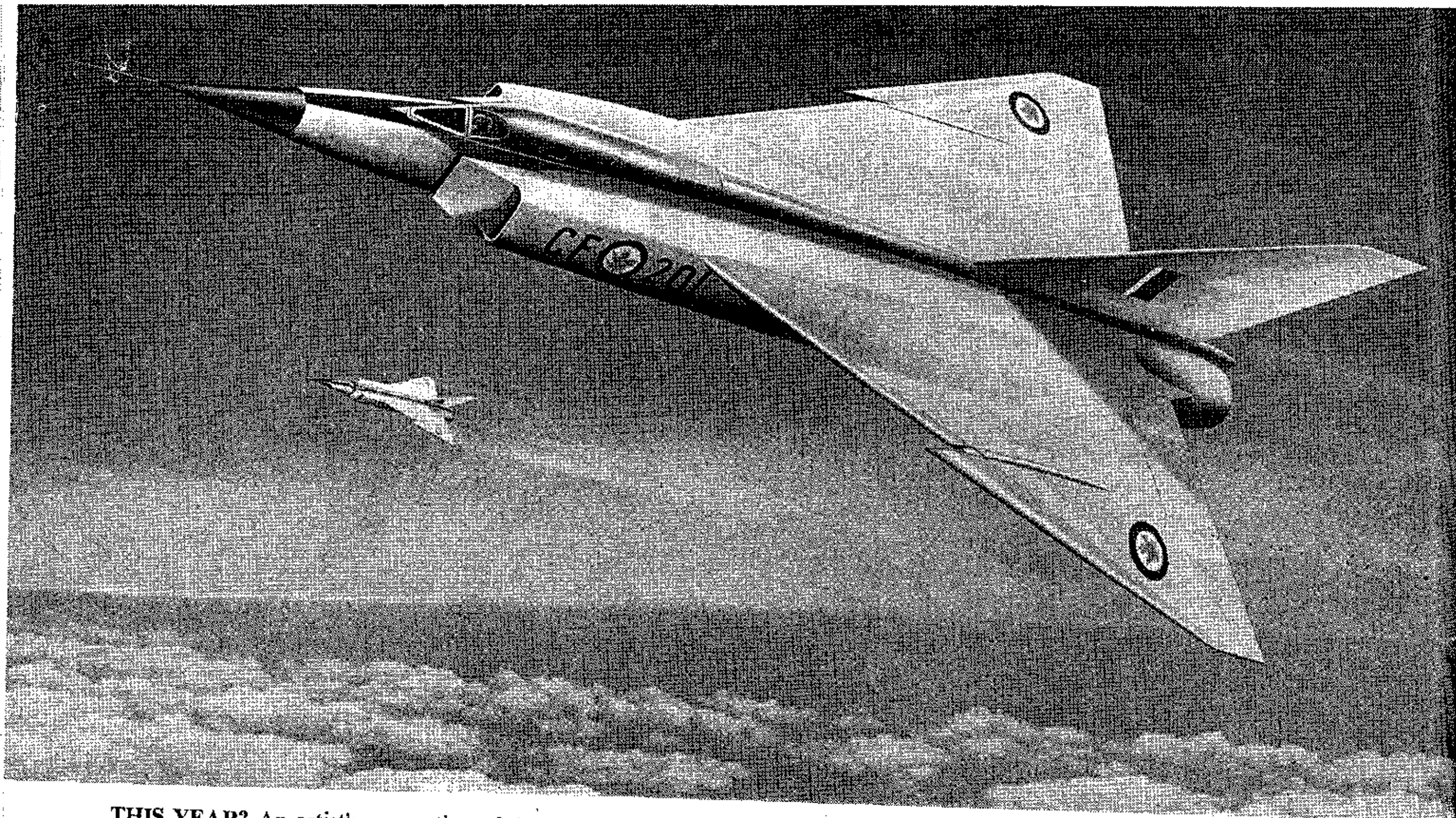




THIS YEAR? An artist's conception of Arrows in flight. Extensive ground tests must precede the initial flight. It is hoped to have the CF-105 airborne sometime in December.

Avro's CF-105

An Ultimate in Interceptors!

The Arrow shows its supersonic lines at Malton roll-out

By Ernie Hemphill

The eyes of the aviation world focused on Malton this month for a first full look at Avro Aircraft's Mark 1 CF-105 Arrow.

From its needle nose to its twin tail pipes, the delta-wing giant more than fulfilled advance billing. "Supersonic" screams from every fine line incorporating the art of aerodynamic design at its most advanced stage.

The aircraft looks capable of everything claimed for it in guarded and not so guarded references over the past 18 months. It belongs to the new breed which will probe the heat barrier at speeds just below Mach 3. The tremendous thrust it will draw from its production model power plants, said by some to be sufficient to shoot it vertically into the stratosphere, could well rocket its two-man crew to their 60,000 foot plus operating altitude in under four minutes.

The Arrow's approximated 34 tons is distributed over a length of 77 feet 9.65 inches, a wing span of an even 50 feet at delta tips and a wheels-down height of about 21 feet three inches to the top of the vertical stabilizer. This makes it the largest known aircraft for its interceptor role.

Area Rule

At first glance, there is little evidence of application of area rule for reduction of drag at trans and supersonic speeds.

However, study and research have shown there need not be sharp conformity with the "coke bottle" fuselage shape in achieving area rule. Where the area rule concept is included as an initial design consideration it can be incorporated by a minimum of refinement to the fuselage shape.

This is particularly true where the wing is distributed over a sizeable portion of the over-all length of the airframe.

A close examination of the CF-105 reveals the fine taper through which area rule is applied. Its achievement is facilitated by the fact that the high delta wing is distributed over better than half the length of the aircraft.

The delta wing is swept back at an angle of 60 degrees. It is an integral fuel tank, built up in two sections, an inner and an outer wing.

At the point where the inner and outer wing are joined the leading edge of the delta is notched. This device serves the same purpose as a wing fence in bringing about the best flow and isobar patterns over the wing. Its effect is to place the leading edge of the outer wing slightly in advance of that of the inner wing in a parallel plane.

The airfoil's high speed characteristics are further enhanced by a shallow wing fence extending aft of the notch just over half way to the trailing edge.

COVER: A scale model of Avro's all-weather CF-105 in its operational white.

The Arrow will make its first flights under power from Pratt & Whitney J-75 engines, each with a thrust of better than 15,000 pounds. The operational version of the aircraft is destined to be powered by two of Orenda Engines Ltd.'s new PS-13 Iroquois.

The Orenda power plant, which is being flight tested in a specially modified B-47, is designed to achieve thrust in excess of 20,000 pounds without afterburner or water injection. With its dry thrust augmented, it has been estimated, the Iroquois could develop up to 28,000 pounds thrust at its present stage of development.

Undercarriage

The CF-105's main undercarriage is two single bogies mounted approximately at the join of the inner and outer wings. The track is a broad 25 feet and 5.66 inches.

Extended for a landing, the bogies are canted so that the aircraft will touch down first on the rear wheels. There is a restraining mechanism which prevents the front wheels from slapping down hard on the runway after the initial touch.

Dowty Equipment Ltd. of Canada designed the main undercarriage.

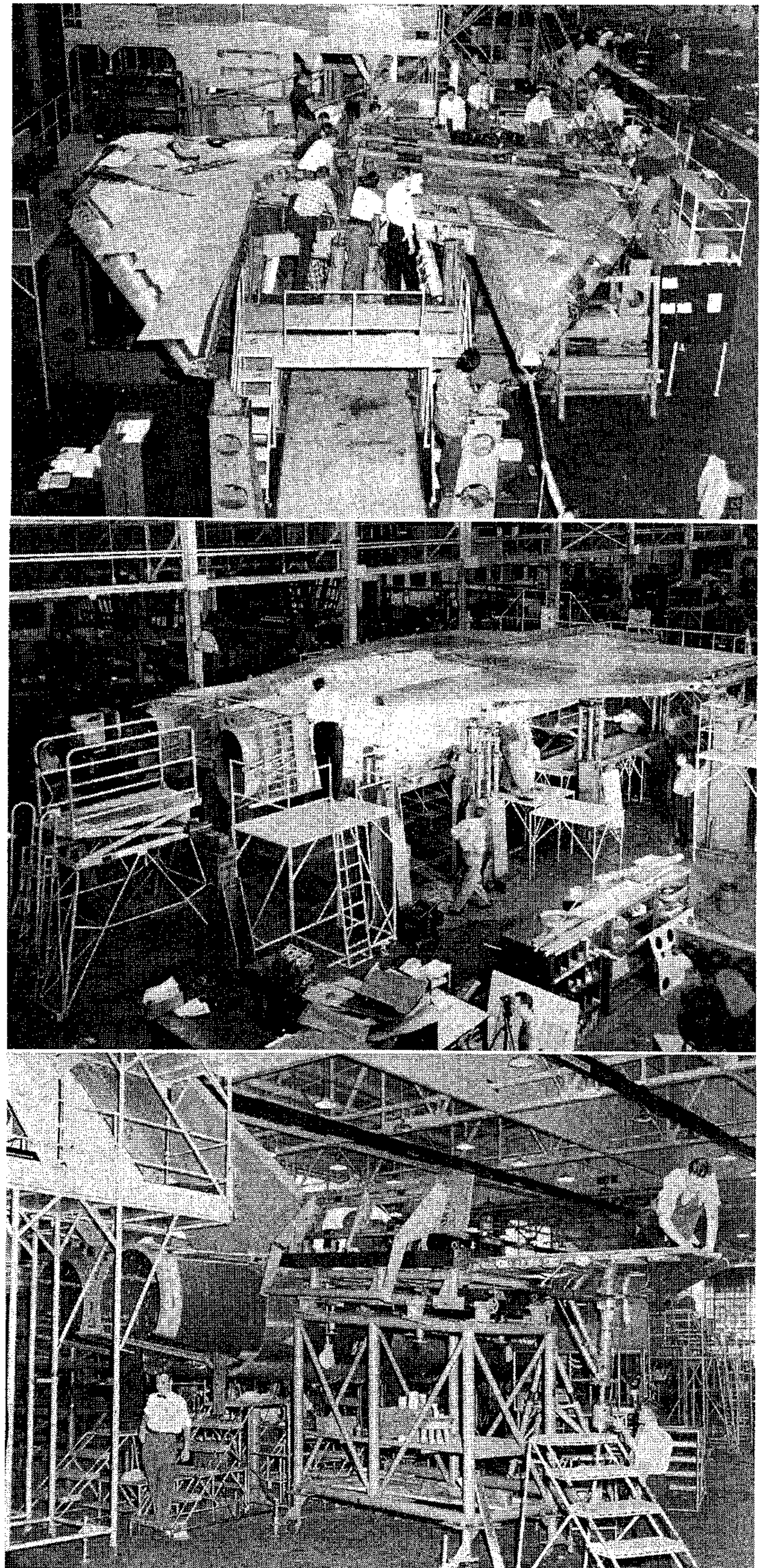
Weapons System

Conceived from the outset as the central component of an integrated "Weapons System," the Arrow established a requirement for a complex system of instrumentation and controls. It incorporates in itself an integrated airborne system for electronic weapons, navigation and communications.

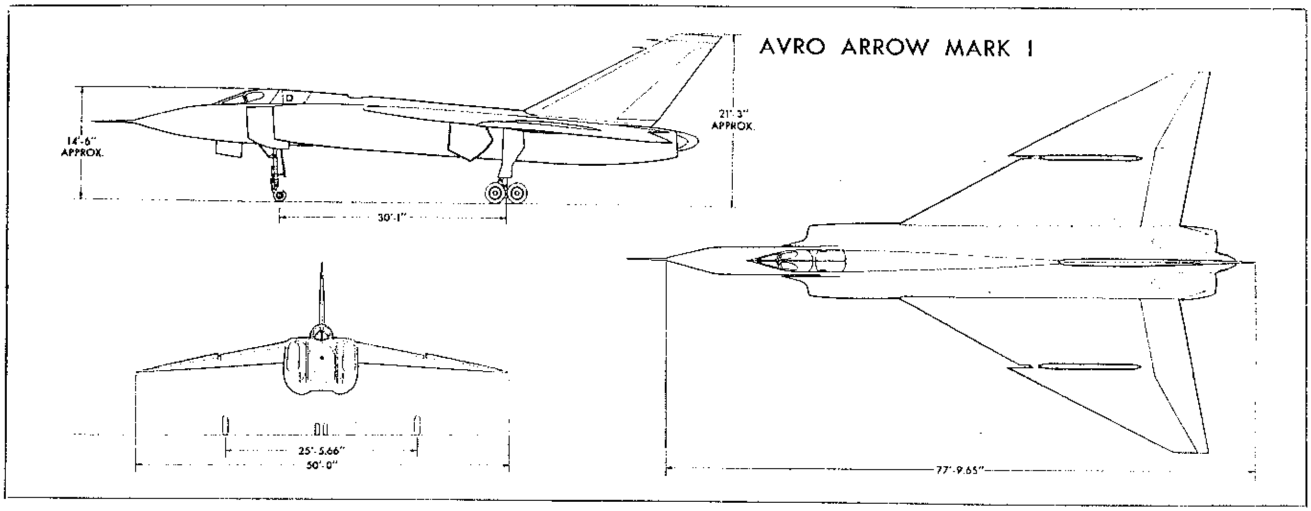
Designated the "Astra 1," this system has been the prime responsibility of Radio Corporation of America in association with the Aeronautical Division of Minneapolis-Honeywell. Canadian firms which have received sub-contract for engineering services on the system are RCA Victor Co. of Canada, Honeywell Controls Ltd. and Computing Devices of Canada Ltd.

Included in "Astra 1" are flight instruments, electronic flight controls, air data computer, vertical reference instrument platform and fire control coupler.

The chain of development which



CF-105 ASSEMBLY. Stage by stage construction and assembly of Avro Aircraft's CF-105 Arrow is shown right. Top, half an inner wing being lowered into the inner wing final assembly jig. Centre, the first centre fuselage and inner wing in assembled position. Bottom, final work on an almost completed air frame. An interchangeability drill rig attached to the delta wing trailing edge drills elevator control box attachment holes.



brought Defense Minister George R. Pearkes, VC, to Avro's Malton plant this month began just over six years ago. It has culminated in the rollout of what many believe to be the most advanced aircraft of its type in the world today.

Avro chose to develop the delta platform as the best compromise between a thin wing section required for supersonic flight and sufficient physical depth at wing root to house the undercarriage and the large amount of fuel required for the mission.

By July of 1953 the government authorized Avro to proceed with design study on a proposal for a twin-engined delta, carrying a crew of two and incorporating a weapons system capable of armament with missiles and rockets. The successful proposal, designated the C105, had been revamped from an earlier proposal to take into account changes in the RCAF requirement calling for a considerable increase in operating altitude.

Tunnel Tests

First tests of the wind tunnel development were initiated in September, 1953.

In addition to the wind tunnel tests, extensive research was carried out with large scale free flight models. Propelled to supersonic speeds by rockets, these models simulated performance of the full scale aircraft at altitude.

Initial proposals, design studies and tests which finally led to establishing the basic CF-105 configuration were almost the entire responsibility of the Preliminary Design Office under the direction of Jim Chamberlain, who is now Avro's Chief of Technical Design. Prime support during the early stages of the project came from Vice-President Engineering J. C. Floyd, who as the then Chief Engineer, convinced management of the merit of the undertaking.

From the time the basic configuration was established to the end of 1956 up to 460 engineers, technicians and draughtsmen worked on design and development of the CF-105 structure and systems under the general direction of Bob Lindley, Chief Engineer, with co-ordination by Guest Hake, Project Designer.

Two problems relative to supersonic flight which have been given careful attention by Avro's stress department are heat and sound.

Friction between the air and the aircraft skin during supersonic flight can produce temperatures which could weaken airframe structure. The research undertaken in this regard led to developments in metal-to-metal bonding. In addition to eliminating time-consuming and difficult methods of riveting and fastening, the metal bonding processes worked out by Avro, particularly as a result of experimental work with titanium and magnesium alloys, produced very satisfactory results, not only increasing strength but also reducing weight.

Extreme temperatures resulting from air friction established a further requirement for an extensive air conditioning system to protect crewmen and vital electronic equipment.

The process of milling wing skins and large machined parts from solid billets of metal has achieved a tremendous increase in strength for the Arrow airframe. At the same time, it reduced design and manufacturing times and eliminated tolerance difficulties in the matching of numerous parts.

The Avro Arrow program is somewhat unique in that the first model which moved over to the flight test hangar this month has been built on production tooling. Normally, aircraft are not committed to production until after flight testing of one or more prototypes.

Avro's Procurement Department has negotiated with over 650 outside suppliers on requirements for the CF-105 program. A policy of developing Canadian sources of supply where possible resulted in a number of sub-contractors undertaking expansion of their facilities and purchase of new equipment.

As the project developed, more than 5,000 people outside of Avro were employed in the manufacture of Arrow parts and tools.

The CF-105 program also brought about a transformation within Avro. More than 176,000 square feet of additional floor space was provided for Arrow work. This included space for a new 15,000 pound rubber forming press, a heat treat furnace and engineering test facilities.

Existing floor space had to be re-arranged to accommodate a new skin mill and heavy machining facilities.

To speed up the solution of dynamic and stress problems analog computing equipment was installed. To accommodate the accelerated research and development program entailed by production of a supersonic aircraft, Avro procured an IBM 704 electronic data processing machine, the latest and most powerful digital computer for scientific applications available to industry.

In its present "Weapons System" concept, the Arrow is a defensive fighter — a modern day bomber-killer capable of delivering its deadly missiles at supersonic speeds over long ranges.

Throughout design and development, however, there has been an effort to maintain an envelope which is flexible to tactical requirements. Its armament bay is as large as the bomb bay of the World War II B-29s.

Avro engineers describe the present Arrow as "on the threshold of the heat barrier." They have set themselves the task of pushing beyond their present limits.