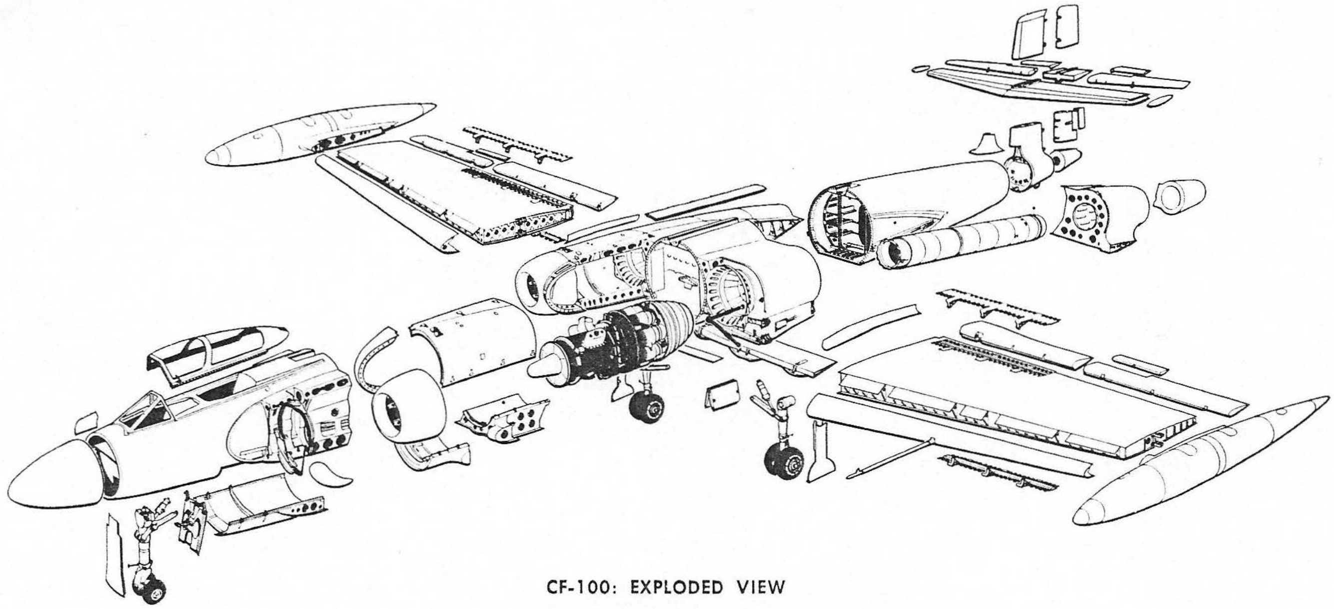

CF-100: EXPLODED VIEW

The CF-100 and How It Grew

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*"In the present-day thinker's attitude towards what is called mechanical progress, we are conscious of a changed spirit. Admiration is tempered by criticism; complacency has given way to doubt; doubt is passing into alarm. There is a sense of perplexity and frustration . . . "**

IF THIS lament had been poured forth by LAC Jetwhine or Group Captain Propclatter in 1952, and directed towards the Avro CF-100 fighter, no one would be surprised. For the years of waiting for the oft-headlined "super-fighter" have taken their toll of patient spirits. Even the man on the street is puzzled: "What's holding up production of these CF-100's? Is it going to be obsolete before it's delivered in quantity? In view of the delay is the project worth while?" And, indeed, when one considers that the CF-100 started on the drawing boards in late 1946, first flew in January, 1950, and is only just now coming into service in the RCAF, one's first impression of the picture is apt to be a bit gloomy.

In point of fact, however, that first impression is very wrong. Let us open AFHQ File S60-3-63, "Avro CF-100", and make a searching analysis of its contents. We shall then realize, I think, that our depression arose, not from the picture, but from the light in which we were viewing it.

First, it must be appreciated that the all-weather fighter of today is a far cry from the 10,000 lb. Mustang and Spitfire of the Second World War. These small day-fighters could be rolled out of the factory for a mere $50,000 each. The CF-100, on the other hand, is a big airplane. Fully loaded, it weighs about half as much as a North Star—34,000 lb. with all internal fuel tanks filled, and almost 40,000 lb. with tip tanks, and it will cost in production about as much as the RCAF originally paid for North Stars.

Hand in Hand: The increased cost is tied in with increased complexity. The modern all-weather fighter is a maze of radar scopes and scanner, intricate radio and navigation aids, precise instruments and armament sight, air conditioning and cockpit pressurization equipment, ejection seats and other safety features. These, along with the aircraft structure, cost 450,000 man-hours of design for the CF-100, compared with 42,000 man-hours for the Mustang. A major part of this CF-100 time was charged to scheming out the 10,000 original drawings required for the shop. At the present pre-production stage, when design changes and service modifications are pouring in, drawing alterations are streaming through the blueprint room at the rate of 300 a week. This is normal for any aircraft of comparable complexity at an equivalent stage of production.

Such design complexity has led British and U.S. authorities to agree that it takes about three years from the start of the design to the first flight of the prototype (Fig. 1), and one-and-a-half to two years from the negotiation of the production contract to initial production of airplanes (Fig. 2). These times cannot be appreciably shortened, for, as production expert William S. Knudsen once said, "You cannot hatch eggs in less than 21 days, no matter how many hens you put on them."

In June, 1950, when the Korean War flared into the headlines, only one aircraft of the twelve CF-100's on order was on preliminary flight trials. In early September, 1950, the UN forces were clinging to the Pusan perimeter. The war in Korea was obviously no flash fire, and defence sights had to be raised: 124 CF-100's were ordered at the rate of five a month. By February, 1951, only one-and-a-half years ago, the Chinese Communists had surged across the Yalu. A world war hung in the balance. Again the

*Sir Alfred Ewing, President of the British Association for the Advancement of Science. 1932.

sights had to be raised, and both the number of CF-100's and the production rate were increased by several hundred per cent above the September order.

The High Side: These significant facts are plotted against the actual time in Fig. 3. Using the first production contract as a base line, and comparing Fig. 3 with Fig. 2, it is apparent that CF-100 production is hitting the high side of the two-year period allowed from contract to initial aircraft off the line. Probably the prime reason for this can be summed up in the modern term "production facility". Avro had to create their aircraft and engine production facility.

Arthur Raymond, vice president of Douglas, has remarked that "it is often easier to build a prototype than it is to put it into production." The truth of these words is reflected in the fact that the production CF-100 requires 15,000 templates, 7,000 forming tools and dies, 3,000 machine tools, and 125 major assembly jigs (which will probably increase to several hundred by the time the production peak is reached). This equipment requires space. Yet at the beginning of this two-year period the Orenda engine production shop was occupying a large portion of the aircraft plant, and work on Lancasters, Sea Furies, Mitchells, and the C-102 Jetliner, was filling up a substantial part of the remainder.

more space

TO GET the direly-needed CF-100 production space, the first move was to find a home for the Orenda engine shop. This necessitated a new factory. In October, 1950, the first sod was broken for a 708,000 sq. ft. engine plant to be erected opposite the main plant. During the two years it took to get the engine factory built and fully stocked with the hundreds of machine tools required for peak production, the work on other aircraft was progressively stopped. Thus, it was the summer of '52 before the full floor space of the aircraft plant was cleared for the production tools, jigs

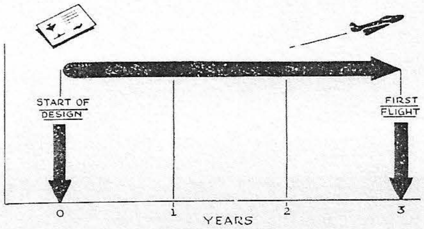


FIGURE 1 PROTOTYPE SCHEDULE

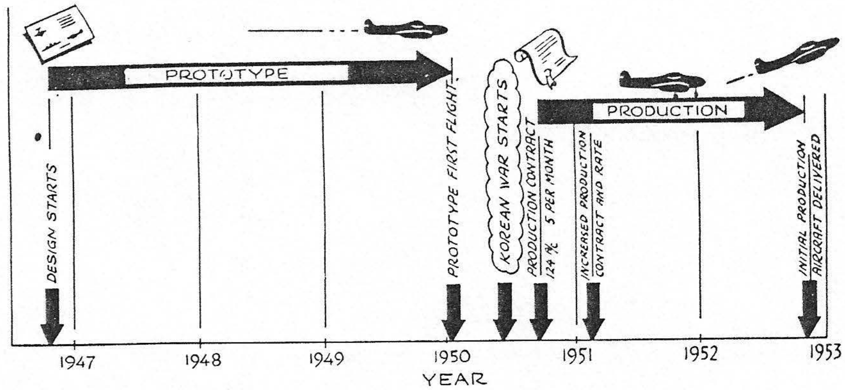


FIGURE 3 : CF-100 SCHEDULE

and fixtures necessary to translate the 10,000 CF-100 drawings into actual parts.

But even such facilities as the above are not enough to produce a modern jet fighter and engine. Sub-contractors had to be found. In many cases eager parts manufacturers could not be usefully employed until they had been through a time-consuming training program in the materials, new techniques, and fine tolerances necessary for aircraft work. In a few cases new factories had to be built even for the sub-contractors. At the present time there are 400 such contractors and suppliers in the aircraft and engine programs, and more may be added as production rolls ahead.

Between the subcontractors and the main contractor, more than 40,000 Canadian workmen are employed. To get the 10,000 required at Avro alone, extensive training courses had to be set up. In the tight labor market of today, required skills cannot always be bought: they have to be developed—at the expense of production time.

Shakedown: While the production facilities were being set up, the aircraft itself was being shaken down in actual flight tests. In pre-war days two prototypes were usually sufficient to put the job well in hand. But the complexity of modern aircraft has changed this concept. At the present only three of the first 11 CF-100's will go to operational squadrons. The remainder will be used for accelerated Service tests.

The product of these flight tests, coupled with the results of numerous static structural tests, is a continual stream of modifications. These are vital changes that weld the aircraft and engine into a superior fighting weapon. The 300 drawing changes a week that are going through the engineering department, however, result only partly from flight tests. The remainder are redesigns to facilitate manufacture with production tooling. During this development period the expansion of the production facility is continually hampered by these changes. As a result, 30% to 40% of the production tooling has required modification. This is a costly delay, but unavoidable in turning out up-to-the-minute fighters.

A further hold-up has been precipitated by changes in production quantities. Immediately before and after the start of the Korean War the unstable world scene was reflected in unstable production policies. For example, the aircraft production rate of five a month was increased considerably only 1½ years ago. Similarly, production of the Orenda engine went through no less than five such changes, since it was tied in with possible use in the F-86 Sabre as well as in the CF-100.

Snowball: It is the easiest thing in the world to alter a Contract Demand from "Production Rate: 30 a month" to "Production Rate: 100 a month", but what happens at the contractor's plant is a much more complex story. Every time production is changed it means a complete revision of all planning and shop layouts, tooling programs, machine tool requirements, and usually a complete re-issue of all purchase orders. The river of material flowing into the plant must be dammed up or speeded up, according as the schedule is revised upwards or downwards. Obviously such changes must

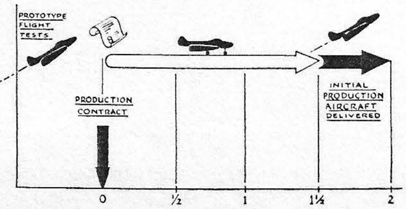


FIGURE 2 PRODUCTION SCHEDULE

be carried right back to the source of the basic materials. And, as regards time, too, it is a costly business.

The unstable world panorama, with its unstable production policies and the build-up of the production facility, probably account for at least 95% of the reasons for CF-100 production hitting the high side of the two-year period. The other 5% can be charged to the administrative machinery; for as the company swung from a development facility to a production facility, extensive changes were necessary in the organization structure.

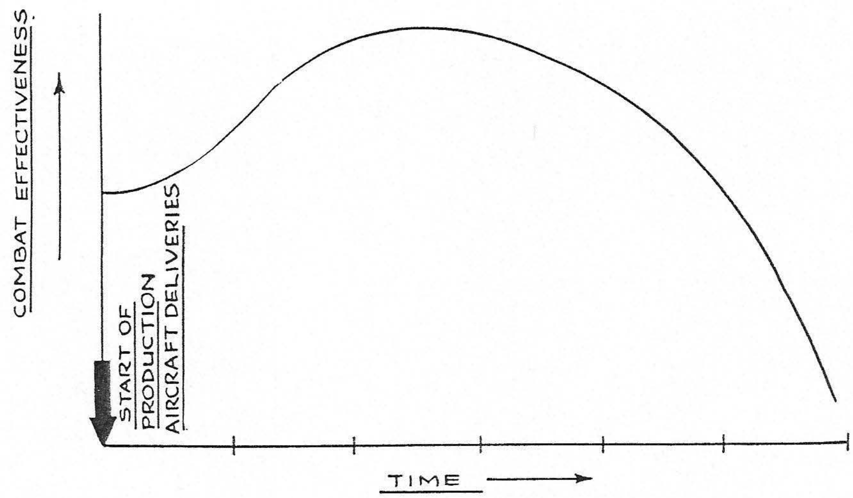


FIGURE 4· AIRCRAFT OBSOLESENCE

spectre of obsolescence

WITH THE administrative machinery overhauled and production of an aircraft beginning to roll, the spectre of obsolescence is always around the corner. Though obsolescence is often spoken of as a point, it is really a graph of combat effectiveness against time (Fig. 4). From the day of the fighter's first flight, or even before, modifications are planned and eased into the production line to step up the fighter's punch. At some point in time, however, the enemy produces a few aircraft that are superior to the fighter. Although further modifications are installed, they fail to stem the enemy's superiority. The fighter's effectiveness-time curve flattens out.

More and more of the superior enemy aircraft are produced. Thus, as time passes, the already flattened combat effectiveness curve of the fighter starts to decline. In the end, the fighter can find few targets that it can attack successfully. A new fighter is required. The old fighter has passed into the shadow of obsolescence, at least for its original design role.

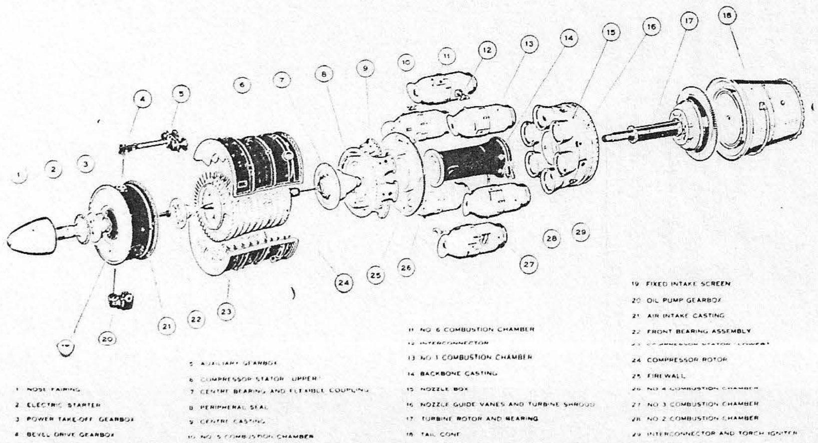
It is very difficult to assess obsolescence, since, as J. H. Kindleberger, chairman of the board of North American, has said, ". . . it is awfully hard to put a time caliper on thinking and invention." This is particularly true when one is attempting to assess the enemy's capabilities. At present it takes from eight to nine years to develop a bomber from the first line drawn to production in quantity. This further complicates the picture. However, when the CF-100 is compared with possible future bombers that would be available in quantity, it still has a number of years to go before it starts the downward slide on the obsolescence graph of Fig. 4. Similarly, when the CF-100 is assessed against all other all-weather fighters in the same stage of production, it is far from being obsolete.

Moreover, decisions are even now being made and major modifications are being planned to increase the CF-100's combat effectiveness. Many of these changes will not bear fruit, in terms of an actual aircraft, for some time yet; but all are aimed at keeping the combat effectiveness graph on the upward swing just as long as possible.

Other Assets: With future plans for the CF-100 going into the blueprint stage, the other assets that the people of Canada have acquired may well be enumerated. For the first time in history Canada has built up a new organization that is capable of designing and developing modern aircraft and engines. Furthermore, she has a production facility that can turn out not only the CF-100 and Orenda engines, but other larger and more complex types. The CF-100 and Orenda programs alone have set up new sources of supply and new techniques, all of which have added to the vital industrialization of the country.

One question possibly remains still unanswered in the minds of our readers, and that is: "Would we have been further ahead by taking some existing aircraft and putting it into production, as was done with the Sabre?" The answer to this is a very definite "no", and events of the subsequent years have proved the validity of the decision made to develop the CF-100 — which was designed to meet the peculiar needs of Canada's defence. Although there are now several aircraft which excel the CF-100 in one or two fields, there is no aircraft which meets Canadian requirements in all fields.

Further, it should be noted that even those aircraft that compare most favorably with the CF-100 are still in the prototype stage and a long way from production.



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